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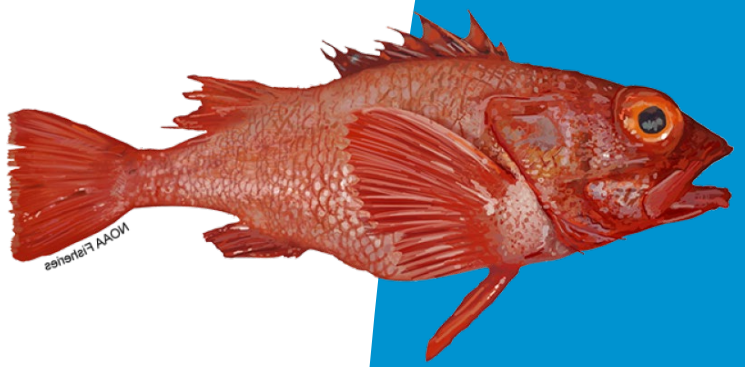
Northwest Fisheries Science Center

Stock assessment for Shortspine Thornyhead (*Sebastolobus alascanus*) along the U.S. West Coast in 2023



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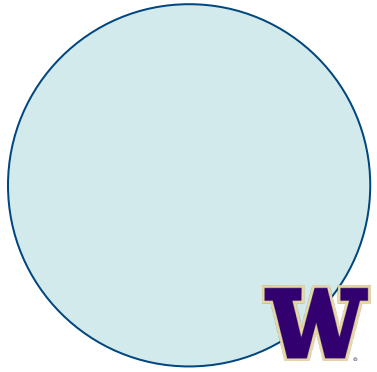
Pierre-Yves Hernvann, Matthieu Véron,
Andrea N. Odell, Jane Y. Sullivan, Adam L. Hayes,
Kiva L. Oken, Vladlena Gertseva, Owen S. Hamel, Melissa A. Haltuch

August 14, 2023

Team Members



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Data Overview

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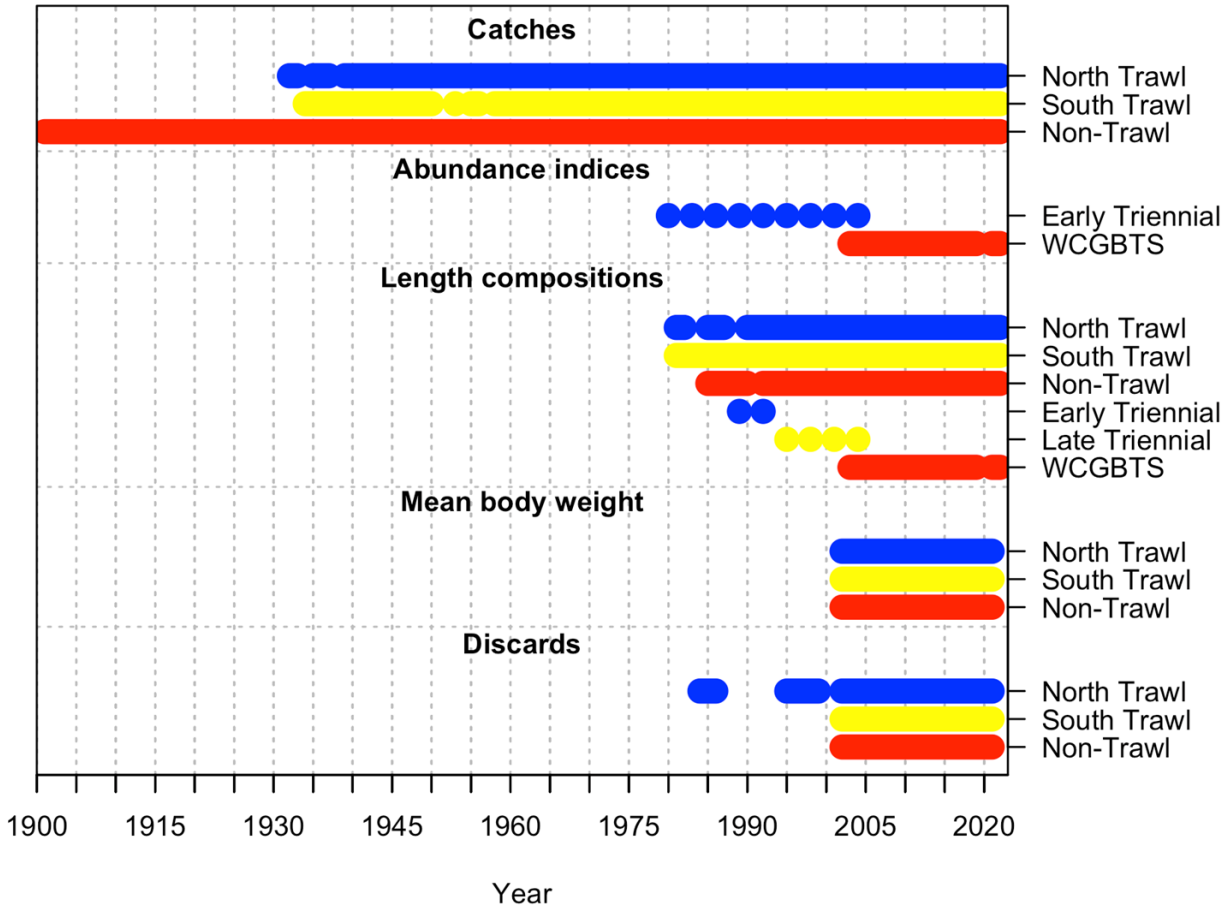
Data Overview

Fisheries fleet structure:

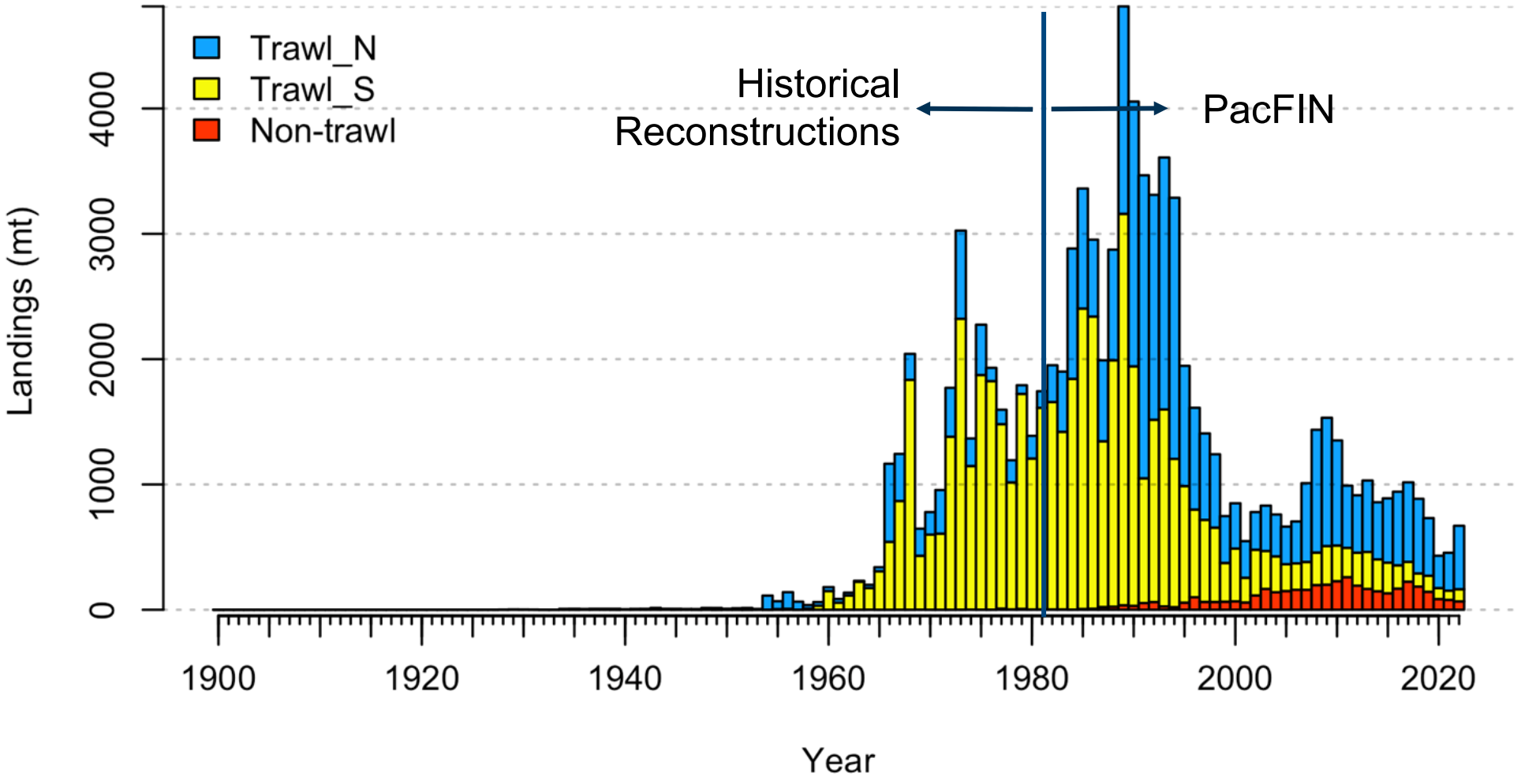
- **'NTrawl'** = OR/WA
- **'STrawl'** = CA
- **'Non-Trawl'** = Coastwide

Survey fleet structure:

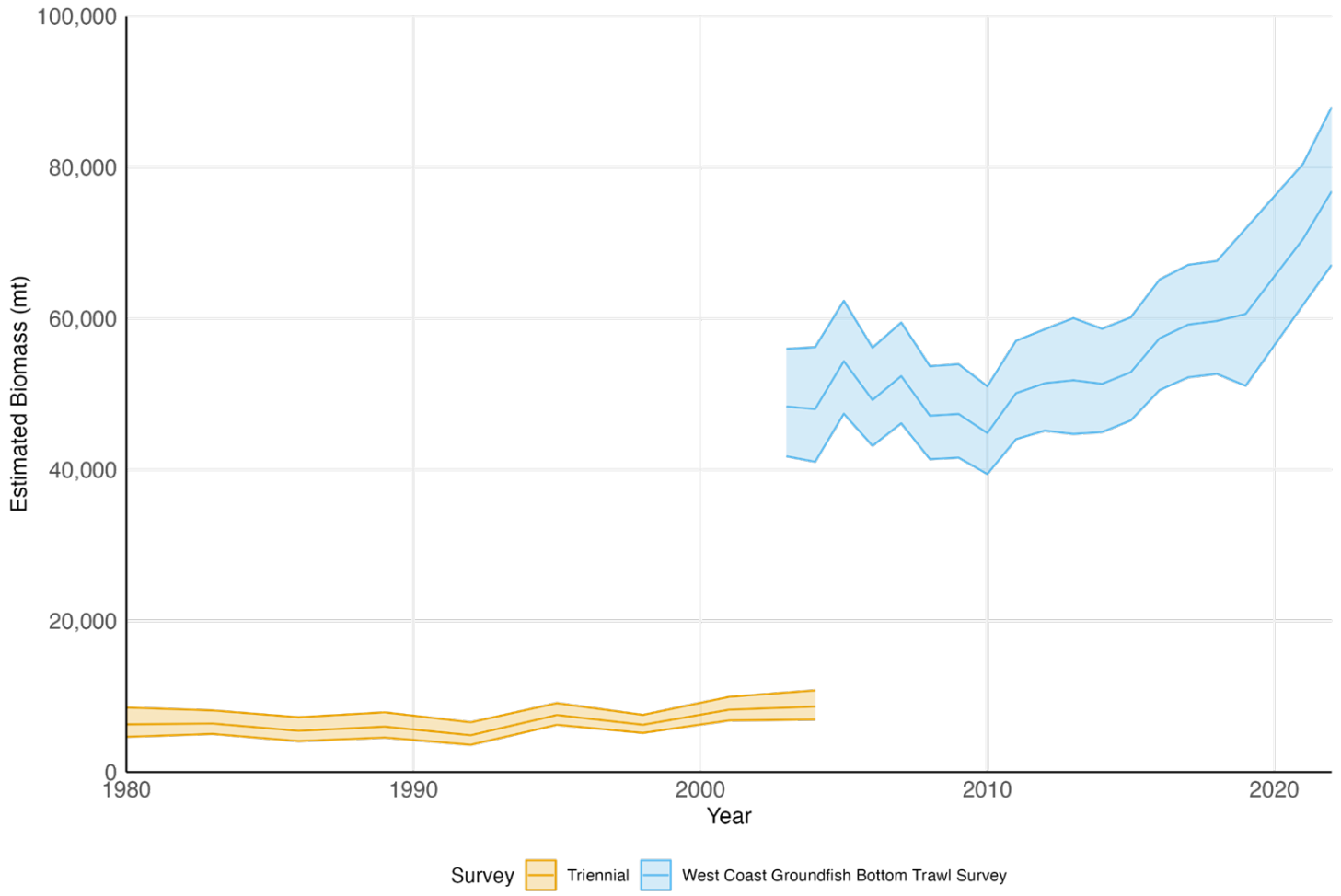
- **'Triennial Survey'**
- **'WCGBTS'**



Full catch time series



Survey Indices



Geostatistical model-based index

Single index for Triennial Survey

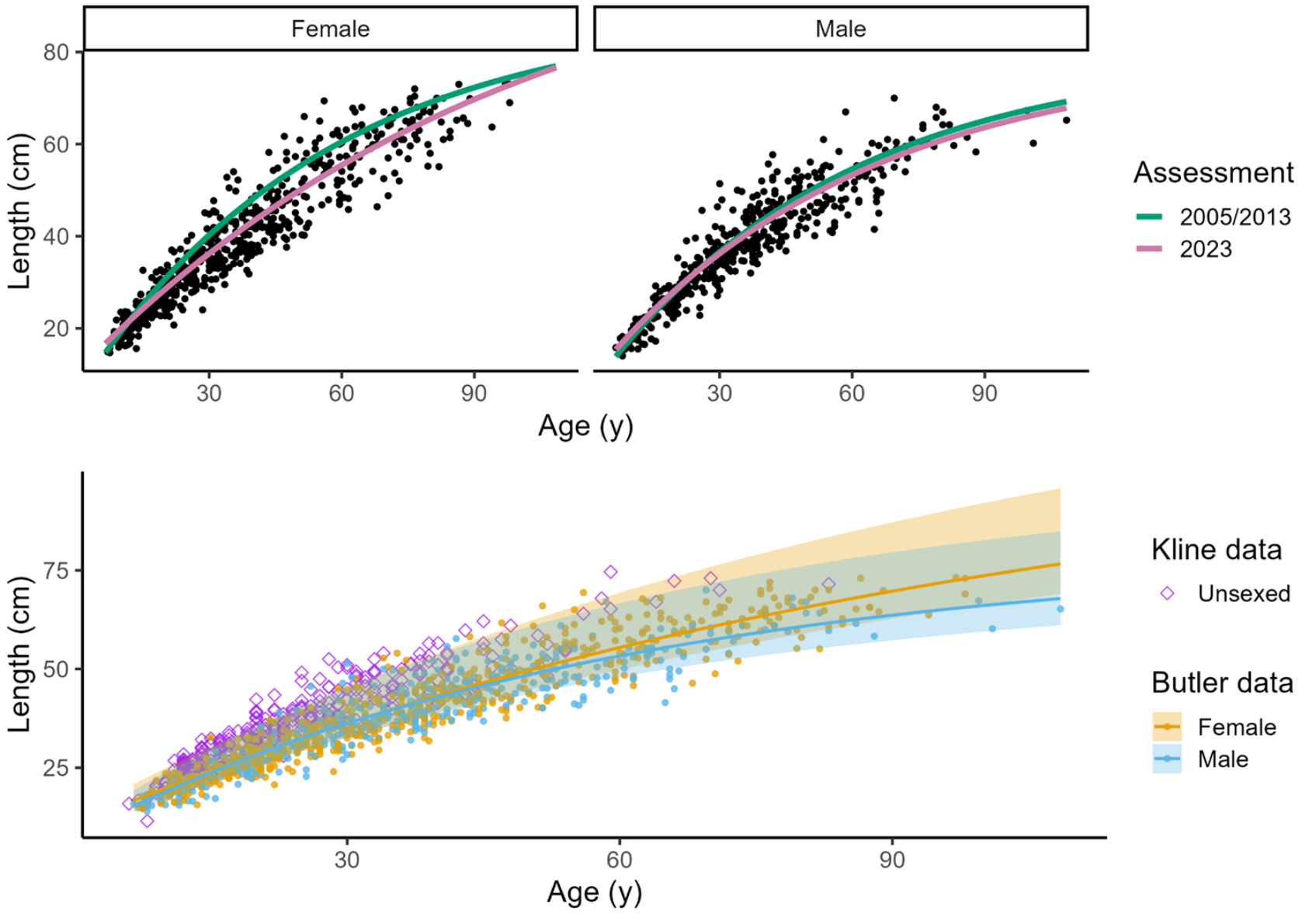
AFSC and NWFSC Slope Surveys dropped

Growth

No validated aging methods

2023 analysis: Sex-specific Schnute growth curves with lognormal error distribution fit

Sensitivity: +25% and -10% on lengths at age-2 and age-100



Other Biological Parameters

	2023	Source
Maturity-at-length	L_{50} = 31.42 cm	WCGBTS [updated]
Fecundity-at-length	$F = 0.0544L^{3.978}$	Cooper et al. 2005 [used in 2013 assessment]
Weight-at-length	Females: $4.86*10^{-6}L^{3.26}$ Males: $4.69*10^{-6}L^{3.25}$	WCGBTS [updated]
Natural mortality	M = 0.04	Highly uncertain due to difficulty in age determination resulting in uncertainty in *A*max; assumes longevity ~ 135 years based on Hamel and Cope 2022; wide likelihood profiles minimized at M = 0.045; between values used in AK, BC and previous West Coast assessments

Natural Mortality

2005: *M* fixed at 0.05

2013: *M* fixed at 0.0505

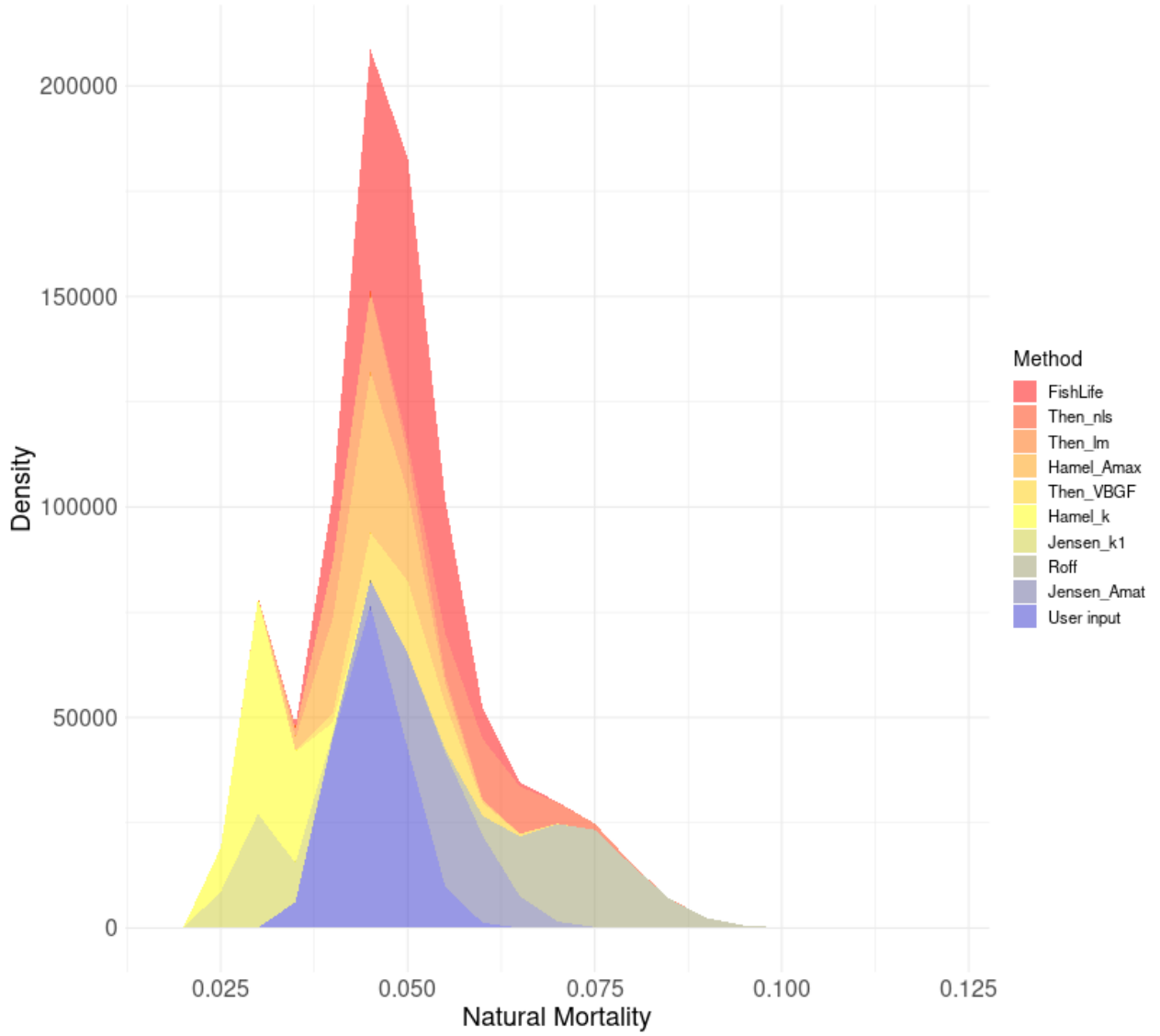
2023: M fixed at 0.04

~135 year maximum age per Hamel and Cope (2022)

Large range in literature

- 0.013-0.07
- AK and BC use 0.03
- 2013 used 0.0505

Wide likelihood profiles



Natural mortality estimates suggest *M* is < 0.05
https://connect.fisheries.noaa.gov/natural-mortality-tool/

2023 Proposed Base Model

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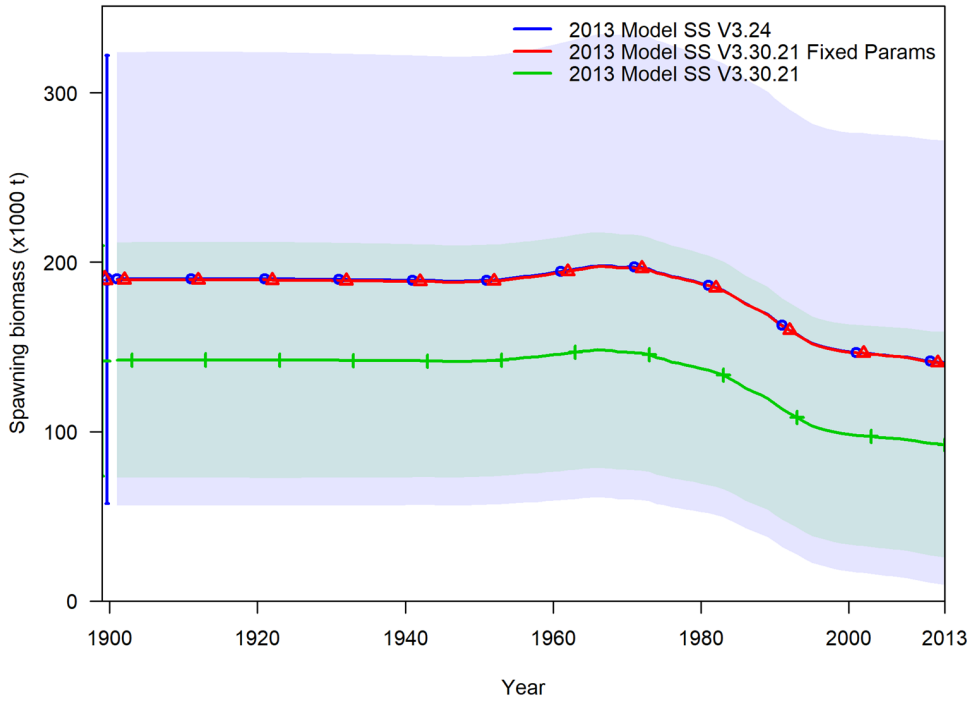
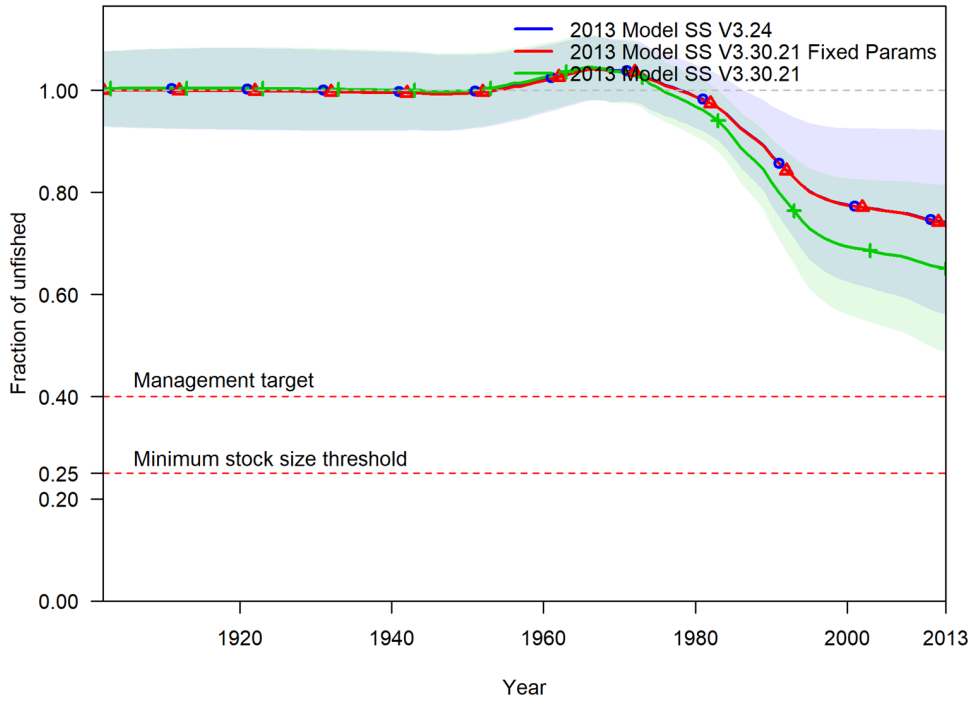
2013-2023 Bridging Process

2013: SS v3.24.O → 2023: SS v3.30.21





2023 Model - Overview of Changes

1. Simplified fleet/survey structure
2. Length-based fecundity relationship
3. Modified maturity and growth curves
4. Lower value of natural mortality
5. Model-based indices of abundance
6. Historical state-level catch reconstructions

2023 Model Overview

- Start Year: 1901
- Condensed fleet structure (3 fisheries; 2 surveys)
    - 2013 fleet structure: 4 fisheries; 5 surveys

- Dome-shaped selectivity, asymptotic retention
- B-H stock recruit relationship h=0.72 (2013: h=0.60)
- Sex-specific growth
- Fecundity-at-length relationship
- Fixed natural mortality M=0.04 (2013: M=0.0505)

Model Results

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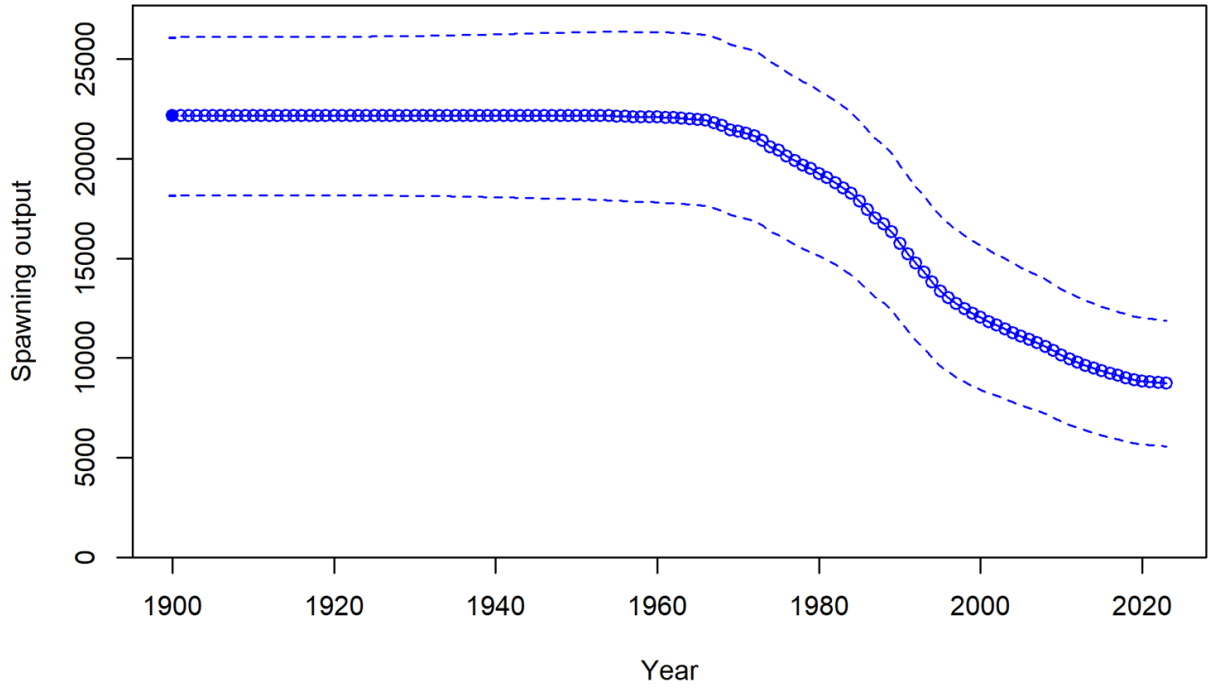
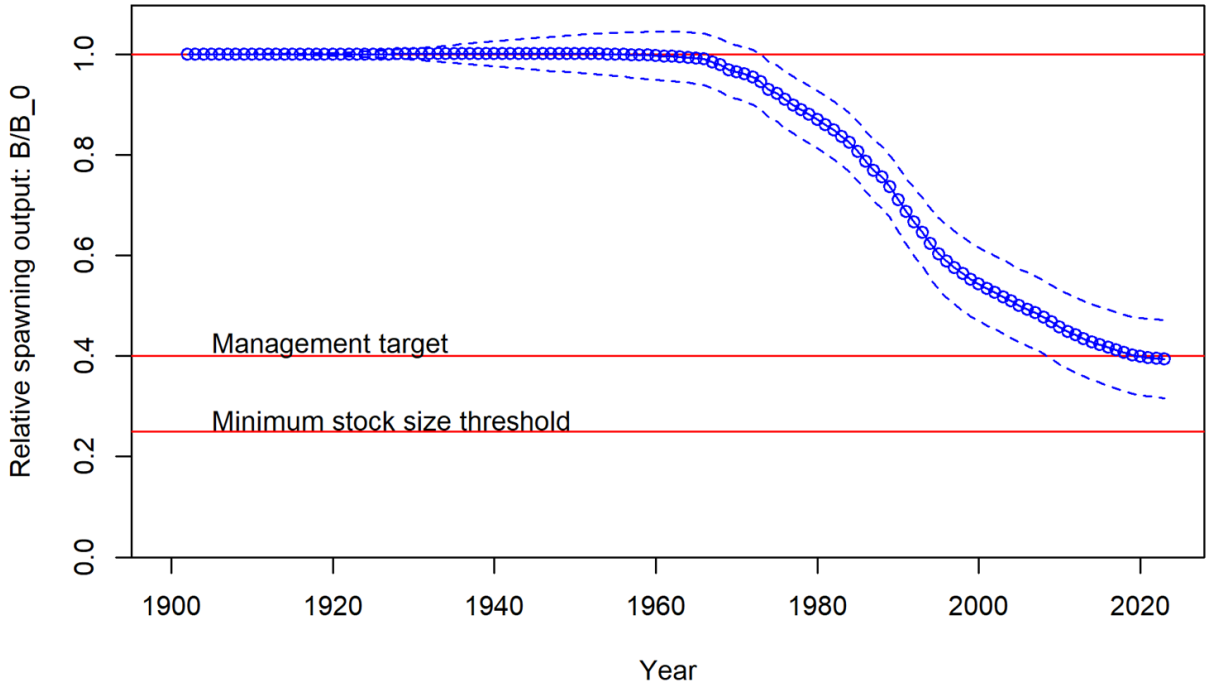
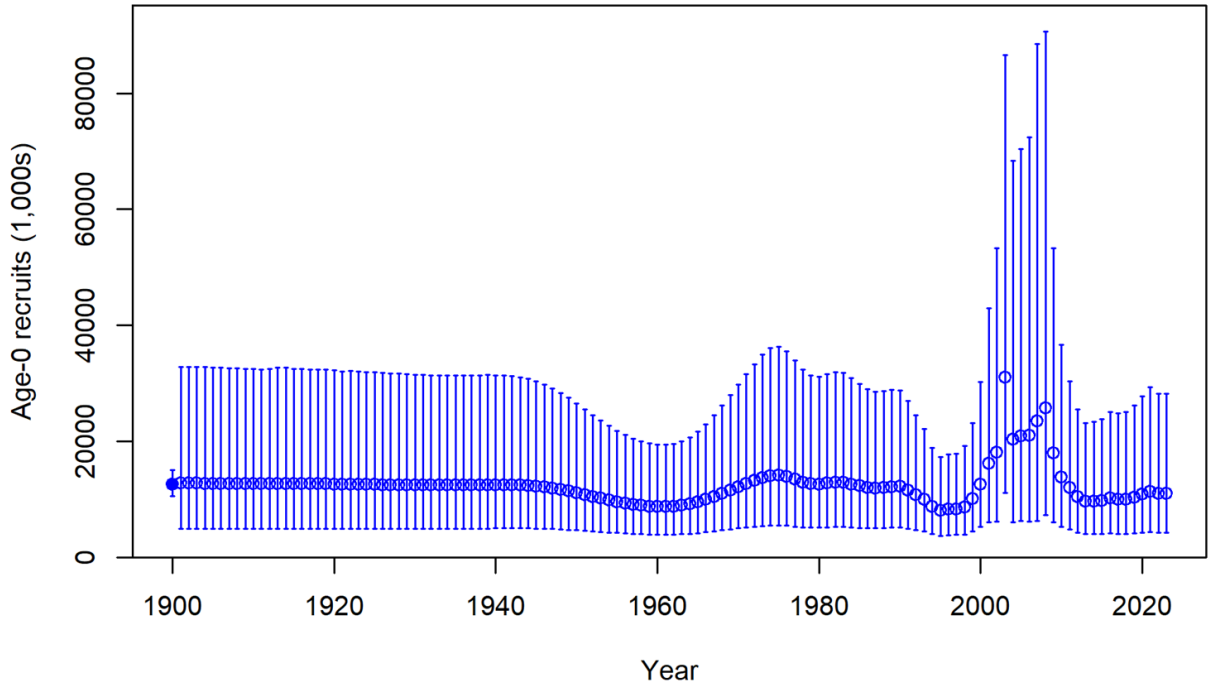
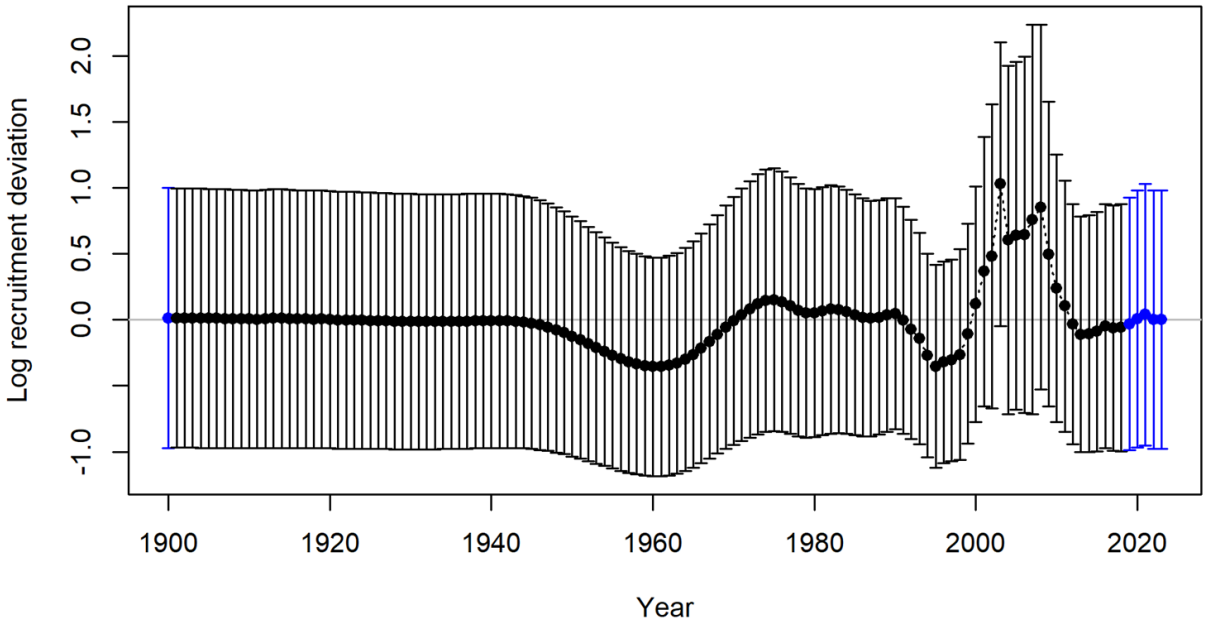
Spawning Output Timeseries

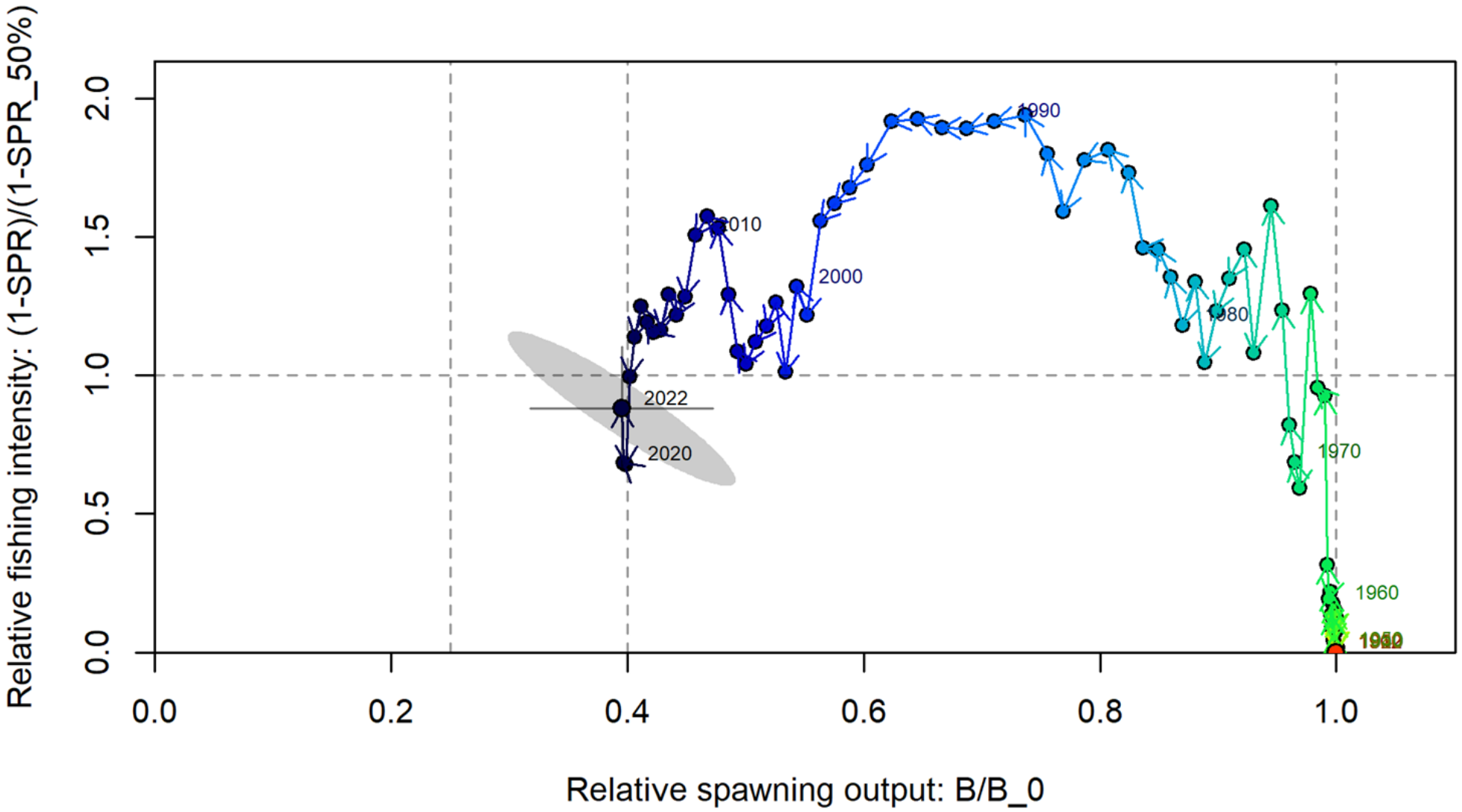




Recruitment Timeseries

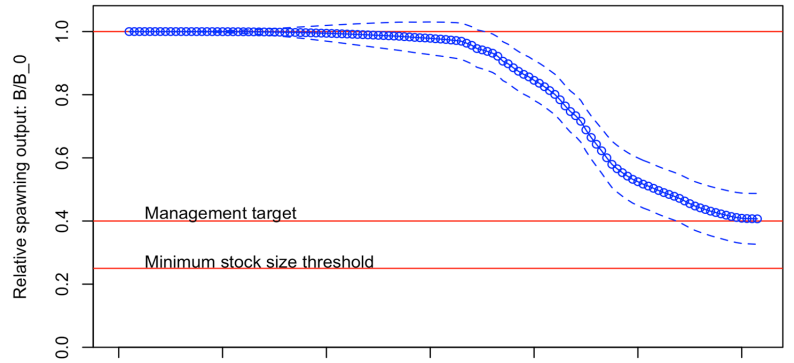


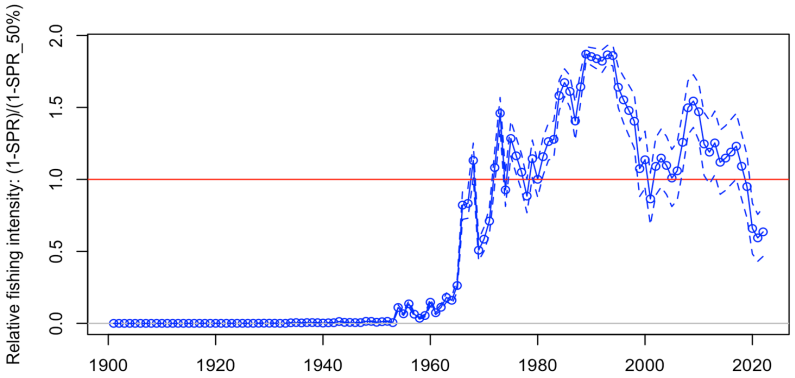


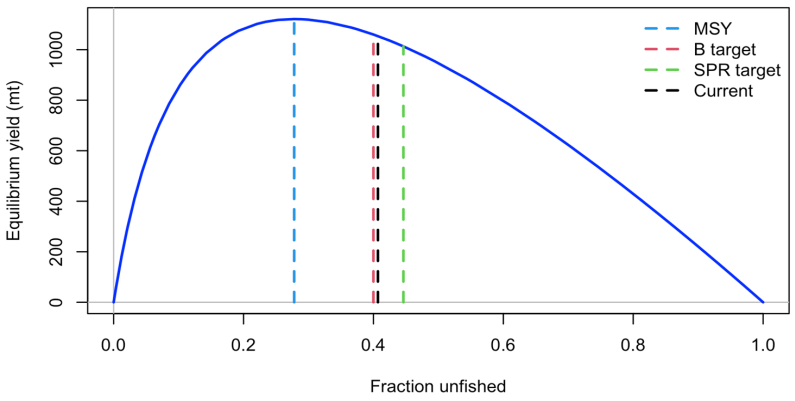

Relative fishing intensity: (1-SPR)/(1-SPR_50%)
0.0
0.5
1.0
1.5
2.0
0.0
0.2
0.4
0.6
0.8
1.0
Relative spawning output: B/B_0
1990
2010
2000
1980
2022
2020
1970
1960

Summary of reference points and management quantities

Variable of Interest	Estimate	95% CI
Unfished Spawning Output	22,145	18,166–26,124
Unfished Age 1+ Biomass (mt)	216,864	177,897–255,831
Unfished Recruitment (R0)	12,580	10,320–14,841
Spawning Output (2023)	8,717	5,545–11,889
Fraction Unfished (2023)	0.39	0.32–0.47
Reference Points Based SB40%		
Proxy Spawning Output SB40%	8,858	7,266–10,450
SPR Resulting in SB40%	0.458	0.458–0.458
Exploitation Rate Resulting in SB40%	0.012	0.011–0.012
Yield with SPR Based On SB40% (mt)	1,160	971–1,348
Reference Points Based on SPR Proxy for MSY		
Proxy Spawning Output (SPR50)	9,880	8,105–11,656
SPR50	0.500	-
Exploitation Rate Corresponding to SPR50	0.010	0.010–0.011
Yield with SPR50 at SB SPR (mt)	1,108	929–1,288
Reference Points Based on Estimated MSY Values		
Spawning Output at MSY (SB MSY)	6,155	5,057–7,253
SPR MSY	0.348	0.345–0.351
Exploitation Rate Corresponding to SPR MSY	0.017	0.016–0.017
MSY (mt)	1,227	1,027–1,426







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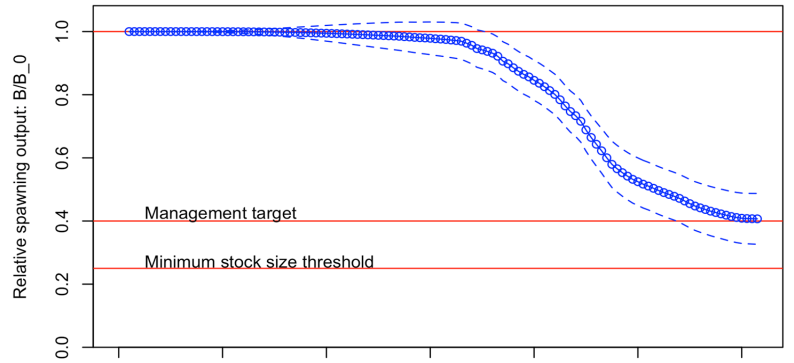

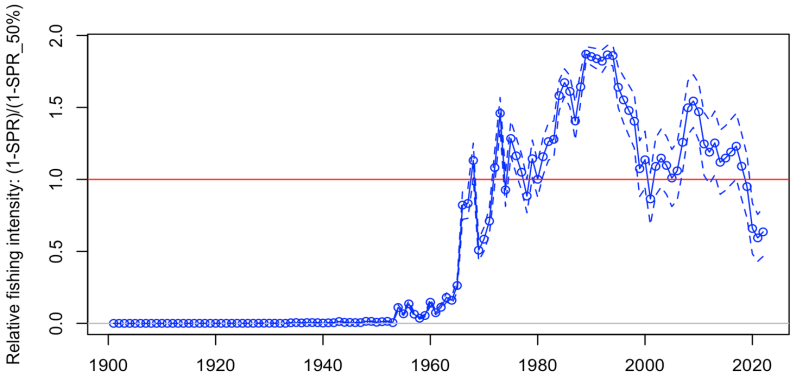

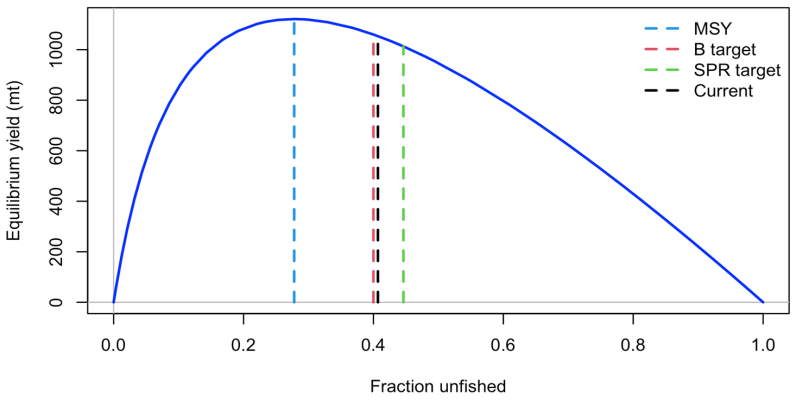

Catch projections under high/low states of nature

		Low: M = 0.03		Base: 0.04		High: M = 0.05	
Year	Catch	SO	Dep	SO	Dep	SO	Dep
ACL P* = 0.4							
2023	756	13485	0.427	8717	0.394	9907	0.494
2024	756	13334	0.422	8687	0.392	9965	0.497
2025	711	13194	0.418	8666	0.391	10032	0.500
2026	713	13067	0.414	8659	0.391	10113	0.504
2027	716	12949	0.410	8660	0.391	10202	0.509
2028	718	12841	0.406	8670	0.392	10298	0.513
2029	720	12742	0.403	8688	0.392	10400	0.519
2030	721	12652	0.401	8712	0.393	10509	0.524
2031	722	12570	0.398	8744	0.395	10621	0.530
2032	721	12496	0.396	8782	0.397	10738	0.535
2033	720	12431	0.394	8826	0.399	10857	0.541
2034	719	12372	0.392	8874	0.401	10978	0.547
ACL P* = 0.45							
2023	756	13485	0.427	8717	0.394	9907	0.494
2024	756	13334	0.422	8687	0.392	9965	0.497
2025	815	13194	0.418	8666	0.391	10032	0.500
2026	825	13060	0.413	8652	0.391	10106	0.504
2027	834	12934	0.409	8645	0.390	10187	0.508
2028	843	12817	0.406	8647	0.390	10275	0.512
2029	851	12708	0.402	8655	0.391	10368	0.517
2030	859	12607	0.399	8670	0.392	10467	0.522
2031	866	12513	0.396	8691	0.392	10569	0.527
2032	872	12427	0.393	8717	0.394	10674	0.532
2033	877	12348	0.391	8747	0.395	10781	0.538
2034	883	12275	0.389	8782	0.397	10889	0.543

- States of nature considered for Natural Mortality
- Projections starting in 2025

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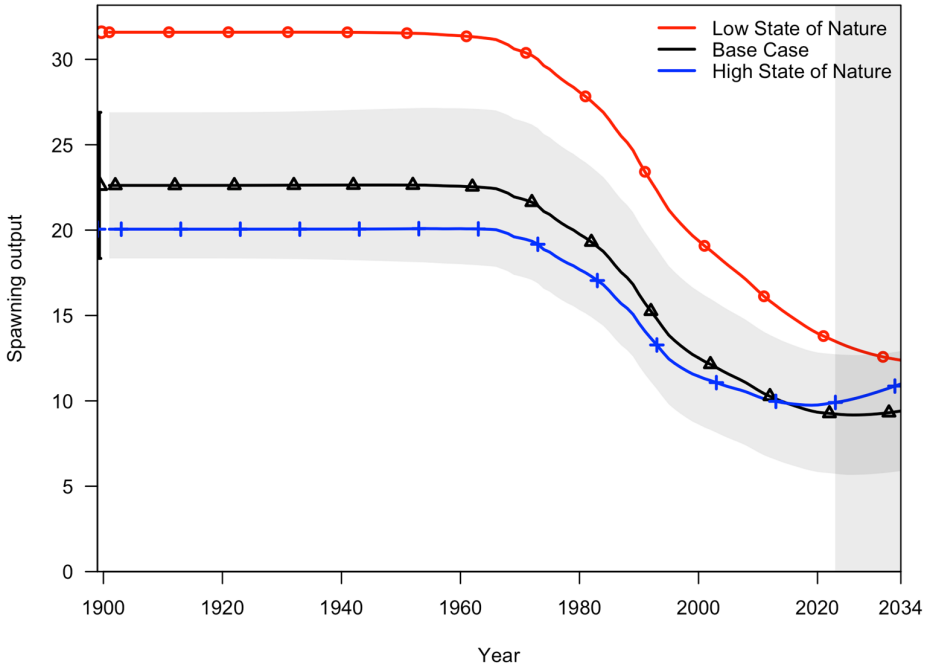
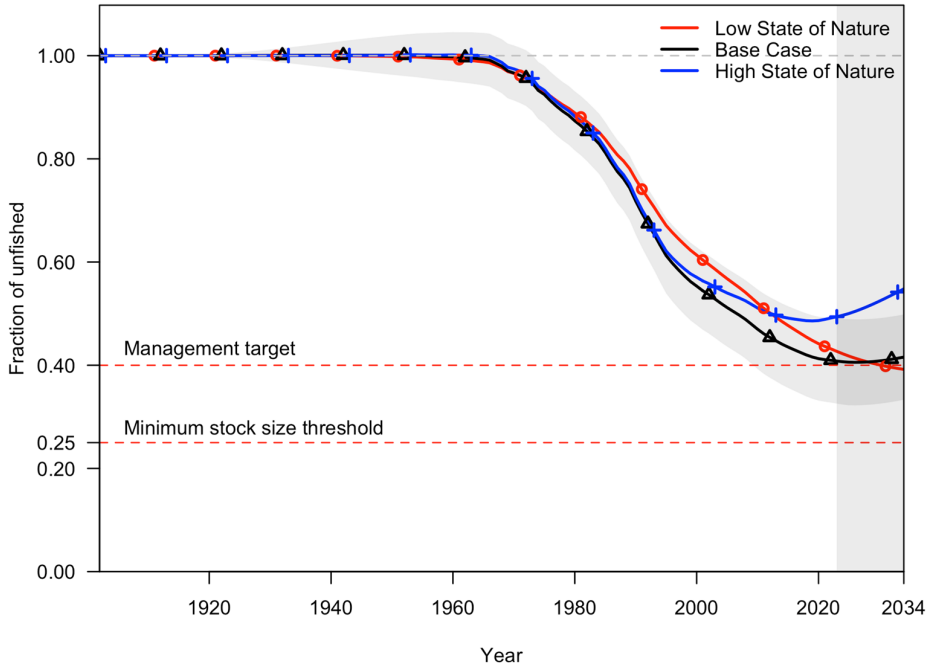
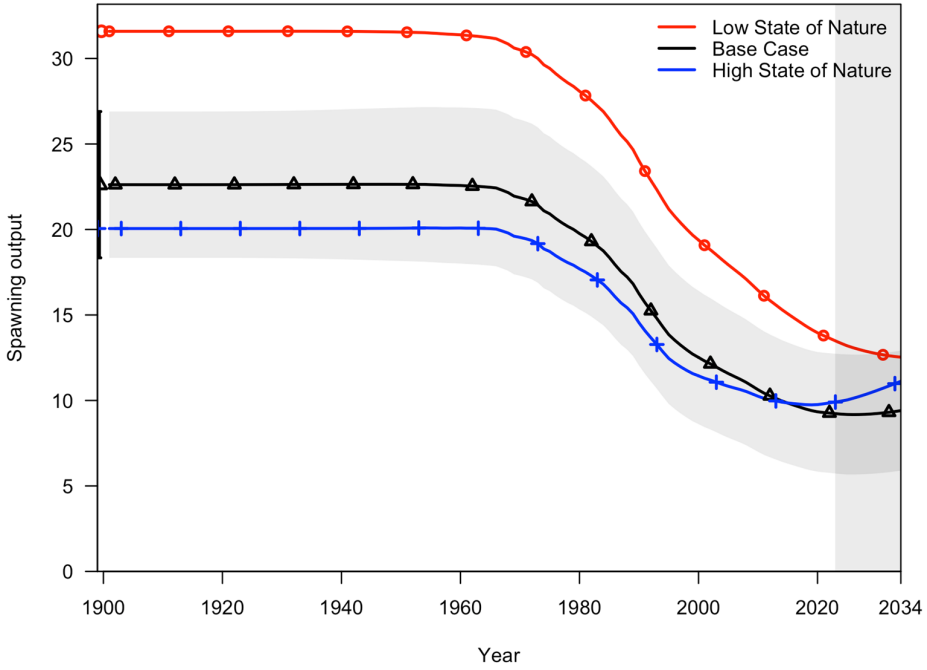
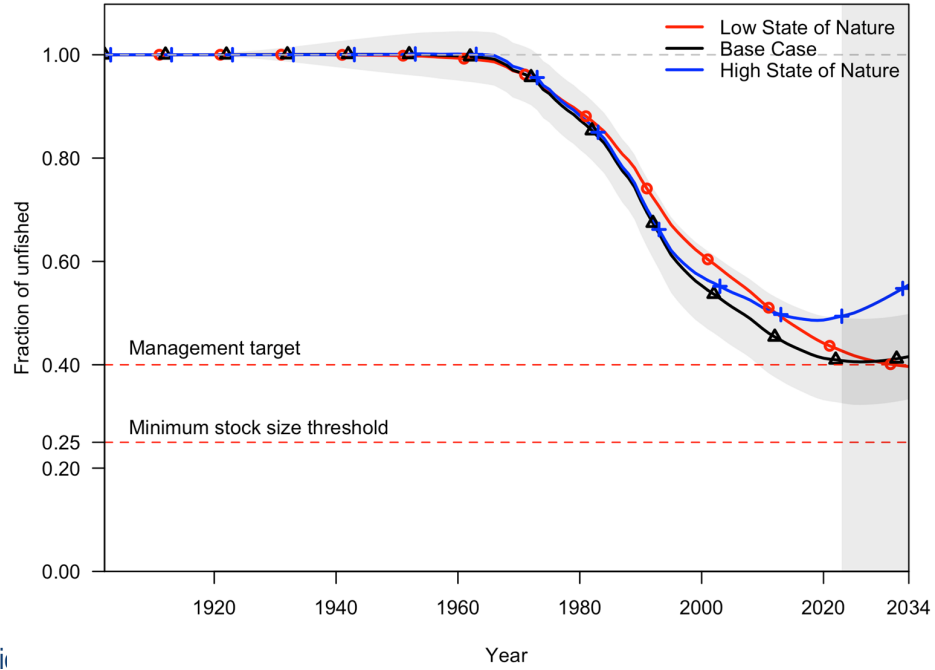

Low State of Nature
Base Case
High State of Nature
Spawning output
Year


Low State of Nature
Base Case
High State of Nature
Management target
Minimum stock size threshold
Fraction of unfished
Year

P*=0.40


Low State of Nature
Base Case
High State of Nature
Spawning output
Year


Low State of Nature
Base Case
High State of Nature
Management target
Minimum stock size threshold
Fraction of unfished
Year

P*=0.45

2023 Key Diagnostics

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Diagnostic Summary

Retrospective Analysis: no strong retrospective patterns

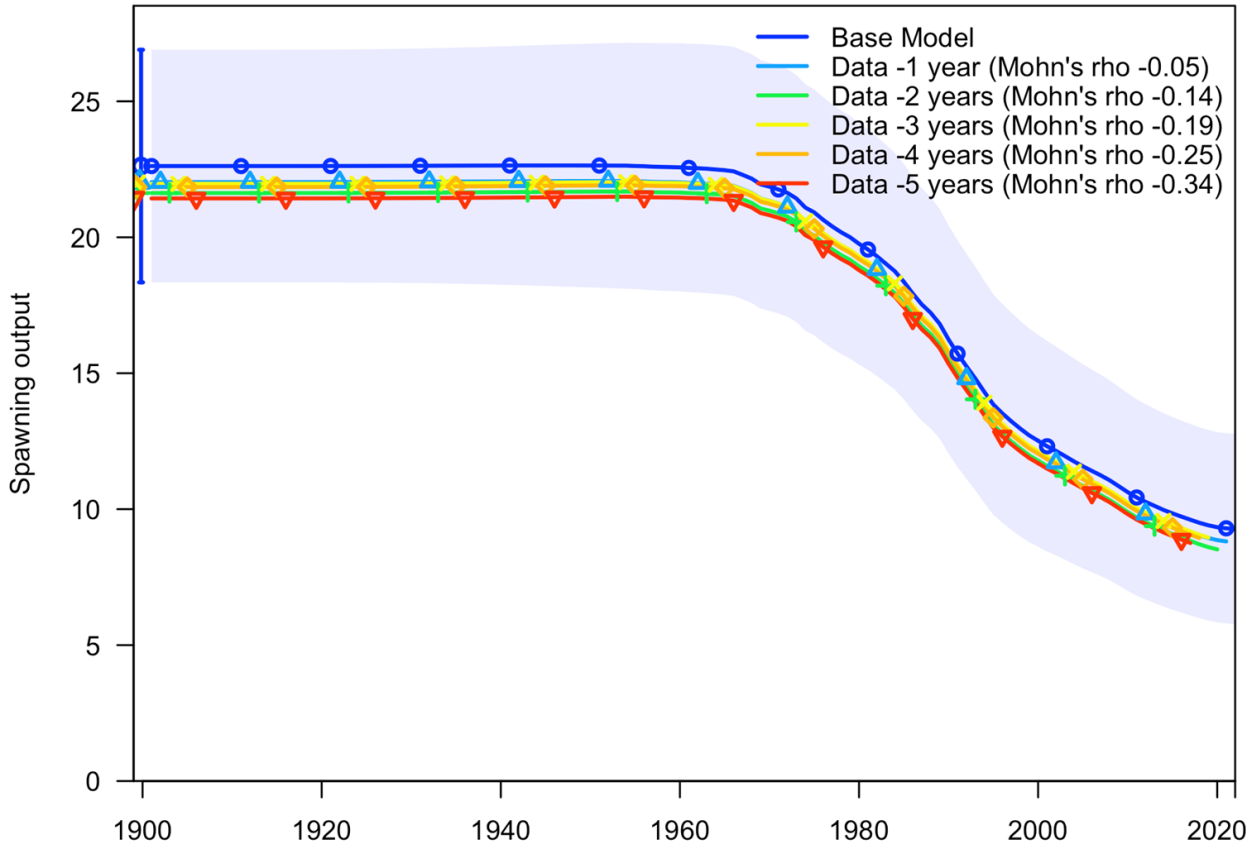
Likelihood Profiles:

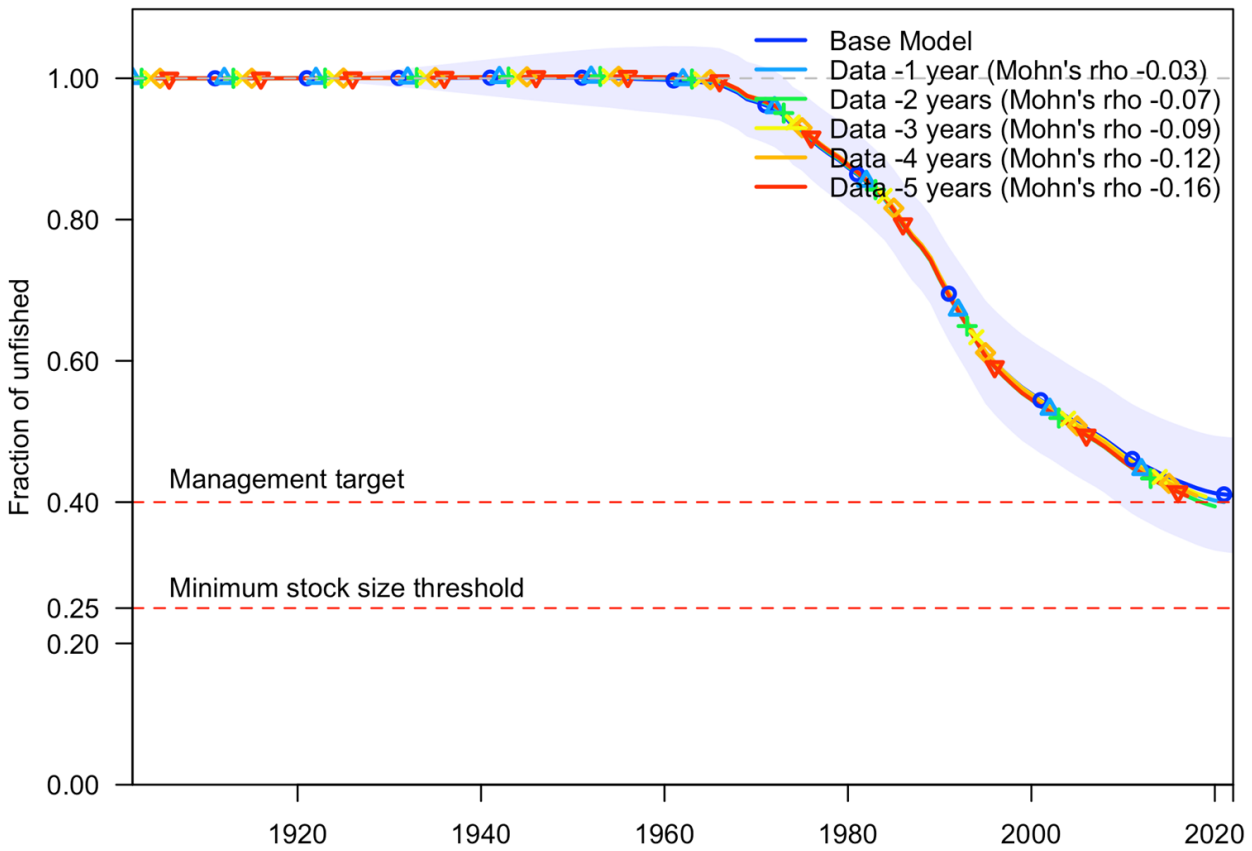
$\mathbf{R_0}$: moderately sensitive

h : insensitive

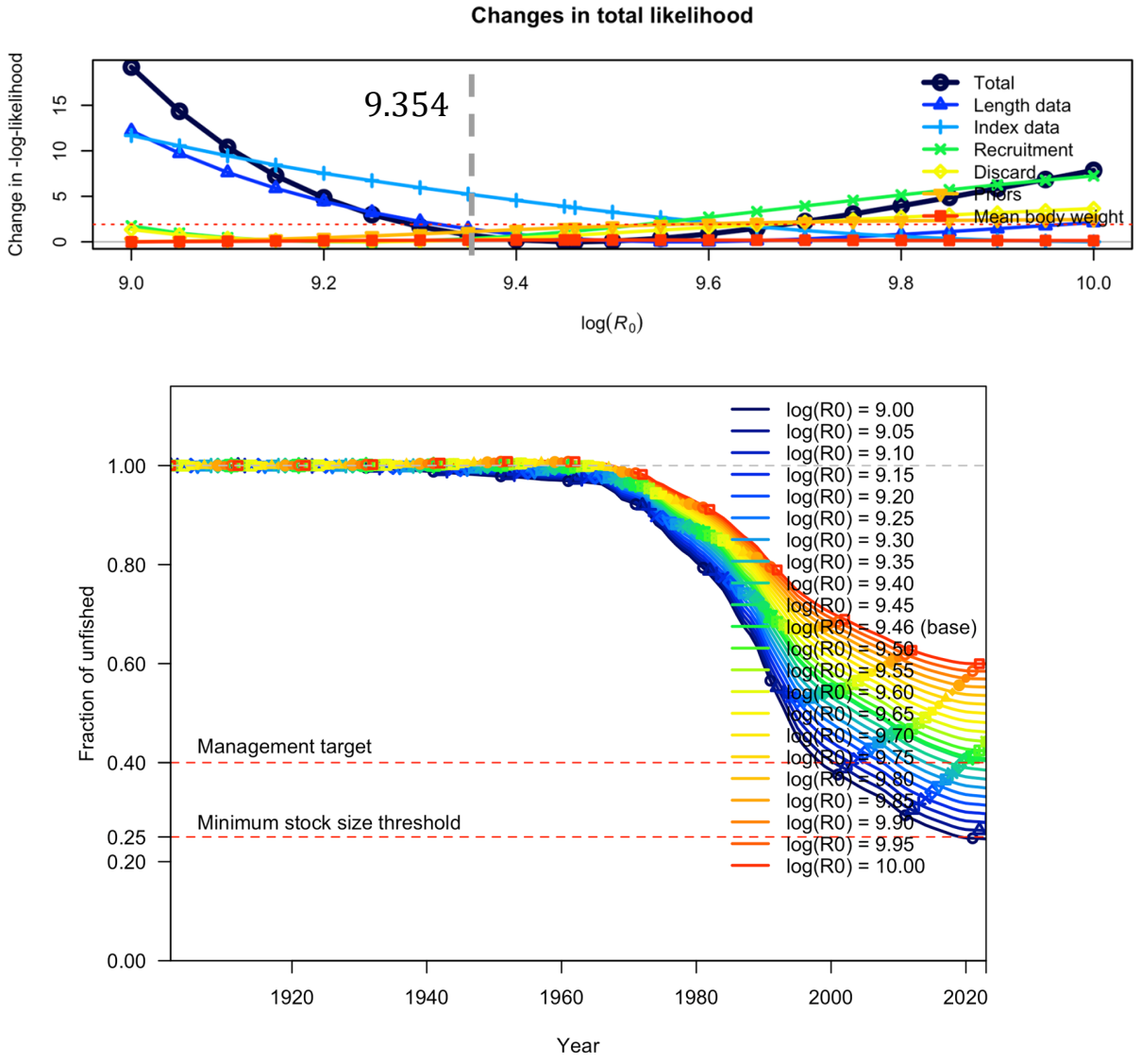
M : moderately sensitive

Retrospective Analysis

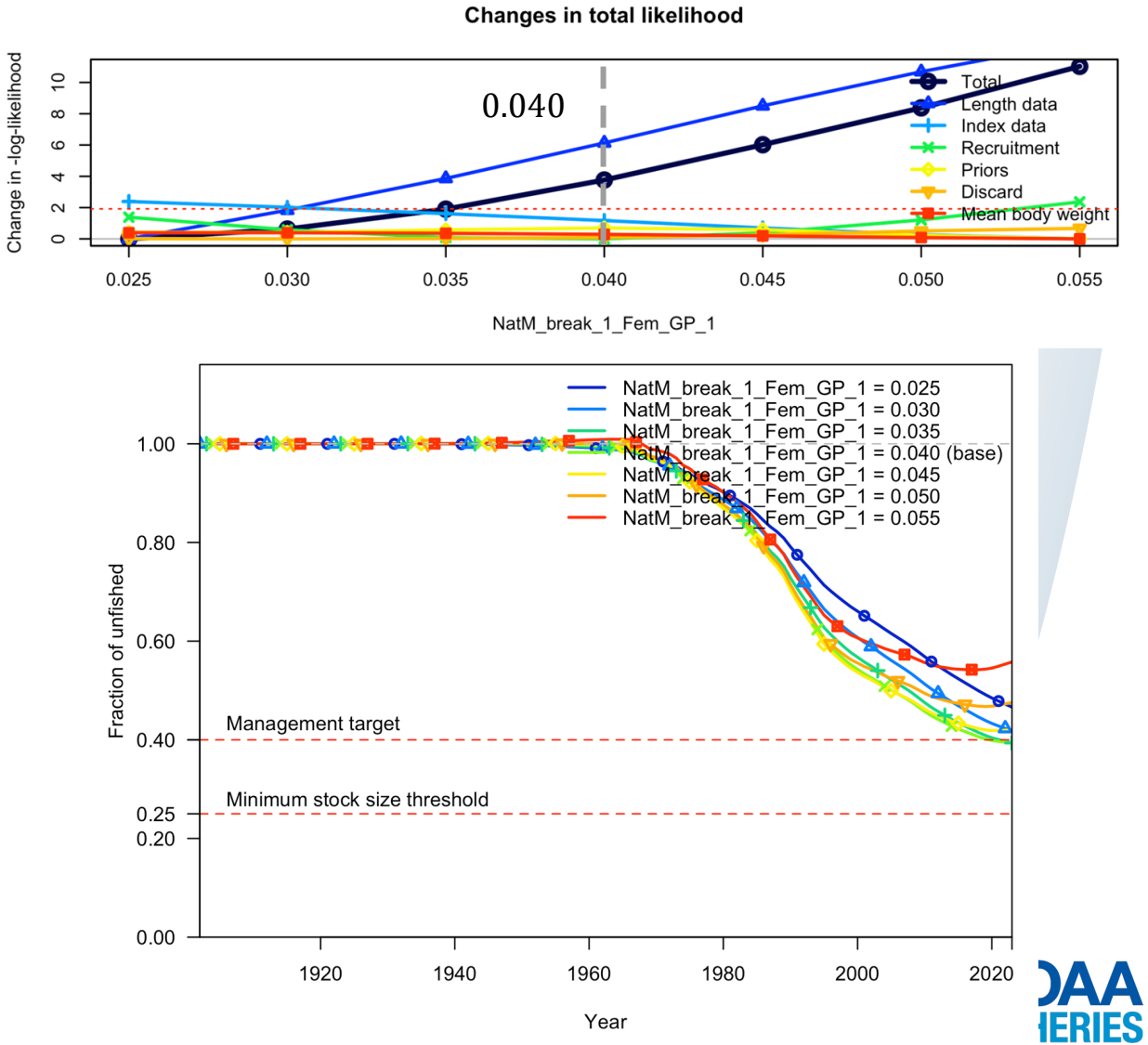




Likelihood Profile over R0



Likelihood Profile over Natural Mortality (M)

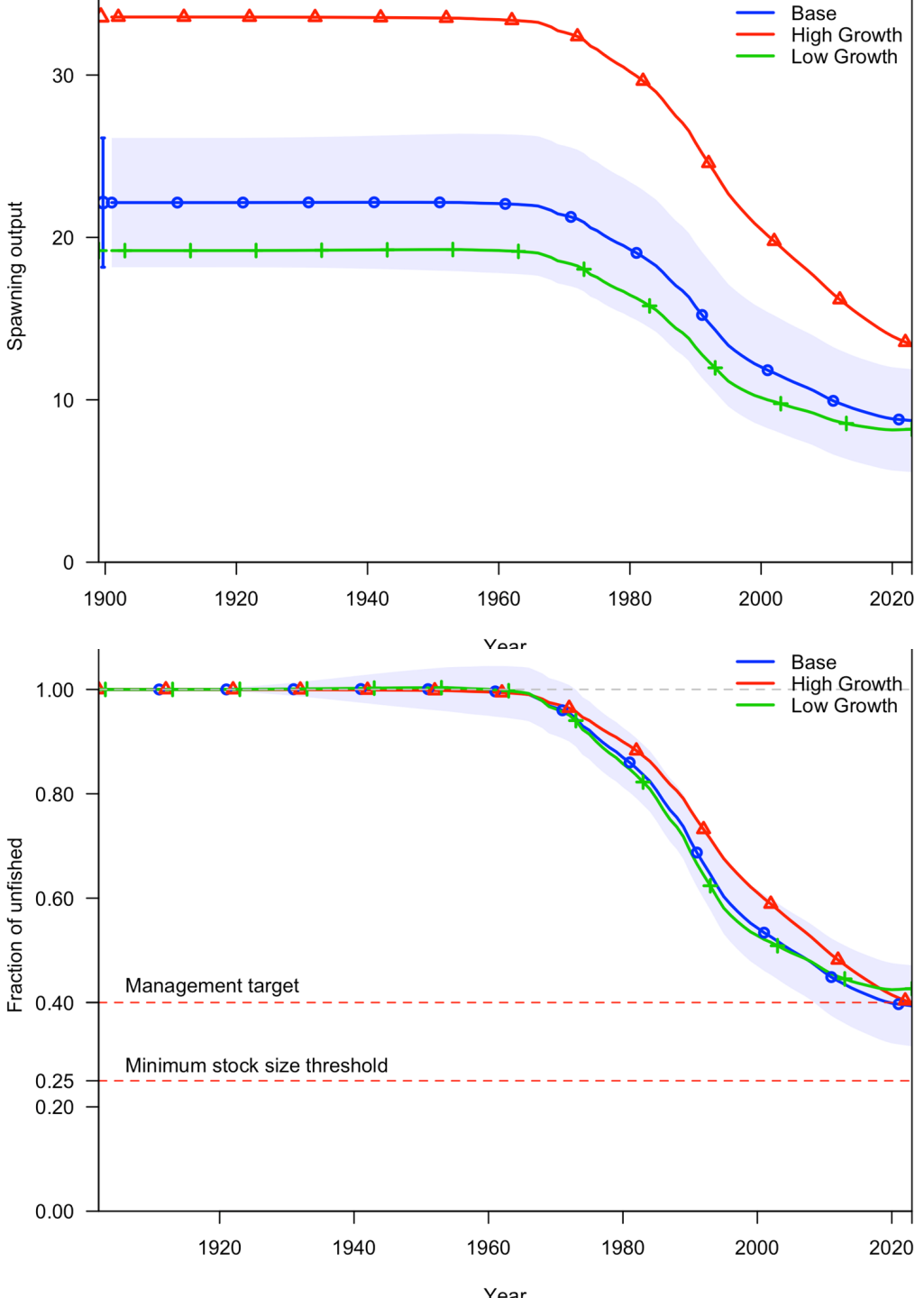


Sensitivities Summary

	Scenarios	Outcomes
Growth	High Growth Low Growth	Stock scale and status sensitive
Maturity	2013 Maturity Curve Intermediate Maturity Curve	Results largely insensitive
Fecundity	Spawning biomass = spawning output (No Fecundity-Length Relationship)	Stock scale sensitive; status insensitive
Landings	Imputed Historical Landings 2013 Historical Landings 4 Fleet Structure (2013)	Results largely insensitive
Surveys	Log-normal model-based error structure Design-based Indices Including Slope Surveys (2013)	Results largely insensitive

Model Sensitivity to Growth (length-at-age)

- Scenarios
  - High growth: +25%
  - Low growth: -10%
- Spawning output (scale) sensitive to assumptions of growth
- Spawning depletion less sensitive, but some variation in final year
- Recruitment sensitive to growth
- High growth scenario slightly better overall fit to the data



Prominent Axes of Uncertainty

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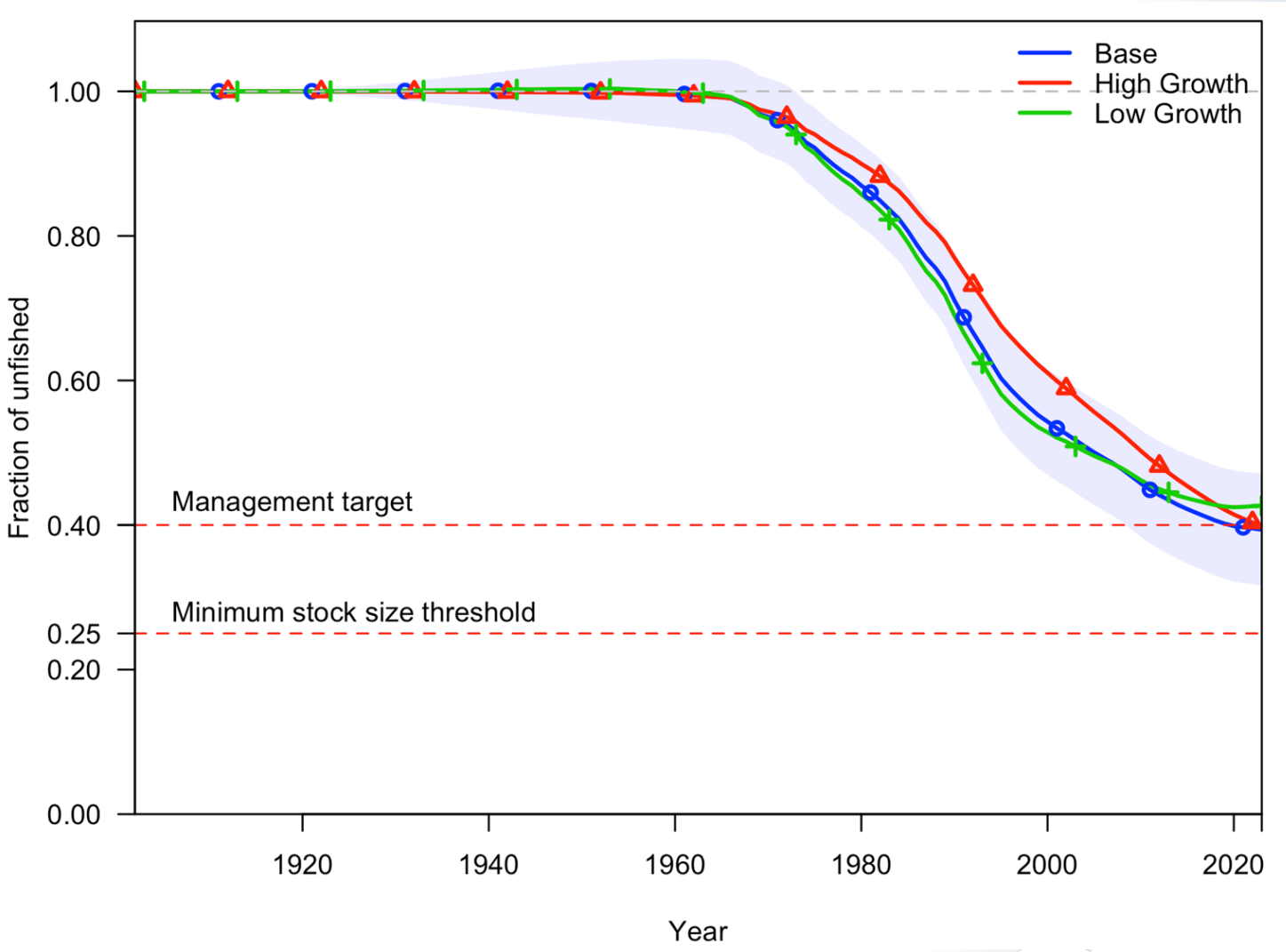
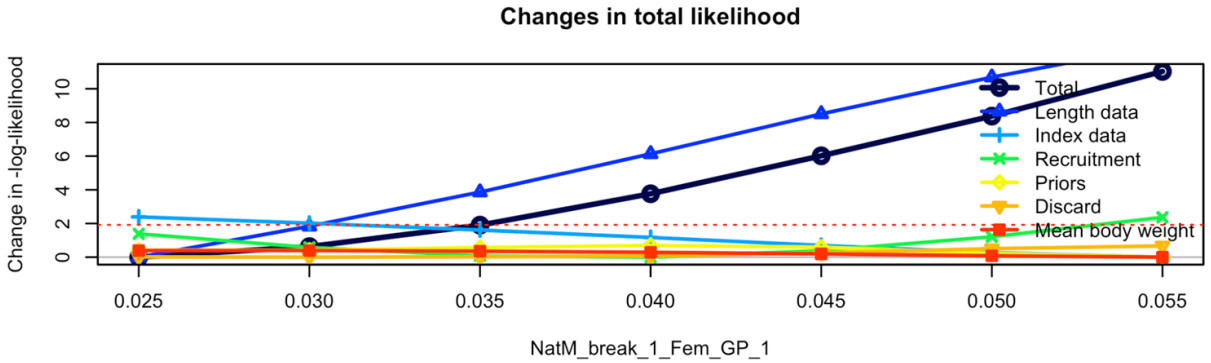
Growth

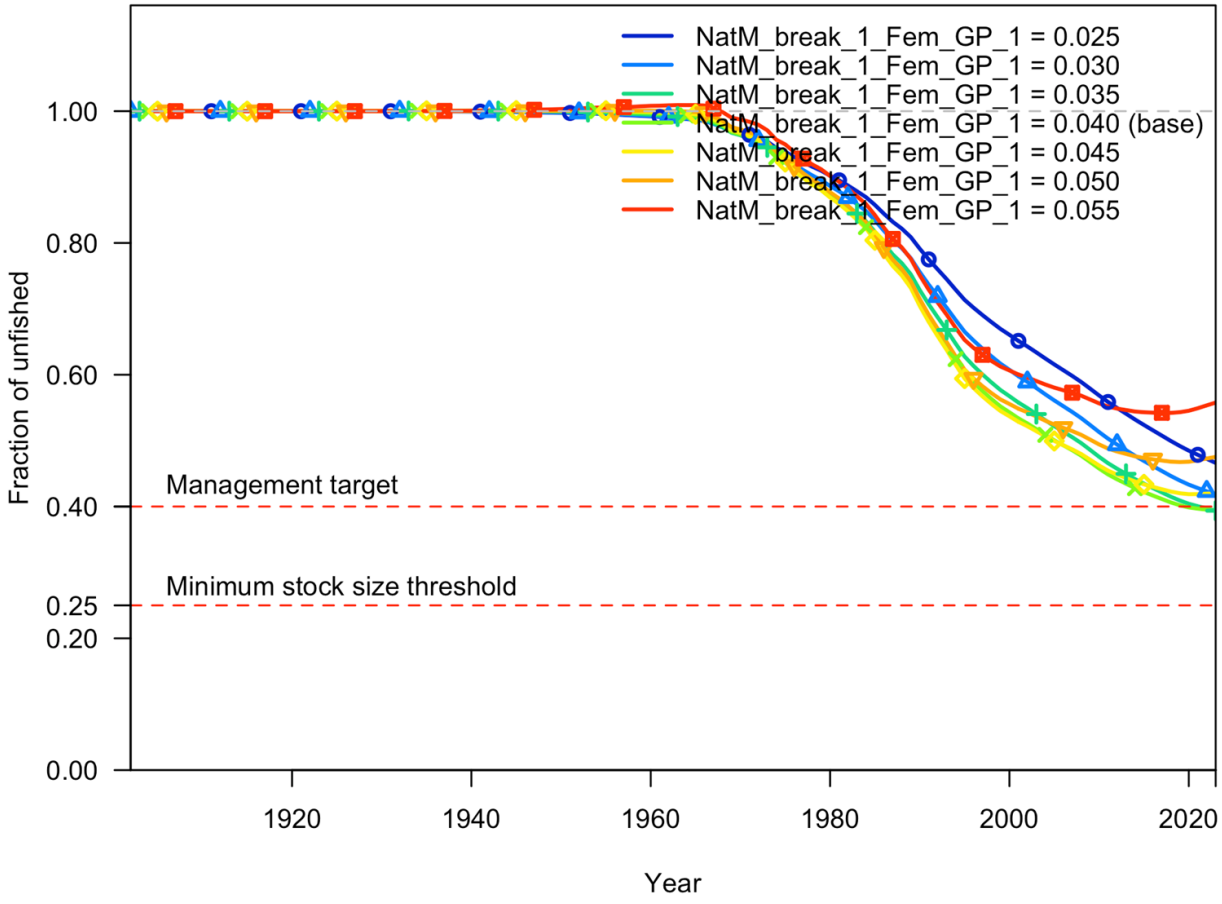
- High uncertainty in age estimation; no validated ageing method for species
- No apparent asymptote with available data



Natural Mortality

- Large range in literature
  - 0.013-0.07
  - AK and BC use 0.03
  - 2013 used 0.0505
- Large range supported by profiles
  - M=0.045 (*95% CI: 0.035-0.051*)
- Related to fish max age
  - Higher M, lower depletion





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2027	883	12927	0.409	8639	0.390	10180	0.508
2028	891	12806	0.405	8636	0.390	10264	0.512
2029	897	12693	0.402	8641	0.390	10354	0.516
2030	903	12588	0.398	8652	0.391	10449	0.521
2031	909	12491	0.395	8669	0.391	10548	0.526
2032	913	12401	0.393	8692	0.392	10650	0.531
2033	916	12317	0.390	8719	0.394	10753	0.536
2034	919	12240	0.387	8750	0.395	10858	0.541

Research and data needs

BIOLOGY

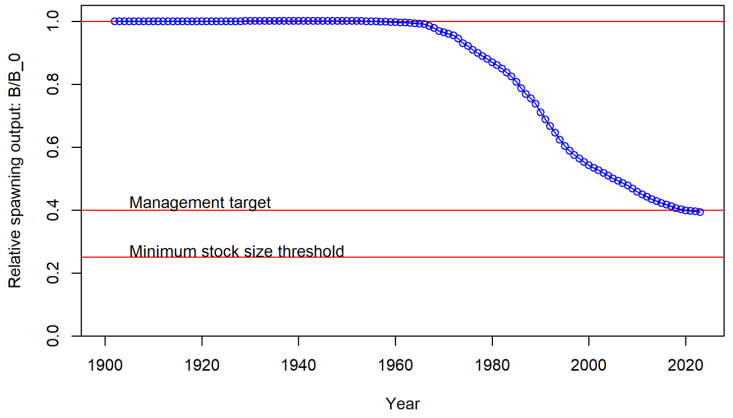
- Research into ageing methods / reliable age data
- Better understanding patterns observed in
  - Growth
  - Maturity
- Effect of bottom type on shortspine distribution → refine abundance indices
- Spatial population structure:
  - Possible effect of migration on stock dynamics
  - Need of a spatially-explicit population model?

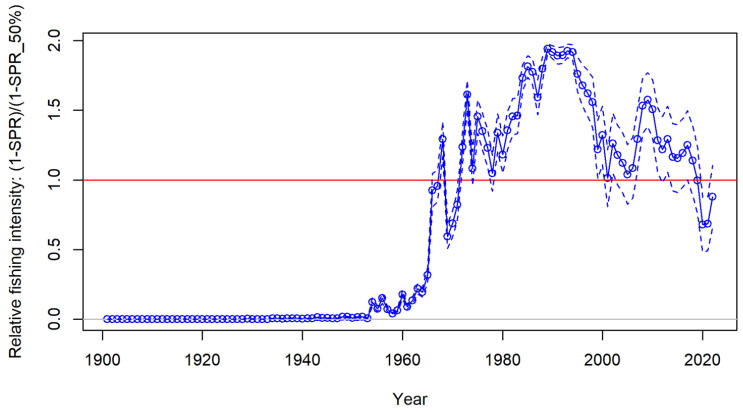
METHODOLOGY

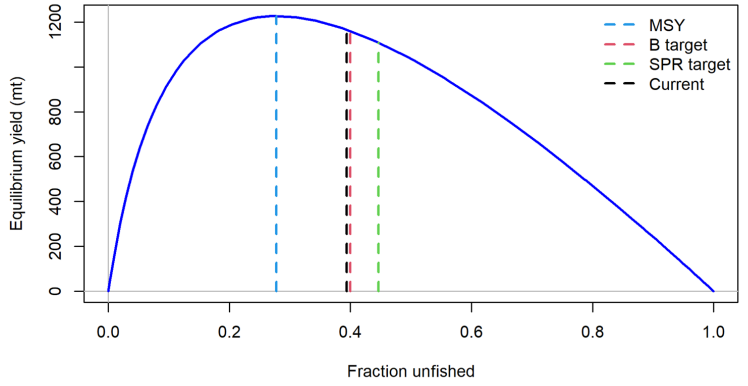
- Research into the Dirichlet-Multinomial data-weighting method for length-composition data

Concluding Comments

- Consistent and continued biomass decline starting in the 1970s
- Growth, mortality and our understanding of ageing are limited, which impact our understanding of biomass levels







Thank you

- Julia Coates
- E.J. Dick
- Melissa Head
- Kelli Johnson
- Donna Kline
- Andi Stephens
- Ian Taylor
- Theresa Tsou
- John Wallace
- Chantel Wetzel
- Ali Whitman

Instructors

- Vladlena Gertseva
- Melissa Haltuch
- Owen Hamel
- Kiva Oken

Additional Figures

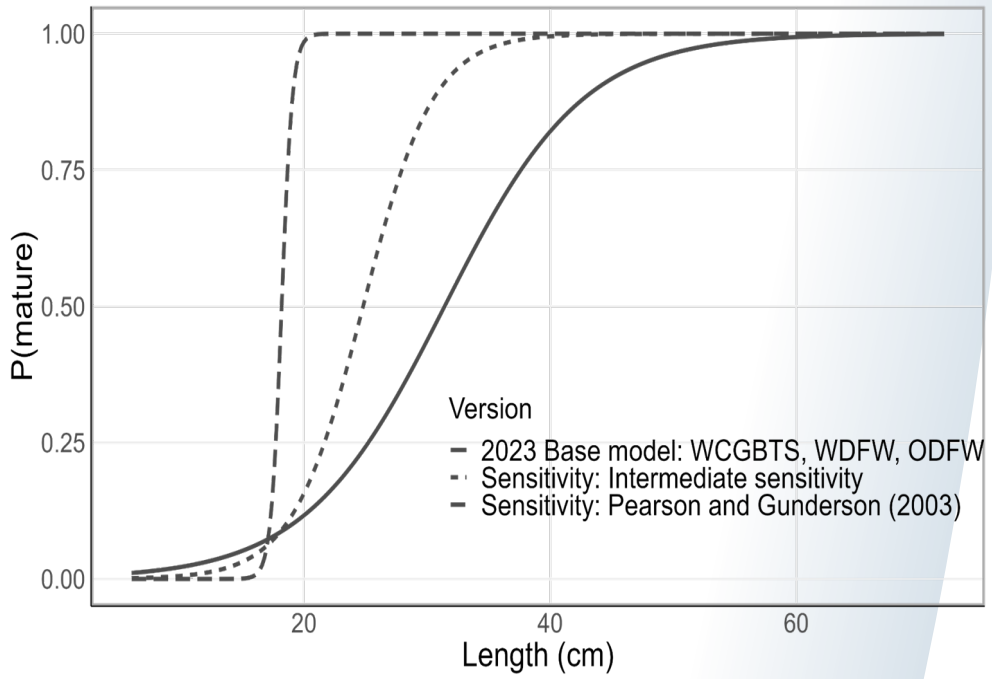
NOAA FISHERIES

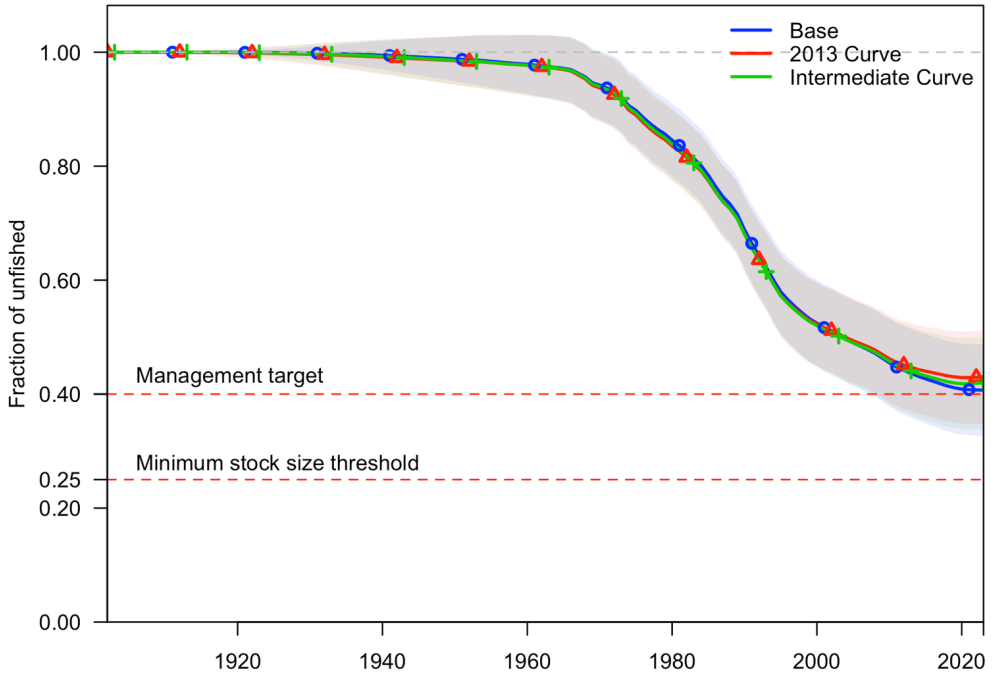
Maturity

Updated length-at-maturity from WCGBTS

$L_{50\%}$= 31.42 cm

2023 model largely insensitive to the updated maturity curve due to slow, continued growth and higher fecundity of larger females



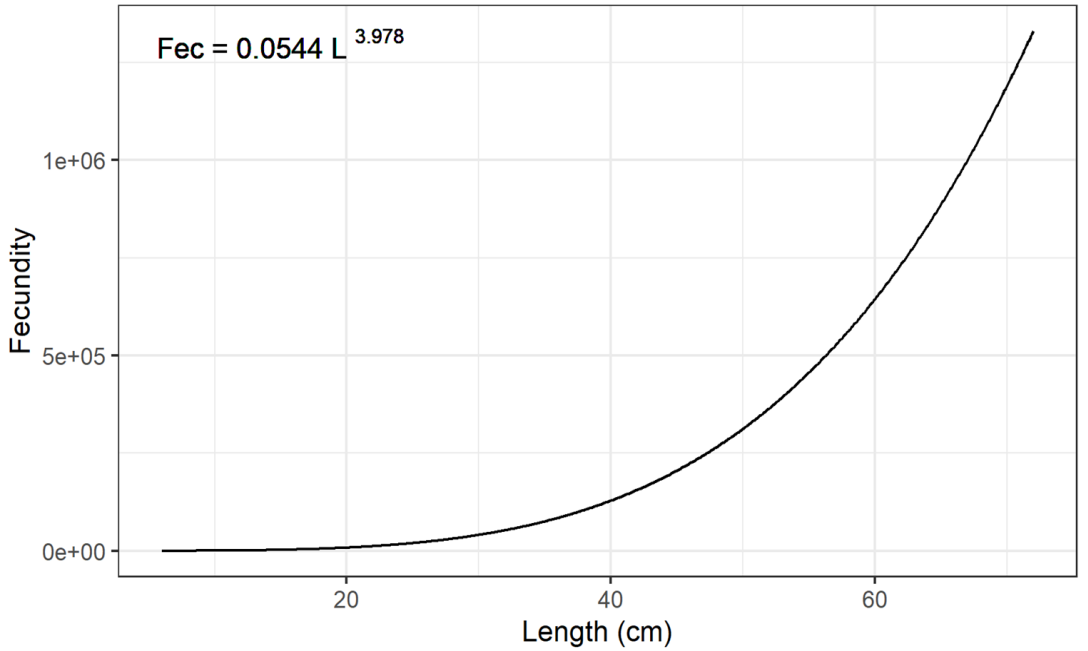


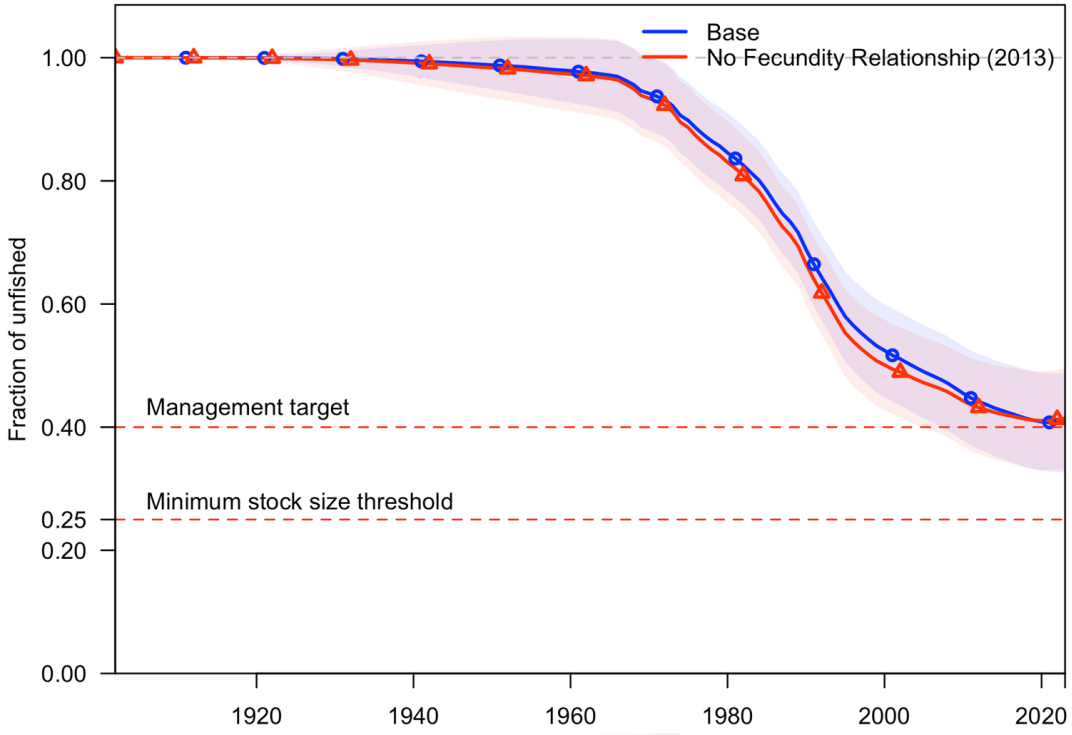
Fecundity

Updated fecundity-at-length from Cooper et al. 2005

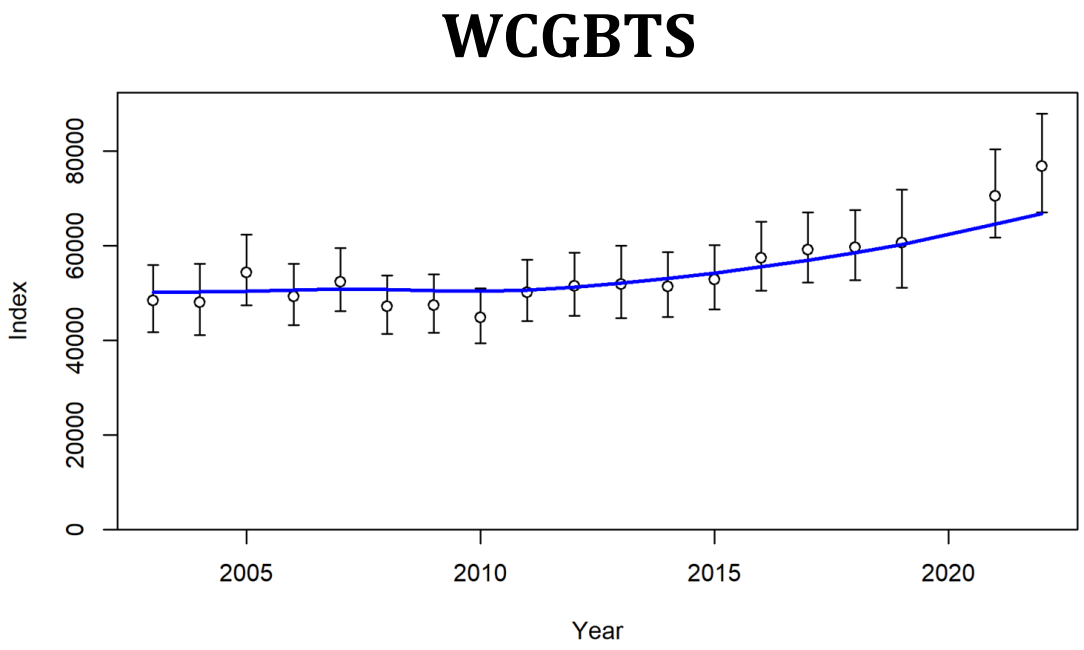
Previous assessments assumed SSB=spawning output

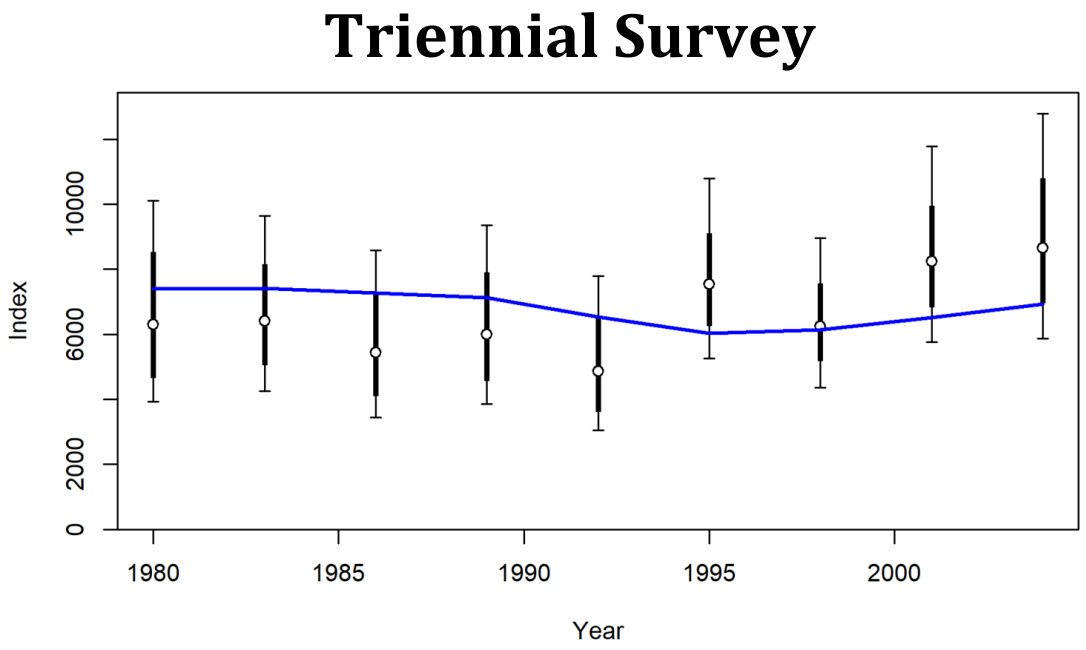
2023 model largely insensitive to updated fecundity information



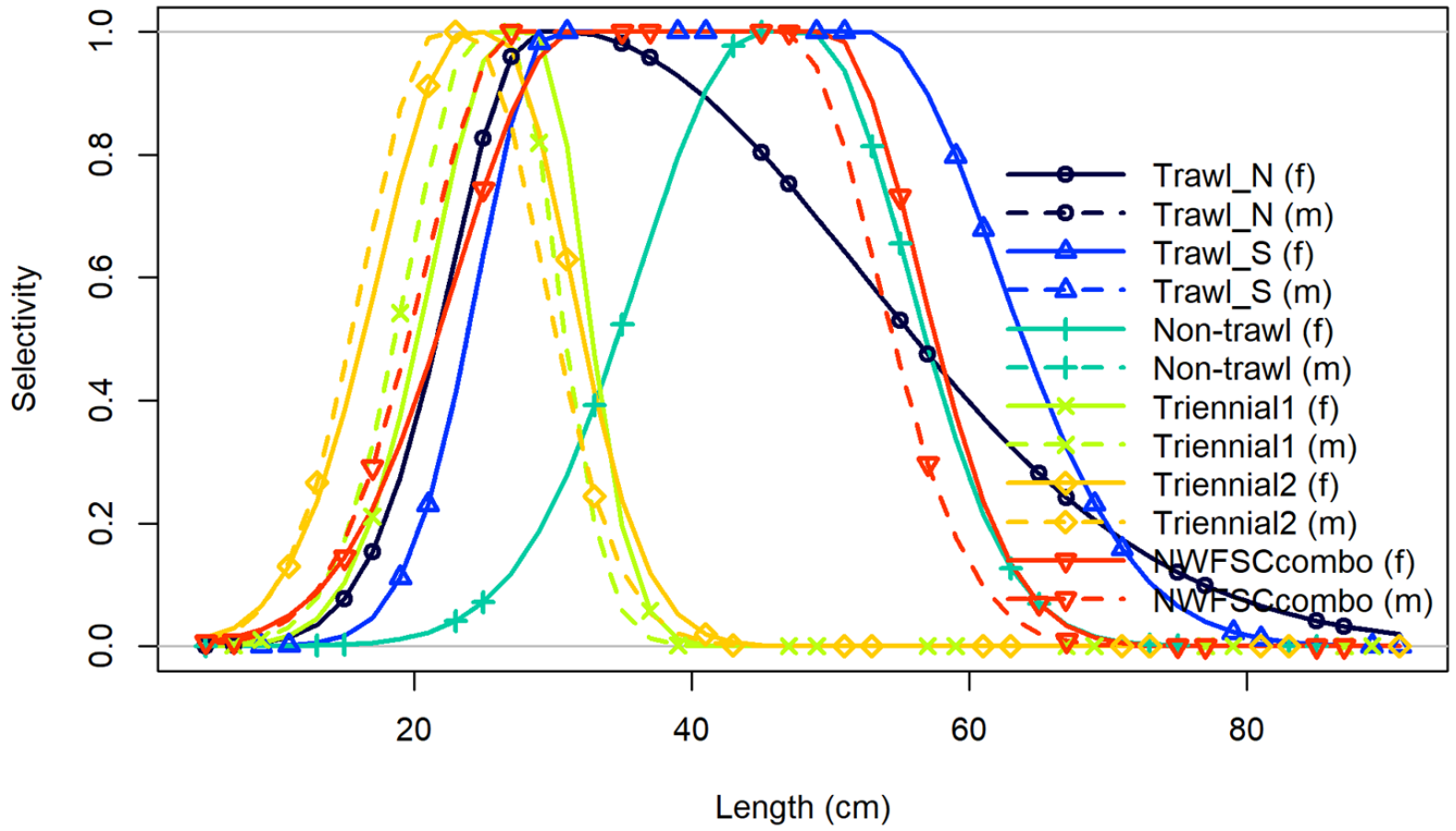


Indices of Abundance

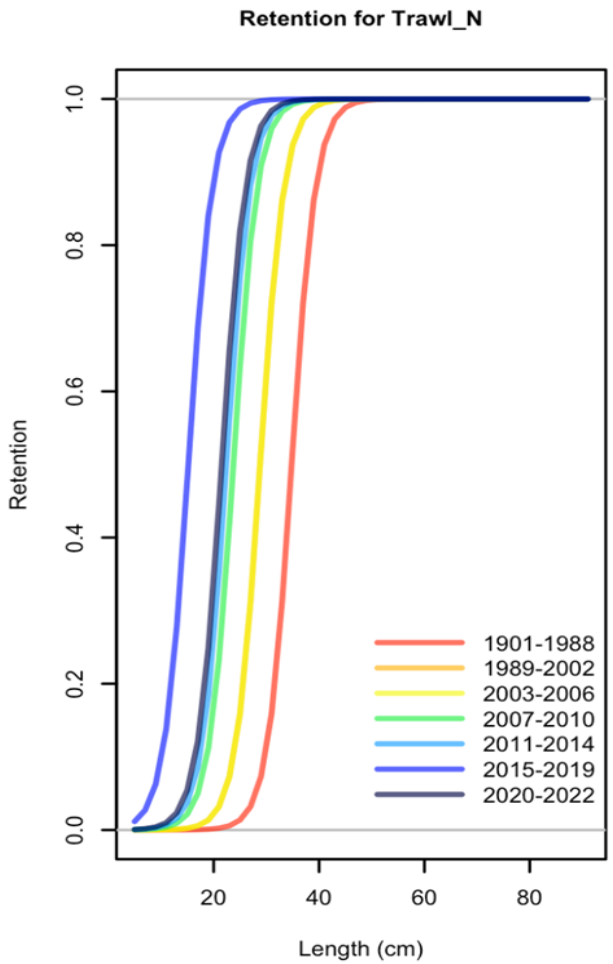


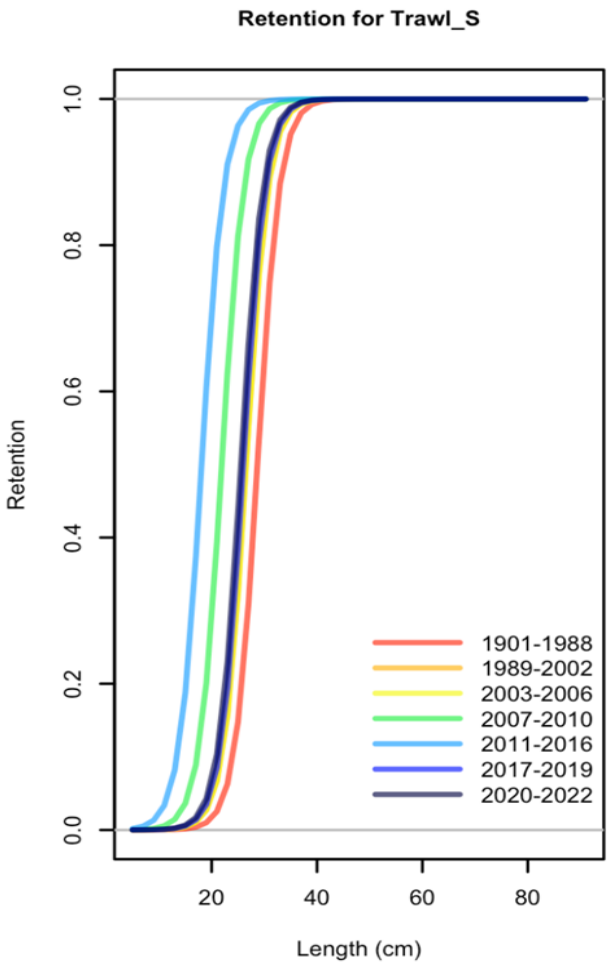


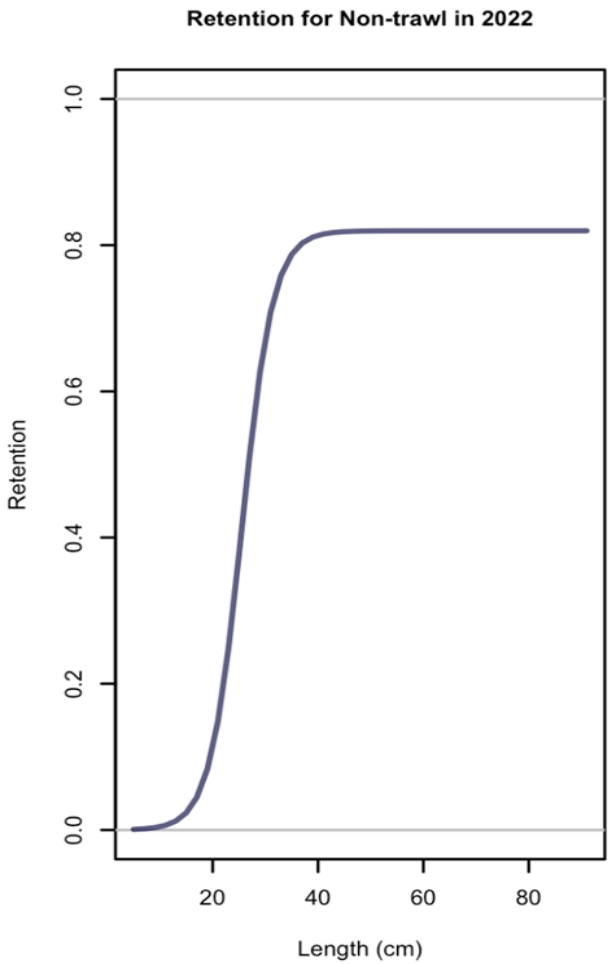
Selectivity and Retention



Selectivity and Retention

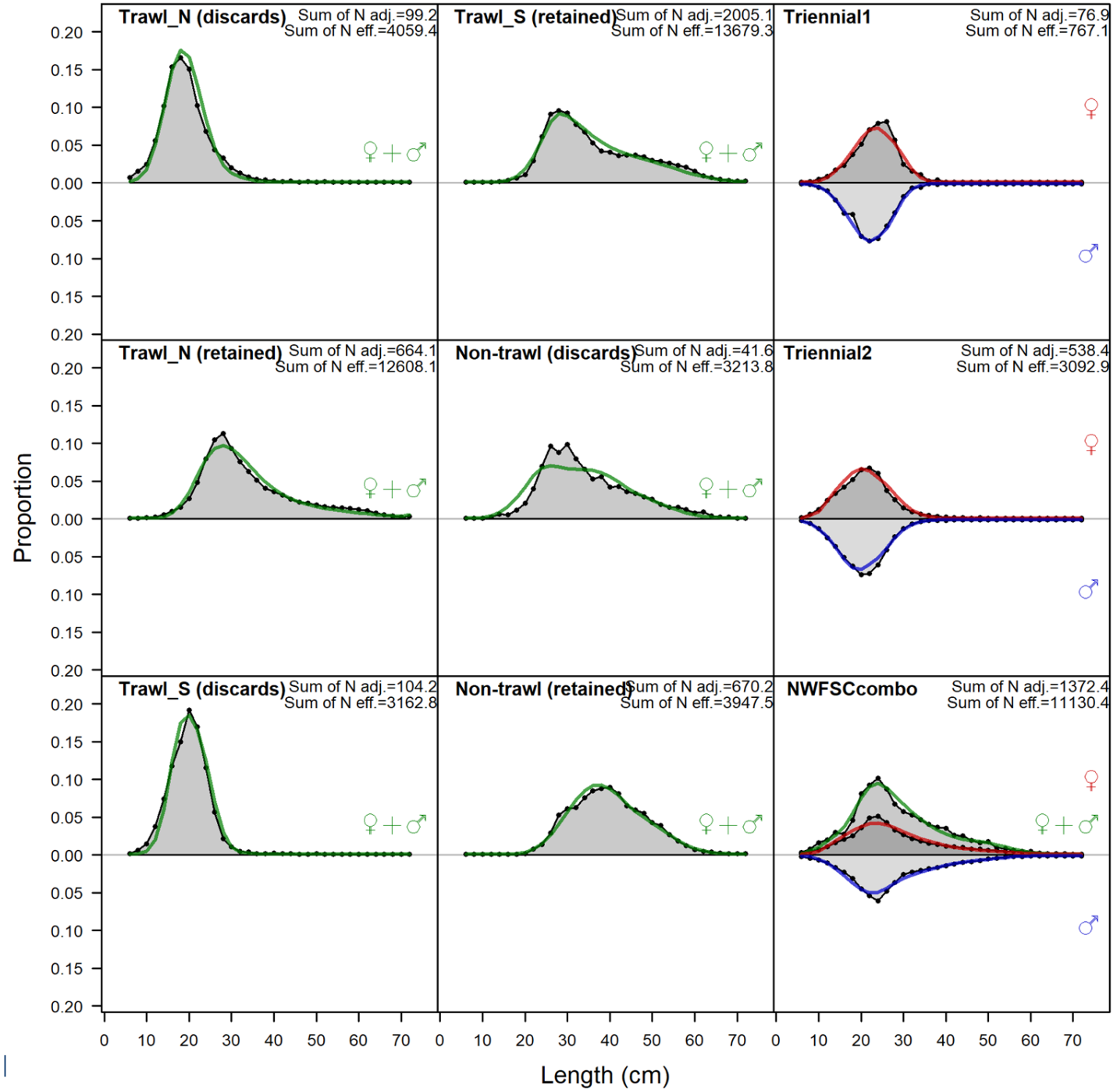




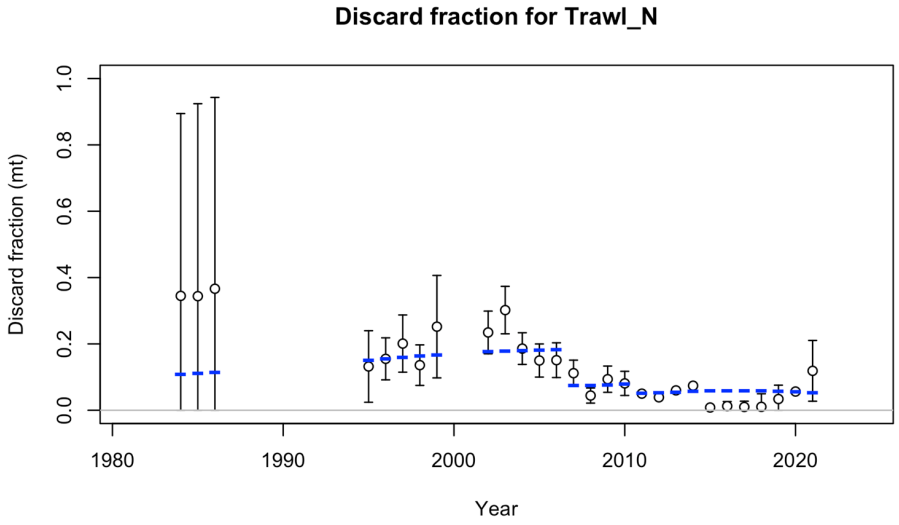


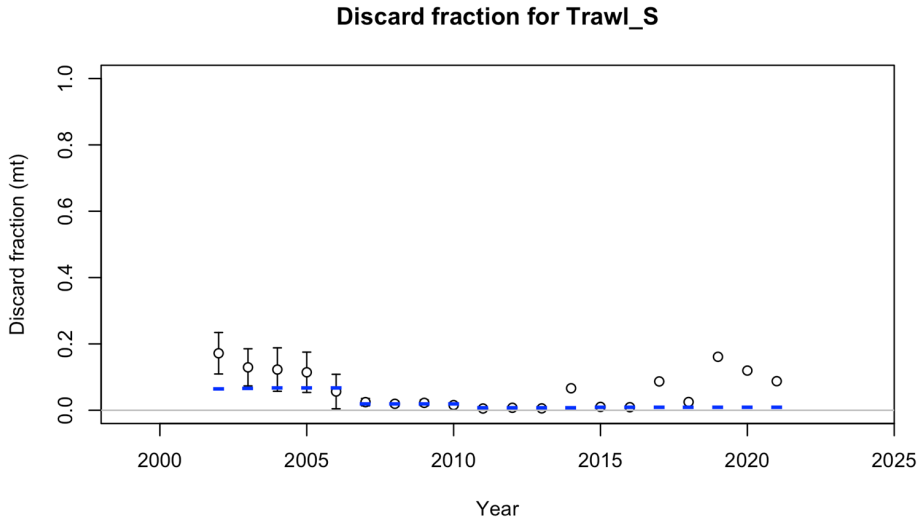
Length Compositions

- Sex-specific selectivity for surveys
- Many years with very low sample sizes
- Some recent patterns imply possible selectivity change

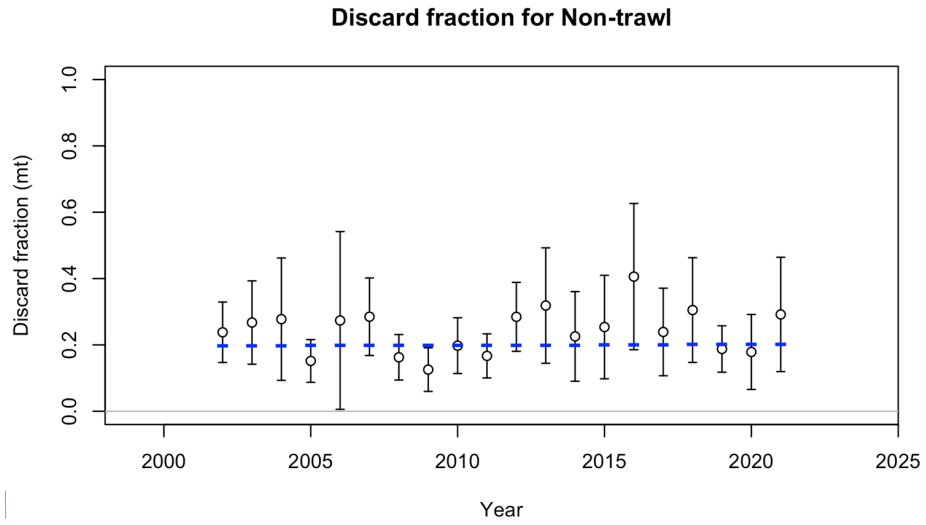


Discard Fractions

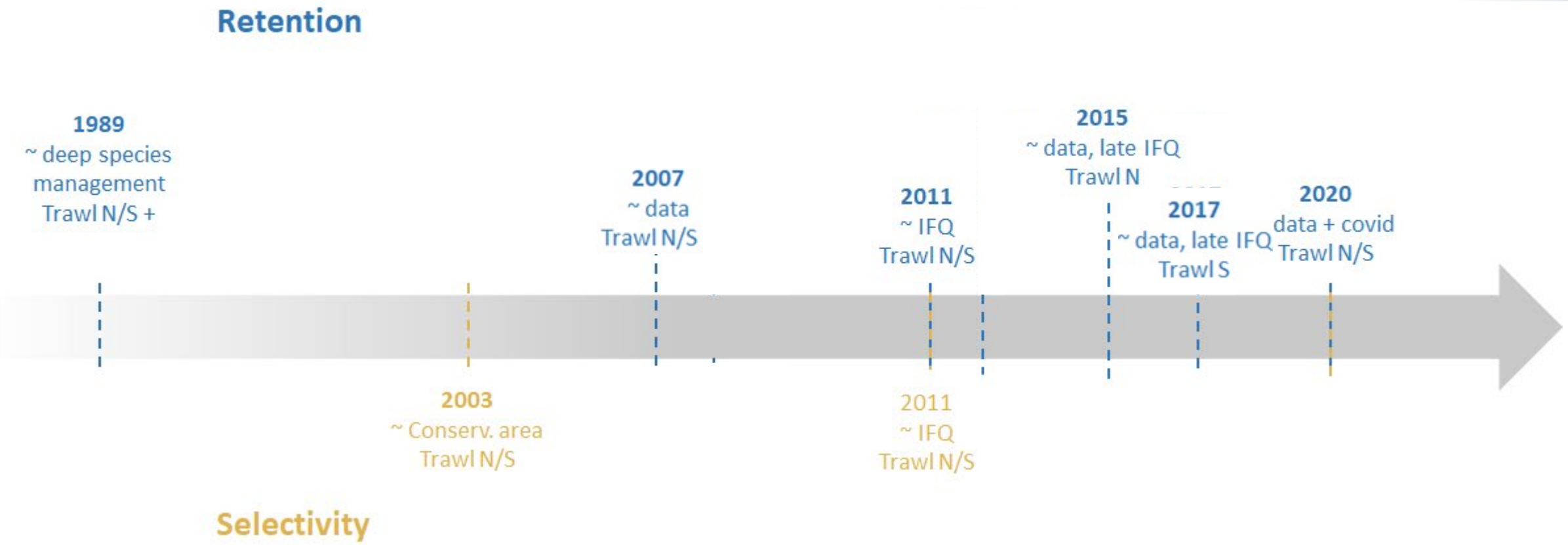




- Lots of alternative time-blocks tested as part of sensitivity analyses
- Extra time-blocks provide significant improvements to model fit, but very little change in management quantities

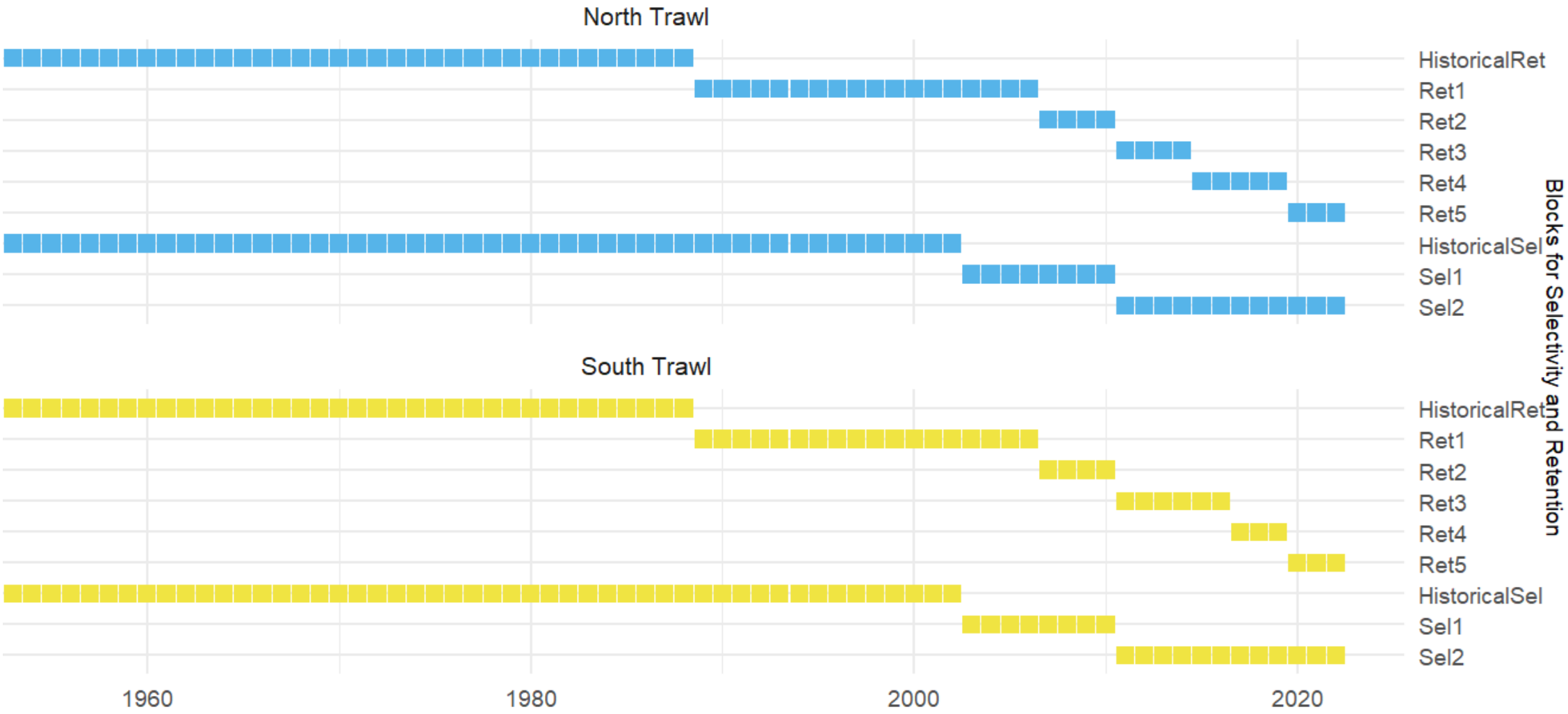


Model Sensitivity to Selectivity and Retention



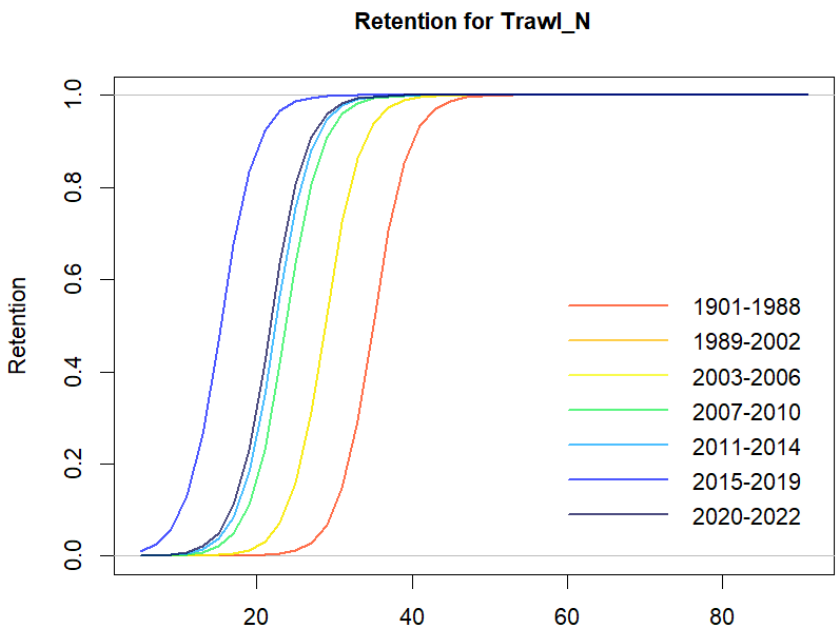
Selectivity and Retention Blocks

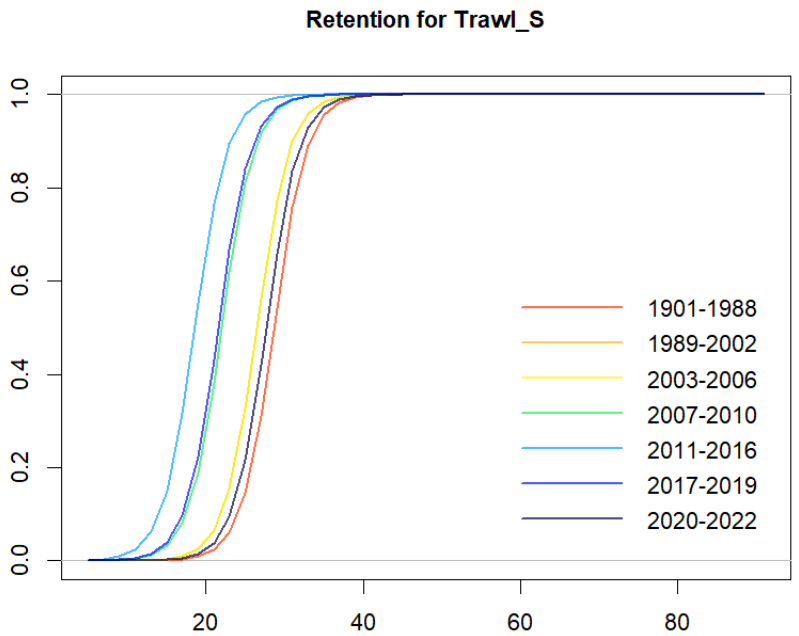
TIME BLOCKS DEFINITION

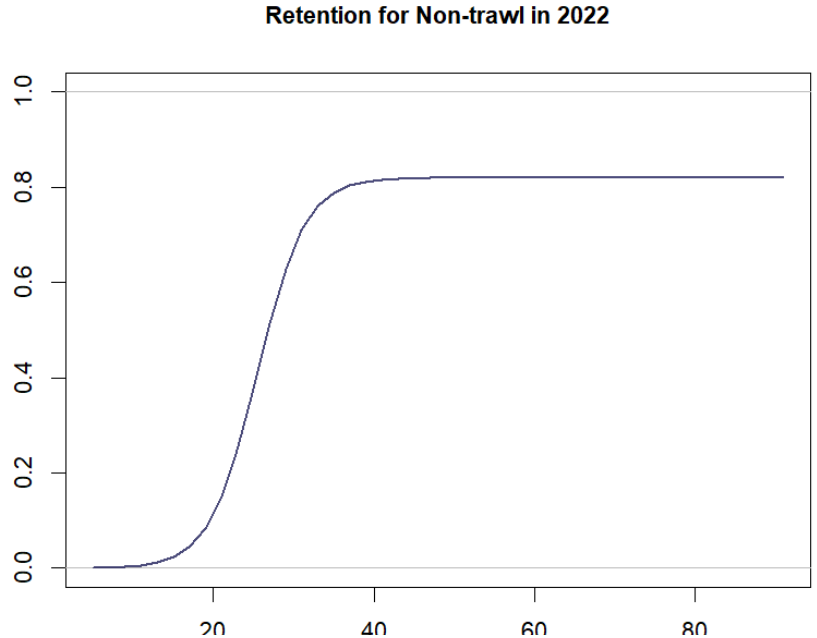


Retention Time Blocks

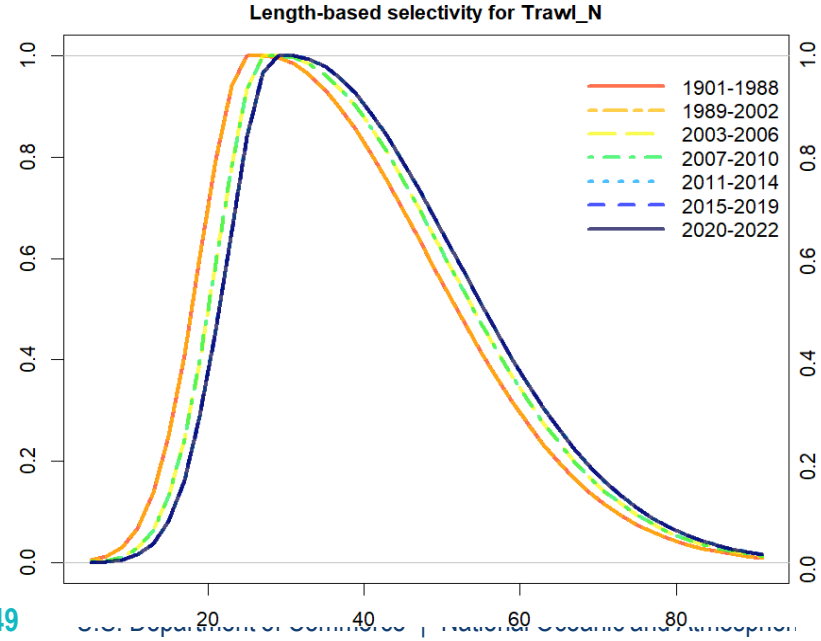
RETENTION CURVES

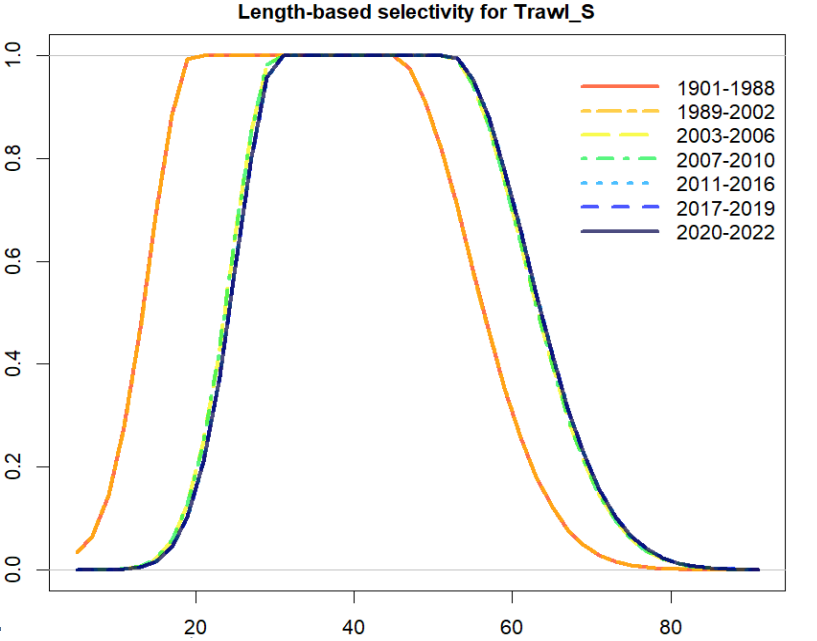


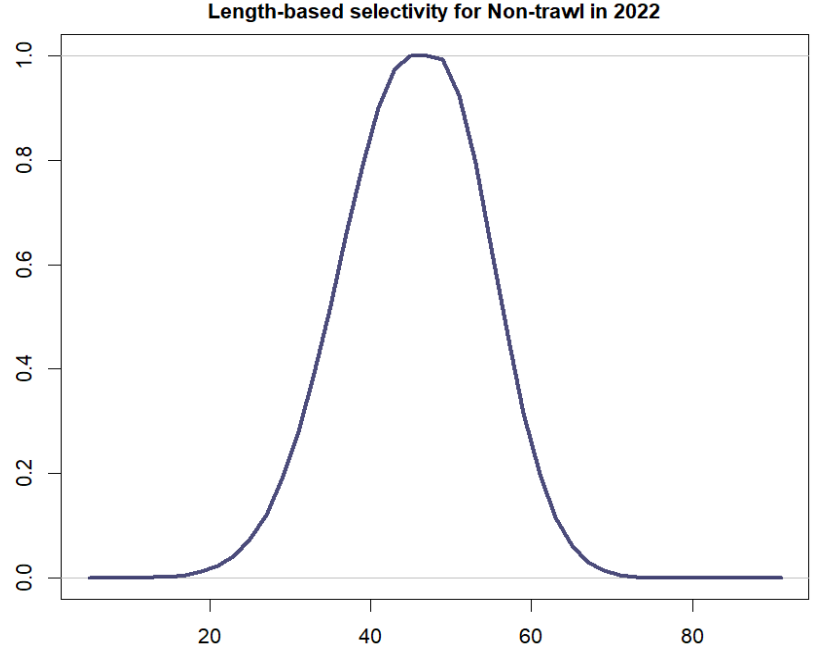




SELECTIVITY CURVES

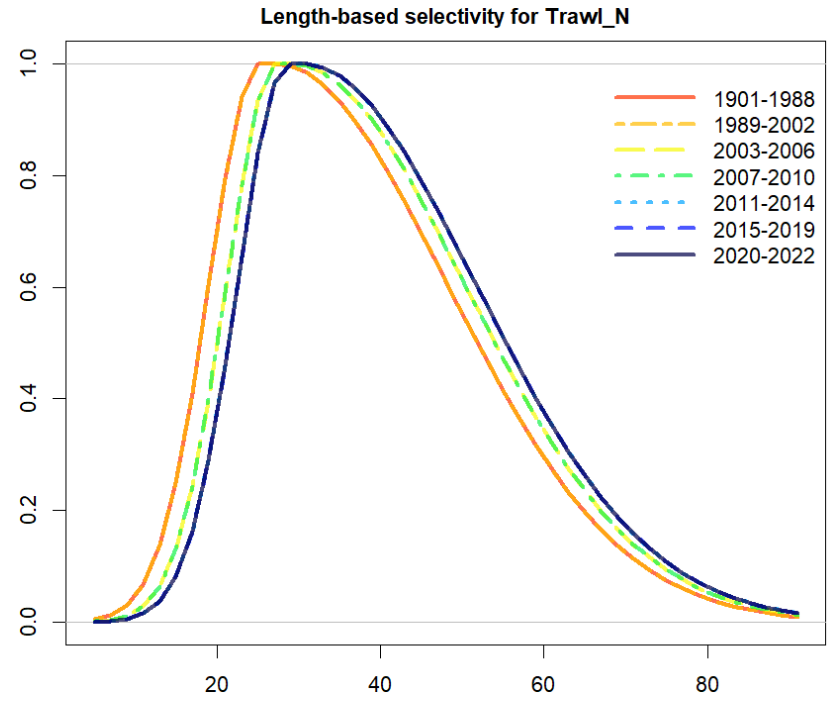


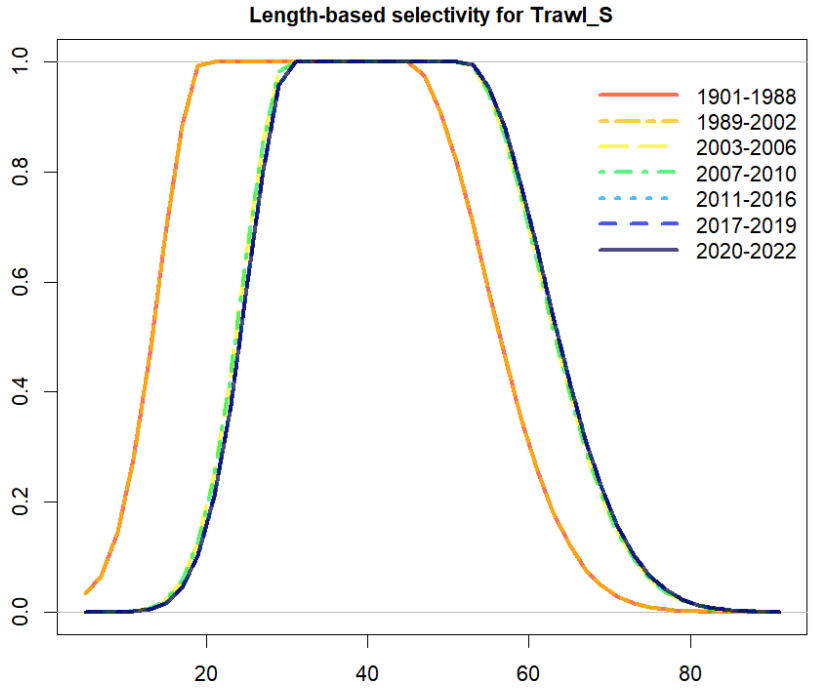


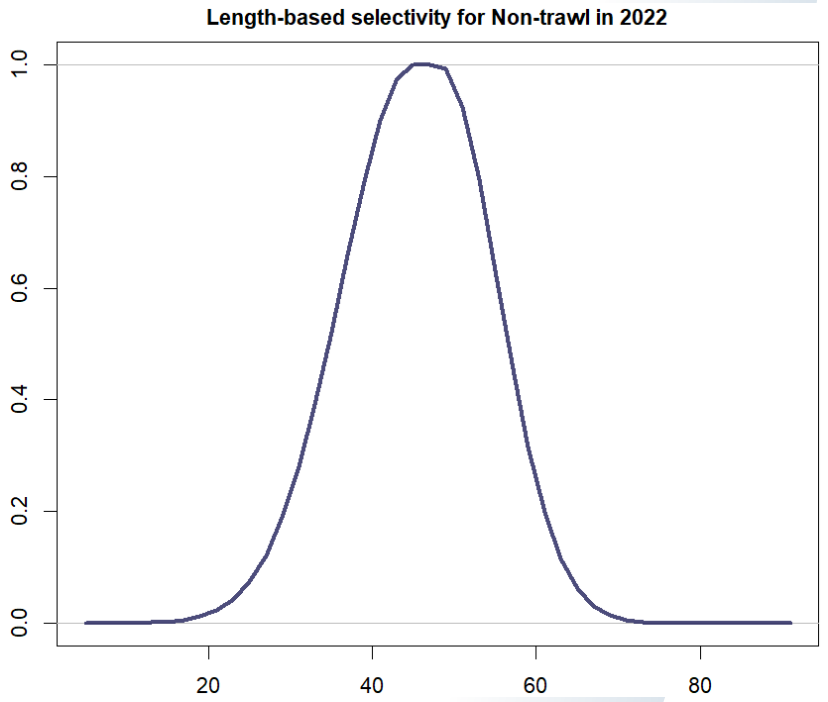


Selectivity Time Blocks

SELECTIVITY CURVES







Likelihood Profile over Steepness (h)