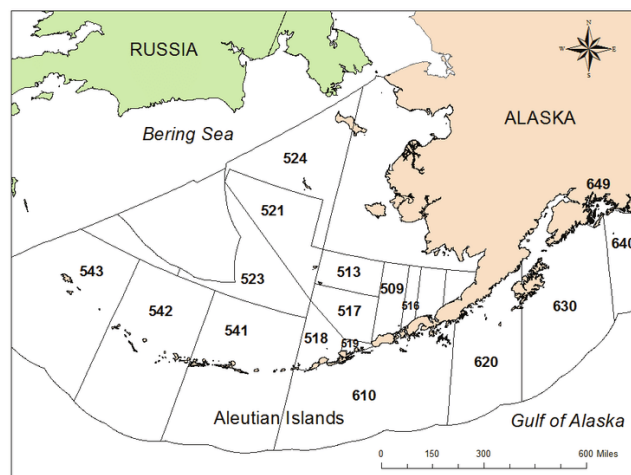# Aleutian Islands Pacific Cod Assessment September 2022

Ingrid Spies

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Aleutian Islands Pacific Cod Assessment September 2022

- Currently a Tier 5 stock,

- Age structured models proposed for this stock since 2013.

- New: Two models in Stock Synthesis for comparison with previous age-structured ADMB model.

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Two models using SS3:

Model 2022_1: COMPLEX MODEL – Three fisheries (pot, trawl, longline) and 2 surveys (trawl and longline survey), and starts in 1978.

Model 2022_2: SIMPLE MODEL - No longline survey and one single fishery (Designed to match ADMB model specifications), and starts in 1991.
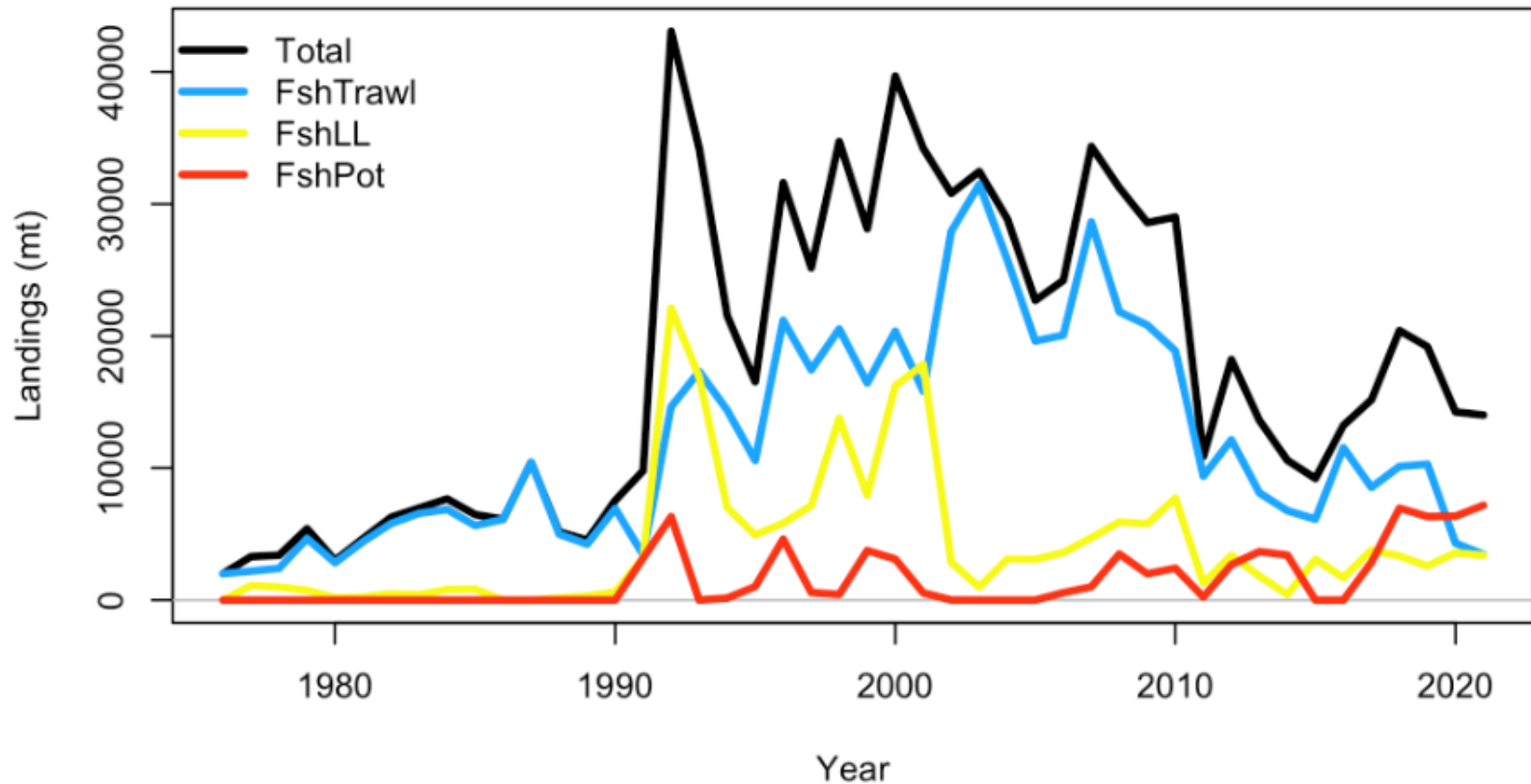
Model 2021: ADMB model - presented in 2021.

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NOAA FISHERIES

Data

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Catch by fishery
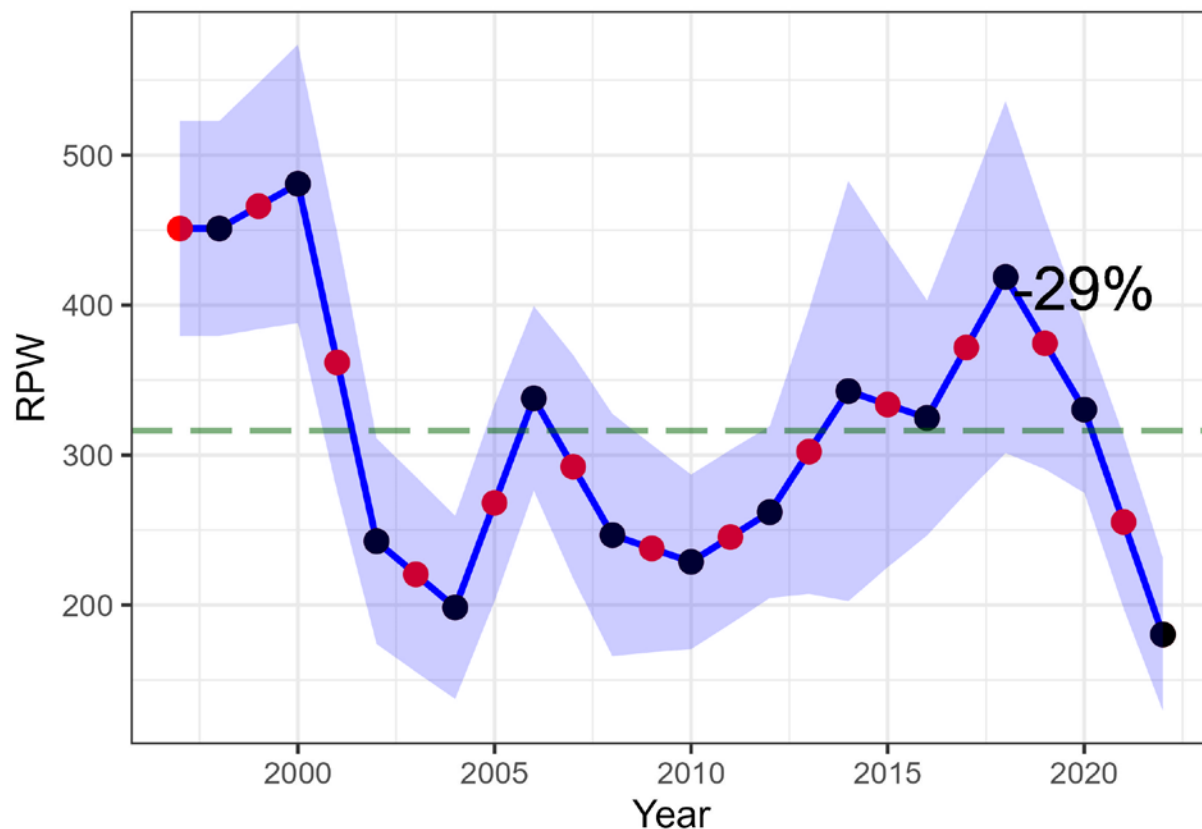
2022 Aleutian Islands trawl survey biomass has declined since 2018.

Aleutian Islands survey biomass for Pacific cod
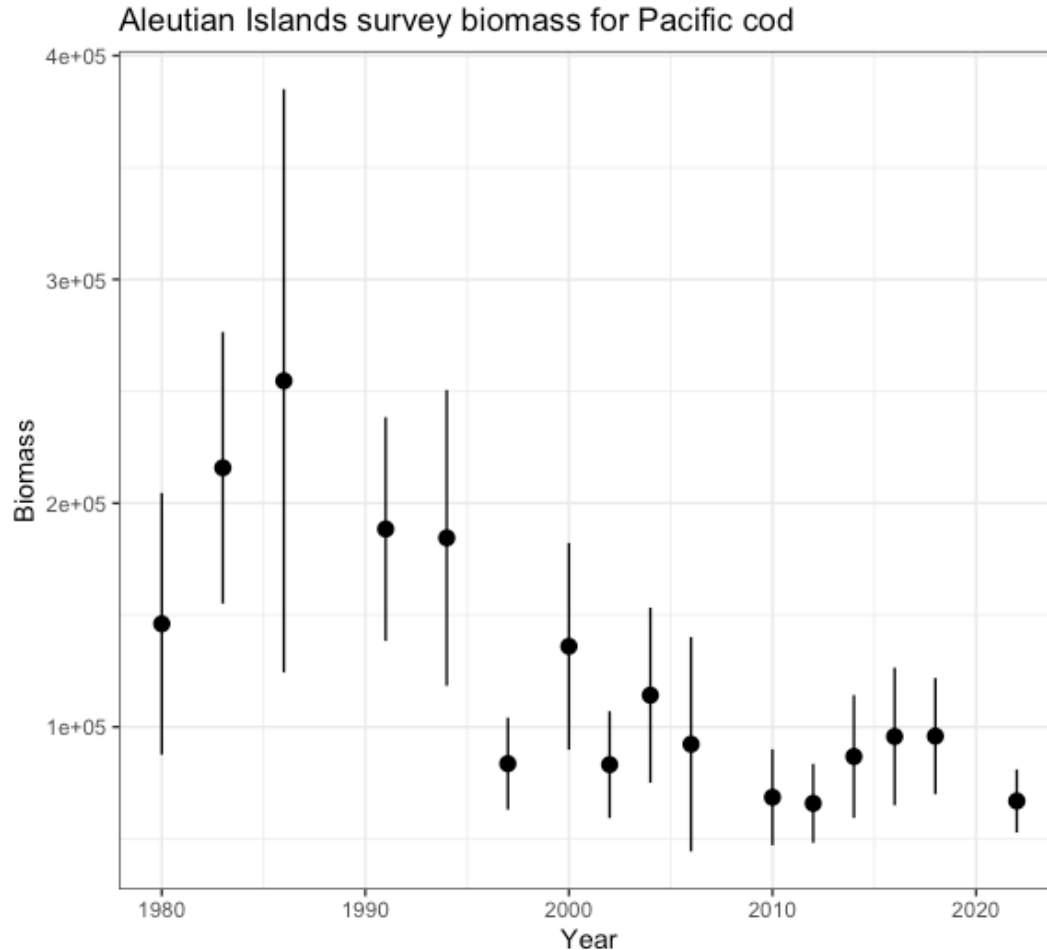
2022 Aleutian Islands longline survey biomass.

Aleutians P. Cod lin. interp. longline survey RPWs

Model configuration

Natural mortality

SS3

- Estimated in model.

- COMPLEX M2022_1: M=0.36.

- SIMPLE M2022_2:

  M=0.42.

ADMB

- Fixed (M=0.4)

Higher natural mortality → higher biomass estimates.

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Growth in the model

SS3

- Growth (von Bertalanffy estimated within the model)

  - $Lage = L\infty - (L\infty - Lmin)e^{-age*k}$

  - K=.236, Linf=115cm, Lmin=11.2cm

ADMB

- Growth (von Bertalanffy) estimated outside the model.

  $$Length_{age} = L_{inf}(1 - e^{-(K(age - t_0))}).$$

  - K=0.1645, Linf=123.8cm, t_0=-0.1020

Weight at length

SS3

The weight-length relationship:

$$\text{Weight}_{age} = 0.005611 * \text{Length}_{age}^{3.176}$$

for both sexes combined.

- Used nonlinear least squares fit to all weight at length data, 9,213 individuals with nonlinear least squares (nls) method.

(Weight is in kilograms and length in centimeters.)

ADMB

- Same.

Maturity

SS3

- Used 1,331 observer records from the Aleutian Islands to fit

A and B parameters.

A = -8.0847

B = 0.1472

ADMB

- Same.

Age error

SS3

- Using Age error but not ageing bias, as samples were aged post 2007 (except <1% which will be removed).

ADMB

- Same.

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Fishery length composition

SS3

- Fishery catch data is weighted by number of fish in the haul, by weight of catch by area, trimester and gear.

ADMB

- Fishery length frequencies were weighted by the relative catch by year in the three NMFS areas (541,542, and 543).

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NOAA FISHERIES

Sigma R (variance in recruitment)

SS3

- Fixed at 0.7

- GOA cod sigma R set at 0.44.

- EBS tuned to 0.6-0.7.

- Tuning this parameter will be explored.

ADMB

- Estimated in model ~0.4.

Selectivity

SS3

- Fishery and survey selectivity curves assumed logistic.

- Estimated within the model.

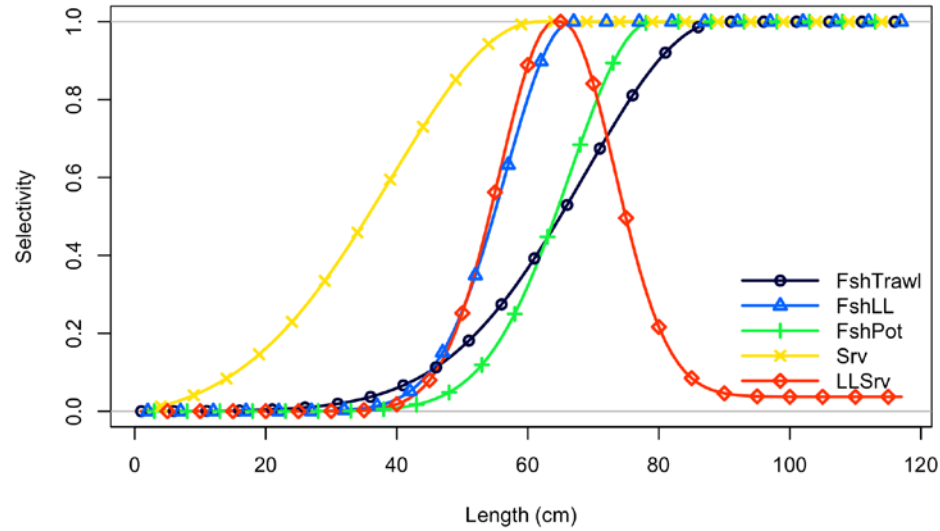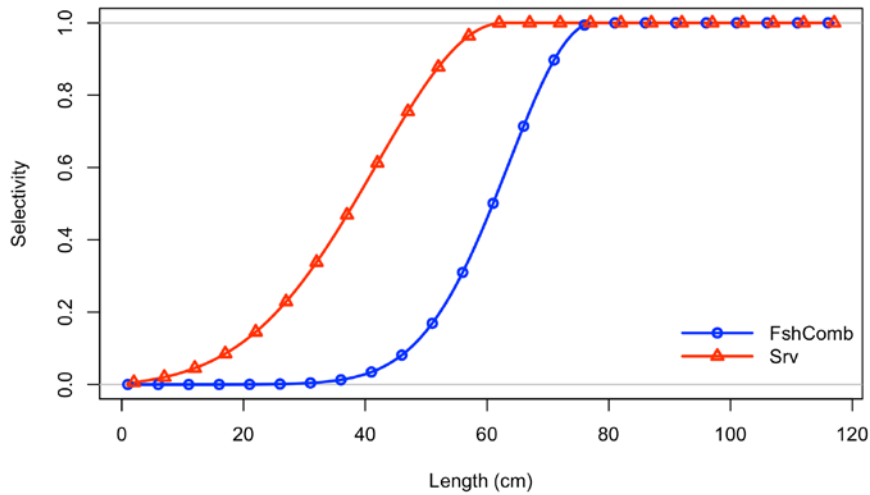- Longline survey dome-shaped, similar to GOA cod assessment.

ADMB

- Same.

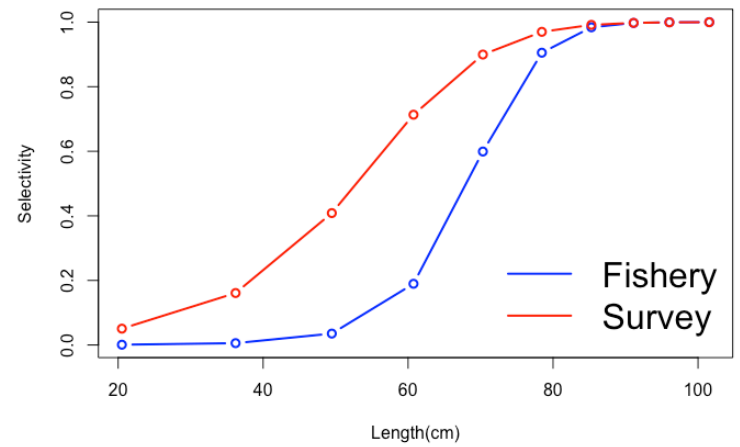U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

Selectivity

Model 2022_1

Model 2022_2

Model 2021

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Mean recruitment (RO) is estimated in each model.

SS3

- M2022_1: R0 = 10.2

- M2022_2: R0 = 10.6

ADMB

- M2021: R0 = 10.19
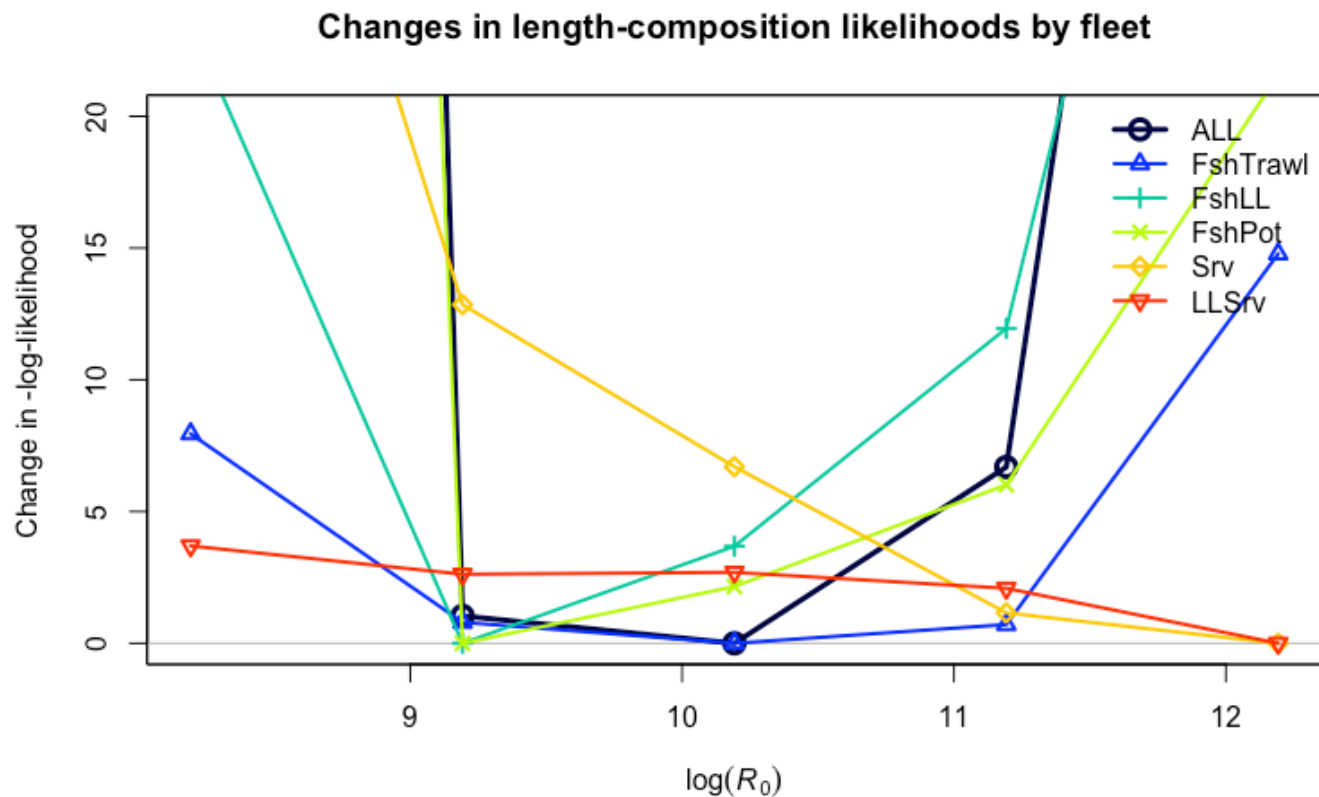
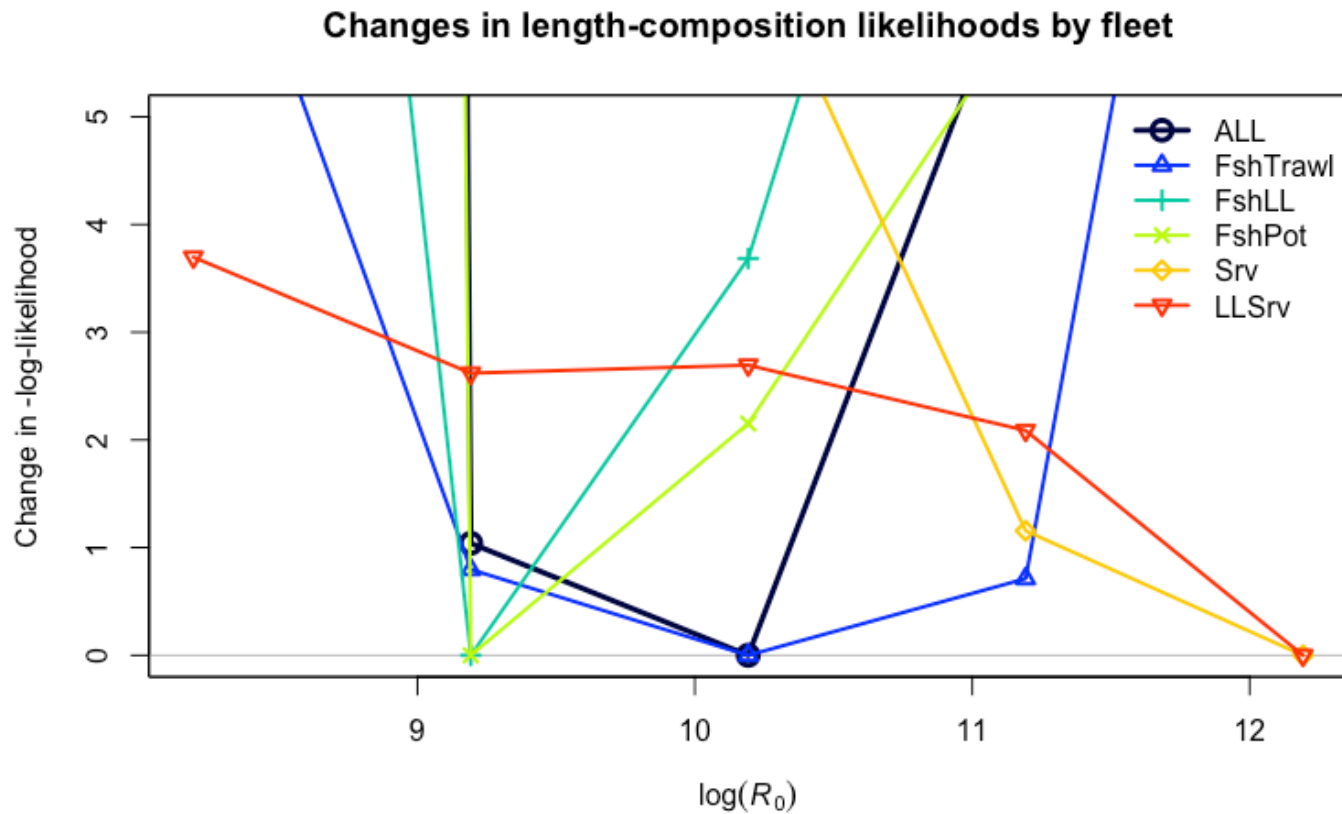U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

Model 2022_1
Likelihood profile over R0 (Piner Plot)

Changes in length-composition likelihoods by fleet

Log(R0)=10.2

Model 2022_1
Likelihood profile over R0 (Piner Plot)

Changes in length-composition likelihoods by fleet

Model 2022_1
Likelihood profile over R0 (SSplotProfile)

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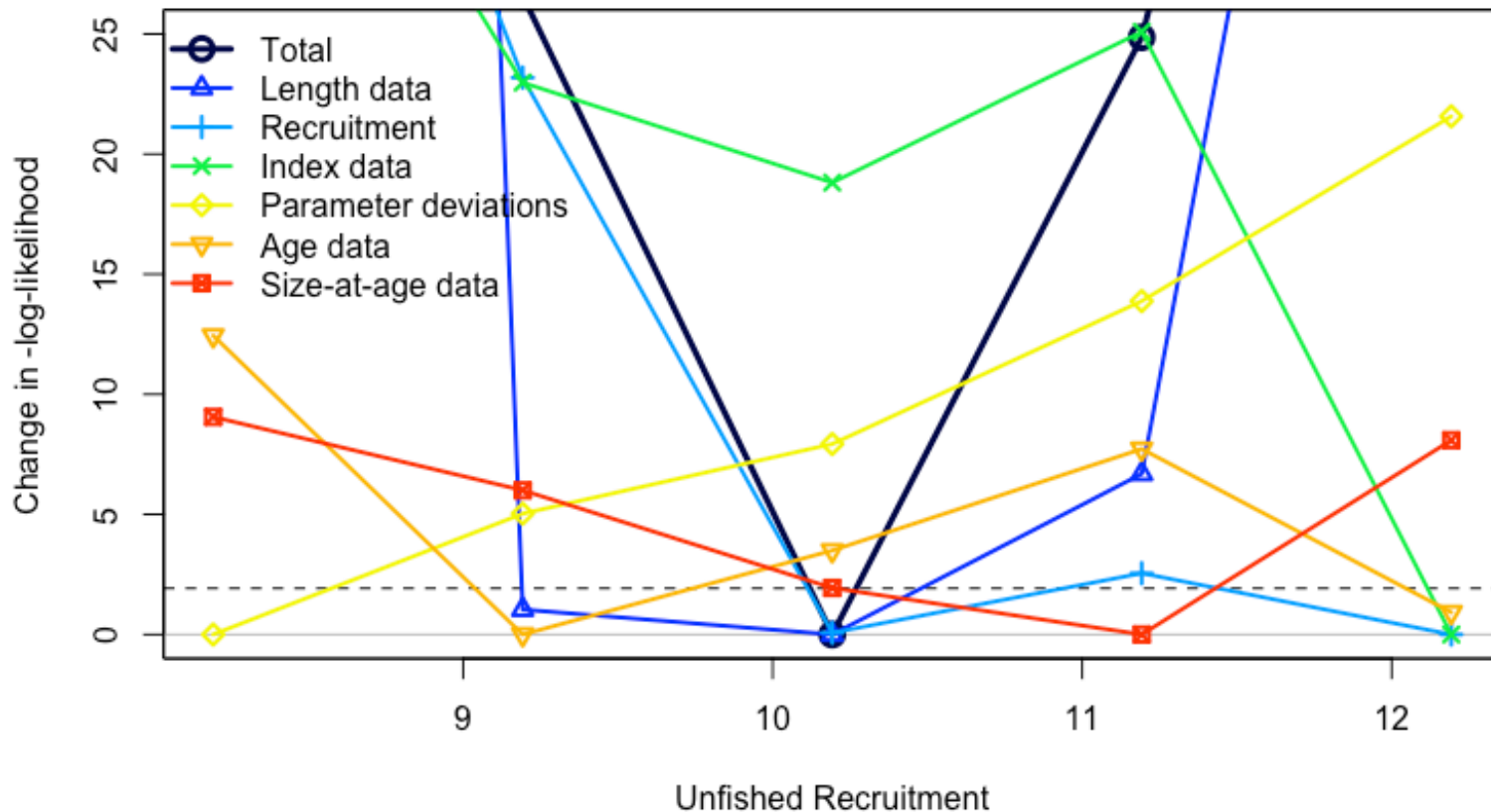
Model 2022_2
Likelihood profile over R0 (Piner Plot)
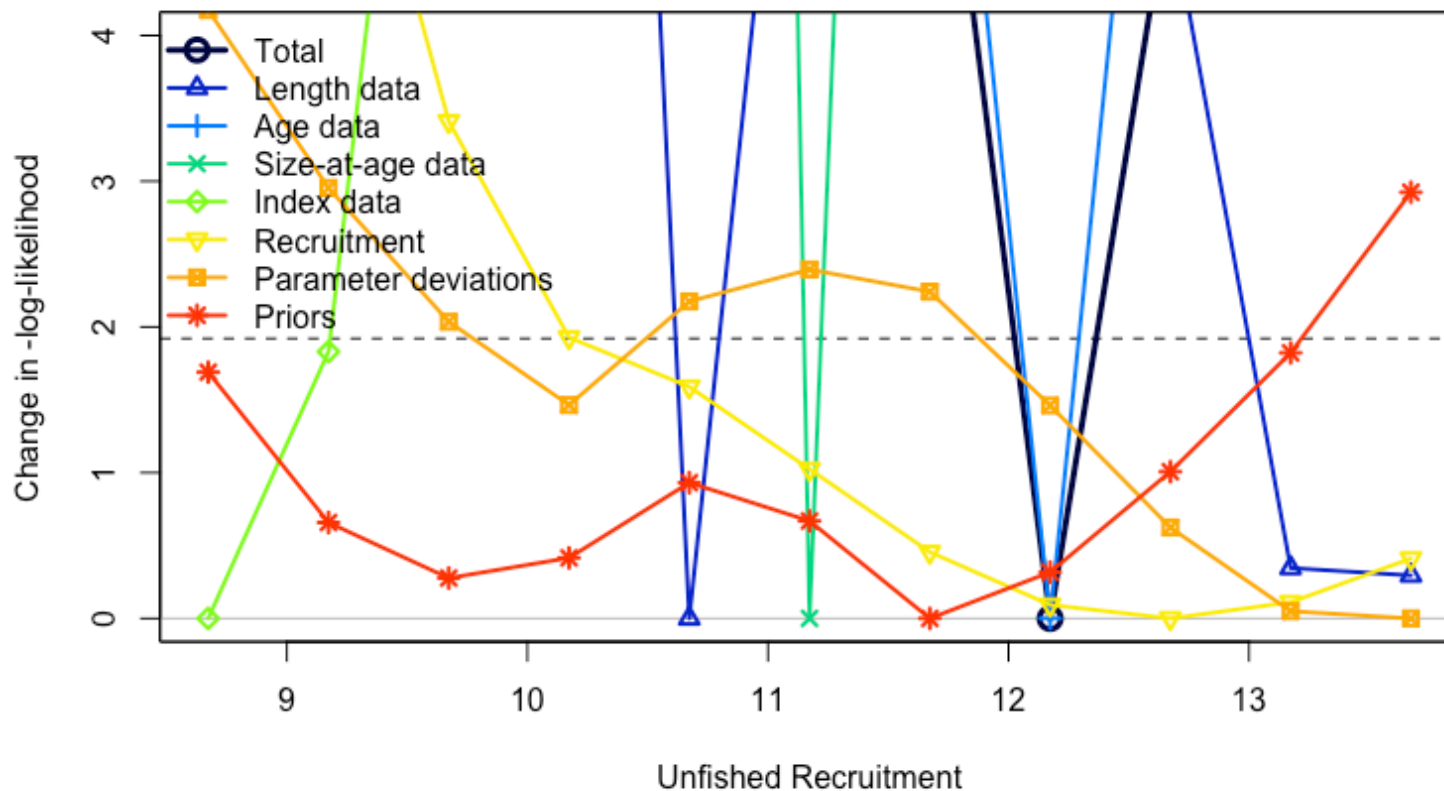

Changes in length-composition likelihoods by fleet
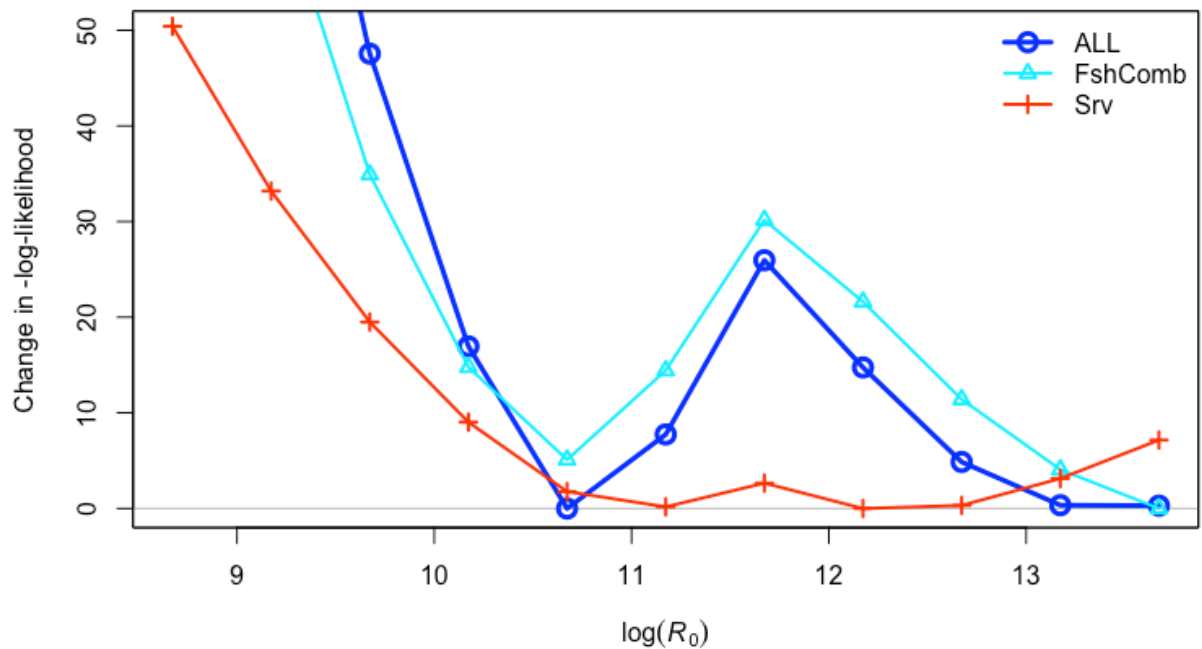
Log(R0)=10.65

Model 2022_2
Likelihood profile over R0 (SSplotProfile)

Log(R0)=10.65

Recommendations for November

- Present Tier 5 estimates.

- Also SS3 Models 2022_1, 2022_2.
  - Time series exist with sufficient data.
  - New survey data in 2022.
  - Consistency with EBS and GOA assessments.

- Consider parameterizations for sigma R, and data weighting.

Model recommendations

- Use Aleutian Islands observer data to estimate maturity at age.

- Weight fishery catch data by number of fish in the haul, by weight of catch by area, trimester and gear.

- Work with EBS and GOA authors to standardized tuning of sigmaR.

- Work with EBS and GOA author on standardizing data weighting.

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PACIFIC COD
(Gadus macrocephalus)

Questions?

The maturity-at-age is governed by the relationship:

$Maturity_{age} = \frac{1}{1+e^{-(A+B*age)}}$, where A and B are parameters in the relationship.

A study based on a collection of 129 female fish in February, 2003, from the Unimak Pass area, NMFS area 509, found that 50% of female fish become mature at approximately 4.88 years ($L_{50\%}$) and 58.0 cm, A = -4.7143, B = 0.9654 (i.e. Tables 2 and 4 in Stark 2007). This maturity ogive is used in the Bering Sea Pacific cod assessment but may not be appropriate for the Aleutian Islands age structured model, because the fish in the sample were not from the Aleutian Islands.

An alternative maturity curve was developed based on observer records of maturity from the Aleutian Islands. This model may be advantageous because it is based on more records and on cod taken from the Aleutian Islands. Observers routinely collect maturity at length from Pacific cod. There are 1,331 records from the Aleutian Islands (Table 3) during the months January – March since 2008. These were used to estimate a maturity ogive by length using the R package *sizeMat*, which estimates the length of fish at gonad maturity. Maturity was considered a binomial response variable and variables were fitted to the logistic function above for maturity, and the length at which 50% of cod are mature is $L_{50\%}$ = -A/B. The formula used to fit proportion mature by length was

$$Maturity_{length} = \frac{1}{1 + e^{-(A+B*length)}},$$

and the resulting parameters were A = -8.0847and B = 0.1472. This ogive provided maturity at length which was converted to maturity at age using the length age conversion matrix. The resulting ogive had $L_{50\%}$, slightly lower than the Stark (2007) estimate. $L_{50\%}$ was estimated to be 54.9 cm, age 4 (Figure 4, Table 4).