GOA Rougheye & Blackspotted Rockfish

JY Sullivan, SK Shotwell, DH Hanselman, PJK Hulson, BC Williams, EM Yasumiishi, BE Ferriss

Rougheye/Blackspotted (RE/BS)

- Tier 3a species – 2021 full assessment
  - No model changes since 2015
  - Uses two surveys (NMFS bottom trawl & NMFS longline) for model and apportionment
  - New data: new/updated catch, new trawl/longline survey, new fishery/longline survey sizes

Take homes

- Declines in both trawl and longline survey indices
- Uncertainty in global scaling parameters
- Downgrade in biomass trajectories, recruitment, unfished spawning biomass
- Mohn’s rho = 0.61 (Risk level 2 for assessment)
- Recommend max ABC
- 2022 ABC = 788 t, 35% decrease since 2021 (1,212 t)

SSC/PT Comments

"The Team recommended that the authors investigate depth strata in which there is overlap between the trawl and longline surveys to evaluate consistency in catch between the two surveys." (GOA Plan Team, November 2019)

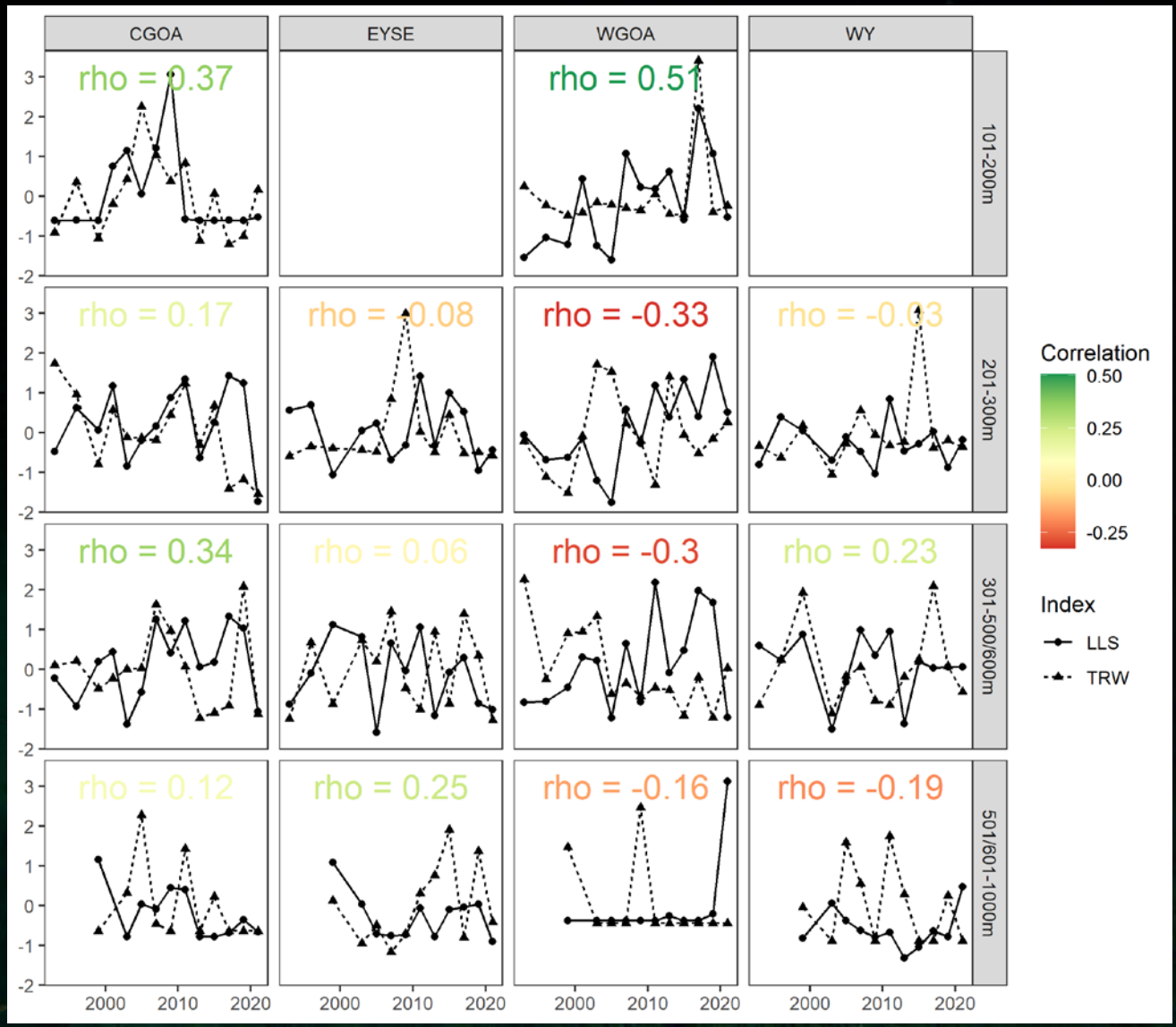
- Different depth strata definitions
- The surveys partition biomass differently among regions
- The surveys do not consistently track each other, even when split by area and depth strata

Trawl and longline surveys have different depth strata definitions

Depth	Trawl survey	Longline survey	Alternative 1	Alternative 2	Alternative 3
1-100	1-100	1-100	1-100	1-100	1-100
101-200	101-200	101-200	101-200	101-200	101-200
201-300	201-300	201-300	201-300	201-300	201-300
301-400	301-500	301-400	301-500/600	301-400/500	301-600/700
401-500		401-600			
501-600	501-700			401/501-1000	
601-700		601-800	501/601-1000		
701-800	701-1000				601/701-1000
801-900		801-1000			
901-1000					

The surveys partition biomass differently among regions

The surveys rarely track each other within a year, even when split by area and depth strata



SSC/PT Comments

"The same model that was used in 2015 and 2017 was used for the 2019 assessment, with similar parameters to 2017. Results included slightly higher survey catchability and slightly lower mean recruitments, and the longline survey selectivity is now slightly dome-shaped in the 2019 assessment. The model fit was similar to that seen in 2017. 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)

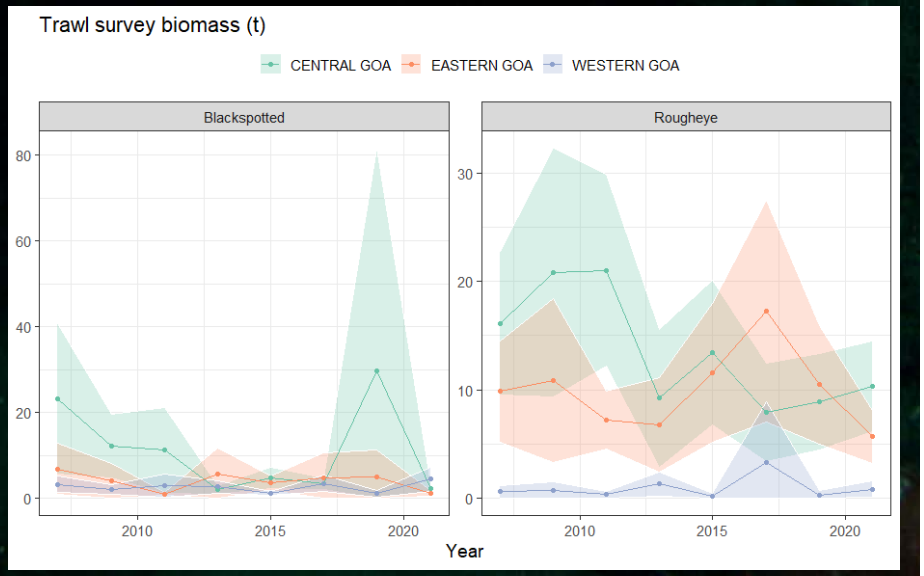
- No model changes this year due to change in authorship
- Continued changes in catchability and recruitment estimates, strong positive retrospective bias

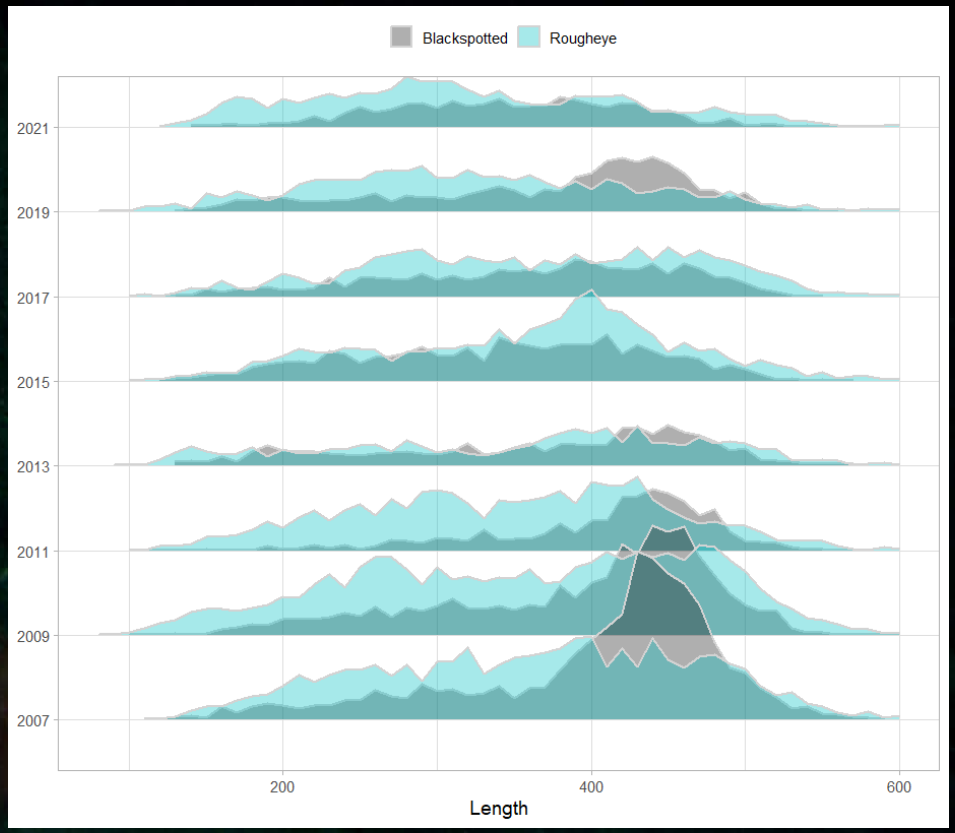
SSC/PT Comments

"The Team recommended that the authors incorporate additional information about species identification obtained through otolith morphology in future assessments." (GOA Plan Team, November 2019)

"The SSC continues to encourage effort to incorporate this information into the assessment as much as possible, to improve species-specific information in this assessment and move towards splitting this complex. Alternative model configurations that incorporate these data would be highly encouraged as a step in this direction." (SSC, December 2019)

Trends by species in trawl survey since 2007





Otolith morphology for species identification

Harris et al. 2019. Fish. Bull. 117:234–244

- Could be used to reliably identify archived otoliths from the past 20-30 years

	% accuracy	
	Rougheye	Blackspotted
Field-based / visual ID	62-66%	92-94%
Harris et al. 2019	86%	97%

Multispectral imaging for species ID

Romain and Magrane (Pacific States)

- Photoshoot box during 2017 and 2018 longline survey experimental legs
- Computer vision model outperformed field ID, confirmed with genetic ID
- Overall accuracy of predictions was 93%
- Observer program project will test broader applicability

		Predicted label accurate predictions highlighted in yellow		
		Blackspotted	Rougheye	Shortraker
True label with number tested	Blackspotted (77)	76	1	0
	Rougheye (42)	3	32	7
	Shortraker (55)	1	0	54

Reproductive biology

Conrath 2017. Maturity and skip spawning rates. Trans Am Fish Soc 146-3.

Conrath and Hulson 2021. Temporal variability in reproductive parameters. Fish. Res. 237.

- Similar length-based maturity, different age-based
- Blackspotted mature later and more slowly

Status quo: Length-based maturity (McDermott 1994) converted to age using this assessment's size-age transition matrix that was updated in 2011.	
Parameter	**Estimate**
l_{50}	43.9 cm
a_{50}	19 y

Length and age-based maturity estimates from Conrath (2017)

	Parameter	**Rougheye rockfish**	**Blackspotted rockfish**
Length-based maturity	l_{50}	45.0 cm	45.3 cm
	δ_l	0.48	0.31
Age-based maturity	a_{50}	19.5 y	27.4 y
	δ_a	0.33	0.25

Reproductive biology cont.

Conrath 2017. Maturity and skip spawning rates. Trans Am Fish Soc 146-3.

Conrath and Hulson 2021. Temporal variability in reproductive parameters. Fish. Res. 237.

- High rates of skip spawning, but variable over time
- Plans to use otolith morphology methods for species ID deterred due to Covid (Charles Hutchinson retired, Chris Gburski, Age & Growth)
- Reproductive data are costly and challenging to collect

Concluding thoughts on SSC and Plan Team comments

- Refinements to survey indices
- Updates to biological parameters estimated outside of the model (growth, maturity, size-age transition matrix, ageing error)
- Potential to develop species-specific age comps using otolith morphology

Blackspotted Rockfish (*Sebastes melanostictus*)

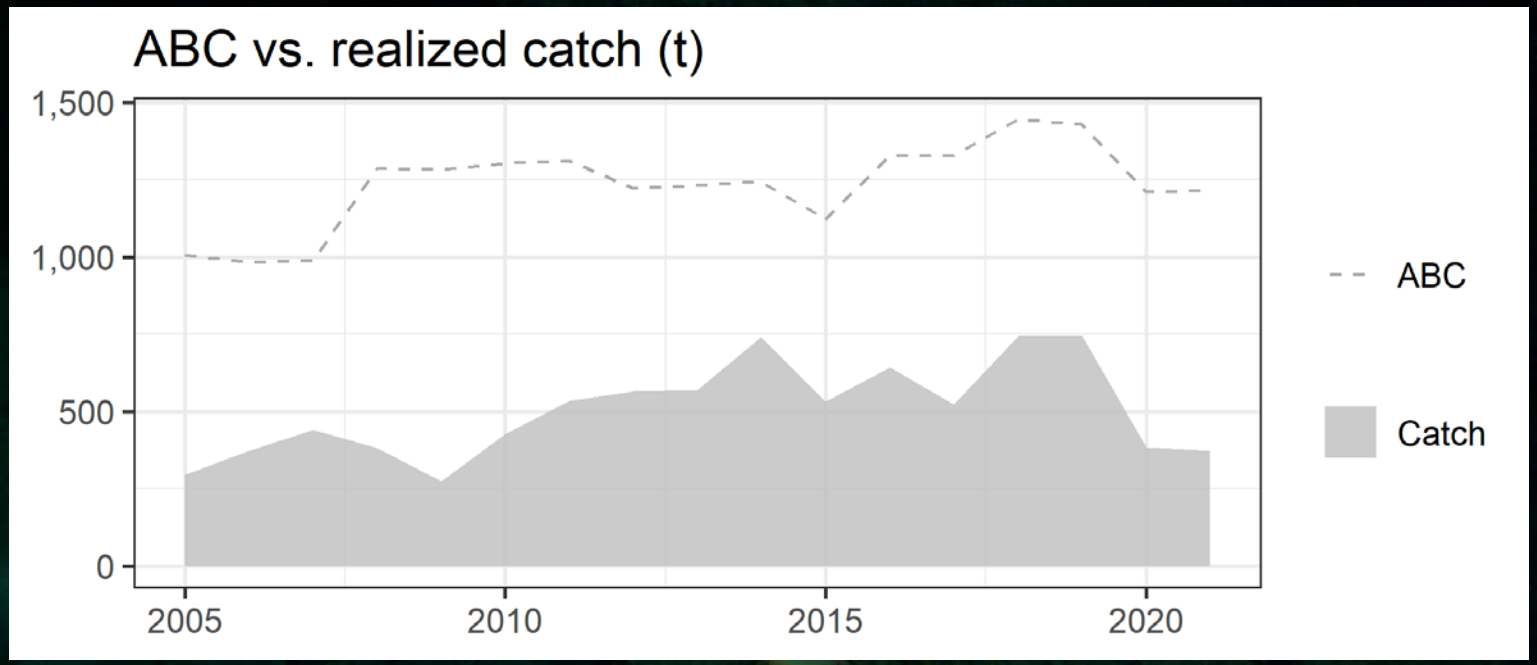
Shortraker Rockfish *(Sebastes borealis)*

Rougheye Rockfish *(Sebastes aleutianus)*

Figure 27. -- Examples of Rockfish species images from the controlled environment (chute) camera systems. (Romain)

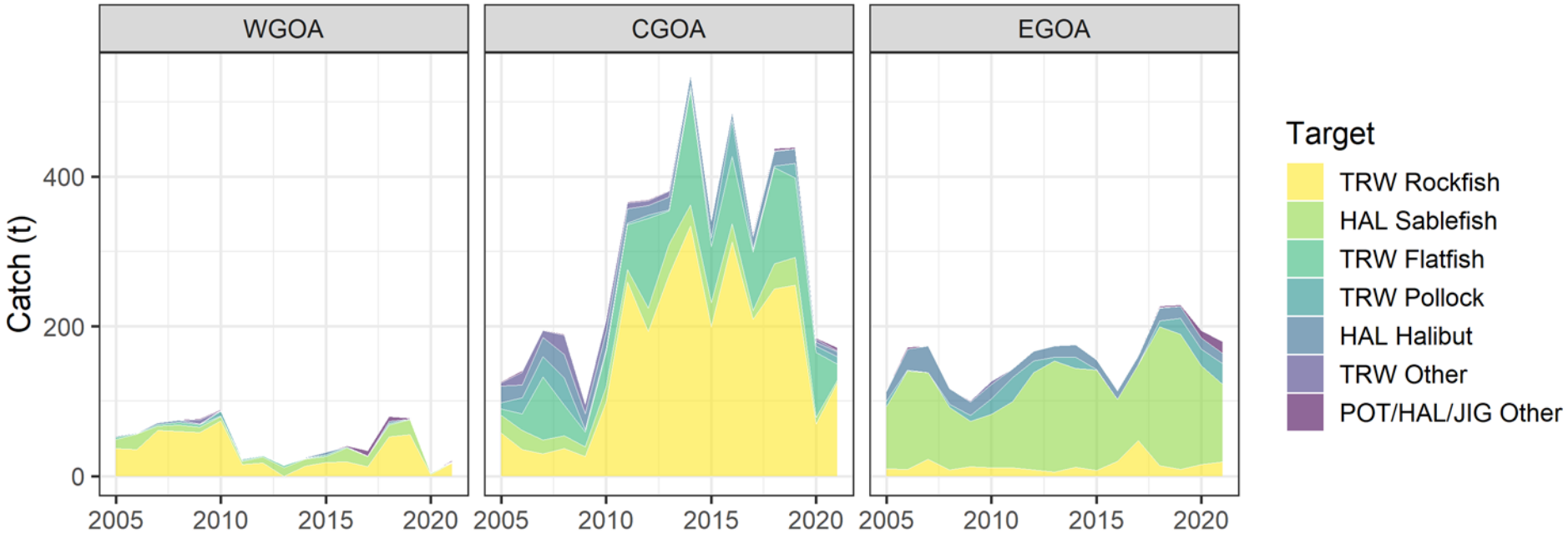
RE/BS Fishery

- Bycatch only
- Catch ranges between 20%-60% of ABC



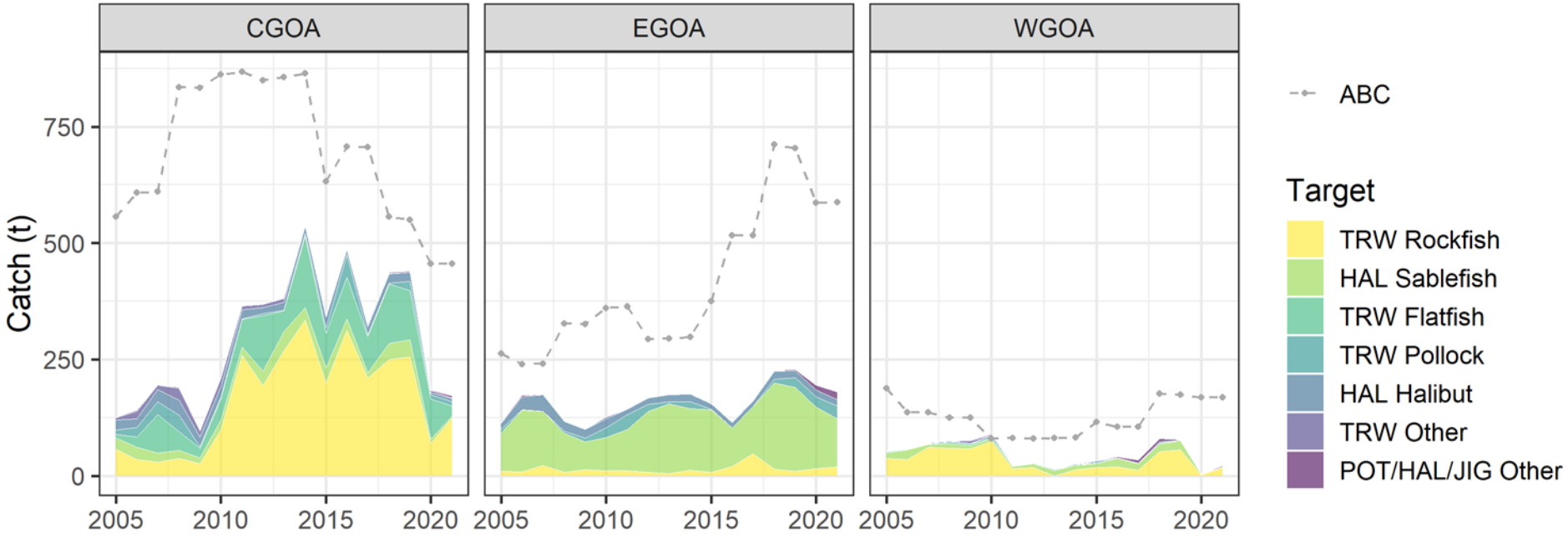
Bycatch by area and fishery target

- Highest catches in Central GOA (rockfish and flatfish trawl fleets), followed by Eastern GOA (hook and line sablefish fleet)
- Sablefish fleet transition to pot gear likely to reduce RE/BS bycatch



Area ABCs

- Catch has not exceeded area apportioned ABCs
- Shift in ABC apportionment from CGOA to EGOA

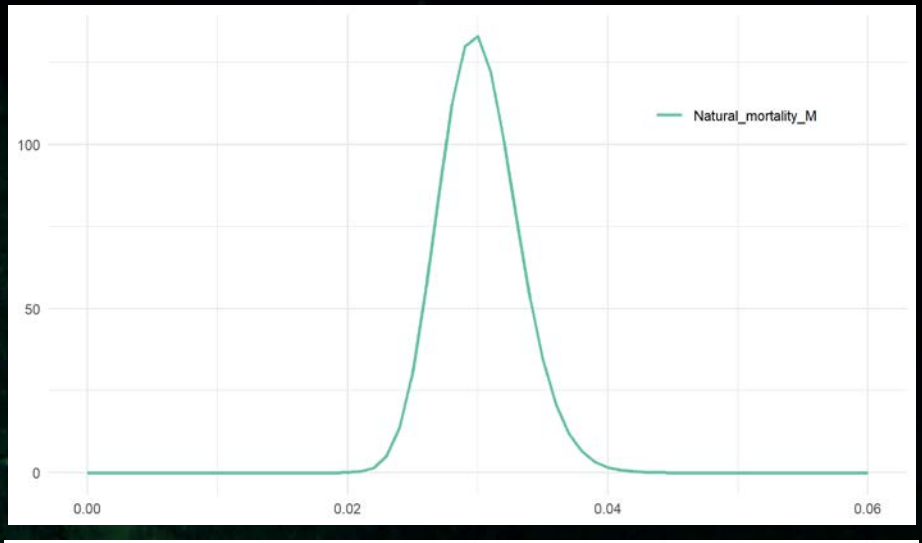


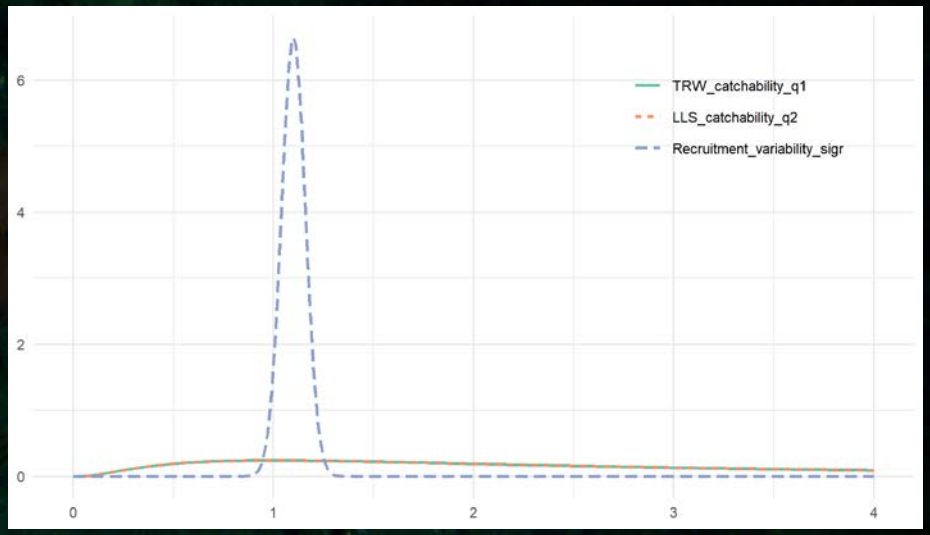
Model overview

- No model changes since 2015
- Single-sex, species combined
- Two surveys (NMFS bottom trawl & NMFS longline)
- Fishery (all gears combined) & longline survey selectivity: penalized, second differences methods
- Trawl survey selectivity: gamma fxn

Model overview

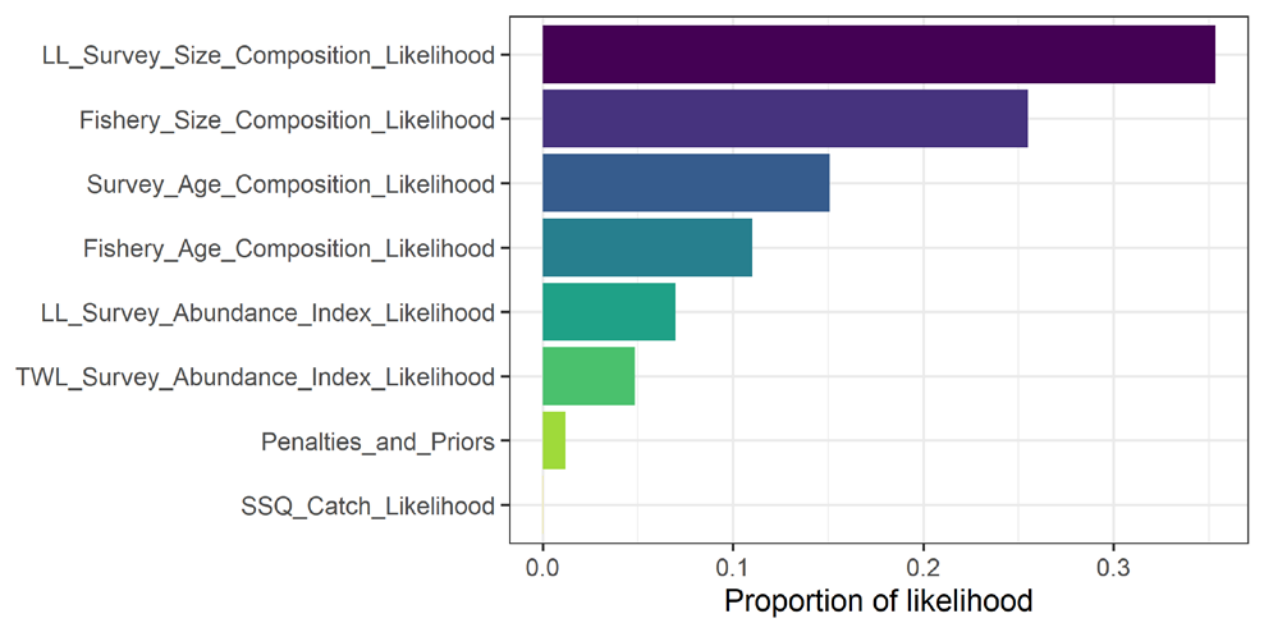
- Informative priors on M and sigmaR
- Uninformative priors on both survey qs
- Ageing error matrix updated in 2011
- Size-age transition and weight-at-age updated in 2015
- User-defined data weighting





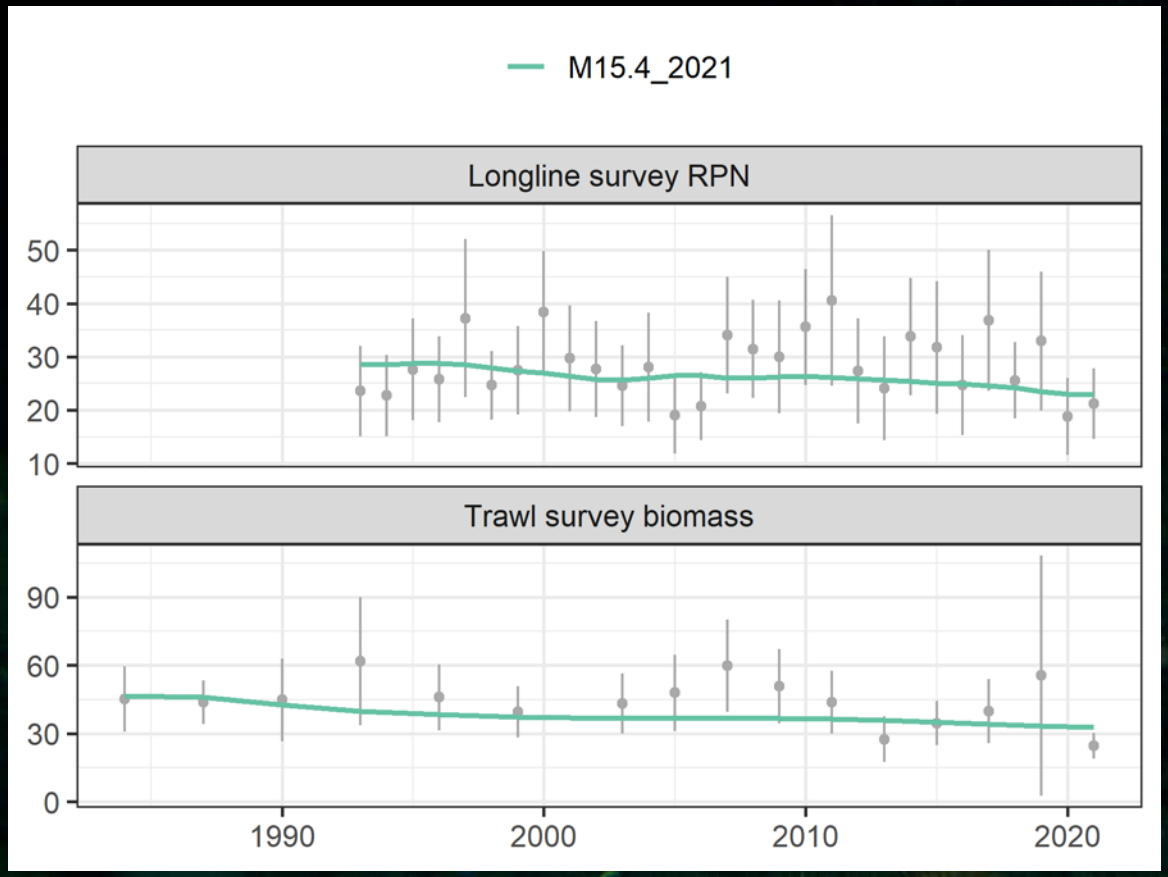
RE/BS Data Table

Source	Data	Years
Fisheries	Catch	1977-2019, **2020, 2021**
	Age	1990, 2004, 2006, 2008, 2009, 2010, 2012, 2014, 2016, **2018, 2020**
	Length	1991-1992, 2002-2003, 2005, 2007, 2011, 2013, 2015, 2017, **2019**
NMFS trawl survey	Biomass index	1984, 1987, 1990, 1993, 1996, 1999, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, **2021**
	Age	1984, 1987, 1990, 1993, 1996, 1999, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017
AFSC longline survey	Relative Population Number (RPN)	1993-2019, **2020, 2021**
	Length	1993-2017, **2018, 2019**



Data	Relative Root Mean Square Error (RMSE)
Trawl survey biomass	0.31
Longline survey RPN	0.29
Trawl survey ages	0.09
Fishery lengths	0.08
Longline survey lengths	0.08
Fishery ages	0.05
Historical catch (wt = 5)	0.02
Modern catch (wt = 50)	0.01

Declines in both survey indices



Data	RMSE
Trawl survey biomass	0.31
Longline survey RPN	0.29
Trawl survey ages	0.09
Fishery lengths	0.08
Longline survey lengths	0.08
Fishery ages	0.05
Historical catch (wt = 5)	0.02
Modern catch (wt = 50)	0.01

LLS:

- 2020 lowest in time series
- 36% decrease since 2019

TRW:

- 2021 lowest in time series
- 56% decrease since 2019
- Low estimated CV in 2021

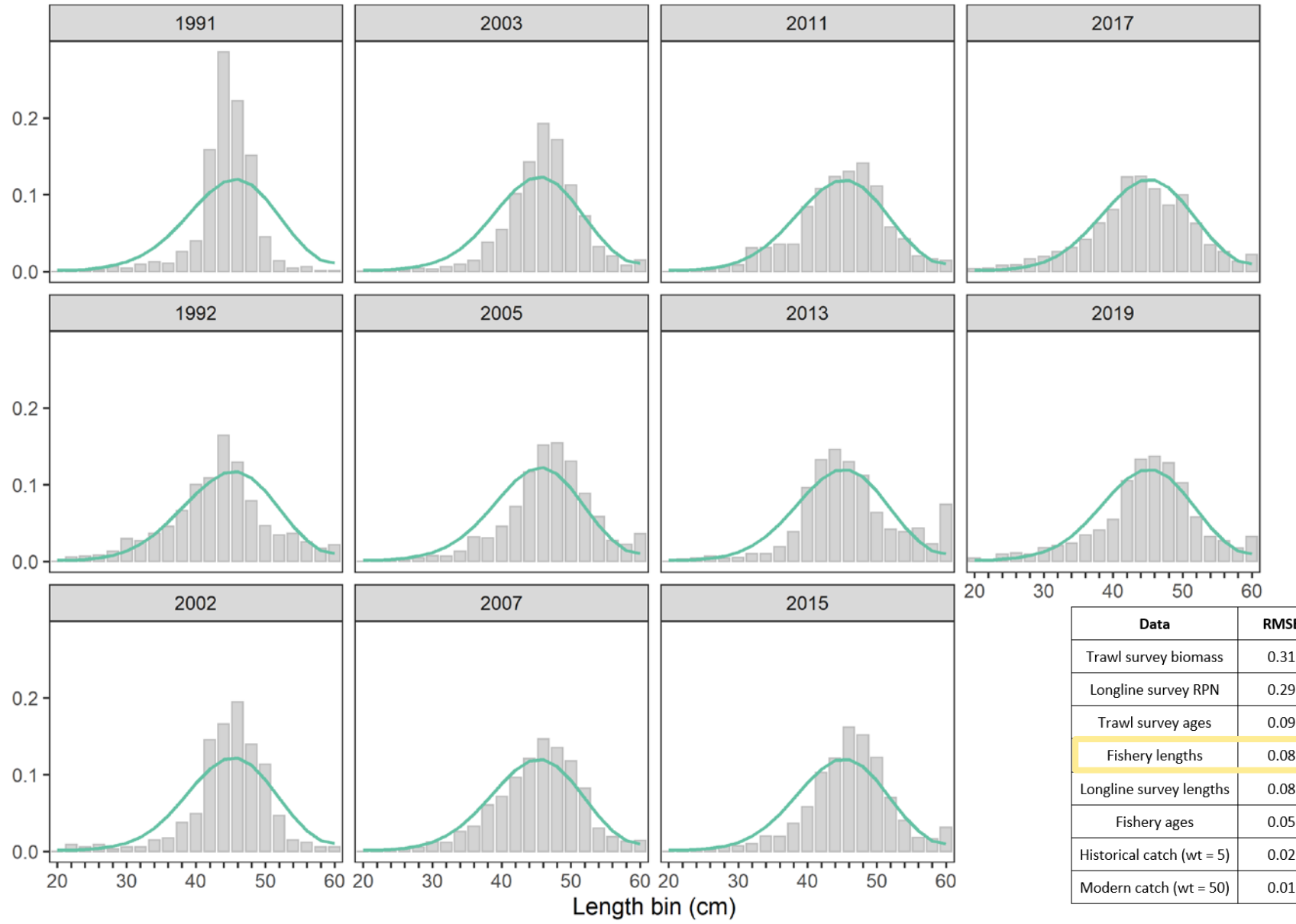
Trawl survey age comps

Data	RMSE
Trawl survey biomass	0.31
Longline survey RPN	0.29
Trawl survey ages	0.09
Fishery lengths	0.08
Longline survey lengths	0.08
Fishery ages	0.05
Historical catch (wt = 5)	0.02
Modern catch (wt = 50)	0.01

Fishery age comps

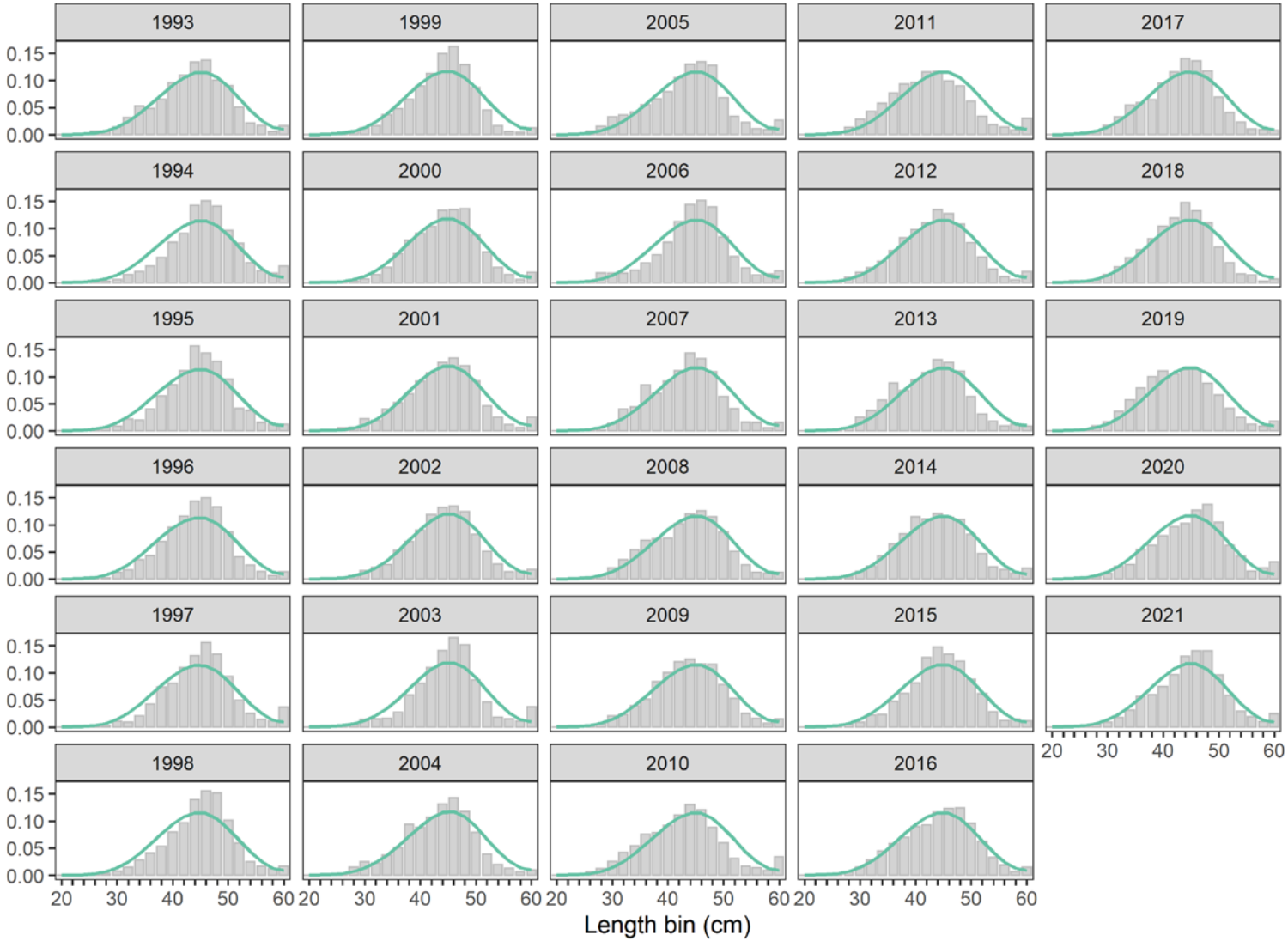
Data	RMSE
Trawl survey biomass	0.31
Longline survey RPN	0.29
Trawl survey ages	0.09
Fishery lengths	0.08
Longline survey lengths	0.08
Fishery ages	0.05
Historical catch (wt = 5)	0.02
Modern catch (wt = 50)	0.01

Fishery length comps



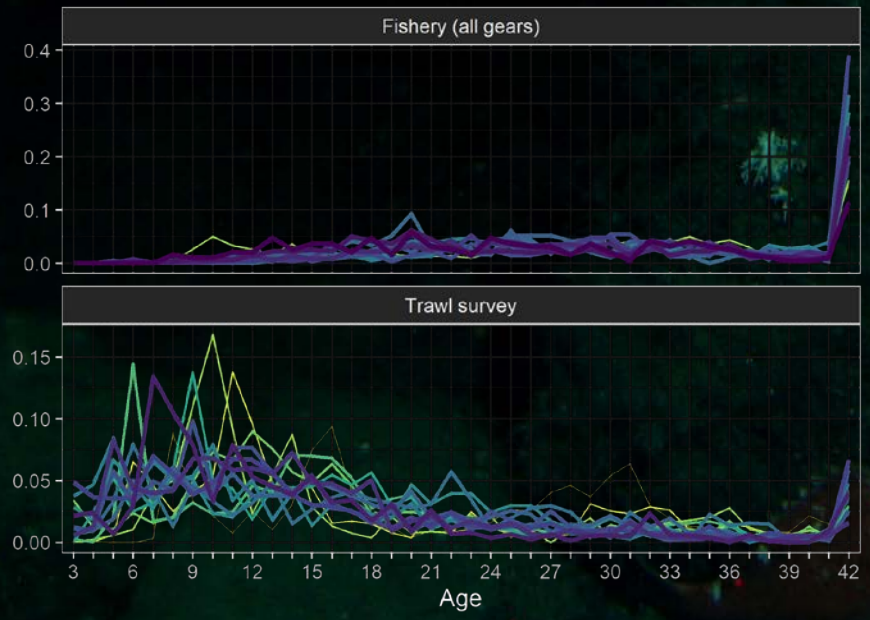
Data	RMSE
Trawl survey biomass	0.31
Longline survey RPN	0.29
Trawl survey ages	0.09
Fishery lengths	0.08
Longline survey lengths	0.08
Fishery ages	0.05
Historical catch (wt = 5)	0.02
Modern catch (wt = 50)	0.01

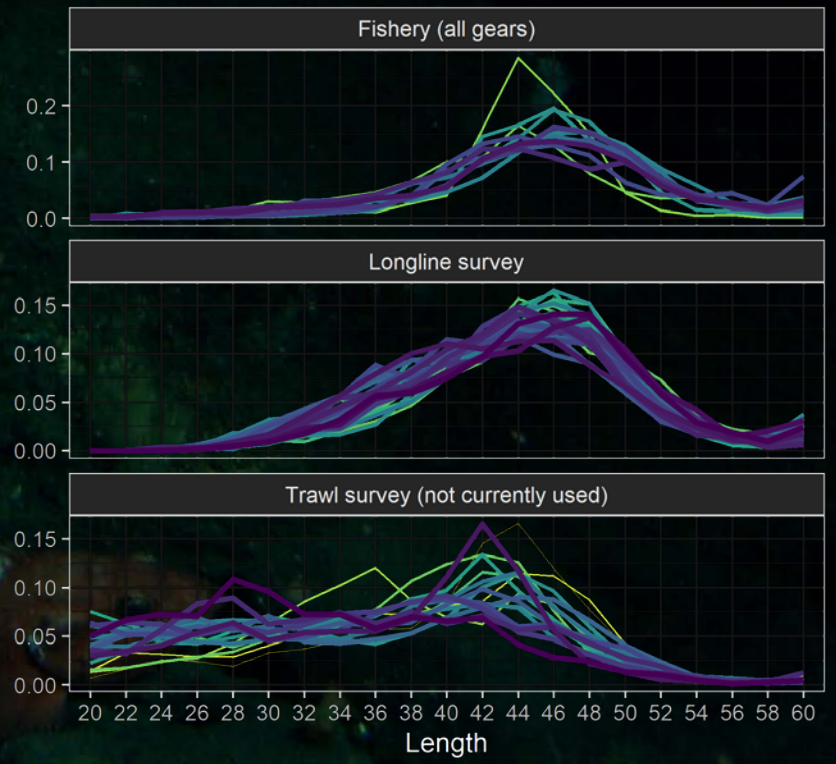
Longline survey length comps



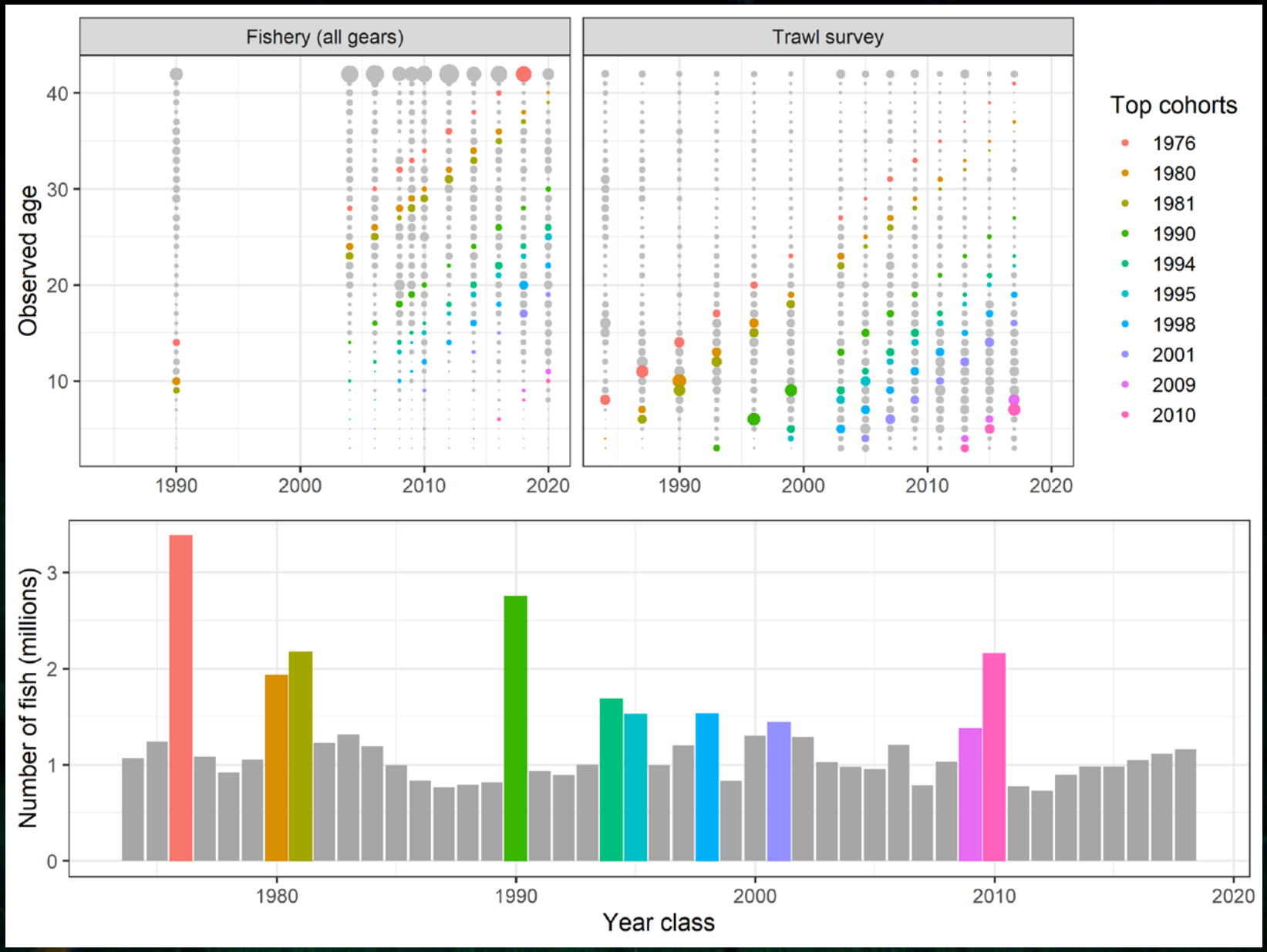
Data	RMSE
Trawl survey biomass	0.31
Longline survey RPN	0.29
Trawl survey ages	0.09
Fishery lengths	0.08
Longline survey lengths	0.08
Fishery ages	0.05
Historical catch (wt = 5)	0.02
Modern catch (wt = 50)	0.01

Utility of trawl survey composition data



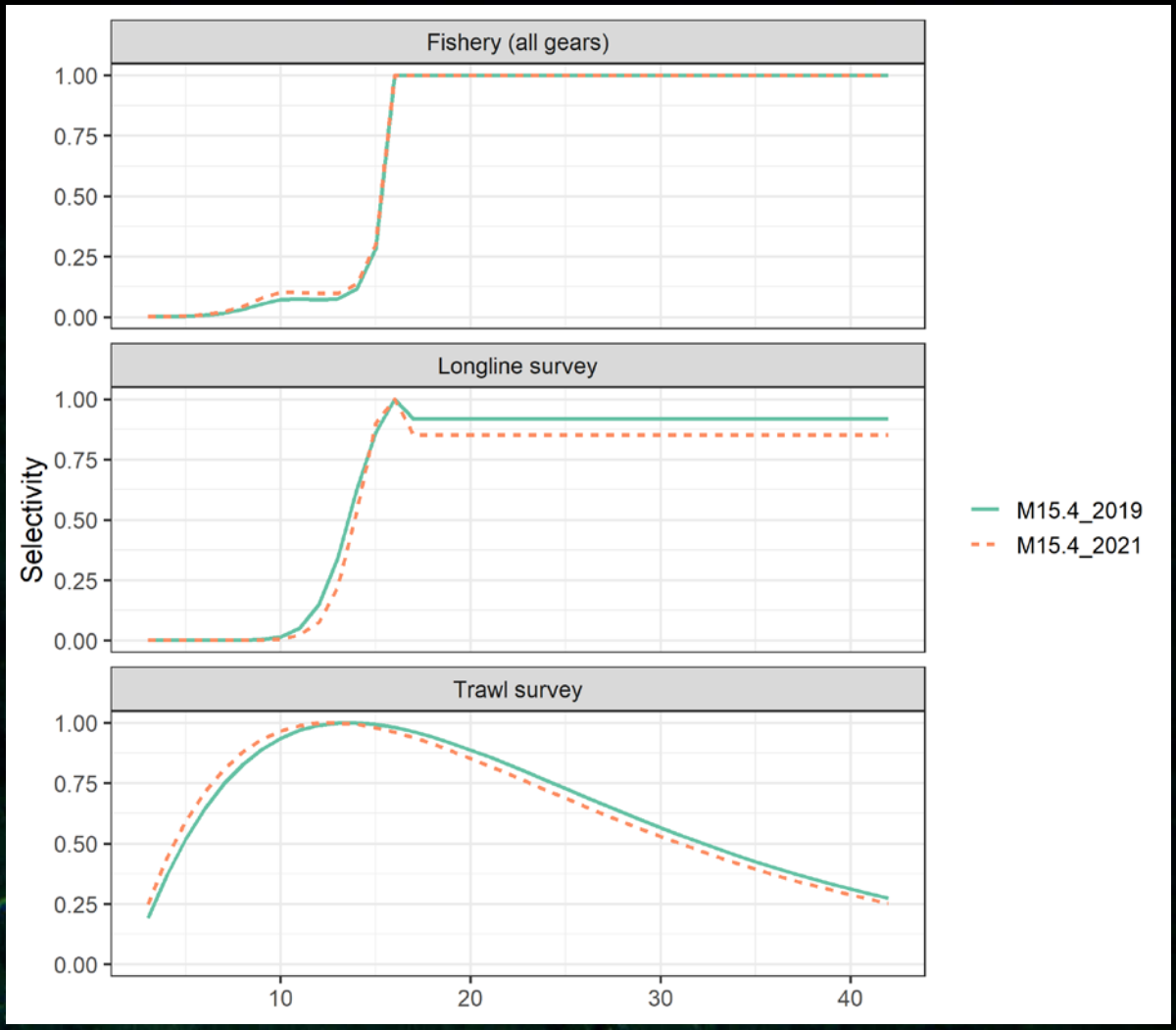


Recruitment signal

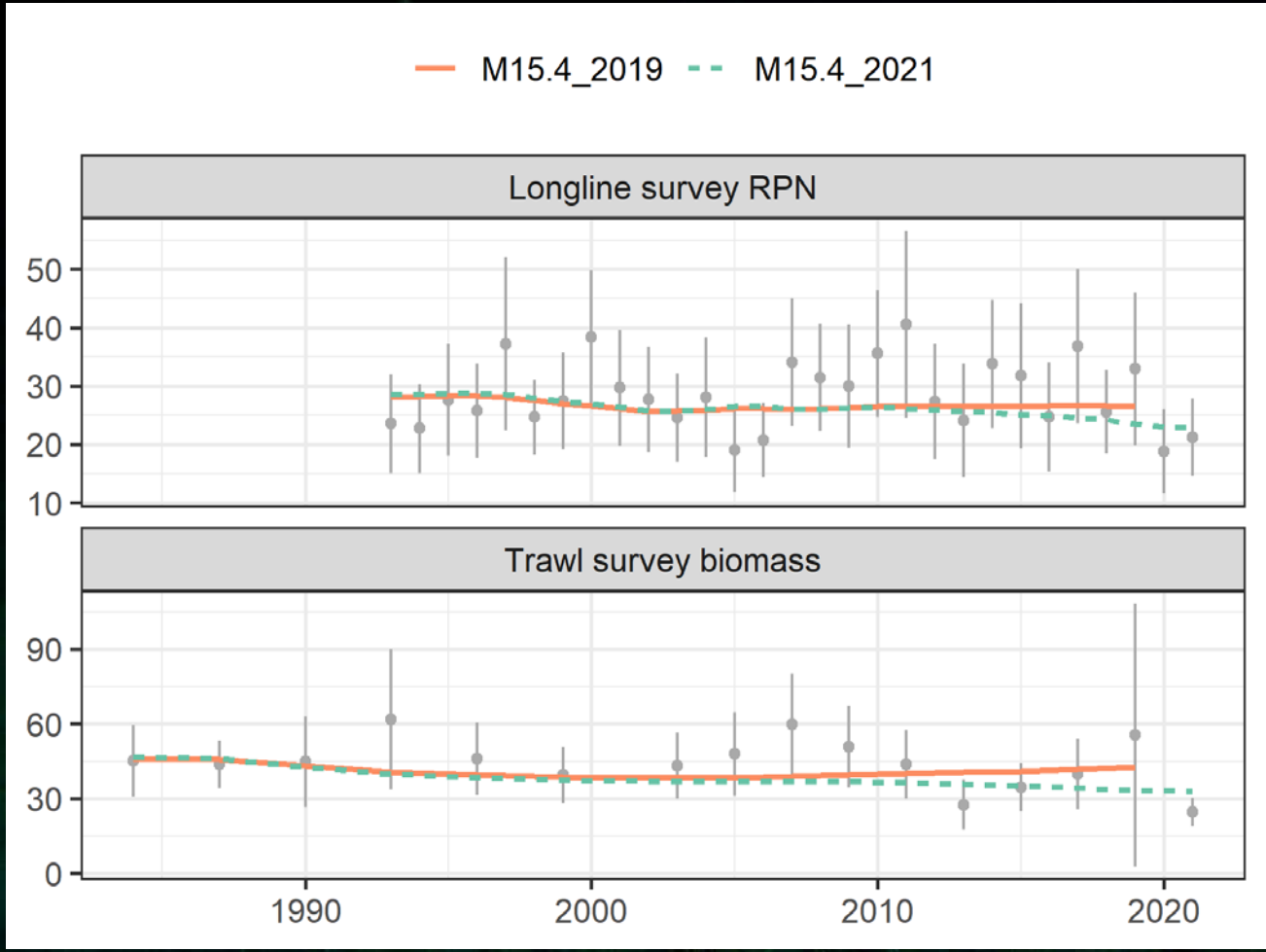


Selectivity

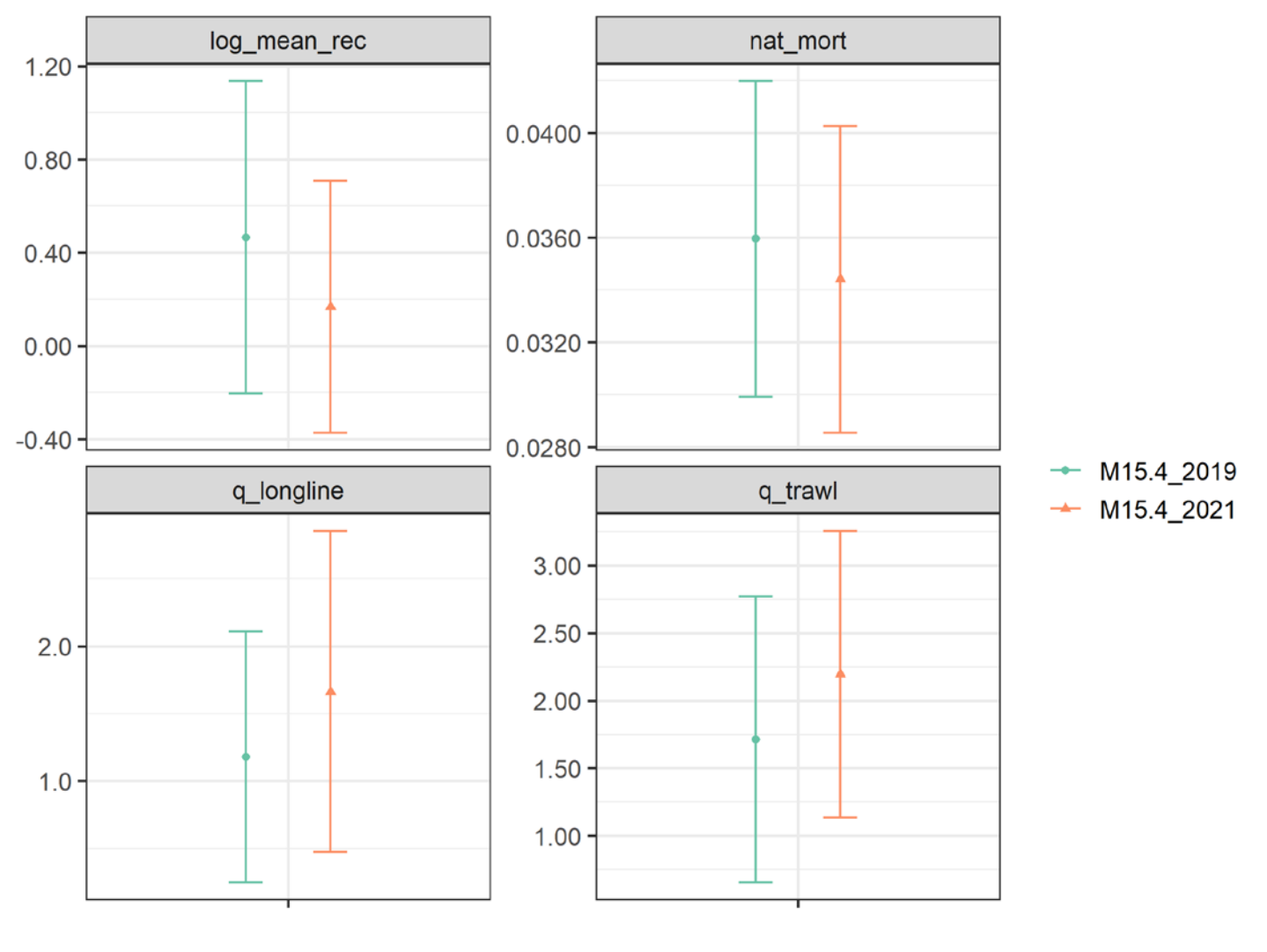
- Fishery & longline survey: penalized, second differences
- Trawl survey: gamma fxn

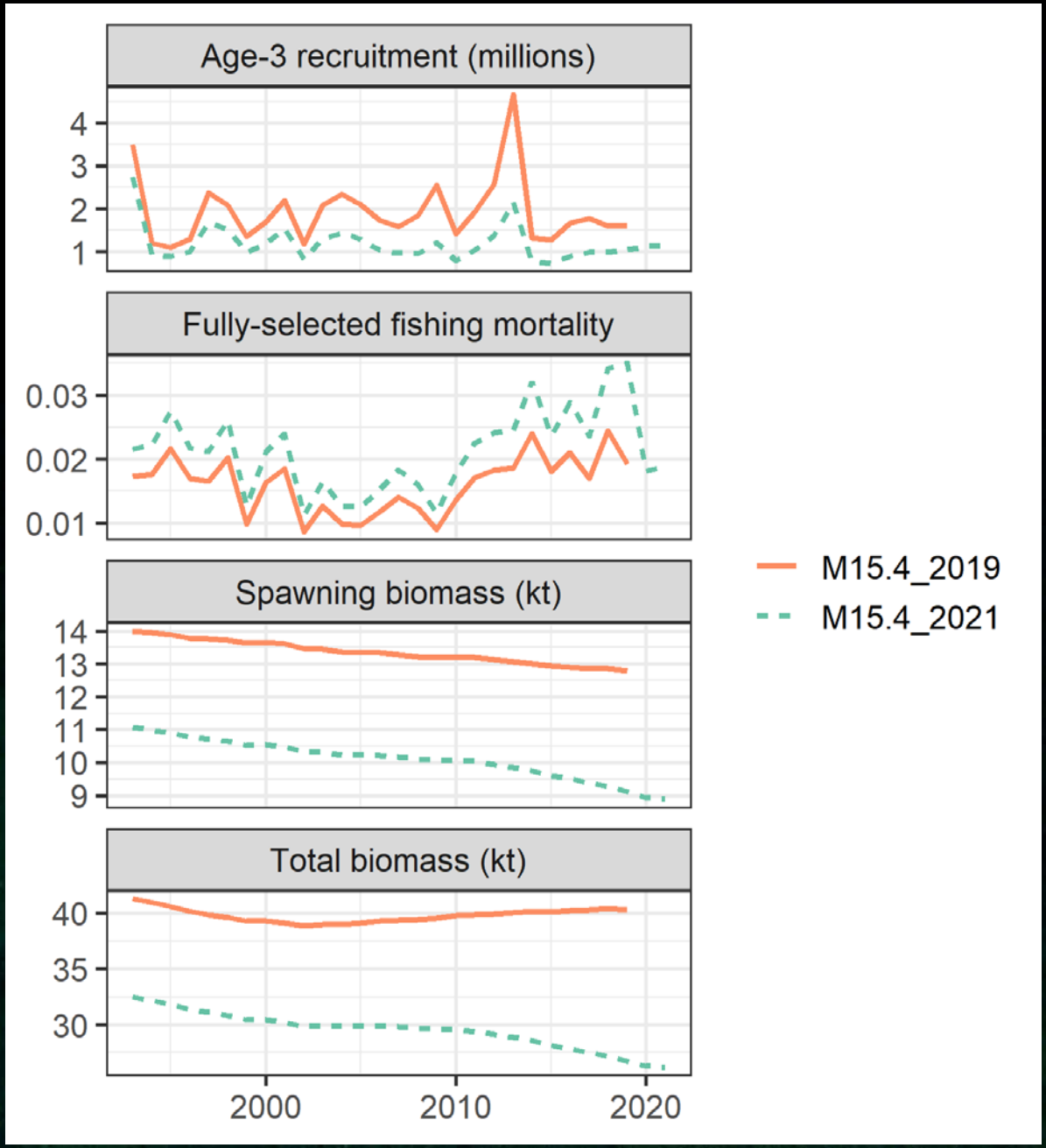


Changes since last assessment



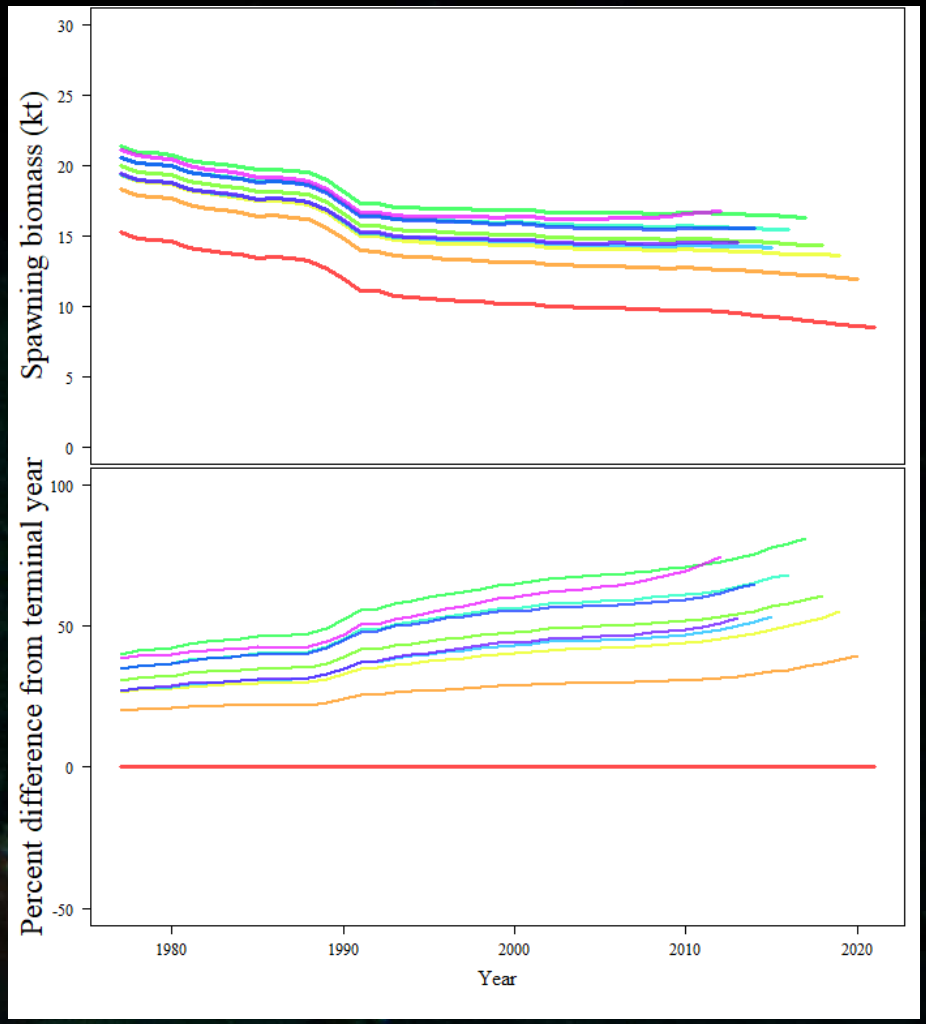
Shift in global scaling parameters




Age-3 recruitment (millions)
4
3
2
1
Fully-selected fishing mortality
0.03
0.02
0.01
Spawning biomass (kt)
14
13
12
11
10
9
Total biomass (kt)
40
35
30
2000
2010
2020
M15.4_2019
M15.4_2021

Strong positive retrospective bias

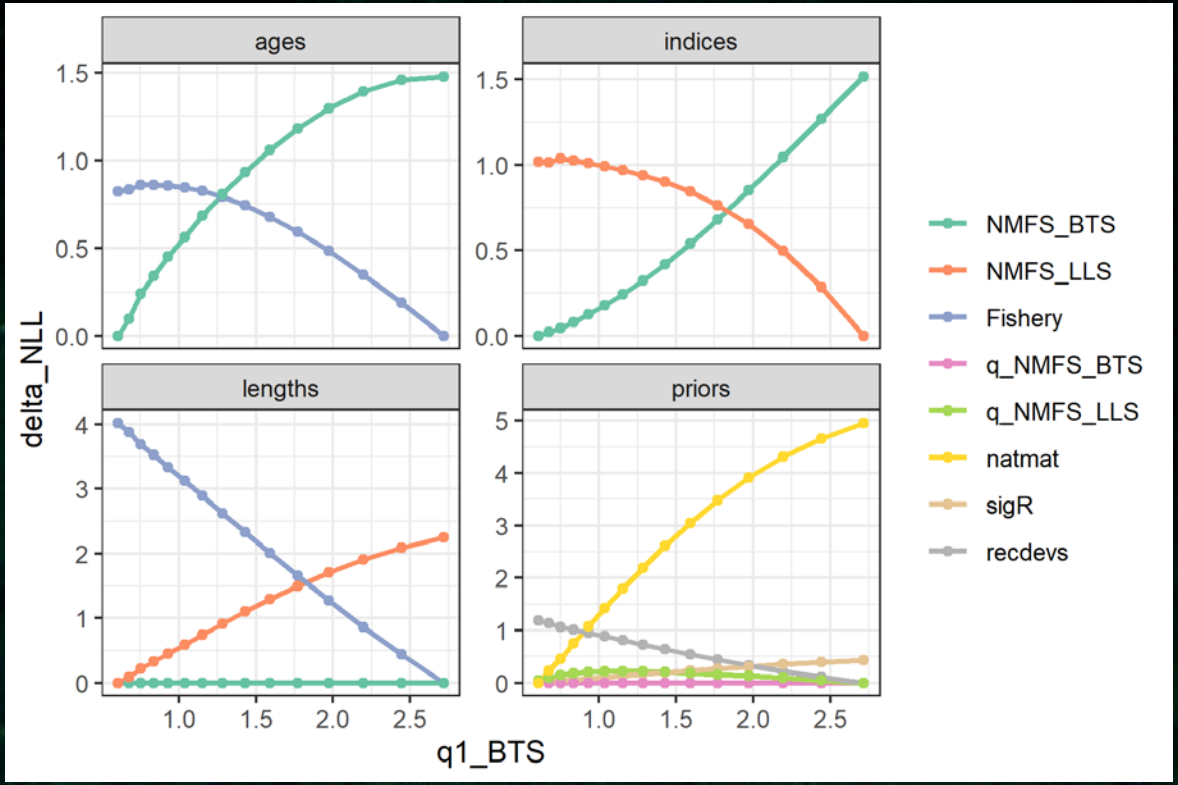
- Mohn's rho >> 0.2 rule of thumb for long-lived species (Hurtado-Ferro et al. 2015)
- Primarily driven by terminal year



Statistic	2017 (M15.4)	2019 (M15.4)	2021 (M15.4)
Mohn's revised ρ	0.009	0.167	0.611

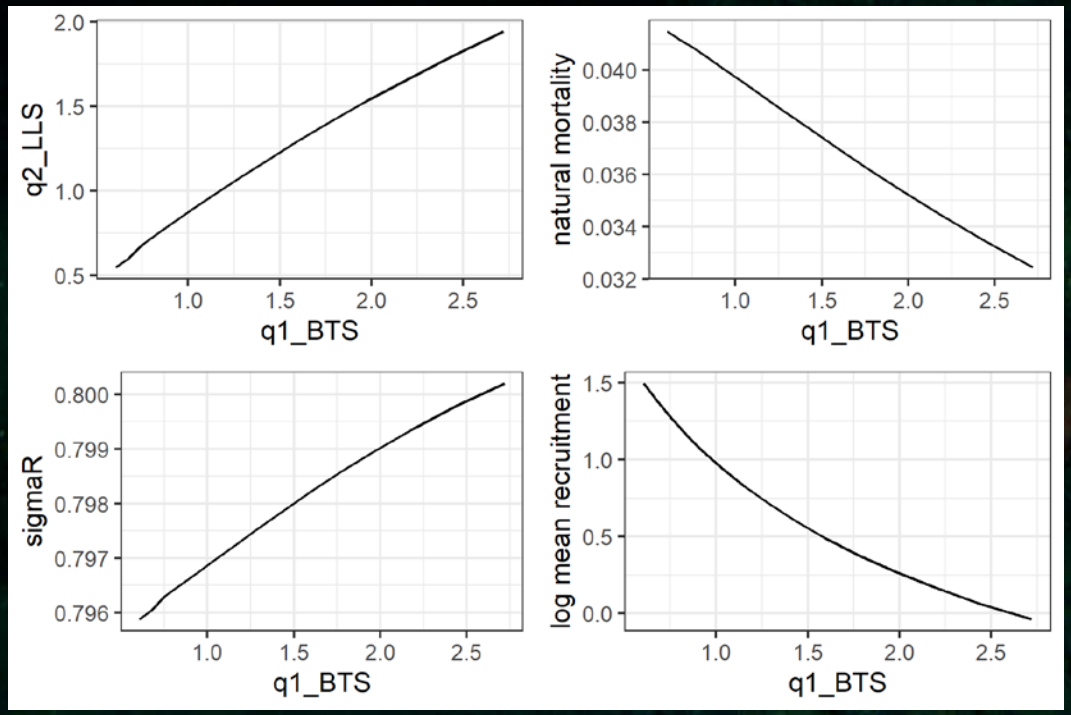
Catchabilities

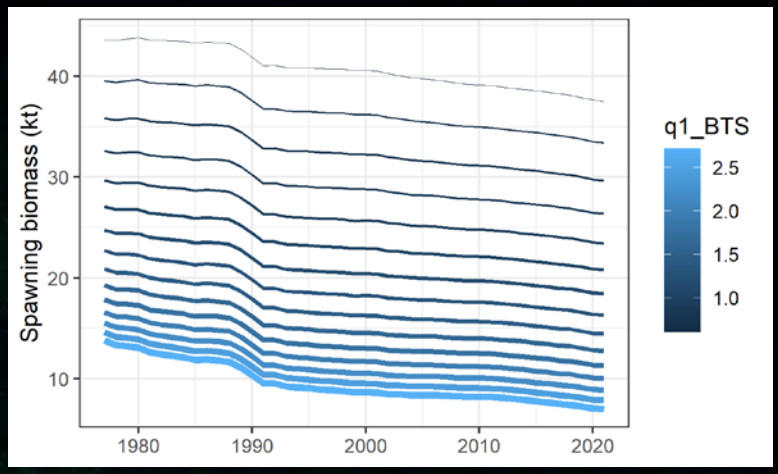
- Diagnostics: Fix trawl survey q, which has uninformative prior with mean = 1
- Likelihood profiles suggest q is not well-estimated or informed by the data

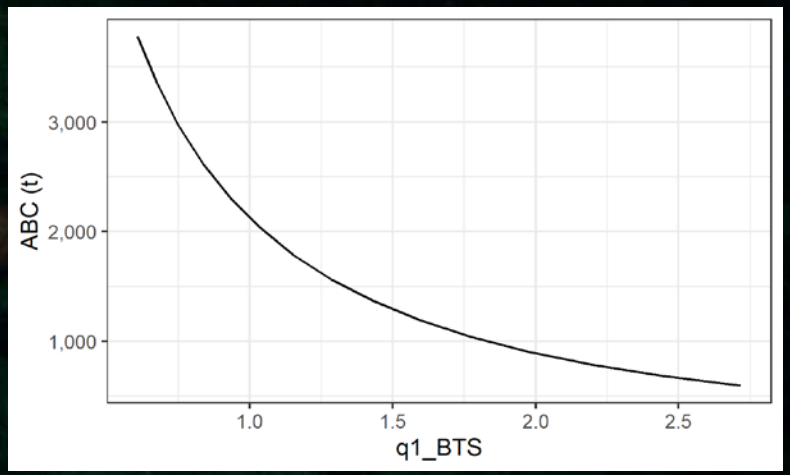


Uncertainty in population scale

- Trawl survey q is correlated with other global scaling parameters
- Trying to estimate too much?







RE/BS Risk Table

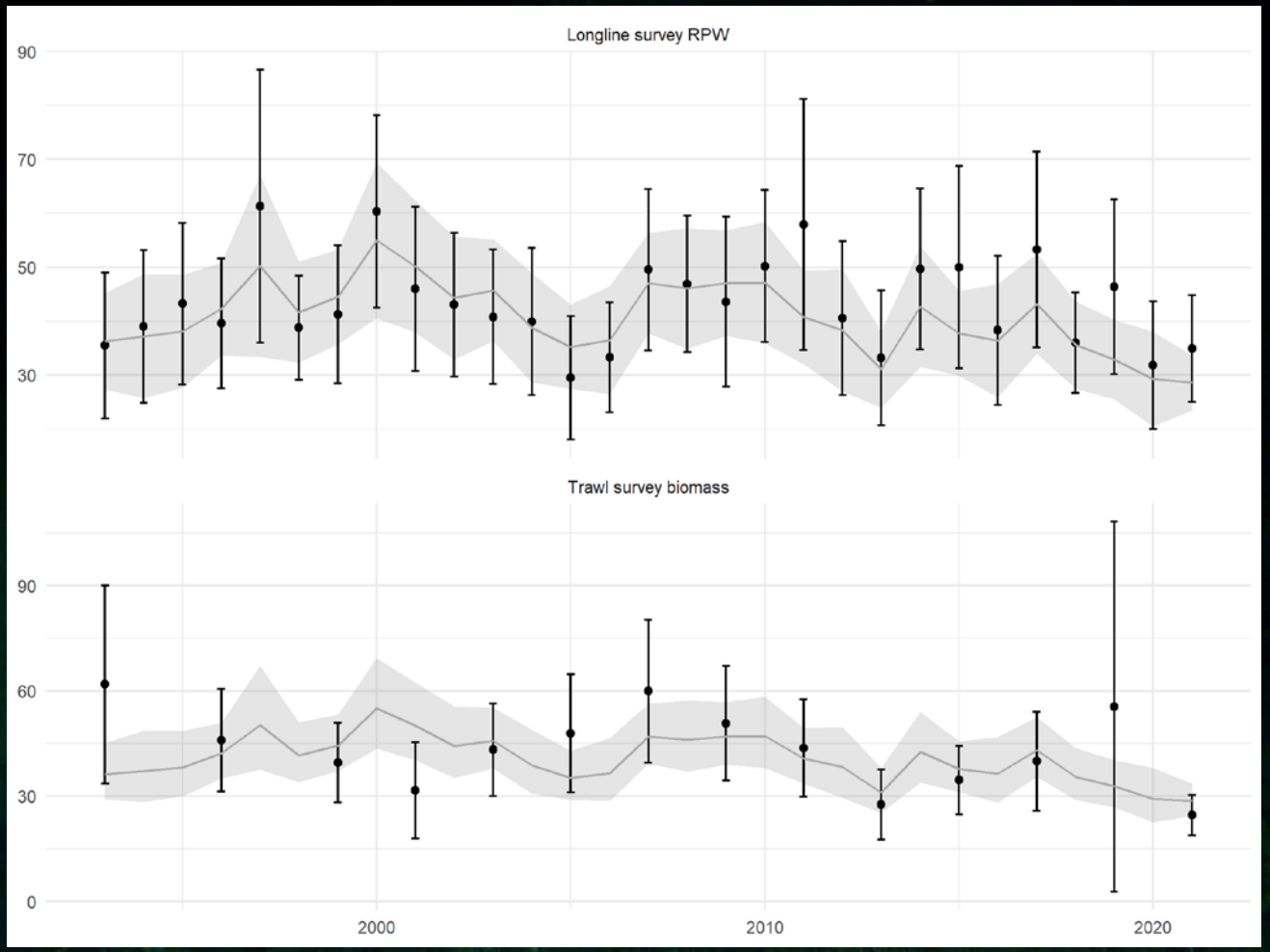
- Assessment (L2): strong positive retro bias (Mohn's rho=0.61), inconsistent trends in surveys.
- Pop dy (L1): downgrade in biomass attributed to assessment; monitoring survey trends/catch. Different maturity and growth between RE/BS is research priority.
- Ecosystem (L1): GOA return to cooler temperatures.
- Fishery Perf (L1): no directed fishery and catch trends are relatively stable, below TAC, and low discard rates.

Reference points and harvest recommendations

Quantity/Status	As estimated or specified *last* year for: 2021	2022	As estimated or recommended *this* year for: 2022	2023
M (natural mortality)	0.036	0.036	0.034	0.034
Tier	3a	3a	3a	3a
Projected total (age 3+) biomass (t)	40,432	40,454	26,060	25,997
Projected female spawning biomass (t)	12,540	12,563	8,648	8,627
$B_{100\%}$	20,658	20,658	14,776	14,776
$B_{40\%}$	8,263	8,263	5,911	5,911
$B_{35\%}$	7,230	7,230	5,172	5,172
F_{OFL}	0.048	0.048	0.046	0.046
$maxF_{ABC}$	0.040	0.040	0.038	0.038
F_{ABC}	0.040	0.040	0.038	0.038
OFL (t)	1,456	1,467	**947**	937
max ABC (t)	1,212	1,221	**788**	781
ABC (t)	1,212	1,221	**788**	781

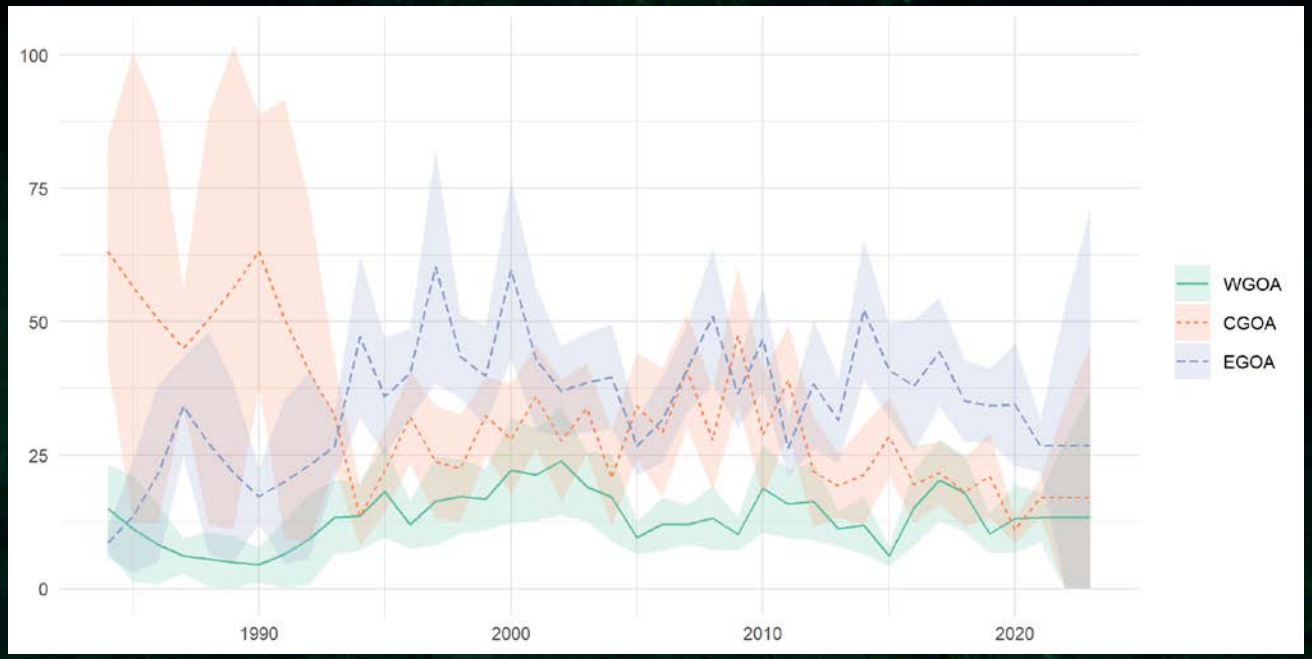
Catch: 384 t (2021), 356 t (2022), 345 t (2023)

Apportionment using two survey random effects model (Hulson et al. 2021)

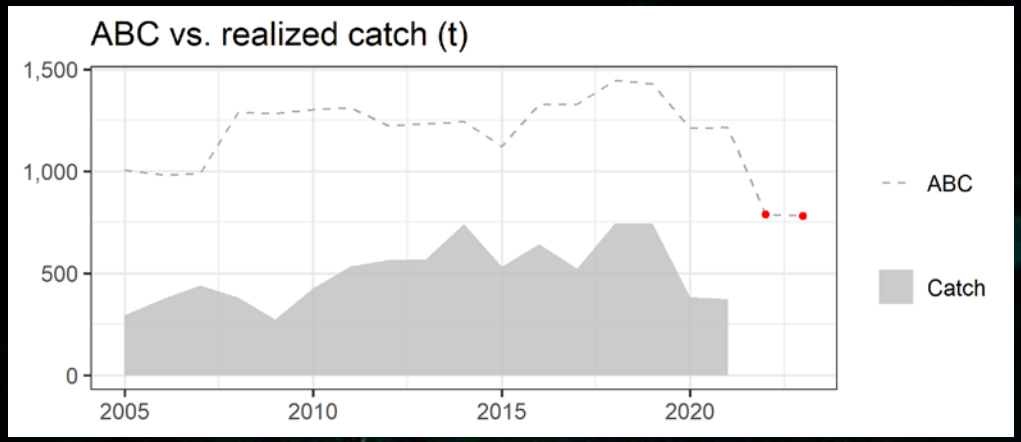


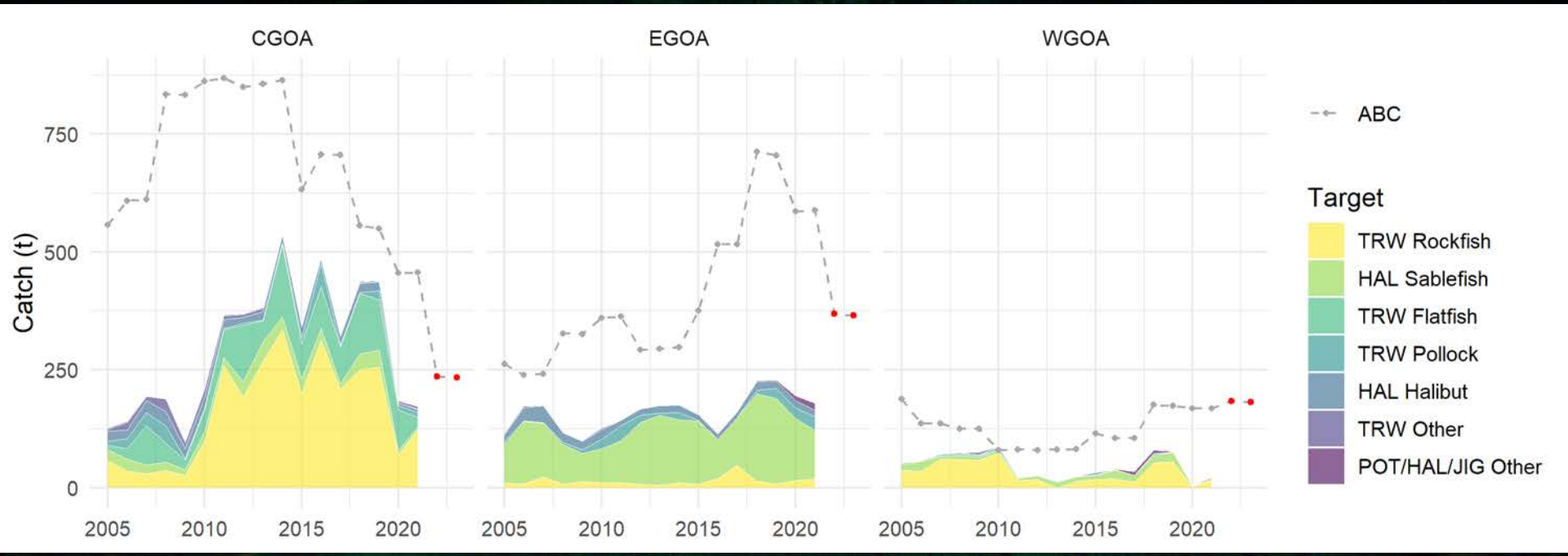
Apportionment results

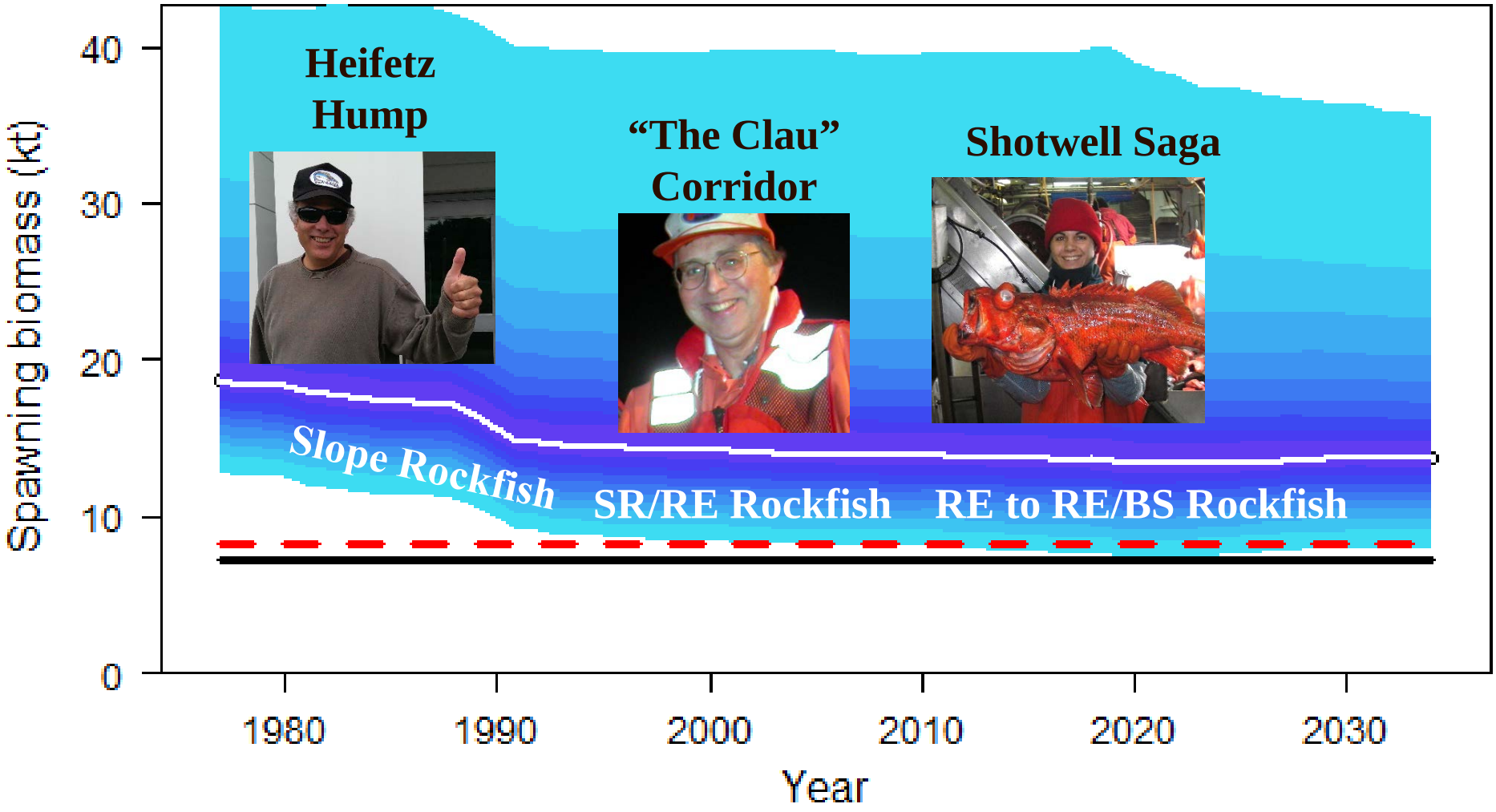
Area Allocation		Western GOA	Central GOA	Eastern GOA	Total
		23.3%	29.9%	46.8%	100.0%
2022	Area ABC (t)	**184**	**235**	**369**	**788**
	OFL (t)				**947**
2023	Area ABC (t)	**182**	**234**	**365**	**781**
	OFL (t)				**937**



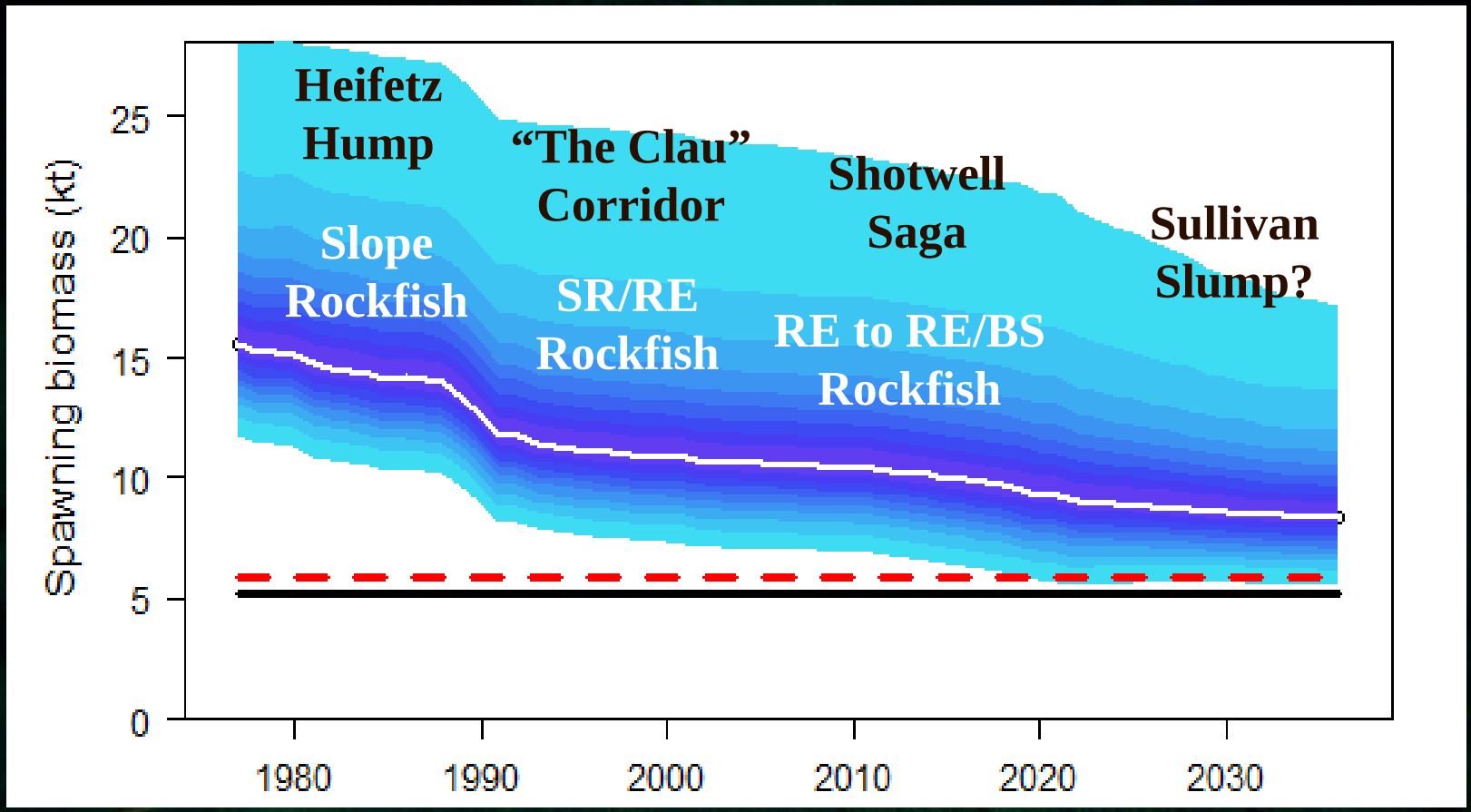
Potential management implications






Heifetz Hump
"The Clau" Corridor
Shotwell Saga
Slope Rockfish
SR/RE Rockfish
RE to RE/BS Rockfish
Spawning biomass (kt)
0
10
20
30
40
1980
1990
2000
2010
2020
2030
Year





Heifetz Hump
"The Clau" Corridor
Shotwell Saga
Sullivan Slump?
Slope Rockfish
SR/RE Rockfish
RE to RE/BS Rockfish
Spawning biomass (kt)
25
20
15
10
5
0
1980
1990
2000
2010
2020
2030

Assessment Research Priorities

1. House keeping
2. Data and model considerations
3. Multispecies

Update externally estimated parameters

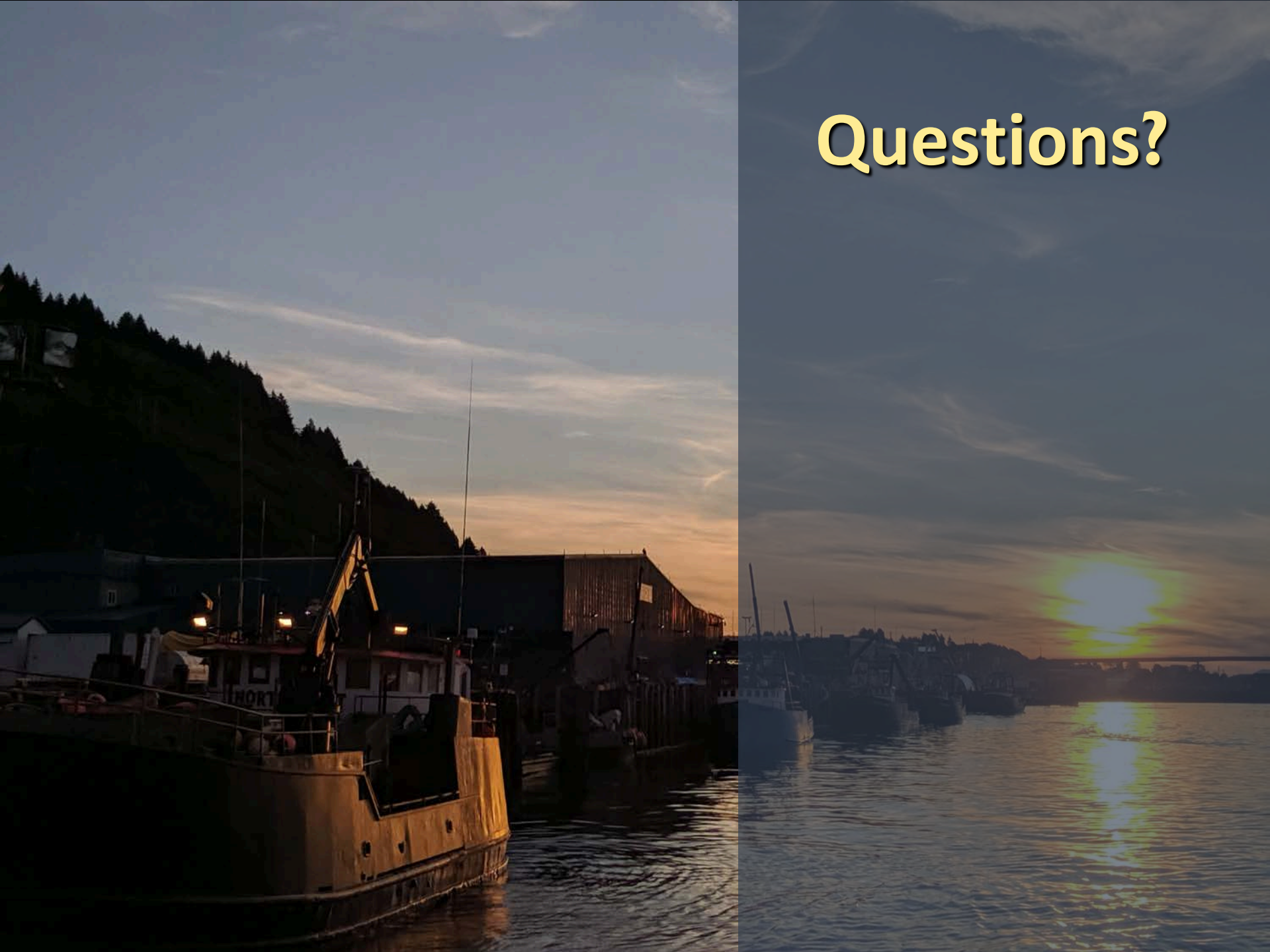
1. Ageing error
2. Weight-at-age
3. Size-age transition
4. Maturity
5. Natural mortality
   (BSAI BS/RE ~0.045)
   (GOA RE/BS ~0.034)

Data and model considerations

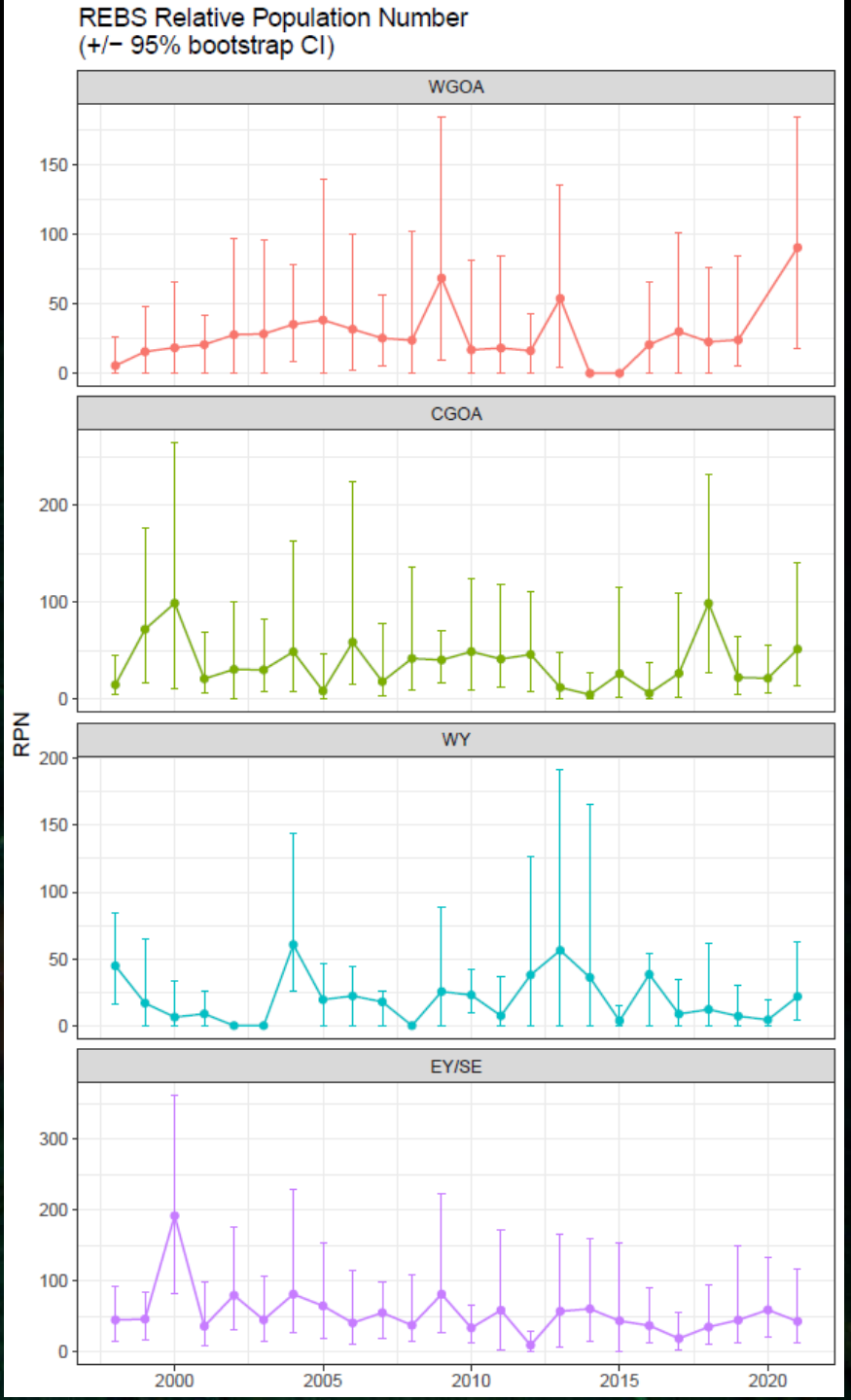
1. Data weighting
2. Trawl survey length data
3. Survey indices (refinements in depth strata, sensitivities, IPHC)
4. Fishery data combined
5. q (priors, alternative parameterizations)
6. Selectivity

Multispecies considerations

1. Maturity and growth sensitivities
2. Species discrimination of archived otoliths


Questions?

IPHC survey


REBS Relative Population Number
(+/− 95% bootstrap CI)
WGOA
CGOA
WY
EY/SE
RPN
0
50
100
150
200
300
2000
2005
2010
2015
2020