GOA Dusky and Northern Rockfish Updates

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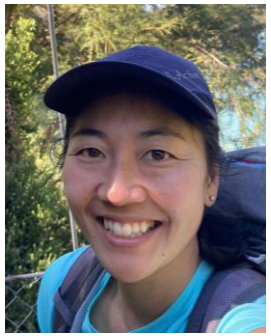
September Plan Team 2024



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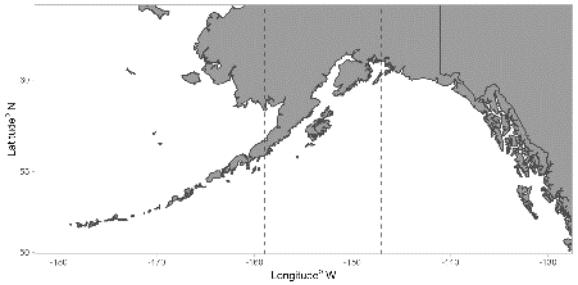
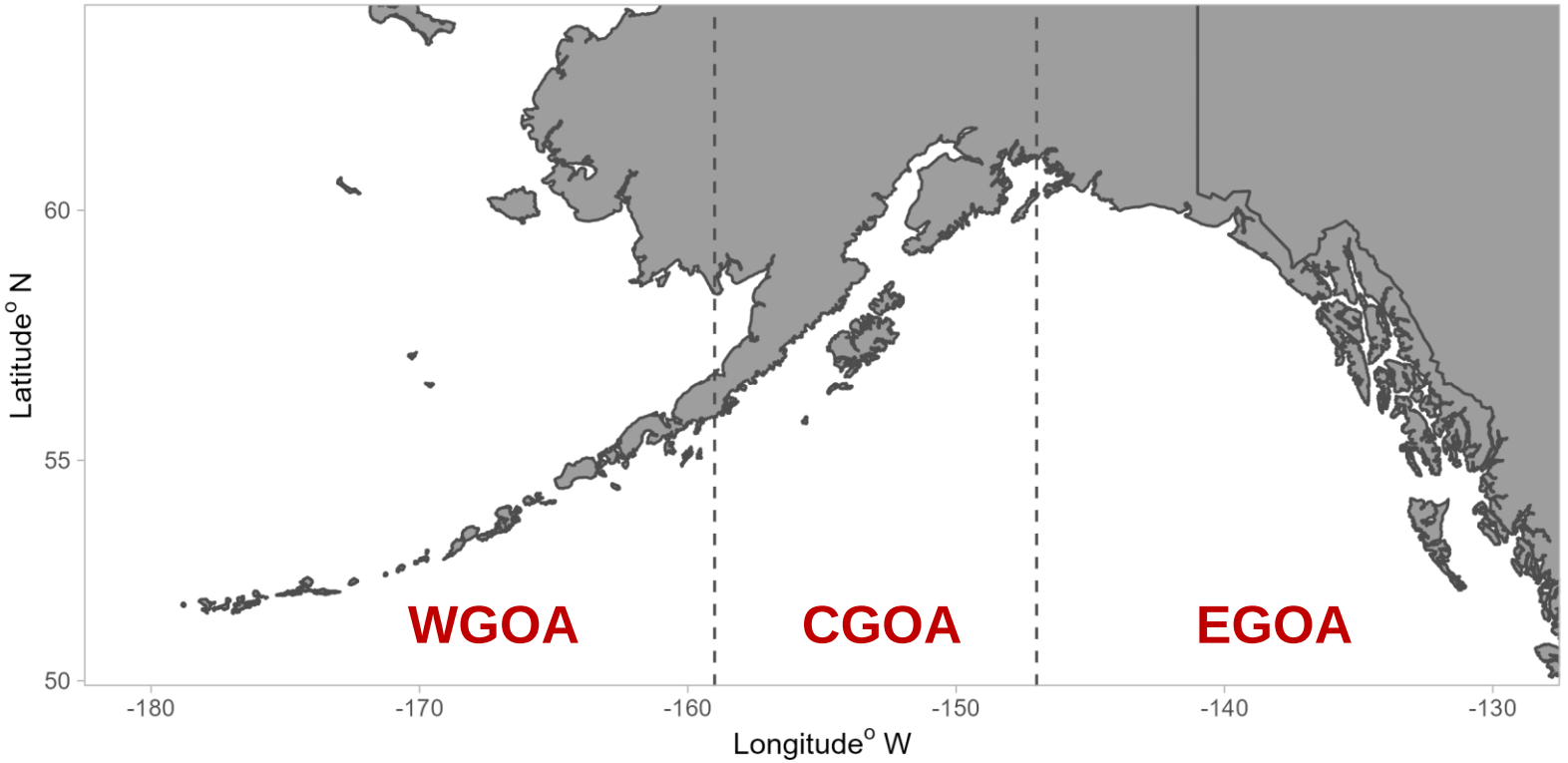
Outline

1. Apportionment methodology for GOA dusky and northern rockfish
2. GOA dusky assessment model updates
3. GOA northern assessment model updates



Apportionment

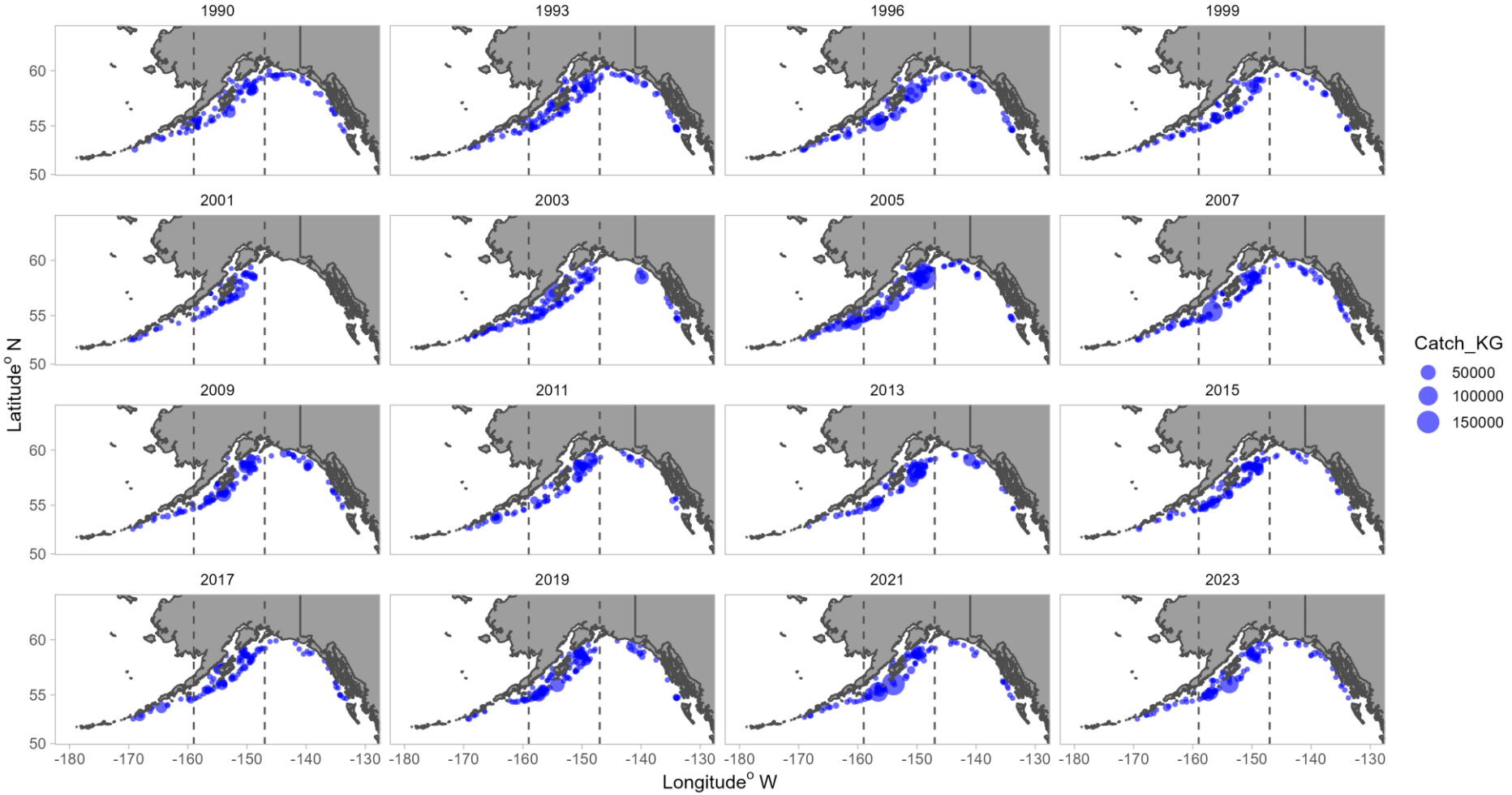
- Apportionment has been based on area estimates from the **design-based** survey abundance
  - Uses the estimated survey abundance from the design-based model run through REMA to get the proportion of abundance in each of the three GOA management areas



Apportionment

- Apportionment has been based on area estimates from the **design-based** survey abundance
  - Uses the estimated survey abundance from the design-based model run through REMA to get the proportion of abundance in each of the three GOA management areas
- Assessment uses a **model-based** index of abundance (i.e., VAST index)
  - VAST model with lognormal error structure and years estimated independently
- For consistency, we propose to change apportionment to be based on the **model-based** index of abundance

Apportionment- Dusky rockfish survey catches



- Patchily distributed, mostly frequently caught in the CGOA

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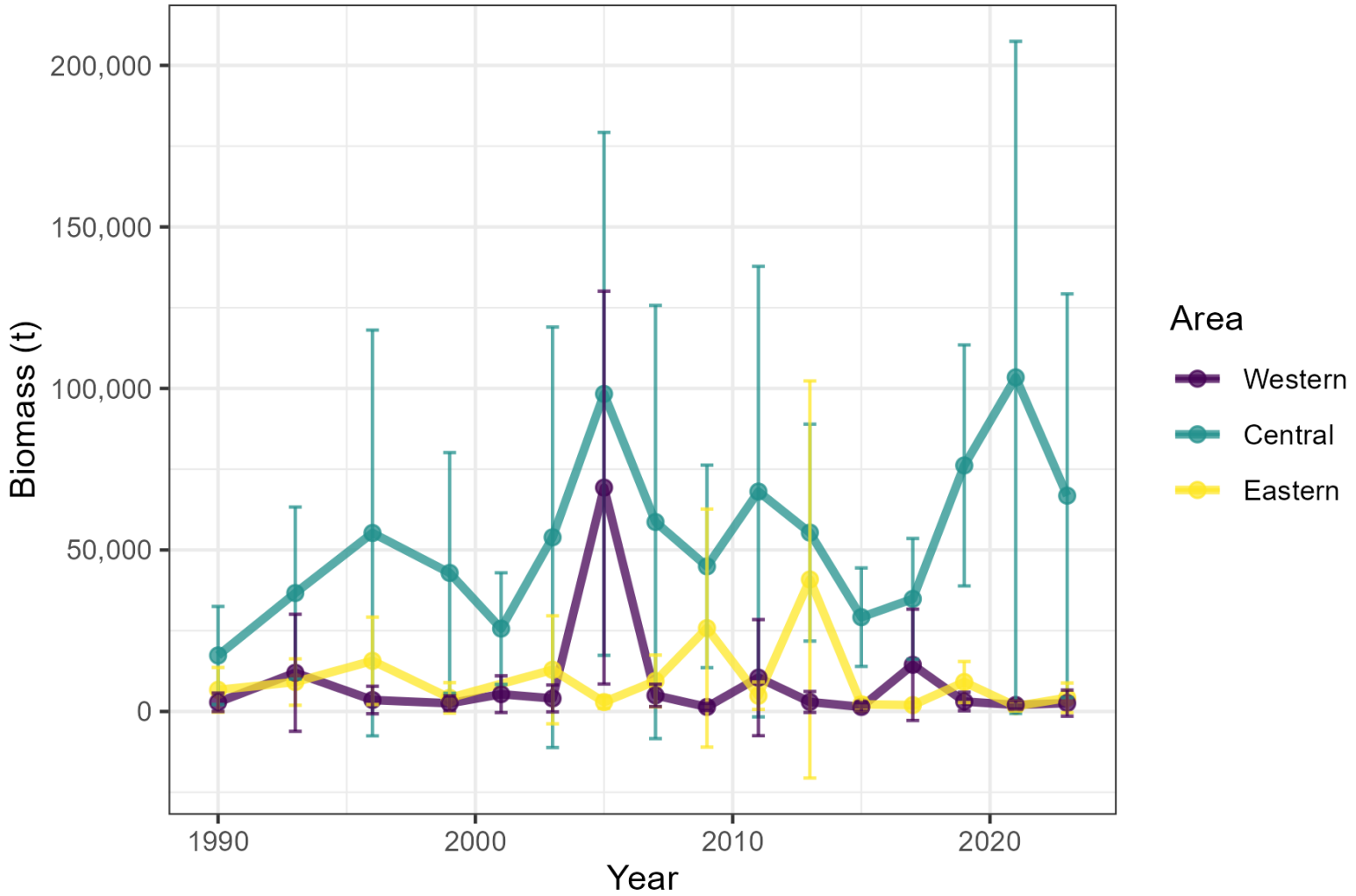
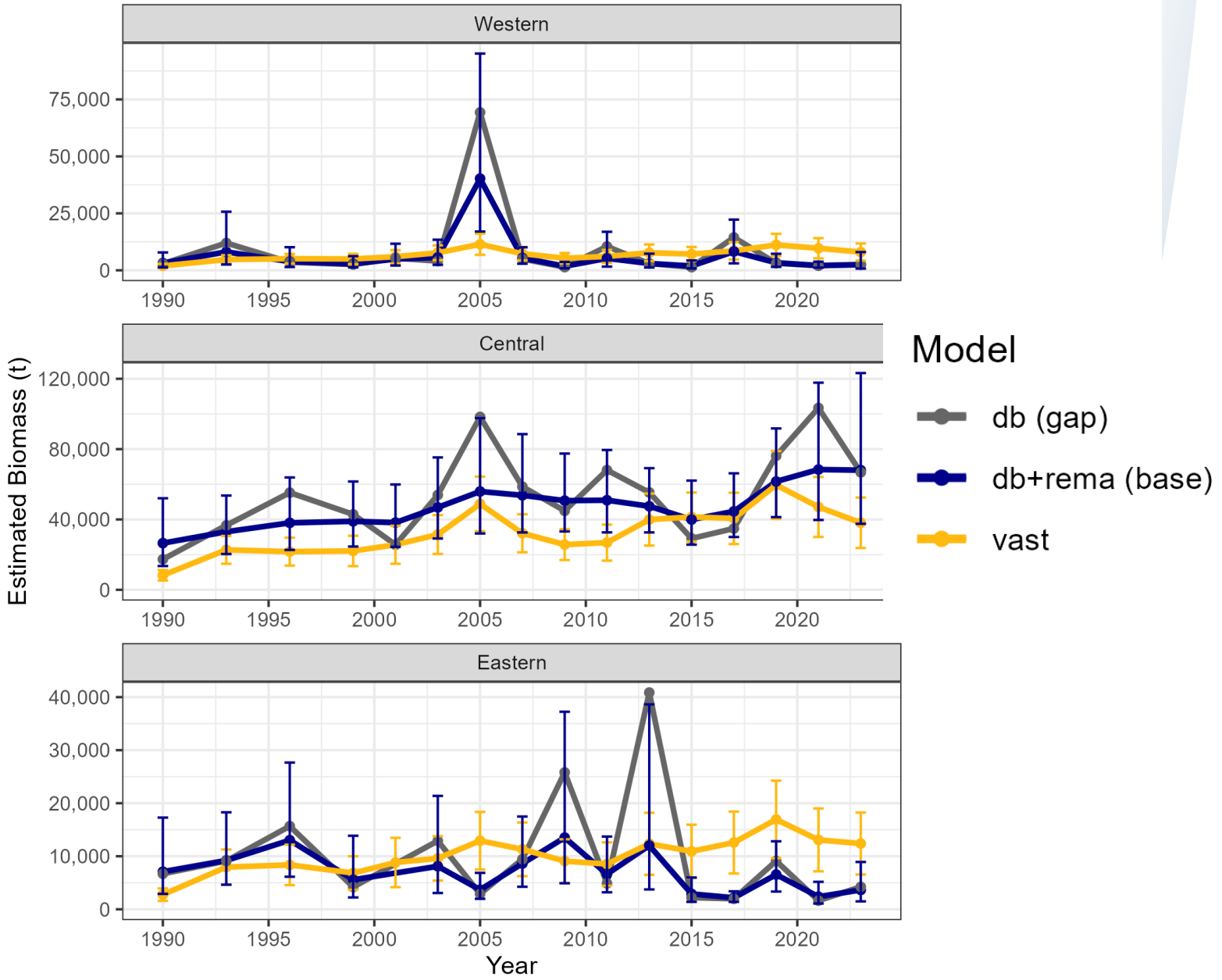
Apportionment- Dusky rockfish survey design-based catch indices

- Variable survey design-based estimates based on the GAP bottom trawl survey in the GOA

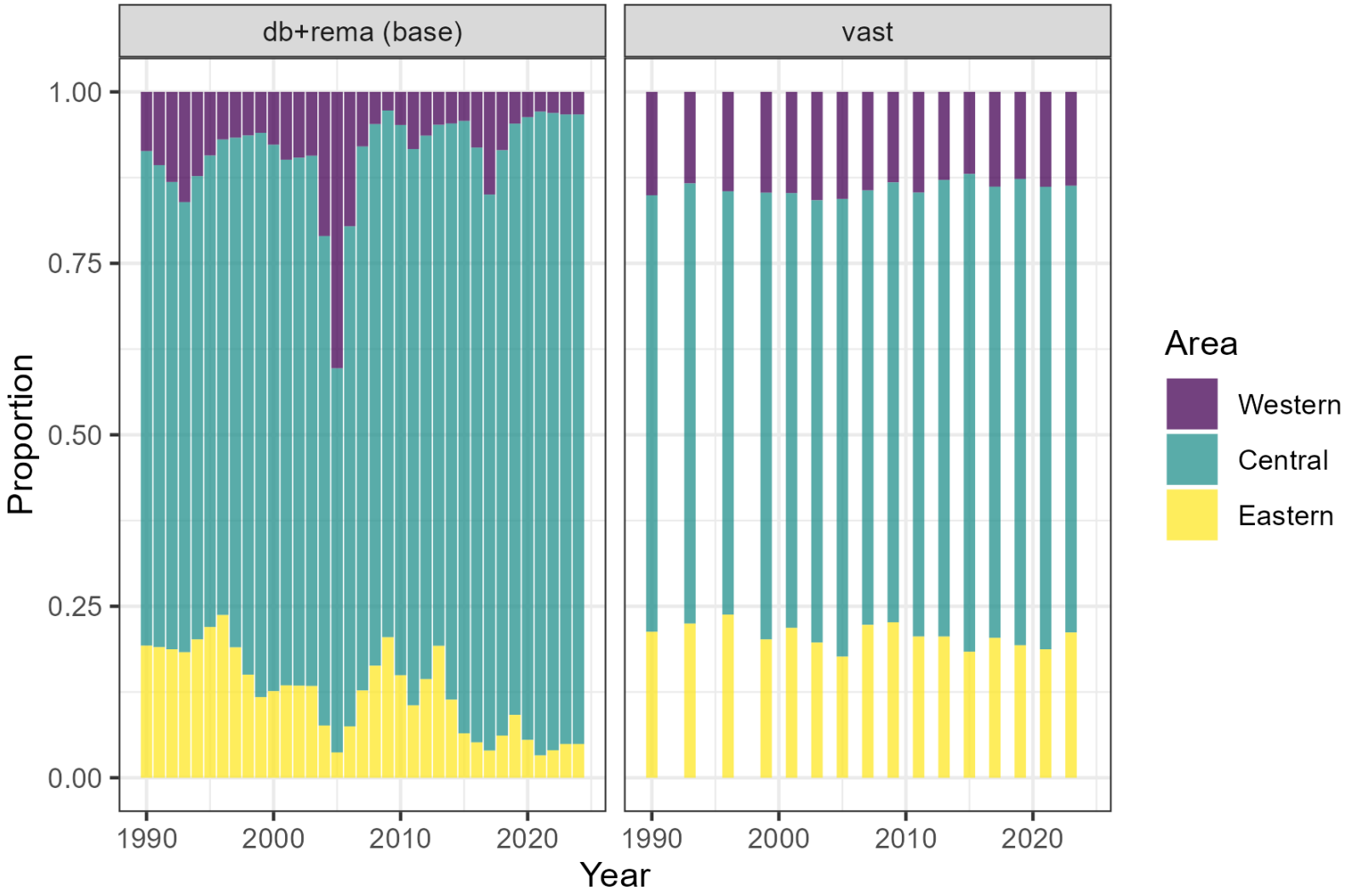


Apportionment- Dusky rockfish indices

- Accepted method: design-based model smoothed by *REMA*
- Alternative: model-based model (VAST)



Apportionment- Dusky rockfish proportions



Design-based model + *REMA*

- More variable
- Higher proportions in CGOA
- Lower proportions in WGOA & EGOA

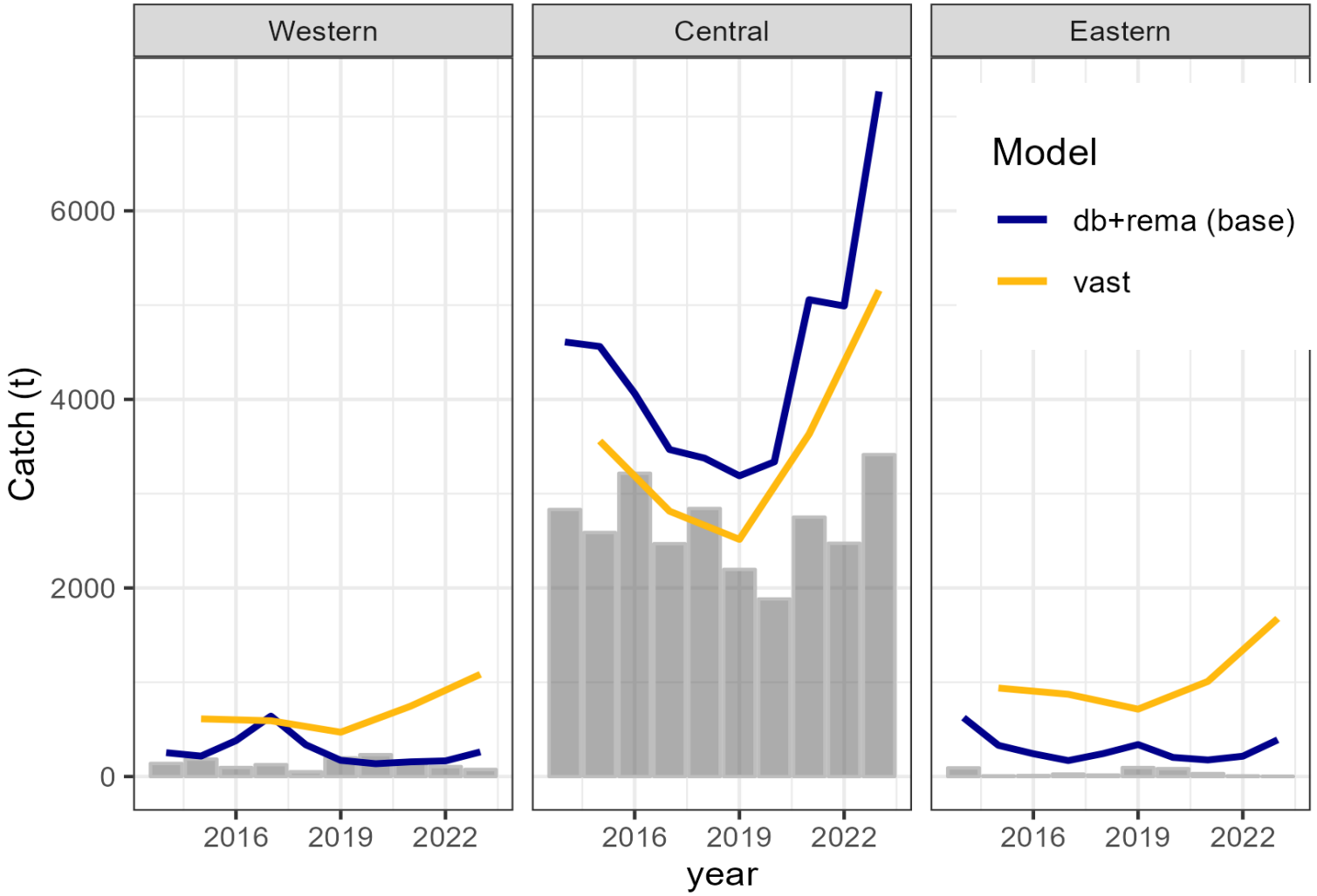
Alternative VAST model

- Less variable
- Lower proportions in CGOA
- Lower proportions in WGOA & EGOA

Apportionment- Dusky rockfish percentage

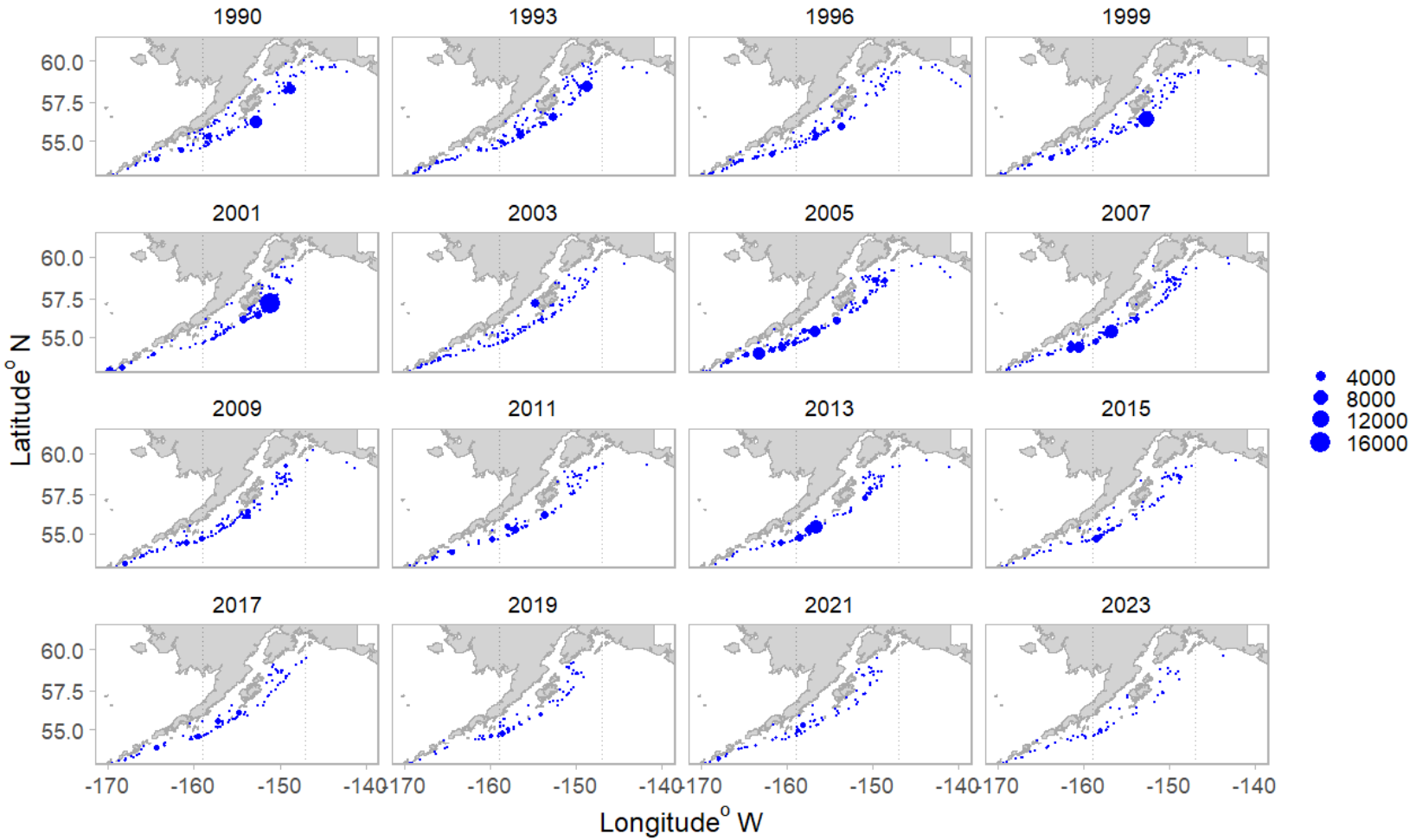
Year	Area	db+rema (base)	vast
2021	Western	2.9	13.8
2021	Central	93.9	67.4
2021	Eastern	3.3	18.7
2022	Western	3.1	-
2022	Central	92.9	-
2022	Eastern	4.0	-
2023	Western	3.3	13.7
2023	Central	91.8	65.1
2023	Eastern	4.9	21.2

Apportionment- Dusky rockfish historical projection of allocated ABC



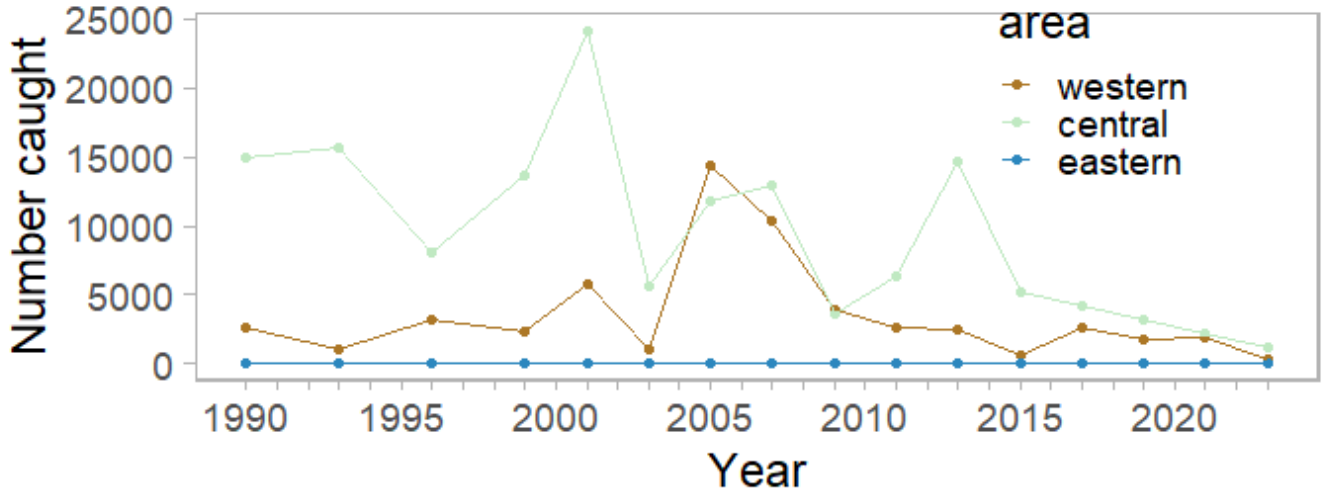
- Design-based+REMA (base) proportions generally led to higher allocated ABC in CGOA, lower in WGOA & EGOA compared to VAST method
- Based on historical projections, catch would not surpass the alternative projected allocated ABC (with one exception), but catch remains significantly under GOA-wide ABC
- Note: EGOA further subdivides the EGOA allocated ABC into West Yakutat and Southeast

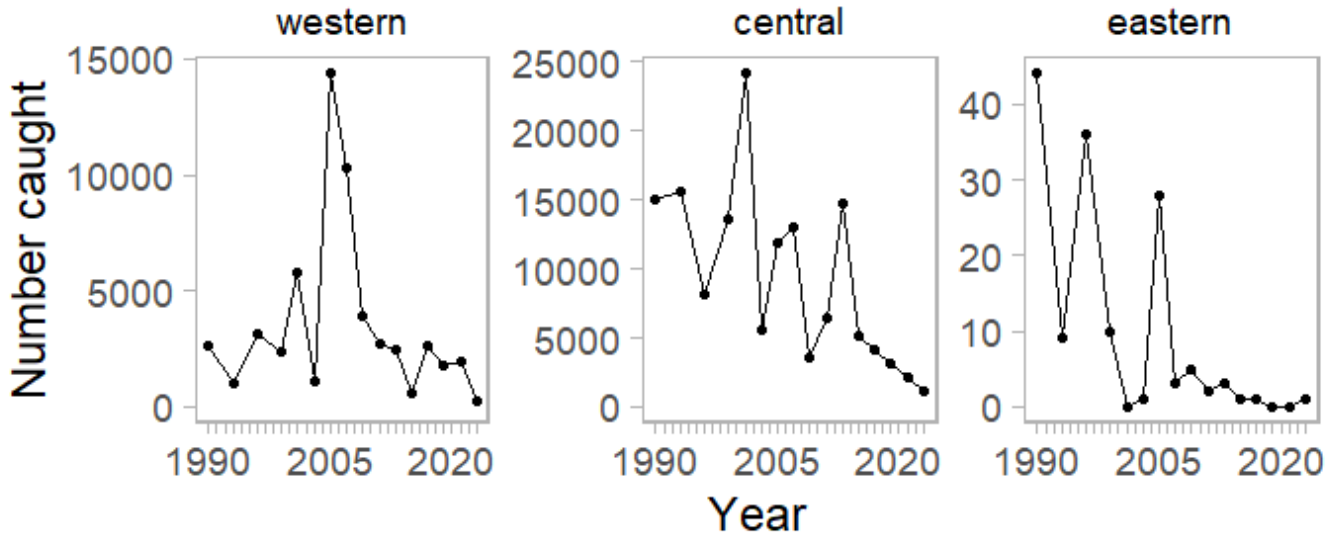
Apportionment- Northern rockfish survey catches



- Consistently low or zero catch in EGOA

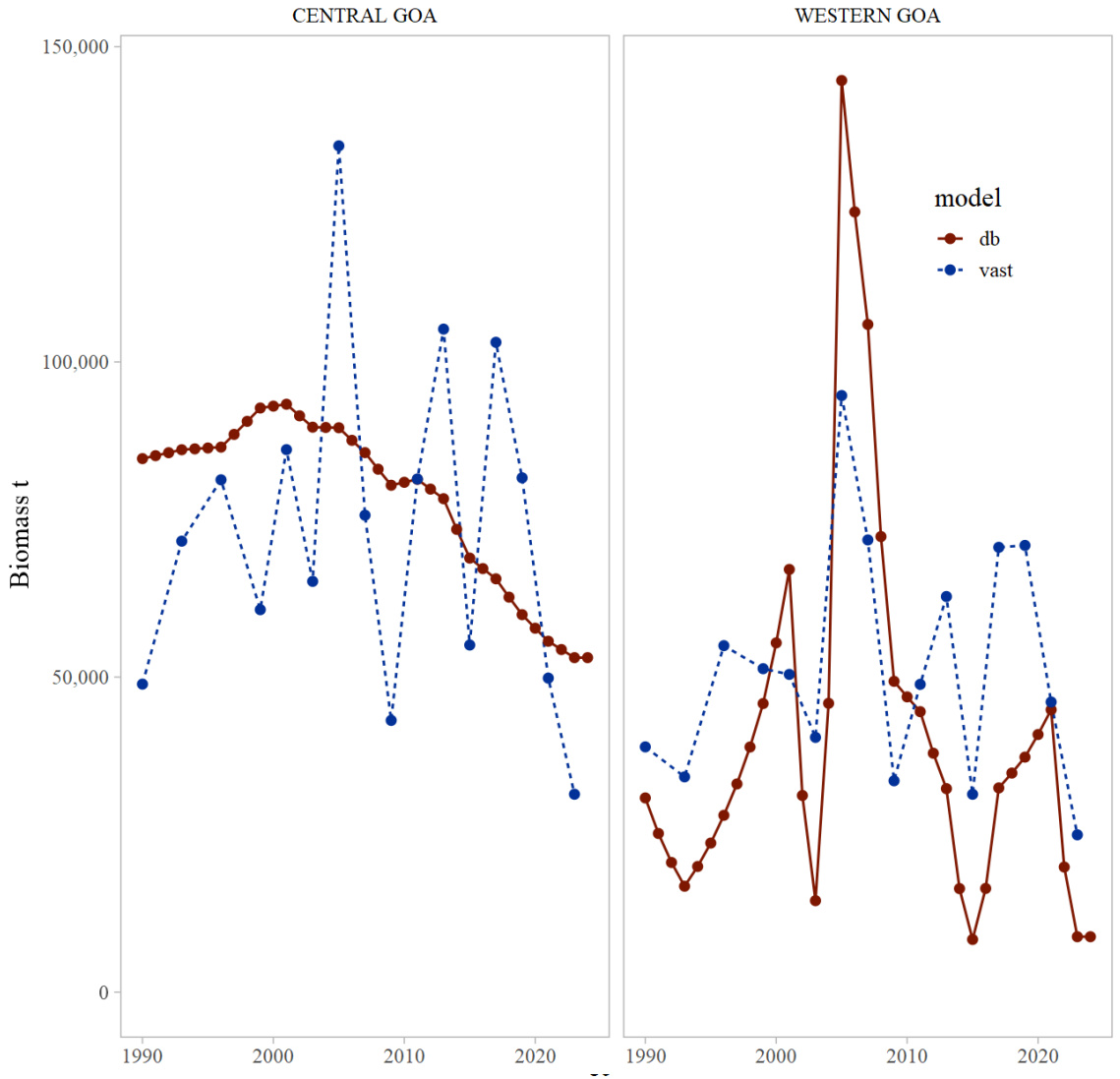
Apportionment- Northern rockfish survey catch





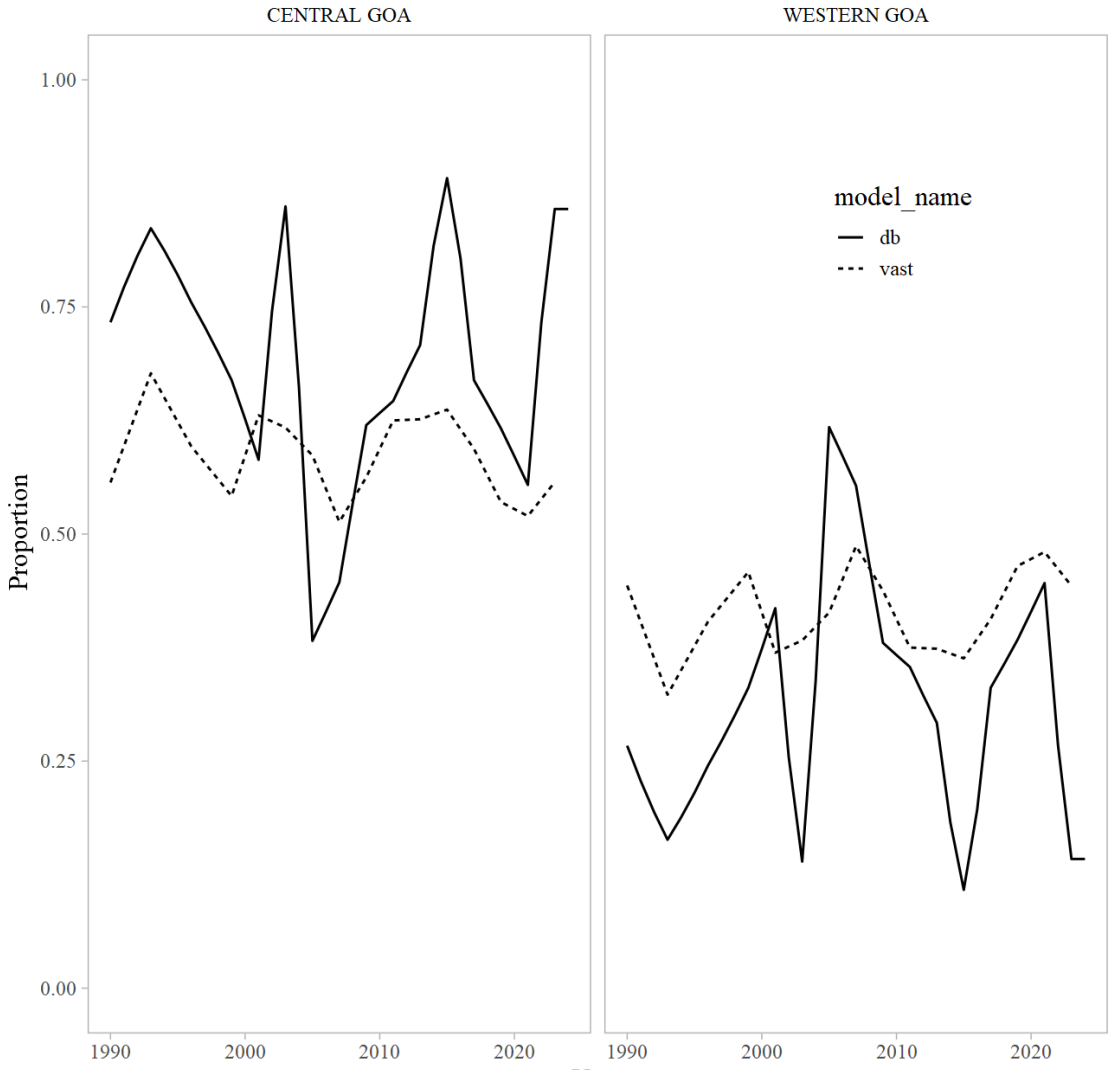
- 1 ton allocated to Other Rockfish complex for the EGOA

Apportionment- Northern rockfish indices



- EGOA dropped from apportionment model

Apportionment- Northern rockfish ratios



- Design-based estimates more variable and “bouncy” compared to VAST

Apportionment- Northern rockfish percentage

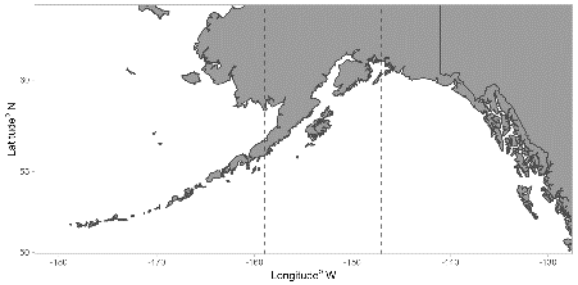
Year	Area	db+rema (base)	vast
2021	Western	44.6	46.0
2021	Central	55.4	54.0
2022	Western	26.7	-
2022	Central	73.2	-
2023	Western	14.2	48.1
2023	Central	85.7	51.9

Apportionment- Summary

- Recommend using **model-based method (i.e., VAST)** for the apportionment method to align with the model-based survey index used in the assessment model for consistency
- Area proportions from VAST are less variable (i.e., smoother), which seems more likely given the life history of these rockfish

Outline

1. Apportionment methodology for GOA dusky and northern rockfish
2. **GOA dusky assessment model changes**
3. GOA northern assessment model updates



Dusky rockfish- Model changes

Assessment model:

- Bespoke, age-structured model in ADMB
- In 2022 the VAST model with lognormal error structure was accepted as the survey biomass estimates

Model changes:

1. Trawl survey biomass updated change to use a lognormal error structure
2. Recruitment starting year correction in population projection model, B_{100}, and B_{40}.

Dusky rockfish- Model changes

Model changes:

1. Trawl survey biomass correction to use a lognormal error structure
   - Current: trawl survey biomass likelihood uses a normal error structure

$$L = \lambda \sum \left(\frac{(I_y - \hat{I_y})^2}{2SE(I_y)^2} \right)$$

   - Change: survey biomass likelihood using a lognormal error structure

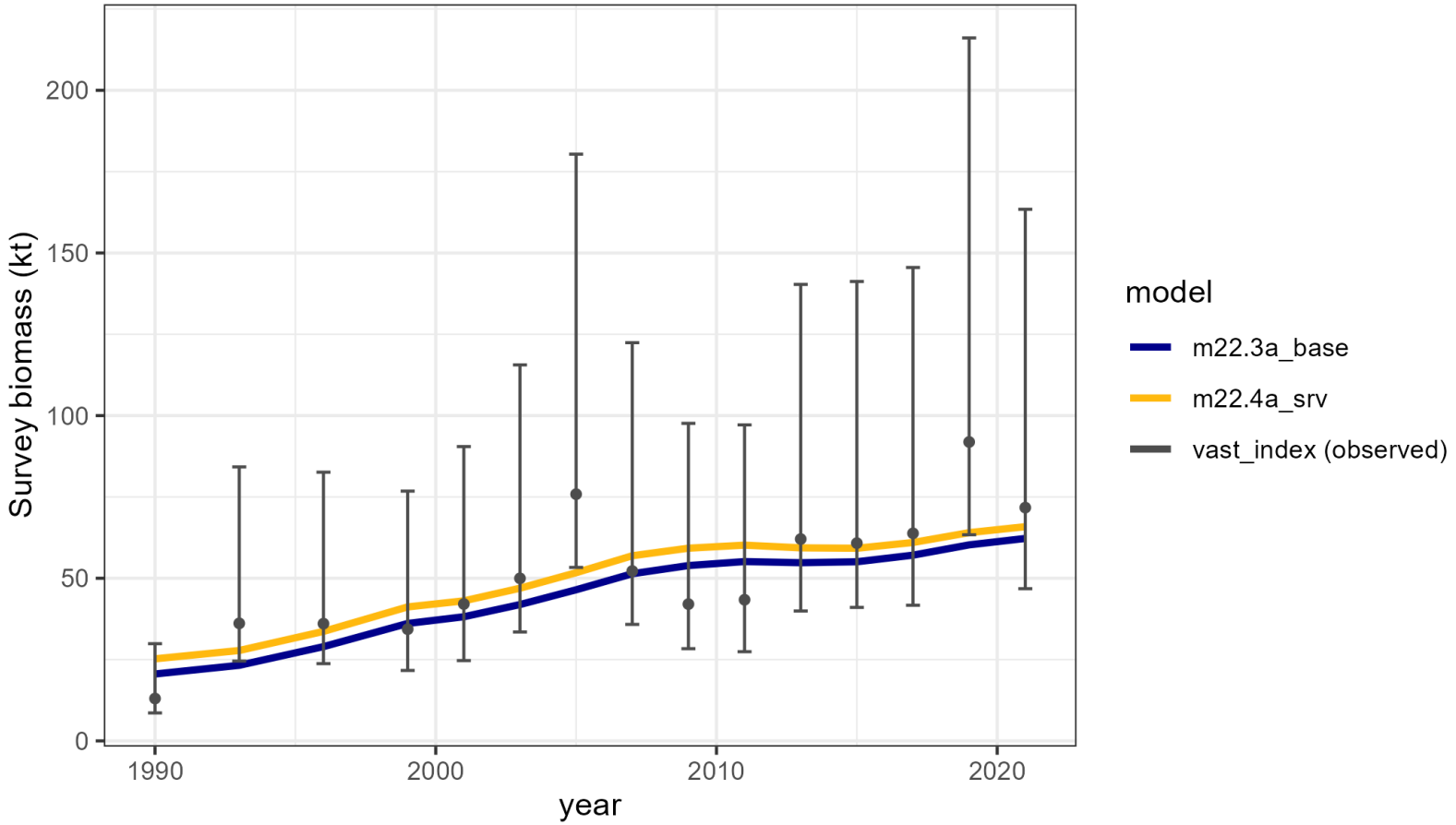
$$L = \lambda \sum \left[log(\sigma_y) + 0.5 \left(\frac{\log\left(\frac{I_y}{\hat{I_y}}\right)}{\sigma_y} \right)^2 \right], \quad \text{where} \quad \sigma_y = \sqrt{\log\left(1 + \frac{SE(I_y)^2}{I_y^2}\right)}$$

y= year
I= survey index
σ=std. error

2. Recruitment starting year correction in population projection model, B_{100}, and B_{40}
   - Current: Hard coded as 1979
   - Change: 1977 (regime shift year) + recruitment age (age-4)

Dusky rockfish- Model changes

Estimated survey biomass with lognormal error (m22.4a)

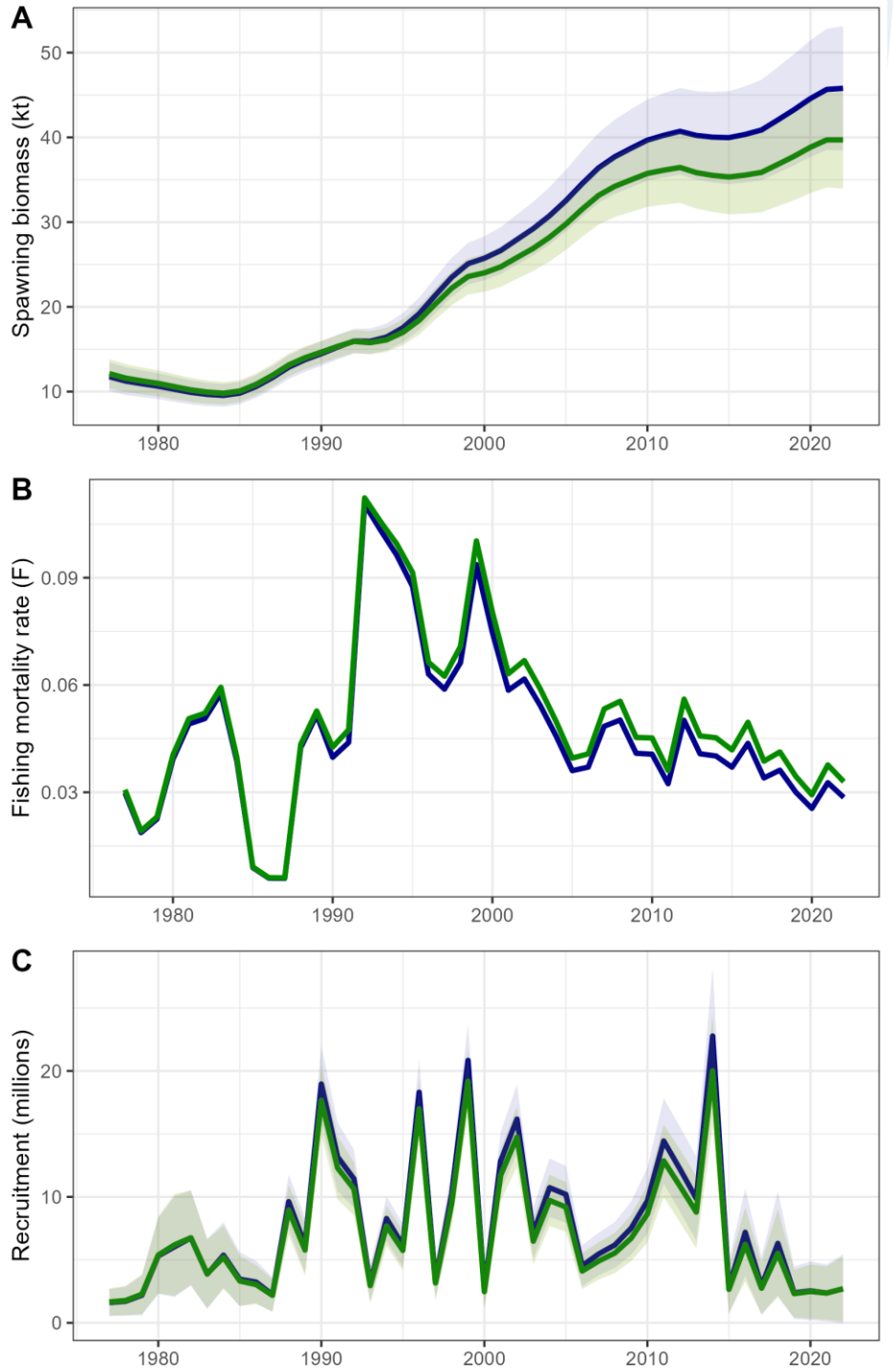


Dusky rockfish- Model changes

Comparing:

- m22.3a: current model (base)
- m22.4a: Survey biomass with lognormal error
- m22.5a: Survey biomass with lognormal error + recruitment start year correction in projection model, B_{100}, and B_{40} calculations

- By switching to lognormal error:
  - Spawning biomass ↓
  - F ↑
  - Recruitment ≈
- Adding recruitment start year correction did not change estimates, only B_{100}, B_{40} , and subsequent calculations



Dusky rockfish- Model changes- Parameter Estimates

Parameter	m22.3a accepted	m22.4a Survey error	m22.5a Surv error + proj recruit yr, *B*
sigmaR	1.003	0.943	0.943
q	0.638	0.776 ↑	0.776
avg rec	2.702	2.705	2.705
F_{40}	0.091	0.092	0.092
Total Biomass	107,186	93,488 ↓	93,531
SSB	44,468	38,464 ↓	38,465
B_{100}	65,565	60,343 ↓	61,962 ↑
B_{40}	26,226	24,137 ↓	24,785
ABC	7,921	6,863	6,863

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Dusky rockfish- Model changes- Likelihoods

Likelihood	m22.3a accepted	m22.4a Survey error	m22.5a Surv error + proj recruit yr, *B*
Catch	25.716	26.948	26.948
Trawl survey	30.034	31.427	31.427
Fishery ages	41.52	41.192	41.192
Survey ages	138.137	138.005	138.005
Fishery lengths	60.026	59.869	59.869
Recruitment devs	36.211	31.491	31.491
sigmaR	0.405	0.539	0.539
q prior	0.503	0.16	0.16
Data LL	295.433	297.442	297.442
Total LL	431.535	428.825	428.825

Dusky rockfish- Model changes

Recommended model changes:

1. Trawl survey biomass correction to use a lognormal error structure
2. Recruitment starting year correction in population projection model, B_{100}, and B_{40}.

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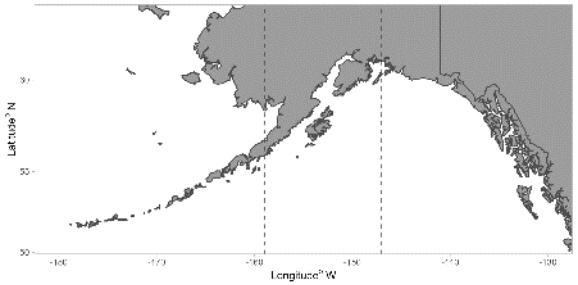


Northern rockfish – Model/Data changes

Assessment model:

- Bespoke, age-structured model in ADMB [Model 22.1 (2022)]
- Tight prior on *M* (0.06, cv 0.05); SigmaR held constant (1.5)

Changes:

1. Trawl survey biomass changed to use a lognormal error structure
2. Survey age composition input sample size (ISS)
3. Bridge model to RTMB
    a. Selectivity priors

Northern rockfish – Model/Data changes (M22.1a)

The model currently estimates the survey biomass likelihood with a normal error structure

$$\mathcal{L} = \lambda \sum_y \frac{(I_y - \hat{I}_y)^2}{2SE(I_y)^2}.$$

Change to a lognormal error structure

$$\mathcal{L} = \lambda \sum_y \left[log(\sigma_y) + 0.5 \left(\frac{log(I_y/\hat{I}_y)}{\sigma_y} \right)^2 \right]$$

where

$$\sigma_y = \sqrt{log\left(1 + \frac{SE(I_y)^2}{I_y^2}\right)}$$

Northern rockfish – Input Sample Size (M22.1b)

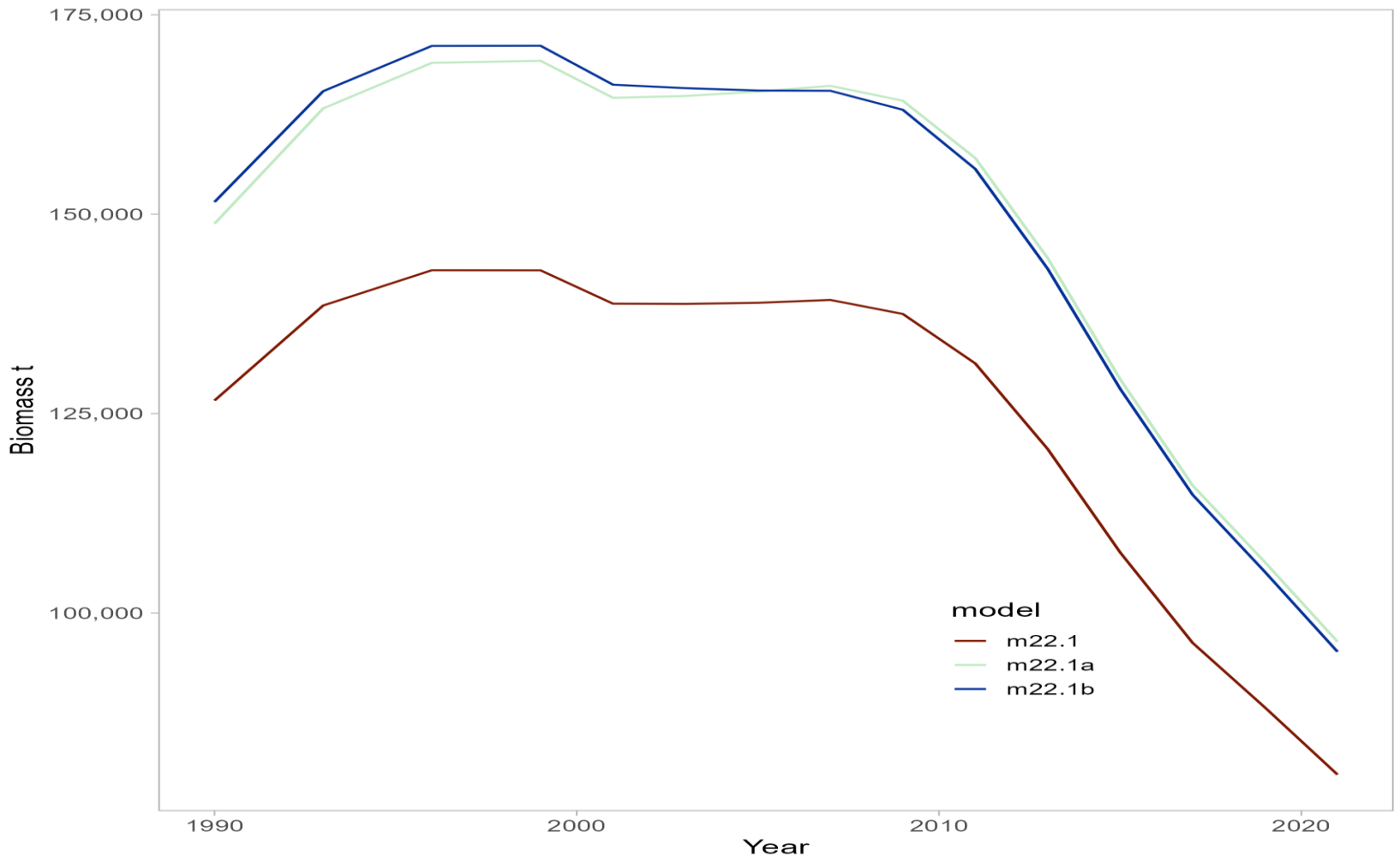
Annual survey age composition input sample sizes that incorporate growth variability and aging error are now available (Hulson and Williams 2024).

Previously used the 'hybrid approach' $\sqrt{no.hauls \times no.samples}$, scaled to a max of 100

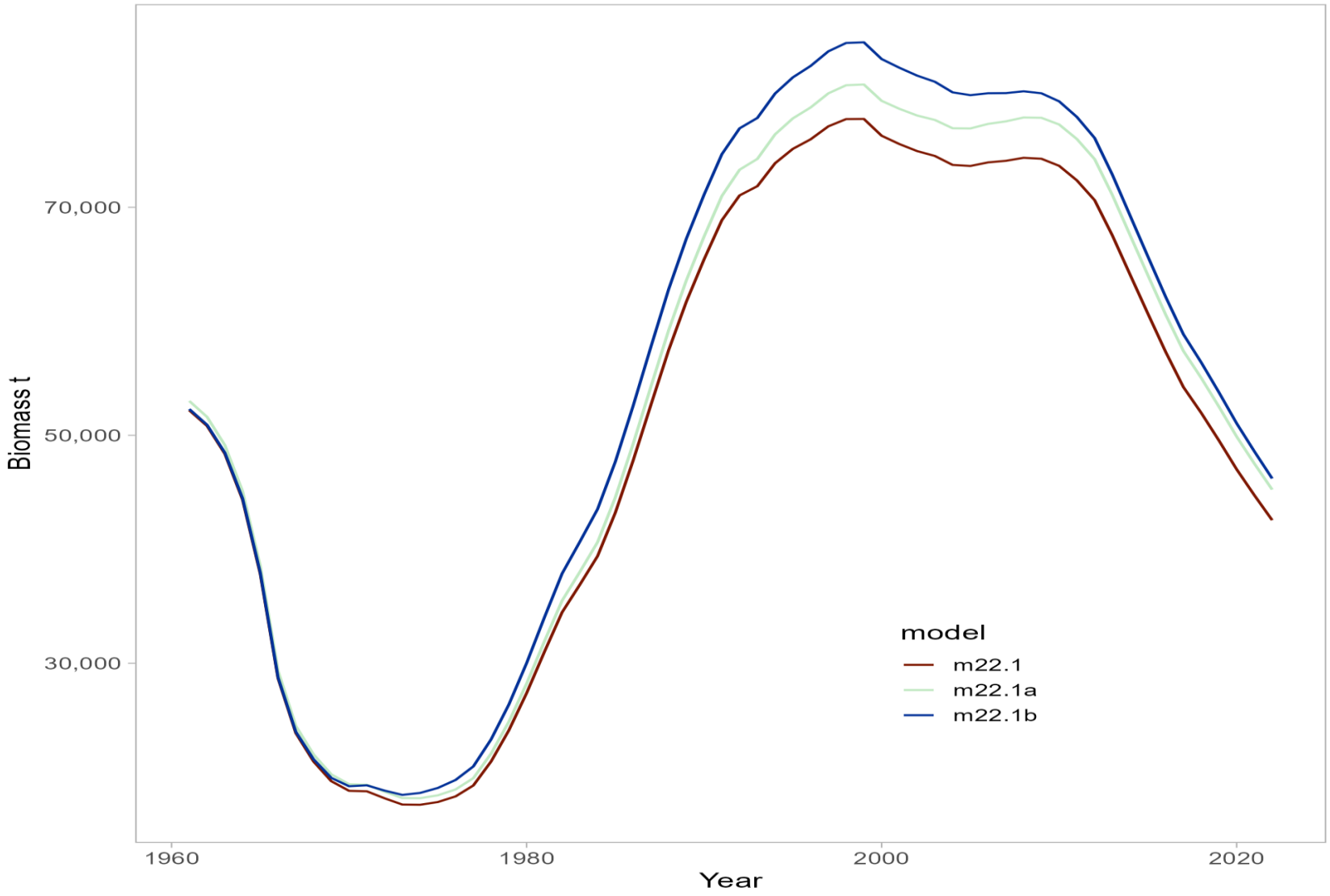
Year	M22.1 ISS	M22.1b ISS
1990	28	52
1993	29	32
1996	42	90
1999	39	42
2001	89	88
2003	31	26
2005	78	66

Year	M22.1 ISS	M22.1b ISS
2007	100	126
2009	95	168
2011	80	91
2013	82	104
2015	72	117
2017	86	118
2019	69	97
2021	84	153

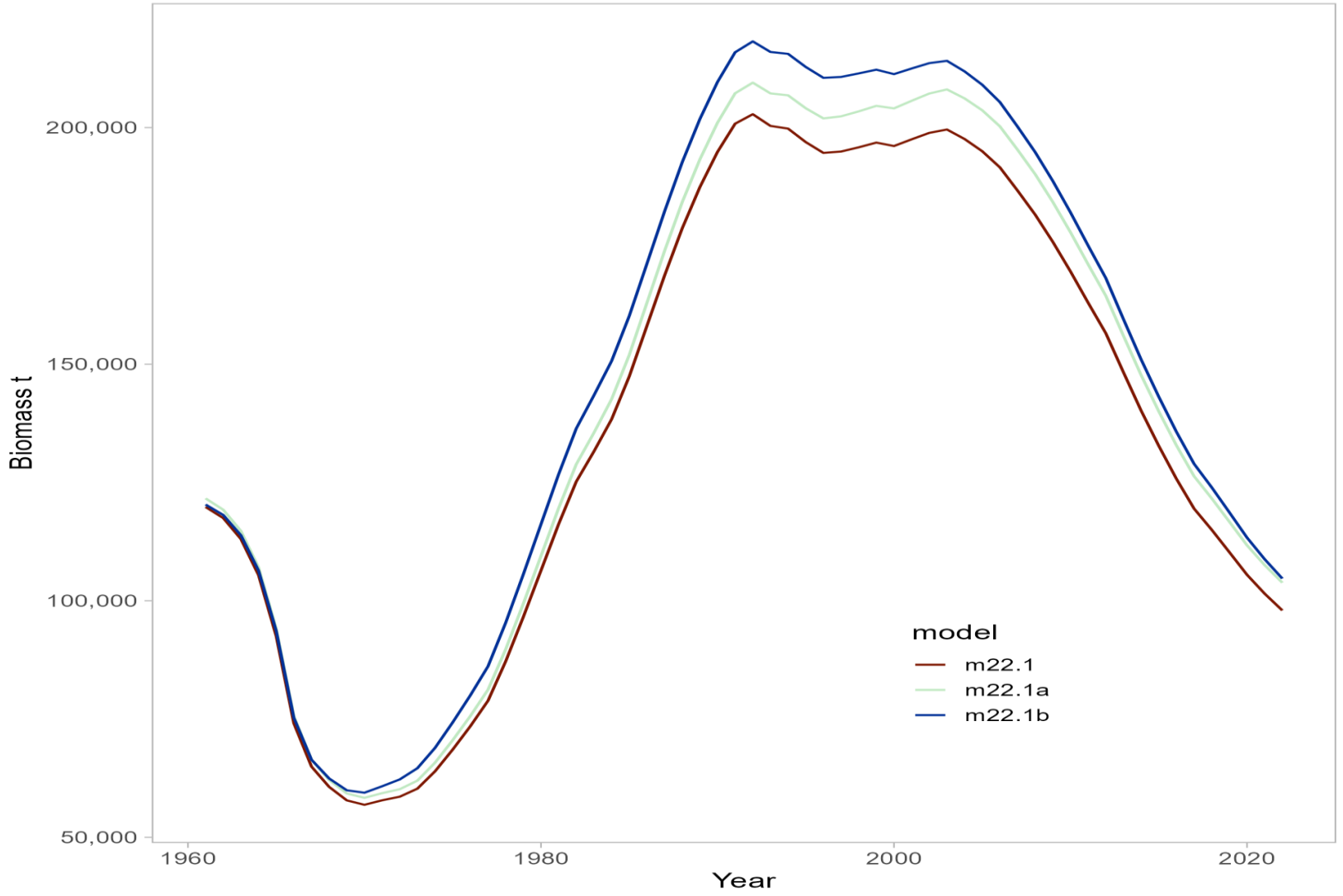
Northern rockfish - survey biomass



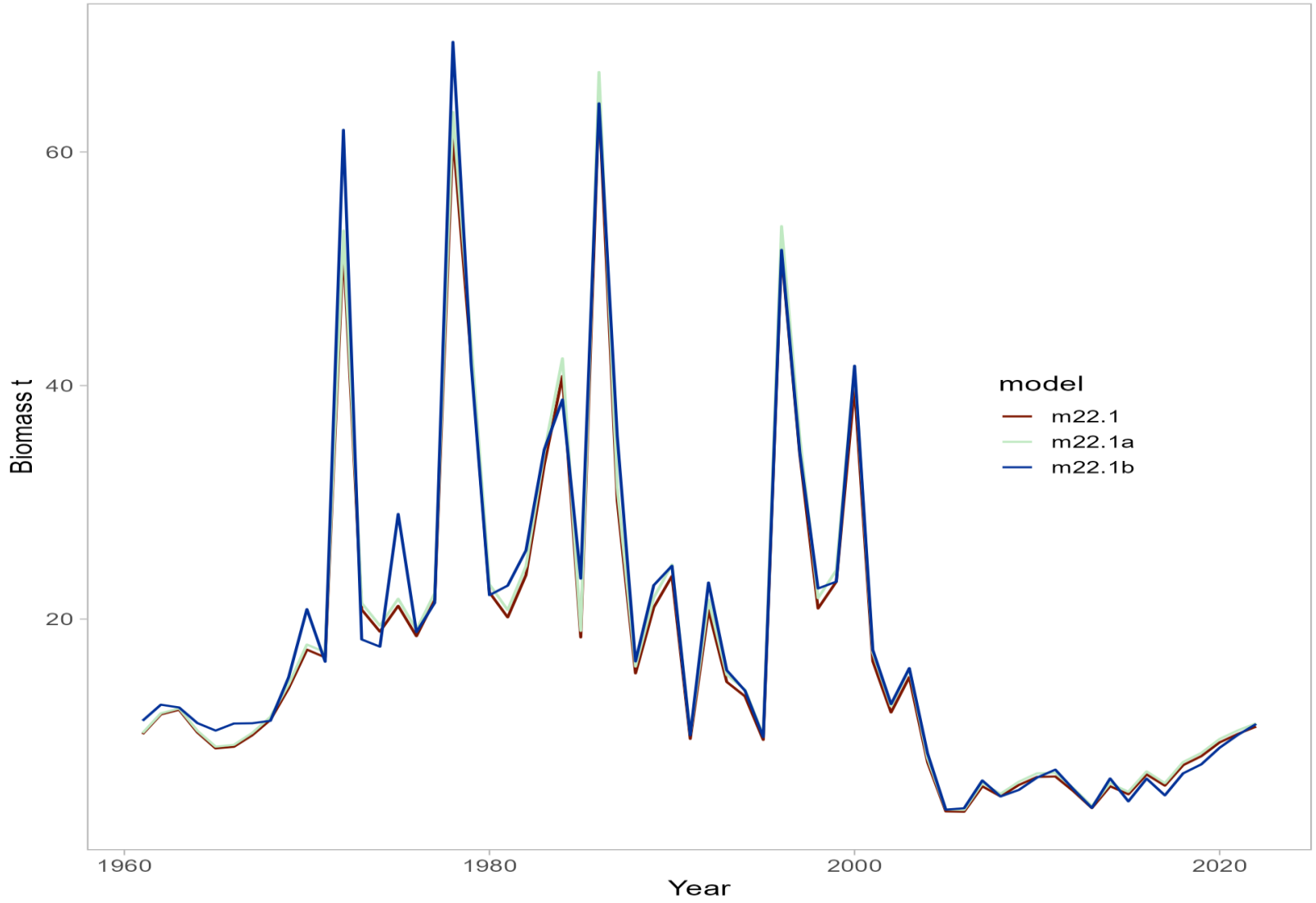
Northern rockfish - spawning biomass



Northern rockfish - total biomass



Northern rockfish - recruitment



Northern rockfish- model comparisons

Likelihood	Model 22.1	Model 22.1a	Model 22.1b
Catch	0.091	0.093	0.109
Survey biomass	6.022	1.907	2.056
Fishery ages	40.177	40.287	41.846
Survey ages	69.160	69.112	83.068
Fishery lengths	67.907	67.854	70.214
Recruitment devs	8.640	8.770	9.312
F regularity	5.457	5.481	5.676
M prior	0.014	0.0069	0.012
q prior	0.052	0.00059	0.0062
Data total	183.4	179.3	197.3

Northern rockfish – Model comparisons

Parameter	Model 22.1	Model 22.1a	Model 22.1b
M	0.0595	0.0596	0.0595
q	0.865	0.985	0.951
Avg recruitment	3.504	3.530	3.524
F40	0.061	0.061	0.061
Total biomass	95,559	101,263	101,794
Spawning biomass	39,463	41,972	42,811
B100	82,350	85,217	85,284
B40	32,940	34,087	34,114
ABC	4,972	5,291	5,343

Northern rockfish – RTMB

Port the ADMB model to RTMB

- Use ADMB (M22.1b) output as fixed inputs to RTMB (M24) to reproduce results
- Run RTMB using the same starting values and parameter bounds as ADMB, check for convergence and adjust if necessary

Northern rockfish- RTMB

Likelihood	M22.1b	M24
Catch	0.109	0.109
Survey biomass	2.0559	2.0559
Fishery ages	41.846	41.843
Survey ages	83.068	82.068
Fishery lengths	70.214	70.214
Recruitment devs	9.312	9.312
F regularity	5.676	5.676
M prior	0.012	0.012
q prior	0.0062	0.0063

Likelihoods are the same or within a few decimal points

Northern rockfish- RTMB

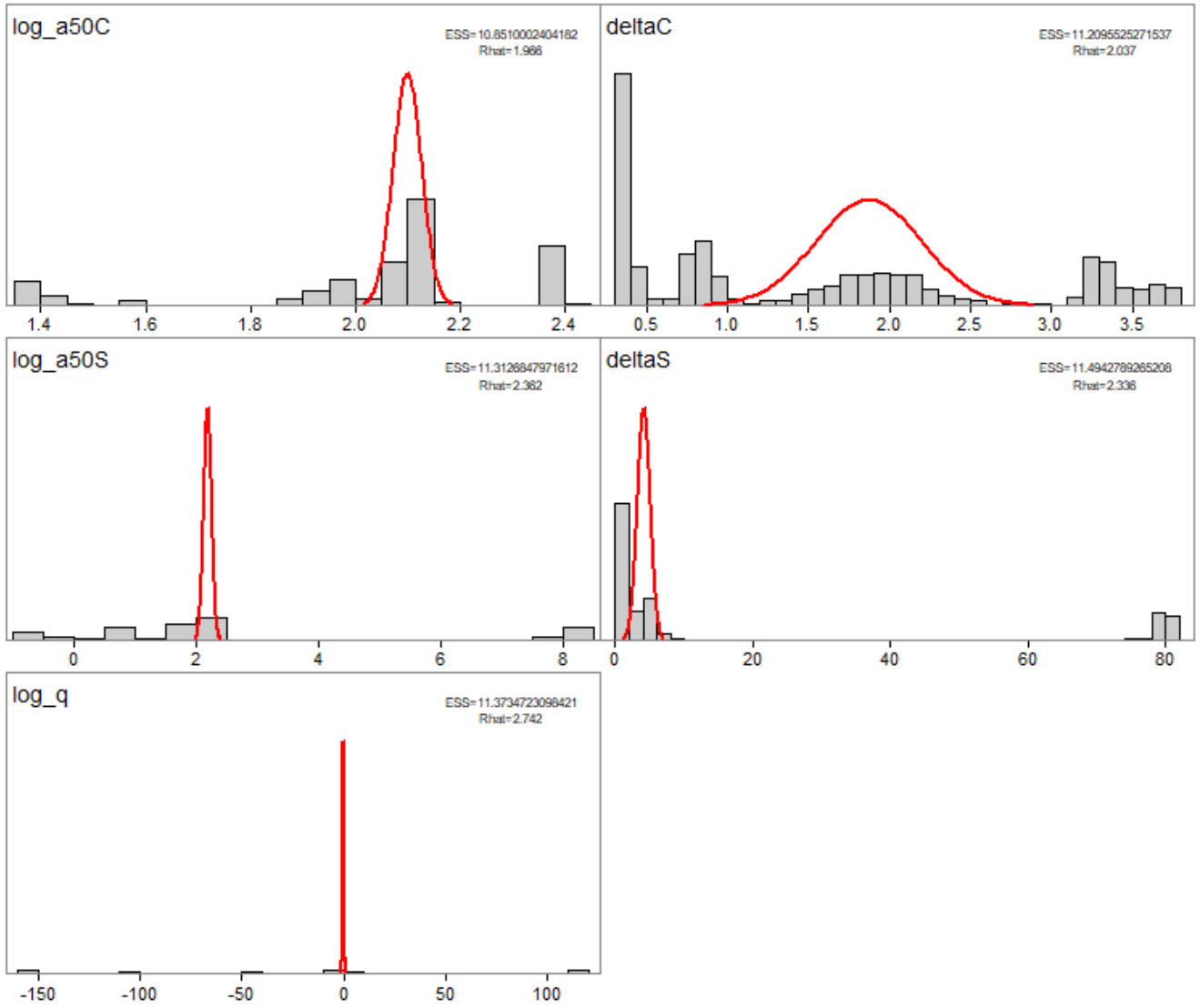
Parameter/Output	M22.1b	M24
M	0.0595	*0.0595*
q	0.951	*0.951*
Avg recruitment	3.524	*3.524*
F40	0.061	0.061
Total biomass	101,794	101,794
Spawning biomass	42,811	42,811
B100	85,284	85,284
B40	34,114	34,114
ABC	5,343	5,343

Output values are the same (italicized values are held fixed between models)

Northern rockfish- RTMB

- RTMB effectively recreates the ADMB model
- When run w/estimated parameters M to lower limit, q to upper limit
- Fixed M – model converged, parameter estimates looked good.

Northern rockfish- RTMB – marginal posterior distributions



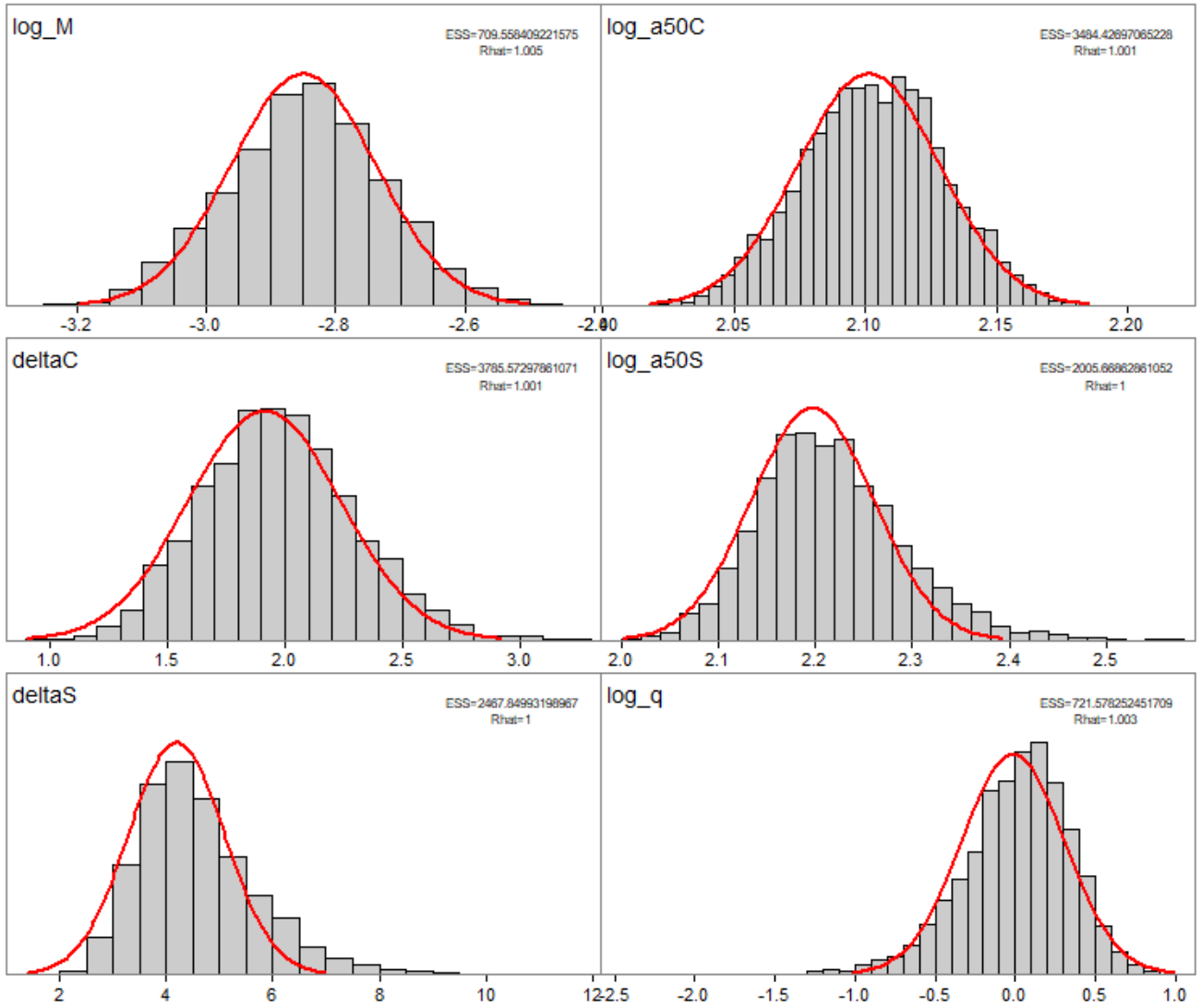
Northern rockfish- RTMB

- RTMB effectively recreates the ADMB model
- When run w/estimated parameters M to lower limit, q to upper limit
- Fixed M – model converged, parameter estimates looked good.
  - MCMC was awful (min effective sample size 3.3, mean $\hat{R}$ *2.5* (aiming for <= 1.05), substantial divergence

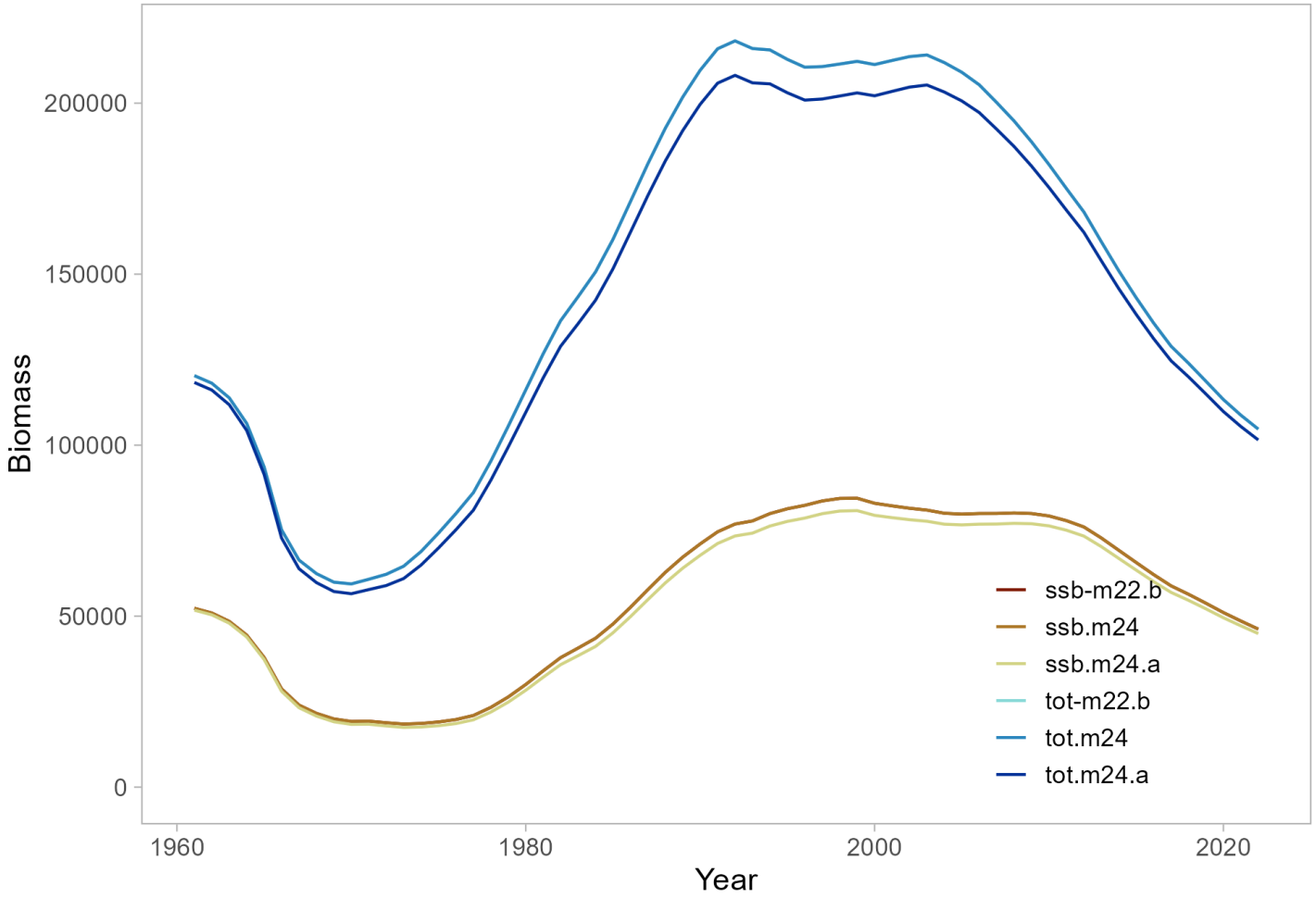
Northern rockfish- RTMB

- RTMB effectively recreates the ADMB model
- When run w/estimated parameters *M* to lower limit, *q* to upper limit
- Fixed *M* – model converged, parameter estimates looked good.
  - MCMC was awful (min effective sample size 3.3, mean $\hat{R}$ *2.5* (aiming for <= 1.05), substantial divergence
- Model 24.a: Estimated *M,* added priors for selectivity parameters (intercept 7.5, cv 1) and (slope 3.8, cv 1), parameter estimates look good
  - MCMC is good (min effective sample size 56.5, mean $\hat{R}$ *1.04,* no divergence
  - *Bonus – can relax prior M prior CV to 0.15, can estimate sigmaR (1.502)**

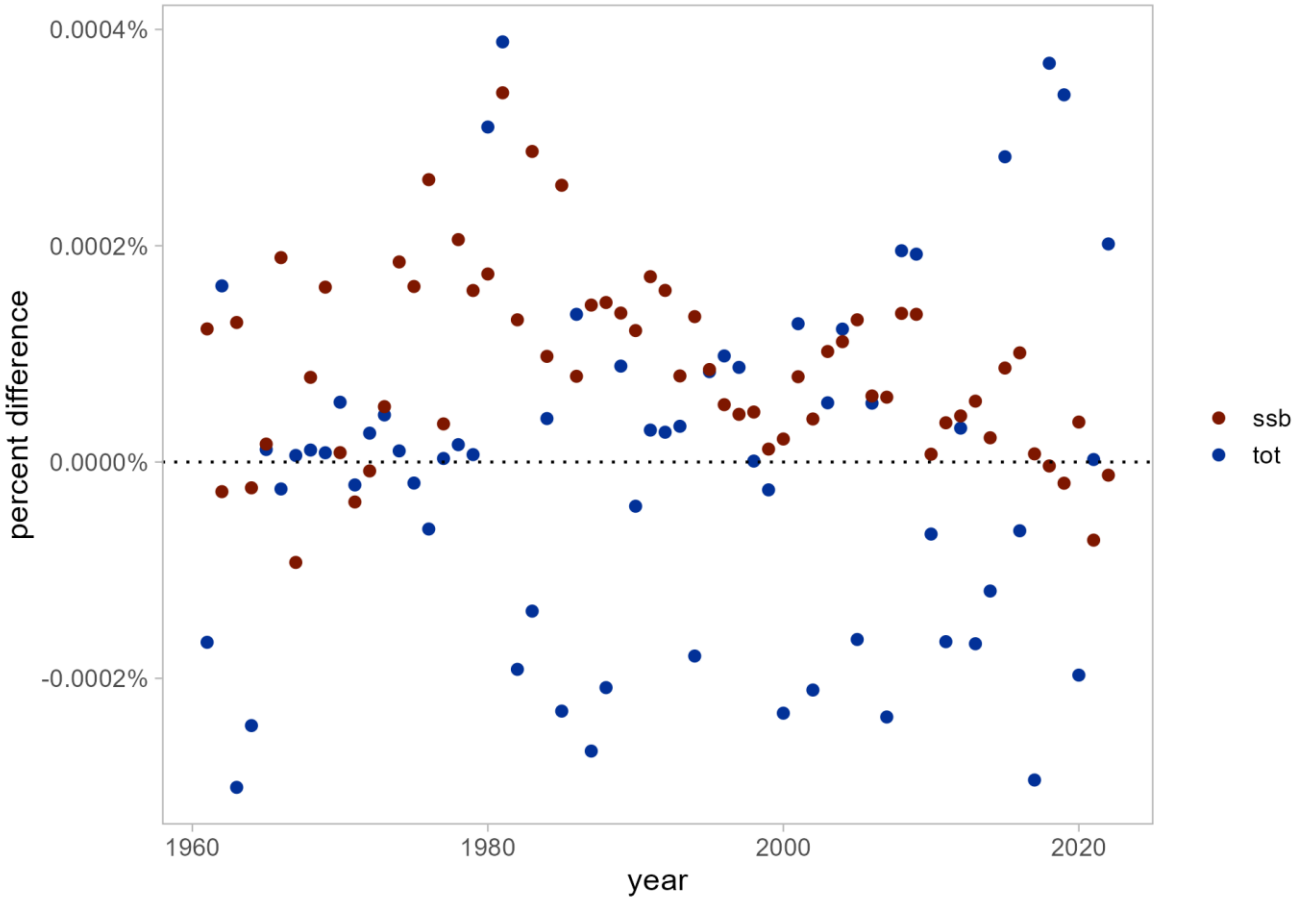
Northern rockfish- RTMB – w/selectivity priors



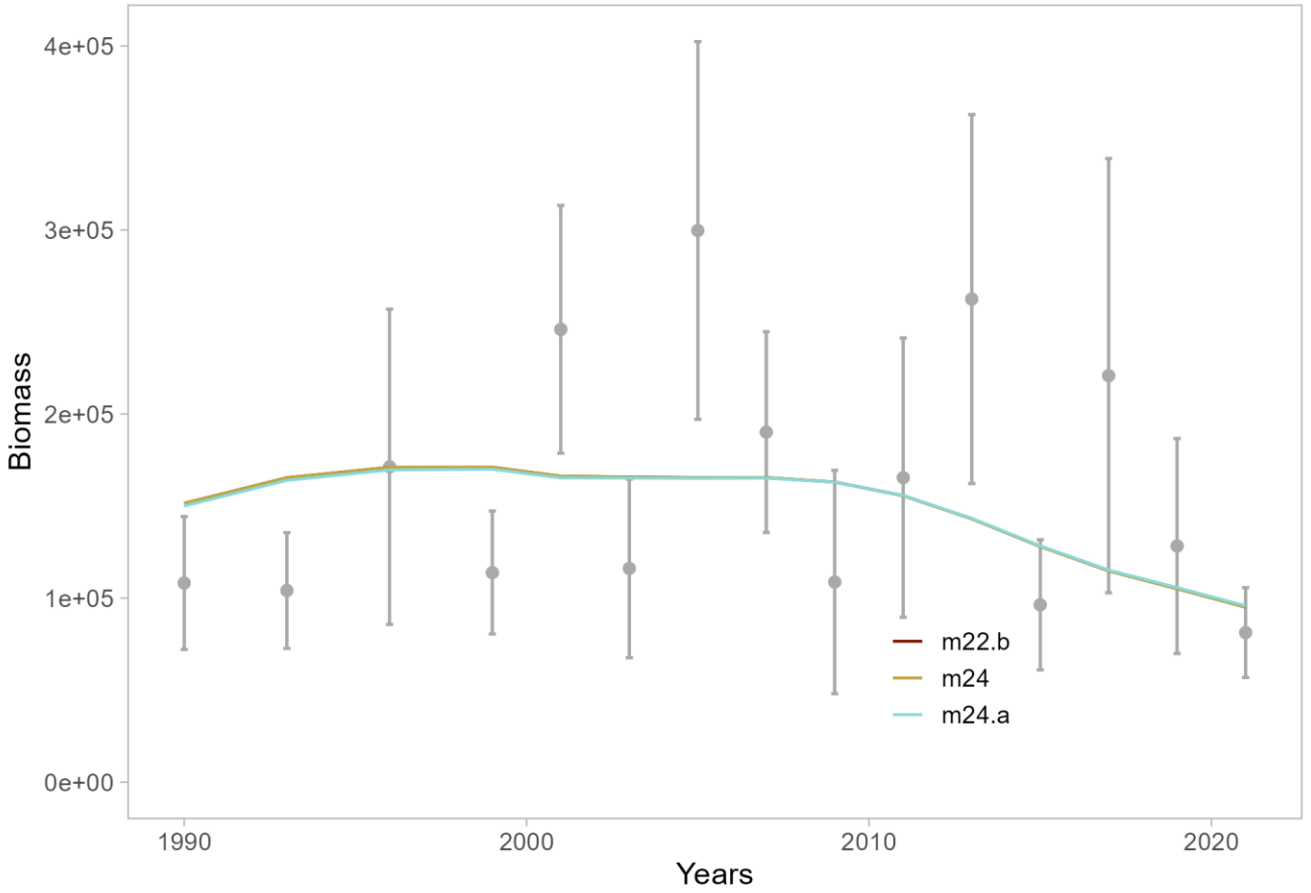
Northern rockfish- RTMB - Biomass



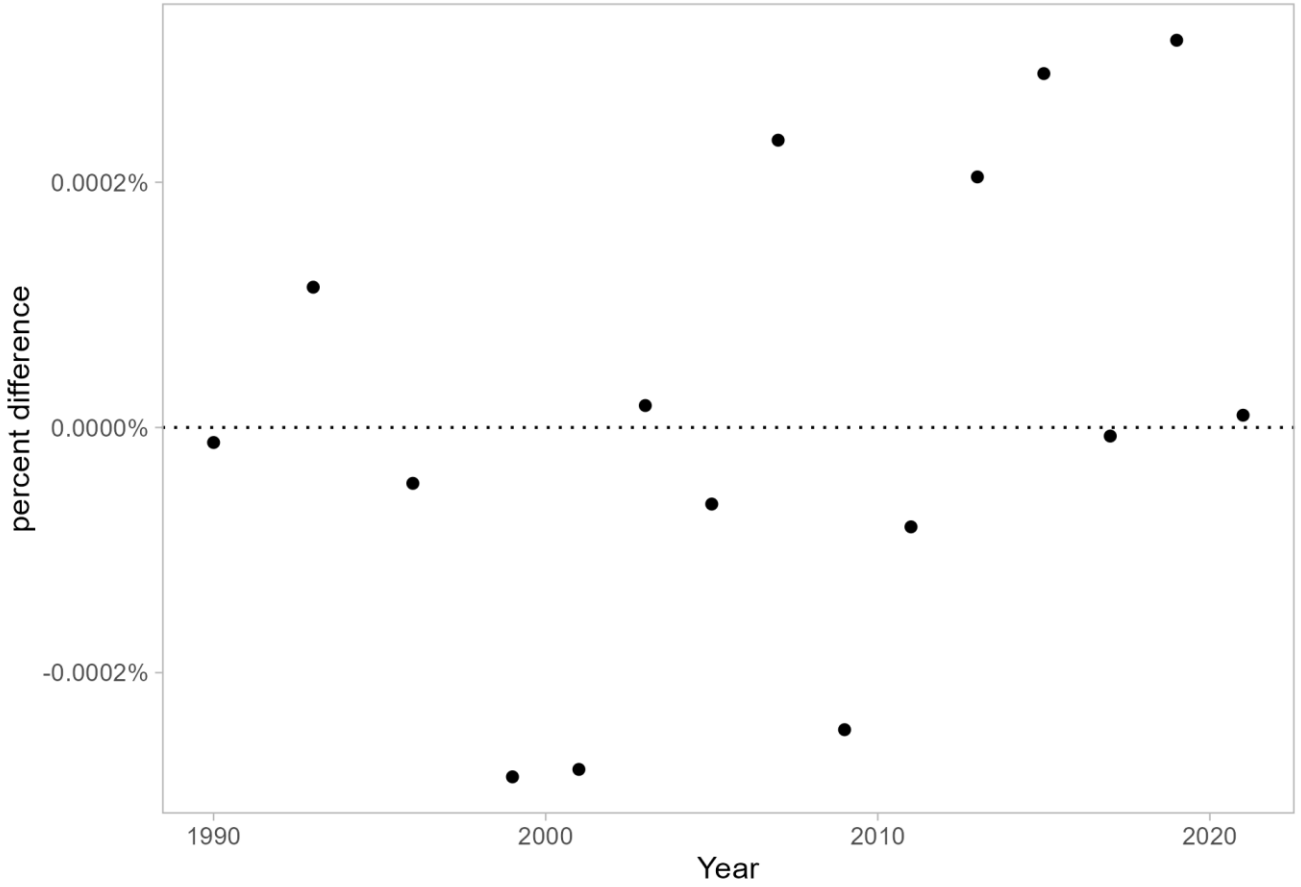
Northern rockfish- RTMB - Biomass



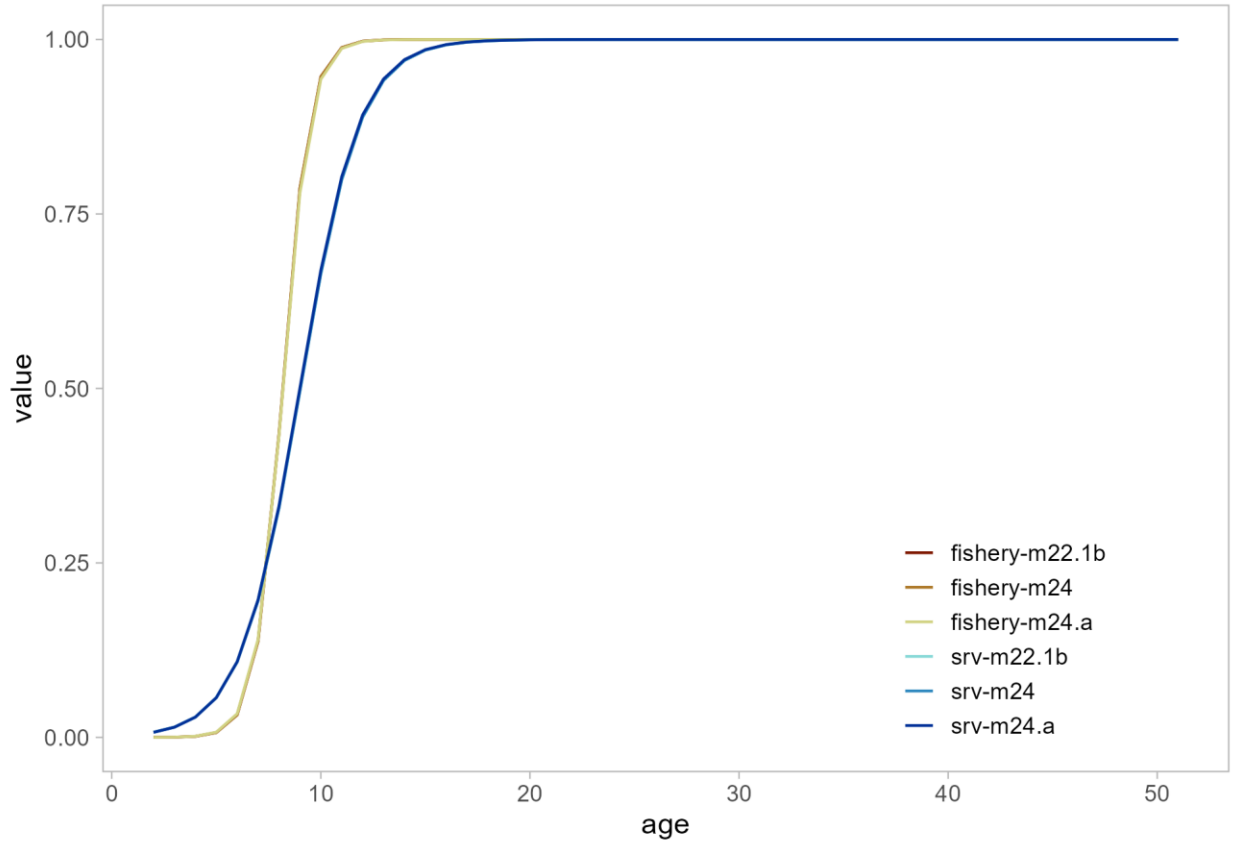
Northern rockfish- RTMB - Survey



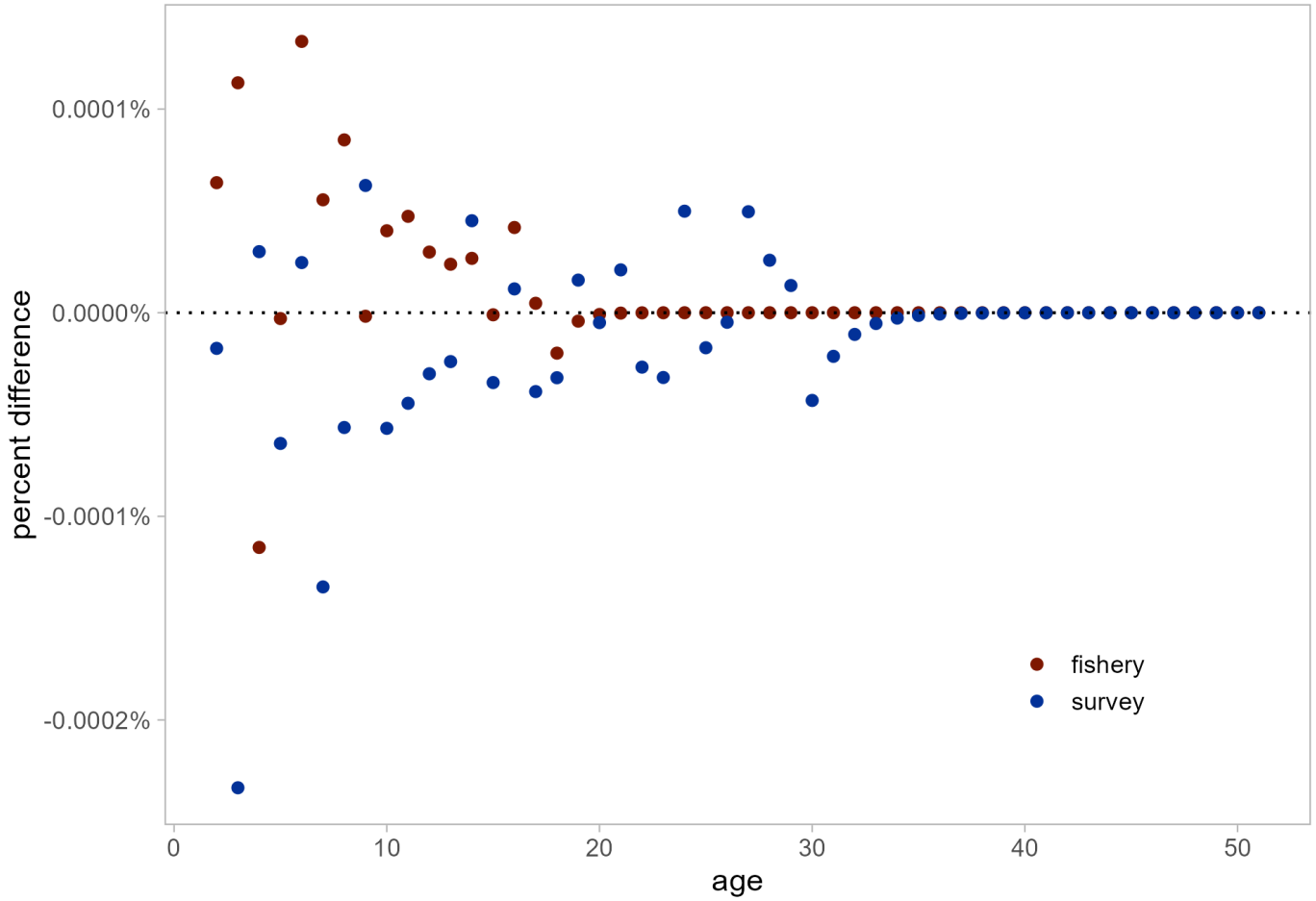
Northern rockfish- RTMB - Survey



Northern rockfish- RTMB - Selectivity



Northern rockfish- RTMB - Selectivity



Northern rockfish- RTMB

Likelihood	M22.1b	M24	M24.a
Catch	0.109	0.109	0.128
Survey biomass	2.0559	2.0559	1.989
Fishery ages	41.846	41.843	41.866
Survey ages	83.068	82.068	82.970
Fishery lengths	70.214	70.214	70.261
Recruitment devs	9.312	9.312	9.361
F regularity	5.676	5.676	5.647
M prior	0.012	0.012	0.949
q prior	0.0062	0.0063	-0.121
A50-fishery prior			-0.923
Delta-fishery prior			-1.154
A5-survey prior			-0.935
Delta-survey prior			-0.924
Data total	197.3	197.3	197.3

Northern rockfish- RTMB

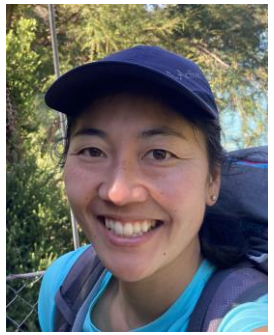
Parameter/Output	M22.1b	M24	M24.a
M	0.0595	*0.0595*	0.0578
q	0.951	*0.951*	0.986
Avg recruitment	3.524	*3.524*	3.454
A50-fishery	8.167	*8.167*	8.176
Delta-fishery	1.876	*1.876*	1.914
A5-survey	9.023	*9.023*	8.996
Delta-survey	4.217	*4.217*	4.188
F40	0.061	0.061	0.596
Total biomass	101,794	101,794	98,737
Spawning biomass	42,811	42,811	41,670
B100	85,284	85,284	84,415
B40	34,114	34,114	33,766
ABC	5,343	5,343	5,087

Northern rockfish- Discussion

Recommendations:

- Transition the model into RTMB
- Add selectivity priors
- Loosen prior on *M*
- *For November*
  - Consider estimating *sigmaR?*
  - Explore differences in model weights

Questions?



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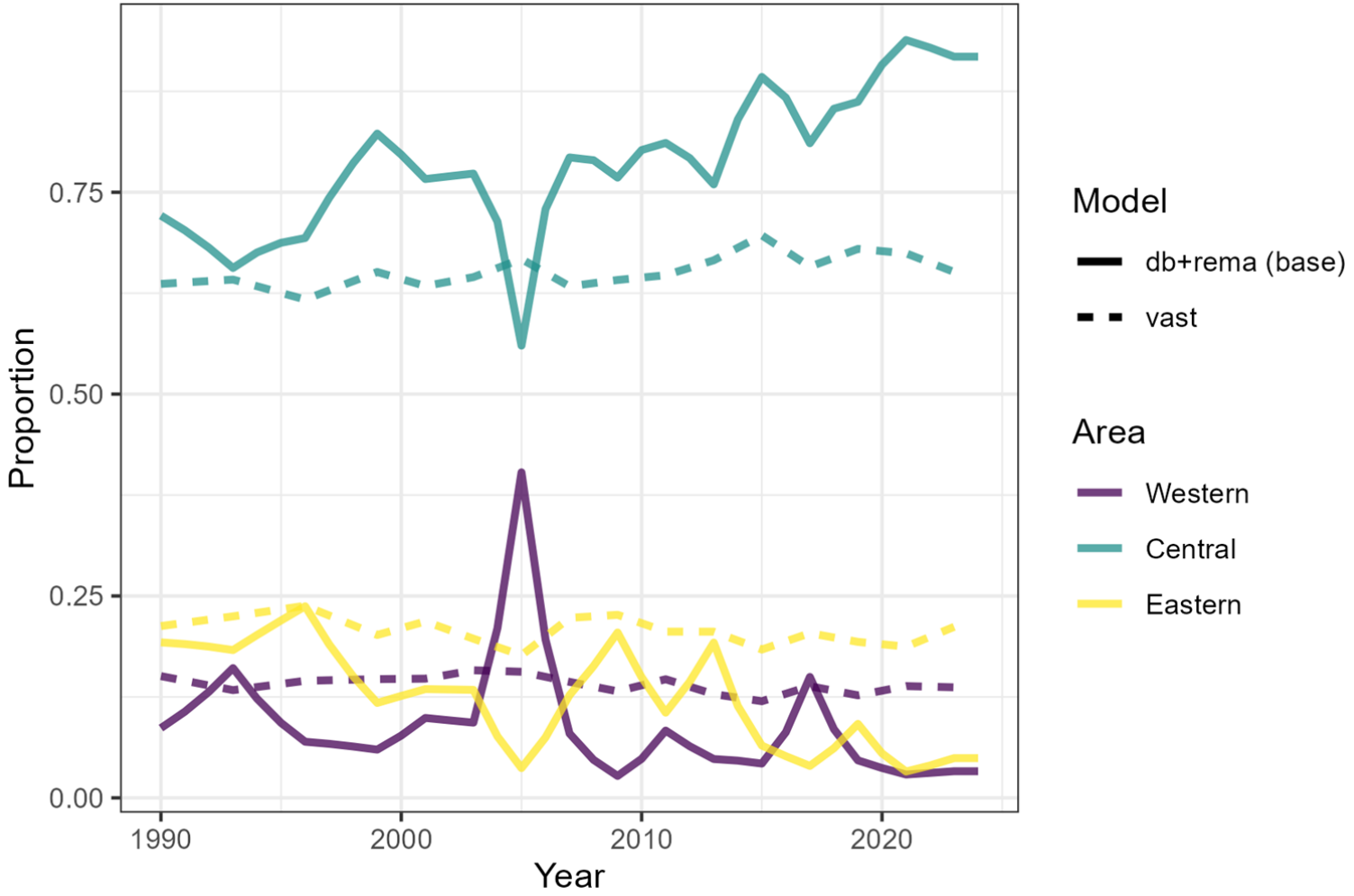
Apportionment- Dusky rockfish proportions



- Accepted model: Design-based model smoothed by *REMA* = more variable
- Alternative model-based (VAST) = less variable