# Preliminary for STAR Panel: Assessment of Pacific mackerel *(Scomber japonicus)* for 2023-24 and 2024-25

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Stock structure

- Range from SE Alaska to Banderas Bay Mexico

- Three hypothesized spawning areas
  - Gulf of California
  - Cabo San Lucas, Mexico
  - Punta Abreojos, BCS
    - Extends north off southern California
    - Focus of US management

Preliminary results presented to STAR panel
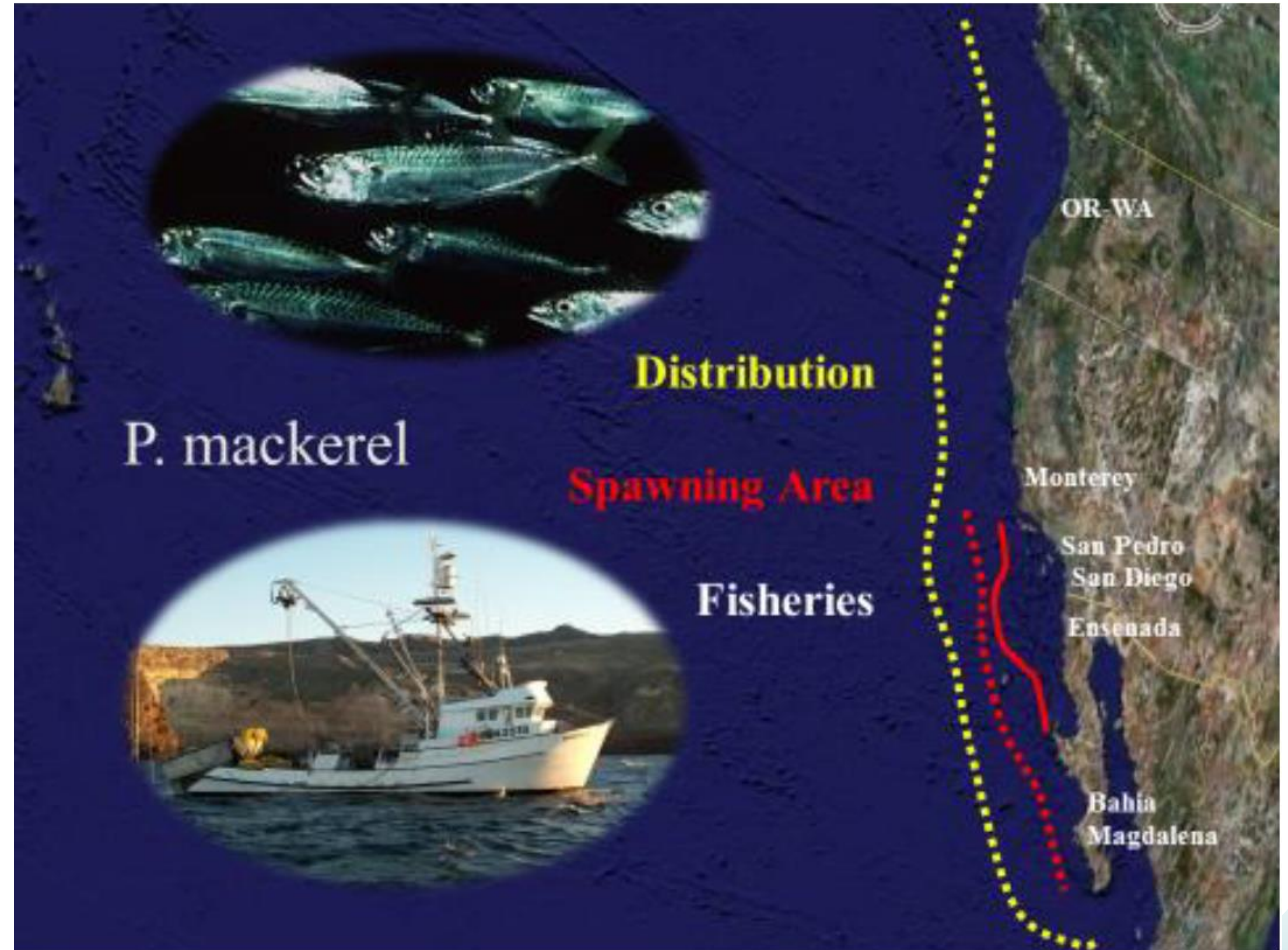
Distributions

- Seasonal movements
  - Northward in late spring/summer
    - Upwelling off OR and WA
  - Southward late fall/winter
    - Spawning in southern CA

- Usually observed within 30 km off coast
  - Have been found up to 400 km offshore

- School with other CPS

Preliminary results presented to STAR panel
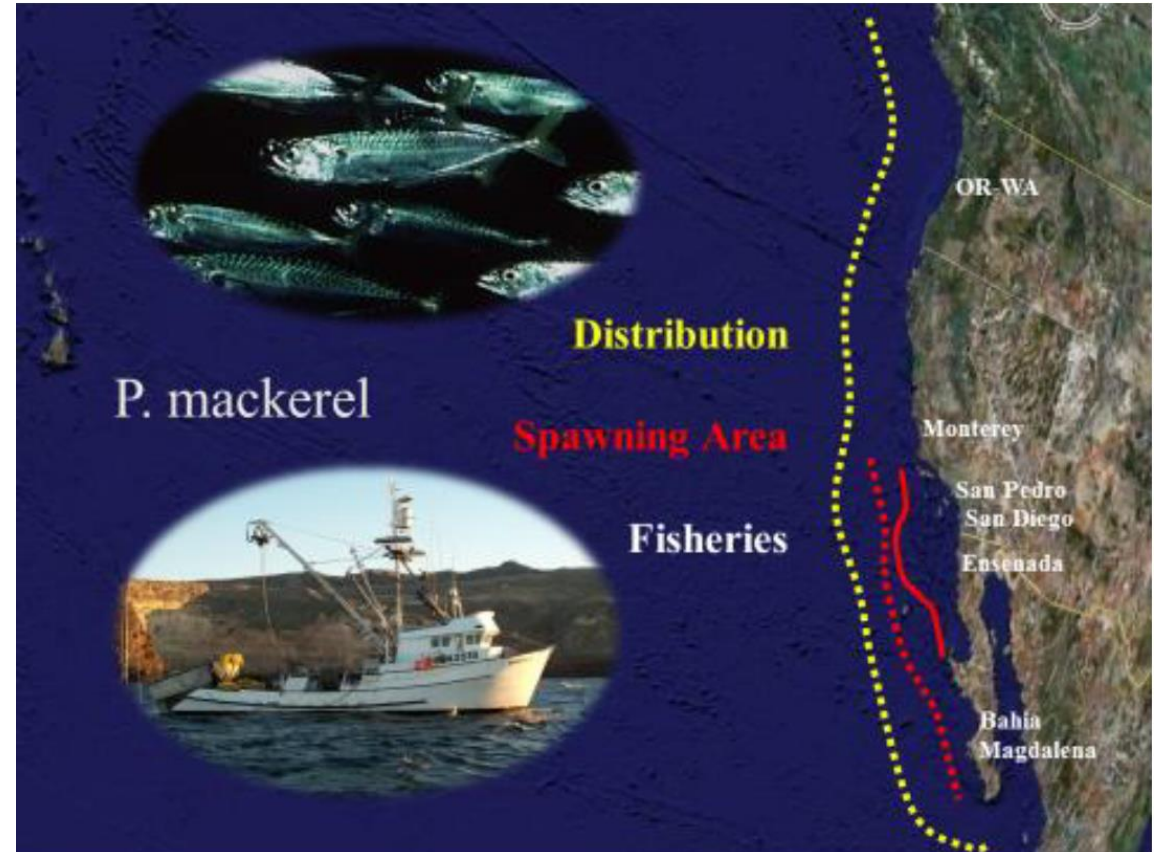
Biological characteristics

- Recruitment
  - Cyclical periods of abundance
    - Less frequent highs than other CPS
    - High biomass once every 60 years
      - MacCall et al. 1985

- Natural mortality (M)
  - Past assessments assume 0.5 yr^{-1}
  - Time-invariant, constant by age
  - 0.3-0.7 (Beverton 1963)

1978 CalCOFI larvae

Preliminary results presented to STAR panel
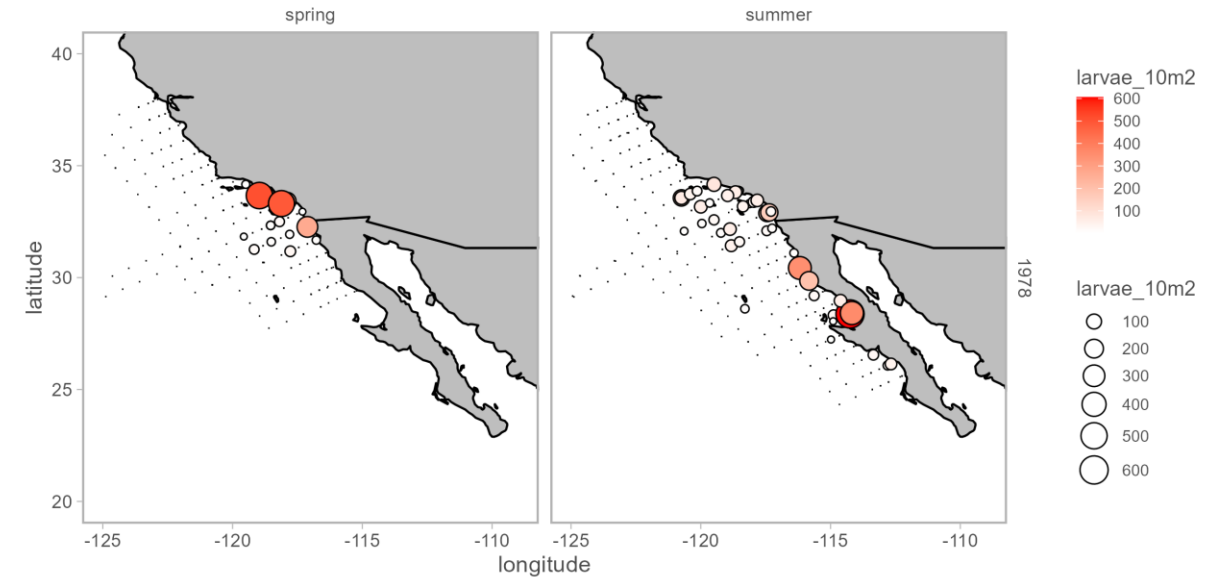
Previous assessment

- Crone et al. (2019)
  - 2008-2019
  - One fishery, AT survey index and age compositions
- No AT survey age compositions
  - Used fishery age-length key to generate survey age comps.
- Fixed steepness, recruitment variability (sigmaR)
- Q estimated, time-invariant
- M estimated with prior
- Empirical weight-at-age
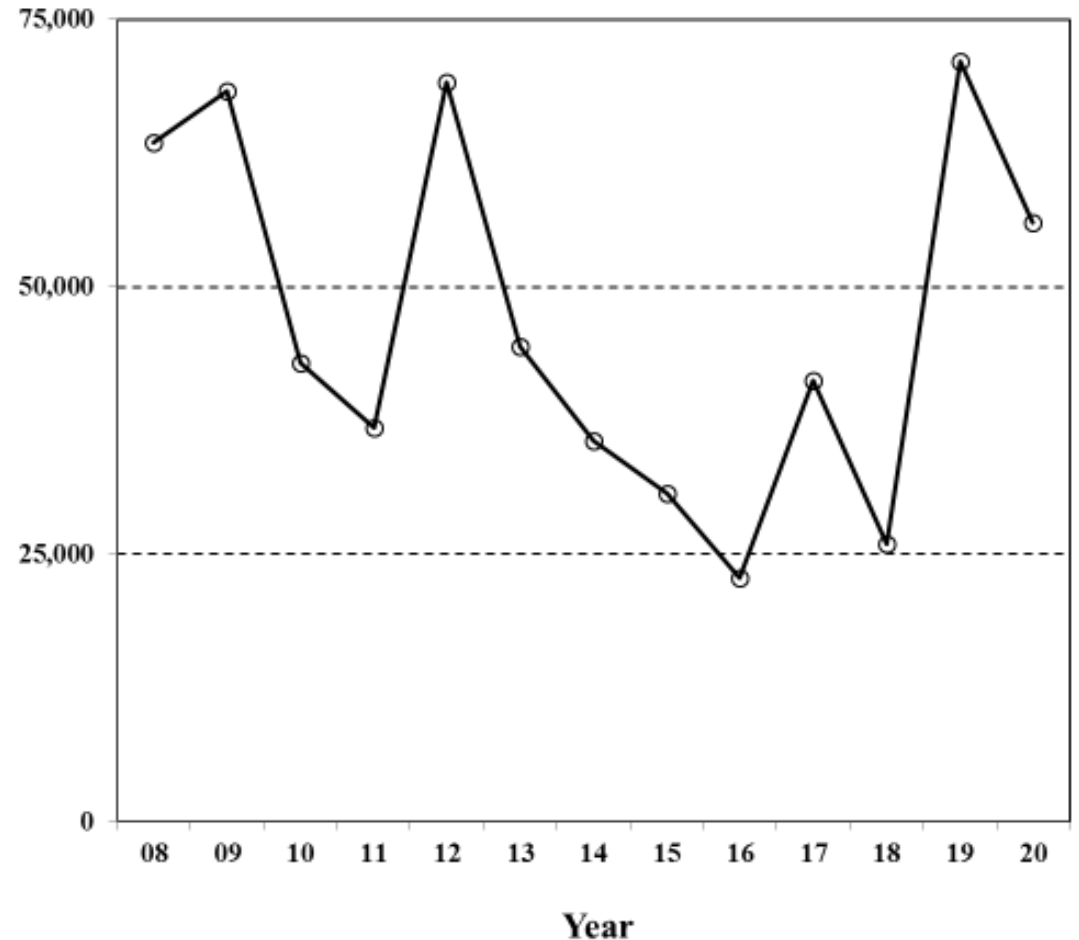
Summary biomass (age-1+)
Fig. 16, Crone et al. (2019)

US Fishery Harvest limits and landings

- Fishing year
  - July 1-June 30
  - Model year

- Table 2 in assessment document

Model Year	OFL	ABC	ACL	HG	USA-TOT	PercHG
2008	NA	NA	40,000	NA	4,543	11%
2009	NA	NA	10,000	NA	3,607	36%
2010	NA	NA	11,000	NA	2,313	21%
2011	44,336	42,375	40,514	30,386	2,074	7%
2012	44,336	42,375	40,514	30,386	5,608	18%
2013	57,316	52,358	52,358	39,268	11,909	30%
2014	32,992	30,138	29,170	24,170	5,593	23%
2015	25,291	23,104	21,469	20,469	4,686	23%
2016	24,983	22,822	21,161	20,161	2,757	14%
2017	30,115	27,510	26,293	25,293	1,808	7%
2018	27,662	25,269	23,840	22,840	2,501	11%
2019	14,931	13,169	11,109	10,109	3,916	39%
2020	11,772	10,289	7,950	6,950	691	10%
2021	12,145	9,446	8,323	7,323	1,007	14%
2022	9,644	7,501	5,822	4,822	990	21%

Assessment configuration

- Annual time steps
  - Model year 2015
    - July 1, 2015 to June 30, 2016

- Two fleets
  - Fishery
    - Mexico, California, Oregon, Washington
  - Acoustic-trawl (AT) survey

- 2008-2021 model period
  - Matches timeline of AT observations for AT survey data
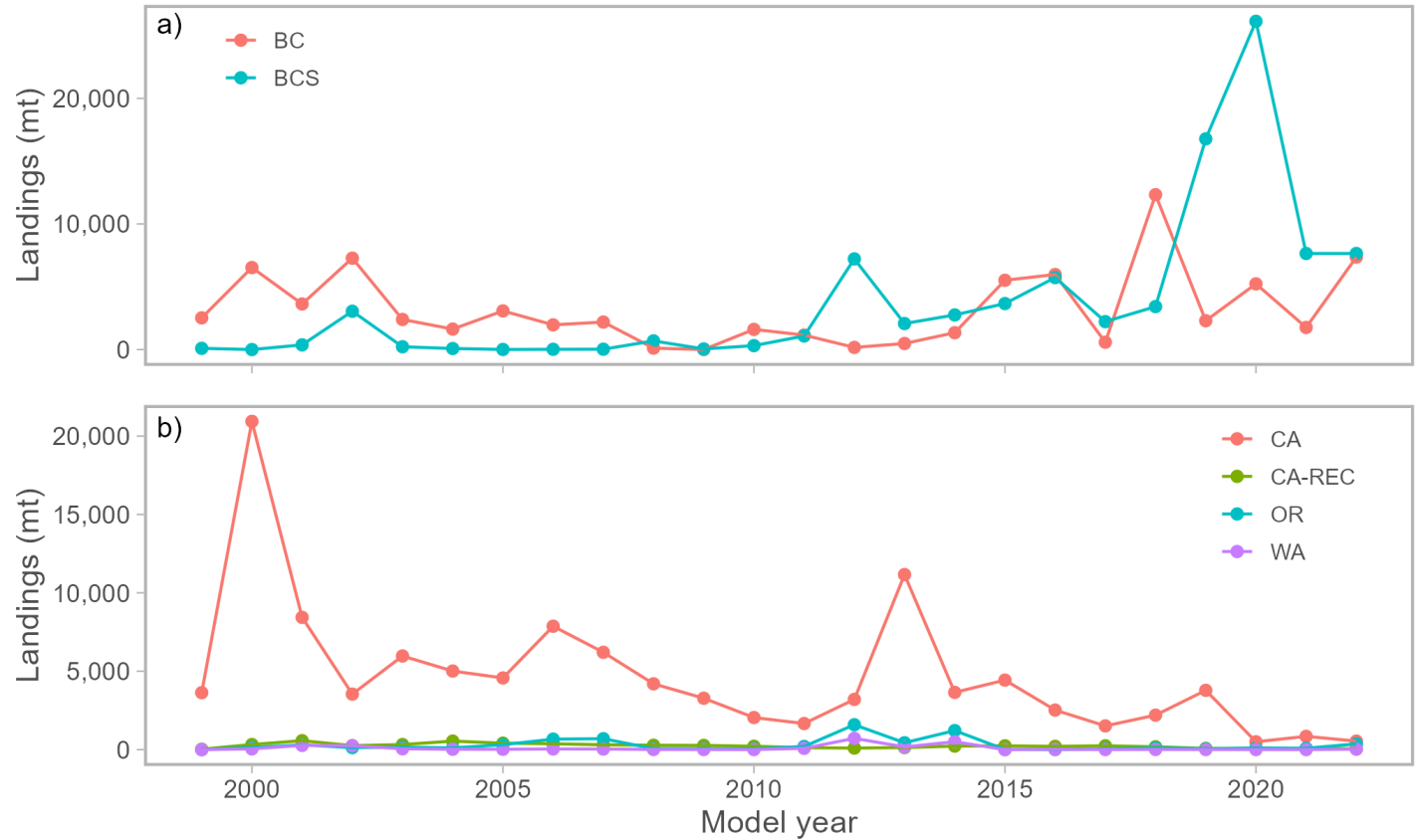 - 2022 AT survey value not finalized

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NOAA FISHERIES
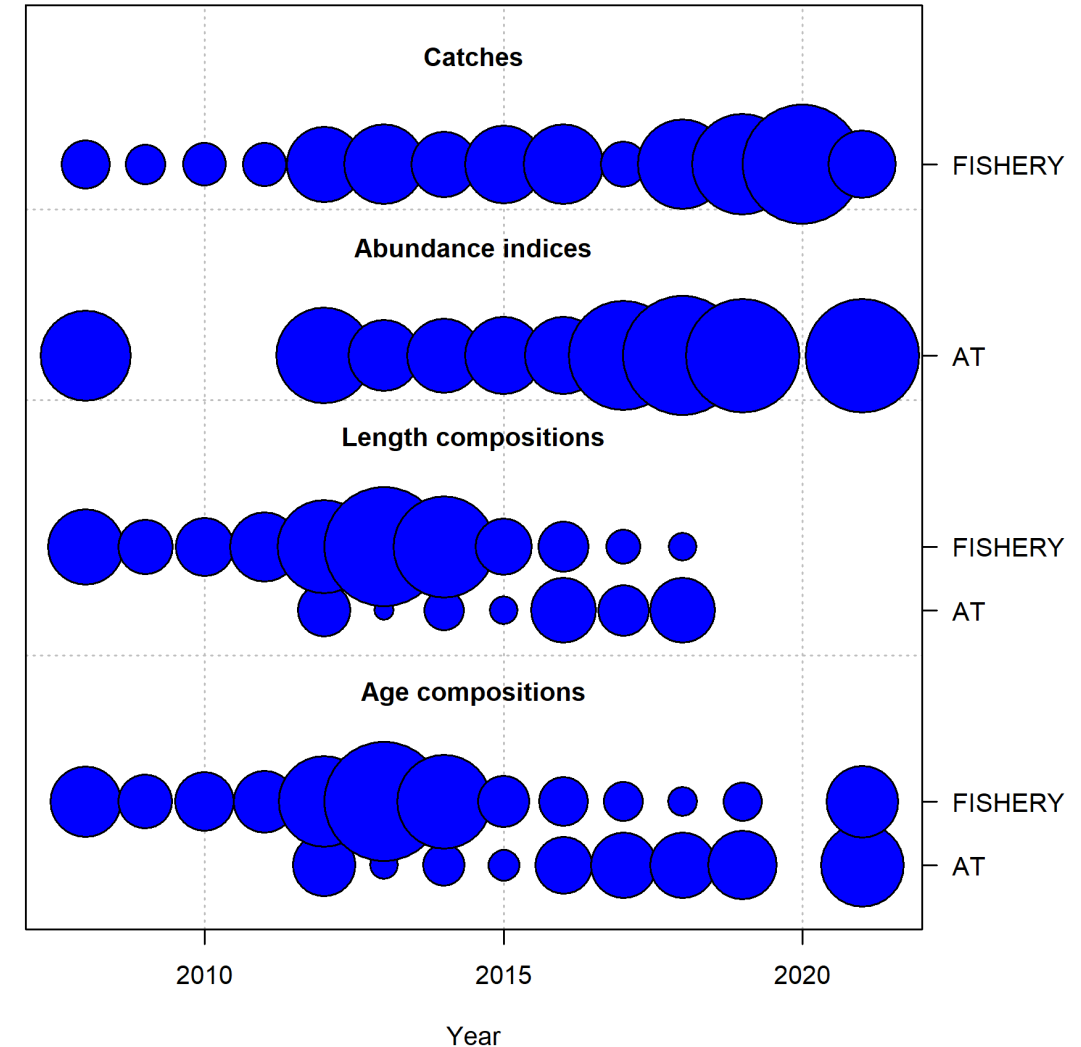
Data in this assessment

- Catch
  - Fishery

- Age compositions (and weight-at-age data)
  - AT survey
  - Fishery

- Index of abundance
  - AT survey

Preliminary results presented to STAR panel

Catch time series

- Mexico
  - Baja California (BC)
  - Baja California Sur (BCS)

- USA
  - California (CA)
  - California recreational (CA-REC)
  - Oregon (OR)
  - Washington (WA)

- Shown back to 1999
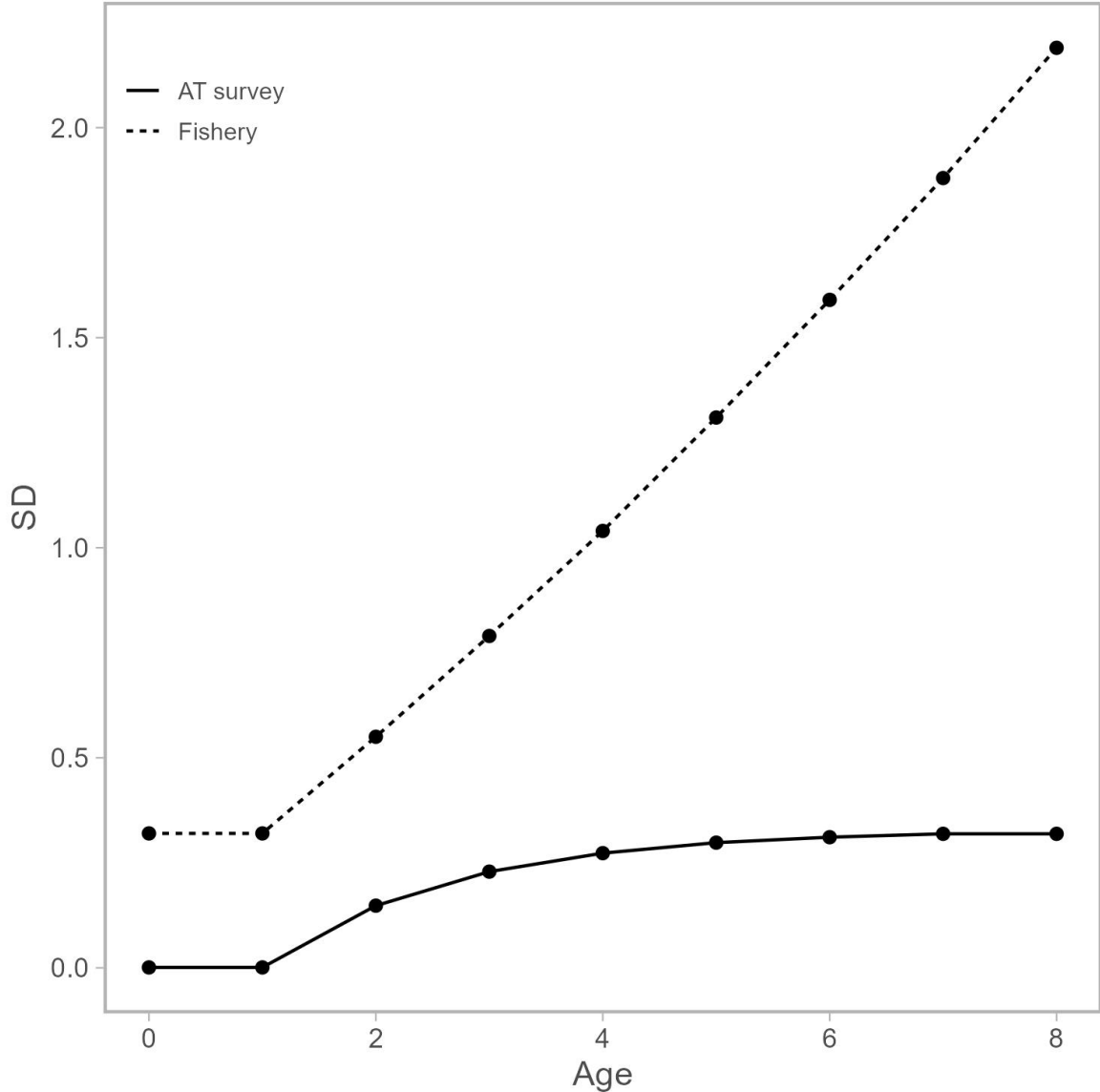
Catch time series

- Input into base model

Age compositions

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Ageing error

Preliminary results presented to STAR panel
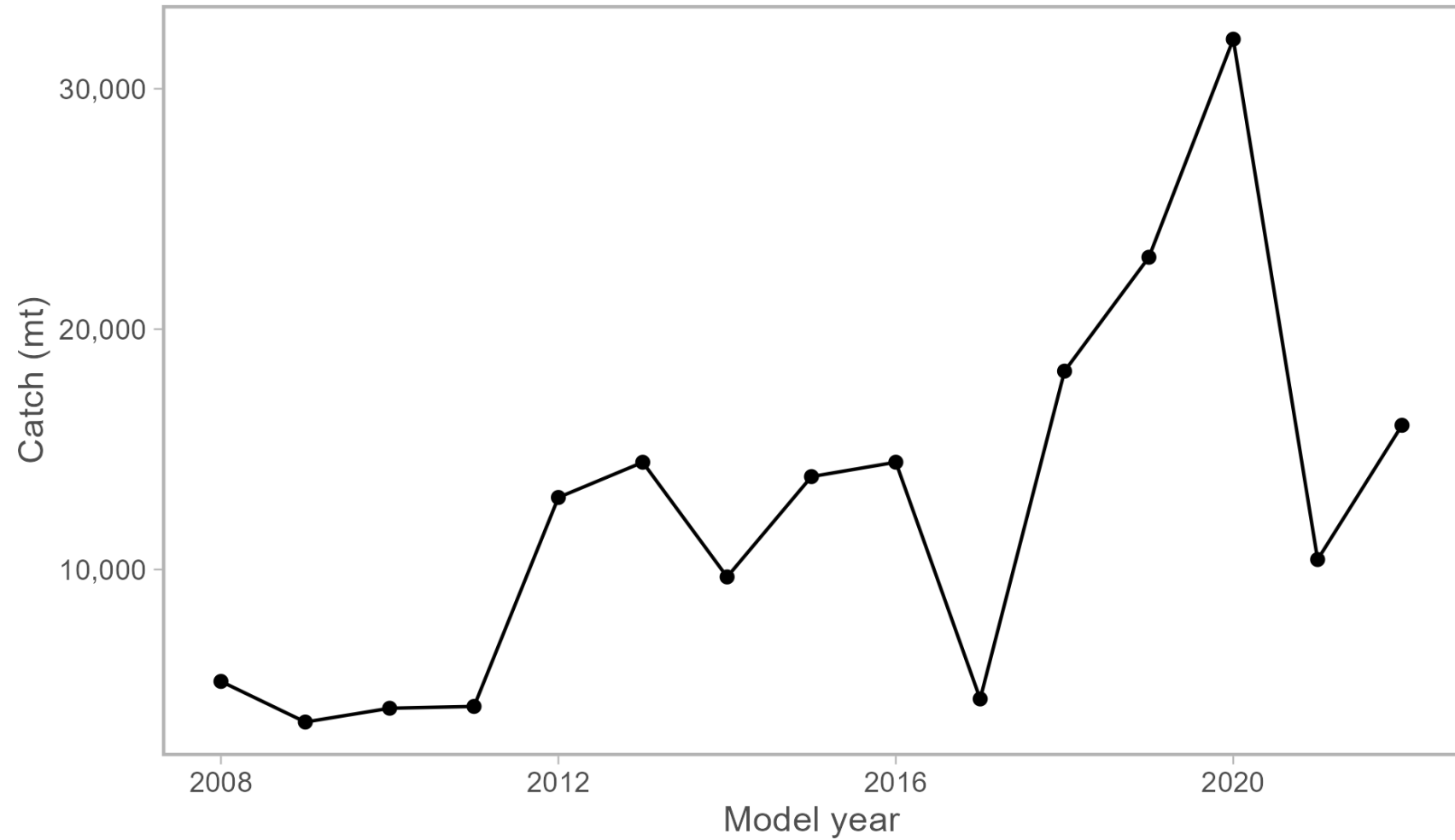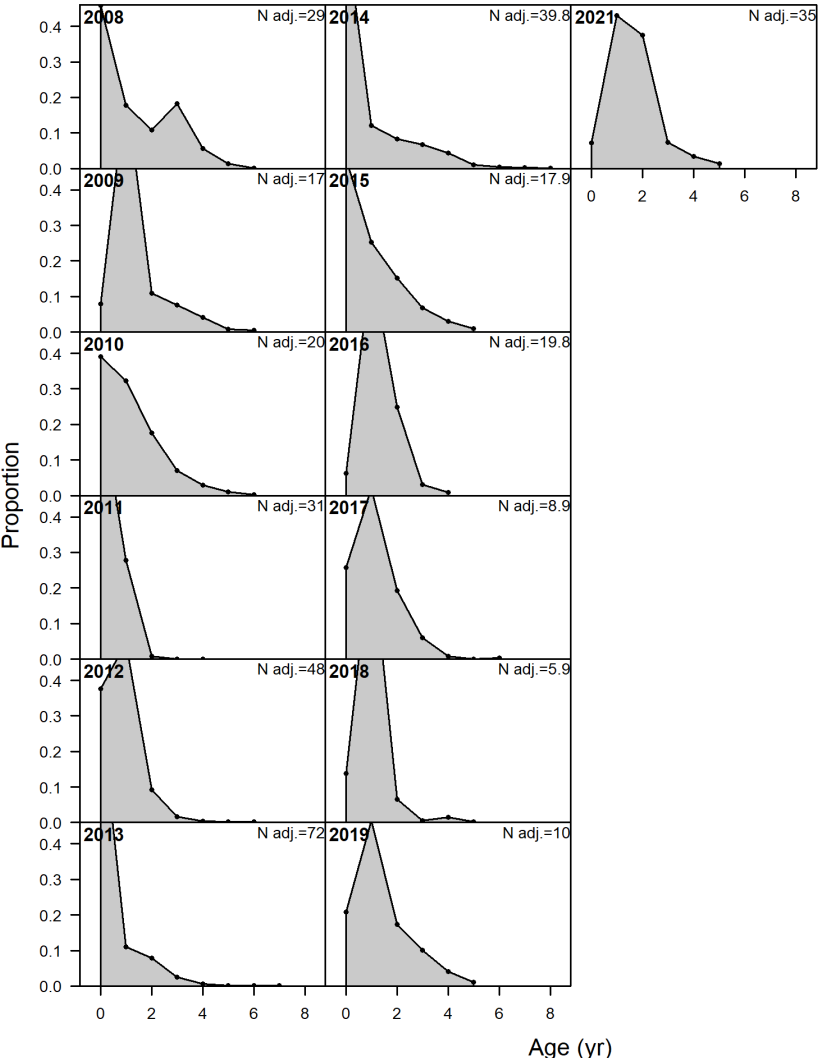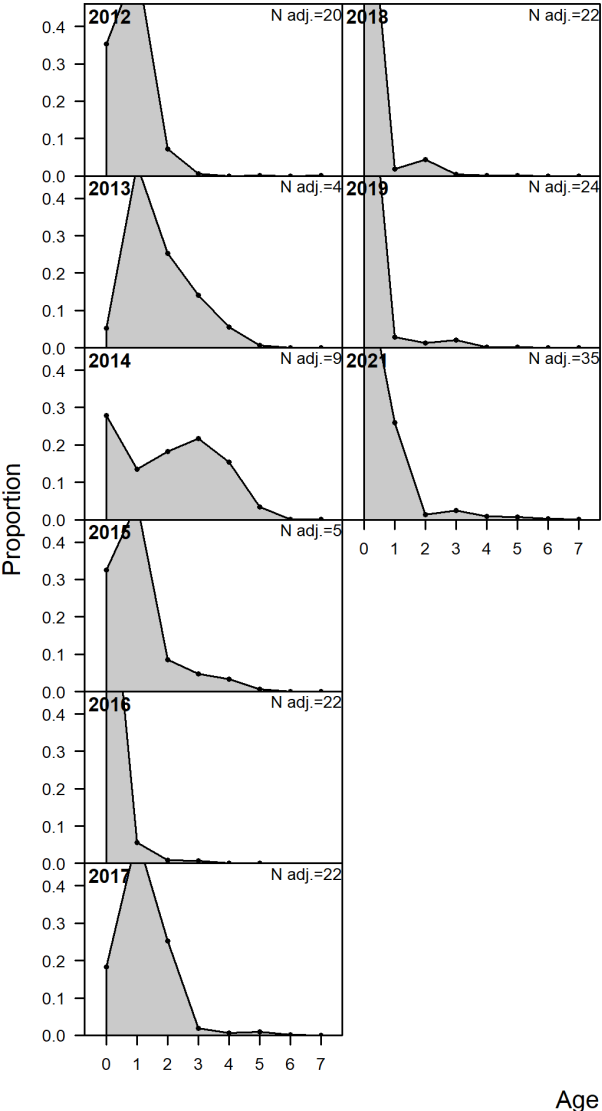
Weight-at-age (by cohort)

- Filled values have white circle

- Sample sizes
  - Numbers of fish in bottom right of each panel

Preliminary results presented to STAR panel
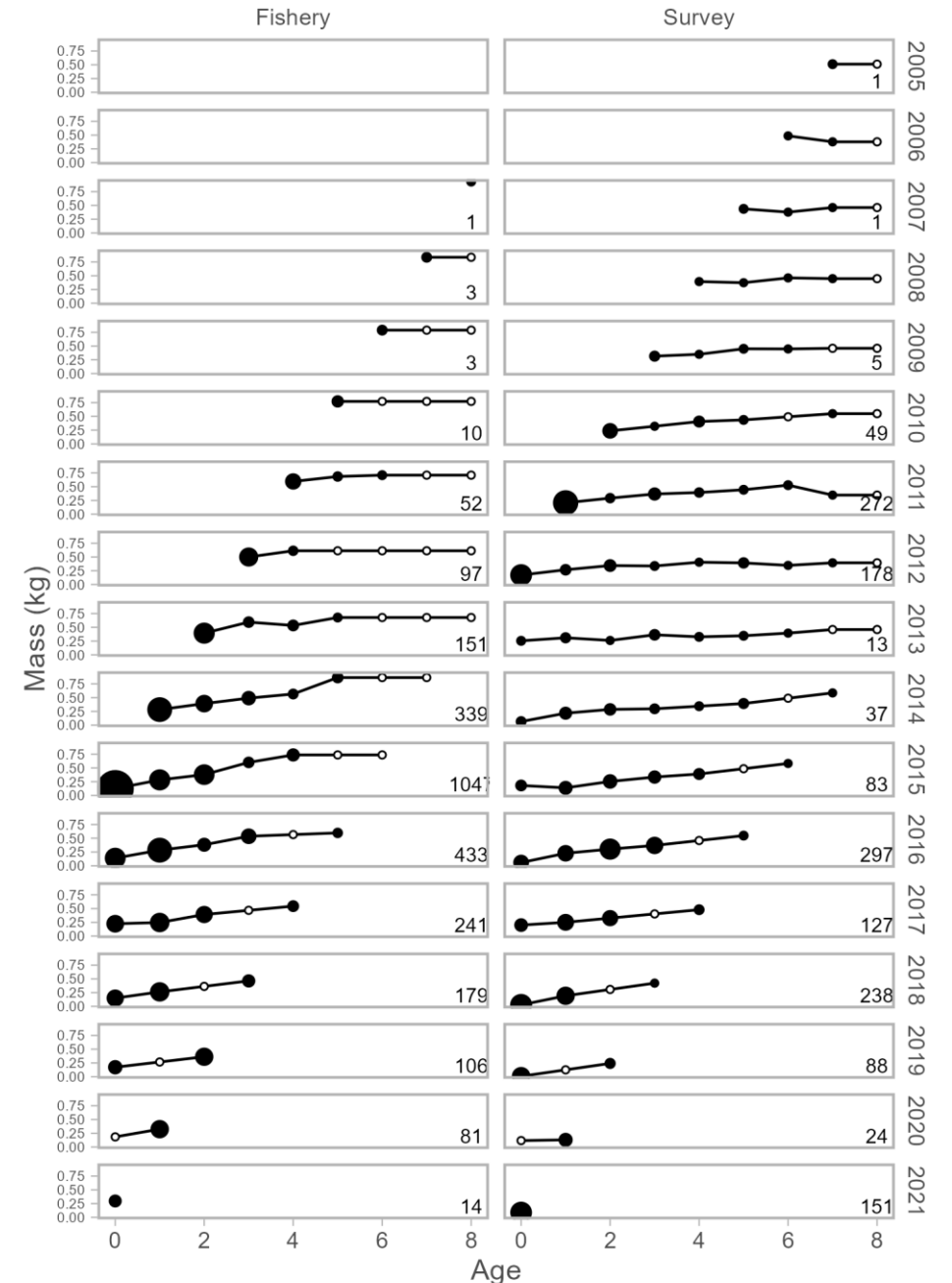
Biological characteristics

- Maturity
  - Age0 = 0.12
  - Age1 = 0.49
  - Age2 = 0.87
  - Age3 = 0.98
  - Age4+ = 1
- From spring cruises in 2010 to 2021 (calendar year)
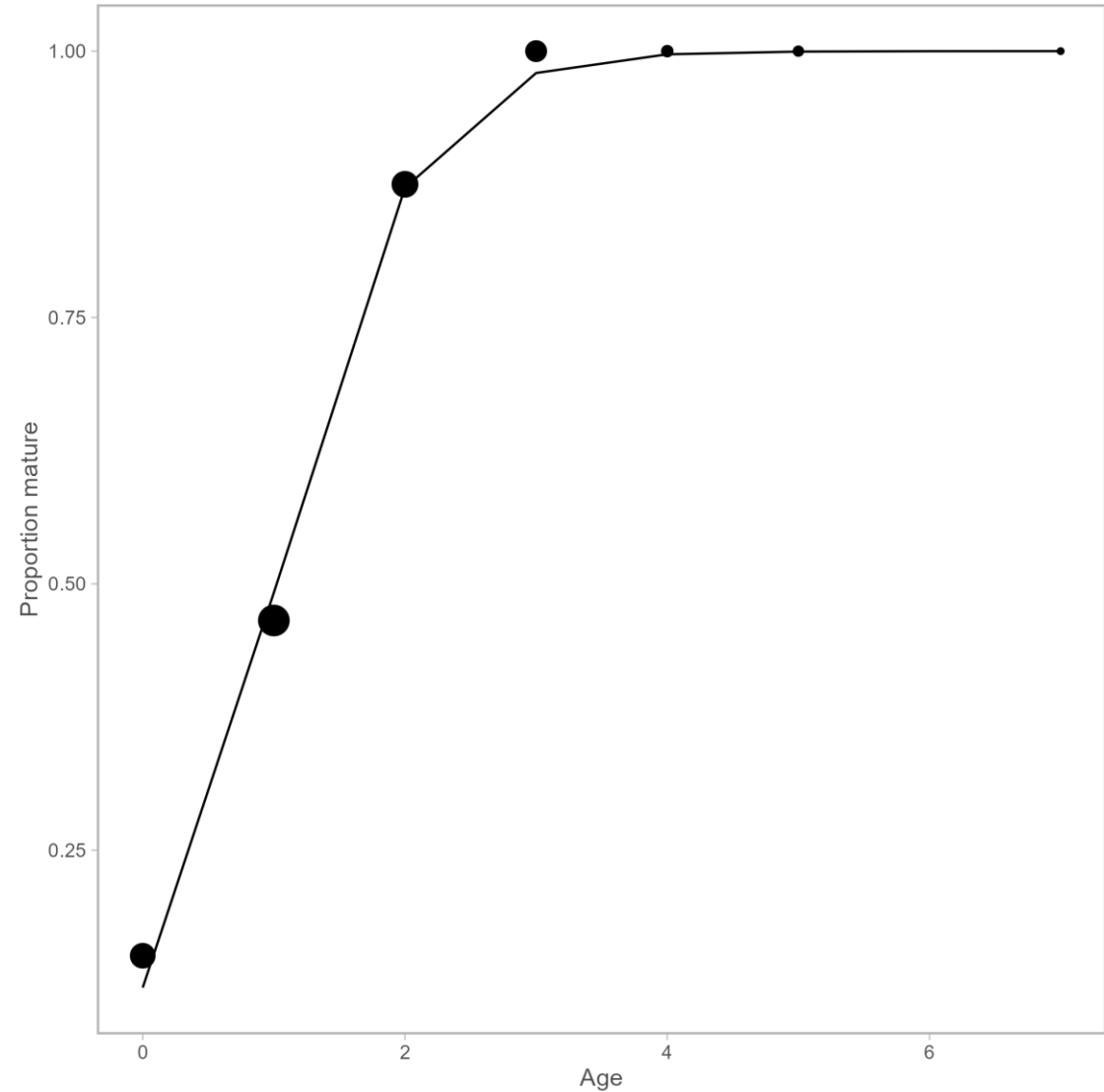
AT survey age compositions

Length Comps ➔ Cruise-specific A-L Keys ➔ Age Comps
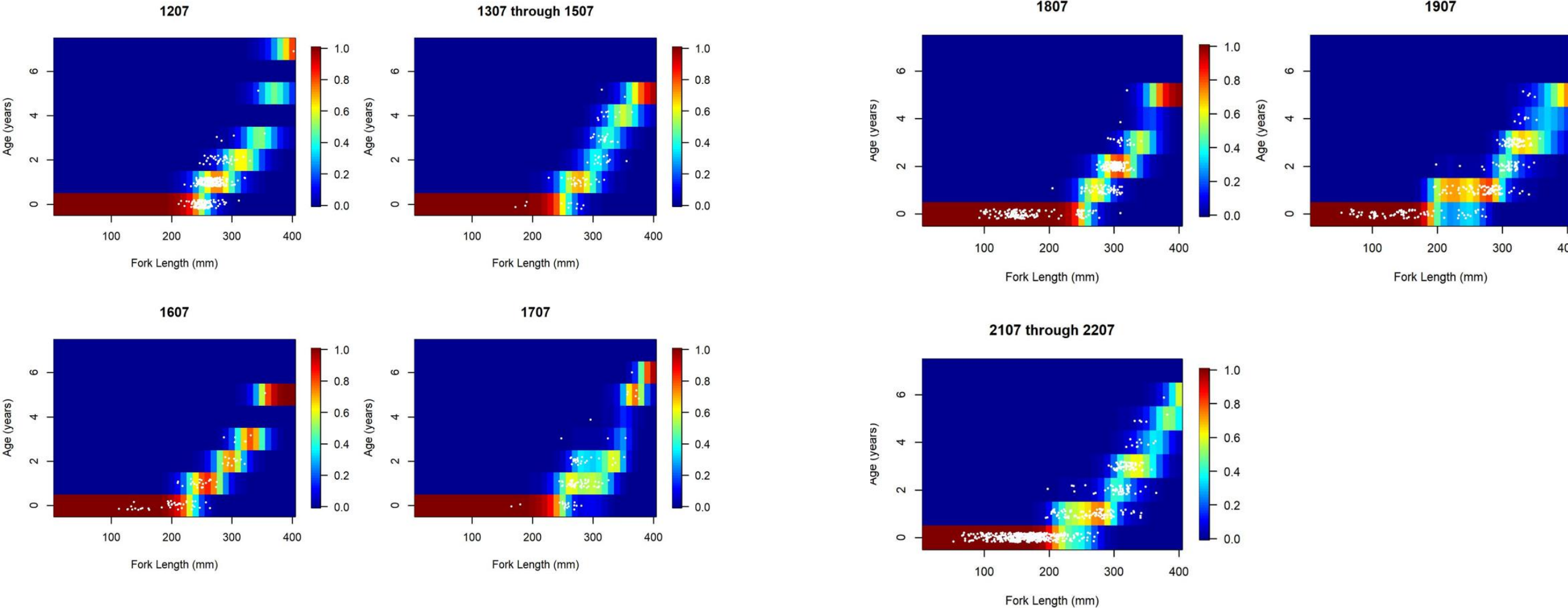
Slight changes to index of abundance

- Prior AT survey biomass used S. African jack mackerel length-weight relationship
  - Due to unknown target strength of US P. mack.
- Recalculated with length-weight relationship from Palance et al. (2019)
  - CVs assumed to be the same
- Updated values (blue-2023 benchmark) slightly higher than 2019
- 2015 value dropped because of echogram reanalysis
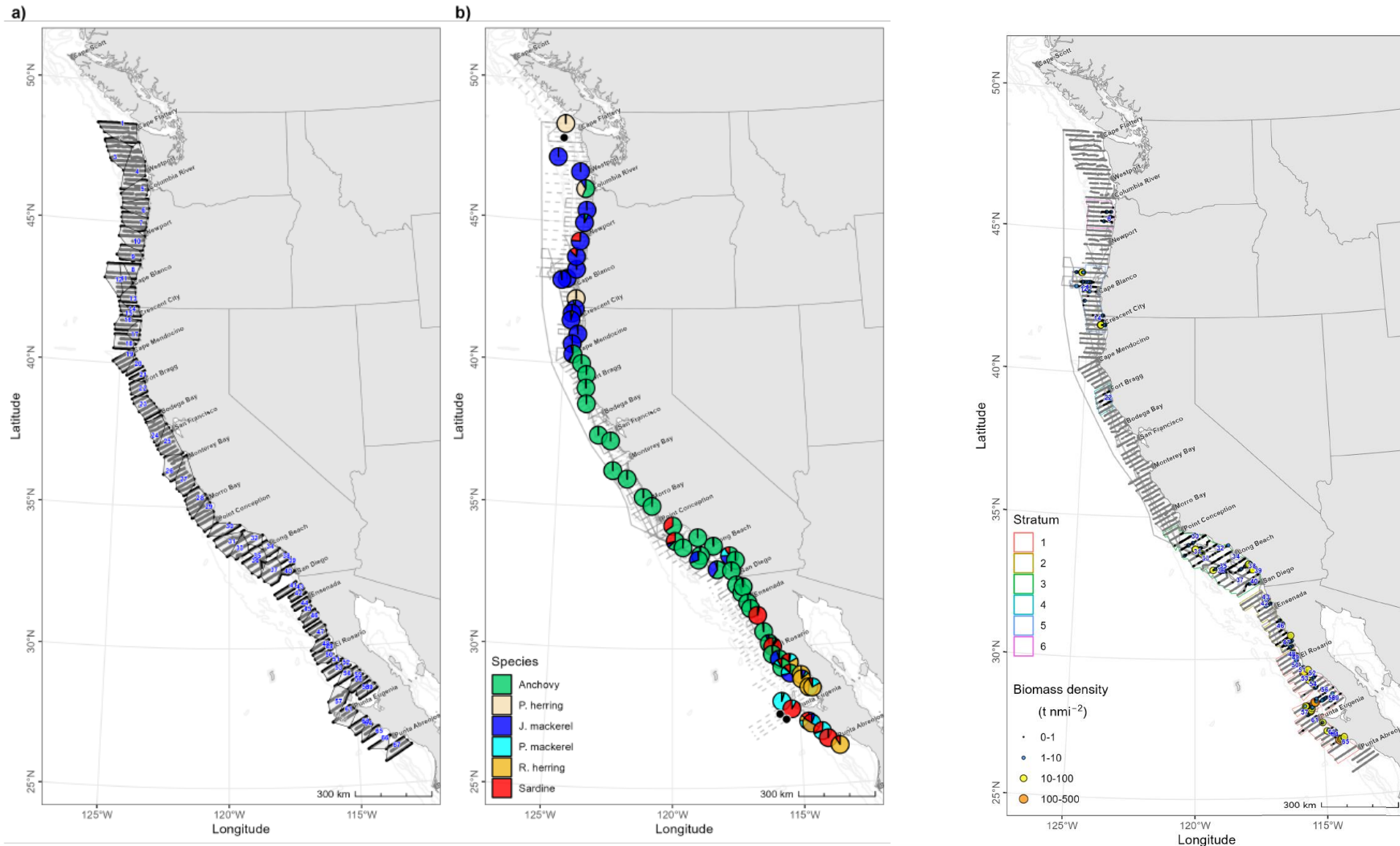- 2022 will not be usable

Index of abundance

Preliminary results presented to STAR panel
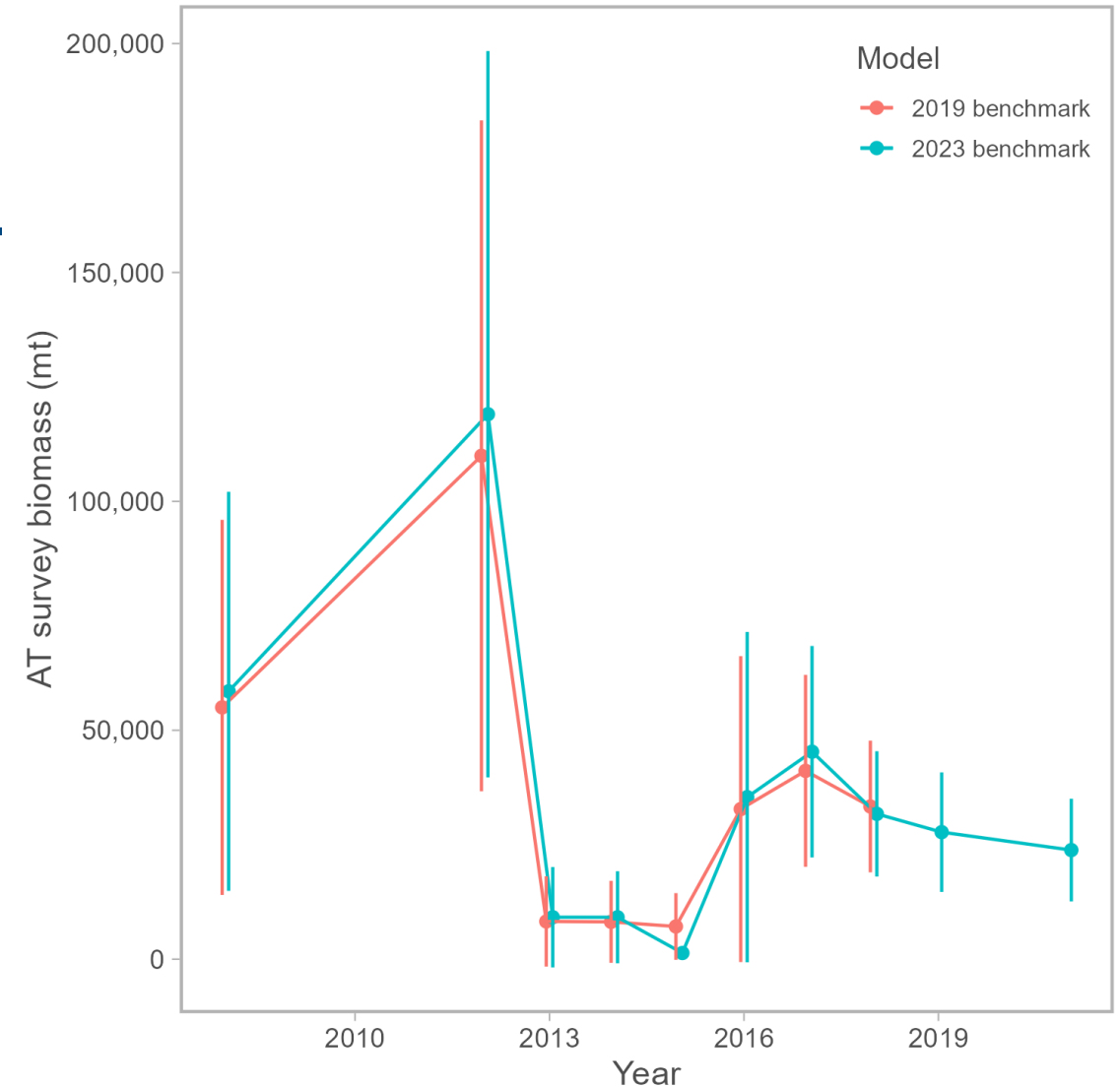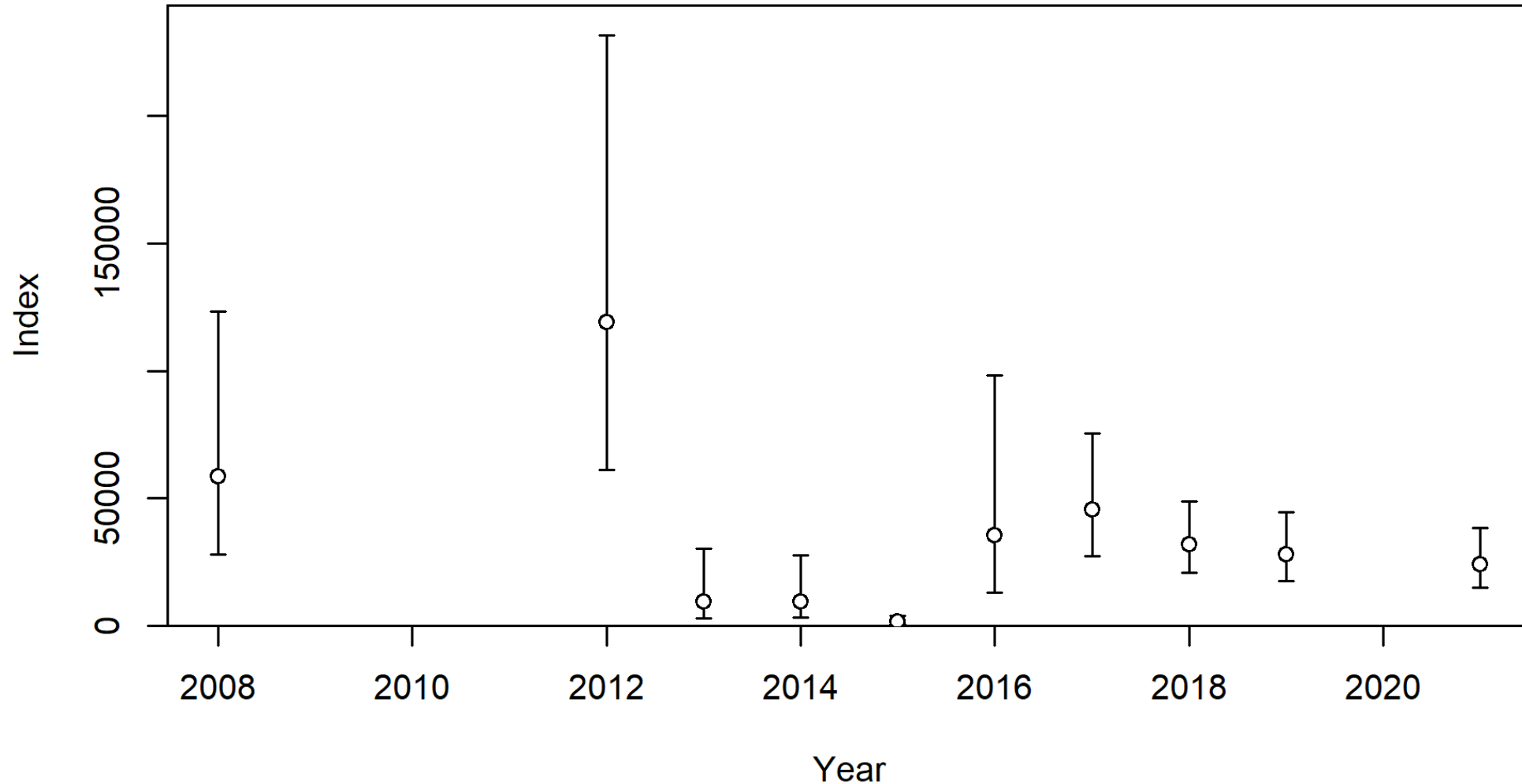
Index of abundance

- Time-varying Q
  - If Q constant
    - 2012; ~100,000mt
    - 2013; ~ 10,000mt
- More likely due to movement than change in M
- Blocked based on similar biomass values
- 2008-2012; 2013-2015; 2016-2020; 2021

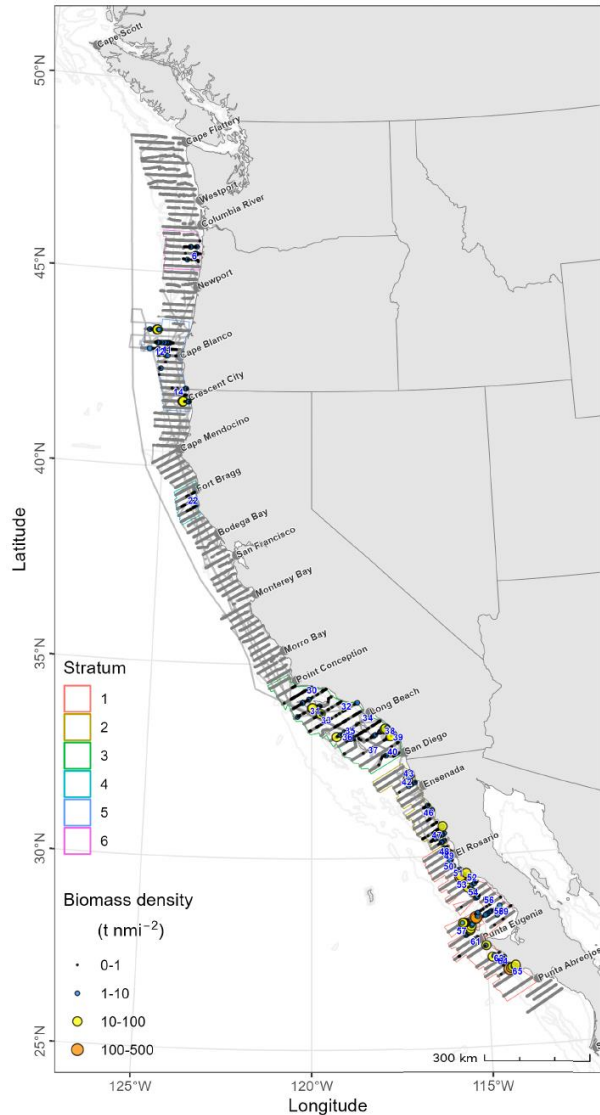# Log index of abundance

Preliminary results presented to STAR panel
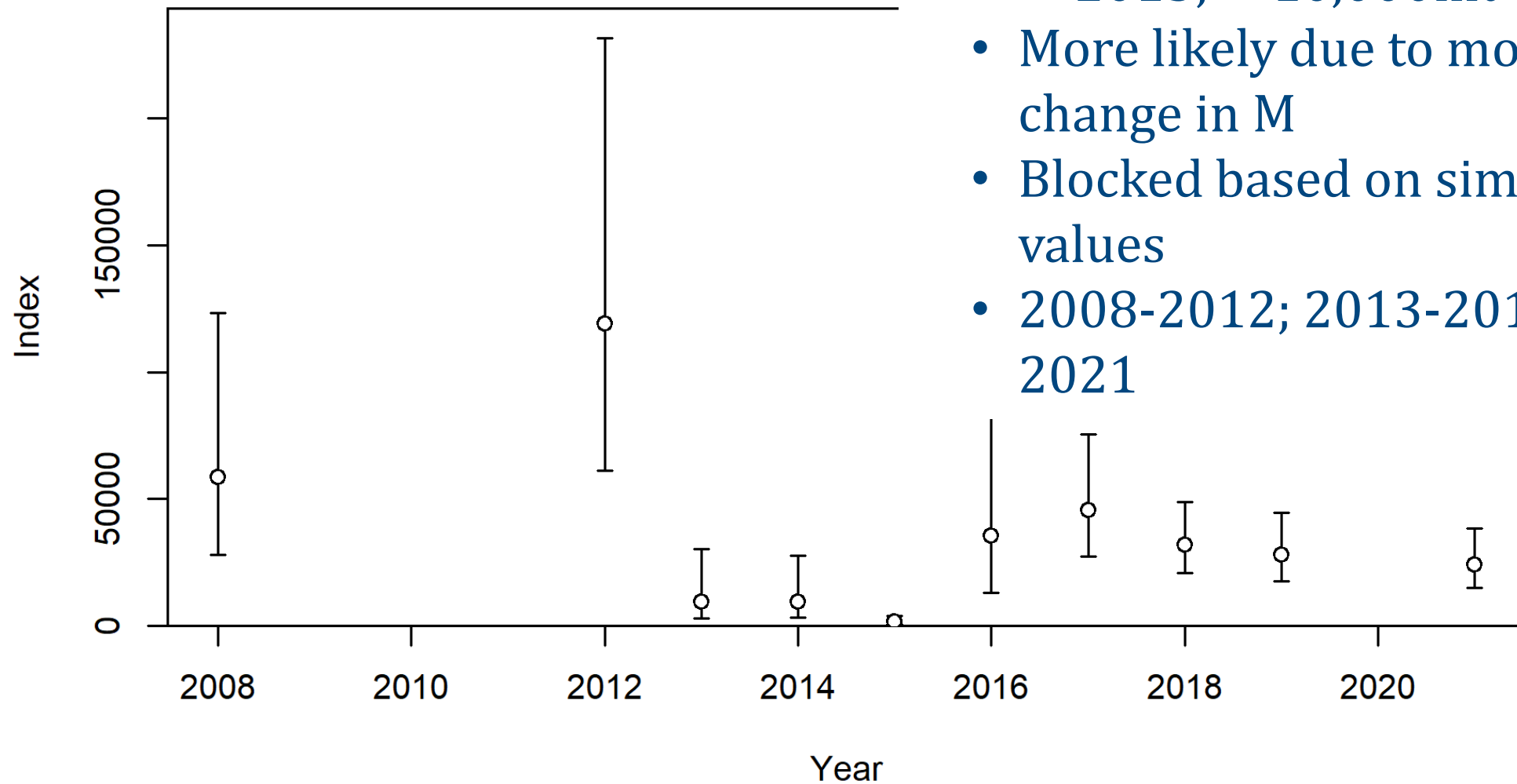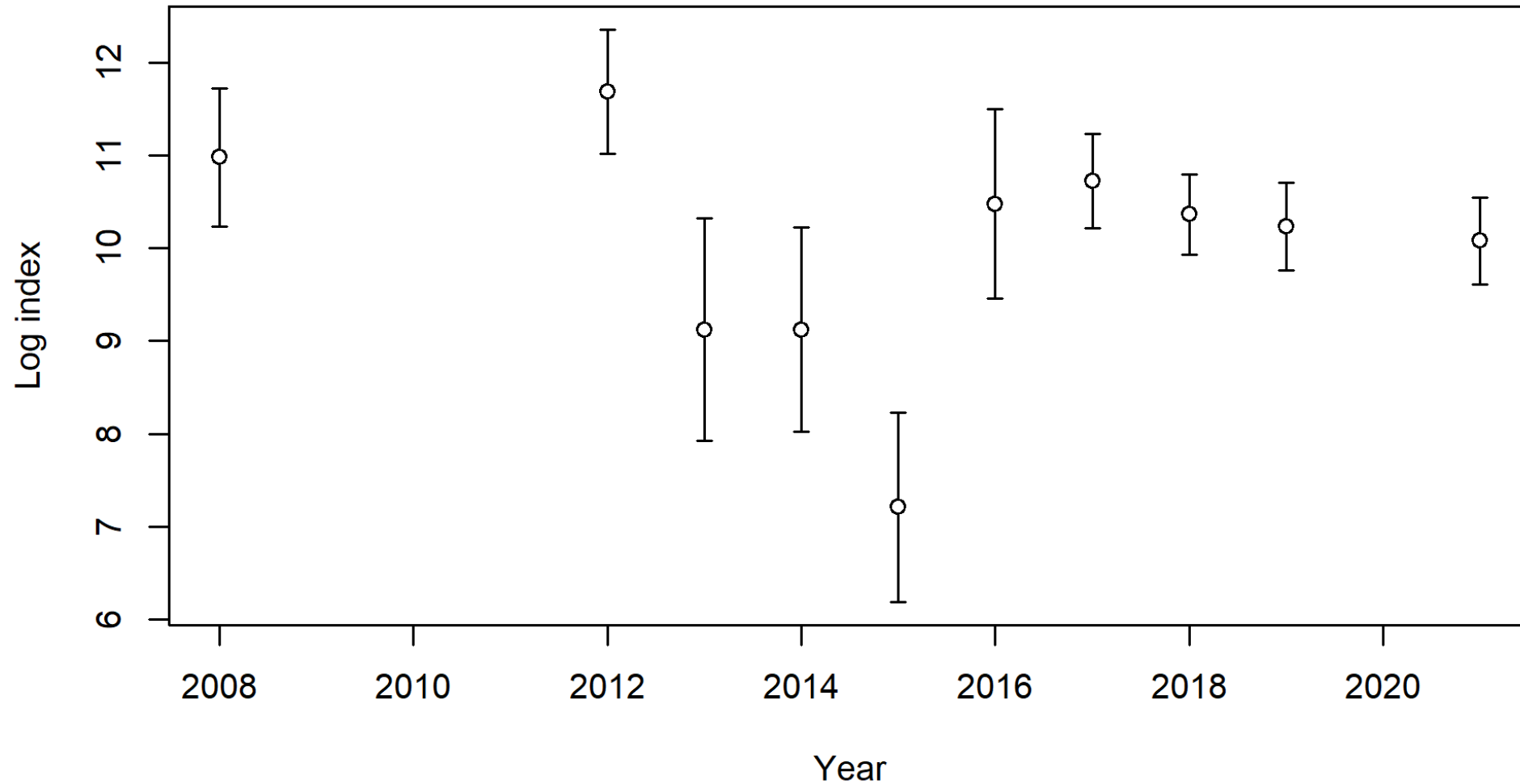
Summer 2021 cruise (Stierhoff et al. 2023)

Preliminary results presented to STAR panel

Summer 2021 catchability (Q)

- 2021 published values
  - US total biomass = 7,796mt
    - Core = 6,289mt; nearshore=1,507 mt
  - Mexico total biomass=14,202 mt
  - Total biomass =21,998mt
- Q in US waters = 7,796 / 21,998
  - 0.354

- 2021 updated values
  - Forthcoming

Model configuration details

Time period	2008-2021
Fisheries	1
Surveys	1, AT
Natural mortality (M)	Estimated (new Hamel prior)
Growth	Fixed (WAA)
Spawner-recruit relationship	Beverton-Holt
Equilibrium recruitment (R0)	Estimated
Steepness (h)	Fixed (0.75)
Total Recruitment variability (sigmaR)	Fixed (0.75)
SR regime offset	Estimated
Catchability	Time-varying; fixed in 2021
Selectivity (age-based)	
Fishery selectivity	
Form	Random walk (option 17)
Time-varying	Yes; 2DAR option
AT survey selectivity	
Form	Asymptotic
Time-varying	No
Data weighting	No

- Age-specific M (Lorenzen-age from 0-8+)

- 2021 Q value
  - Most anchovy biomass in US waters from summer 2021 cruise
  - Time-varying Q
    - 2008-2012
    - 2013-2015
    - 2016-2019
    - No survey 2020

Natural mortality (M)

- Hamel and Cope (2022)
- Assumed maximum age of 8 (plus group)
  - Data not used in this model have age-14 mackerel caught in 1998
- No recent estimates of growth from data not used in this assessment

- Lognormal prior with mean = 5.40 / 8 (assumed age) = 0.675
  - SD of 0.31

Forecast file catch settings

- Catch for model year 2022 is 16,000mt (actual value)
- 2023, 2024 used average of catch from 2019-2022
  - 20,366 mt

Preliminary results presented to STAR panel

Model results

Parameter		
	NatM_Lorenzen_averageFem_GP_1	0.784
	SR_LN(R0)	13.331
	SR_BH_steep	0.75
	SR_sigmaR	0.75
	SR_regime_BLK3repl_2007	-0.305
	LnQ_base_AT(2)	-1.03
	LnQ_base_AT(2)_BLK4repl_2008	-0.57
	LnQ_base_AT(2)_BLK4repl_2013	-2.765
	LnQ_base_AT(2)_BLK4repl_2016	-0.698
Biomass (mt)	2020 Age1+	54,025
	2021 Age1+	40,024

- 2015 index value due to reanalyzed echogram
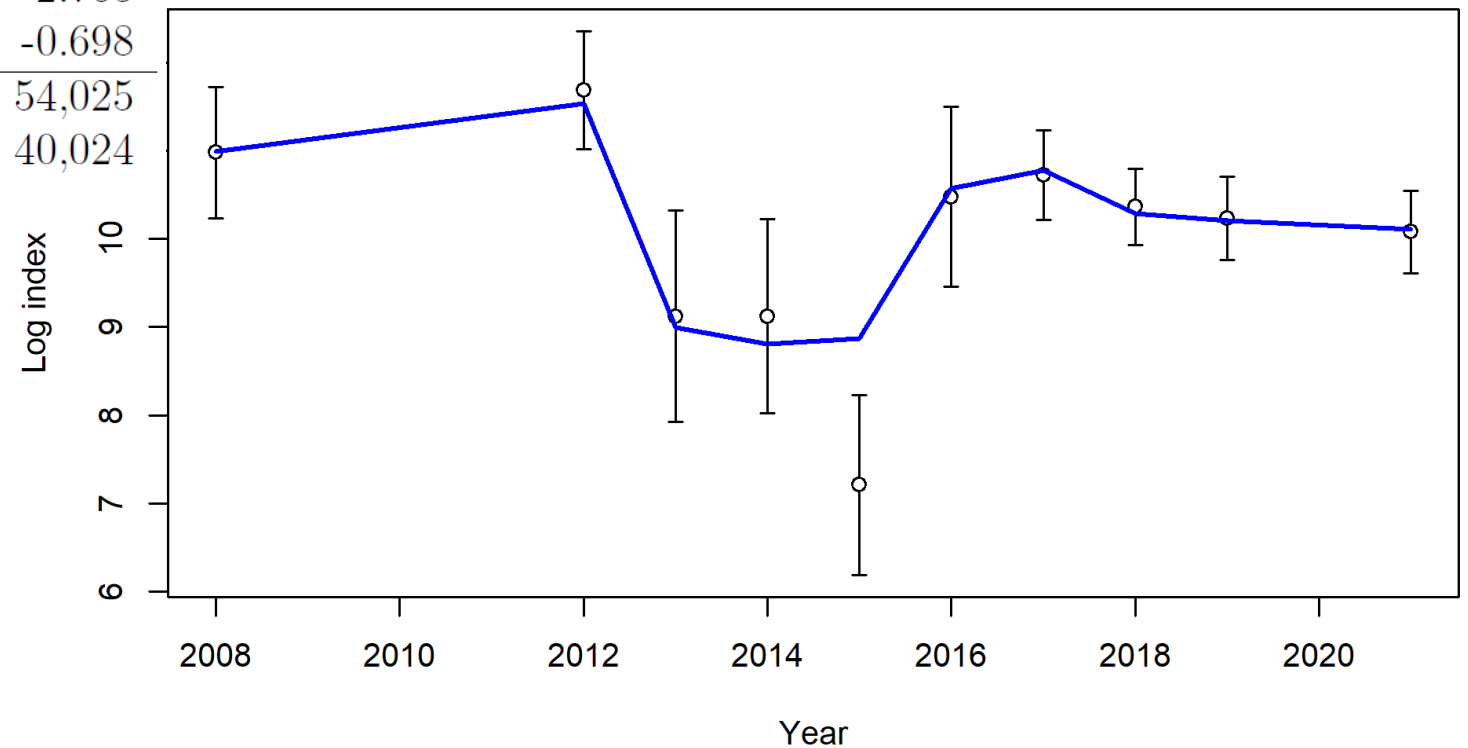
Age-specific M (average estimate = 0.784)
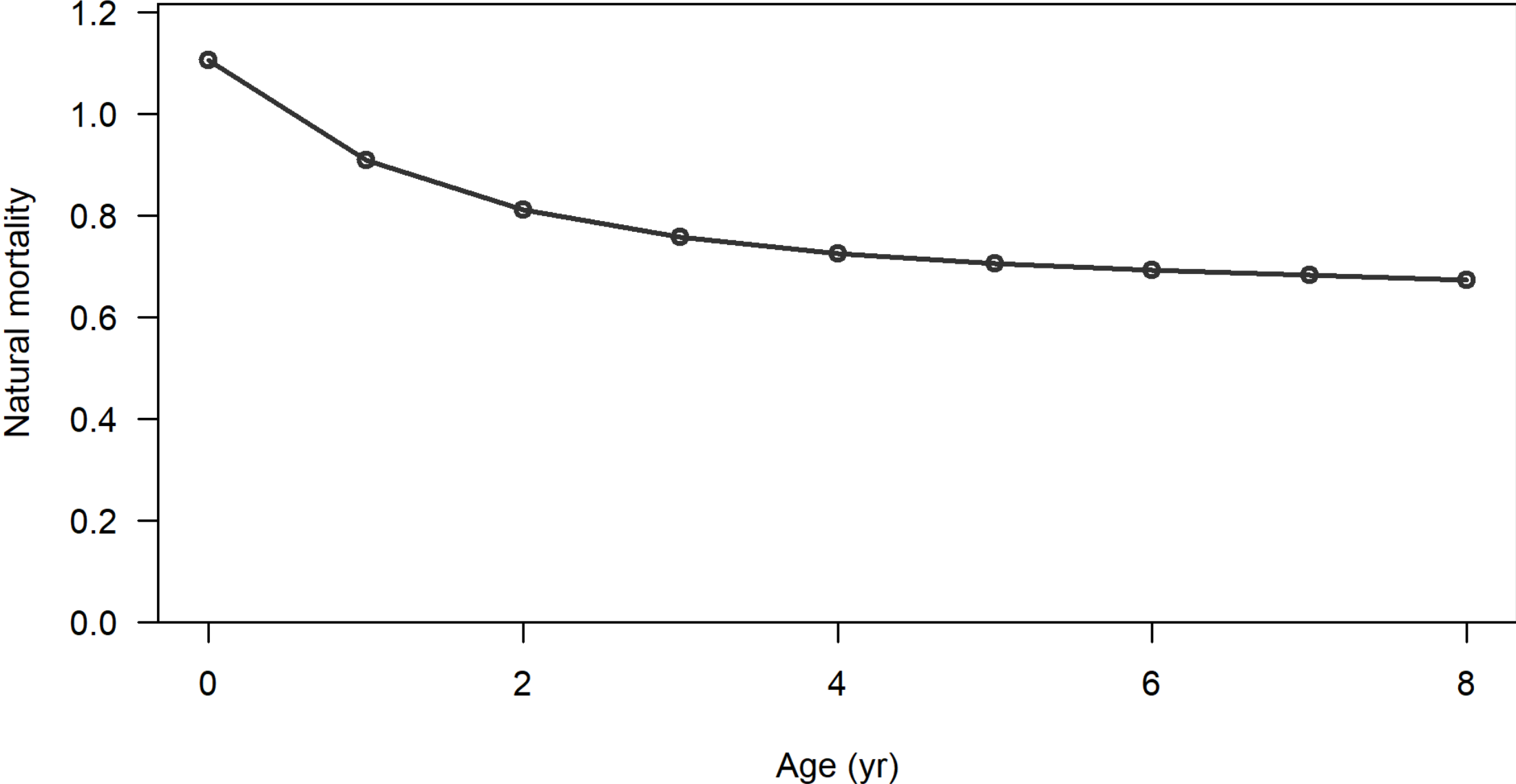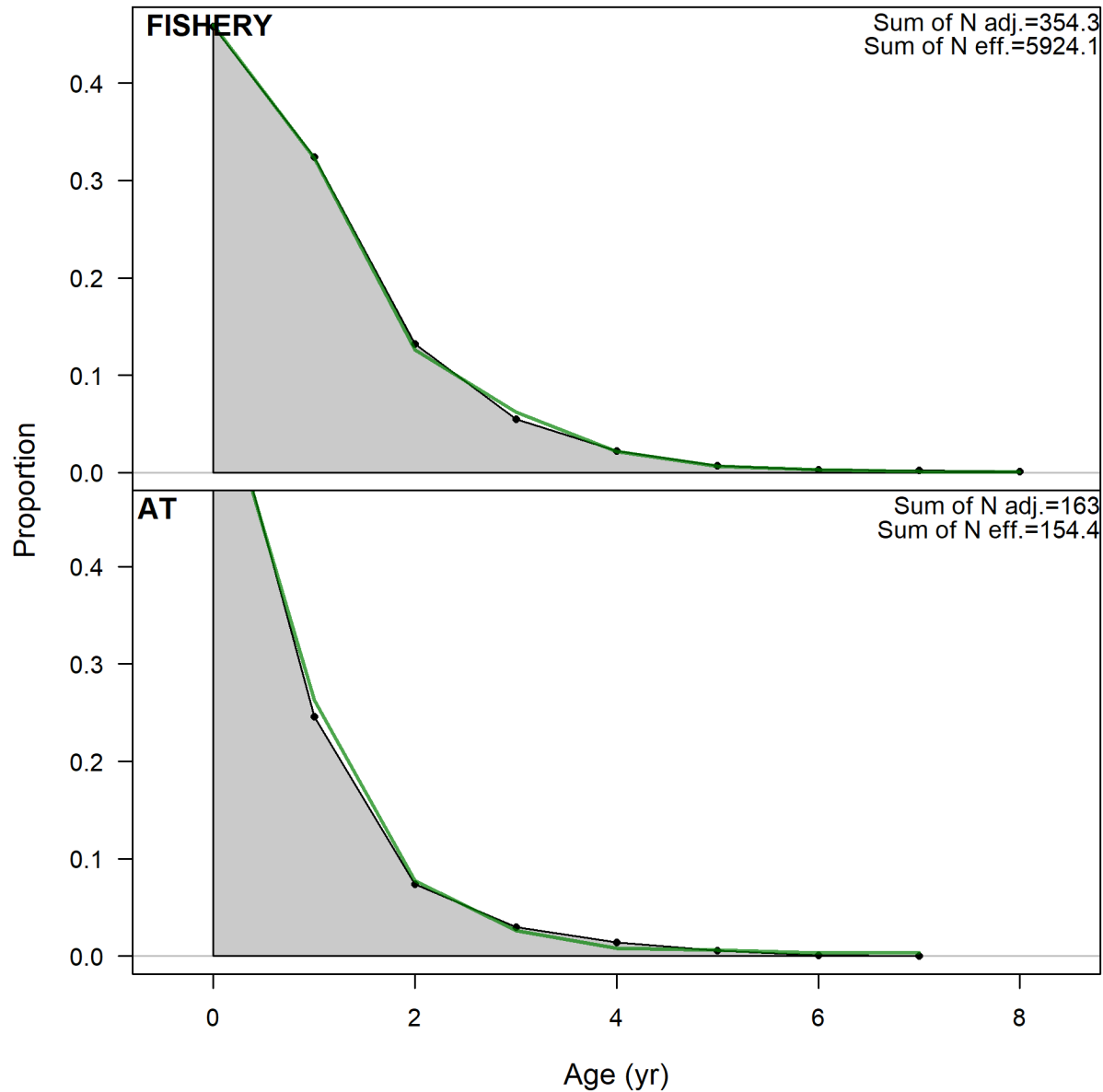
Time-varying Q
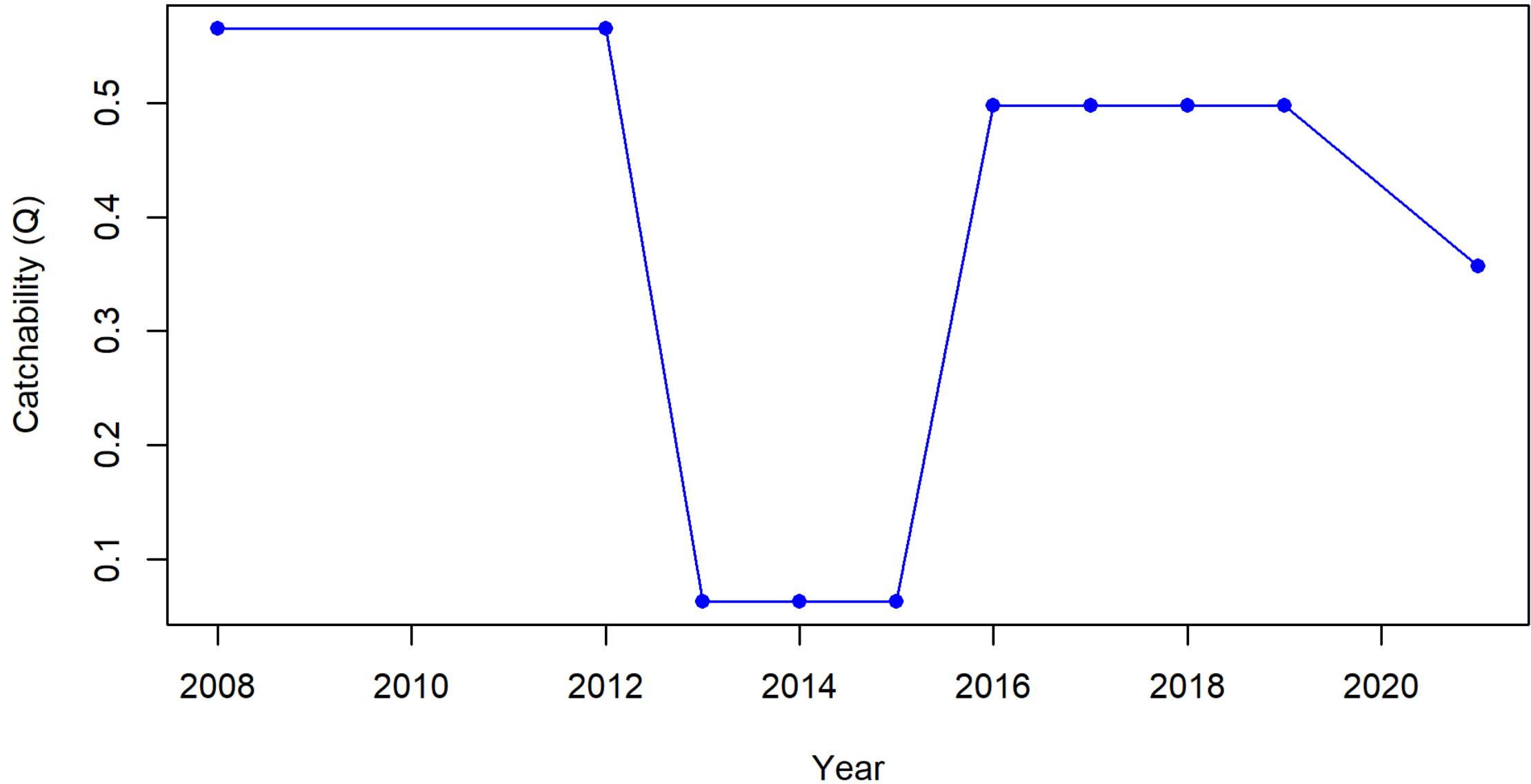
Age selectivities
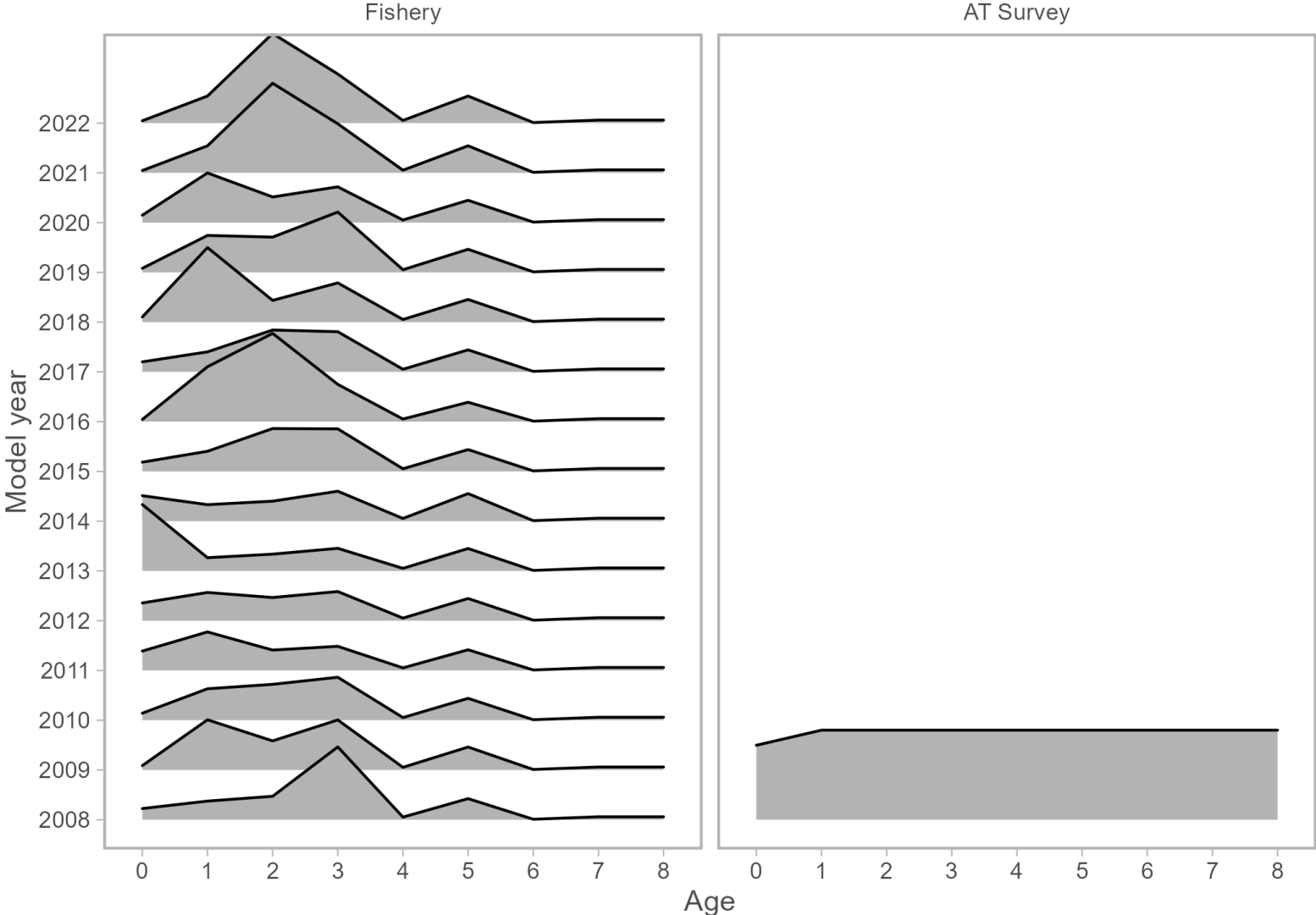
Population numbers at age

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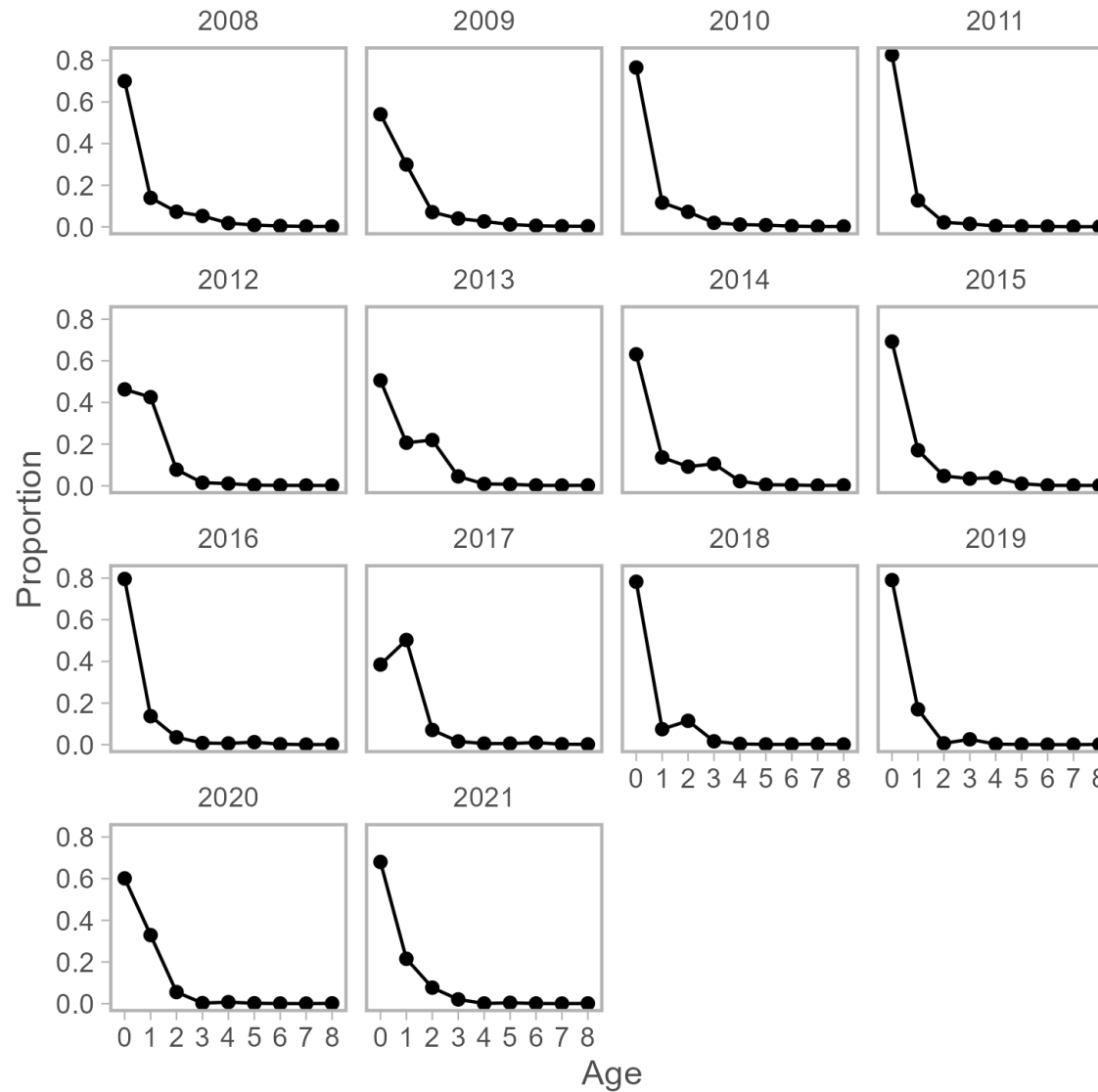
Fits to age compositions (fishery)
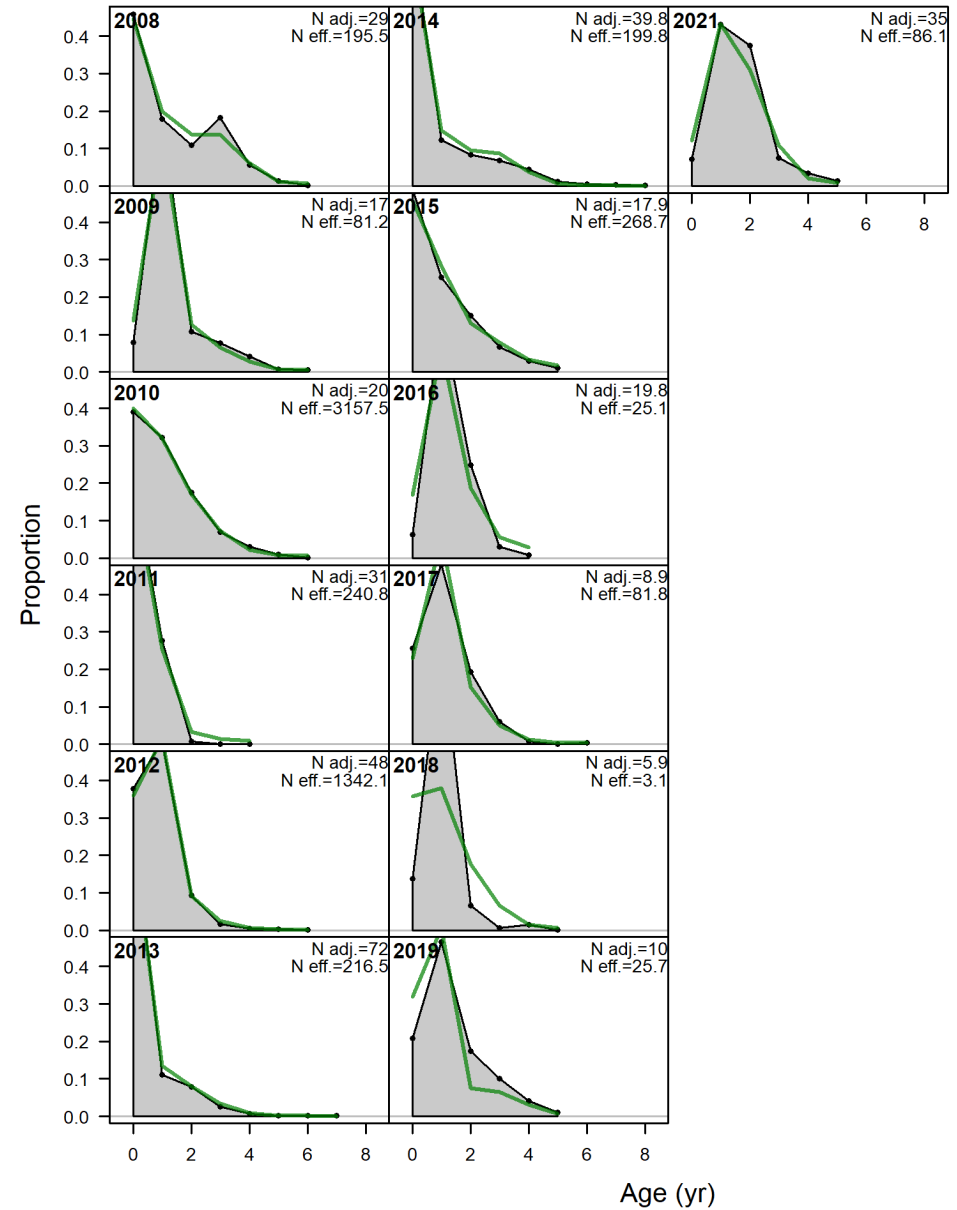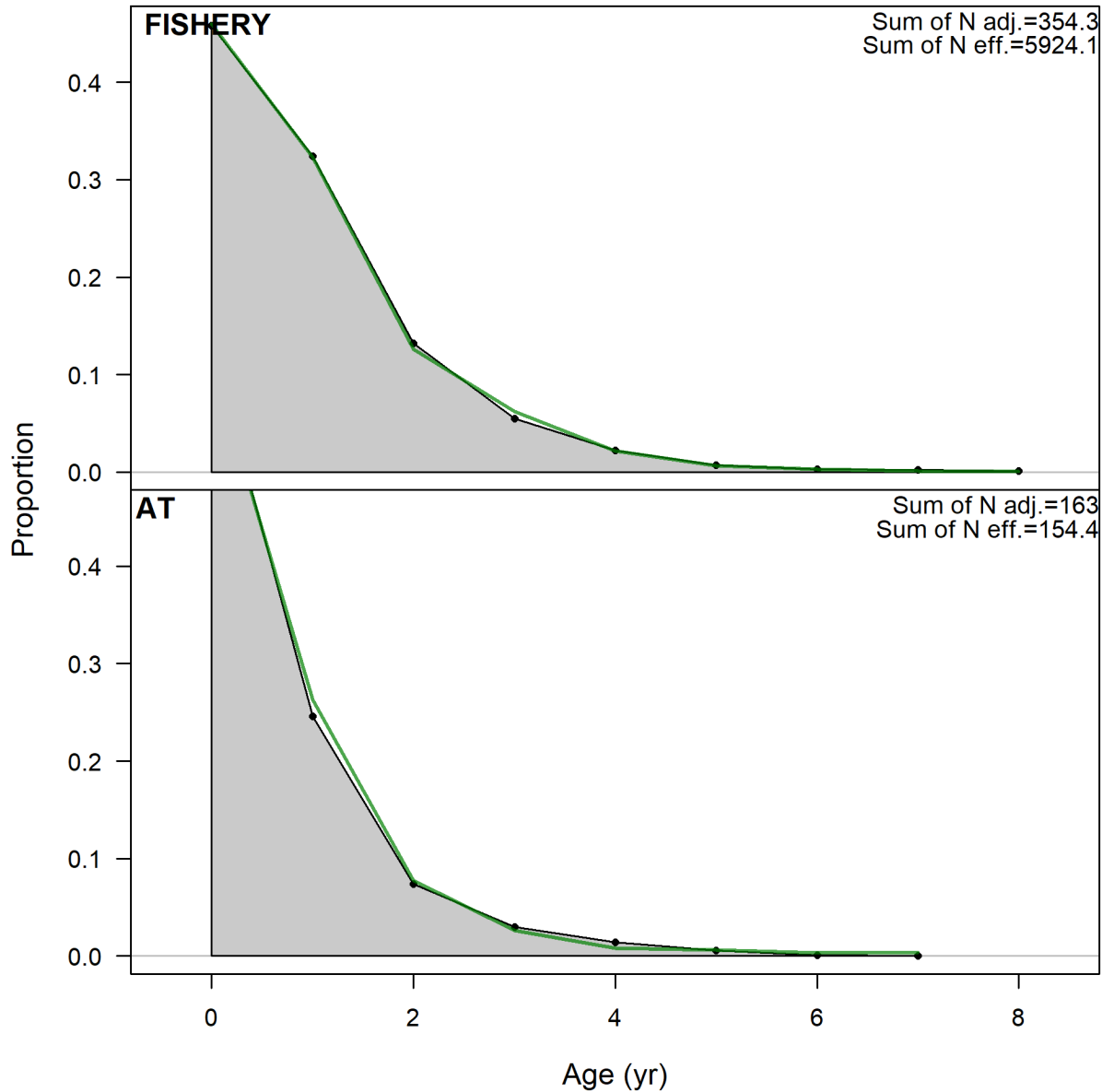
Residuals from fishery age comp. fits

Preliminary results presented to STAR panel
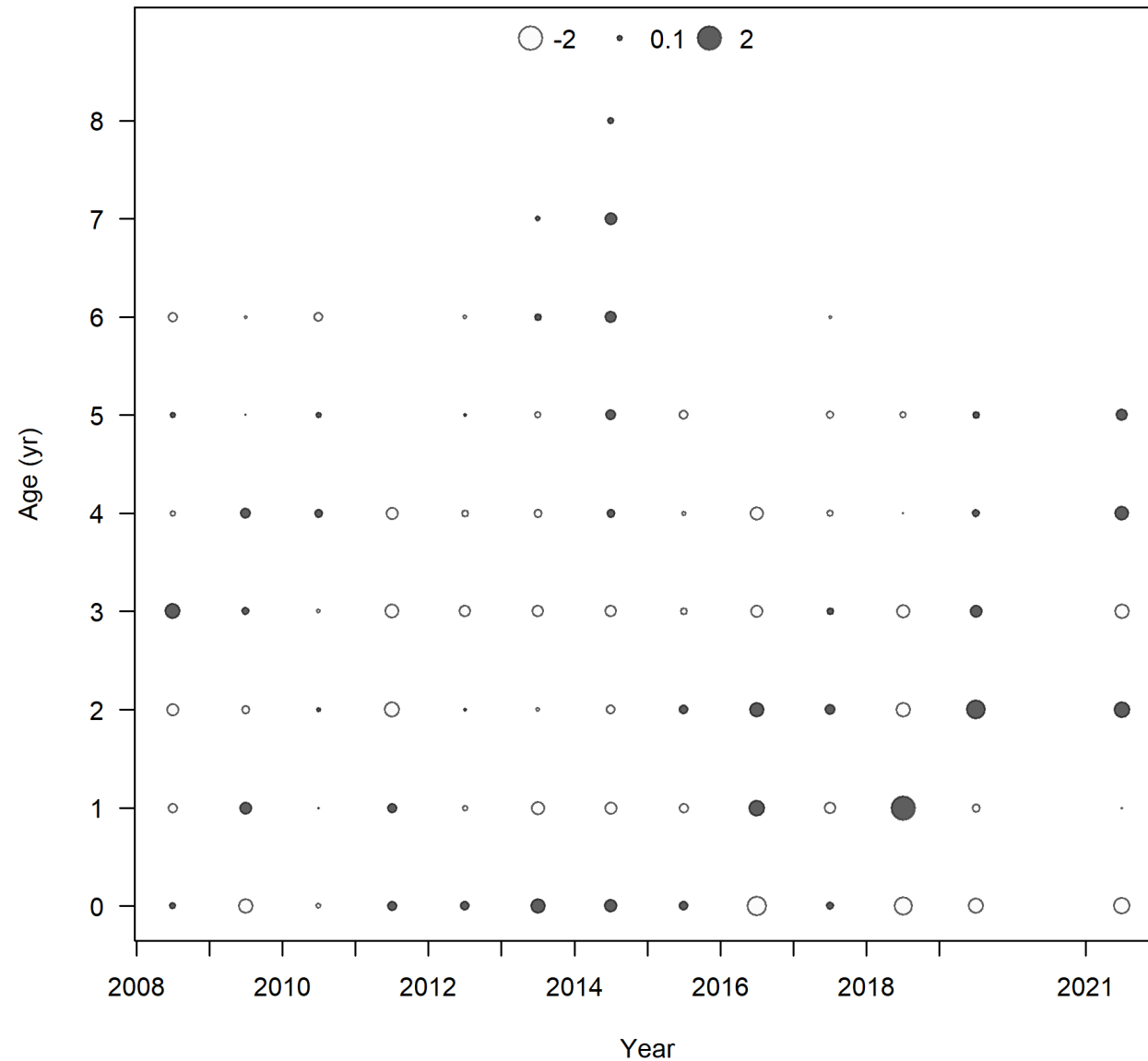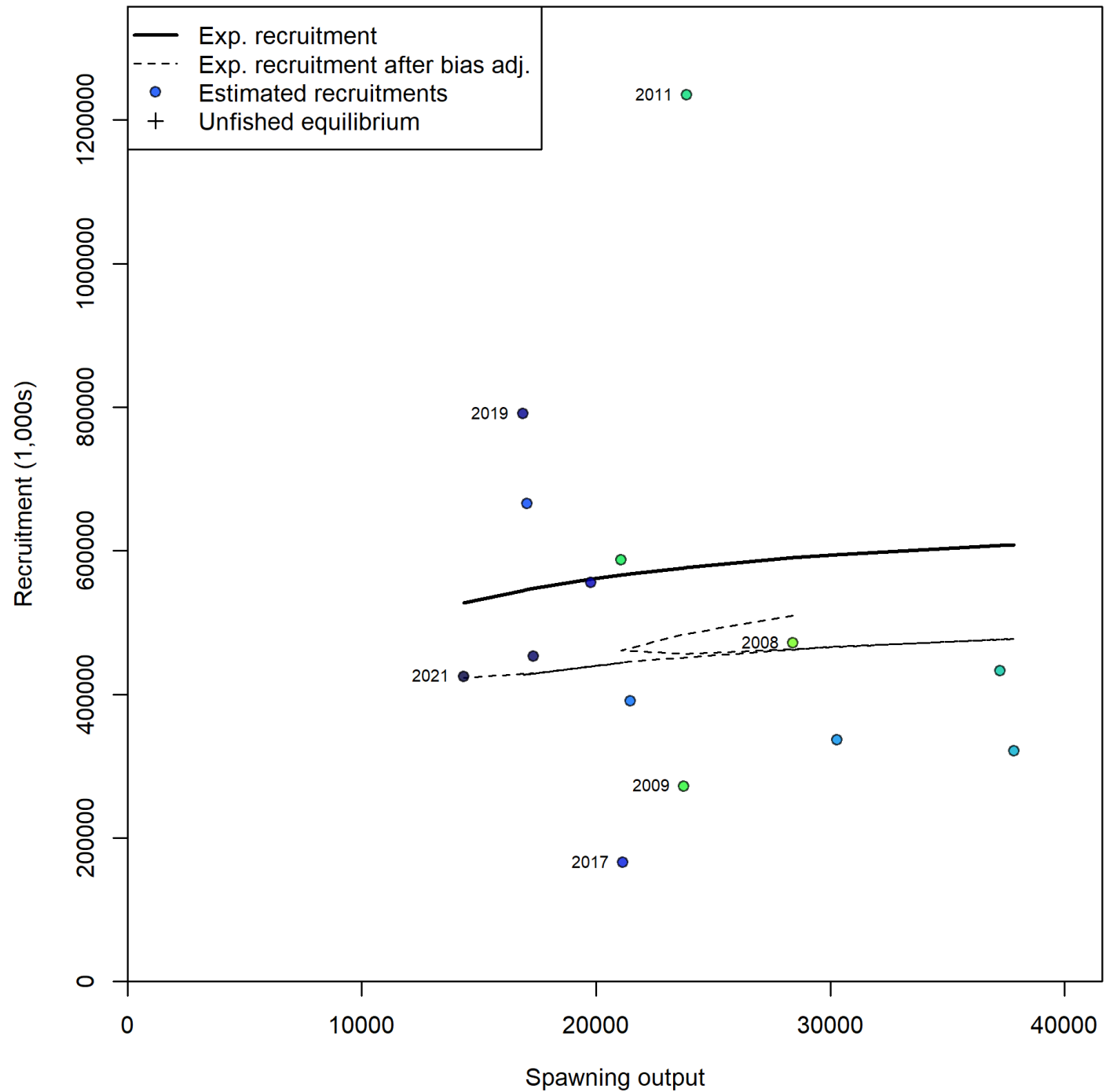
Fits to age compositions (AT survey)
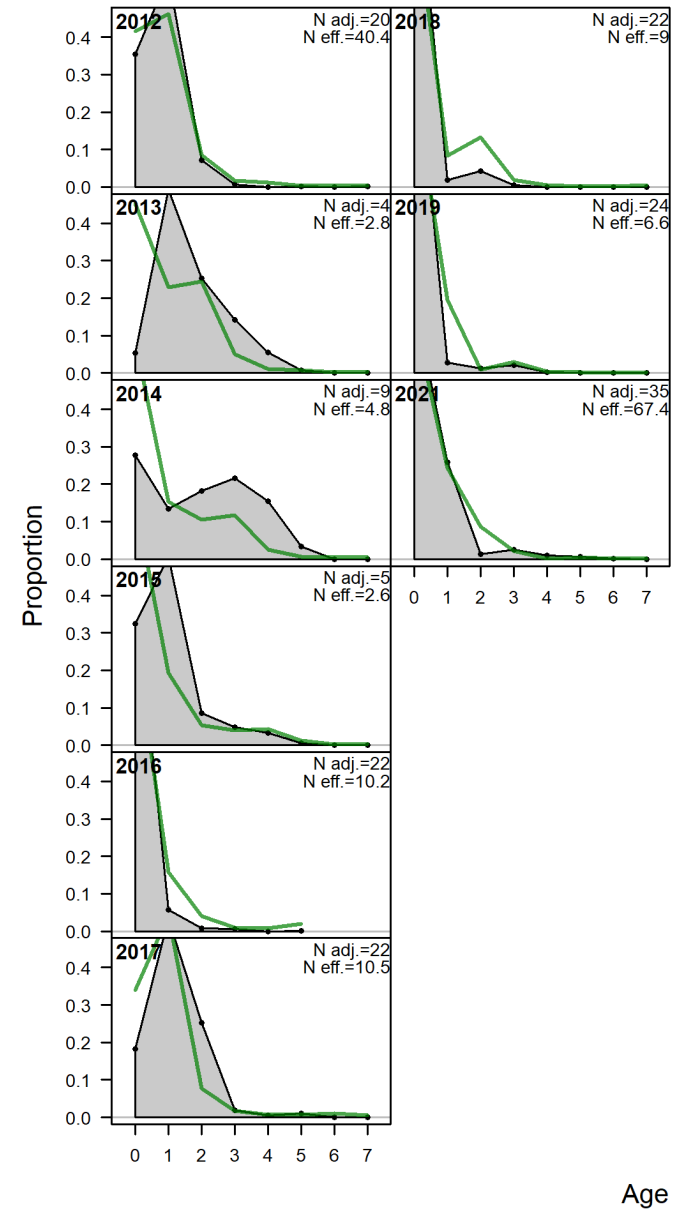
Residuals from AT survey age comp. fits

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SR relationship

Preliminary results presented to STAR panel
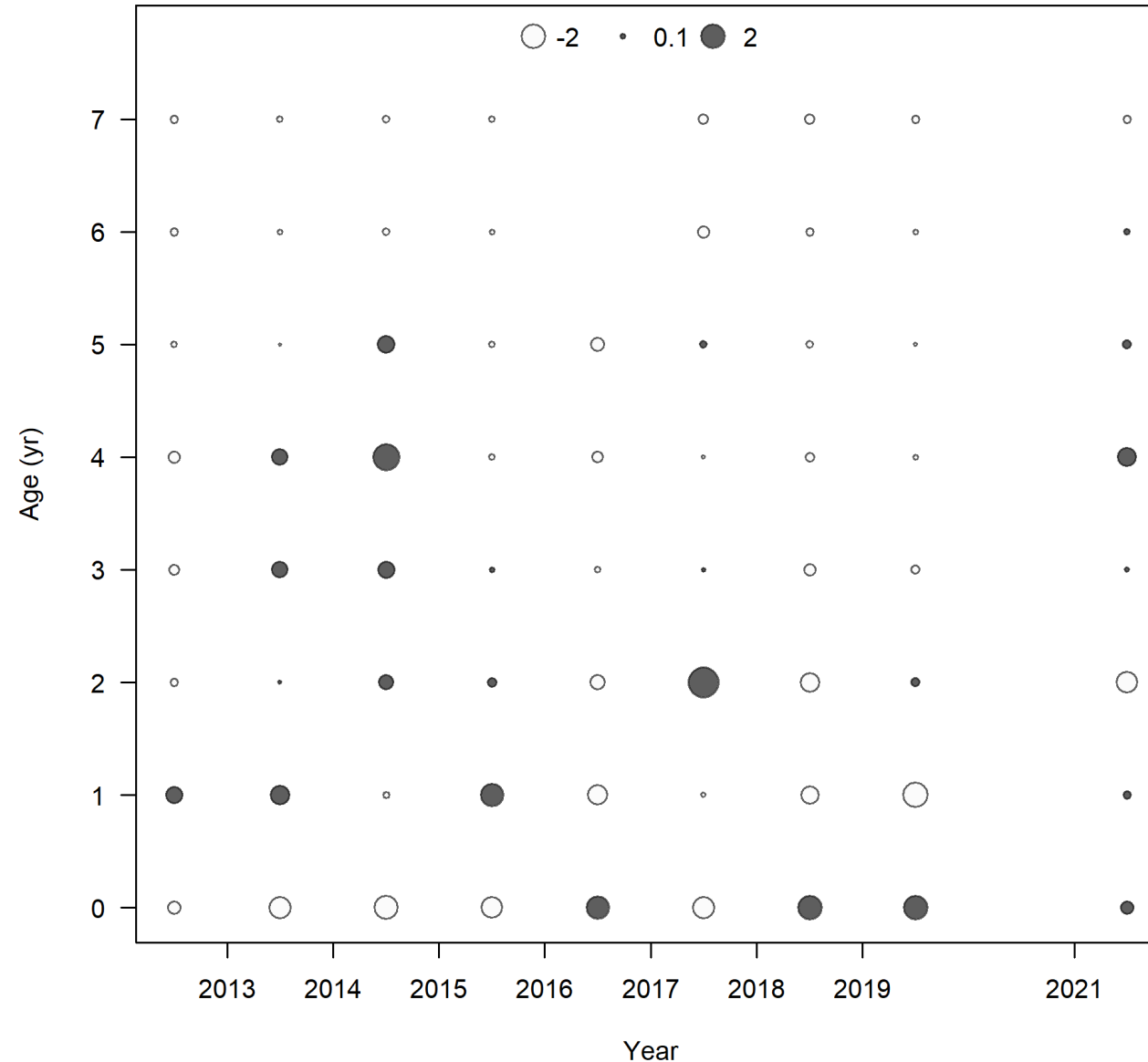
Rec Devs
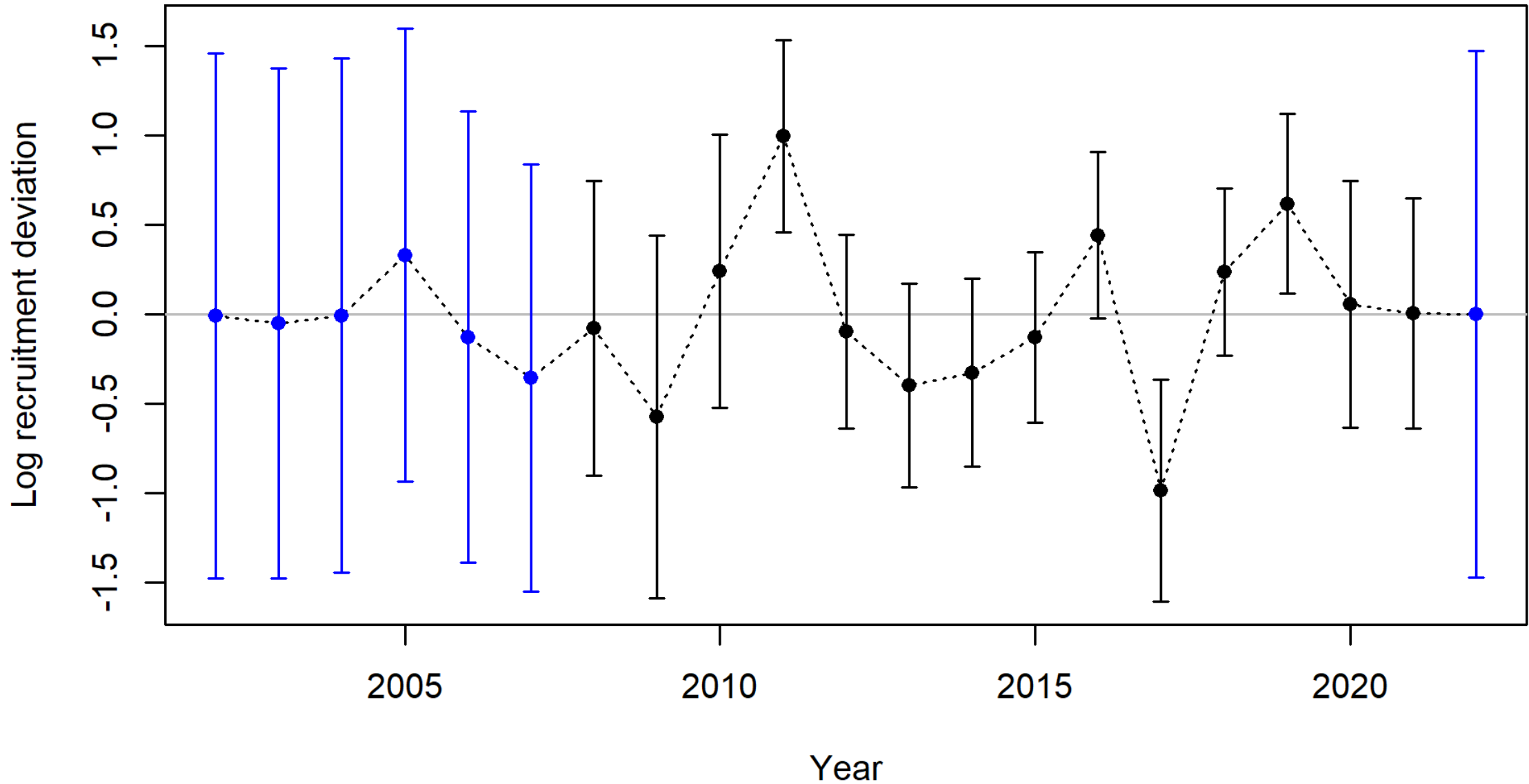
Spawning stock biomass time series

Preliminary results presented to STAR panel
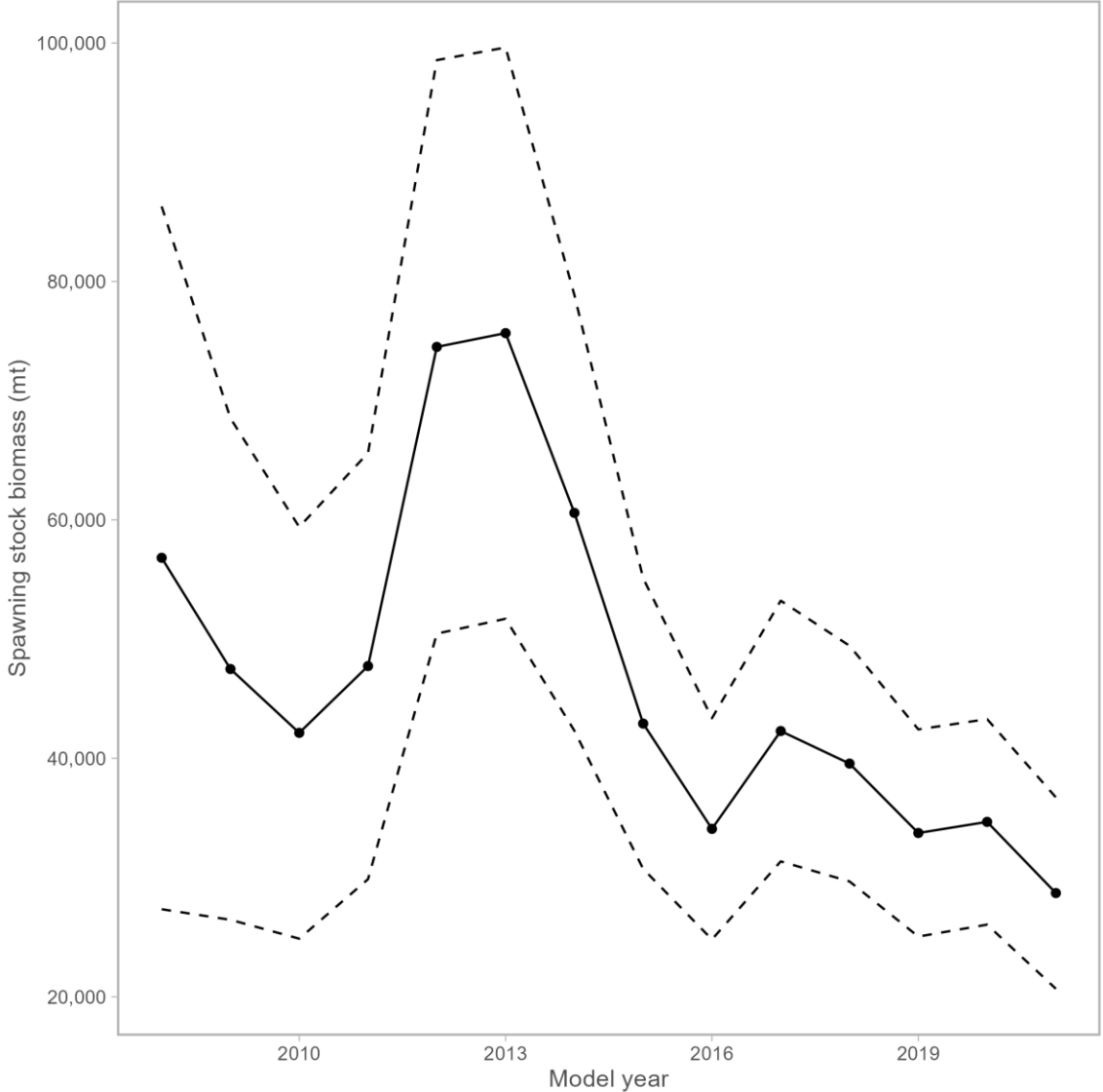
Recruitment time series

Preliminary results presented to STAR panel

Age-0+ and age-1+ biomass

Preliminary results presented to STAR panel
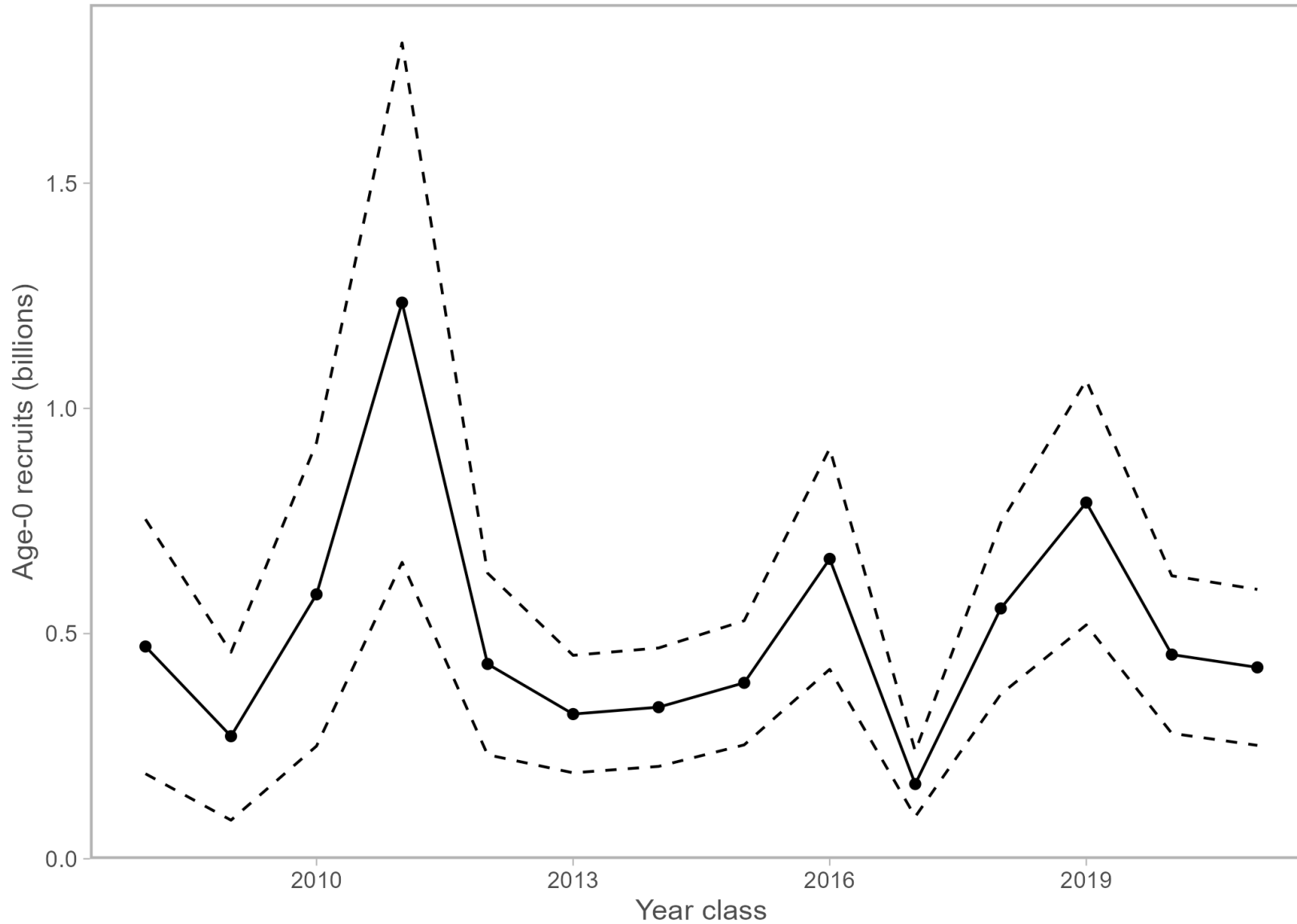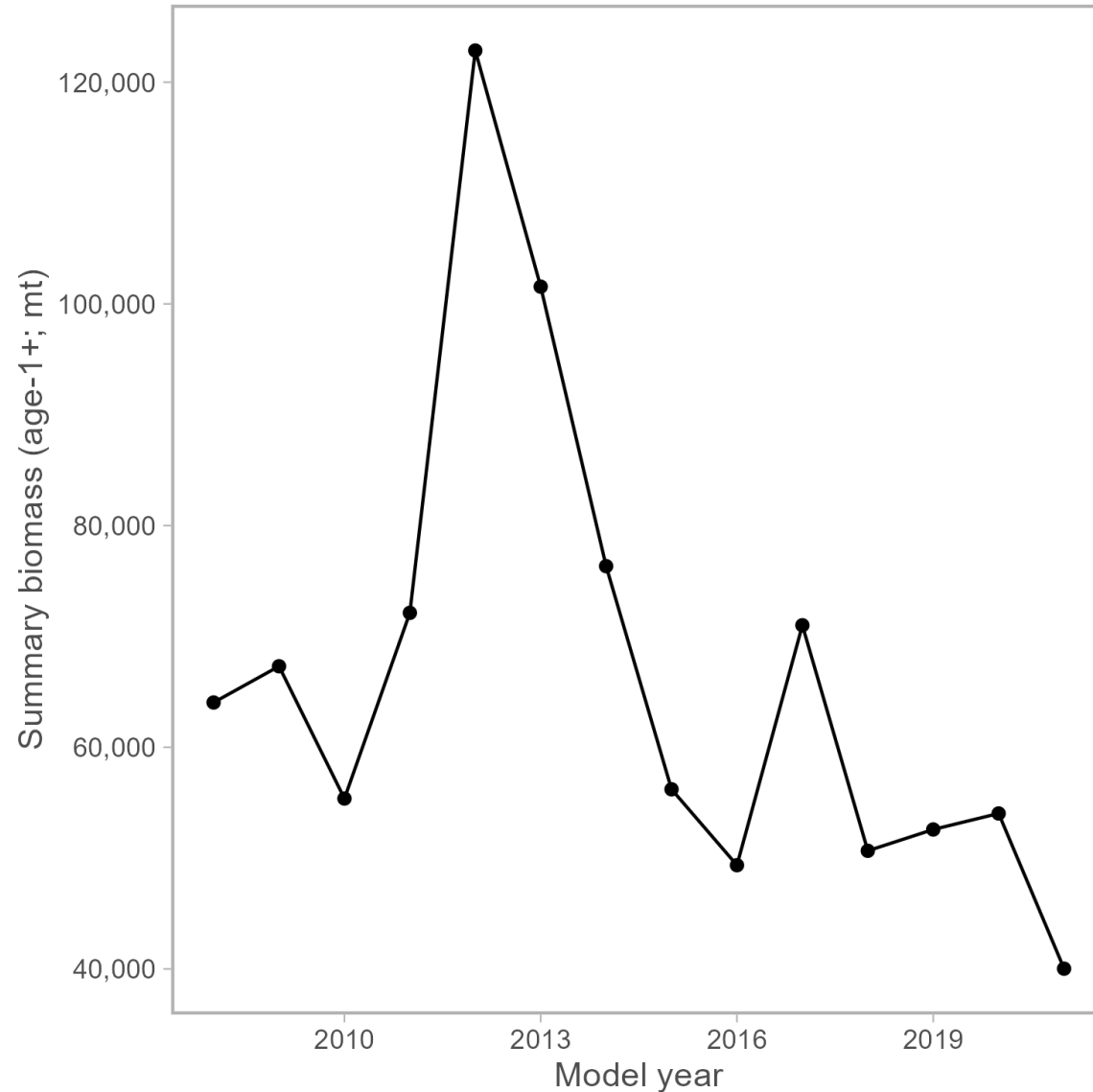
F time series

Historical analysis

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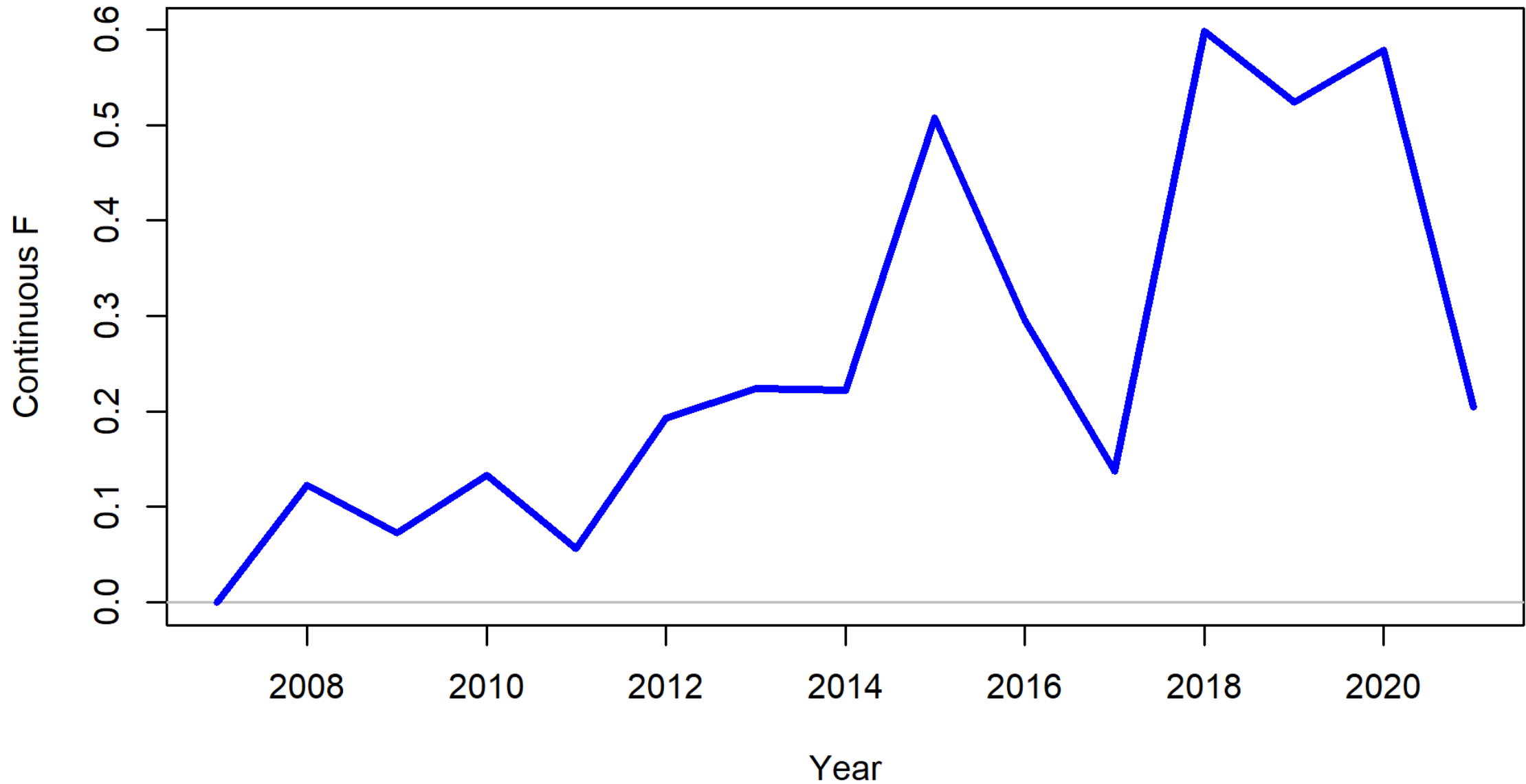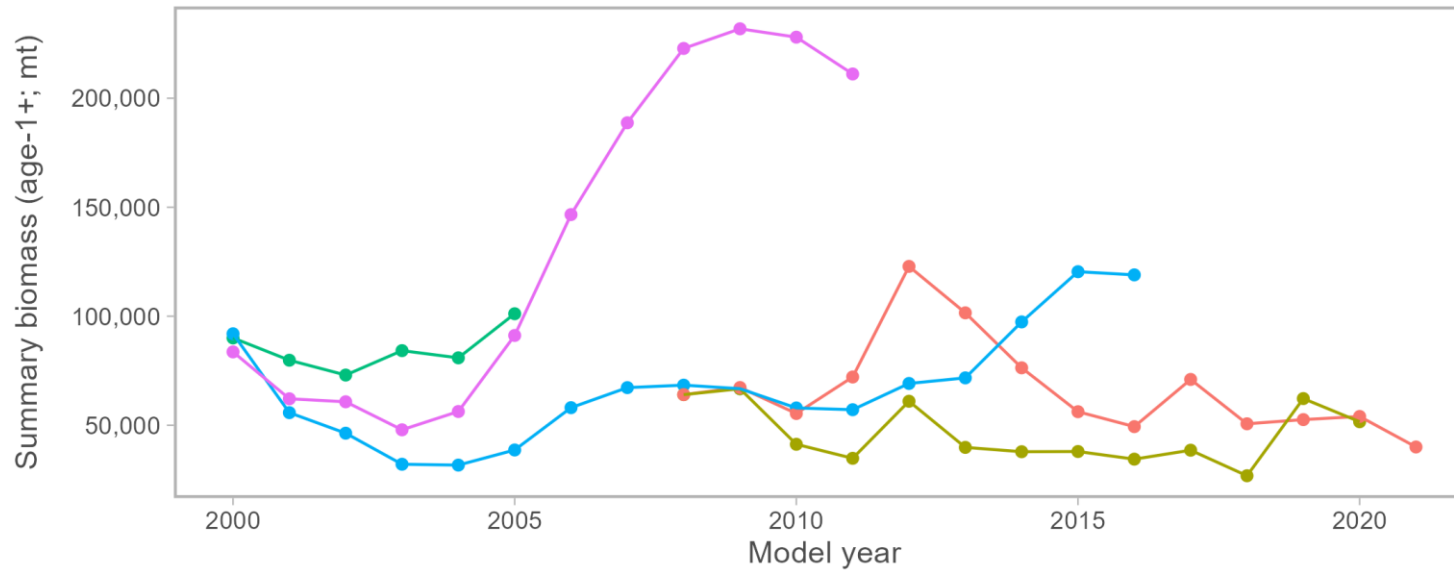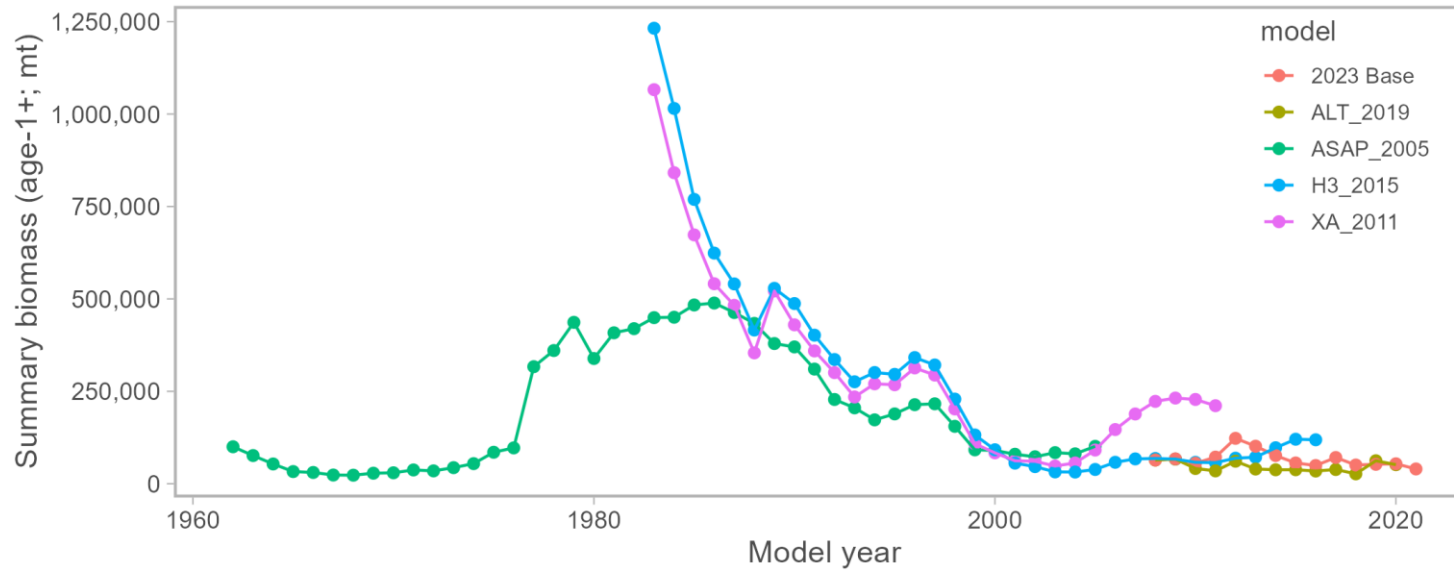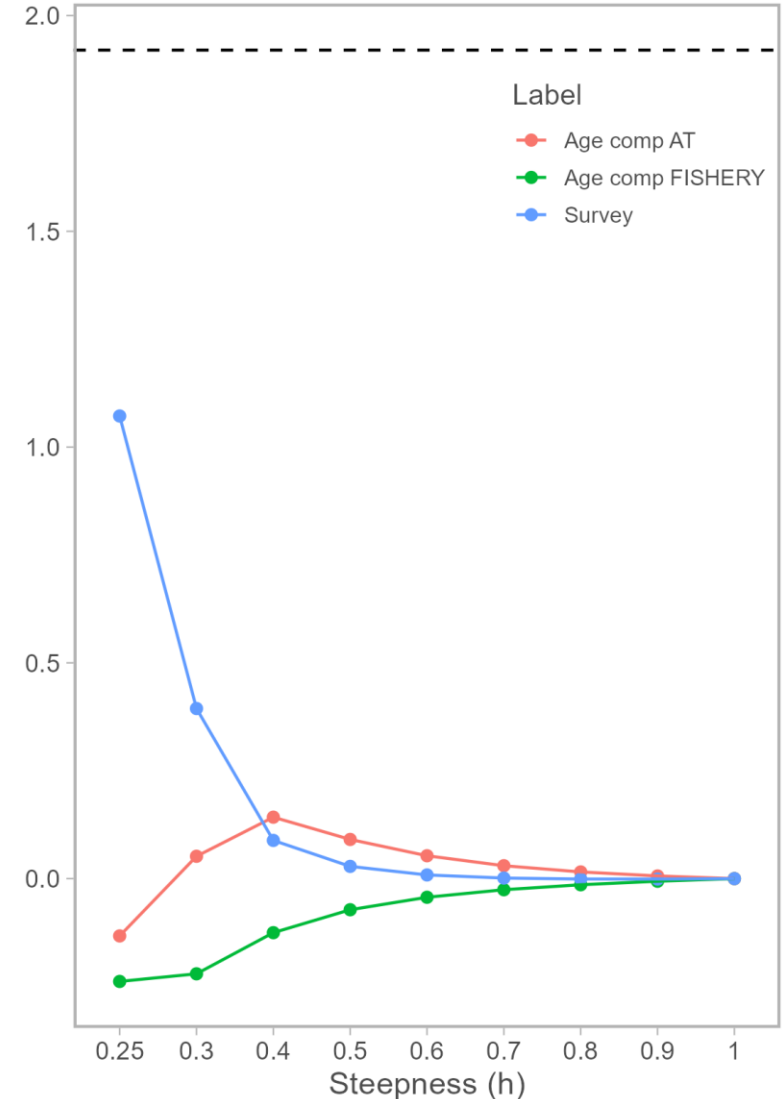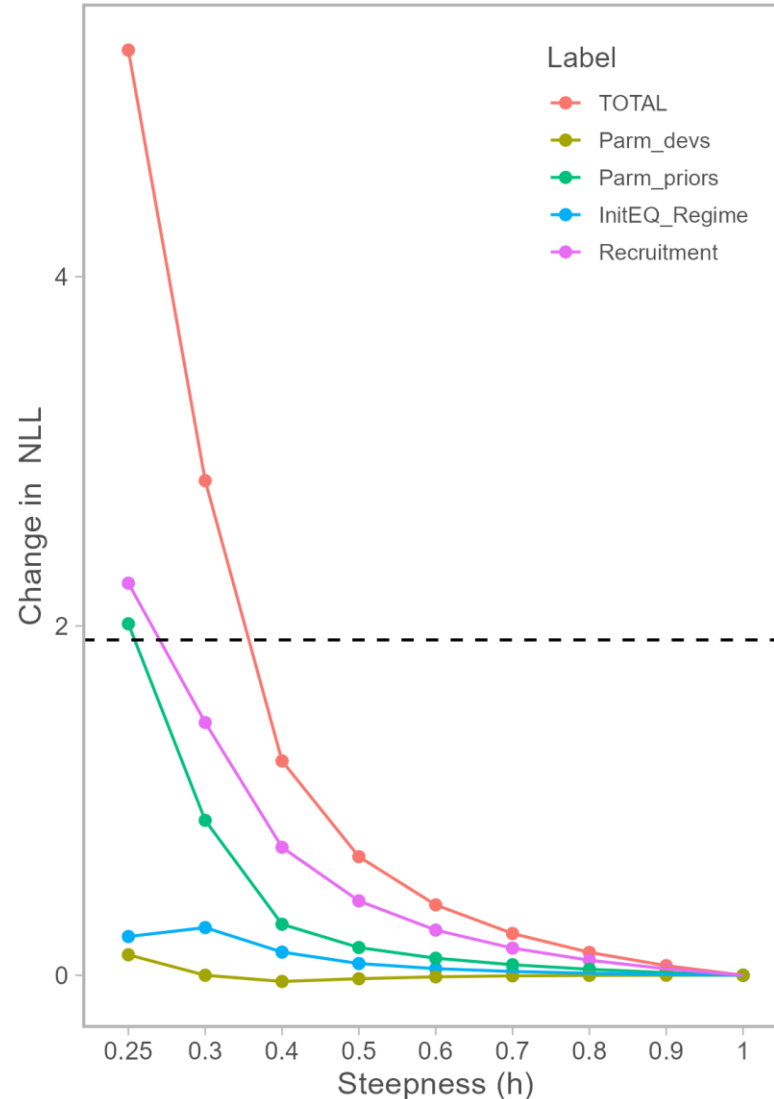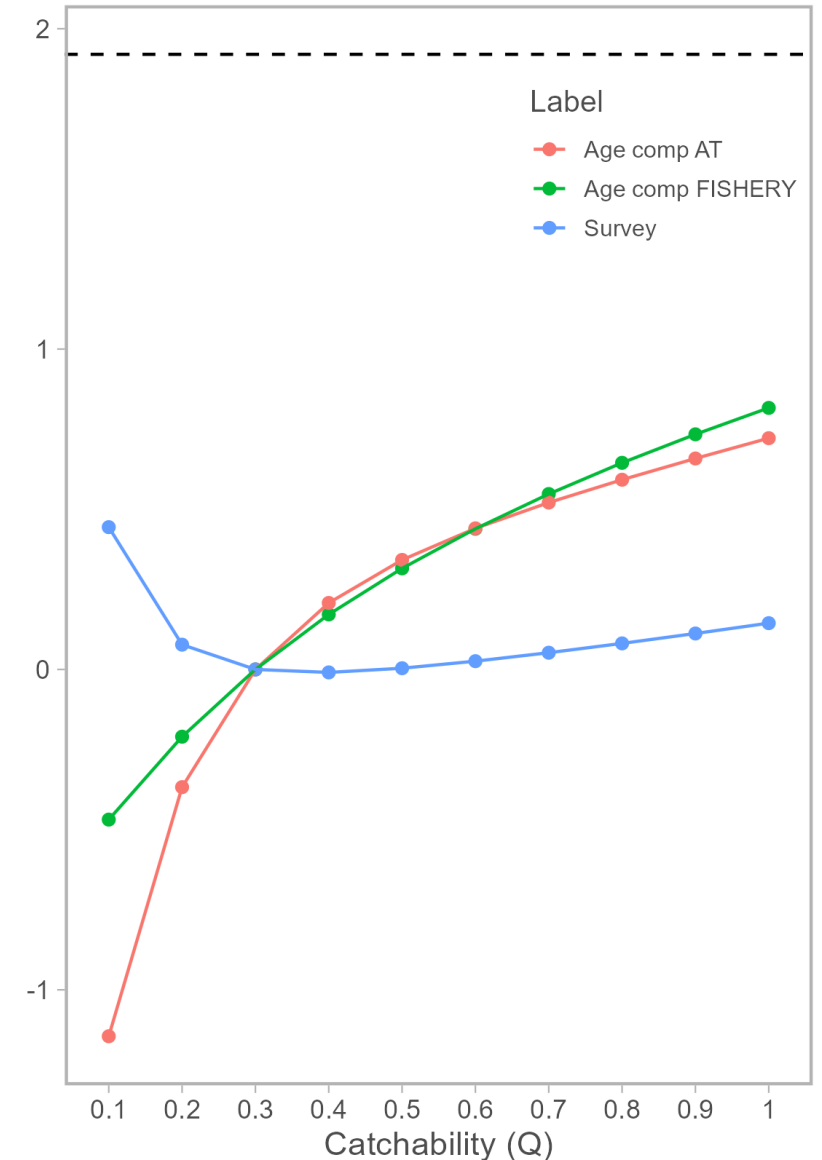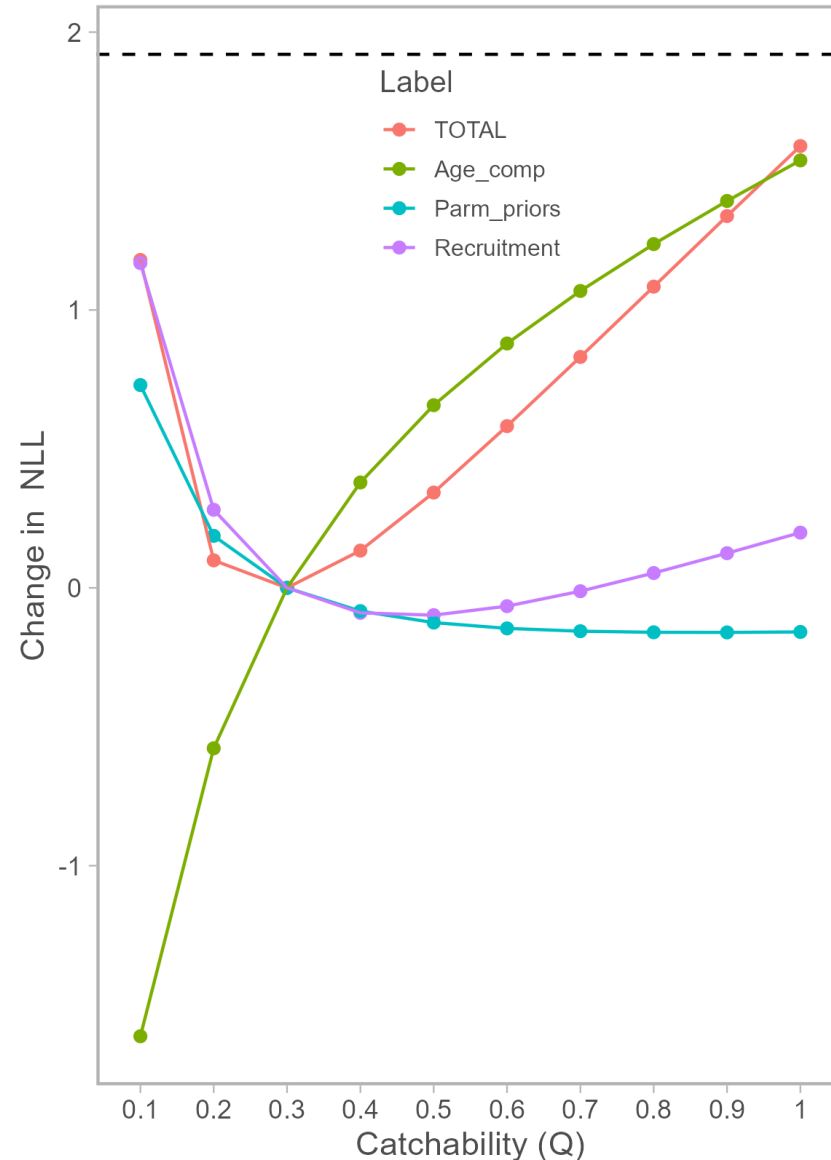
Likelihood profile for steepness (h)

- M estimated

- 2021 age-1+ biomass estimates (mt)
  - h=0.25; 39,539
  - h=0.5; 39,903
  - h=0.7; 39,986
  - h=1.0; 40,215

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Likelihood profile for Q

- Profile over 2021 fixed Q value

- 2021 Q value

- 2021 biomass estimates (mt)
  - Q=0.1; 115,519
  - Q=0.3; 46,534
  - Q=0.6; 25,490
  - Q=1.0; 16,661

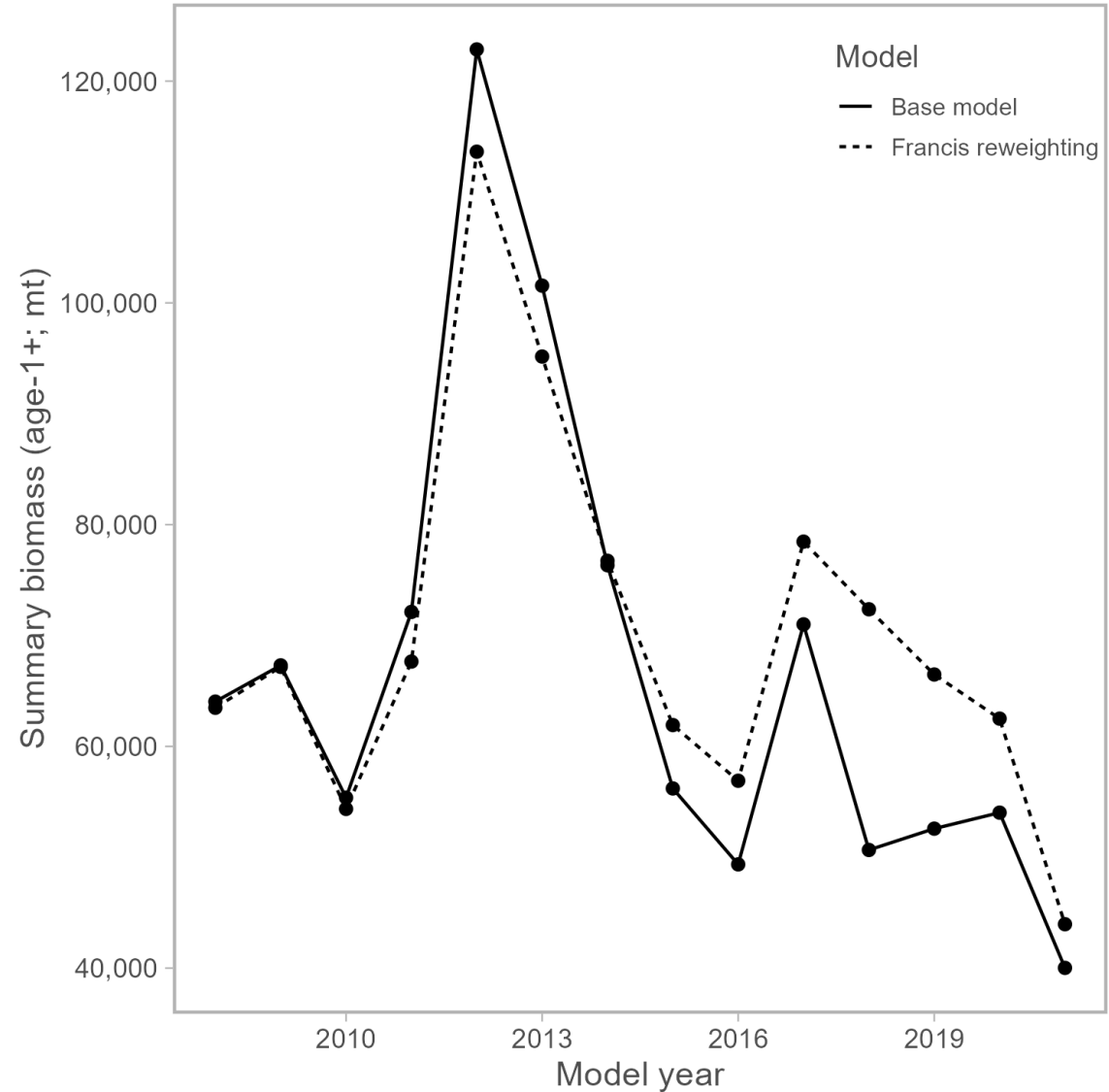Preliminary results presented to STAR panel

Likelihood profile for M (with estimated h)

- M is average value from age-specific curve
- 2021 age-1+ biomass estimates (mt)
  - M=0.3; 54,045
  - M=0.5; 49,542
  - M=0.8; 42,495
  - M=1.0; 42,044
- Steepness estimates at 1

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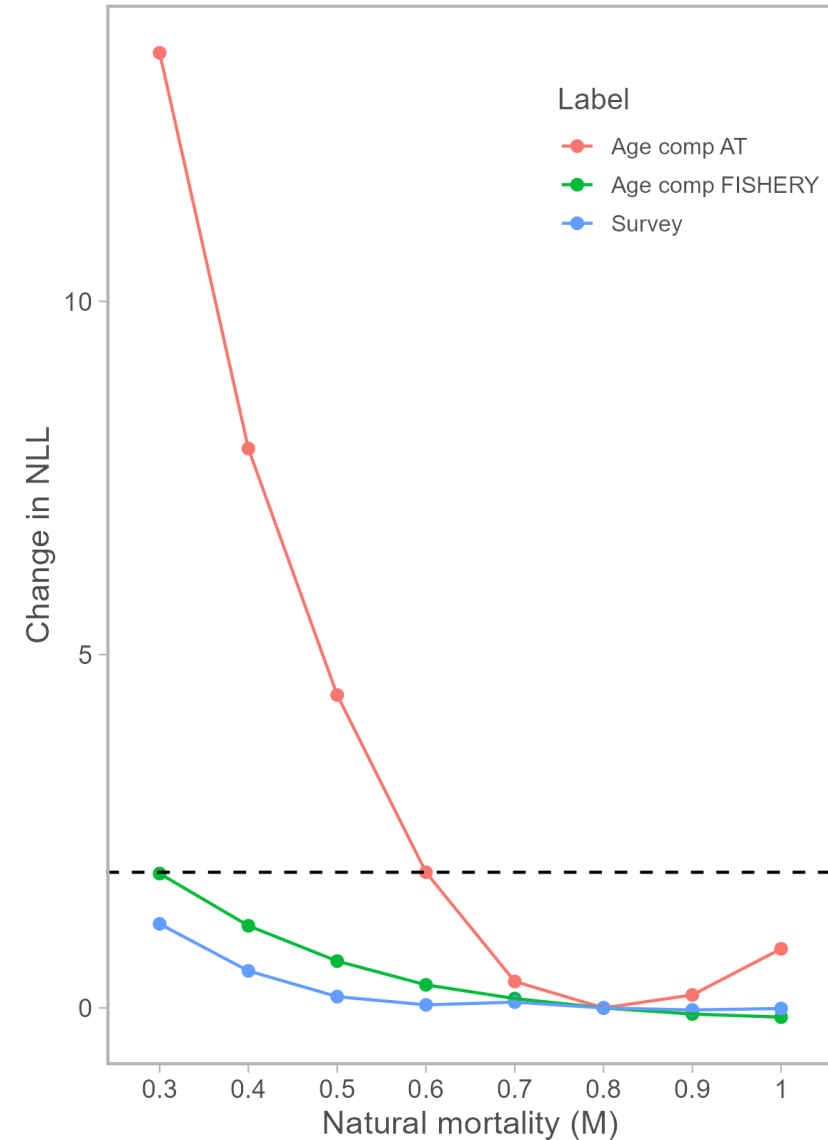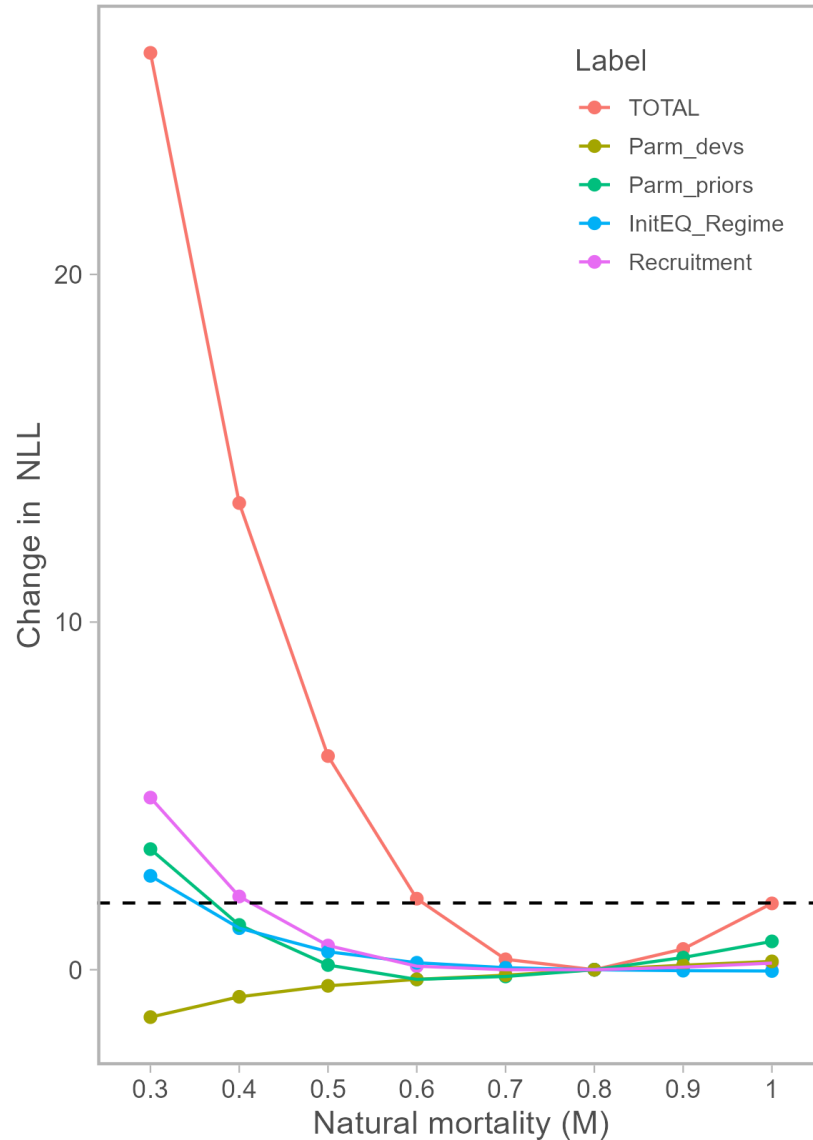
Sensitivity to Francis reweighting

- 2021 age-1+ biomass estimates (mt)
  - Base; 40,024
  - Francis; 43,962

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Sensitivity to downweighting

- lambda = 0.5
- 2021 age-1+ biomass estimates (mt)
  - Base; 40,024
  - Fishery down; 38,207
  - AT down; 41,439

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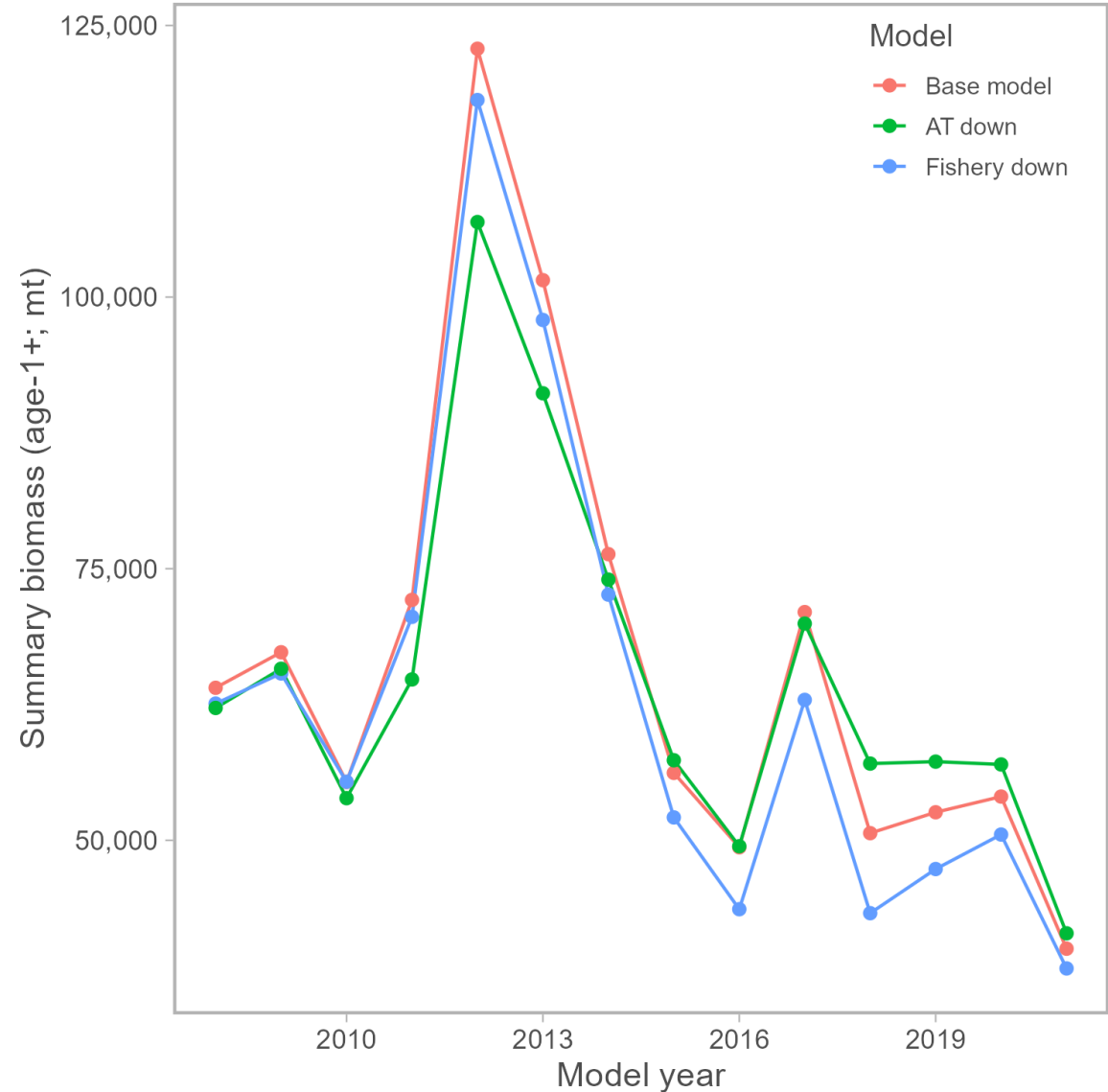
Retrospective pattern

- Expected to have a strong retrospective pattern
- Time-varying Q

- Drop 2021 data
  - Q fixed for 2021, data unavailable to fix Q 2020

Model uncertainties

- Forecast for 2022 and 2023 model years
  - Catch and compositions available for 2022 but no AT index

- Movement and US/Mexico distributions
  - Q is fixed for 2021, year with data

- AT age compositions
  - Time-varying age-0 selectivity (as done in sardine and anchovy assessments) resulted in M estimates high (above 1)
  - Biologically, mackerel probably do not have M greater than anchovy

- Nearshore does not seem to be major uncertainty

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