Atlantic Spiny Dogfish

2023 Management Track Assessment
OFL/ABC recommendations

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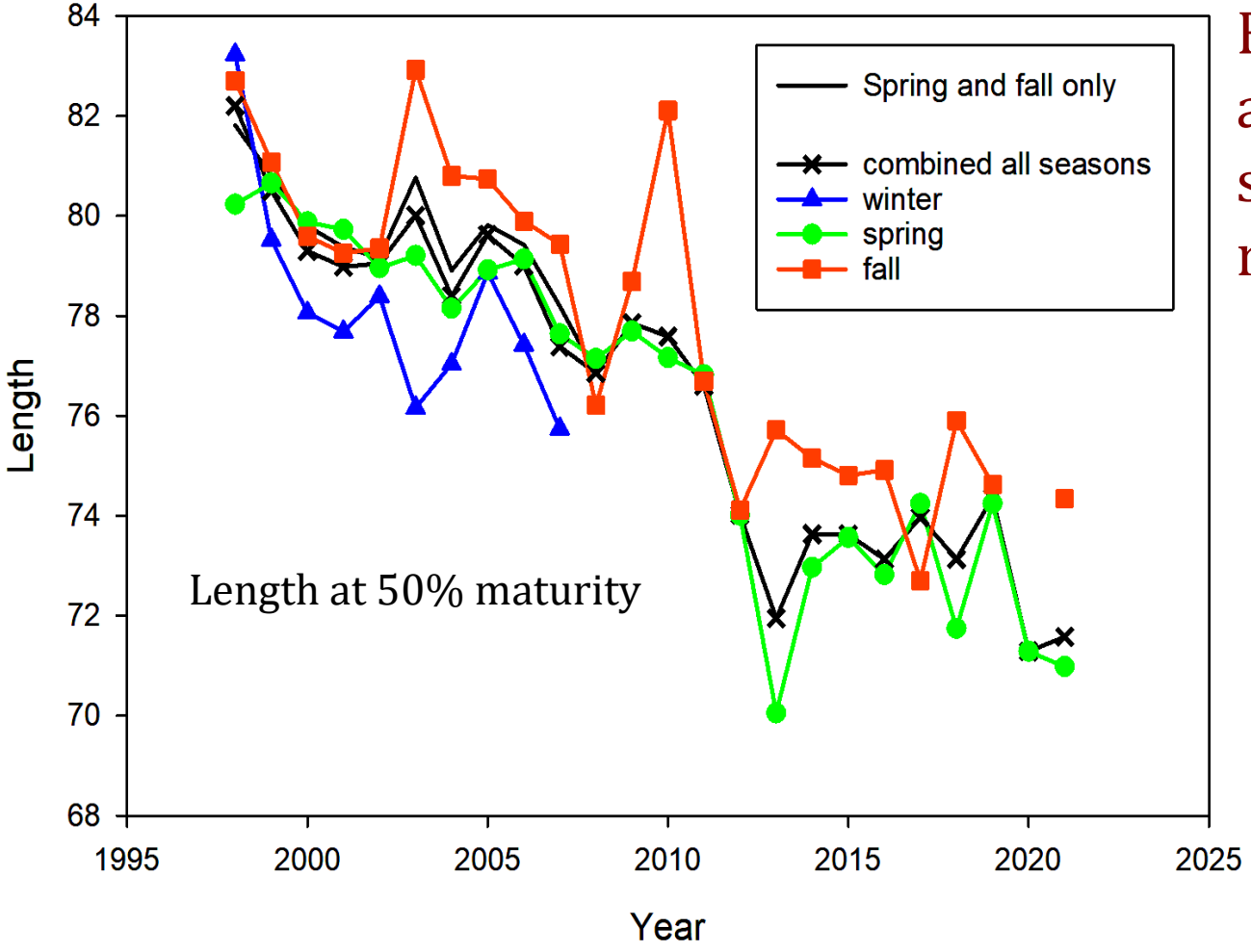
NEFSC

Life History

Decreasing length at maturity



Female spiny dogfish are maturing at smaller lengths in recent years

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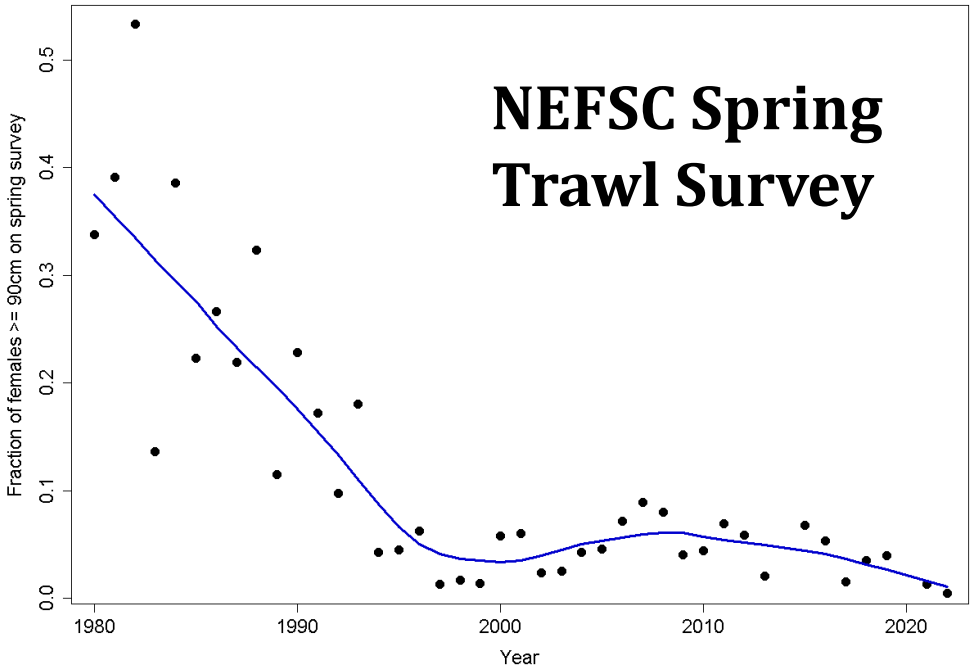
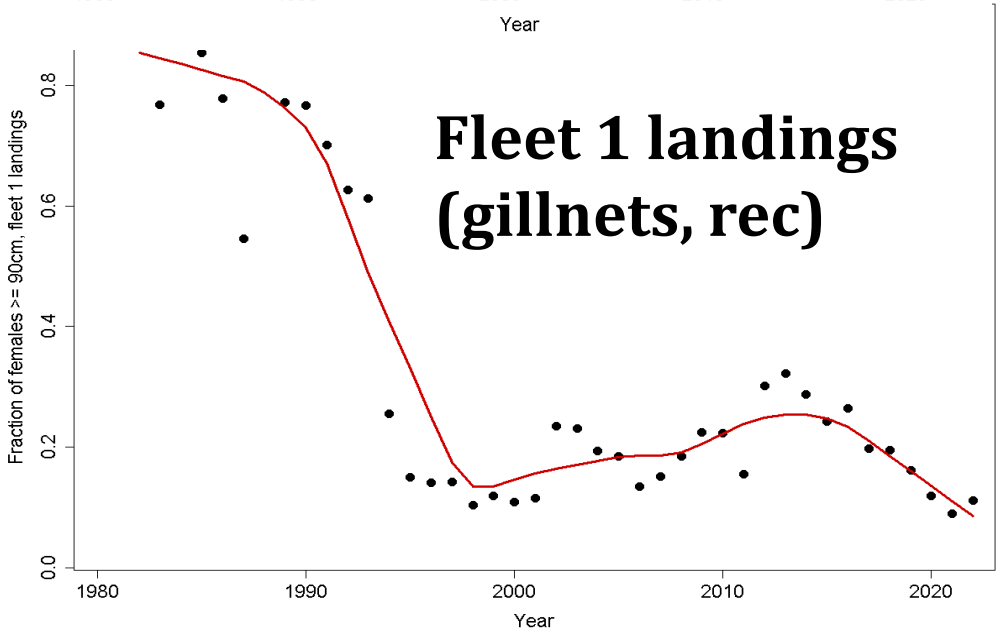
Life History





The fraction of large (>= 90 cm) females has drastically declined in both the survey and landings in recent years, more so than can be explained by direct fishing mortality

These changes in life history are incorporated in the SS3 model

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Assessment History

- Until last year, the stock was assessed using the "stochastic estimator" that estimated biomass using spring trawl survey swept area, assuming q=1 (not counting doors).

- 2022 Research Track used Stock Synthesis 3 (SS3) model. This model was used since it can tune directly to lengths, as well as model sexes separately

- 2023 Management Track also used SS3, with some modifications, as will be discusssed

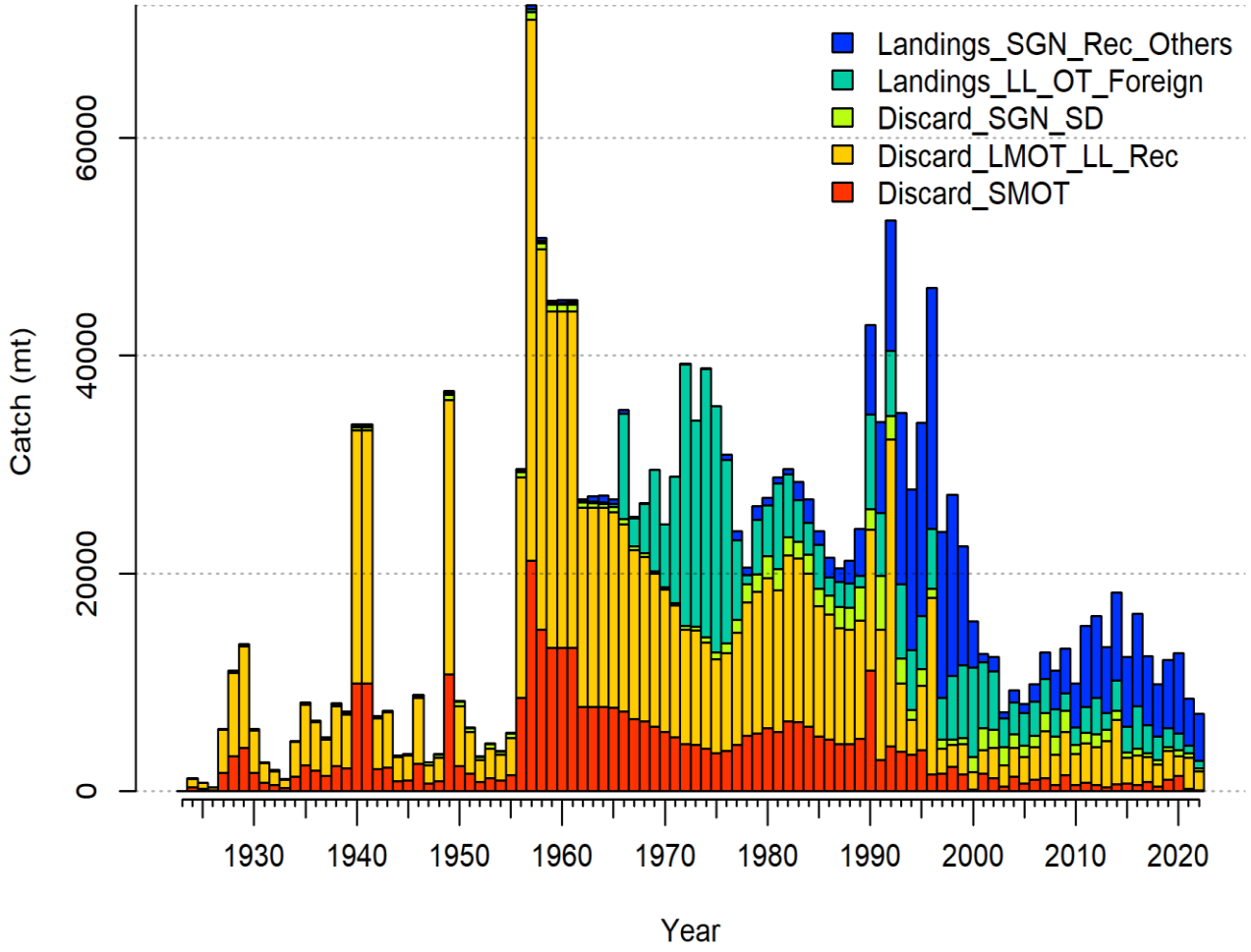
SS3 Model Years

RT assessment: 1989-2019
MT assessment: 1924-2022

SS3 is designed to be initialized to an equilibrium population, preferably an unfished equilibrium (Rick Methot per. comm.). We therefore initialized the model in 1924 (assumed to be unfished), rather than the 1989 non-equilibrium conditions, despite uncertainties regarding early catch.

Commercial Catch

Early landings (1924-1961) and discards (1924-1988) from Fowler and Campana (2015)



Substantial discards, especially from otter trawls, in early period. Recent landings are mainly from gillnets

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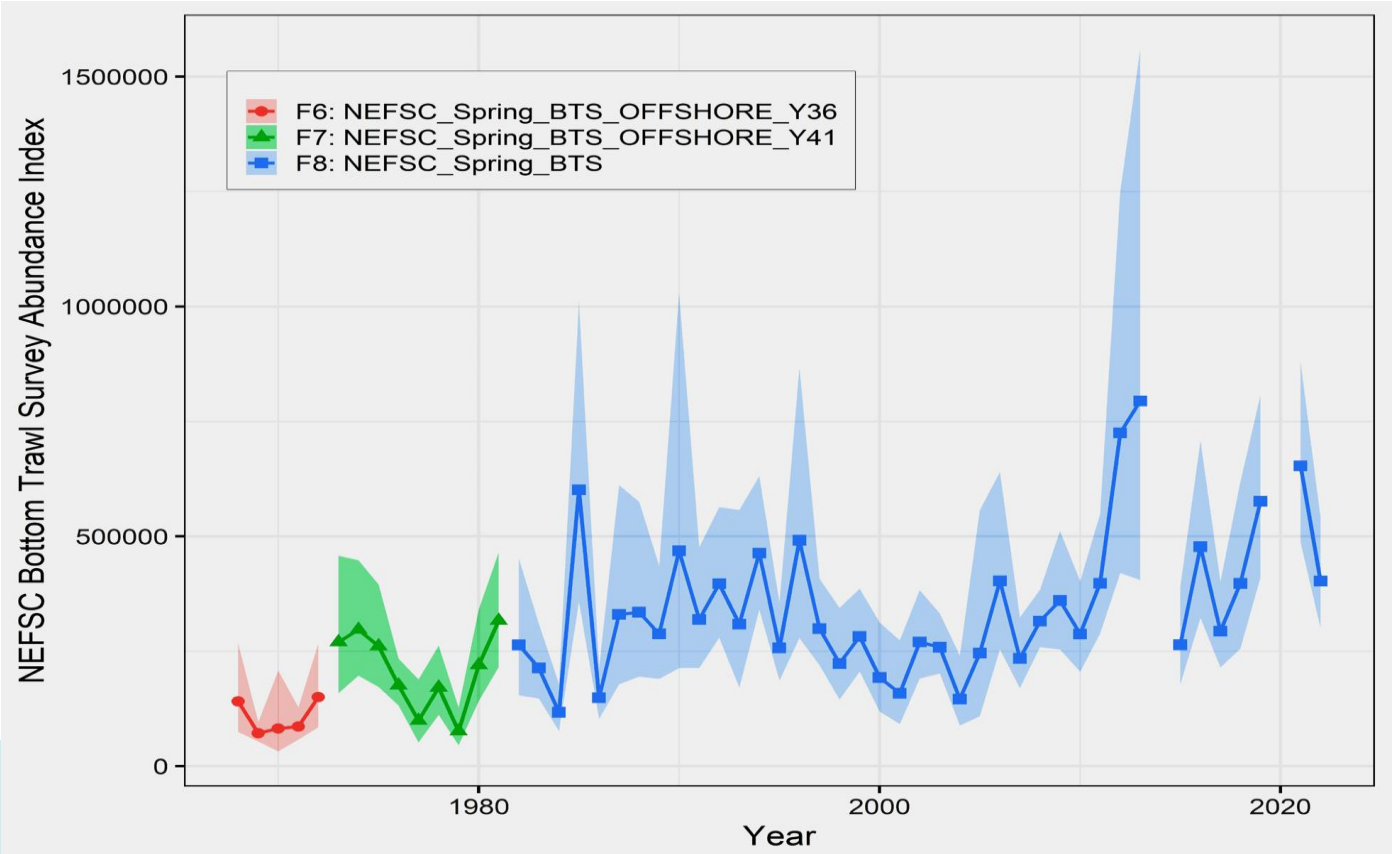
Surveys

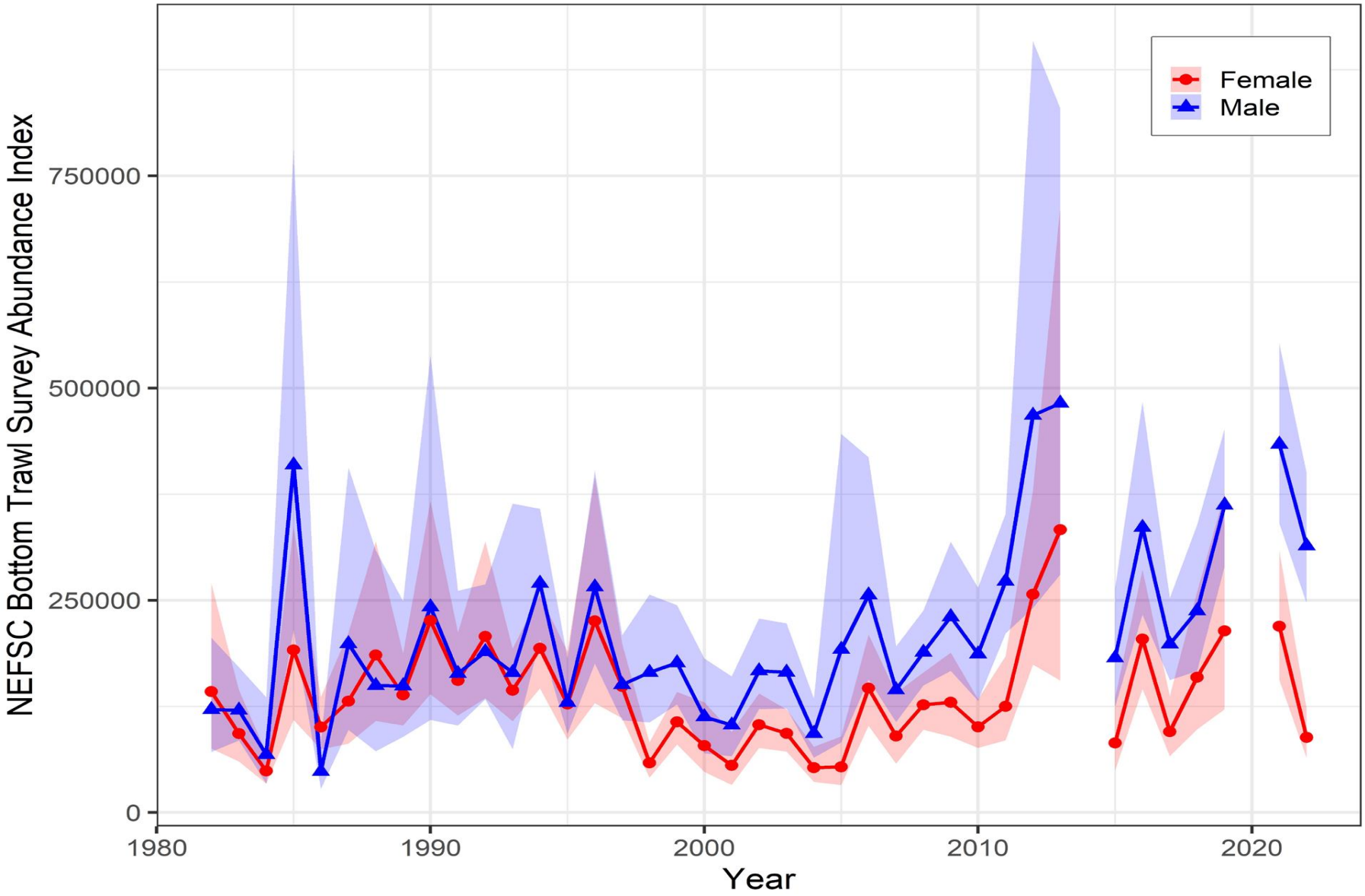
Because of availability concerns in the fall, only the NEFSC spring bottom trawl survey was used in SS3

Time series incorporates Albatross/Bigelow calibration. No good calibration exists between Yankee 41 and 36 nets, so these were split into different time series. Survey since 1982 includes some inshore strata not in the earlier time series.



Combined sex index, NEFSC spring survey

Spring survey indices by sex, 1982-2022
Note decreasing female:male ratio



Fleet Definitions

Two landings fleets, three discard fleets, three survey fleets

Type	Gear	Fleet	Label
Landings	• Sink Gill Net + Others • Recreational	**1**	Landings_SGN_Rec_Others
	• Longline • Otter Trawl + Foreign	**2**	Landings_LL_OT_Foreign
Discard	• Sink Gill Net • Scallop Dredge	**3**	Discard_SGN_SD
	• Longline • Large Mesh Otter Trawl • Recreational	**4**	Discard_LMOT_LL_Rec
	Small Mesh Otter Trawl	**5**	Discard_SMOT
Survey	NEFSC Spring Bottom Trawl Offshore Yankee 36 1968-1972	**6**	NEFSC_Spring_BTS_OFFSHORE_Y36
	NEFSC Spring Bottom Trawl Offshore Yankee 41 1973-1981	**7**	NEFSC_Spring_BTS_OFFSHORE_Y41
	NEFSC Spring Bottom Trawl	**8**	NEFSC_Spring_BTS

Time Blocks

Consistent with the 2022 research track assessment:

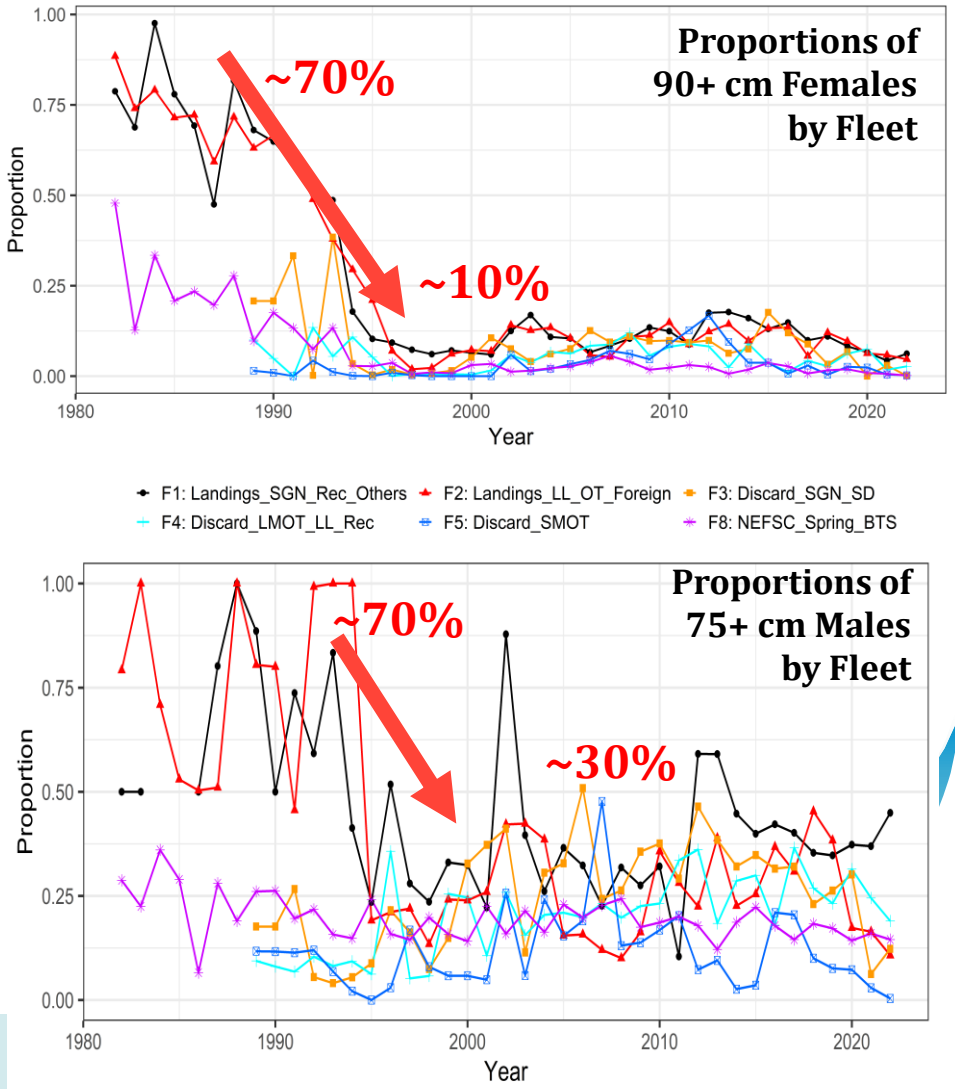
- **Survey block**: different selectivities for *Albatross* (1982-2008) and *Bigelow* (2009-2022) surveys.
- **Biology block**: different growth, fecundity, and maturity for the years prior to 2012, and for 2012 and afterward to accommodate the life history changes. Nammack (1985) growth parameters were used for the earlier period, whereas L_∞ was estimated for the later period.

Fisheries Time Blocks
(not in RT model)

Early fishery targeted large fish

With reductions in the numbers of large fish, the fishery became less selective around 1994.

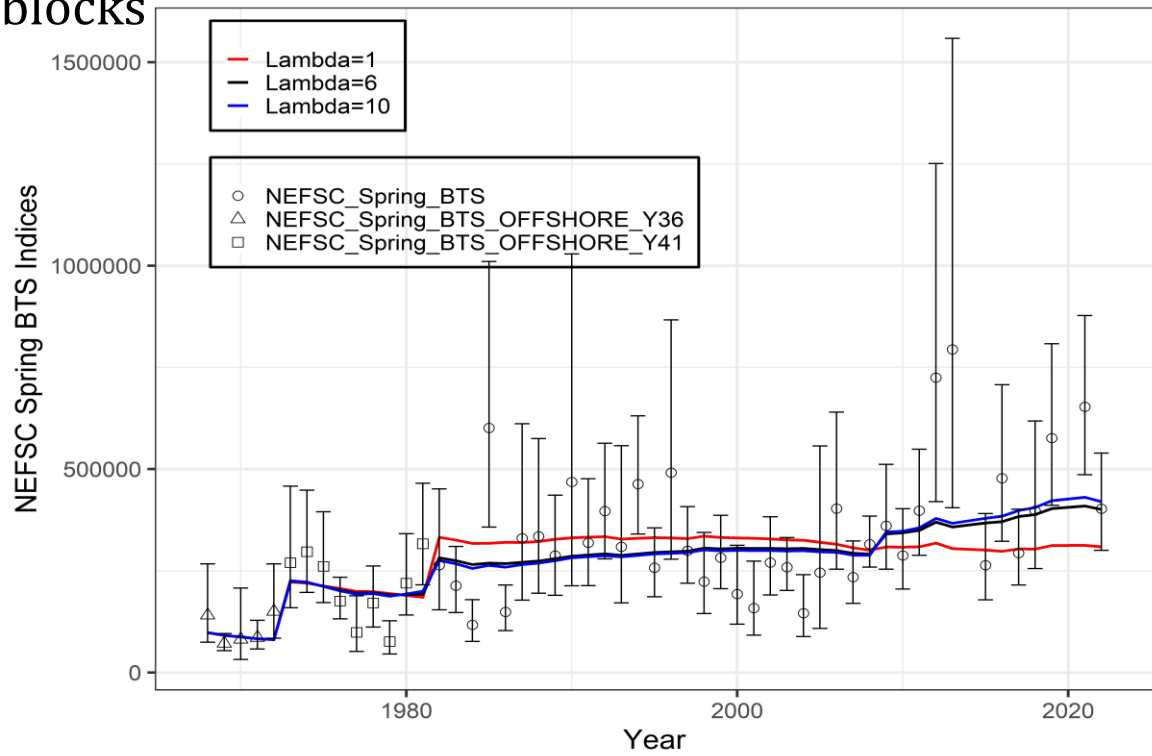
So we implemented a second fishery block starting in 1994 with different selectivity



Data (Likelihood) Weighting

- Preliminary (unweighted) model runs showed poor fit to the 1982-2022 (combined sex) survey index
- Different likelihood weights (λ) for the three survey indices were explored to better fit the indices.
- Increasing λ changed sex-specific survey catchabilities and the relative catchability in the two survey blocks

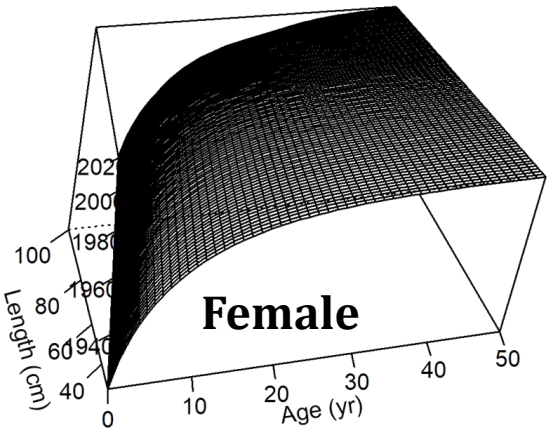
λ = 6 was selected for this assessment so that the survey catchability of large females during the *Albatross* period matched that of the *Bigelow* period, consistent with the vessel calibration.

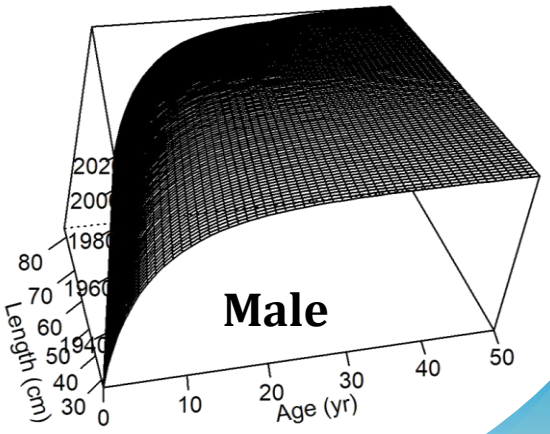


Model Results - Growth Estimates

Considerable reduction in estimated L_∞ during 2012-2022, especially for females

Sex	VB Parameters	1924-2011	**2012-2022**
		Nammack et al. (1985)	**Est L_∞**
Female	L_∞	100.50	**88.52**
	k	0.1057	0.1057
	L_{Amin}	26.53	26.53
Male	L_∞	82.49	**79.74**
	k	0.1481	0.1481
	L_{Amin}	26.94	26.94





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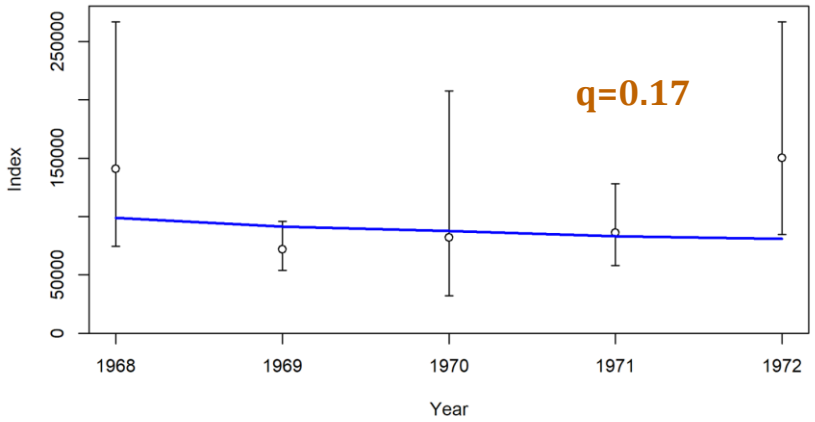
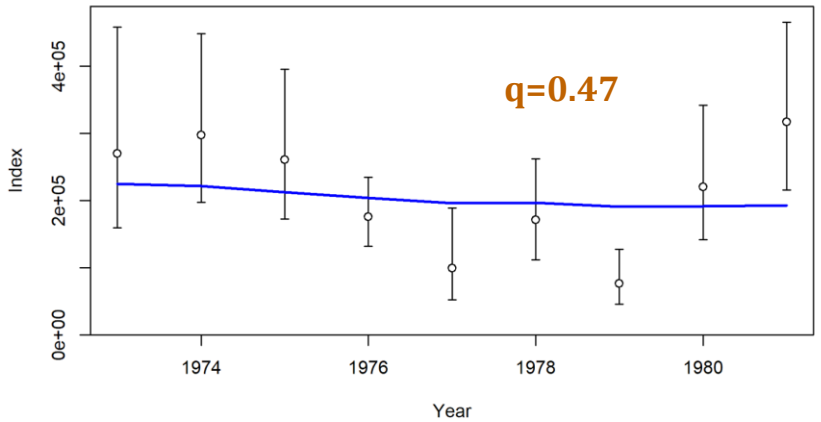
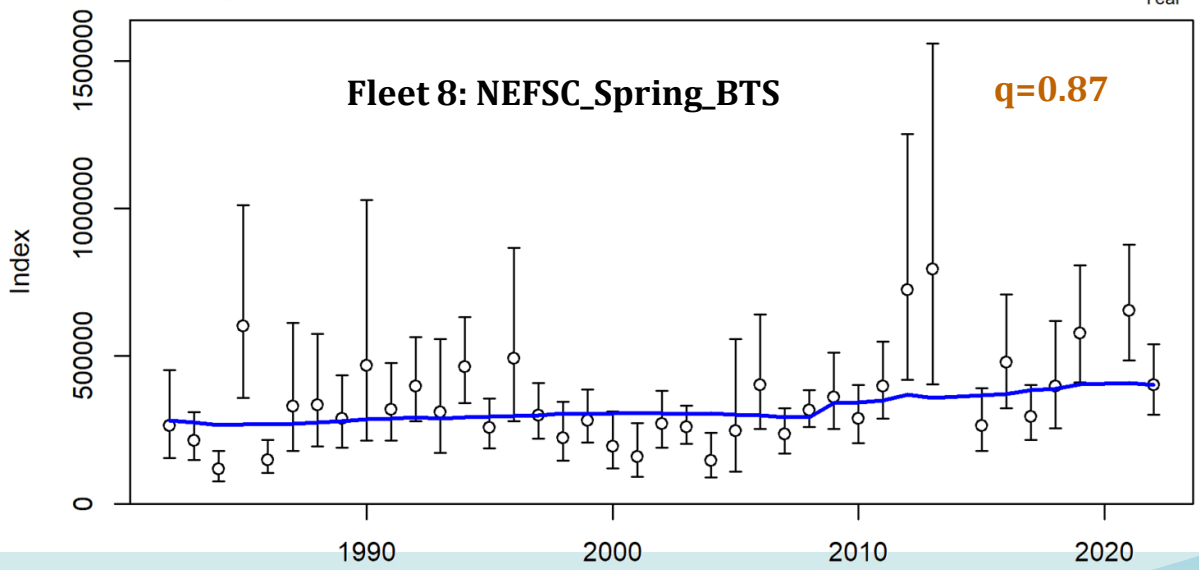
Base Model Results – Abundance Indices

Fleet 6: NEFSC_Spring_BTS_OFFSHORE_Y36



Fleet 7: NEFSC_Spring_BTS_OFFSHORE_Y41





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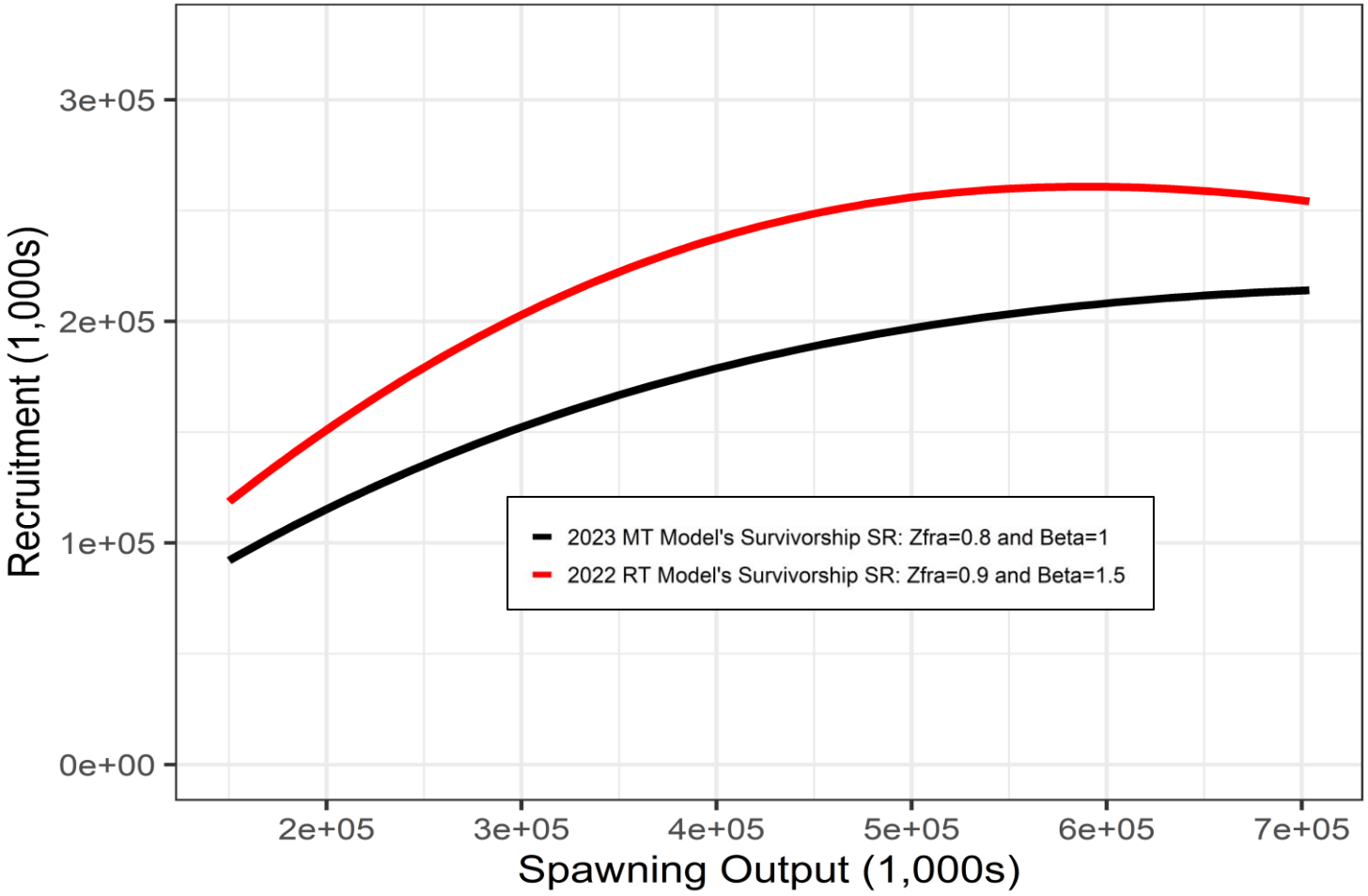
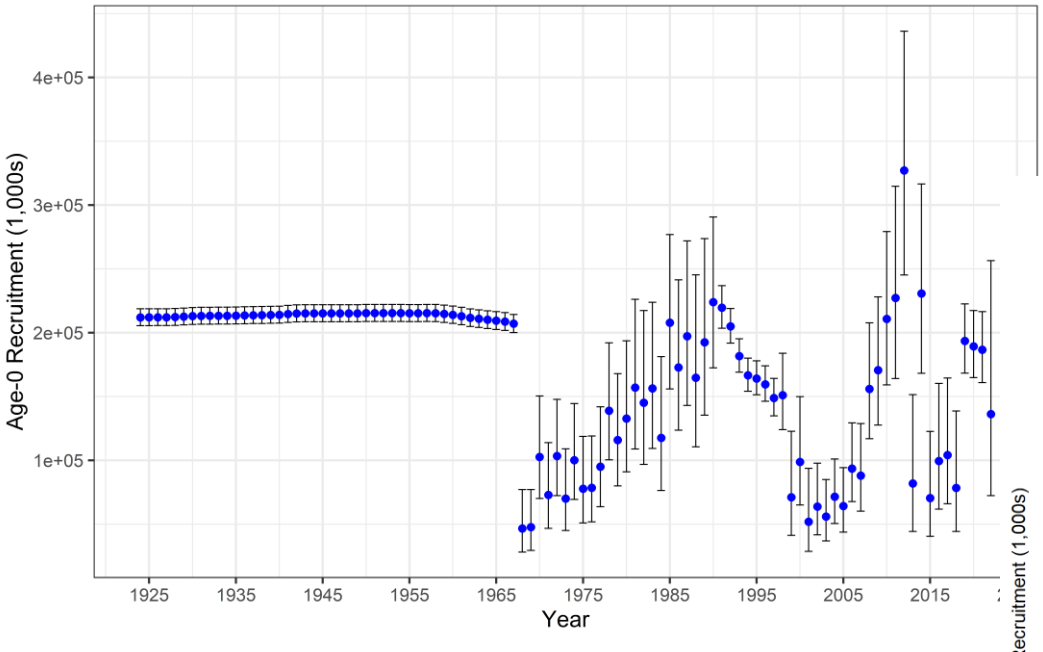
SR Parameters

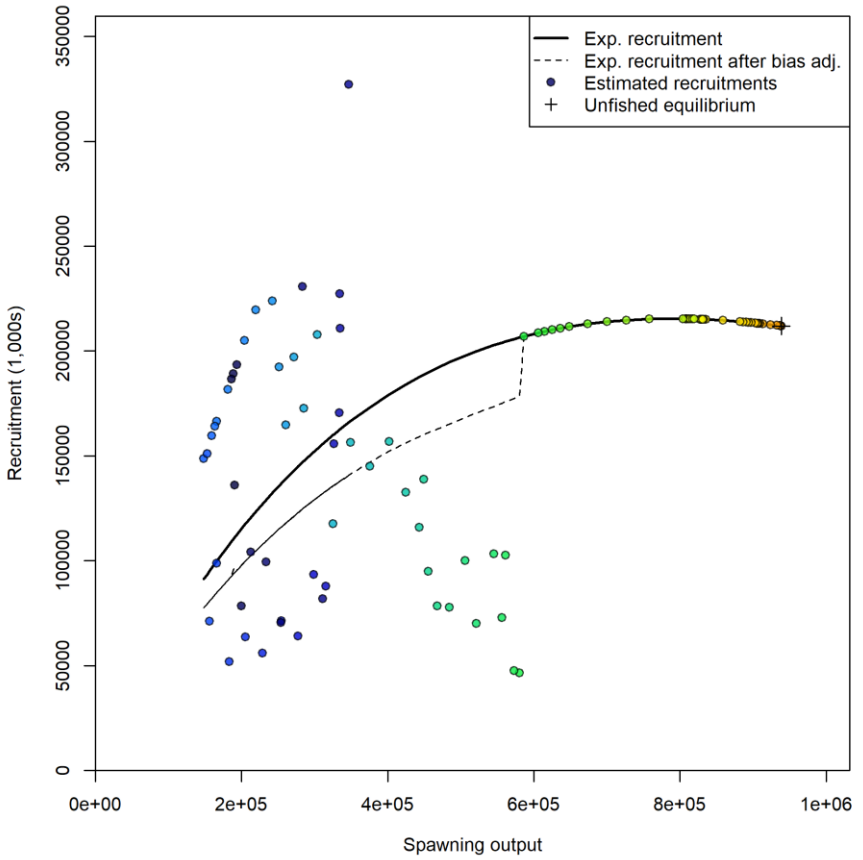
The survivorship (Taylor et al. 2013) spawner-recruitment (SR) parameters were updated based on a profile analysis for the model configuration for this assessment.



MT model suggests that the stock is somewhat less productive

Base Model – Recruitment





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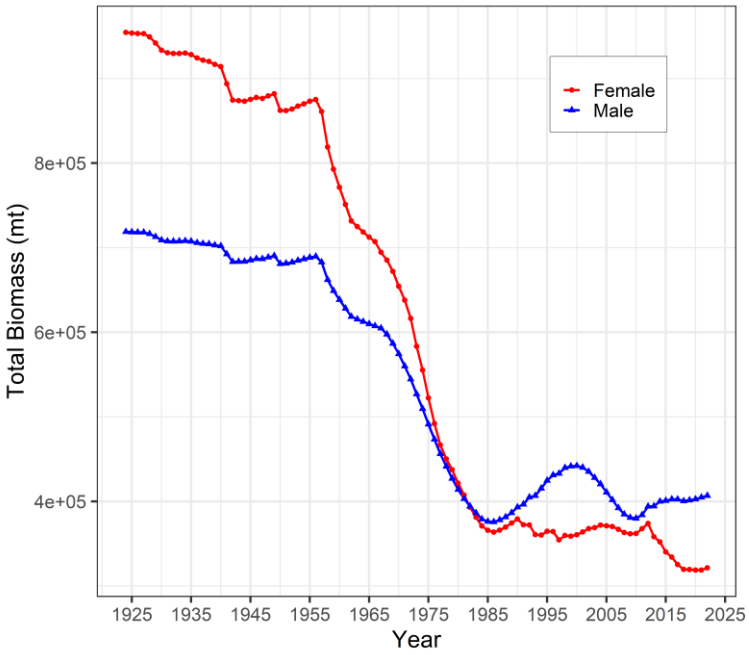
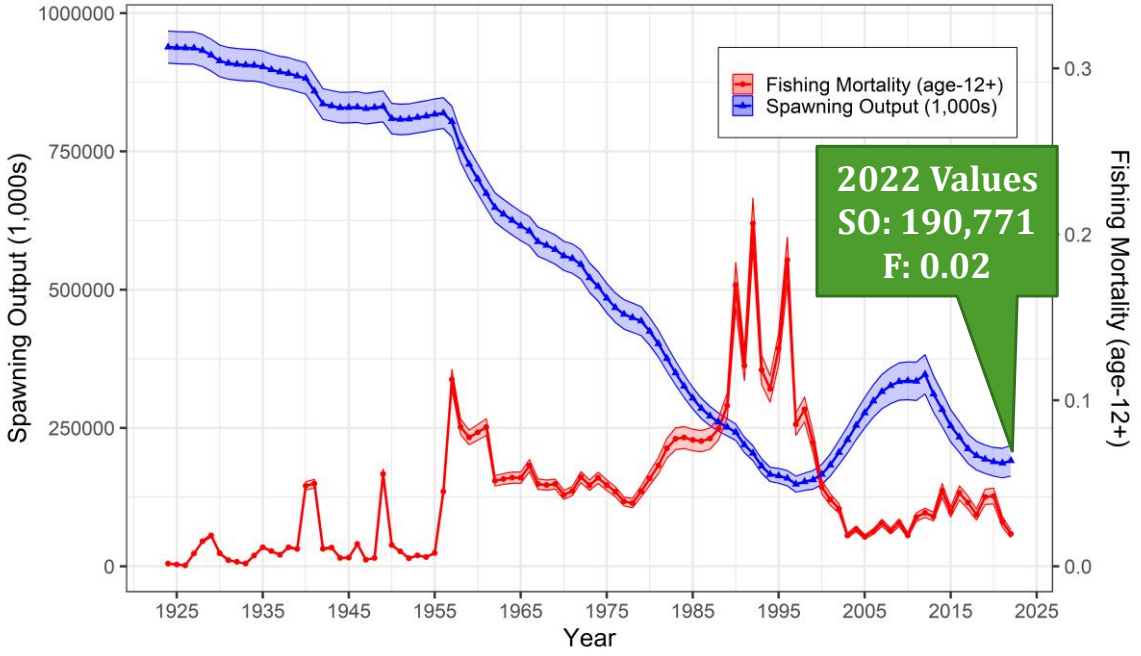
Base Model Results – Population Time Series

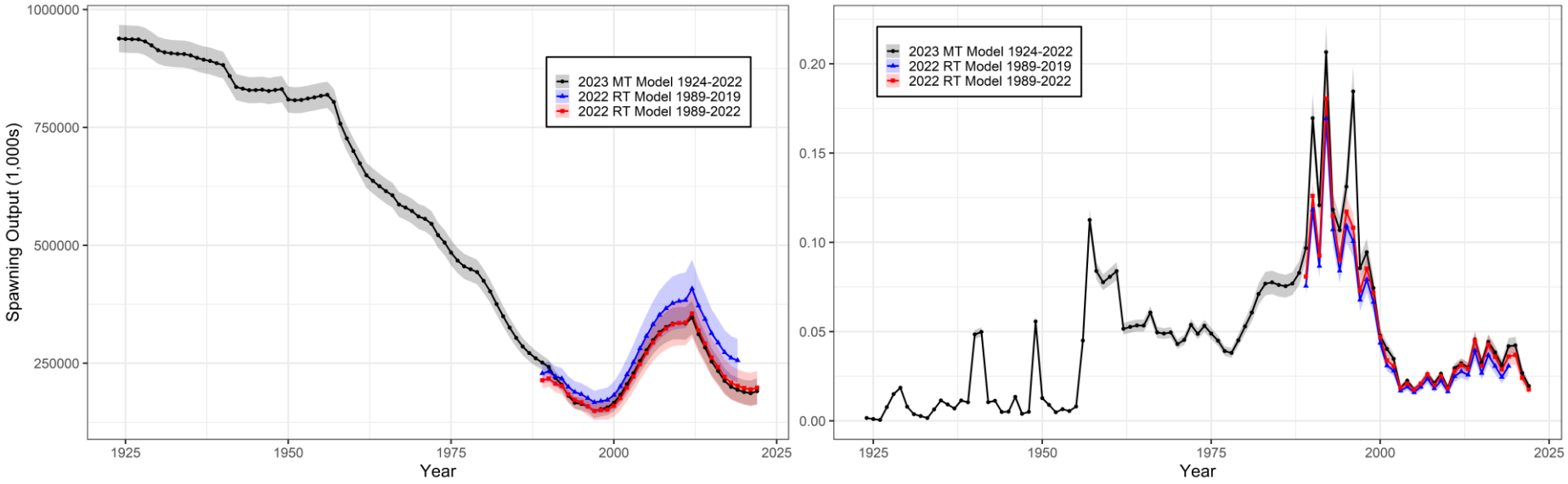




Note the substantial reduction of the female:male sex ratio

The estimated spawning output declined from 2012-2020 but has leveled off. Fishing mortality has been slightly decreasing in the most recent years

Comparison to 1989-2019 and 1989-2022 Research Track Models



Results using the 2022 RT model with additional three years of data (1989-2022) are similar to the 2023 MT model (1924-2022). The original RT model (1989-2019) estimates slightly higher spawning output and slightly lower F than the other two models

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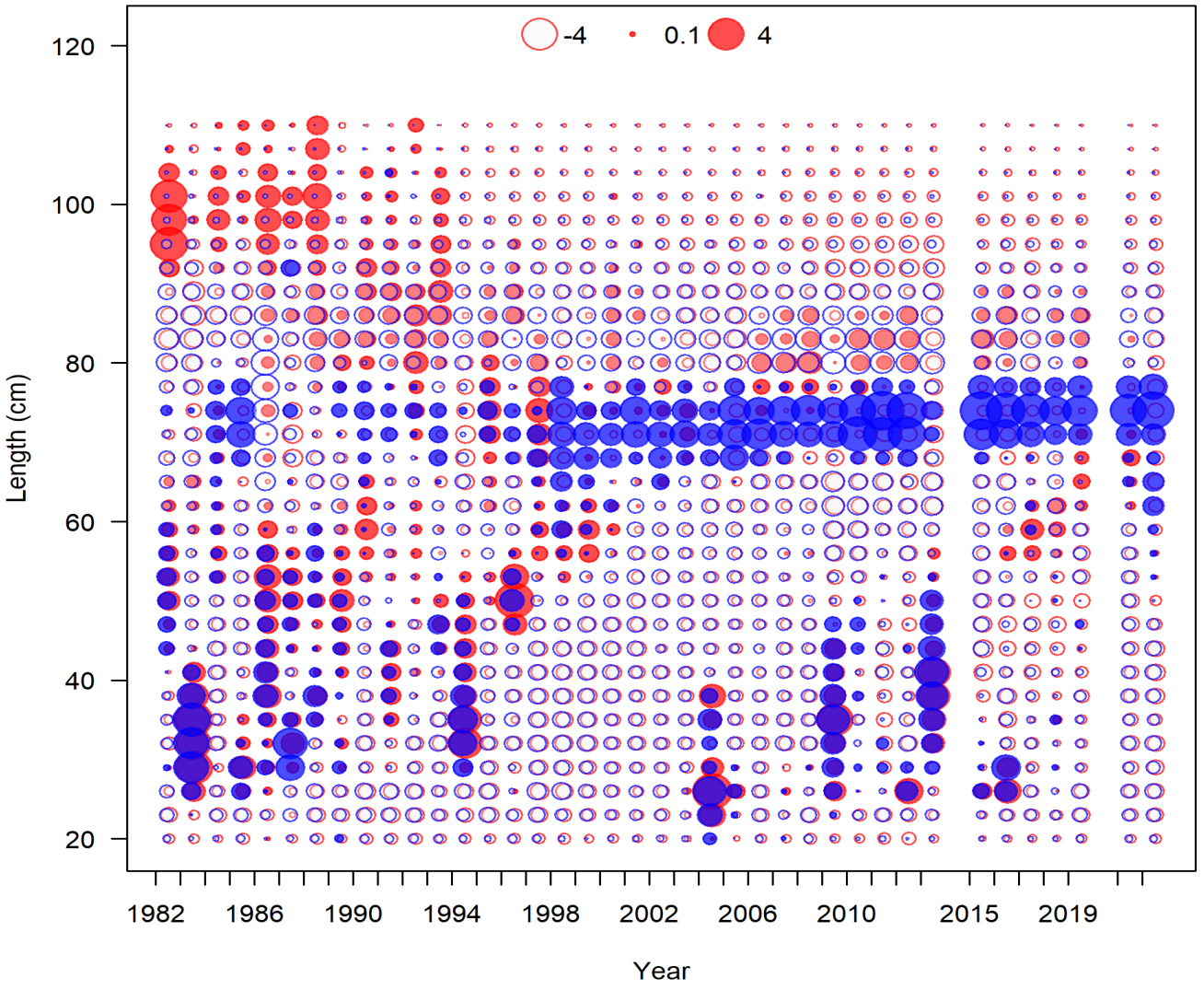
Base Model Results – Length Comp Residuals

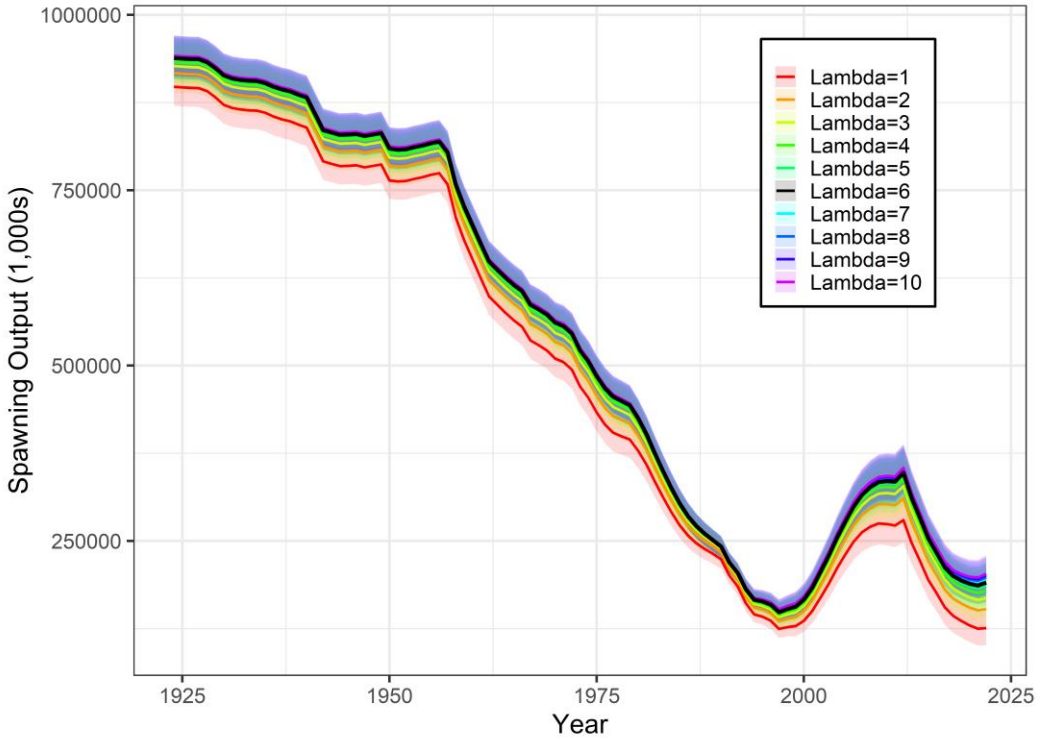
Survey 1982-2022 (Fleet 8)

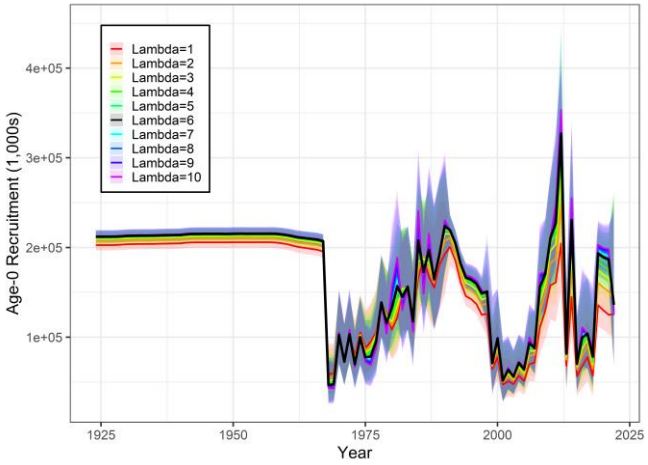
Red: Females
Blue: Males

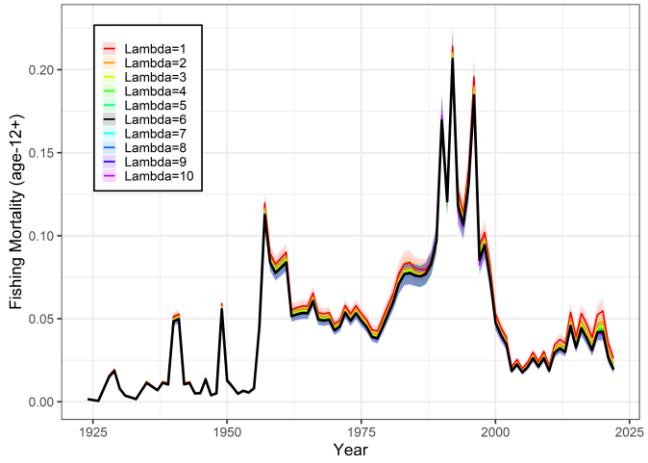


Sensitivity – Likelihood Weights (λ)

The estimated spawning output increased, F decreased, and recruitment increased with increasing survey likelihood weighting.







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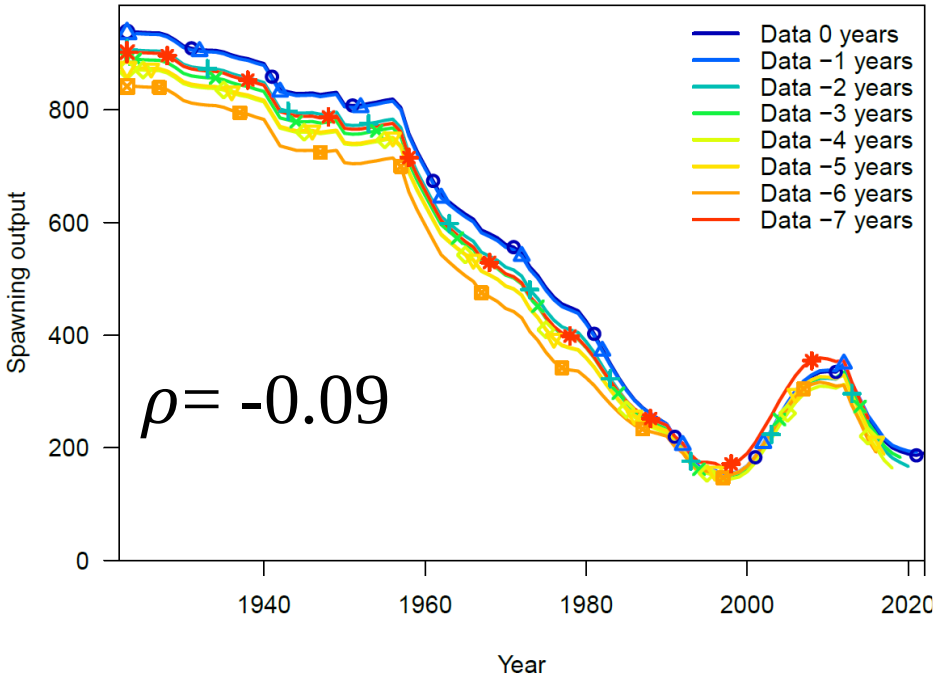
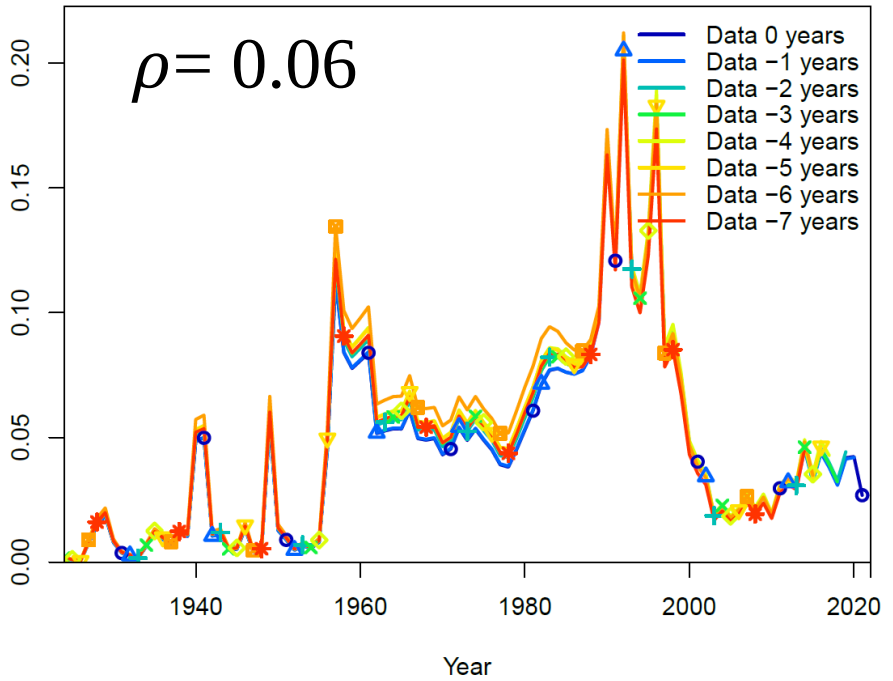
Minimal Retrospective Pattern

Spawning Output



Fishing Mortality (Age 12+)



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TOR4: Biological Reference Points

- Reference point estimations and projections were conducted in SS3
- **F_{MSY} proxy**: F at SPR 60% as in RT
- **SSB_{MSY}**: median of the final 10 years' spawning output from a 100-year projection fishing at the F_{MSY} proxy.
- **MSY**: median of the final 10 years' catch from a 100-year projection fishing at the F_{MSY} proxy

	Research Track	Management Track
F_{MSY} proxy	0.025	0.025
SSB_{MSY} (million pups)	371	188 (148- 227) (Spawning output$_{MSY}$)
MSY (mt)	N/C	7134 (5631 - 8636)
Recruits (million pups)	N/C	109.9
Overfishing	Yes	No (but OF in 2019)
Overfished	No	No

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OFL/ABC Calculations

- Conducted using the SS3 forecast module
- Catch in 2023 assumed to be the ACT/ACL (7751 mt)
- OFL for 2024 was estimated by fishing at F_{MSY} for 2024.
- ABC estimated using the council risk policy spreadsheet
- OFL for 2025 was then calculated assuming catch in 2024 was the calculated ABC
- Repeat as necessary

These steps were done for both assumed CVs of 100% and 150%

OFL/ABC Calculations

Year	OFL	ABC (ACT)	Spawning Output	SSB/BMSY
	mt	mt	millions pups	
Assuming 100% CVs				
2023		*7788 (7751)*	*196.9*	*1.05*
2024	7818	7135	202.8	1.08
2025	7970	7312	208.7	1.11
2026	8112	7473	213.3	1.13
Assuming 150% CVs				
2024	7818	6940	202.8	1.08
2025	7975	7130	208.9	1.11
2026	8122	7301	213.6	1.14

Evaluation of Risk/Uncertainties

Factors increasing uncertainties/risks

1. Uncertain catch, especially discards and assumptions on discard mortality
2. Changing life history especially growth, and lack of growth data
3. Lack of good fit to survey index and use of data weightings

Factors reducing uncertainties/risk

1. Lack of retrospective pattern
2. Relatively high estimate of survey *q* (0.87 for 1982-2022 survey index) suggests that biomass cannot be substantially overestimated

Thank You!

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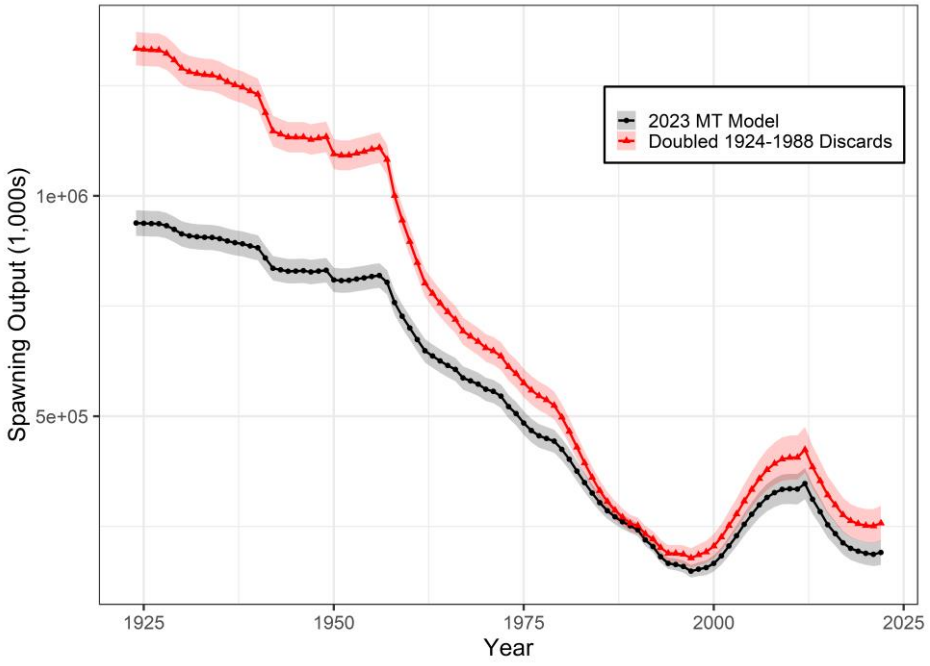
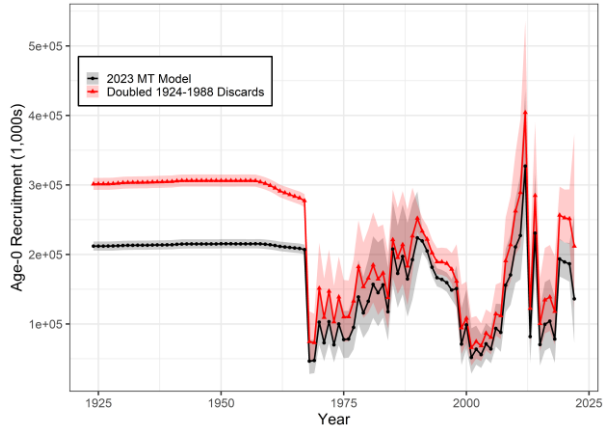
Sensitivity – Likelihood Weights (λ)

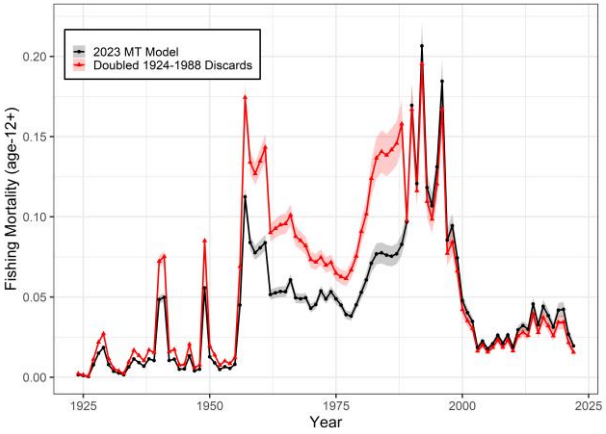
Run	F_{MSY}	SSB_{MSY}	MSY	F_{2022}	SSB_{2022}	Overfishing	Overfished
Lambda=1	0.024	154	5676	0.026	126	Yes	No
Lambda=2	0.024	166	6242	0.023	153	No	No
Lambda=3	0.024	173	6528	0.021	169	No	No
Lambda=4	0.024	179	6766	0.020	179	No	No
Lambda=5	0.025	184	6962	0.020	186	No	No
Lambda=6	0.025	188	7134	0.020	191	No	No
Lambda=7	0.025	192	7297	0.019	195	No	No
Lambda=8	0.025	195	7424	0.019	198	No	No
Lambda=9	0.025	197	7499	0.019	201	No	No
Lambda=10	0.025	198	7564	0.019	203	No	No

Sensitivity – Doubled 1924-1988 Discards

The estimated SO increased, F decreased, and R increased with doubling earlier year's discards.







TOR6: Responses to reviewer comments

RT Panel Report: *The base model and the sensitivity runs did not fit the indices well, because of the strong influence from the length-frequency data. The review panel agreed that all the TORs were met, but some were met with reservations. The review panel recommended continuing to explore the sensitivity of the SS3 model parameterization and configuration before the following management stock assessment review.*

We have addressed this concern in this assessment, and the fit to the survey indices is now improved

TOR6: Responses to reviewer comments

RT Panel Report: *The landings and discards uncertainty were quantified and reported in the assessment report. However, these uncertainties were not accounted for in the SS3 model runs because of convergence issues. The review panel recommended that uncertainty should be considered in the future SS3 model configuration (TOR4)*.

We agree that catch, especially discards (including discard mortality assumptions), carries uncertainty. Uncertainty in catch can only addressed in SS3 (and most other stock assessment models) using sensitivity runs.
One sensitivity run as to the level of estimated discards was performed.

TOR6: Responses to reviewer comments

RT Panel Report had concerns regarding the projections done in the research track, stating that "*The 3-year projection showed a sharp decrease in 2020 but increased after that…*"

The drop in 2020 was due to an issue with the SS3 control file. This issue has been corrected (thanks Rick!), and the projections are now more reasonable.

TOR6: Responses to reviewer comments

RT Panel Report: *The review panel also suggested that the ageing-length data collection and analysis should be continued considering its importance in both the assessment model, BRPs and projections (TORs 4, 5 and 6).*

An ageing study has been funded and is underway. We agree that the collection of updated age/growth data will considerably reduce the uncertainties of this assessment