NOAA FISHERIES

Integrated Age-Structured Single-Species Model for ʻŌpakapaka

WPSAR 2023

‘Ōpakapaka’s role

40%

‘Ōpakapaka comprise approximately 40% of the total Deep 7 biomass as estimated by the BFISH survey

50%

‘Ōpakapaka comprise approximately 40-50% of the total Deep 7 commercial catch based on fisher reported catch data

NOAA FISHERIES

Why develop another model?

> "Continue to present both the Deep 7 complex and single-species assessments for important species with sufficient information (e.g., ʻōpakapaka) in next benchmark assessment"
>
> -Panel Summary Report, WPSAR 2021

- Supports the Deep 7 complex JABBA model by
  - Explicitly addressing some limiting assumptions of surplus production model
  - Improving our understanding of the population dynamics of ʻōpakapaka
  - Revealing if differences in input data and assumptions causes differences in trend and scale of outputs

NOAA FISHERIES

Terms of reference

> "Given the limitations associated with using a surplus-production model on a multi-species complex, is the ***supplementary single species, age-structured ʻōpakapaka model*** useful in ***supporting the general conclusions*** from the surplus-production model (biomass and mortality trends and stock status)?"

This model is *not*:

- ✗ A stand-alone product
- ✗ To inform single-species management measures

This model *is*:

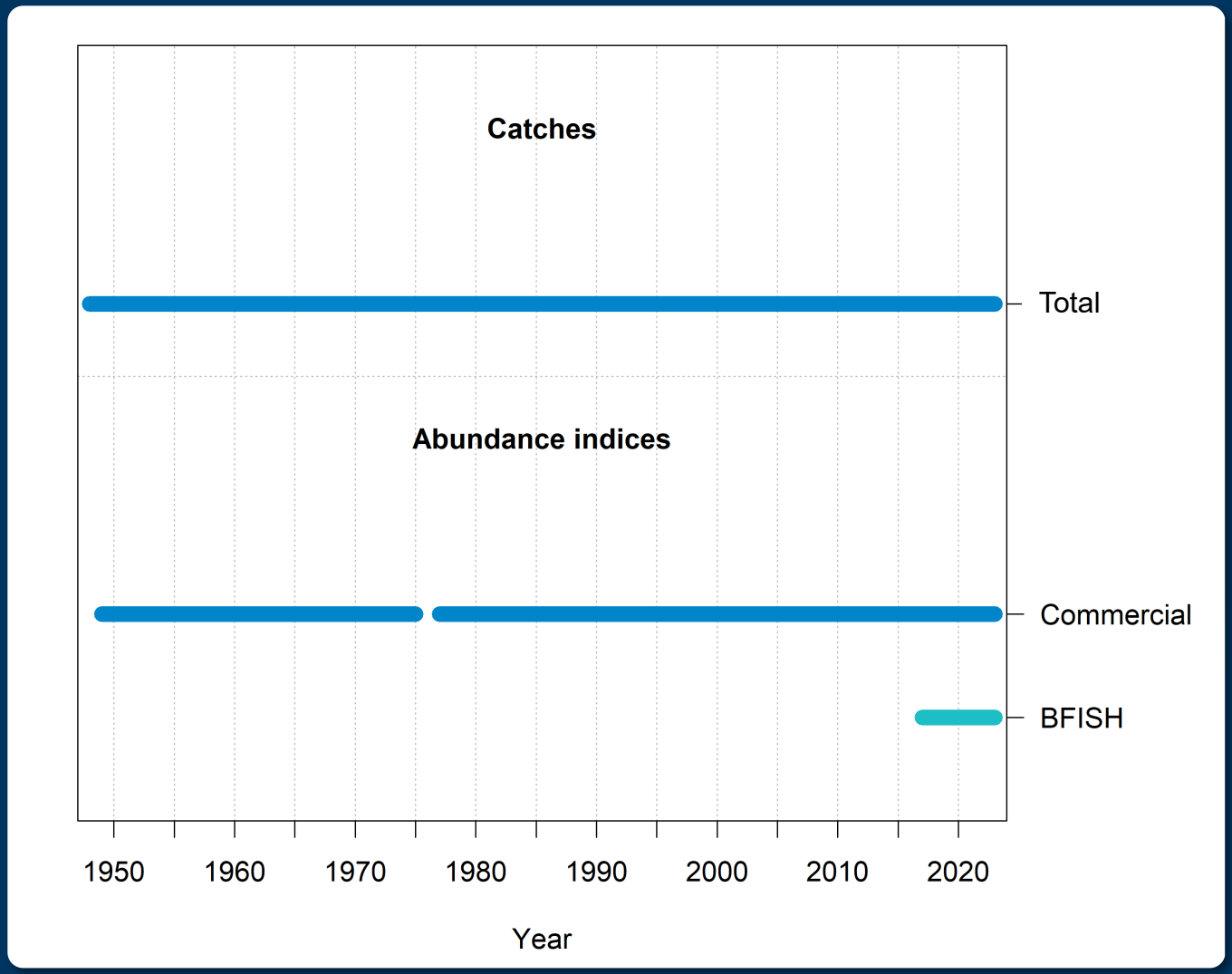
- ✓ Valuable tool for enhancing our understanding of a key species
- ✓ A foundation for future research

NOAA FISHERIES

Modeling framework

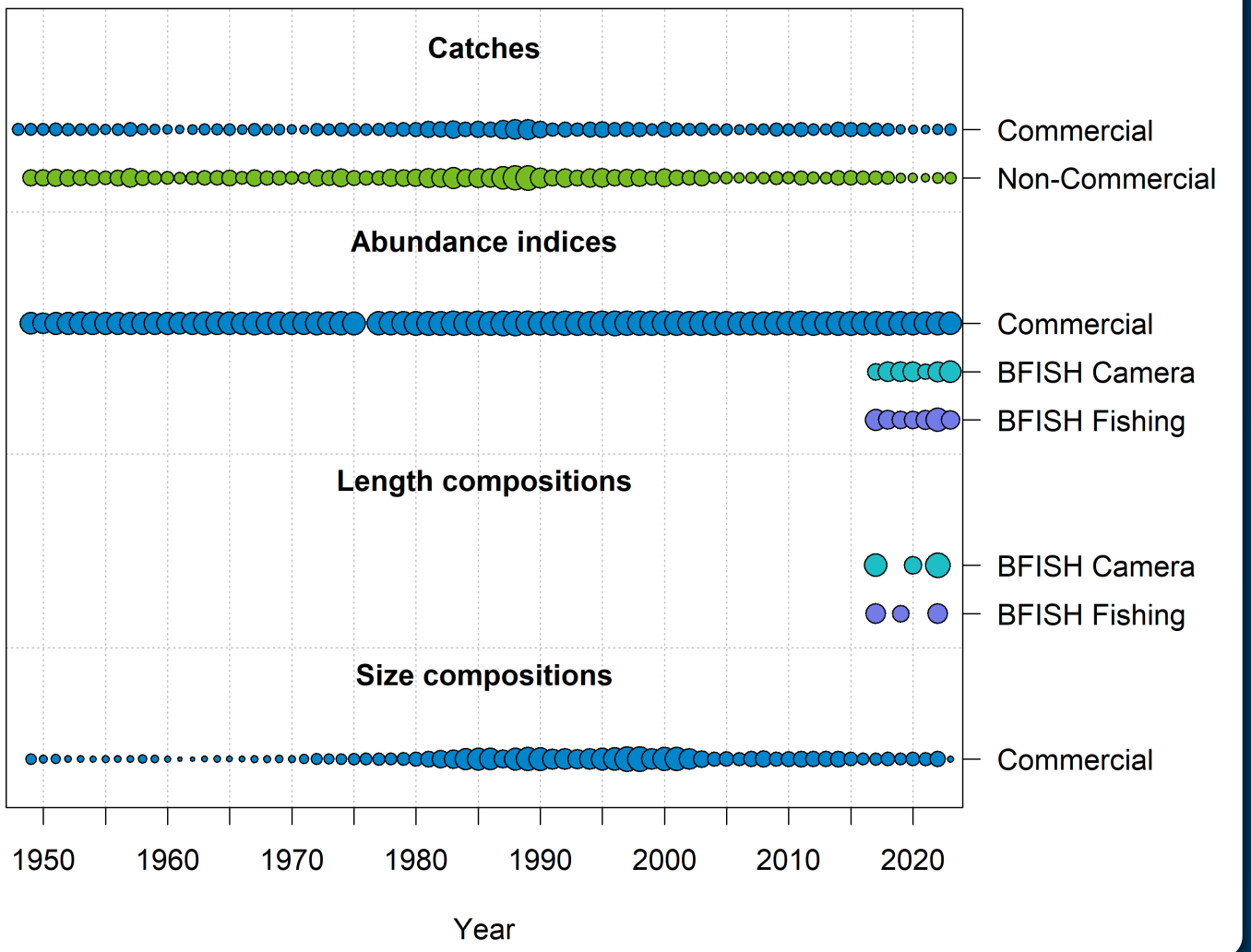
- Assumptions of surplus production models:
  - No age structure, all individuals are equivalent
  - Catch and CPUE are good indicators of population size and dynamics
- Integrated, age-structured Stock Synthesis:
  - Can integrate life-history components such as growth and reproduction because many aspects of the population dynamics are related to age-structure (fecundity, survival, etc.)
  - Can include other types of data to get better estimates of biomass and fishing mortality
    - Length data
    - Weight data
  - Can account for different selectivities of fleets

Input data for JABBA



NOAA FISHERIES

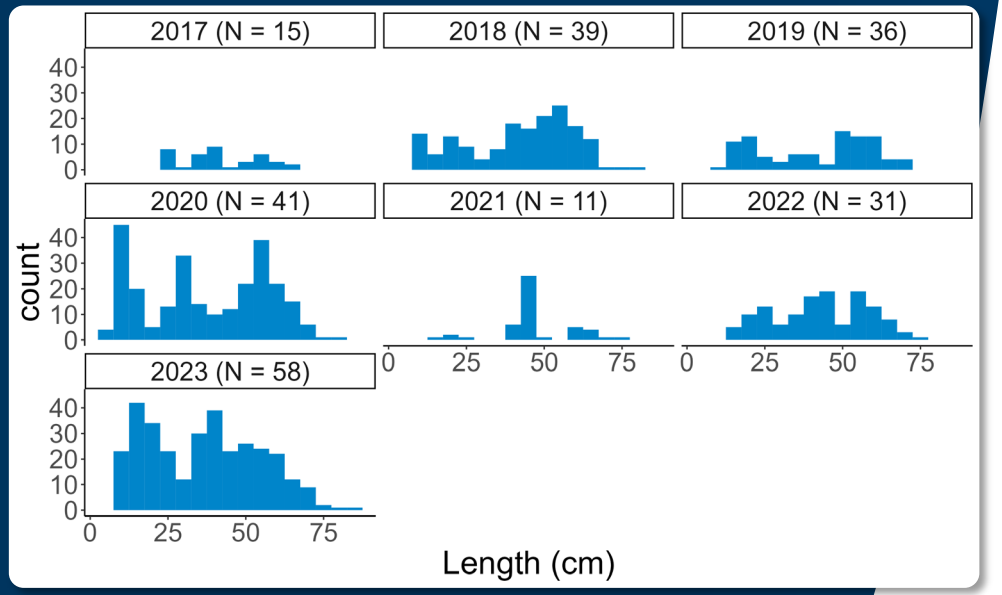
Input data for Stock Synthesis



NOAA FISHERIES

BFISH camera length composition

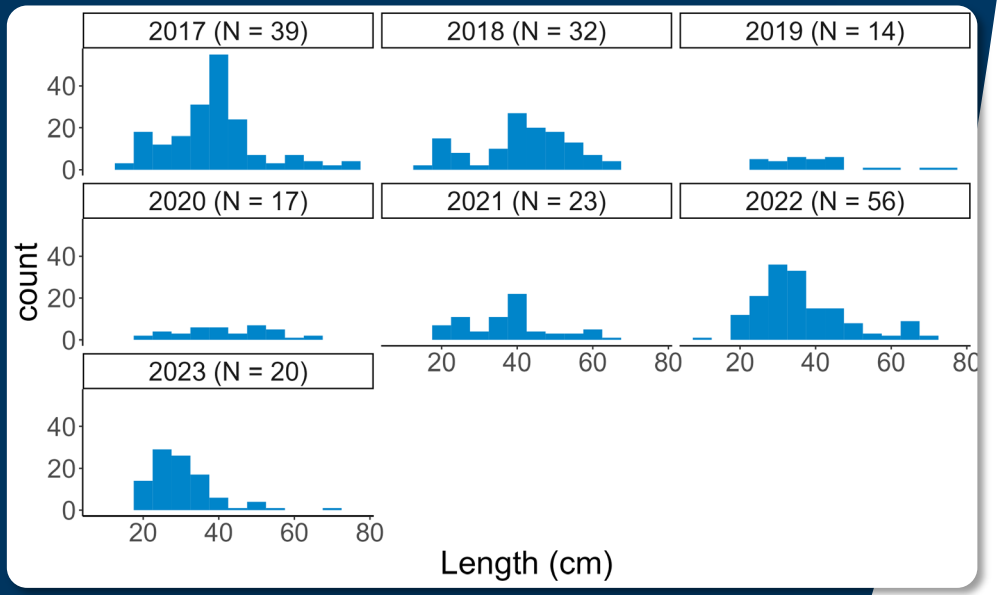
- Video analysis of fish lengths
- 5 cm bins
- Input sample sizes were the number of primary sampling units (PSU) in a year
- Years with $N < 45$ were combined
  - 2017-2019
  - 2020-2021
  - 2022-2023



NOAA FISHERIES

BFISH fishing length composition

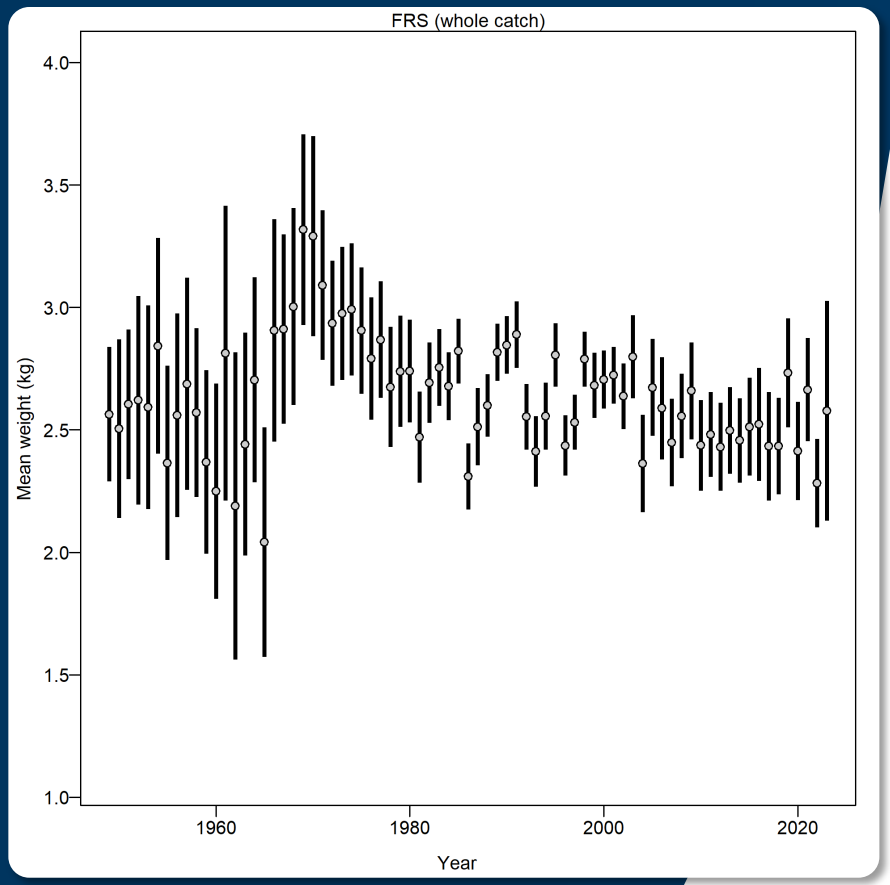
- 5 cm bins
- Input sample sizes were the number of primary sampling units (PSU) in a year
- Years with $N < 45$ were combined
  - 2017-2018
  - 2019-2021
  - 2022-2023



NOAA FISHERIES

Commercial weight composition

- Filtered for trips with 1 fish caught and under 21 lbs.
- Input sample size was number of single ʻōpakapaka trips in a year
- Weight bins were in 1lb increments (converted to kg)



NOAA FISHERIES

Incorporating uncertainty and data weighting

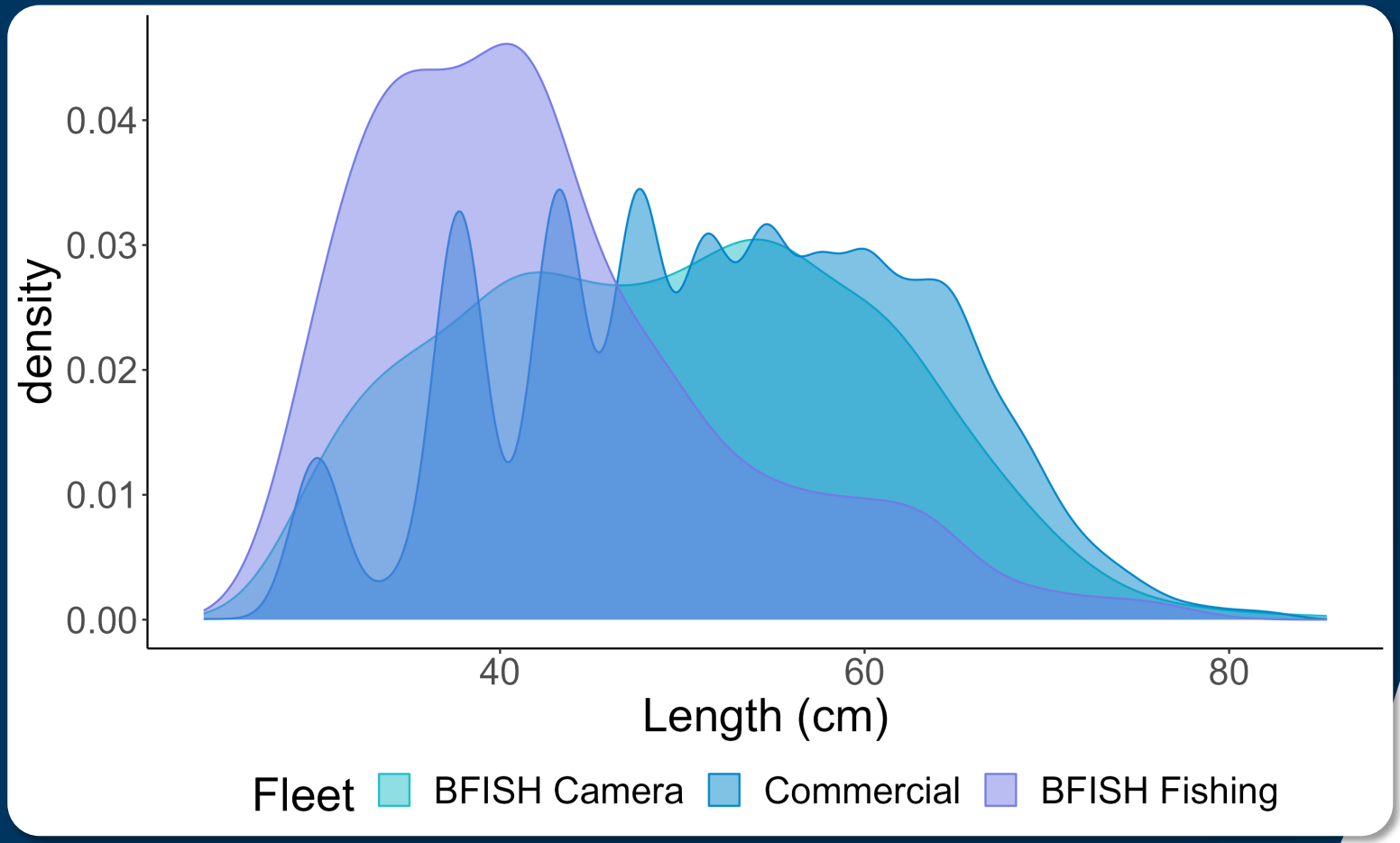
- Catch – assumed known with no error
  - JABBA used lognormal error with CV of 13% (for non-commercial catch)
- Indices of abundance CVs of:
  - 5-10% for commercial
  - 19-37% for BFISH camera
  - 16-28% for BFISH fishing
  - Francis adjustment to FRS CPUE to re-weight (+~11%)
    - JABBA estimated additional observation error
- Size composition
  - Dirichlet-multinomial distribution for effective sample size

Life history parameters

Model	r	K (carrying capacity)	B_{MSY}/K	ψ
JABBA	0.095	9.32 million	0.315	0.747

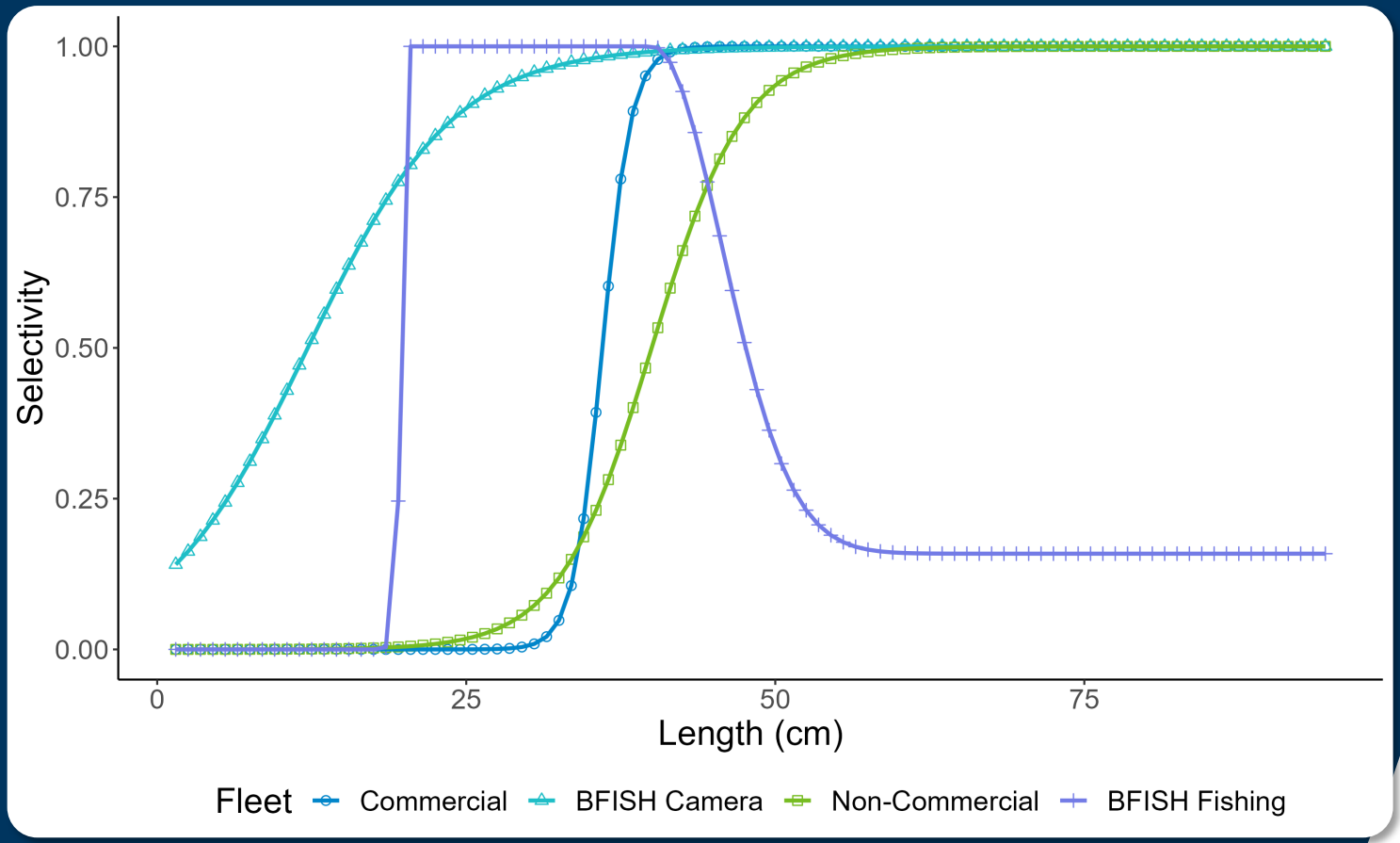
Model	L_∞	K	A_0	L_{Amin}	A_{max}	M	Length-weight A	Length-weight B	Lm_{50}	h	σ_R
Stock Synthesis	67.5	0.24	-0.3	6	40	0.14	1.75E-05	2.99	40.7	0.76	0.52

Selectivity



NOAA FISHERIES

Selectivity

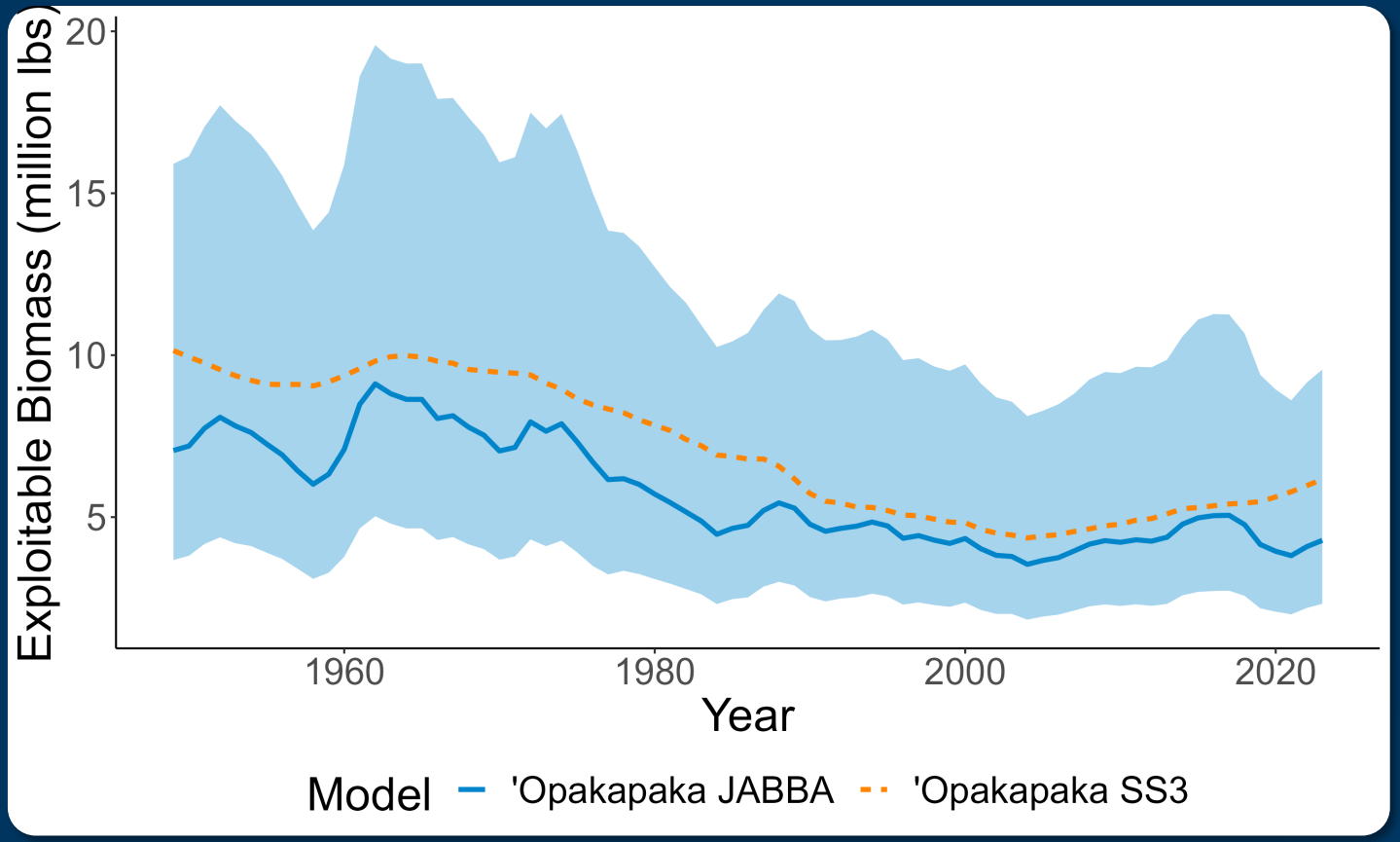


NOAA FISHERIES

Model Results and Performance

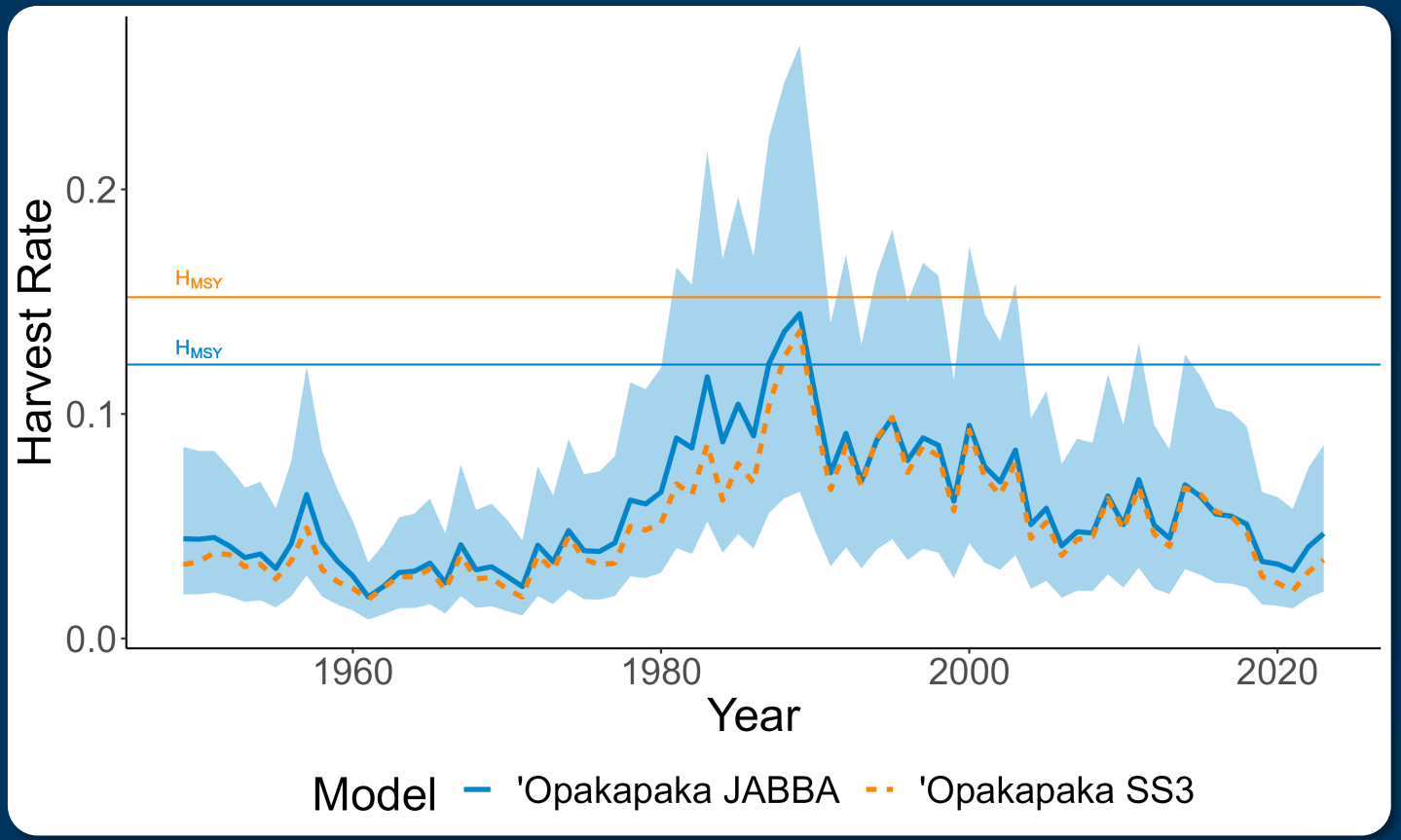
NOAA FISHERIES

Biomass estimates



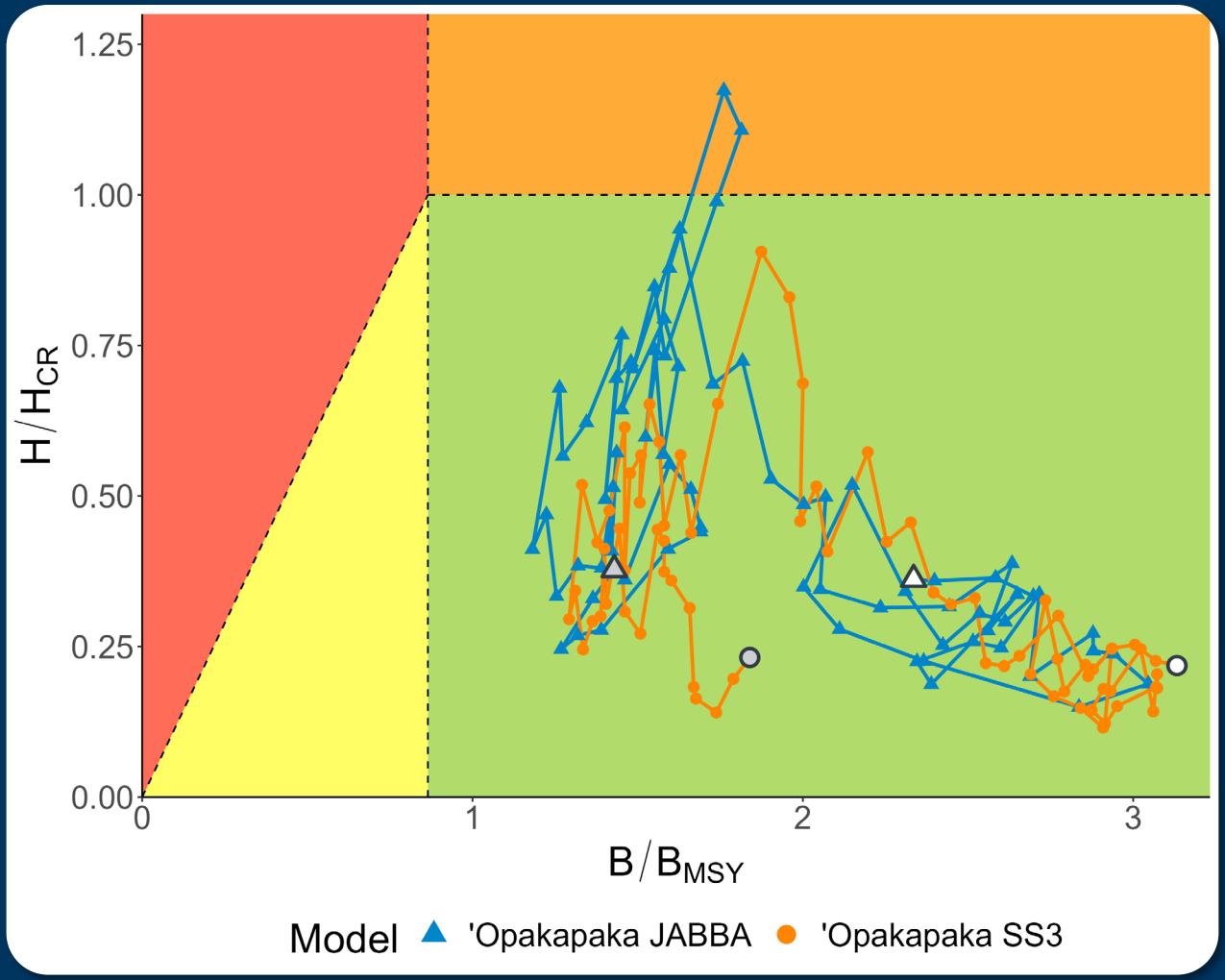
NOAA FISHERIES

Harvest rate estimates



NOAA FISHERIES

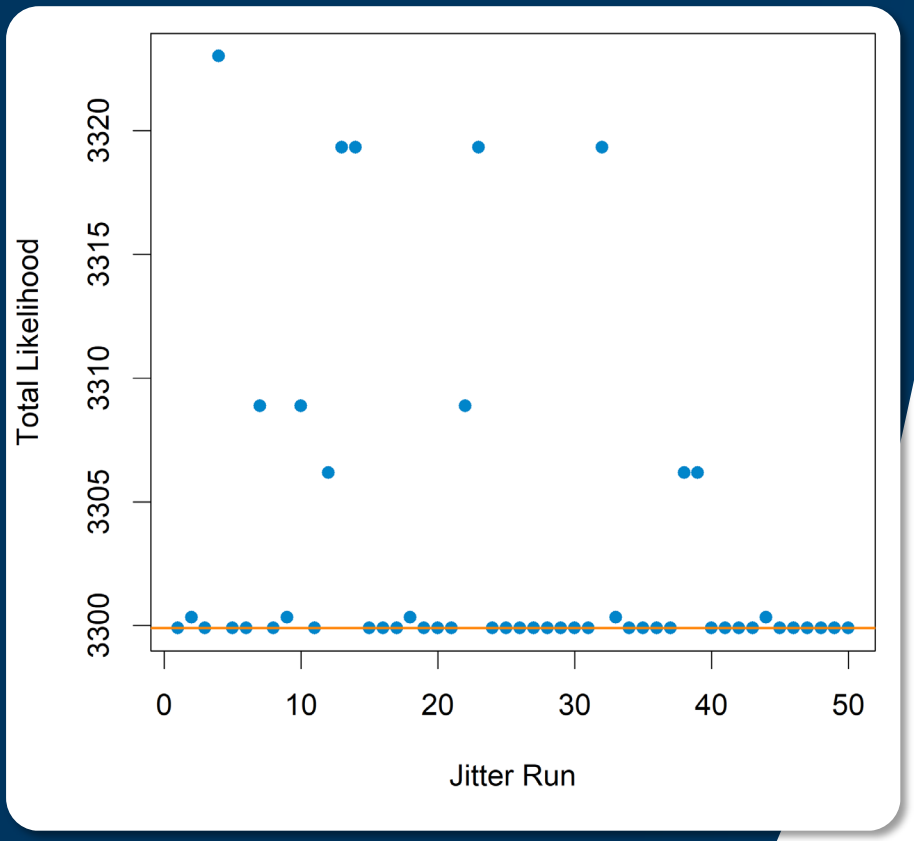
Stock Status



NOAA FISHERIES

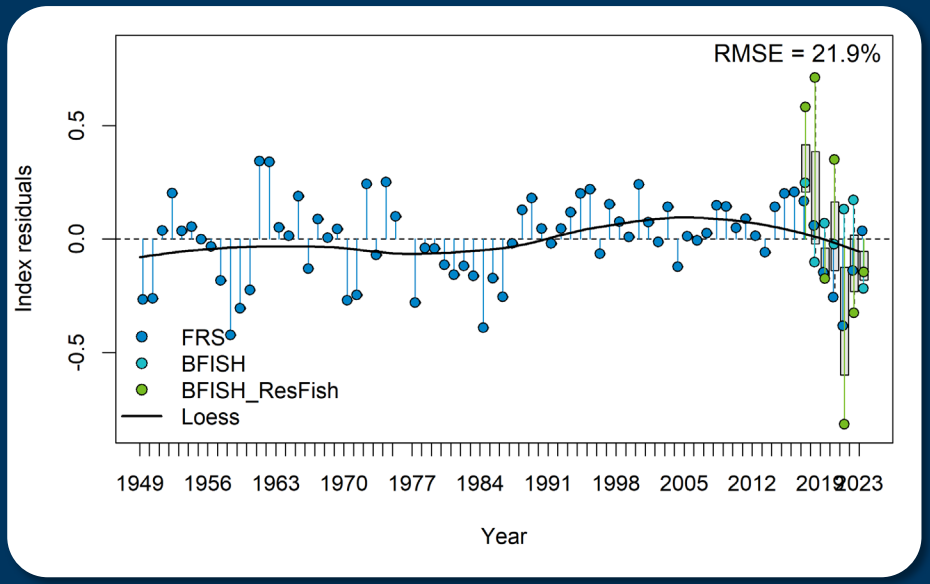
Convergence and global minimum

- Small gradient
- Invertible Hessian
- 50 jitter runs showed it reached global minimum

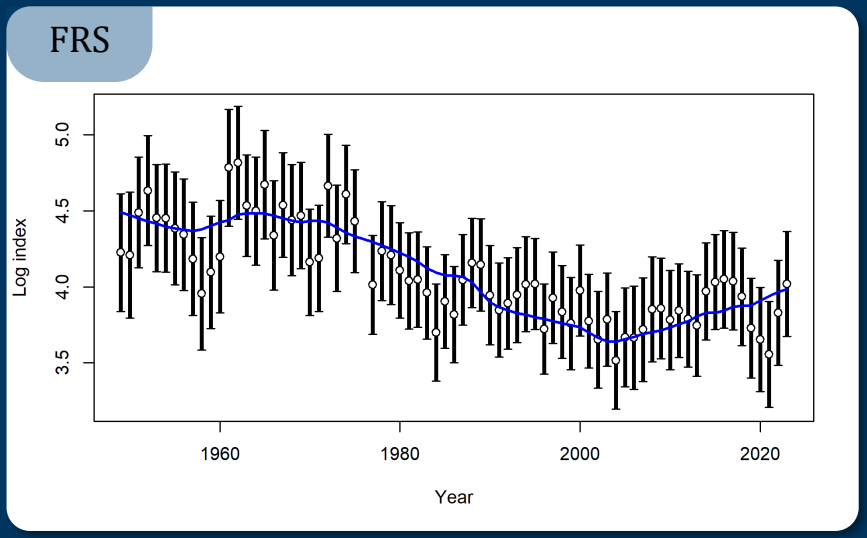


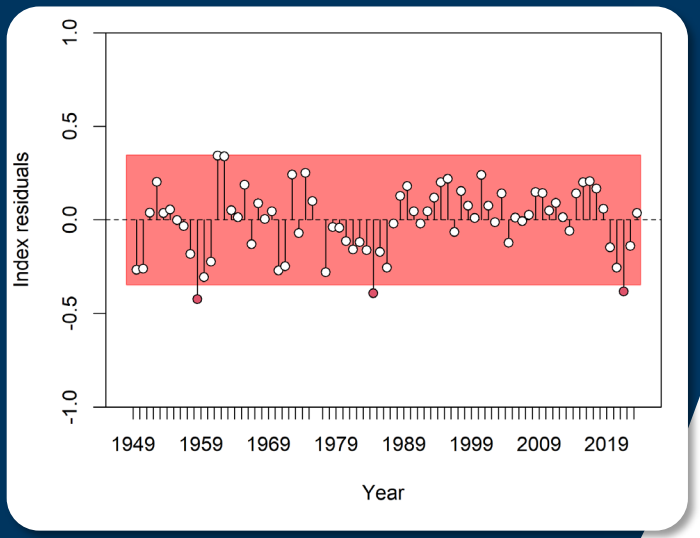
NOAA FISHERIES

Data fits



FRS

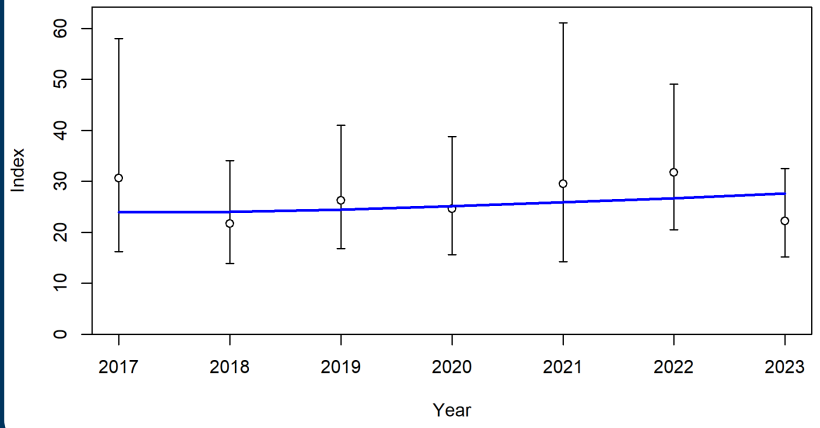




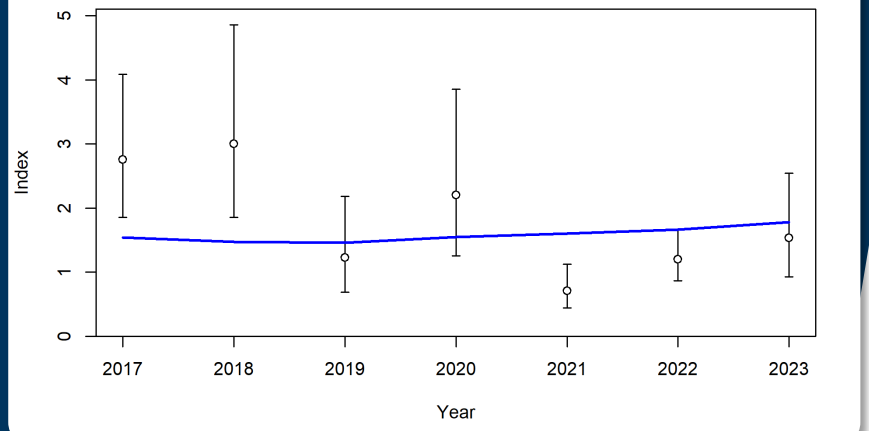
NOAA FISHERIES

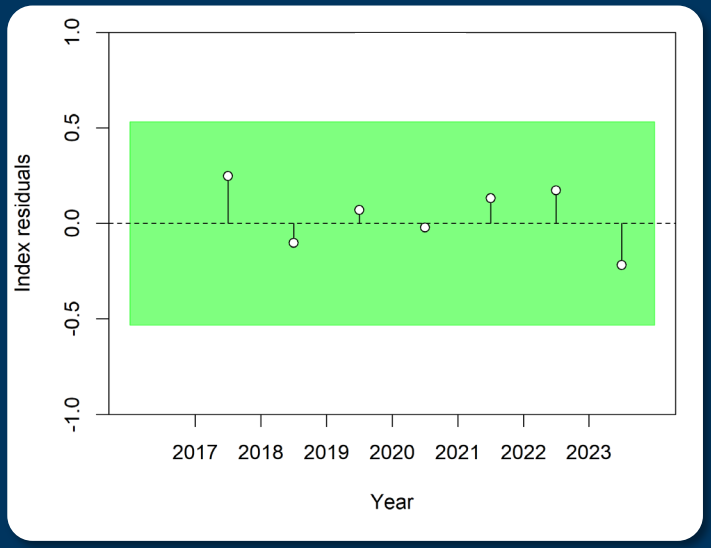
Data fits

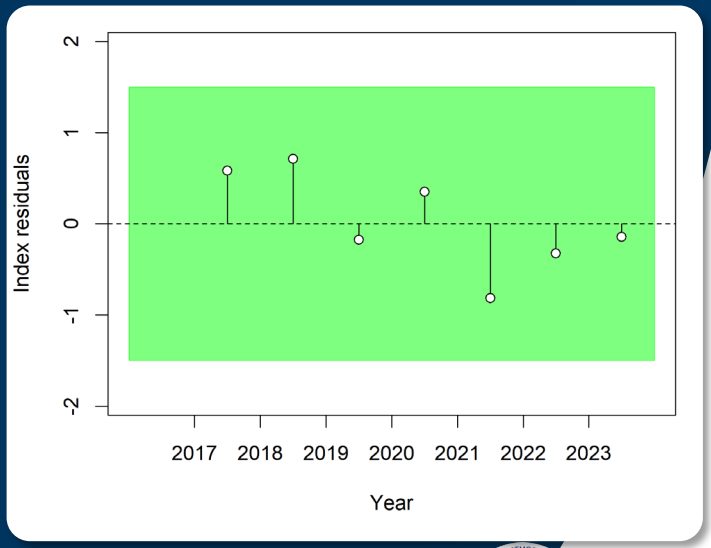
BFISH Camera



BFISH Research Fishing

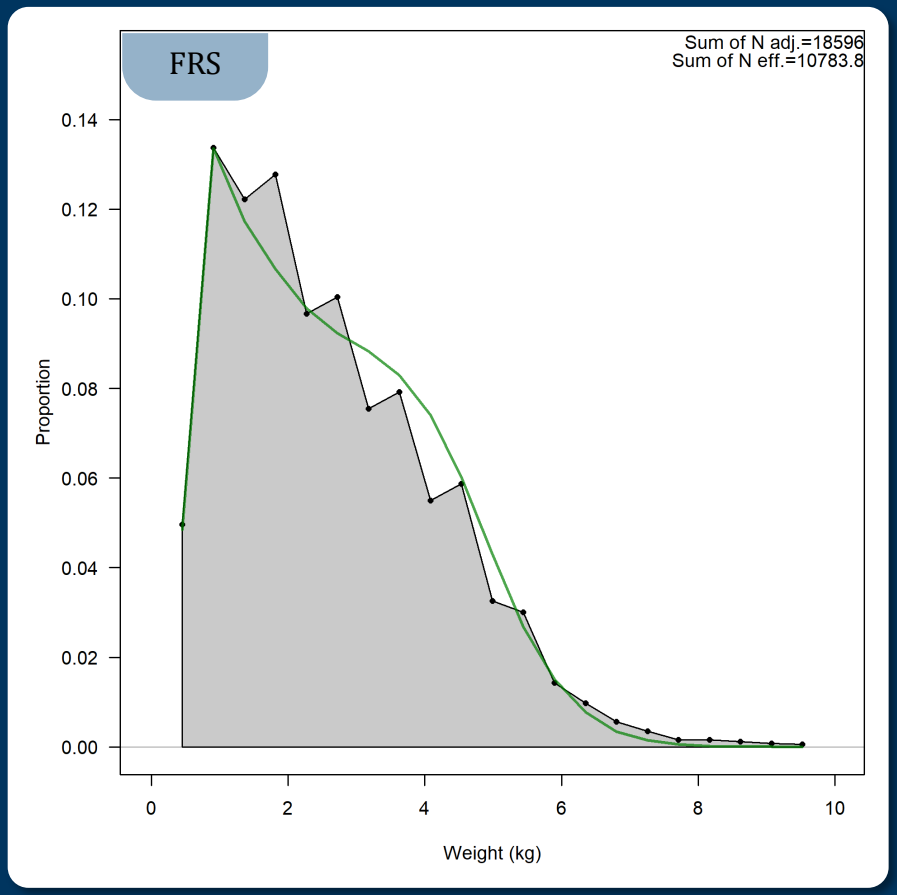


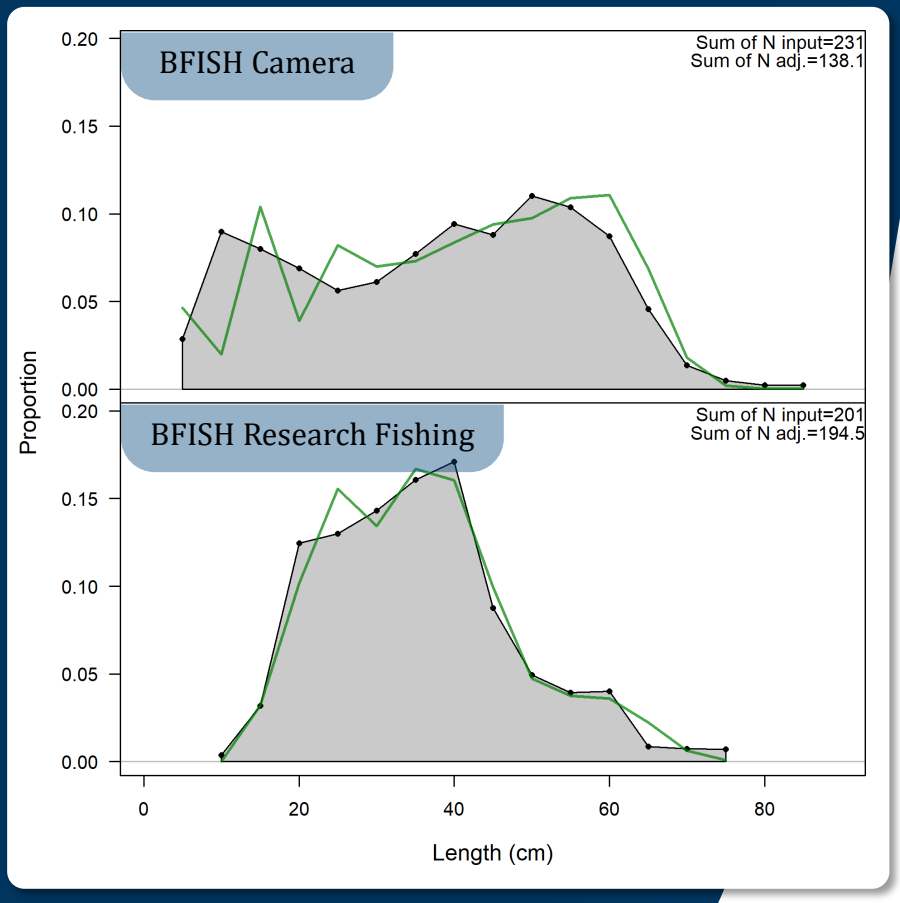




NOAA FISHERIES

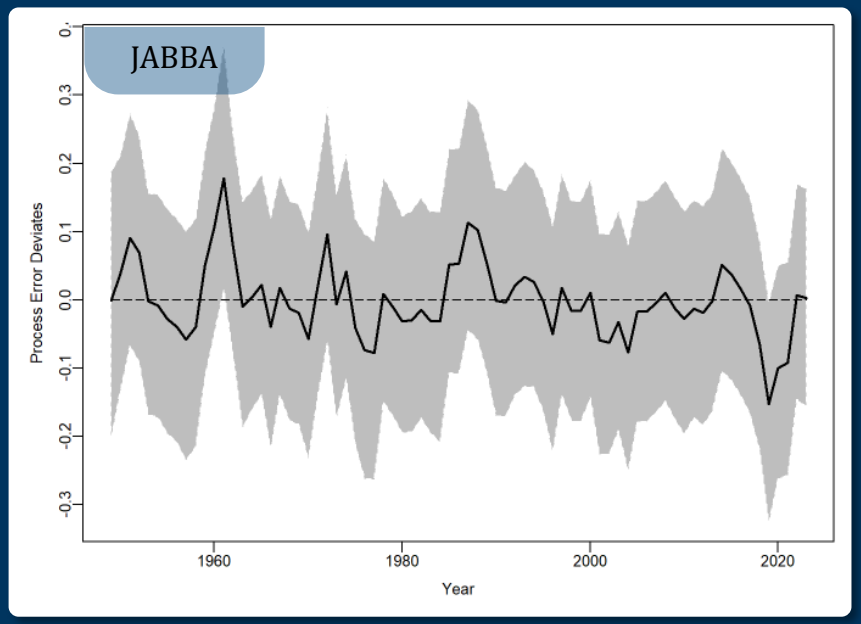
Size composition fits

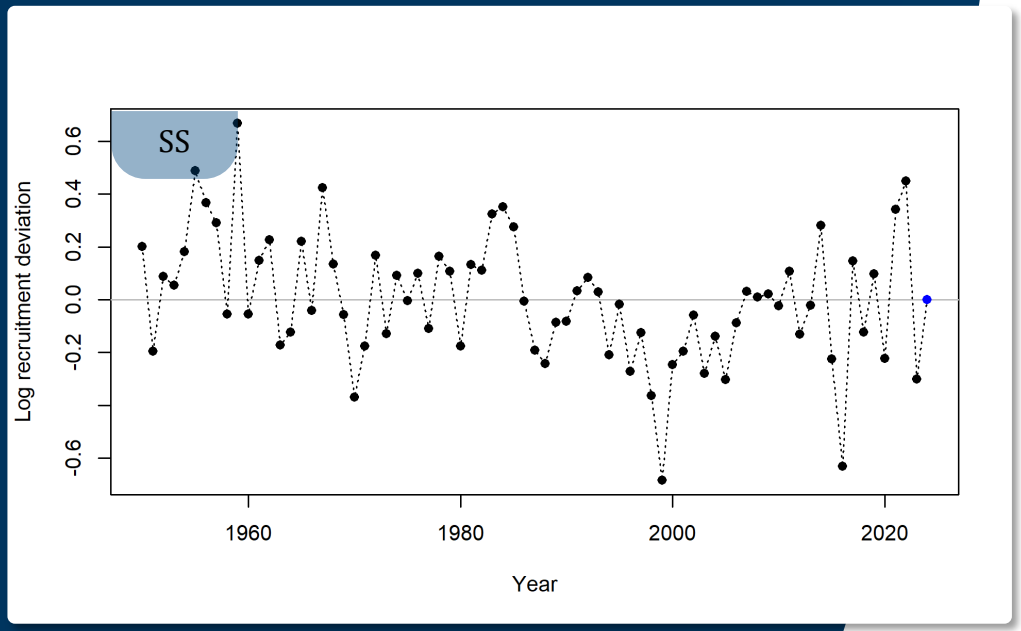




NOAA FISHERIES

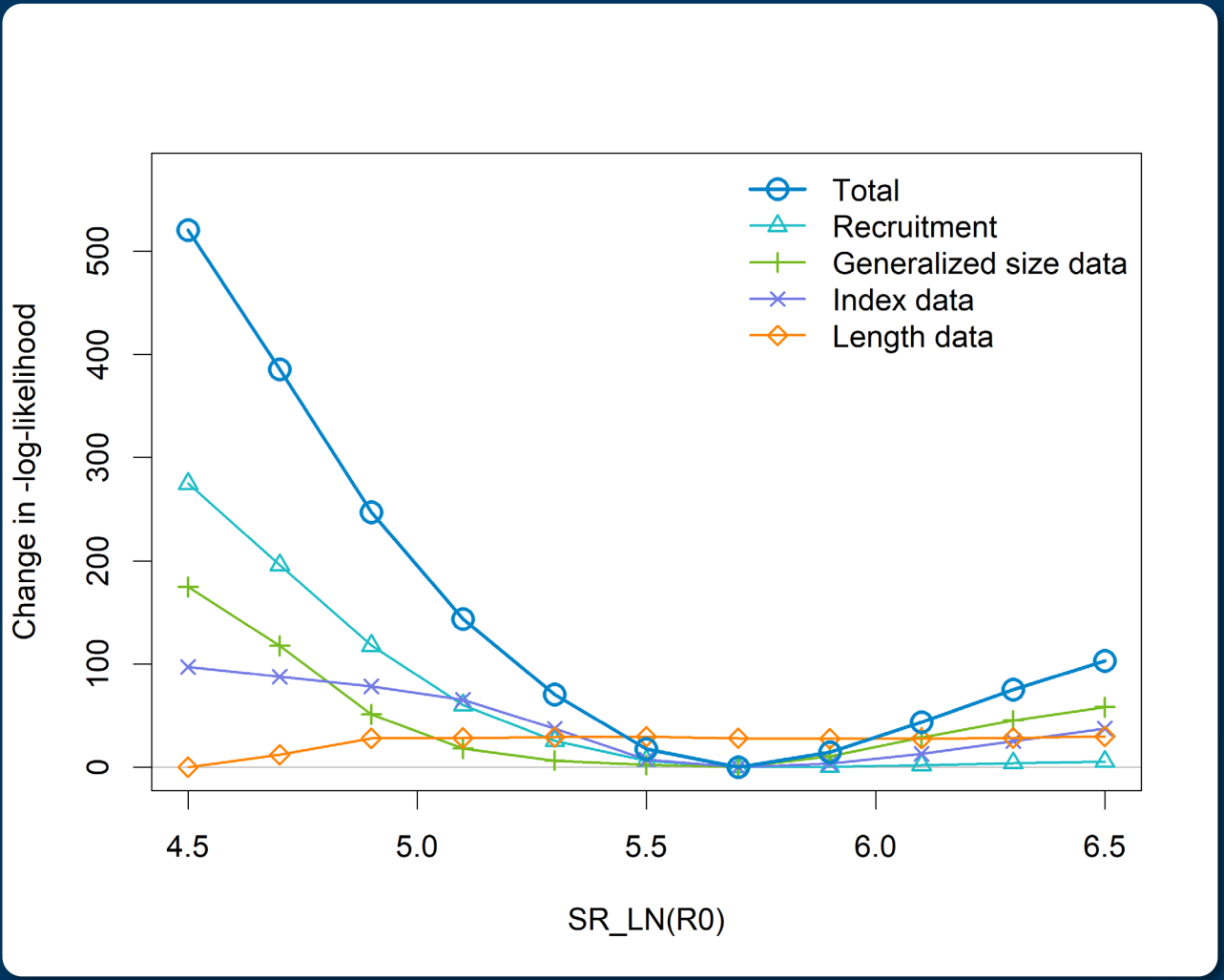
Process error and recruitment deviations





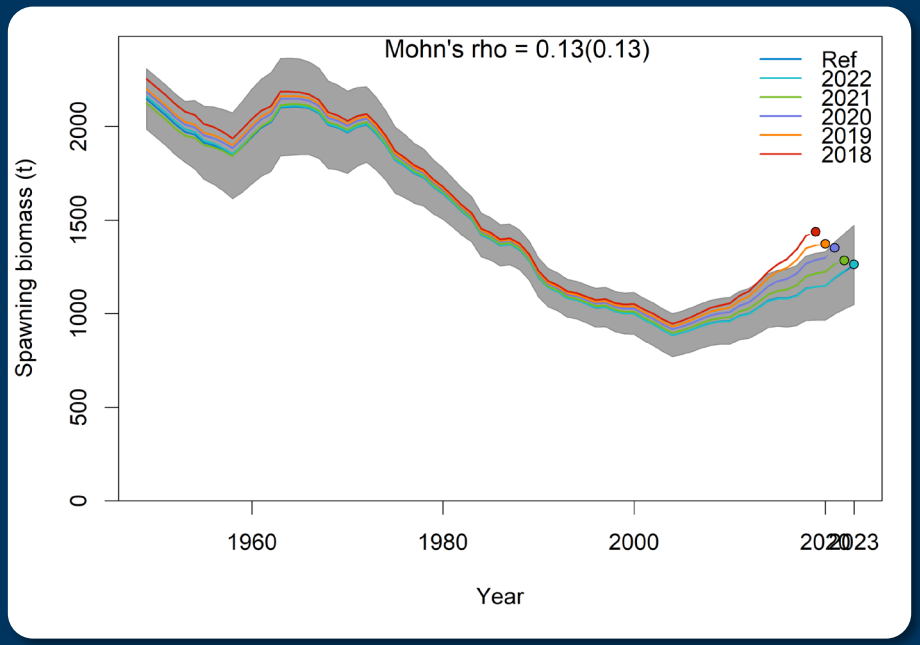
NOAA FISHERIES

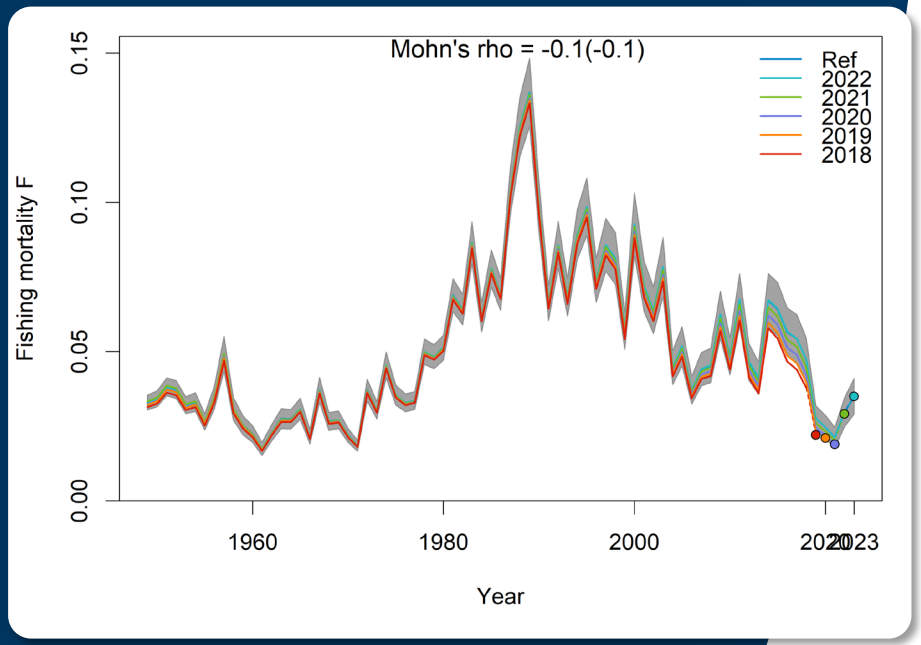
R_0 profile



NOAA FISHERIES

Retrospective analysis





NOAA FISHERIES

Conclusions

- SS model similar to JABBA results in terms of trends in biomass and mortality, and stock status
- Highlighted some differences in selectivity of the BFISH gears
- We can be confident that the limitations of surplus production models are not significantly impacting our understanding of the ʻōpakapaka stock and its status relative to reference points

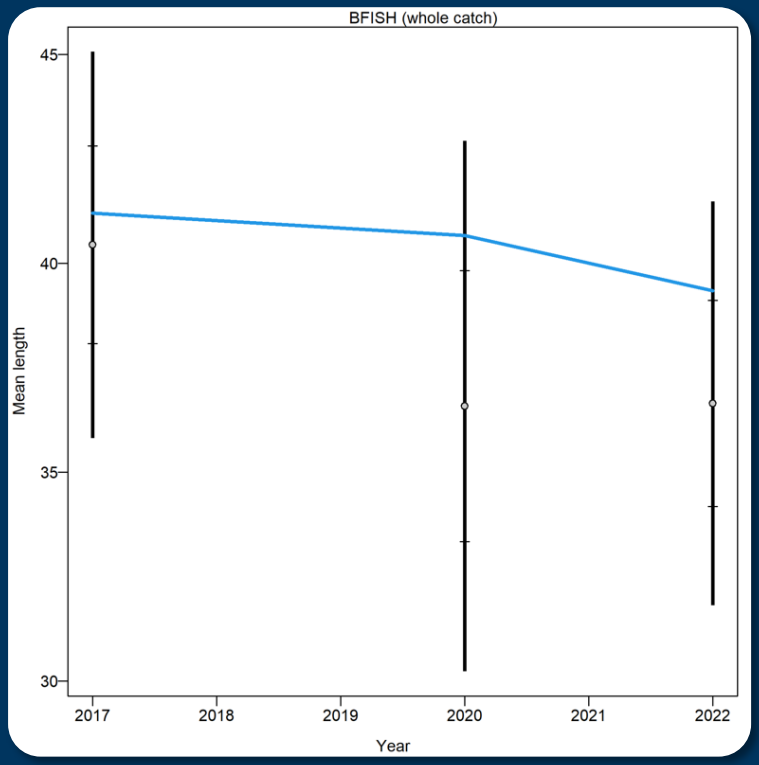
Questions

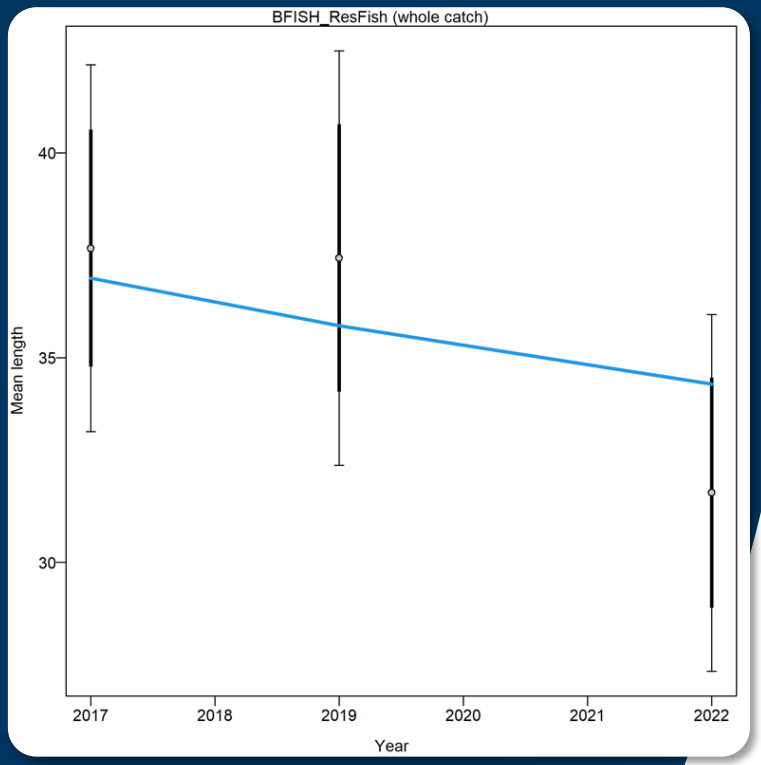
NOAA FISHERIES

Extra slides

NOAA FISHERIES

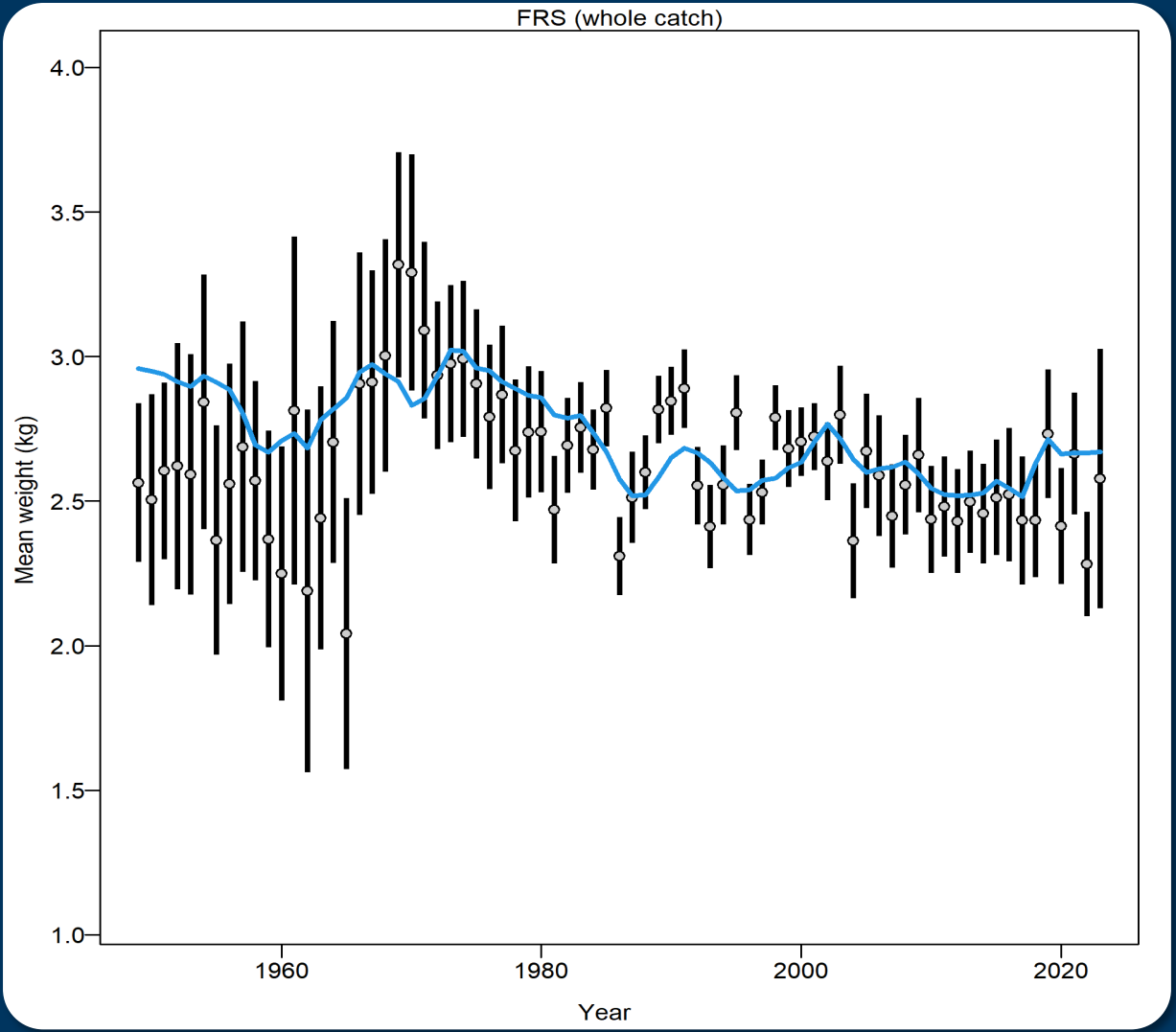
Mean length fits





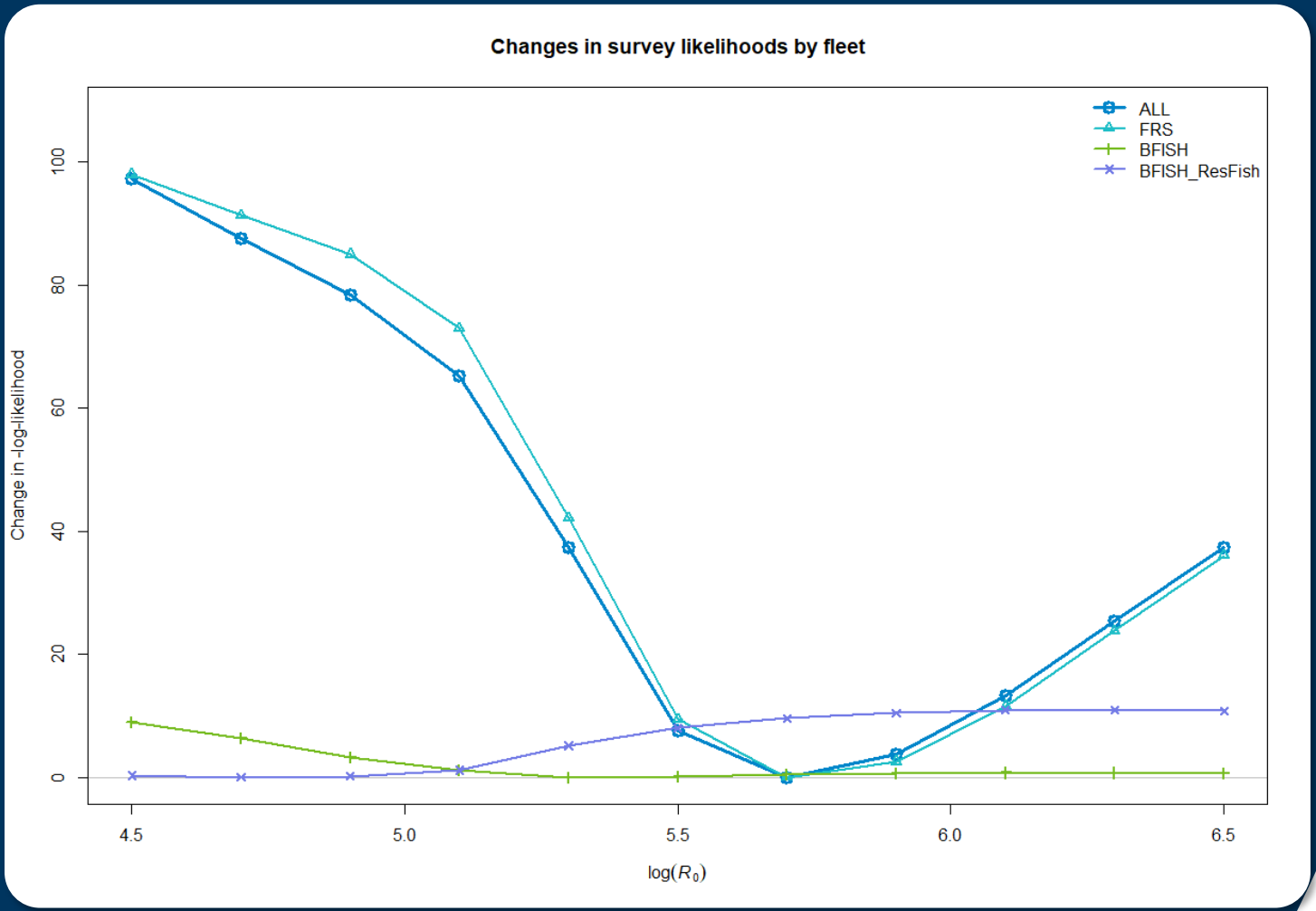
NOAA FISHERIES

Mean weight size composition fit



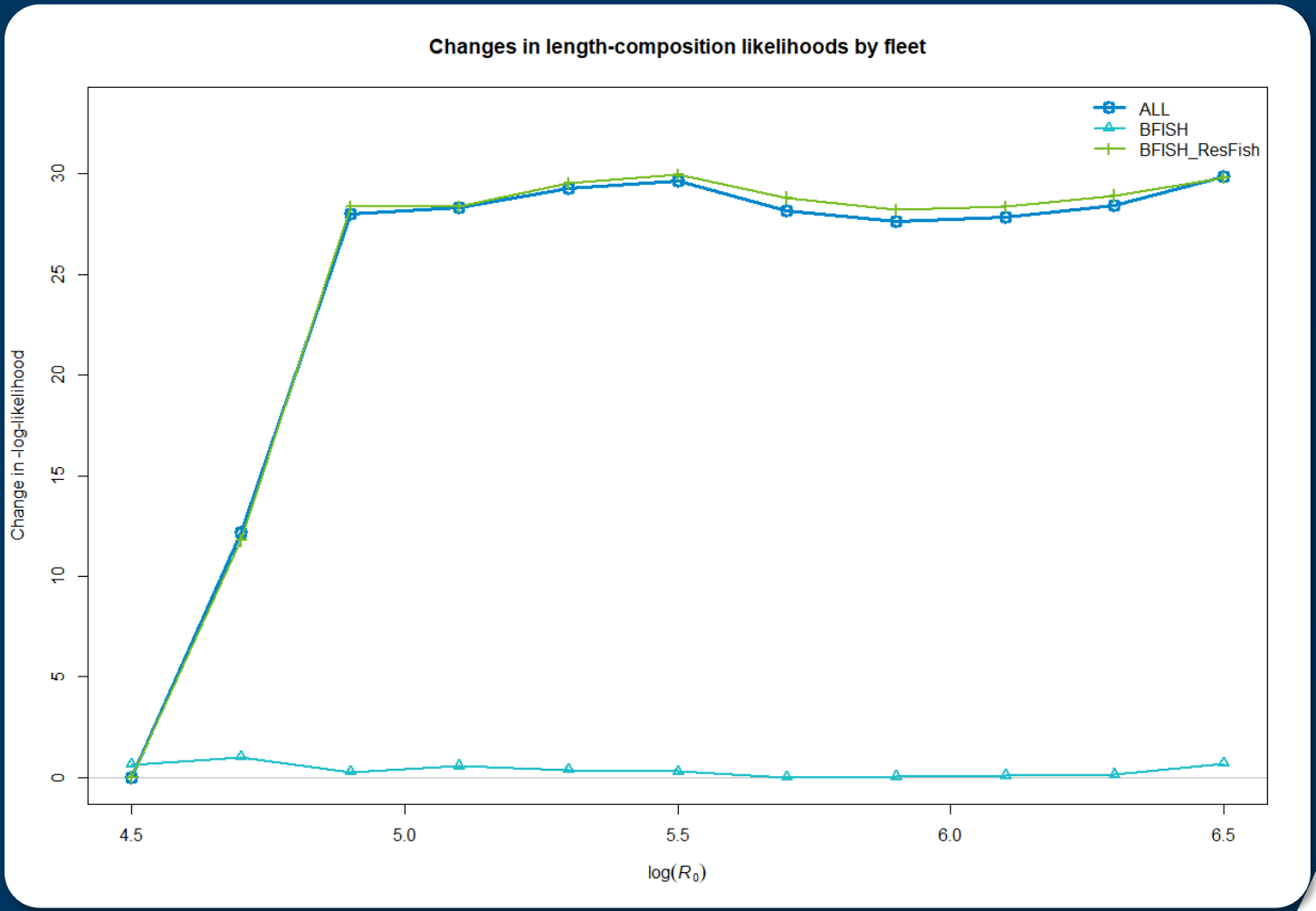
NOAA FISHERIES

Likelihood by fleet: Indices of Abundance



NOAA FISHERIES

Likelihood by fleet: Indices of Abundance



NOAA FISHERIES