Preliminary assessment of BSAI Greenland turbot

Meaghan D. Bryan and Alberto Rovellini
September 2024

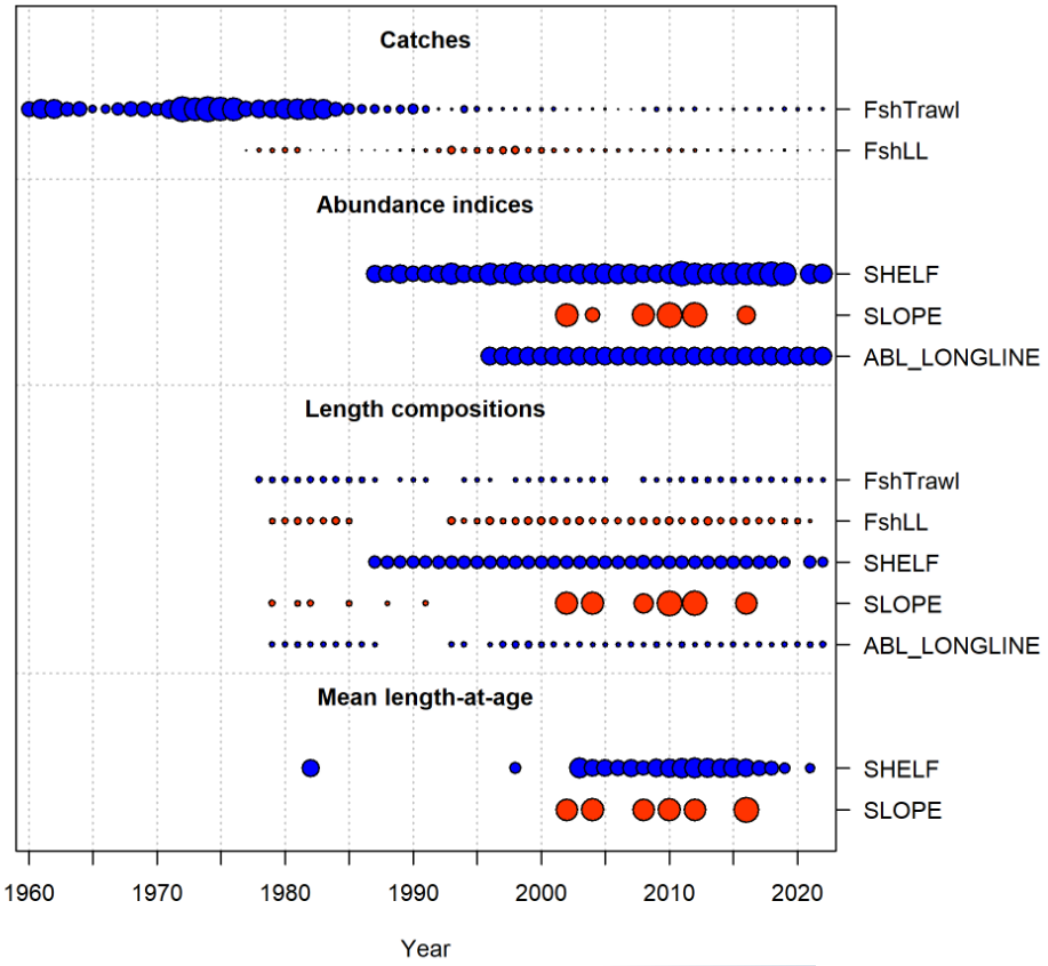
Outline

- Brief review of last accepted model assumptions
- Description of sensitivity runs and results
- Candidate models, results, and diagnostics
- Future model improvements and research suggestions

NOAA FISHERIES

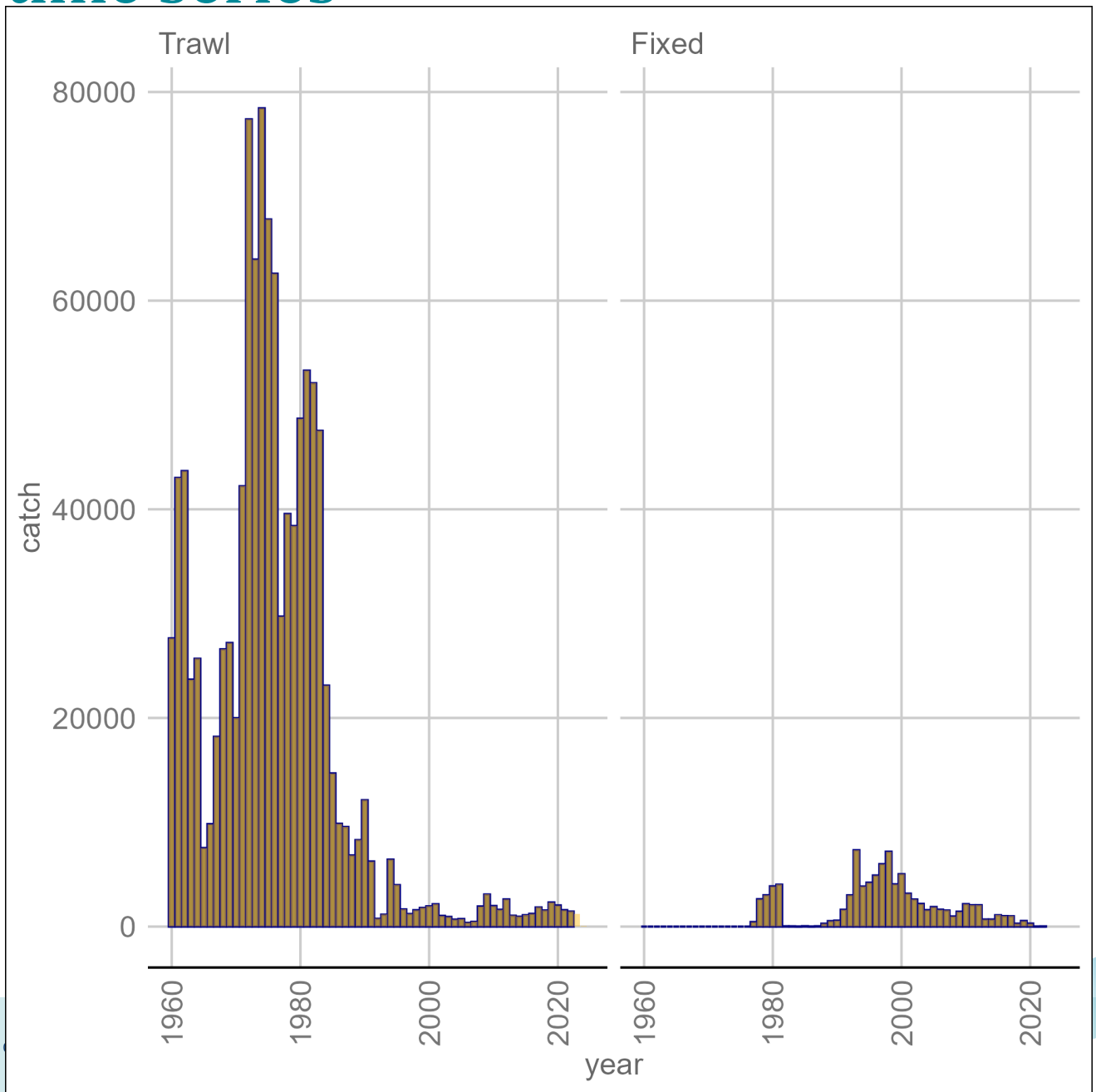
2022 assessment model (M16.4c)

- Fleet structure
  - Trawl fishery
  - Longline fishery
  - EBS shelf bottom trawl survey
  - EBS slope bottom trawl survey
  - AFSC longline survey
- Catch data starting in 1960
- Length data starting in the late 1970s



NOAA FISHERIES

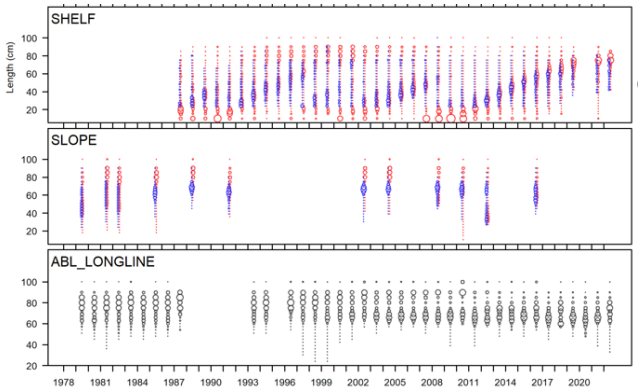
Catch time series



NOAA FISHERIES

General model setup

- Sex-specific model
- von Bertalanffy growth estimated
  - CV associated with young and old fish fixed (15% and 9%)
- Natural growth fixed and assumed the same for females and males (Cooper et al. 2007)
- Maturity at age externally estimated (D'yakov 1982)
- Stock-recruitment relationship (Beverton – Holt)
  - sigmaR – 0.6
  - Steepness (h) – 0.79 (Myers et al. 1999)
  - R0 and autocorrelation estimated
    - SS3 developers recommend not estimating autocorrelation (sensitivity run)
      - Additional sensitivity run was to fix autocorrelation par = 0.45
  - Recruitment deviations estimated
    - Early (1945-1970)
    - Main (1970 – 2018)
    - Late (2019-2022)



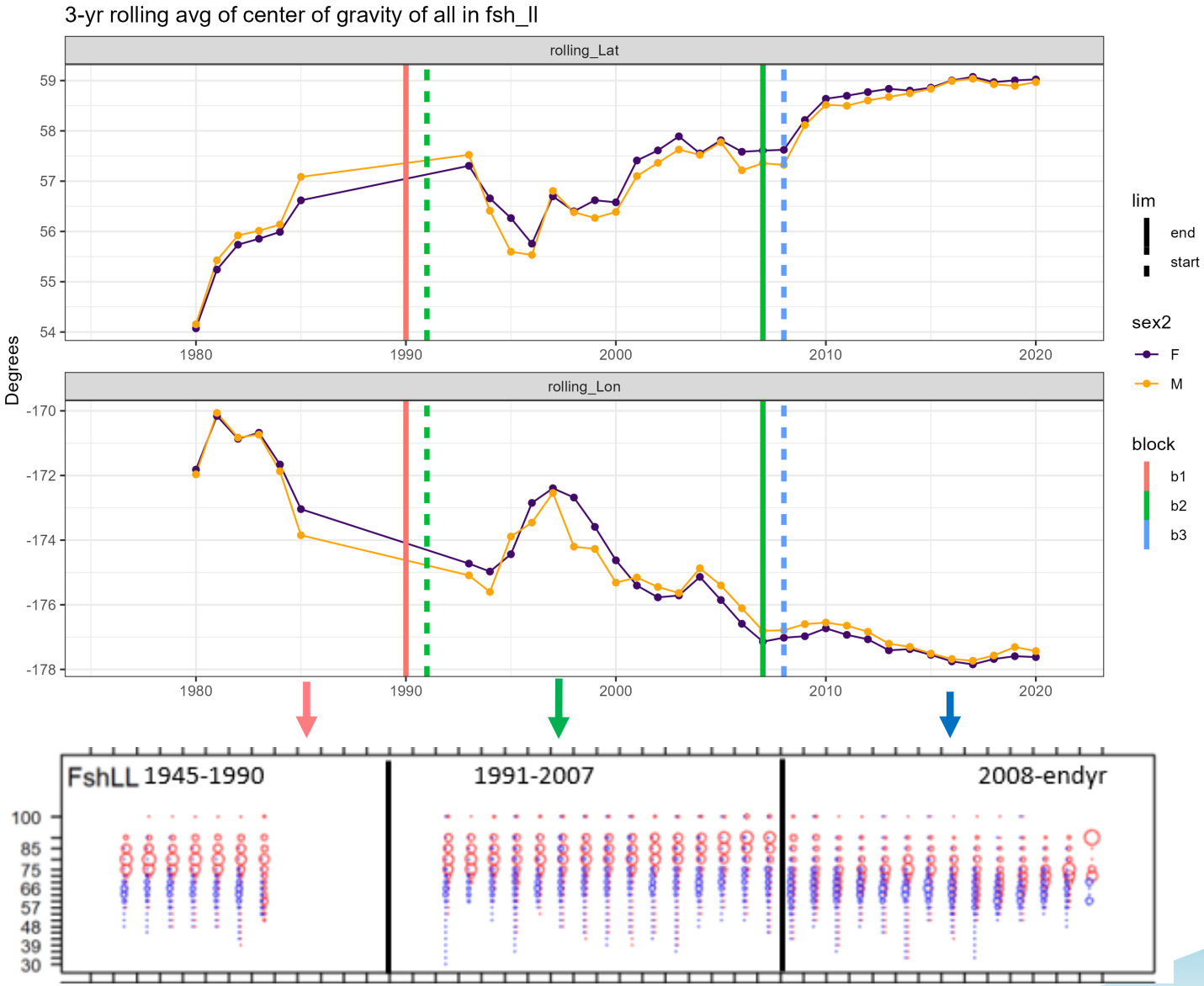
NOAA FISHERIES

General model setup

- Survey catchability
  - EBS bottom trawl surveys - catchability not estimated
    - Fixed estimates from a 2015 model run
      - Did not include the bottom trawl survey data from 2007-2015
    - Concern is that this approach is using the data twice
      - Implemented analytical solution in Stock Synthesis as sensitivity
  - AFSC longline survey estimated
- Selectivity
  - AFSC longline survey
    - Logistic
    - Not sex-specific – prior to 2021 sex not identified when measuring lengths
  - All other fleets
    - Double normal pattern
    - Sex - specific
    - Time blocks

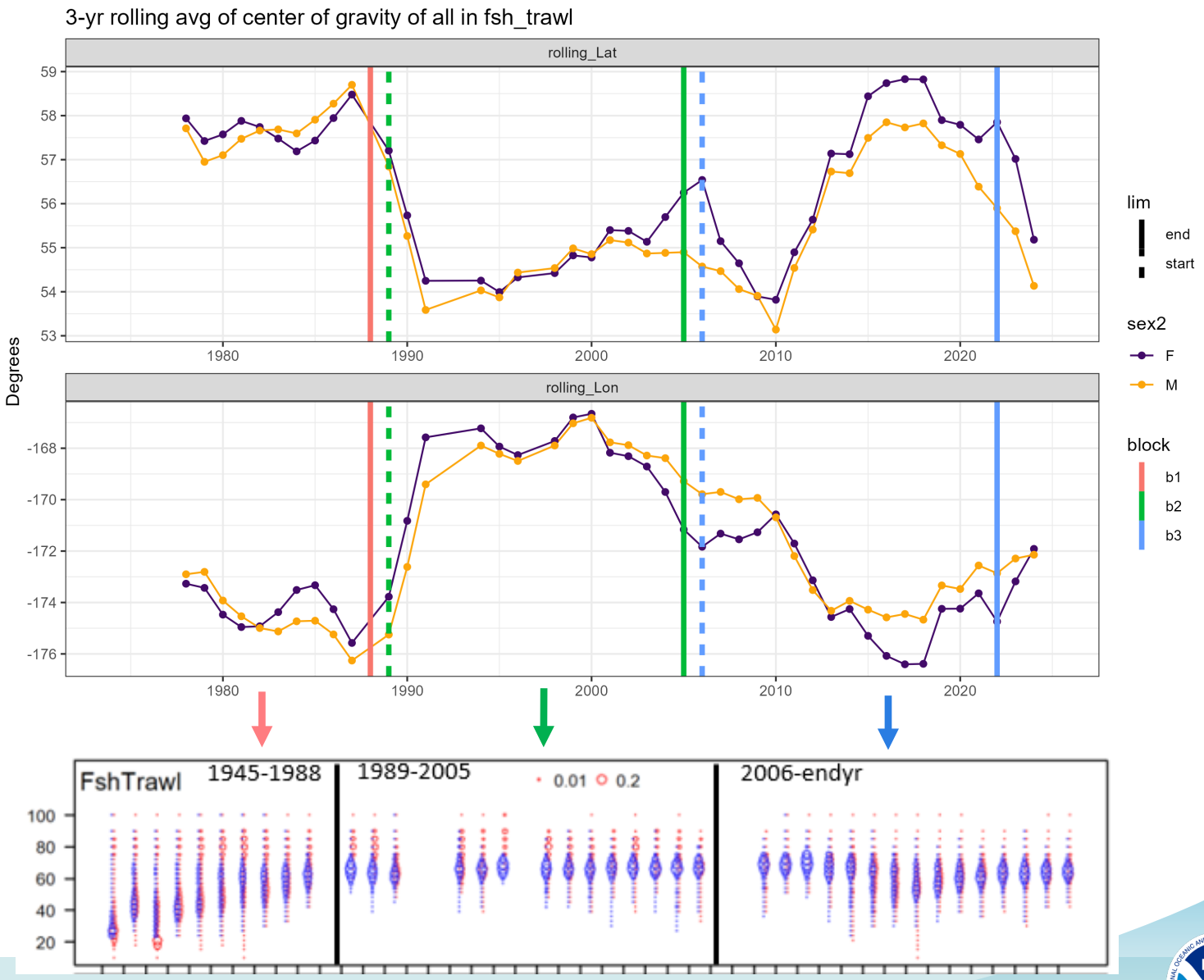
NOAA FISHERIES

Time blocks on selectivity



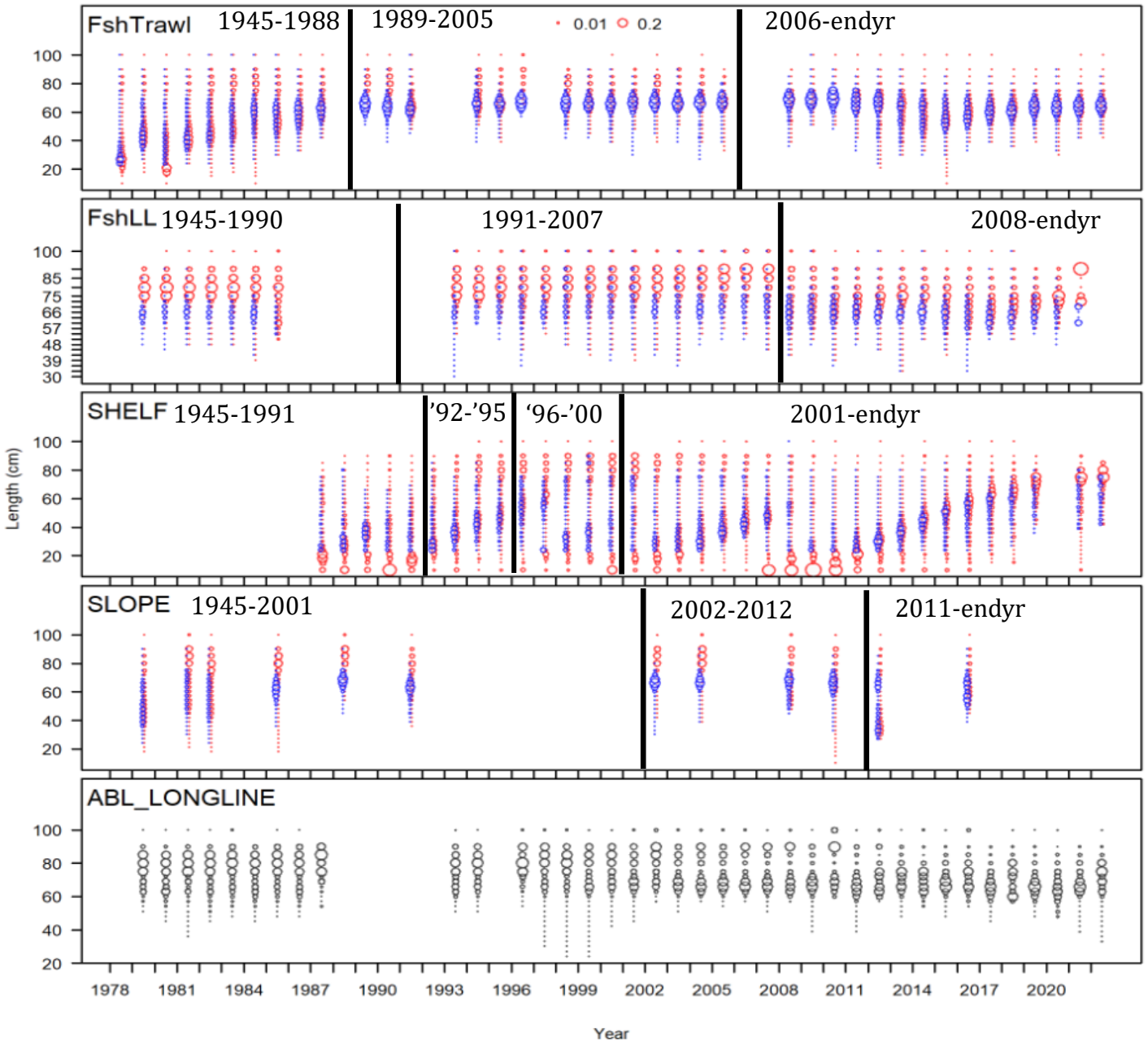
NOAA FISHERIES

Time blocks on selectivity



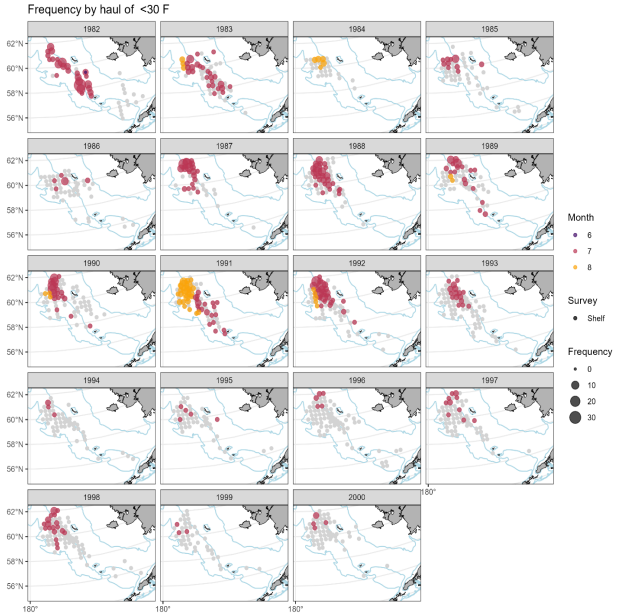
NOAA FISHERIES

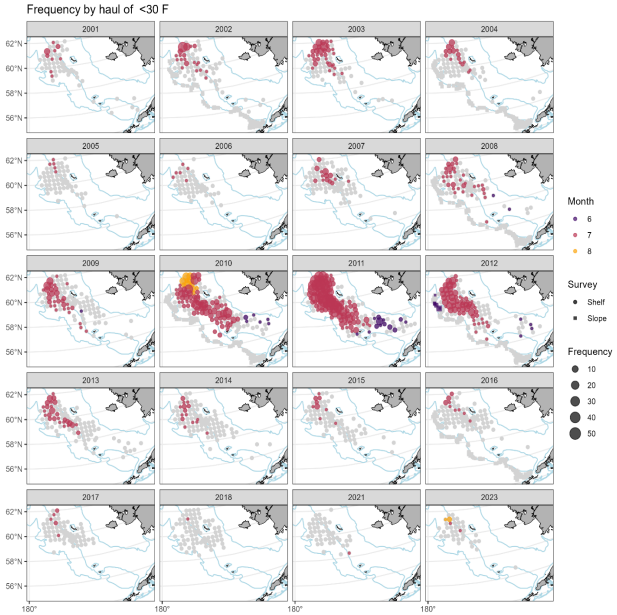
Time blocks on selectivity

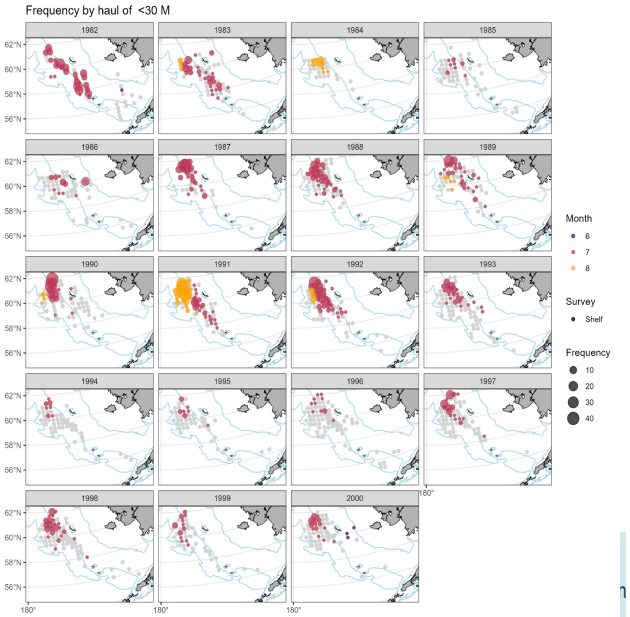


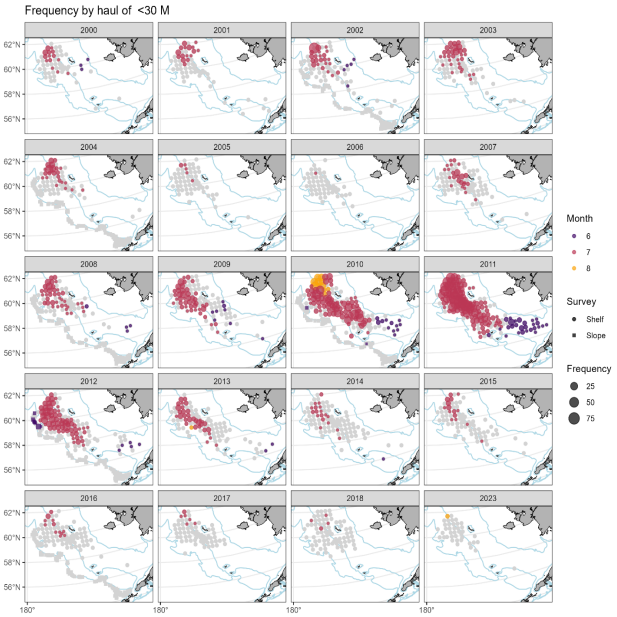
NOAA FISHERIES

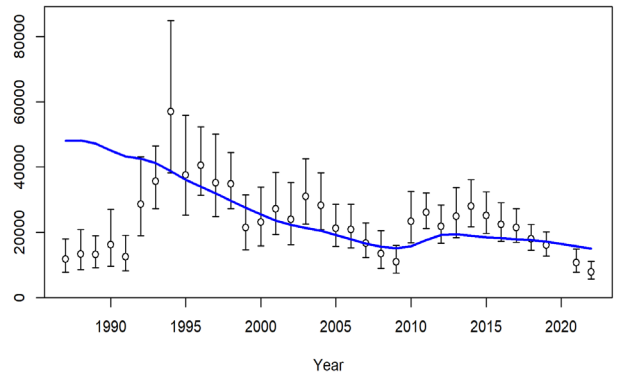
EBS shelf survey selectivity time block







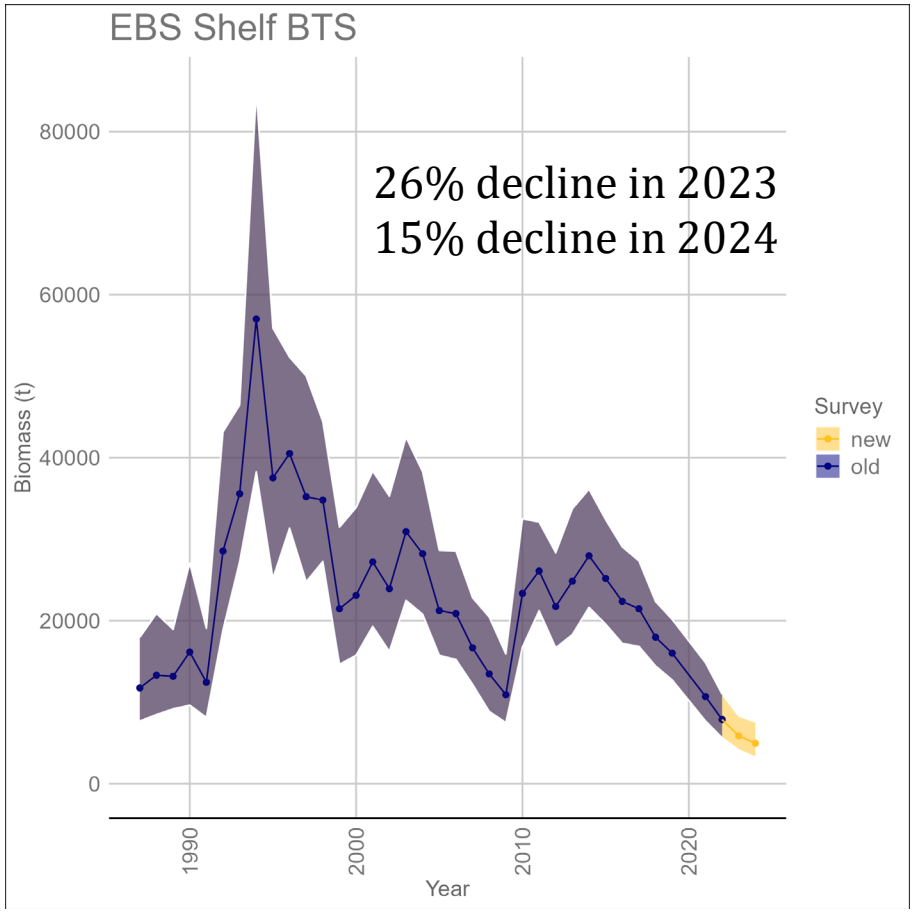


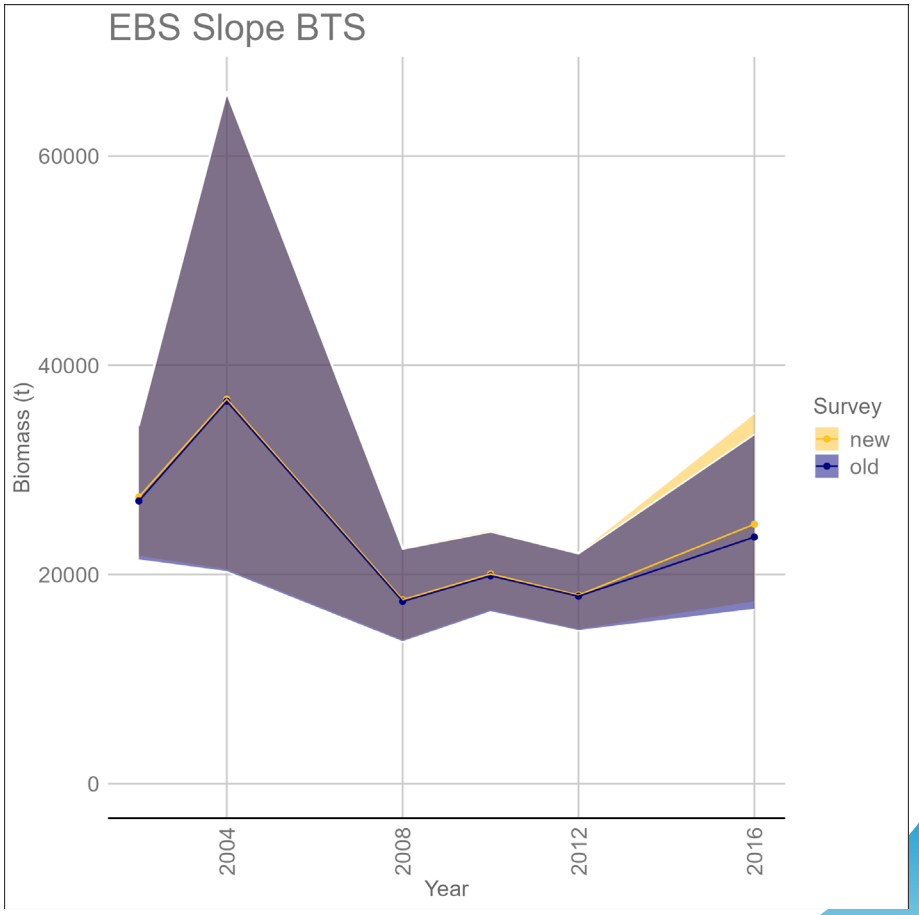


- Evidence of changing availability/area occupied
  - Time-varying selectivity or catchability?
- Explored tv'ing q and model over fit data
- Without tv'ing selectivity, poor fit to early observations
  - Decided to keep early time blocks

NOAA FISHERIES

Eastern Bering Sea bottom trawl survey biomass





NOAA FISHERIES

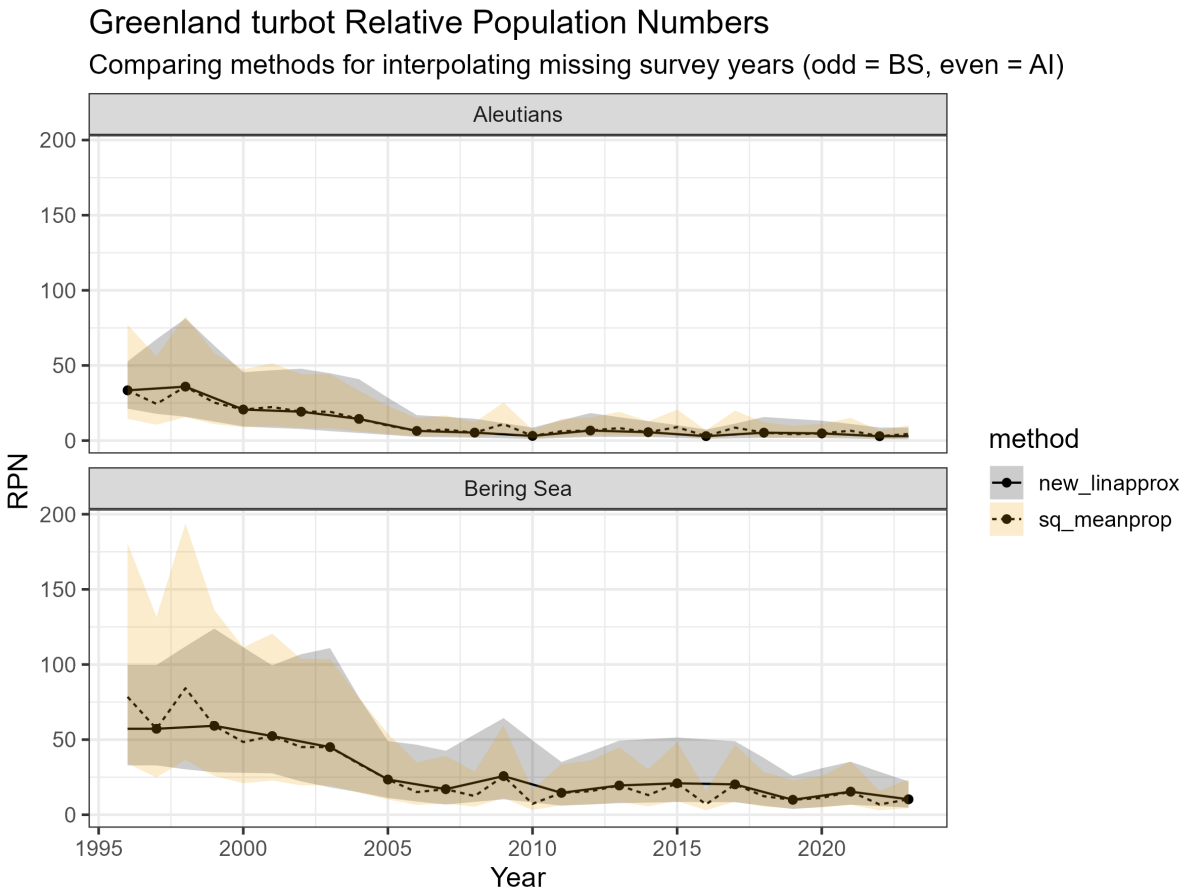
AFSC longline Relative Population Numbers (RPNs)

- Status quo mean proportion approach

$$RPN_t^c = I_t^{AI} \frac{RPN_t^{AI}}{p^{AI}} + I_t^{EBS} \frac{RPN_t^{EBS}}{p^{EBS}}$$

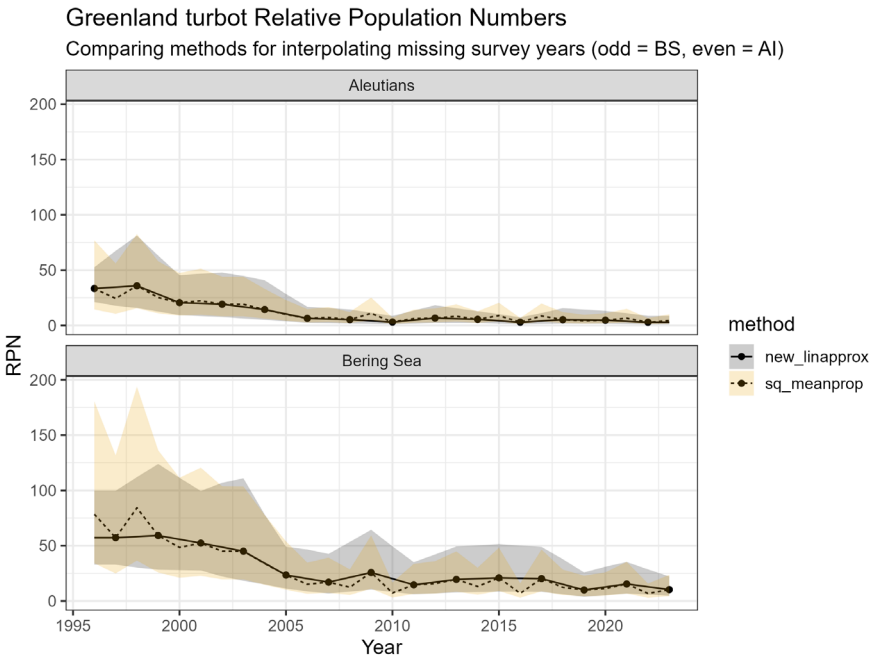
  - I_t – 0 or 1 depending on year
  - $p_{EBS} \sim 0.68$
  - $p_{AI} \sim 0.32$

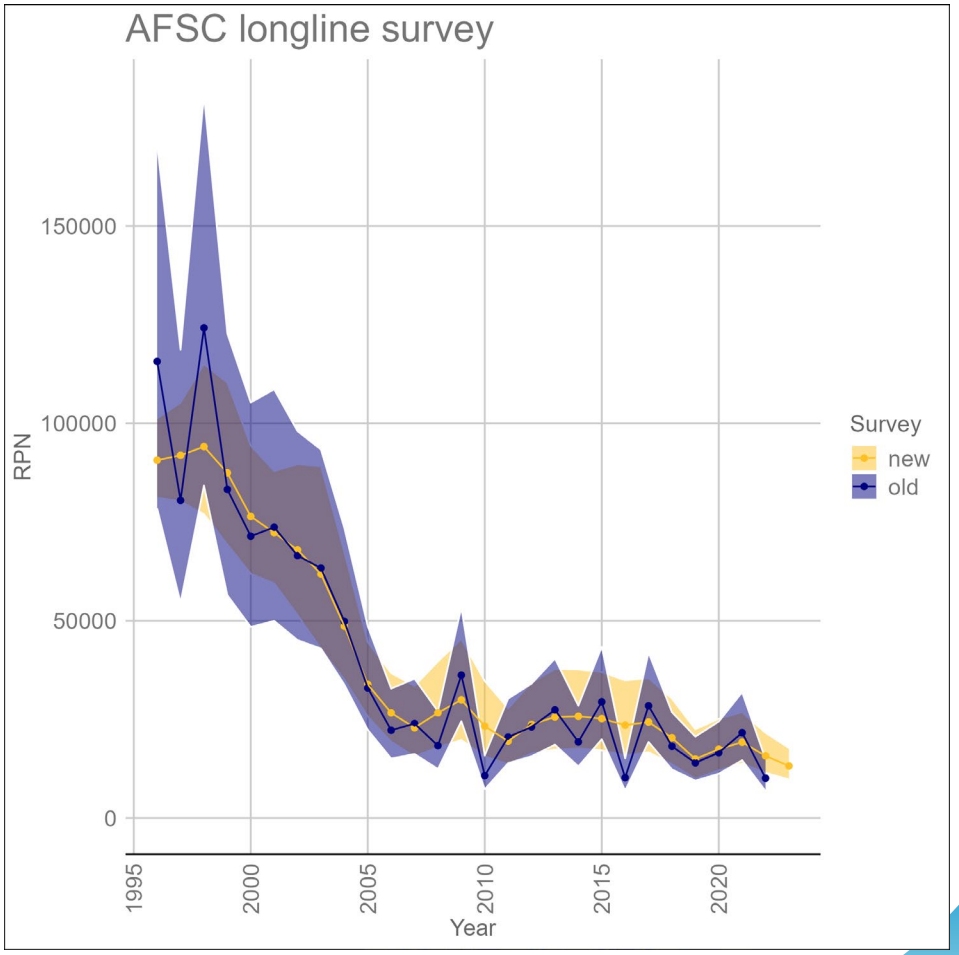
- Linear interpolation
  - Assumes nearest neighbors are a better approximation of area specific abundance in missing year
    - Done for RPN and CV



NOAA FISHERIES

AFSC longline Relative Population Numbers (RPNs)

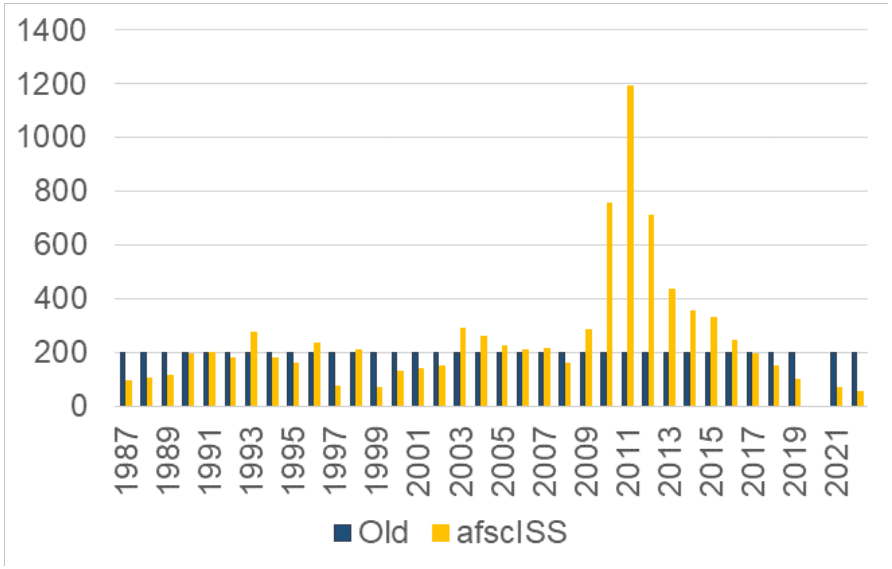




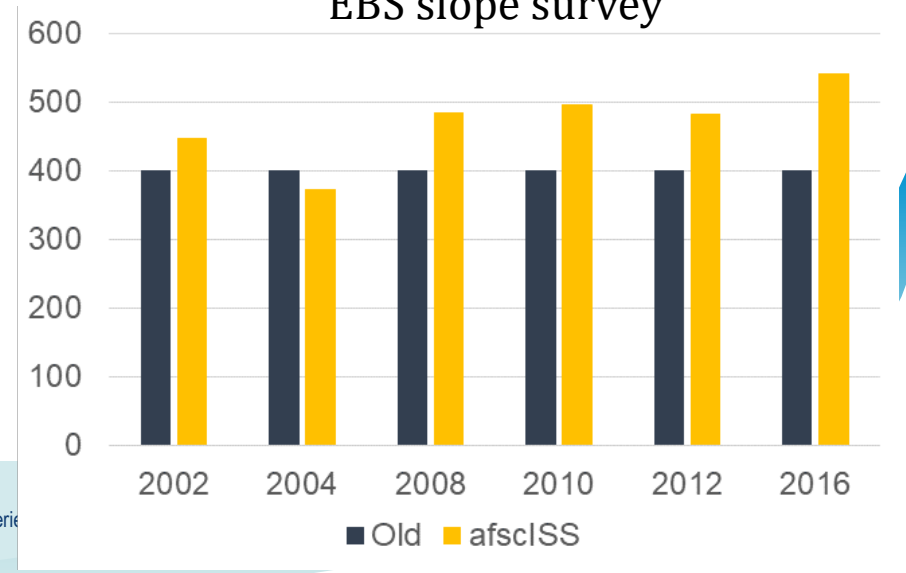
Length composition input sample size and variance adjustment

- Length comp ISS
  - 50 fishery fleets
  - 200 EBS shelf survey
  - 25 (pre-2002) and 400 (2002-) EBS slope survey
  - 60 AFSC longline
- Williams and Hulson afscISS Rpackage
  - Average of 250 for shelf survey
  - Average 470 for slope survey
- Variance adjustment
  - 0.25 for Trawl fleet and shelf survey
  - 0.5 for Longline fleet, slope and AFSC longline survey

EBS shelf survey



EBS slope survey



Sensitivity models presented

Model	Description
m1	Updated slope data
m2	m1+No EBS slope survey time block
m3	**m1+Analytical solution for survey catchability values**
m8	**m1+New survey multinomial sample size**
m9	**m1+No variance adjustment of length composition data**
m9a	**m9+Francis reweighting on length composition**
m10	m1+Linear interpolation method AFSC LL RPN
m11	m1+No SRR autocorrelation
m15	m1+Fixed SRR autocorrelation (rho = 0.45)

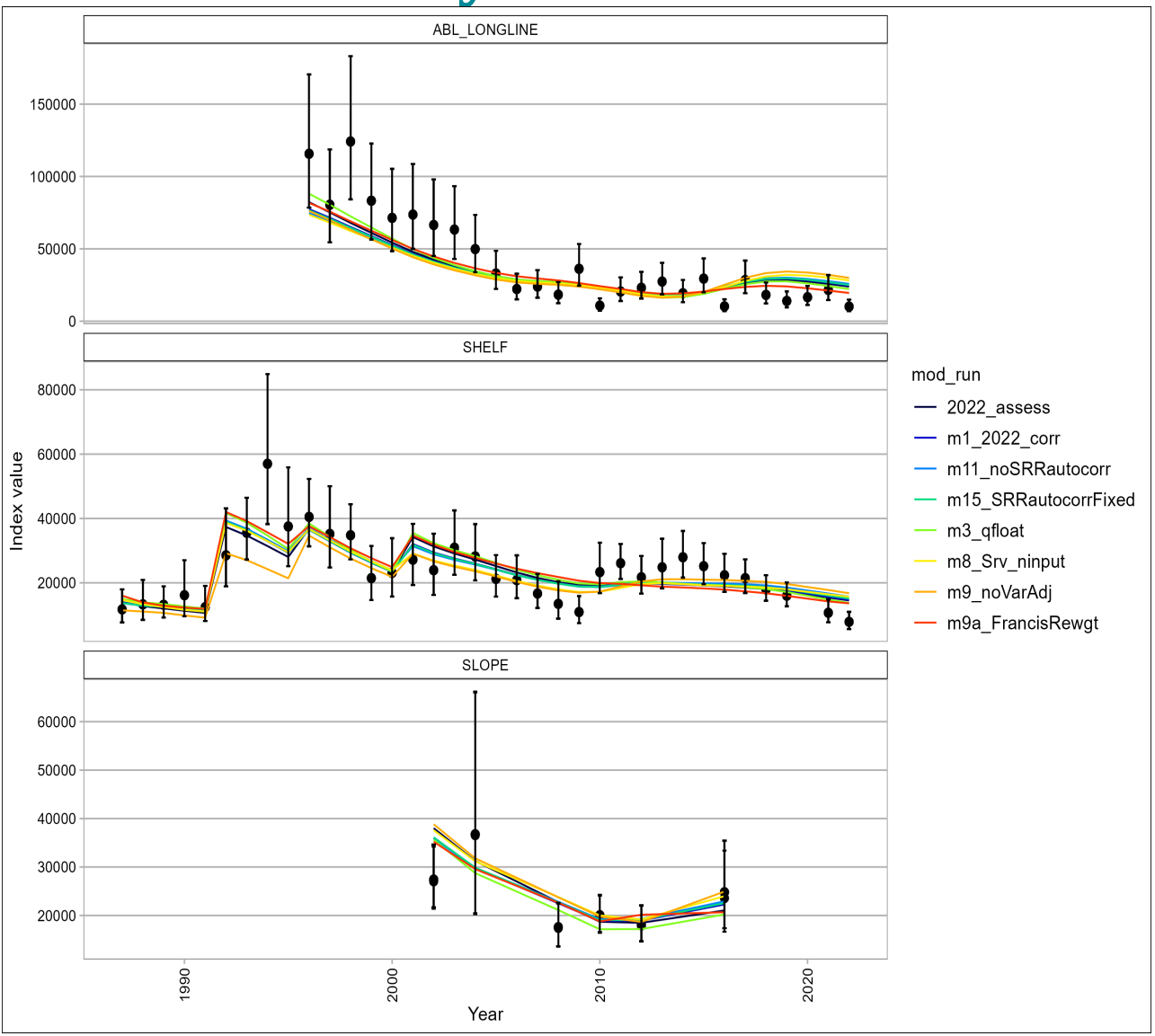
NOAA FISHERIES

Candidate models

- m1 : Model 16.4c with updated slope data
- m17: m1 + AFSC longline linear approx RPN + q float + afscISS
- m18: m1 + AFSC longline linear approx RPN + q float + afscISS + autocorrelation in recruitment (rho = 0.45)
- m19: m1 + AFSC longline linear approx RPN + q float + afscISS + remove slope survey time blocks
- m20: m1 + AFSC longline linear approx RPN + q float + afscISS + autocorrelation in recruitment (rho = 0.45) + remove slope survey time blocks

NOAA FISHERIES

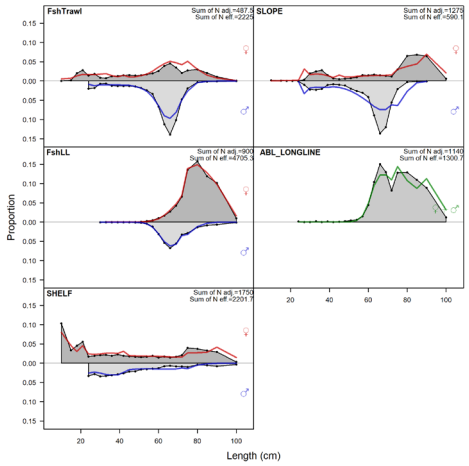
Fits to survey biomass and RPNs



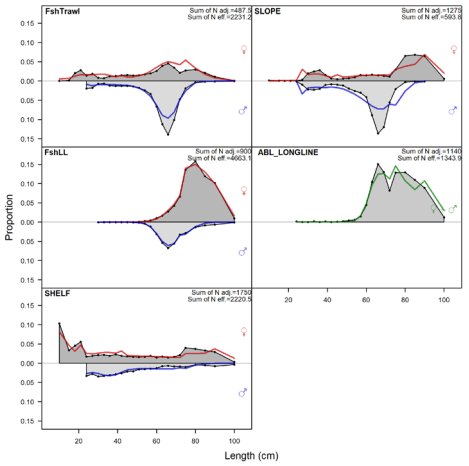
- m3 improved fit to the indices
  - Estimates of q increase for all
- m8 afscISS
  - Slightly poorer fits to slope and AFSC longline
- m9 not implementing variance adjustment on length comp
  - More weight on lengths, poorer fits to the indices
    - Most obvious EBS shelf 1993-1995
- m9a Francis reweighting
  - Improves fit to the AFSC longline

Fits to length composition data

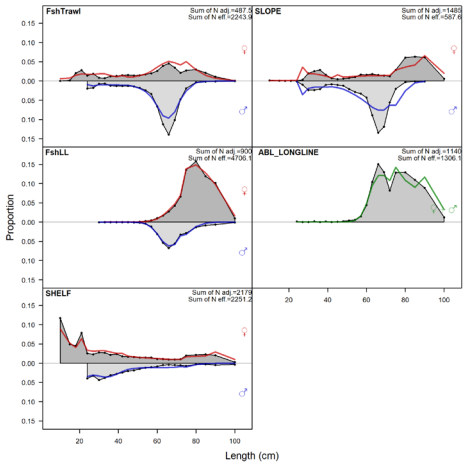
m1 updated slope data



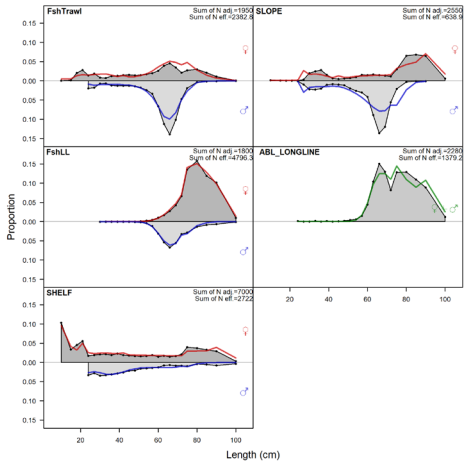
m3, m1+ qfloat



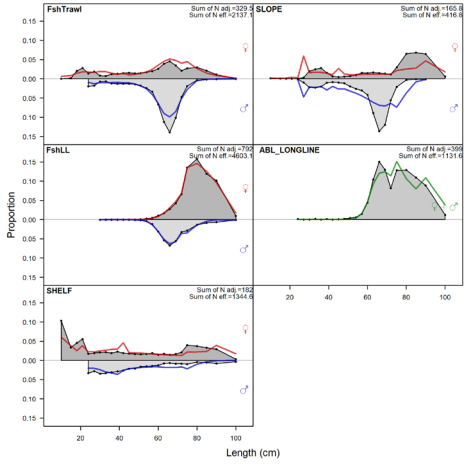
m8, m1 + afscISS



m9, m1 + no var adjust



m9a, m9 + Francis reweighting

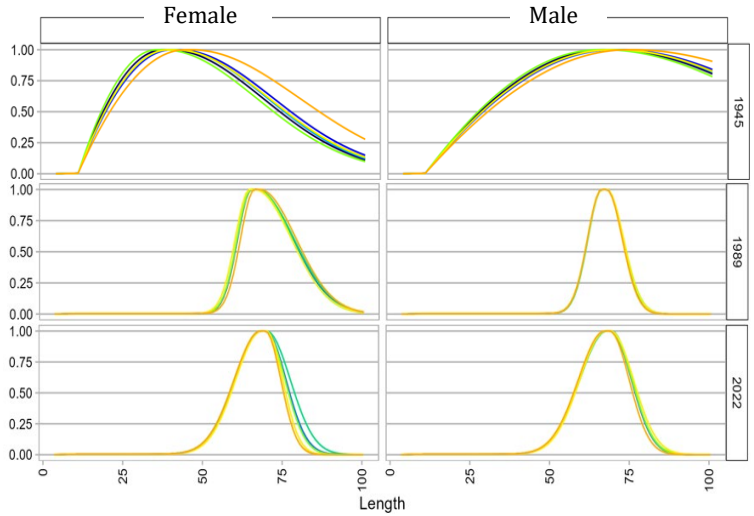


- Fit to the fishery data fairly consistent among model runs
- Improved fit to EBS shelf survey with change in input sample size (m8)
- Improved fit to shelf survey and AFSC longline survey when not implementing variance adjustment (m9)
- Poorer fit to the bottom trawl survey data when Francis reweighting is applied (m9a)

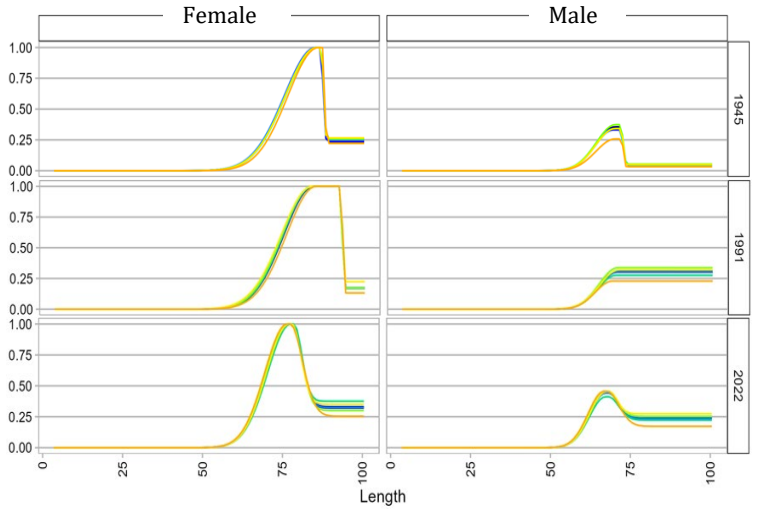
NOAA FISHERIES

Selectivity

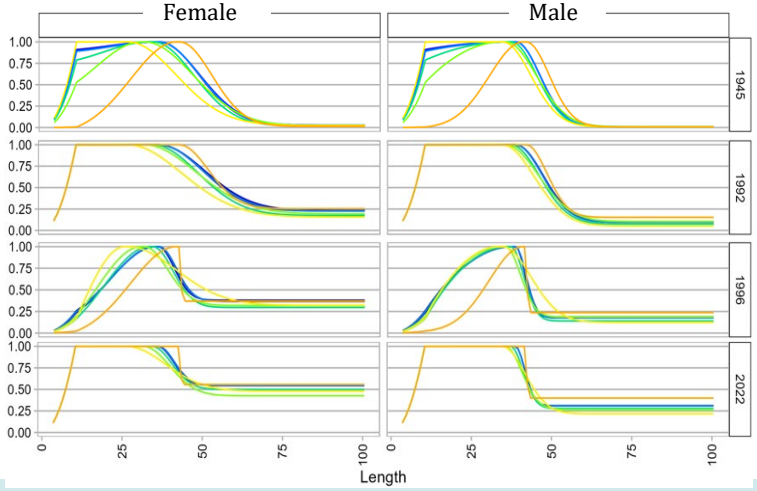
Trawl fishery



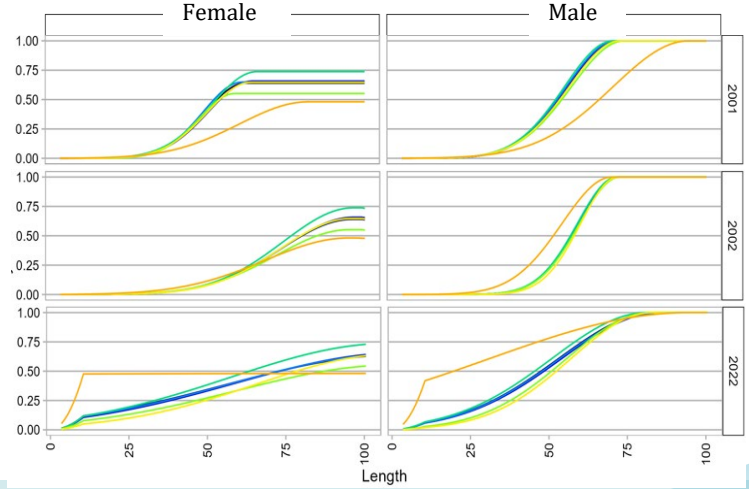
Fixed gear fishery

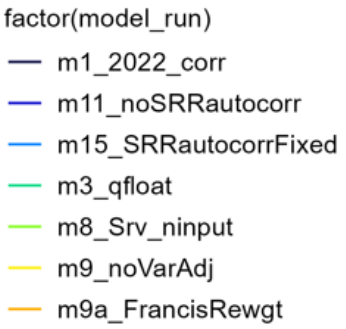


EBS shelf bottom trawl survey



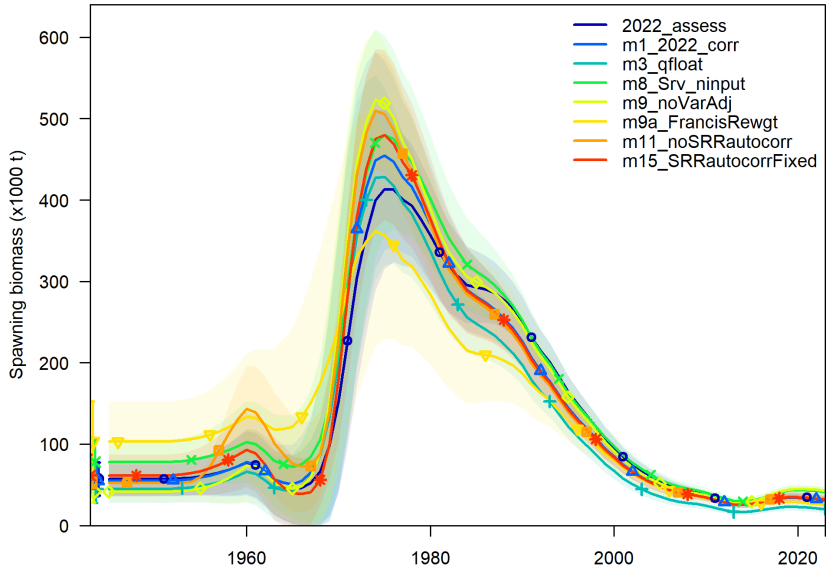
EBS slope bottom trawl survey

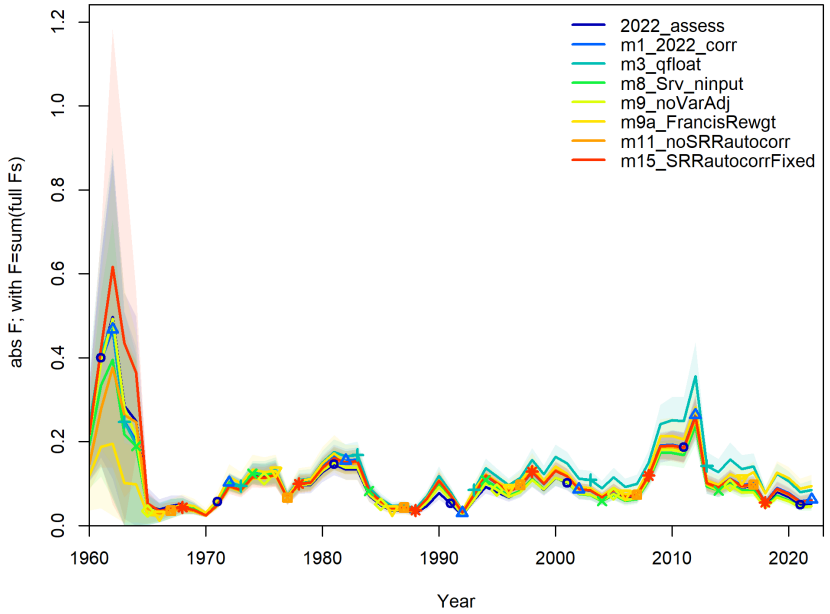


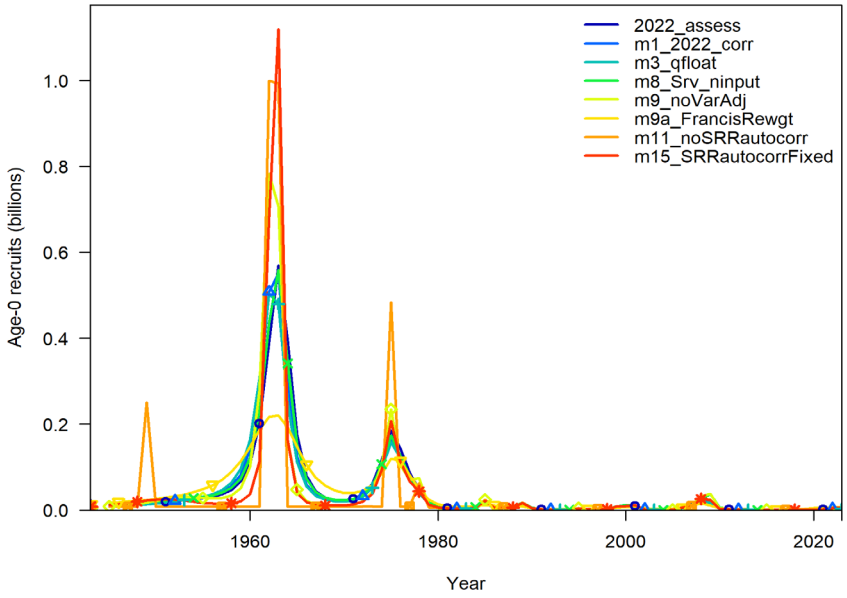


NOAA FISHERIES

Time series – sensitivity runs







- Variable start among the models
- Assumption about autocorrelation in recruitment impacts early recruitment
  - Not including autocorrelation leads to larger number of peaks in recruitment early on
- Most converge to a similar end point
- Estimate of SSB lower when using analytical solution for catchability and recent estimates of fishing mortality are higher (m3)
  - Increase in q values and increase in selectivity of larger fish in recent fishery fleet time blocks

Key take homes from sensitivity runs

- Implementing analytical solution for survey catchability
  - Increases q estimates for shelf and AFSC longline
  - We see some increase in fishery selectivity at larger sizes
  - Scales the population downward
- Francis reweighting leads to poorer fits to the shelf and slope survey length data – better fit to the AFSC longline survey RPN
  - Some selectivity parameters for the shelf and slope hits bounds – this would have to be addressed if Francis reweighting is used going forward
- Including a fixed estimate of recruitment autocorrelation allows smoothes peaks in early years, but less so than the previous estimate from the assessment model
  - Not a major influence on fits to the data

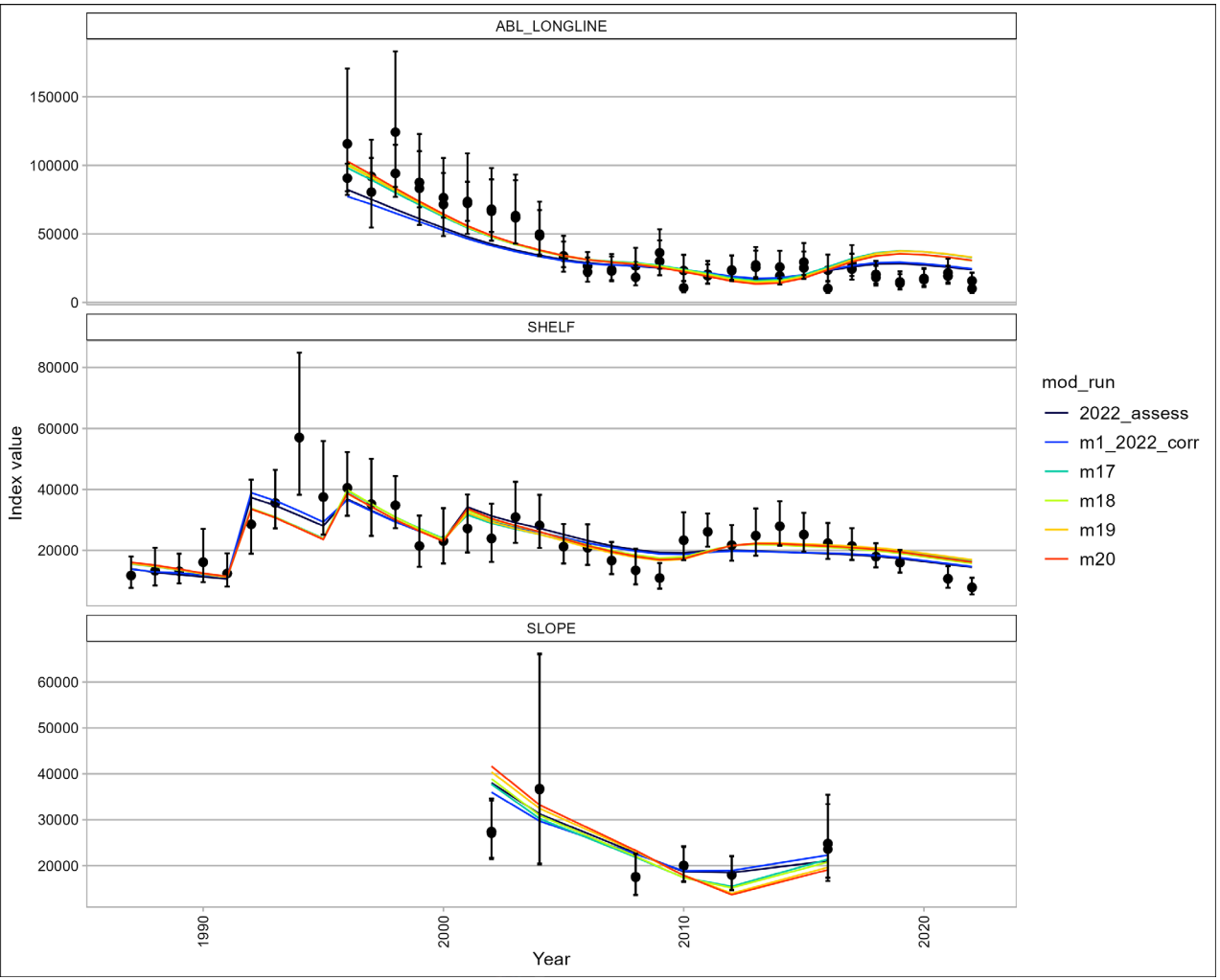
NOAA FISHERIES

Candidate models

- m1 : Model 16.4c with updated slope data
- m17: m1 + AFSC longline linear approx RPN + q float + afscISS
- m18: m1 + AFSC longline linear approx RPN + q float + afscISS + autocorrelation in recruitment (rho = 0.45)
- m19: m1 + AFSC longline linear approx RPN + q float + afscISS + remove slope survey time blocks
- m20: m1 + AFSC longline linear approx RPN + q float + afscISS + autocorrelation in recruitment (rho = 0.45) + remove slope survey time blocks

NOAA FISHERIES

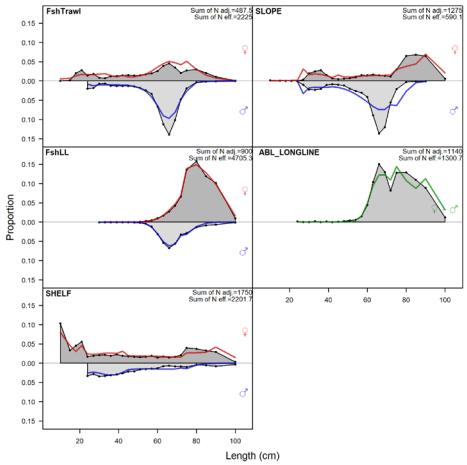
Fits to survey biomass and RPNs



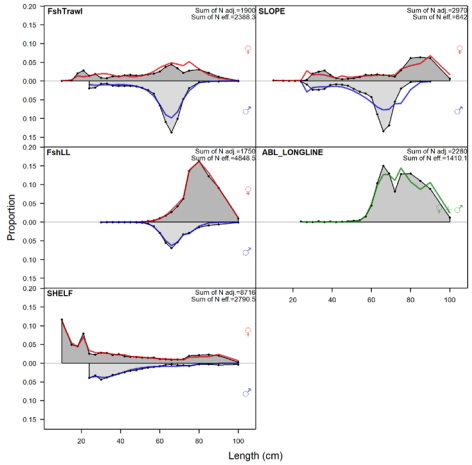
- Trade-off in fit to AFSC longline and the bottom trawl fisheries
  - Improved fit to AFSC longline, while slight poorer fit to bottom trawl survey biomass
  - Models without time block on slope survey selectivity fits data less well (m19-20)
- Increase in q for models m17-m20
  - m1
    - shelf q = 0.62
    - slope q = 0.57
    - AFSC q = 2.22
  - m17-m20
    - shelf q = 1.2 - 1.3
    - slope q = 0.64 – 0.68
    - AFSC q = 3.2 – 3.3

Fits to length composition data

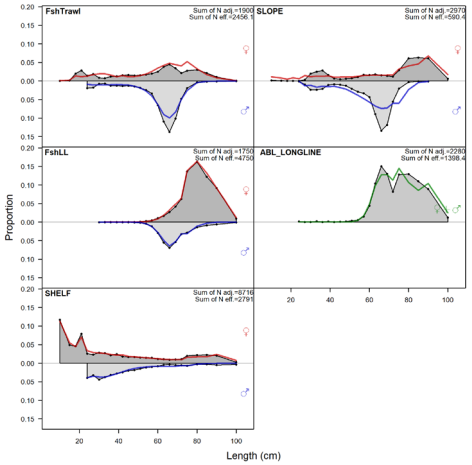
m1



m17

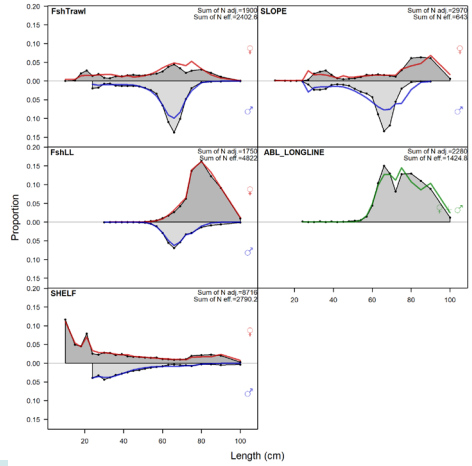


m19

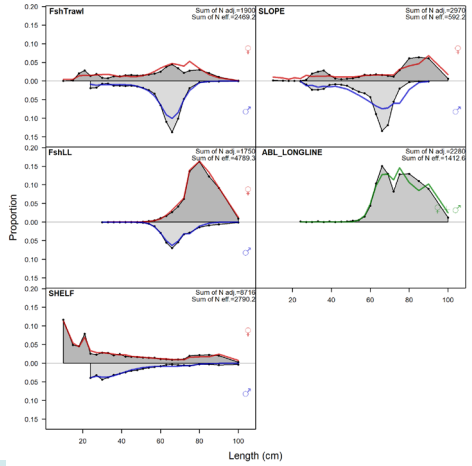


- Fits to fishery length comp consistent among models
- See improved fit to the shelf bottom trawl survey overall and AFSC longline (especially larger fish)

m18

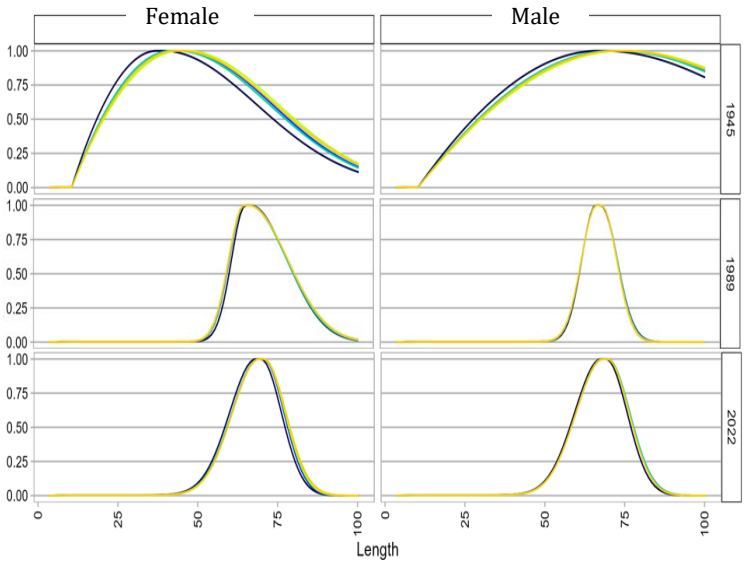


m20

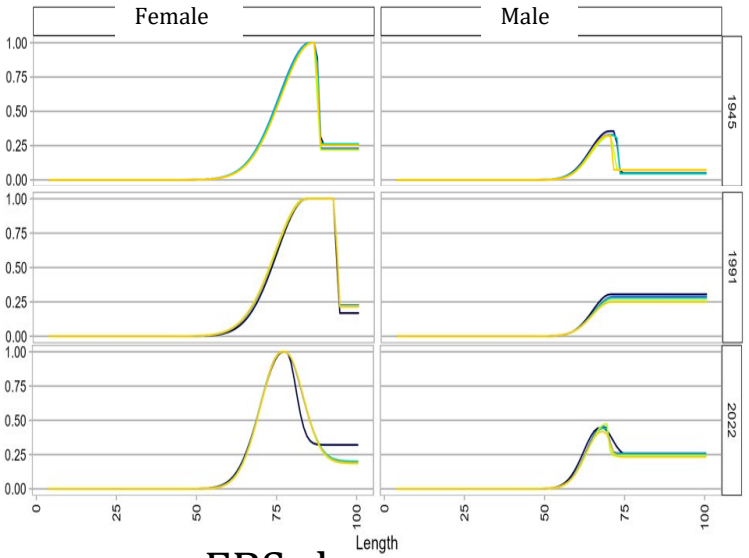


Selectivity

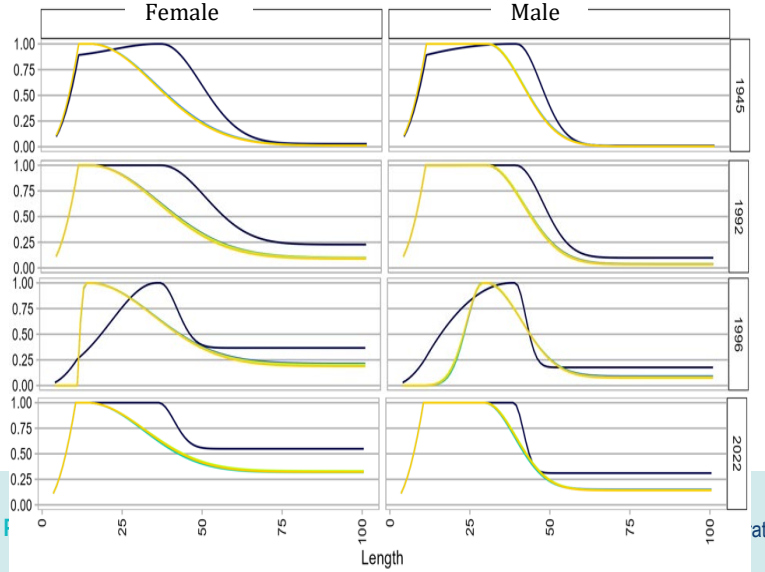
Trawl fishery



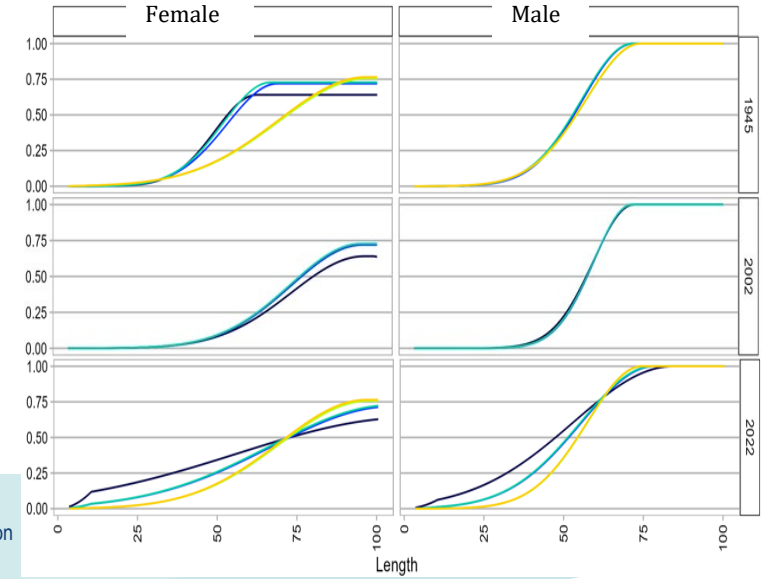
Fixed gear fishery

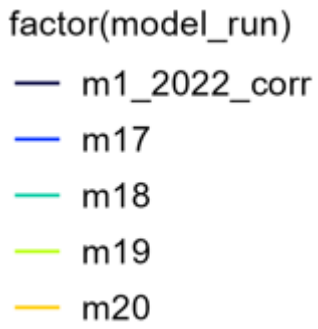


EBS shelf survey



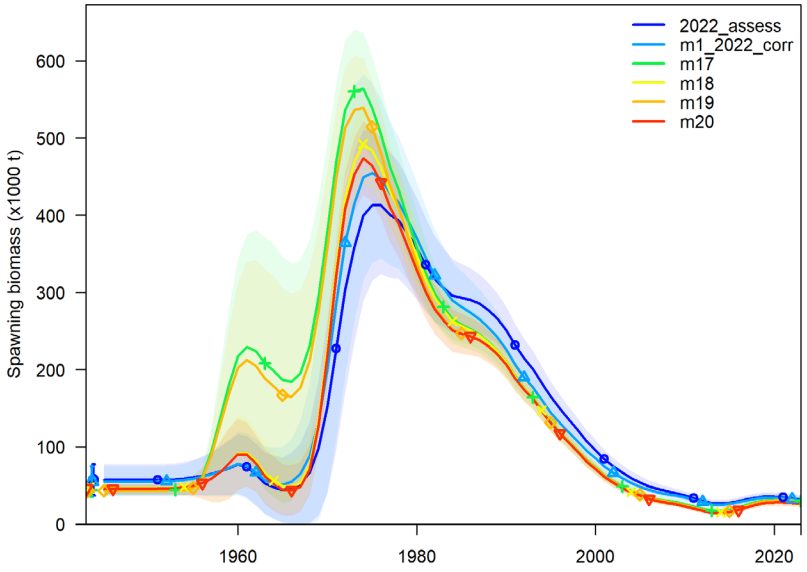
EBS slope survey

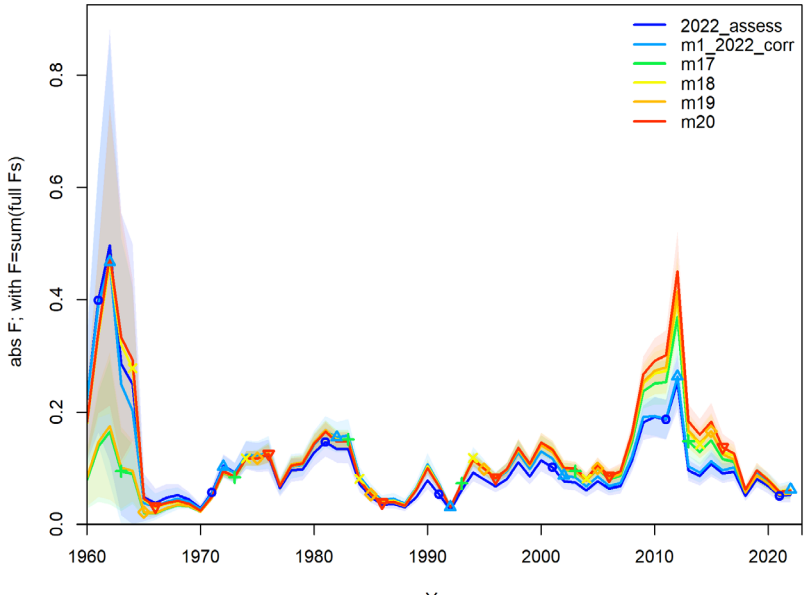


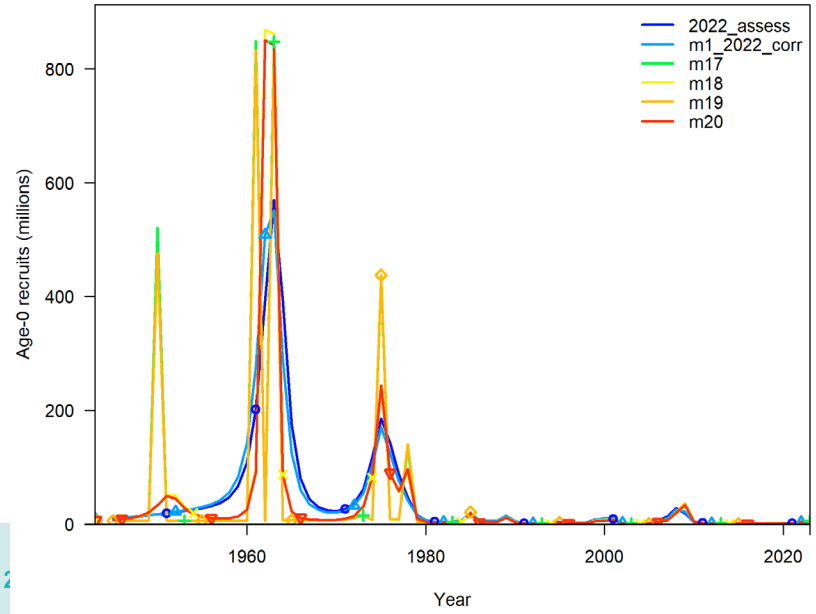


NOAA FISHERIES

Time series



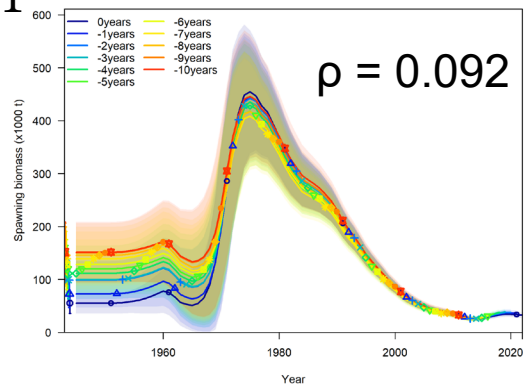


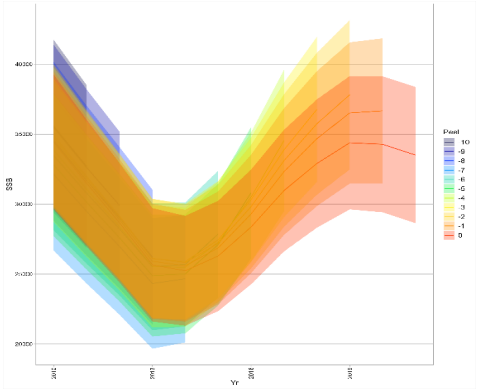


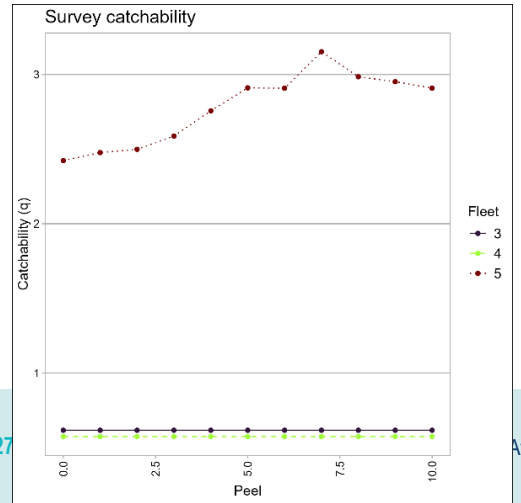
- Estimate of SSB lower and recent estimates of fishing mortality are slightly higher when using analytical solution for catchability
  - Increase in q values and increase in selectivity of larger fish in recent fishery fleet time blocks

Retrospectives

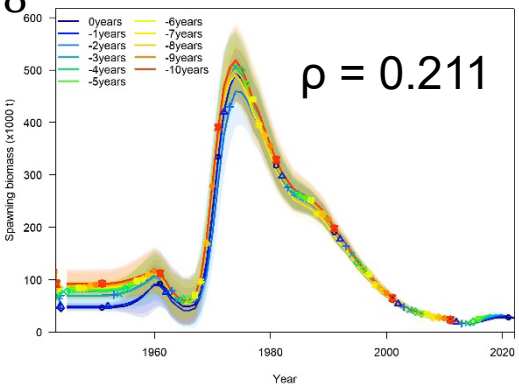
m1

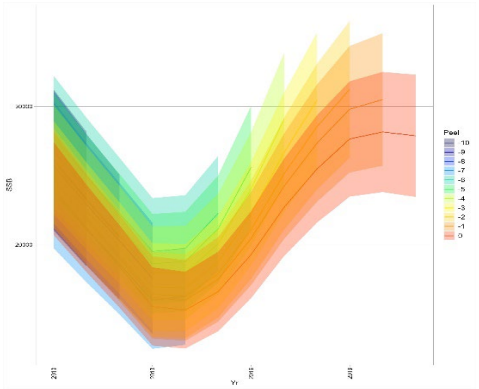


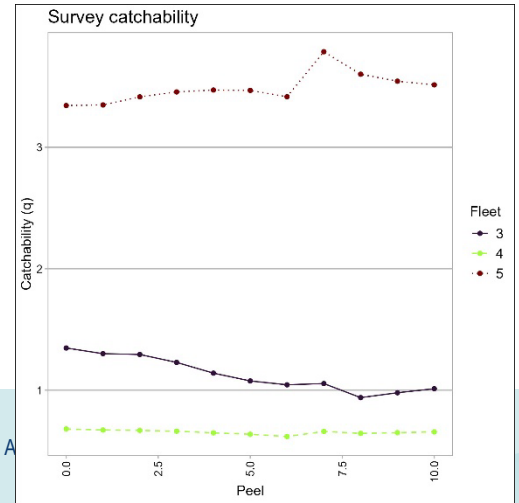




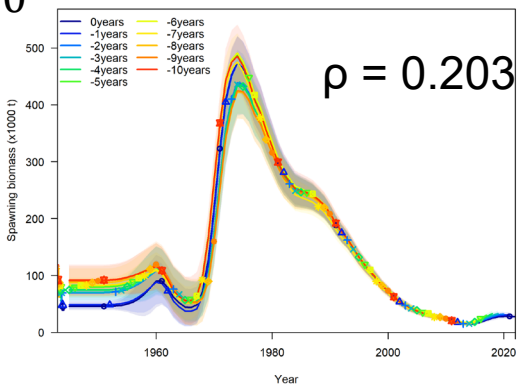
m18

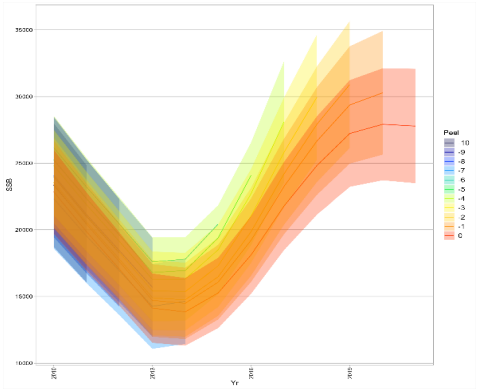


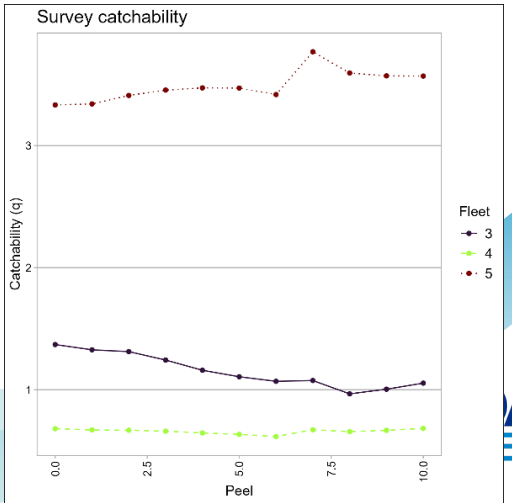




m20

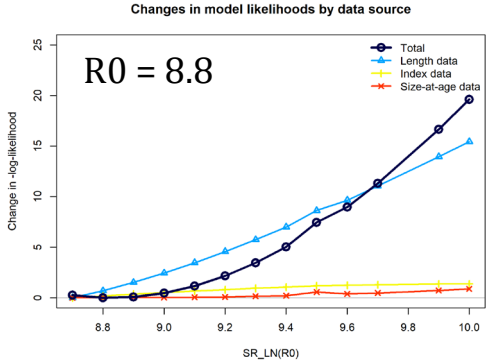


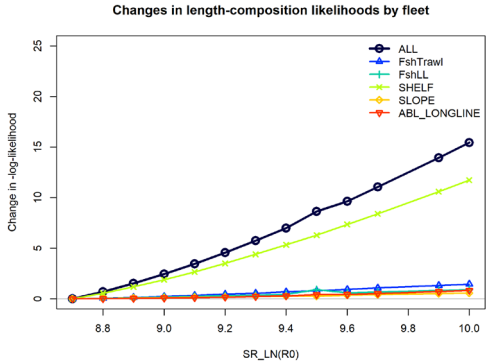


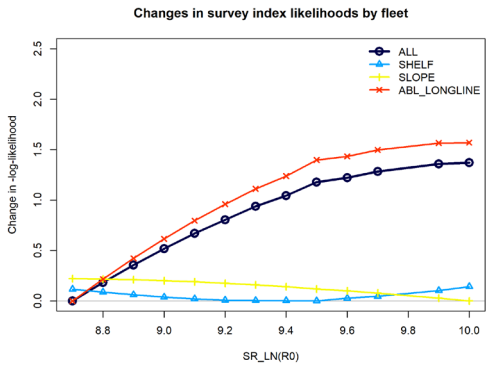


R0 likelihood profile

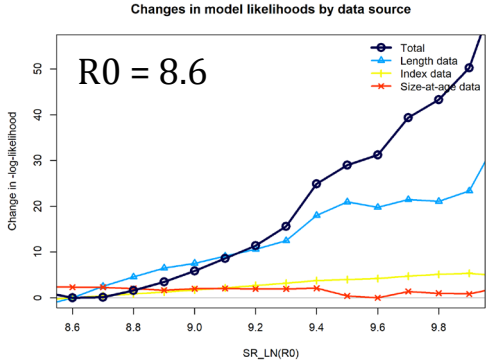
m1

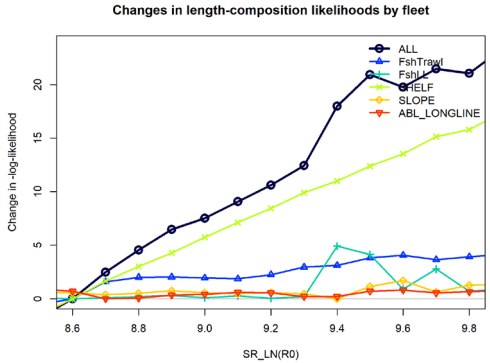


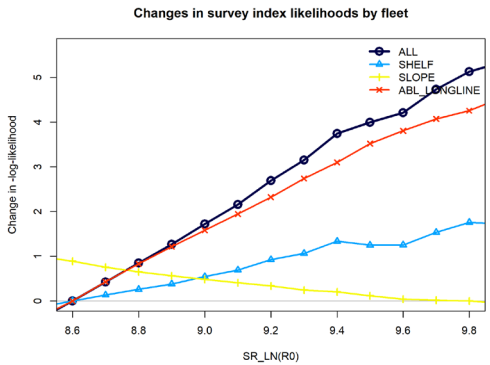




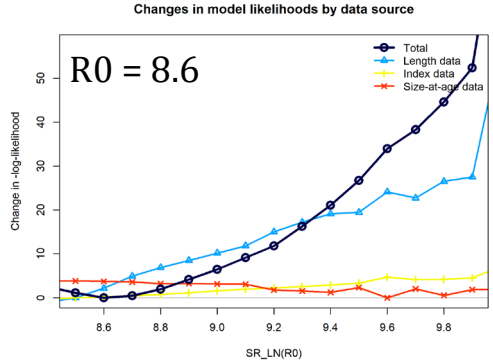
m18

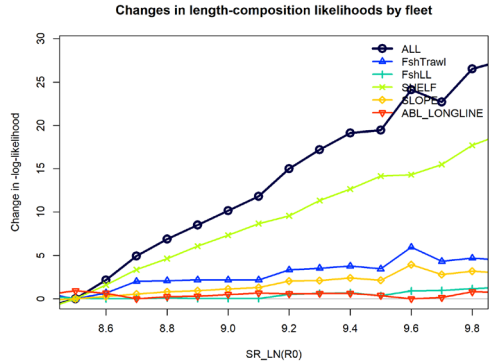


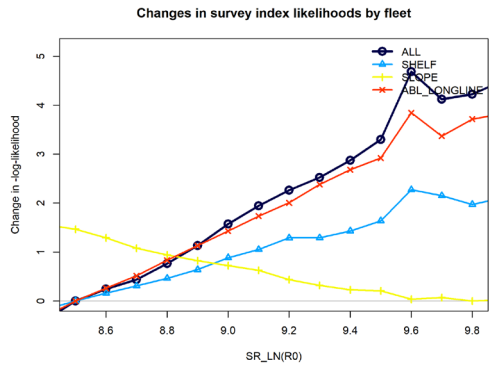




m20







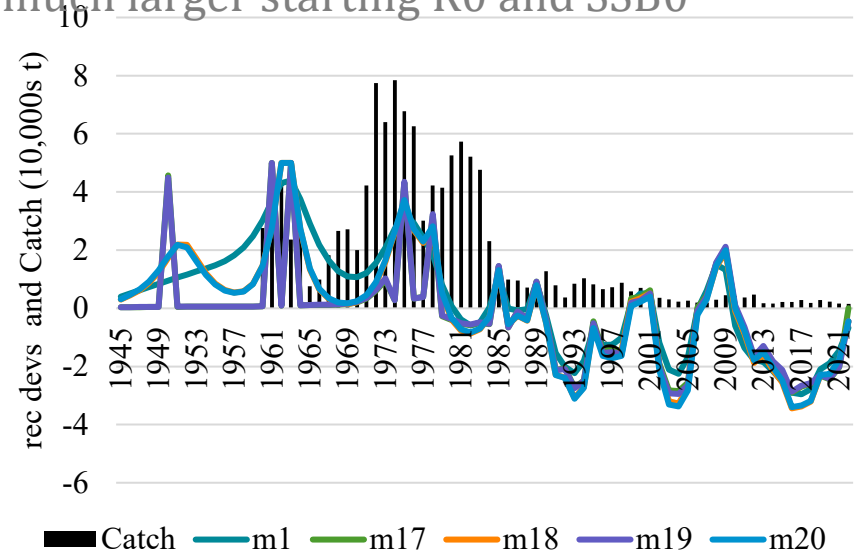
NOAA FISHERIES

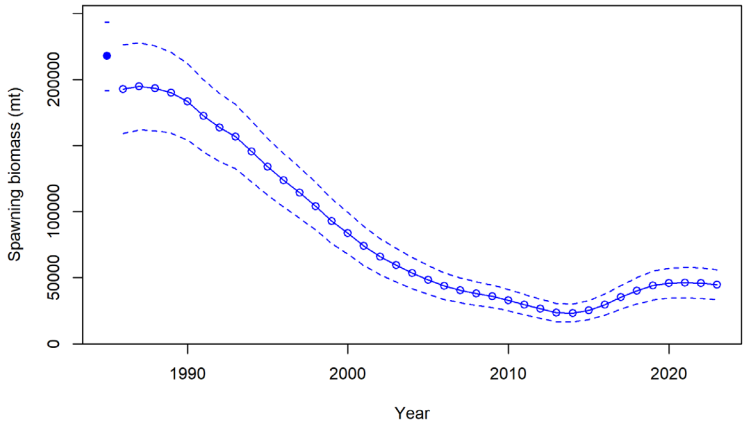
Summary

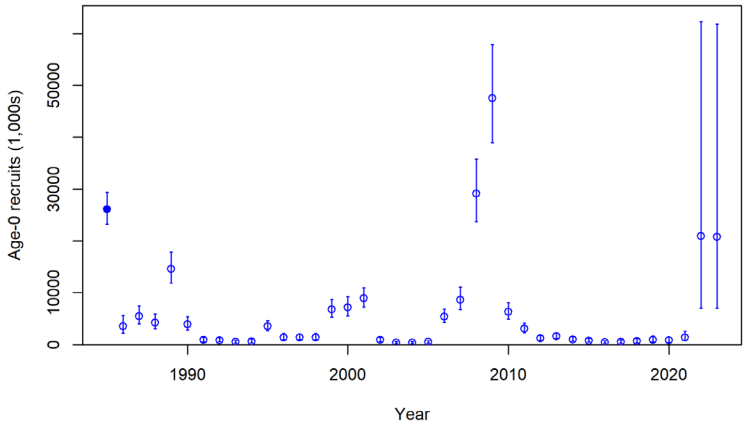
- Data conflict between the AFSC longline index and the bottom trawl survey data
  - Currently the only index of adult abundance
  - May have to try to address this outside the model
- Variance adjustment of length data is often recommended. Attempts led larger emphasis of fishery length comp, poorer fits the bottom trawl survey length composition data, and 7 bottom trawl selectivity parameters encountered bounds
  - This was true for model m9a as well
- Using analytical solution for survey catchability moves us away from using fixed estimates from a separate model run using subset of data
- Removing the time block on the slope survey biomass led to poorer fit. Given the short time series and few years of information within blocks seems reasonable to not include time block
- Last assessment estimated autocorrelation in recruitment
  - Practice is discouraged by SS3 developers
  - Evidence of autocorrelation, fixed estimate based on meta-analysis seems prudent
- AFSC longline linear approx. estimated RPNs are an improvement to the previous method
  - Recommended by AFSC longline survey team
  - Greater stability in estimates from year to year

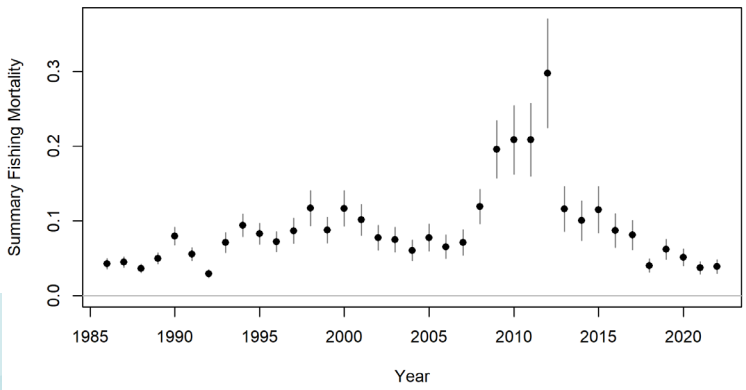
Uncertainty about initial population

- Current model estimates a small unfished population followed by large recruitment events to support large early catch history
  - Early recruitment deviations mainly informed by early catch
- Modifying the start year, the model estimates a much larger starting R0 and SSB0









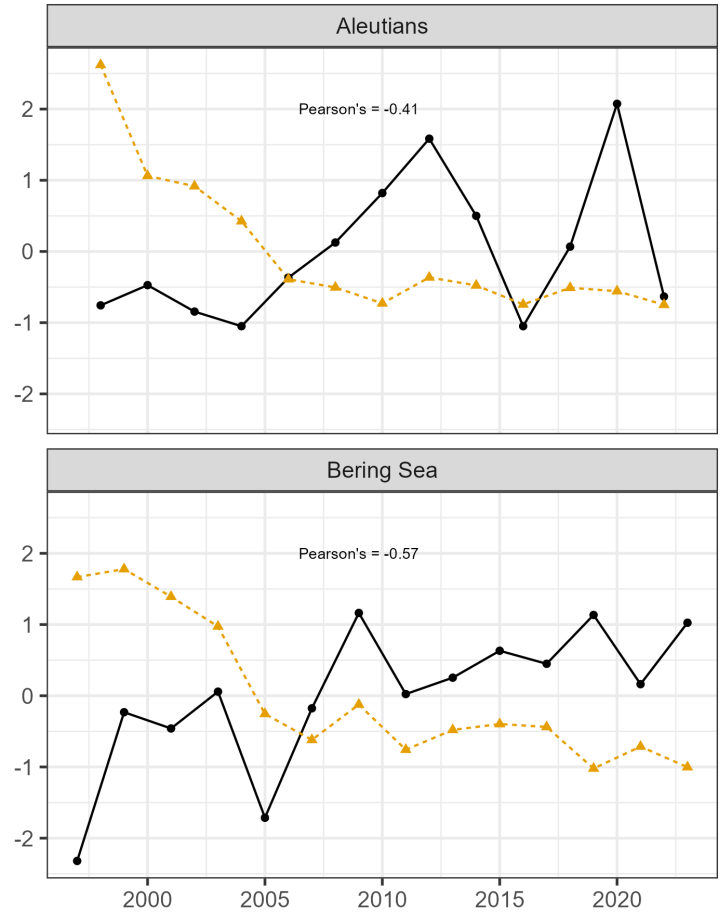
Potential future research

- Further explore options to identify the most appropriate start year of the model
- Refine fishery and AFSC longline survey input sample sizes
- Simplify the double normal parameterization of fishery selectivity
- Continue exploring options to better parameterize AFSC longline selectivity (difficult to fit bimodal length distribution)
  - Explored using cubic spline – encountered convergence issues; may require changing bin size
- Update maturity ogive (Ten Brink and Bryan)
- Killer whale depredation on the longline survey in the Bering Sea is an issue
  - Cameras on nets to estimate impact on the different species
  - Can we develop a method to account for

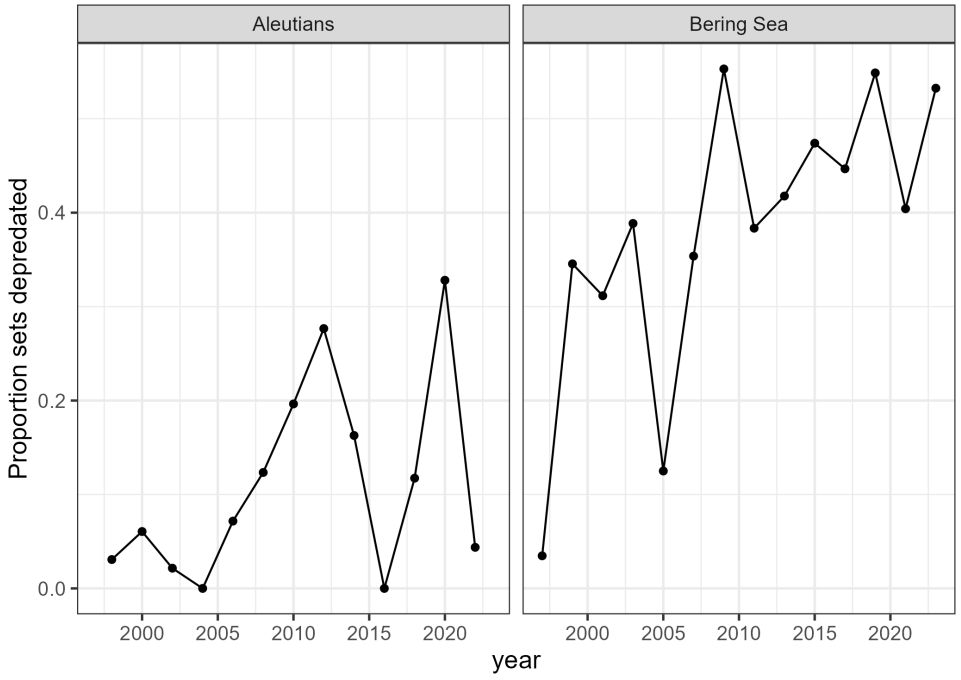
NOAA FISHERIES

NOAA FISHERIES

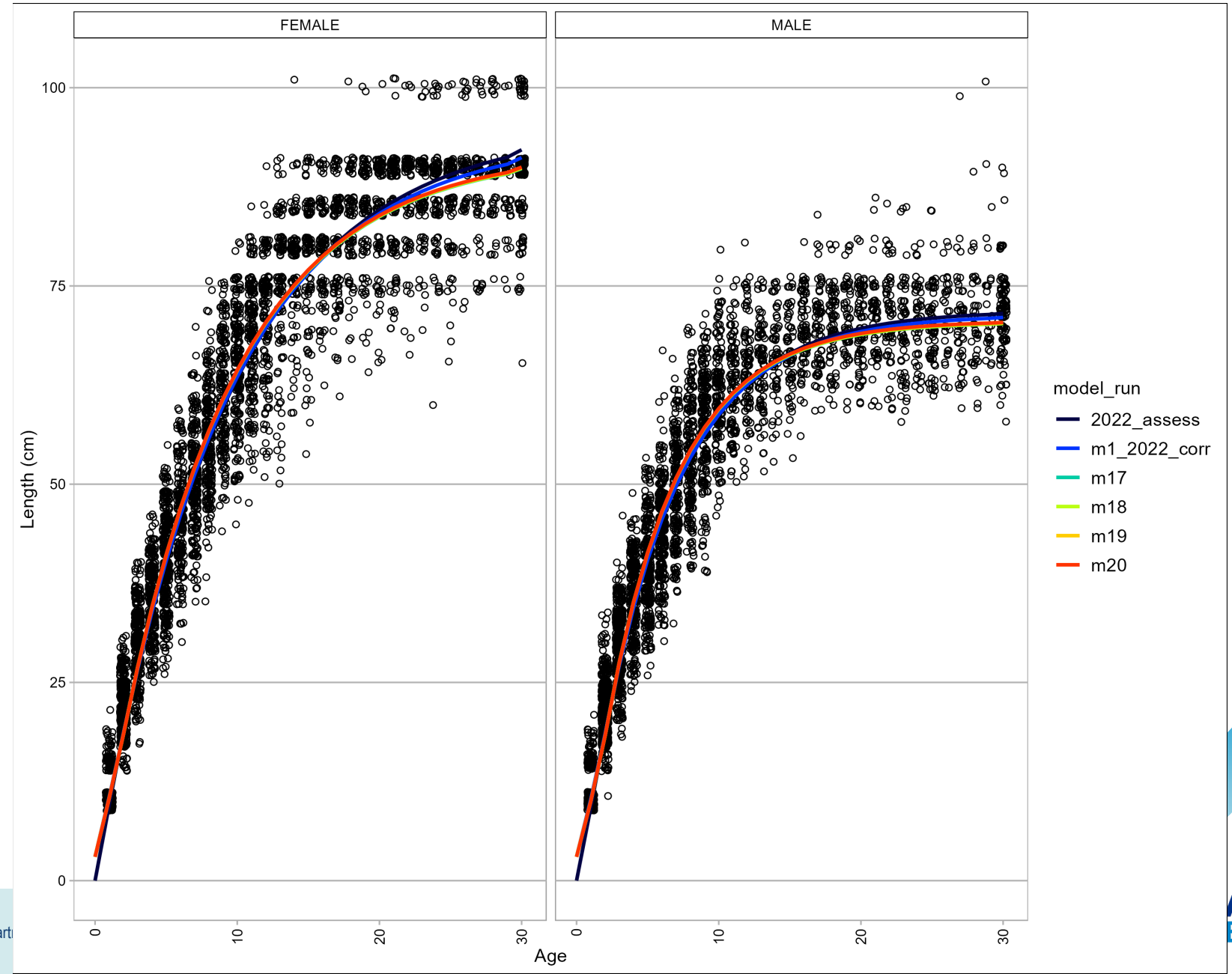
Killer whale depredation : AFSC longline



Standardized KW depred
Standardized turbot RPN

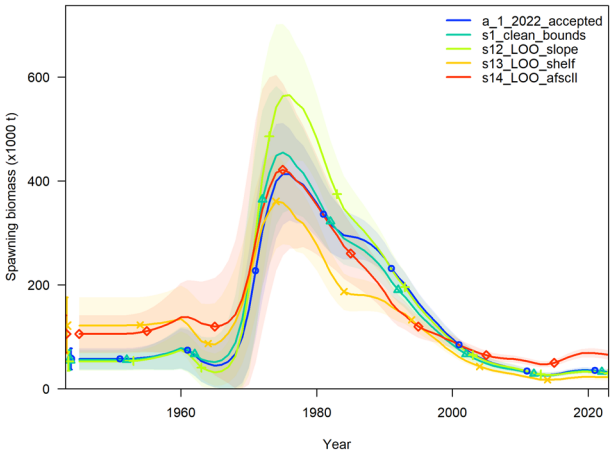


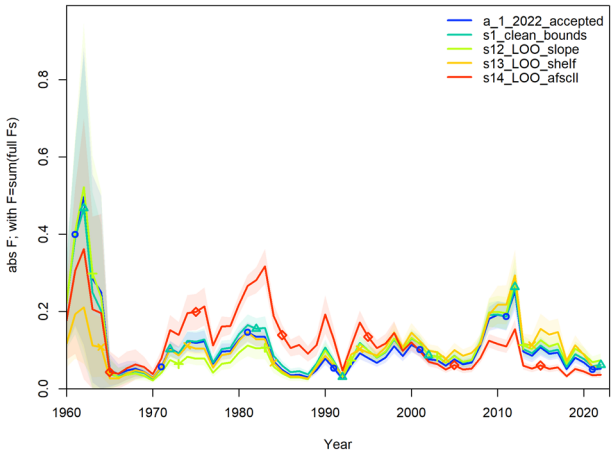
Growth

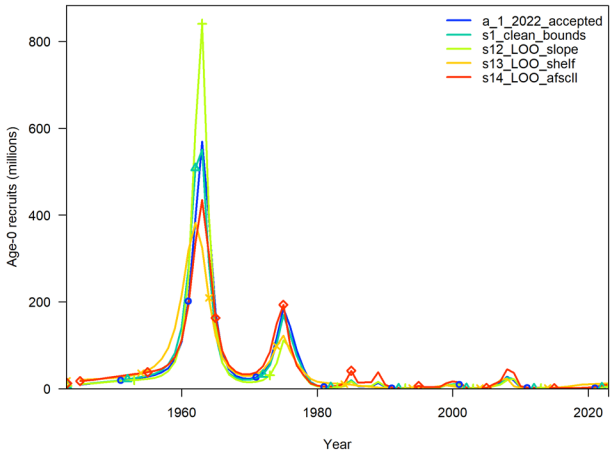

FEMALE
MALE
Length (cm)
100
75
50
25
0
0
10
20
30
Age
model_run
2022_assess
m1_2022_corr
m17
m18
m19
m20

Leave one out analysis

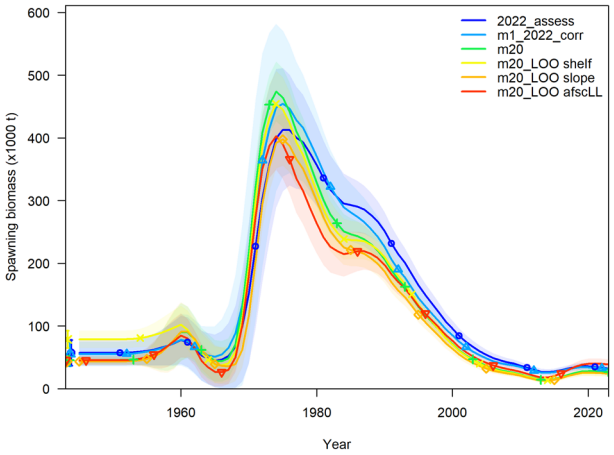
m1

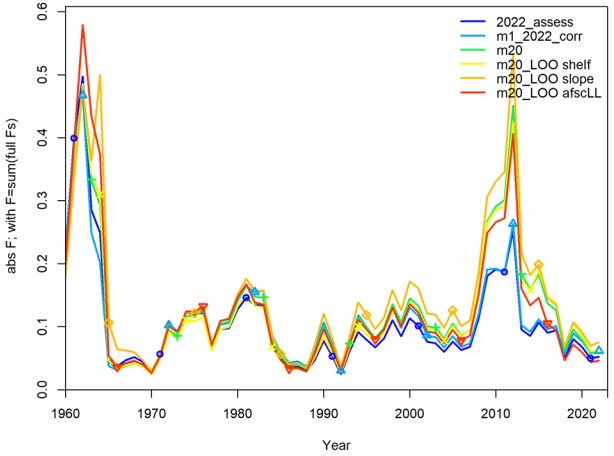


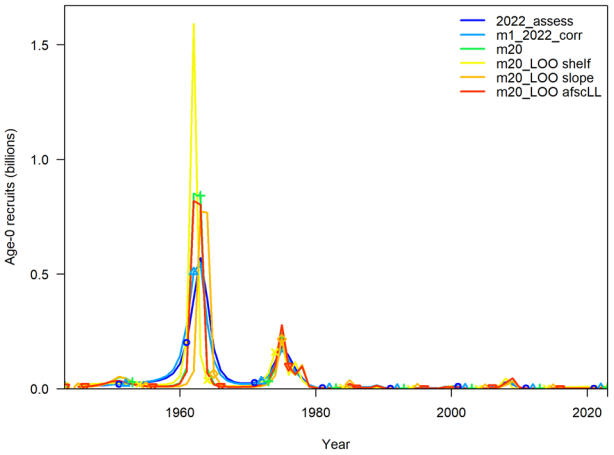




m20

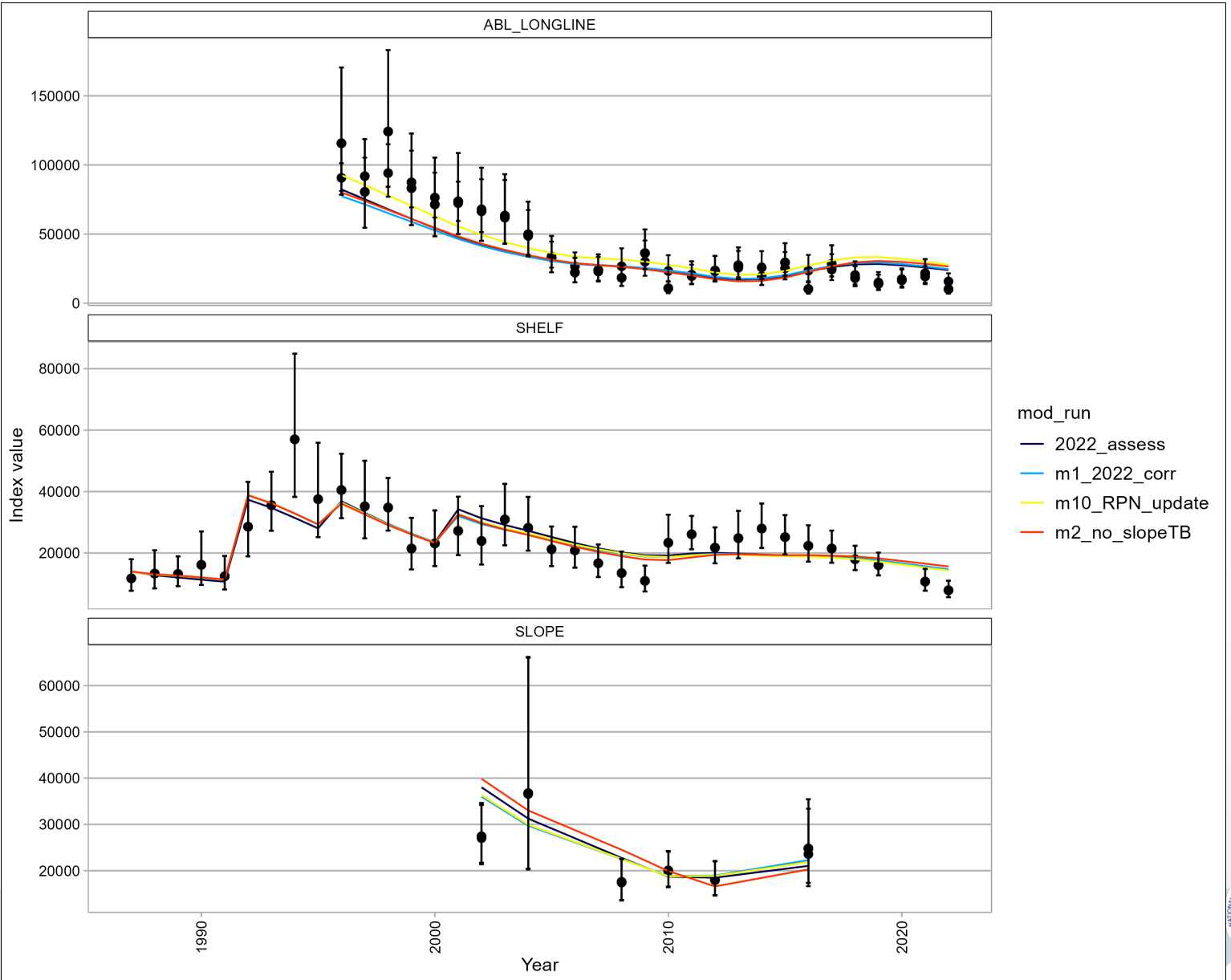






NOAA FISHERIES

Survey biomass



NOAA FISHERIES