Assessment of Ling in 5a

Bjarki Þór Elvarsson

HAFRANNSÓKNASTOFNUN

Settings

- Two stock model: immature and mature
  - Age: 3–10 and 5–15
  - Length: 20–160 cm, Δl 4 cm
  - Length based maturation function
  - Natural mortality set to be 0.15 for all years
  - Length based Von Bertalanffy growth
  - Annual recruitment of 3 year olds
- Five fleets: survey, longlines, bottom trawlers, gillnets and foreign vessels
- Model time: 1982–2016, quarterly timestep
- A total of 71 parameters estimated

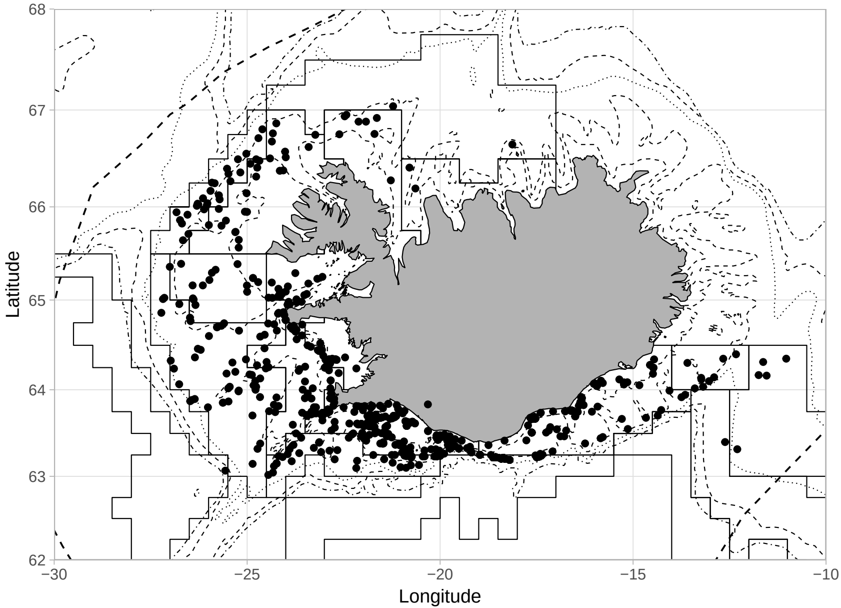
HAFRANNSÓKNASTOFNUN

Observational data

- Survey indices from the Icelandic groundfish survey from 1984:
  - si.20-50
  - si.50-60
  - si.60-70
  - si.70-80
  - si.80-90
  - si.90-100
  - si.100-160
- Survey samples from 1984 (as available):
  - ldist.igfs: proportion at length
  - aldist.igfs: proportion at length and age
  - matp.igfs: proportion mature at length
- Commercial samples from 1982 (as available)
  - ldist.lln, gil, bmt: proportion at length by gear
  - aldist.lln, gil, bmt: proportion at length and age by gear
- Commercial catches by gear since 1982

HAFRANNSÓKNASTOFNUN

Location of samples

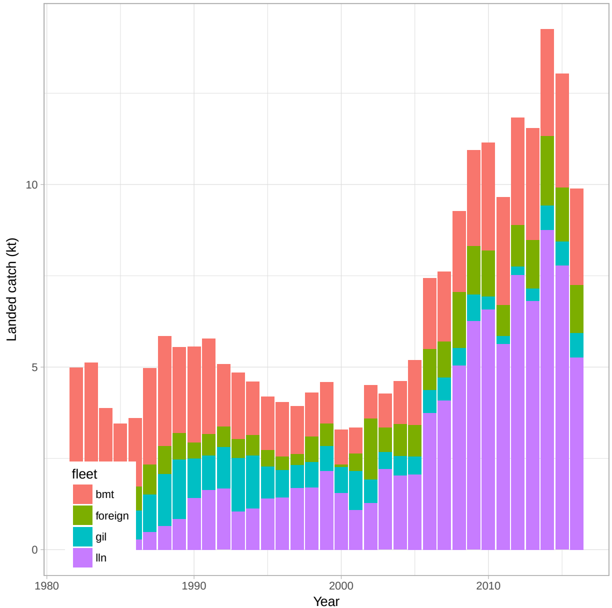


HAFRANNSÓKNASTOFNUN

Landings data

Sources of landings data:

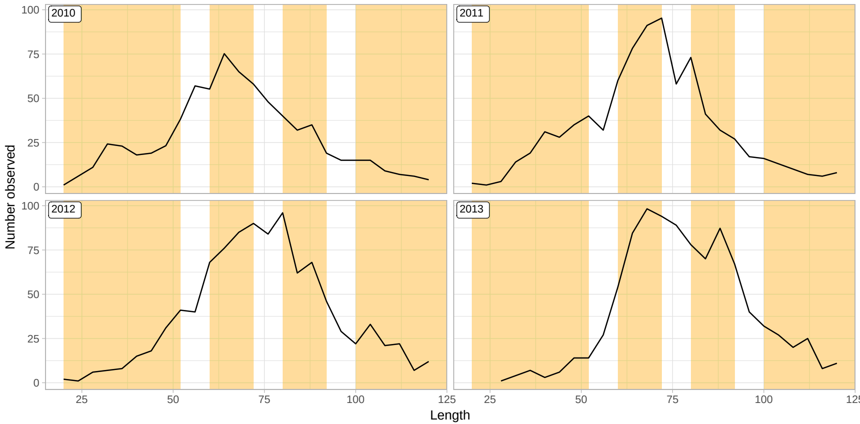
- Landings of Icelandic vessels:
  - Pre 1993: landings by port from Fiskifélagið
  - Post 1993: Directorate of fisheries, catches reported by vessel
- Landings of foreign vessels:
  - Pre 2014: Statlant
  - Post 2014: Directorate of fisheries, catches reported by vessel



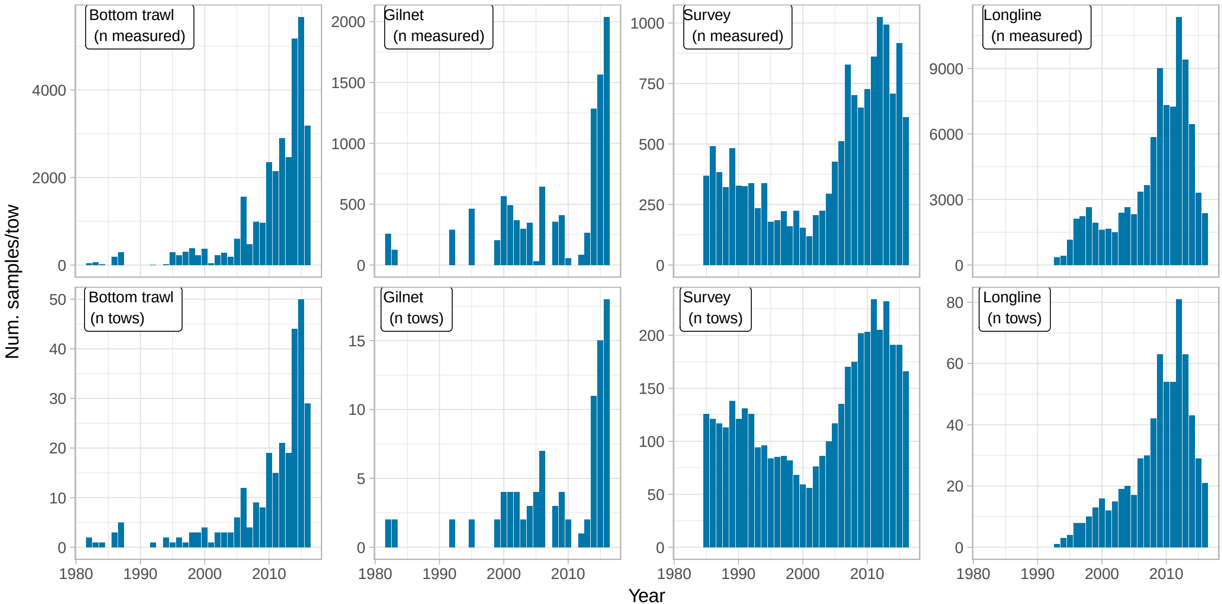
HAFRANNSÓKNASTOFNUN

Survey indices

Name	min	max
si.20-50	20	52
si.50-60	52	60
si.60-70	60	72
si.70-80	72	80
si.80-90	80	92
si.90-100	92	100
si.100-160	100	160

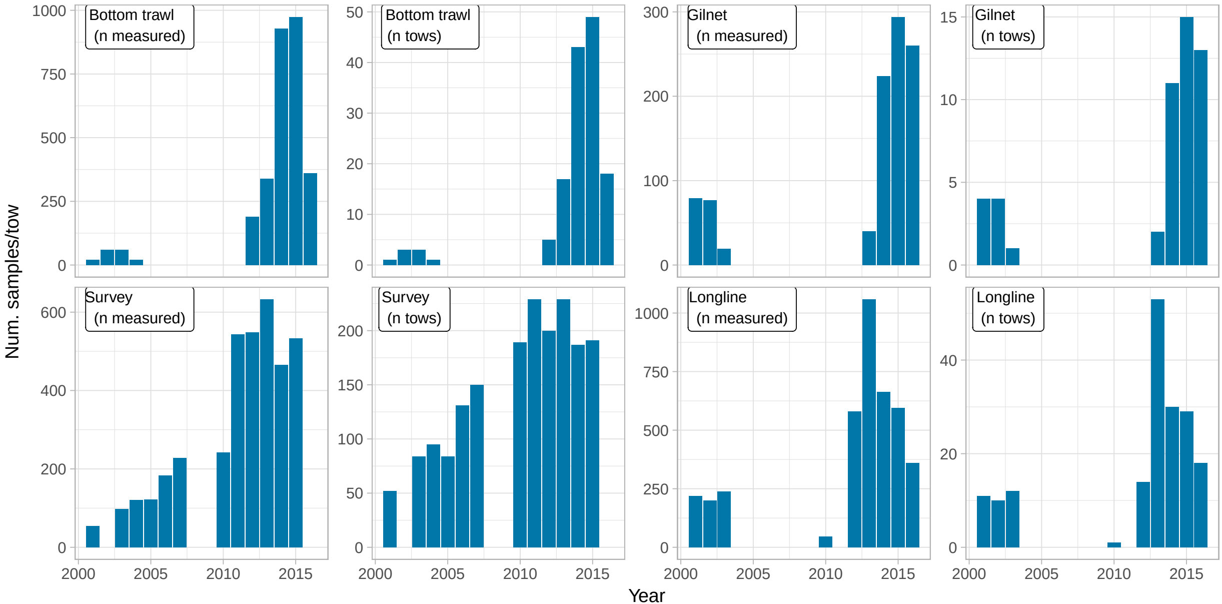


Available samples on length



HAFRANNSOKNASTOFNUN

Available samples on age



HAFRANNSOKNASTOFNUN

Objective function

- The total objective function used the modeling process combines the contribution of each data set using the following formula:

$$l^{\mathrm{T}} = \sum_{g} w^{\mathrm{SI}}_{gf} l^{\mathrm{SI}}_{g,S} + \sum_{f \in \{S,C\}} \left(w^{\mathrm{LD}}_{f} l^{\mathrm{LD}}_{f} + w^{\mathrm{AL}}_{f} l^{\mathrm{AL}}_{f} \right) + w^{\mathrm{M}} l^{\mathrm{M}} \tag{1}$$

  where $f = S$, L, G, B denotes the spring survey, and the commercial fleets respectively and w's are the weights assigned to each likelihood component.

- For each length range g the survey index is compared to the modeled abundance at year y and time-step t using:

$$l^{\mathrm{SI}}_{g} = \sum_{y} \sum_{t} (\log I_{gy} - (\log q_g + b_g \log \widehat{N_{gyt}}))^2 \tag{2}$$

  where

$$\widehat{N_{gyt}} = \sum_{l \in g} \sum_{a} \sum_{s} N_{alsyt}$$

- For compositional data the likelihood is of the form:

$$l^{\mathrm{LD}}_{f} = \sum_{y} \sum_{t} \sum_{l} (\pi_{flyt} - \hat{\pi}_{flyt})^2 \tag{3}$$

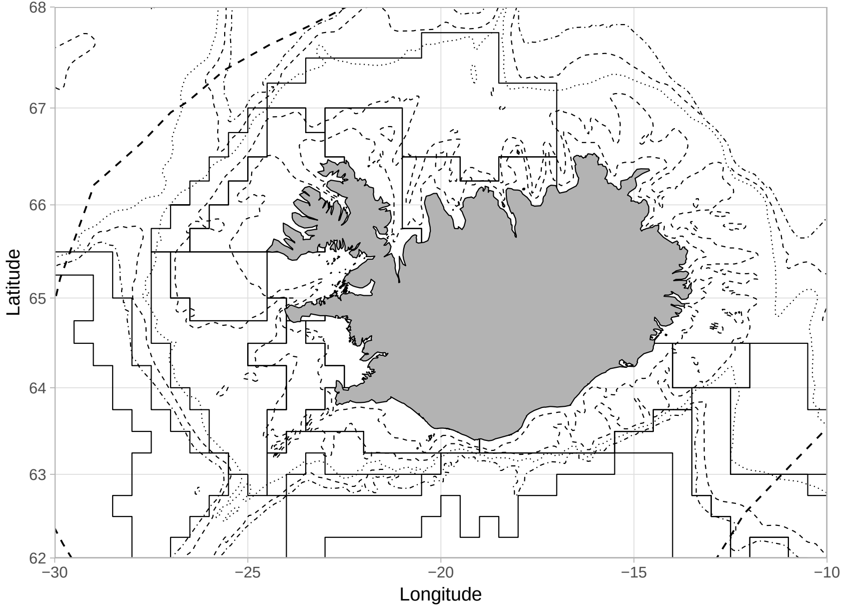
HAFRANNSÓKNASTOFNUN

Weighting heuristic

1. Calculate the initial sums of squares (SS) given the initial parametrization for all likelihood components. Assign the inverse SS as the initial weight for all likelihood components.
2. For each likelihood component, do an optimization run with the initial SS for that component set to 10000. Then estimate the residual variance using the resulting SS of that component divided by the degrees of freedom (df^*), i.e. $\hat{\sigma}^2 = \frac{SS}{df^*}$.
3. After the optimization set the final weight for that all components as the inverse of the estimated variance from the step above (weight $= 1/\hat{\sigma}^2$).

HAFRANNSÓKNASTOFNUN

Uncertainty estimates



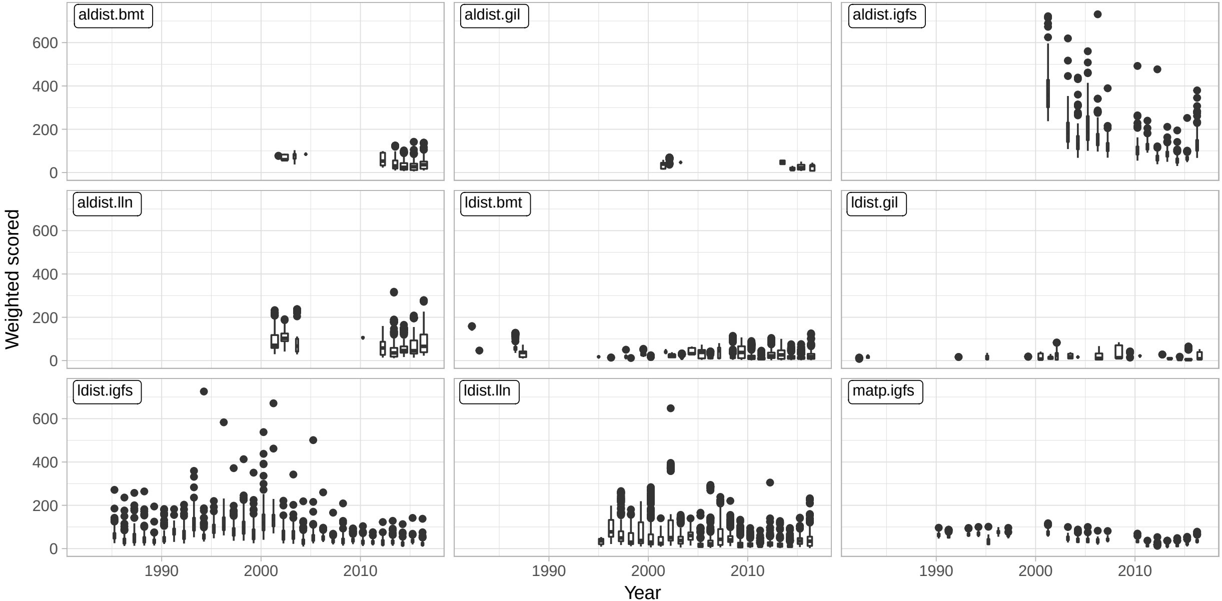
Order of calculations

The order of calculations is as follows:

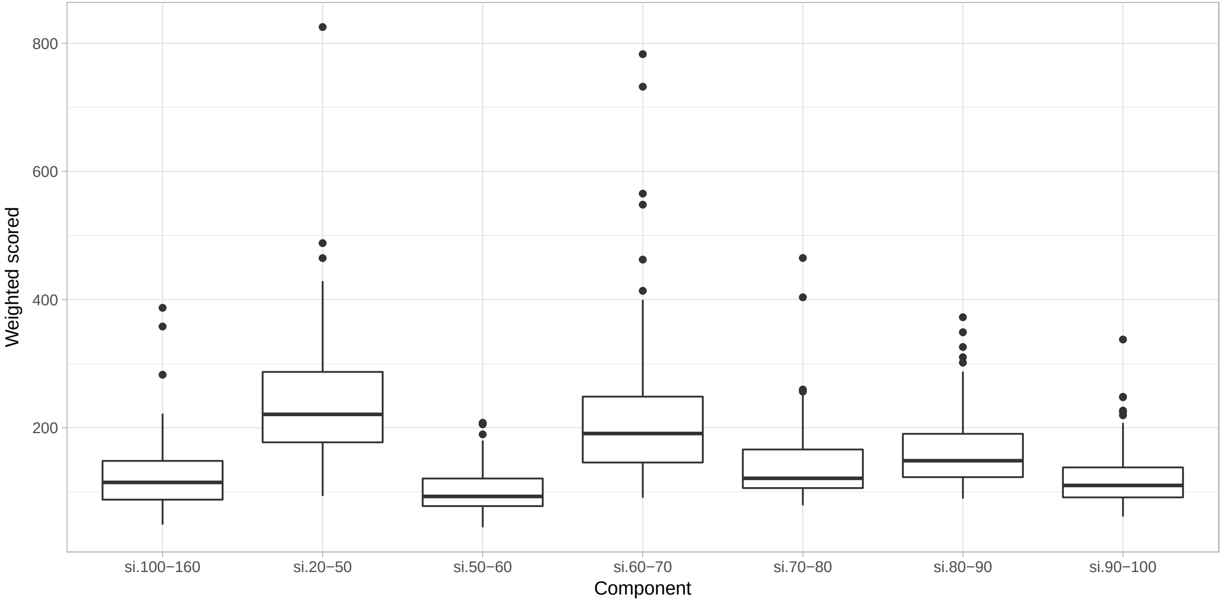
1. **Printing**: model output at the beginning of the time-step
2. **Consumption**: mainly fleet harvesting
3. **Natural mortality**: Natural mortality is applied after consumption
4. **Growth**: length update is applied
5. **Maturation**: maturing fish moved from one stock component to the other
6. **Spawning and recruitment**: New individuals enter the immature stock component
7. **Likelihood comparison**: likelihood score is calculated here, note that the comparison is based on the modeled processes in previous steps
8. **Printing**: model output at the end of the time-step
9. **Ageing**: if this is the end of year the age is increased

HAFRANNSÓKNASTOFNUN

Likelihood values - compositional data

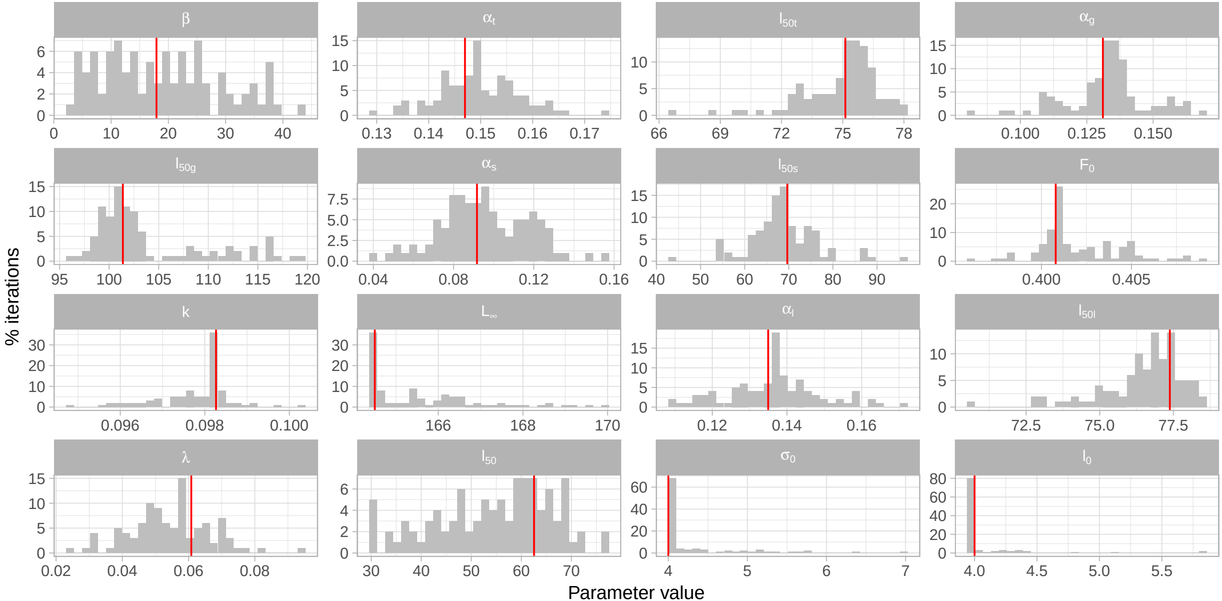


Likelihood values - survey indices



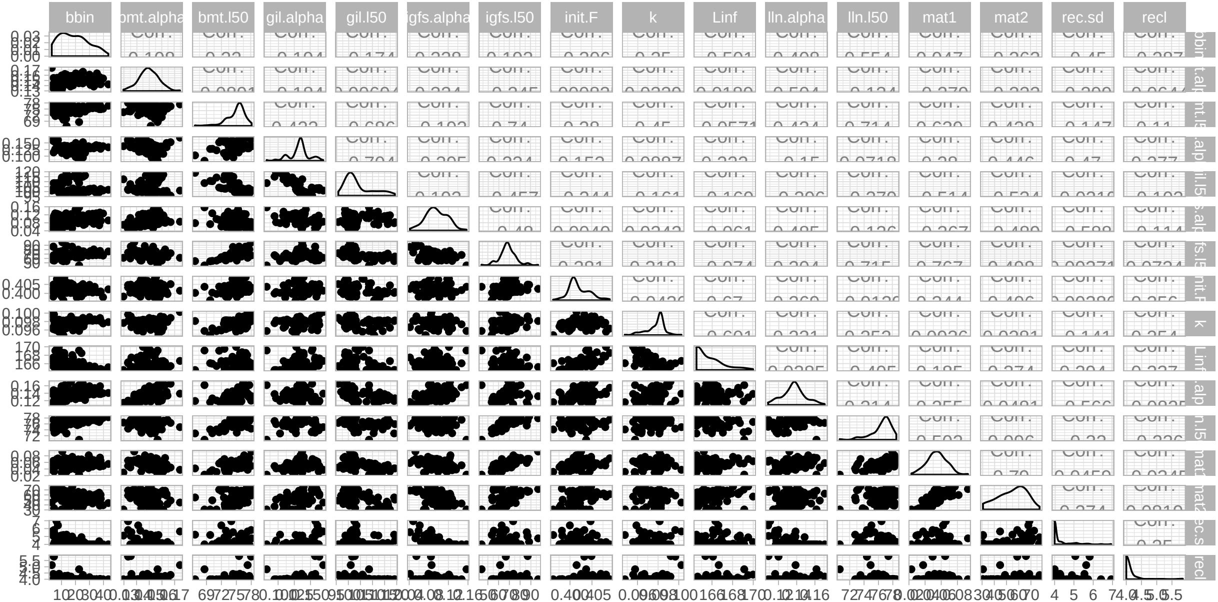
HAFRANNSOKNASTOFNUN

Parameter estimates



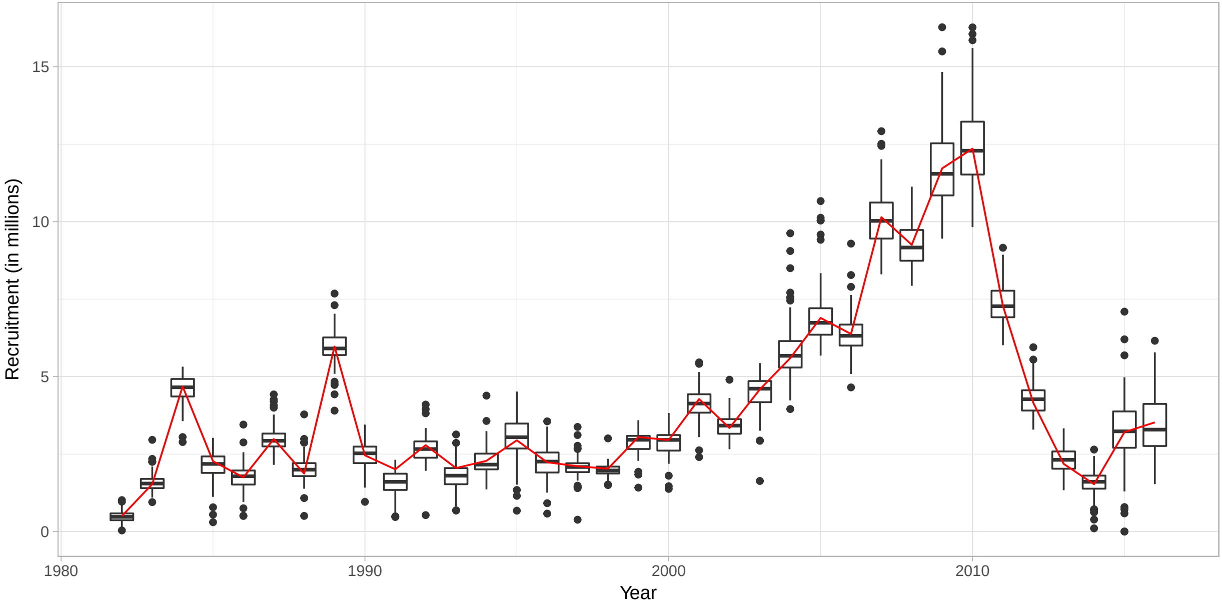
HAFRANNSOKNASTOFNUN

Parameter correlations



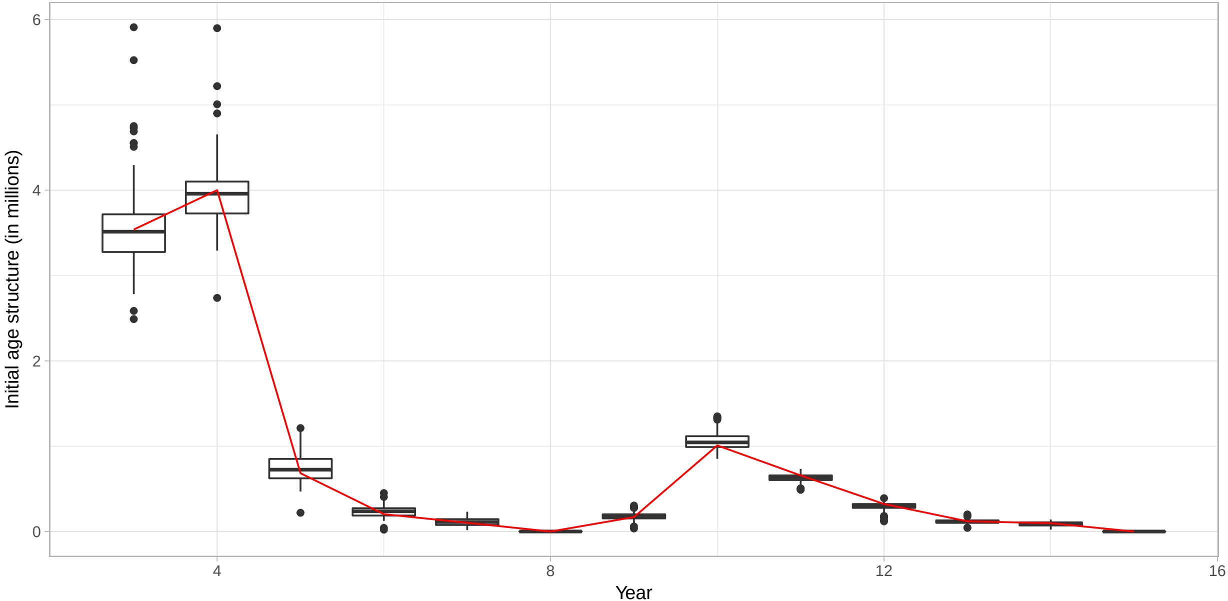
HAFRANNSOKNASTOFNUN

Recruitment parameters



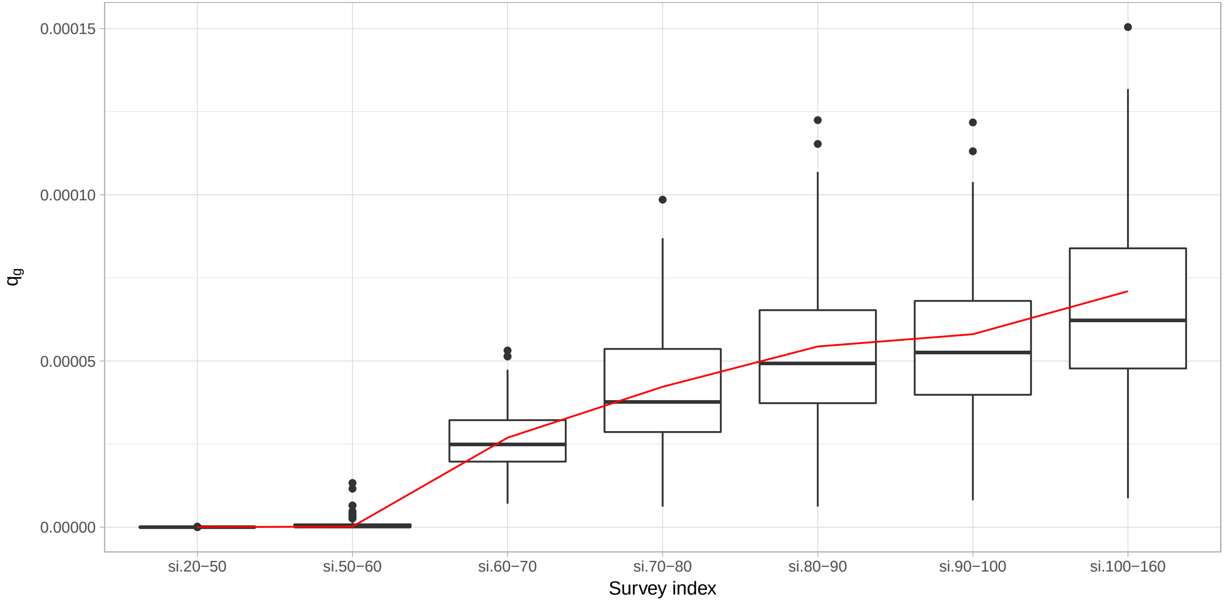
HAFRANNSOKNASTOFNUN

Initial population



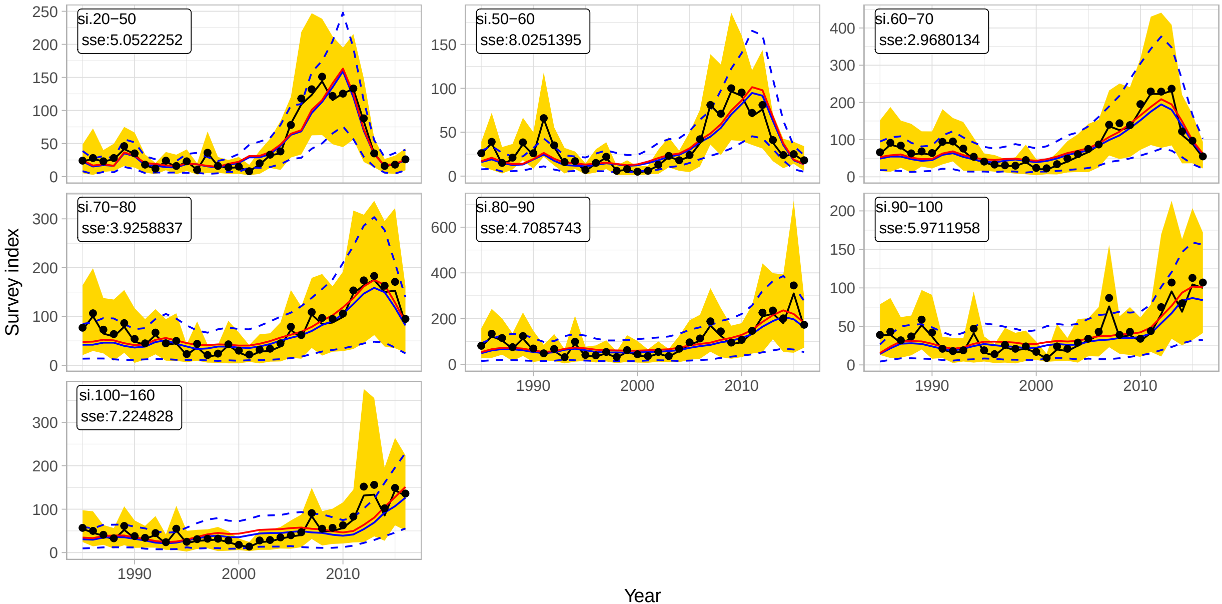
HAFRANNSOKNASTOFNUN

Survey catchability



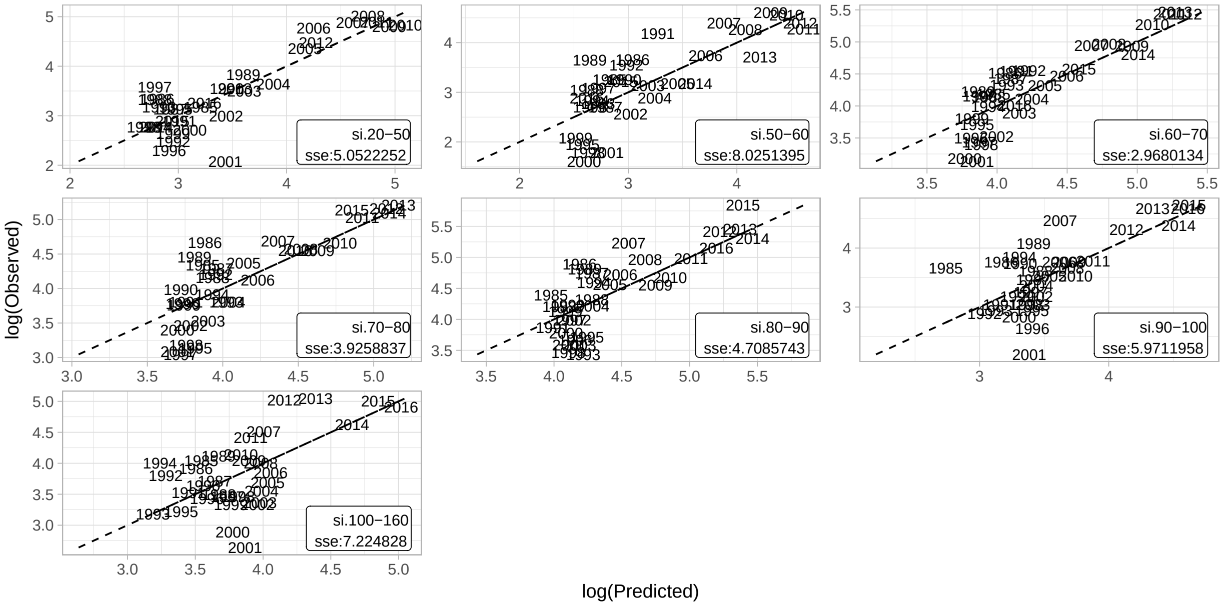
HAFRANNSOKNASTOFNUN

Fit to data – Indices

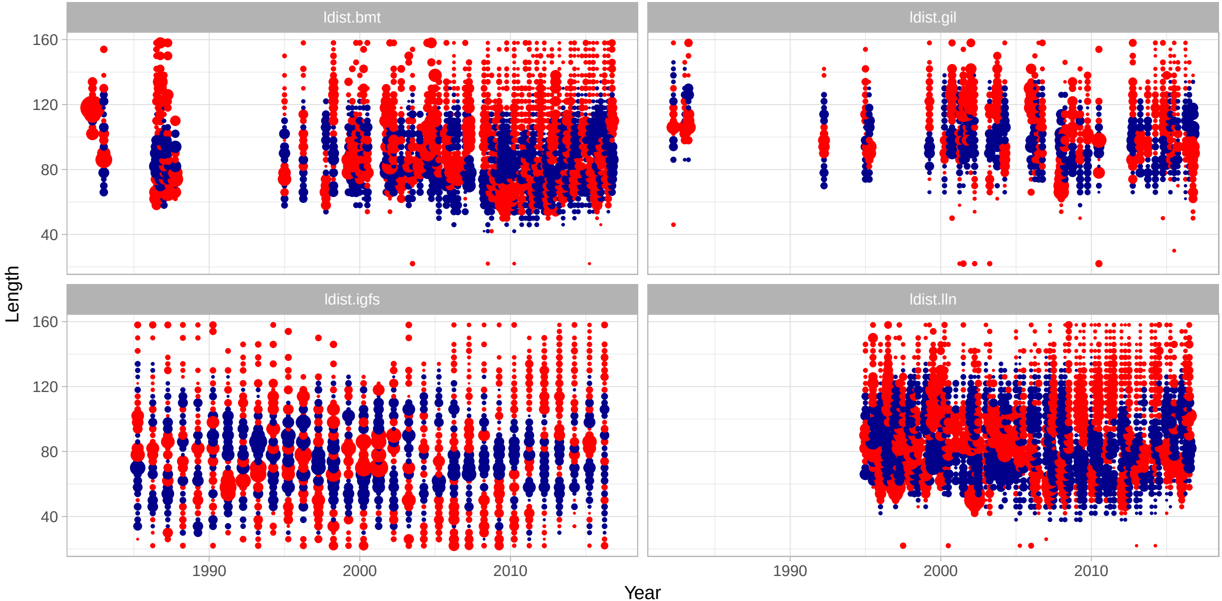


HAFRANNSOKNASTOFNUN

Fit to survey indices

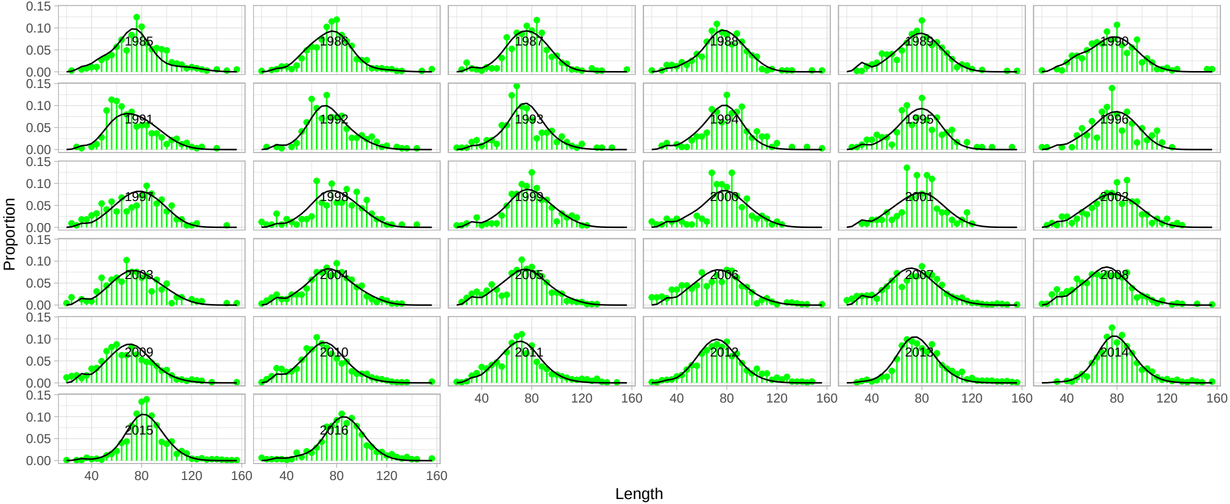


Fit to length distributions



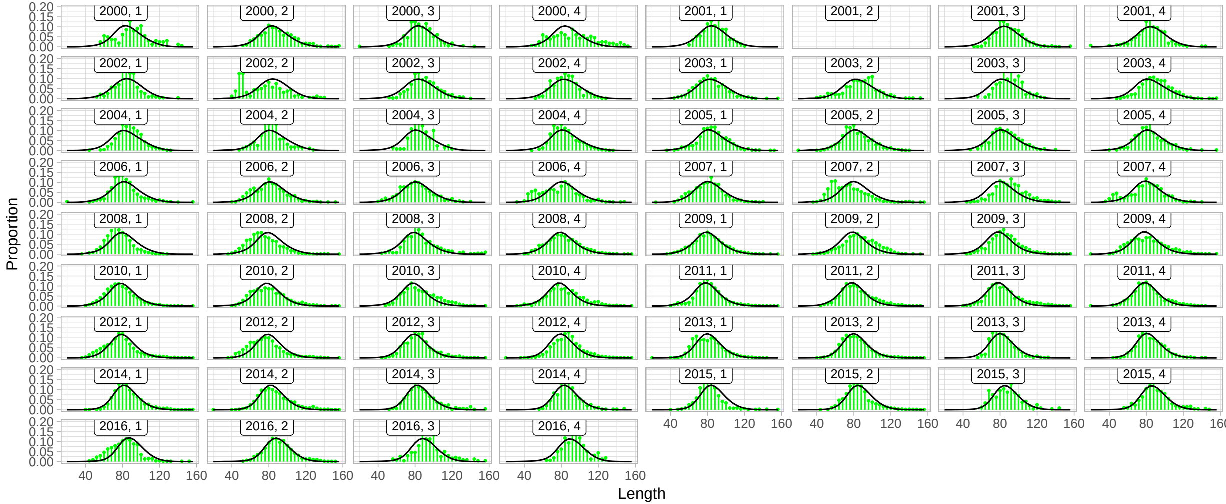
HAFRANNSOKNASTOFNUN

Fit to data – survey length distributions

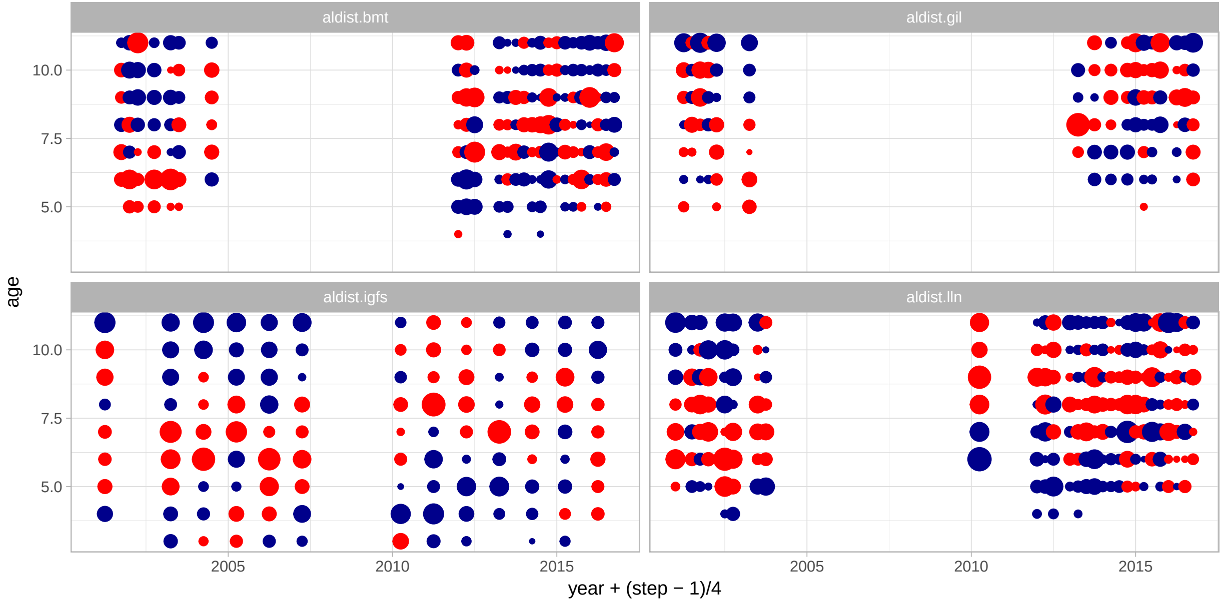


HAFRANNSÓKNASTOFNUN

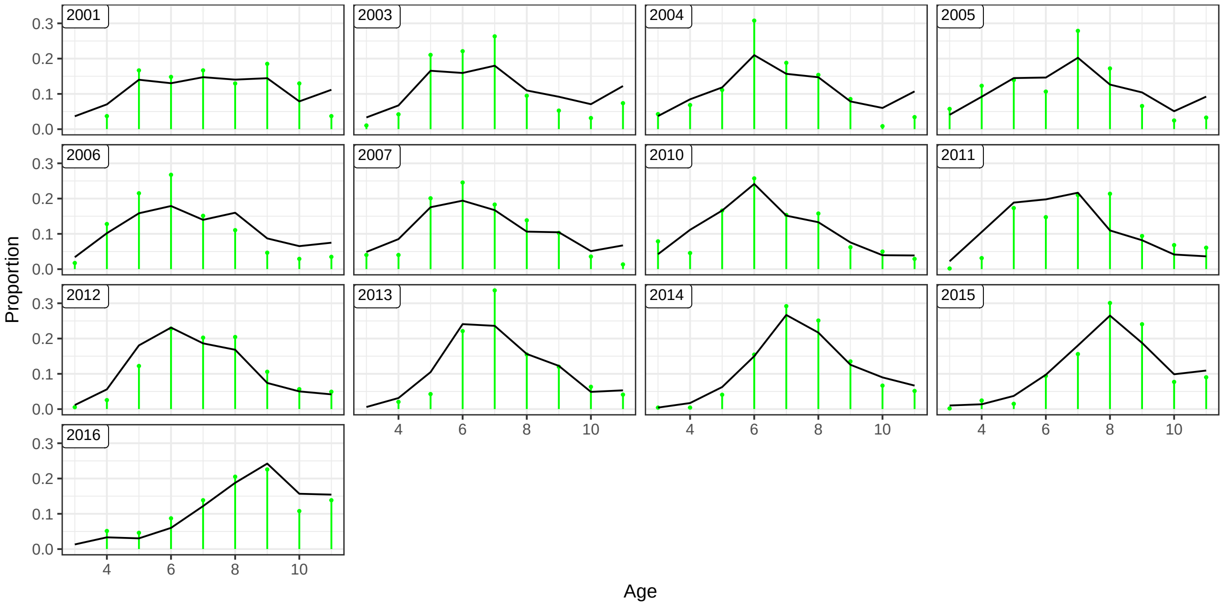
Fit to data – longline length distributions



Fit to age distributions

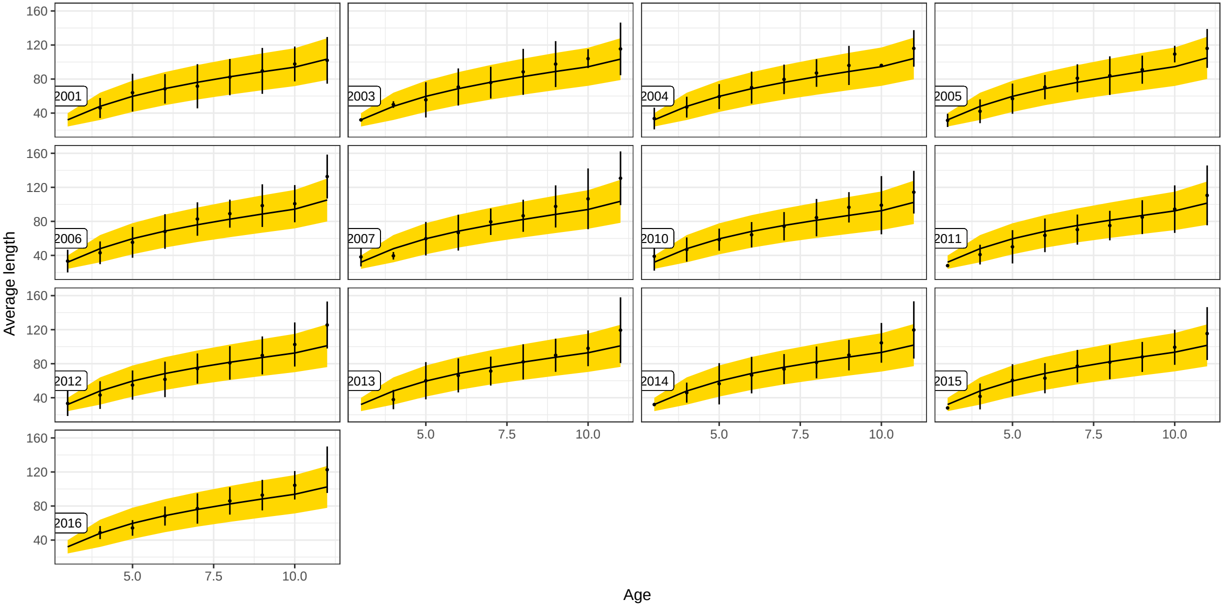


Fit to data – survey age distributions



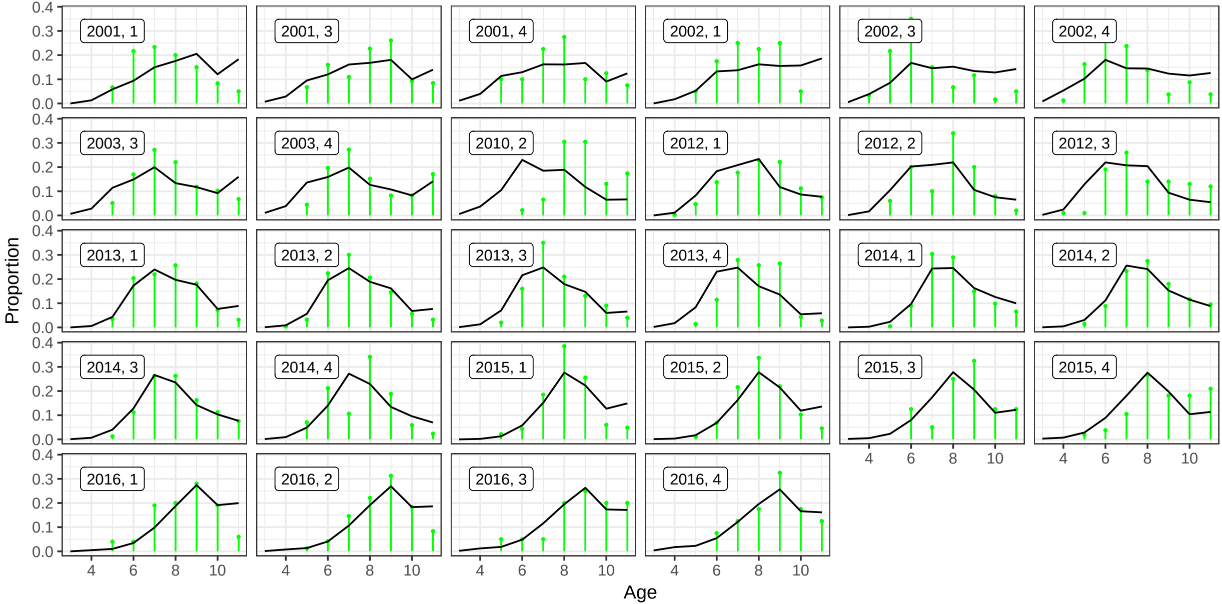
HAFRANNSOKNASTOFNUN

Fit to data – survey growth data



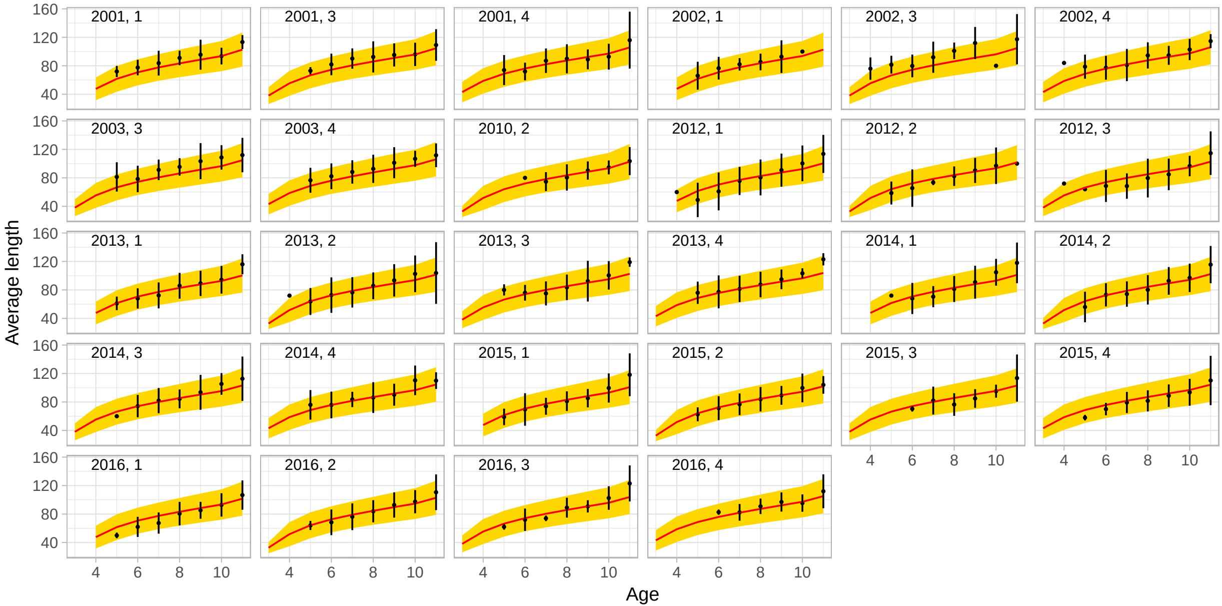
HAFRANNSOKNASTOFNUN

Fit to data – longline age distributions



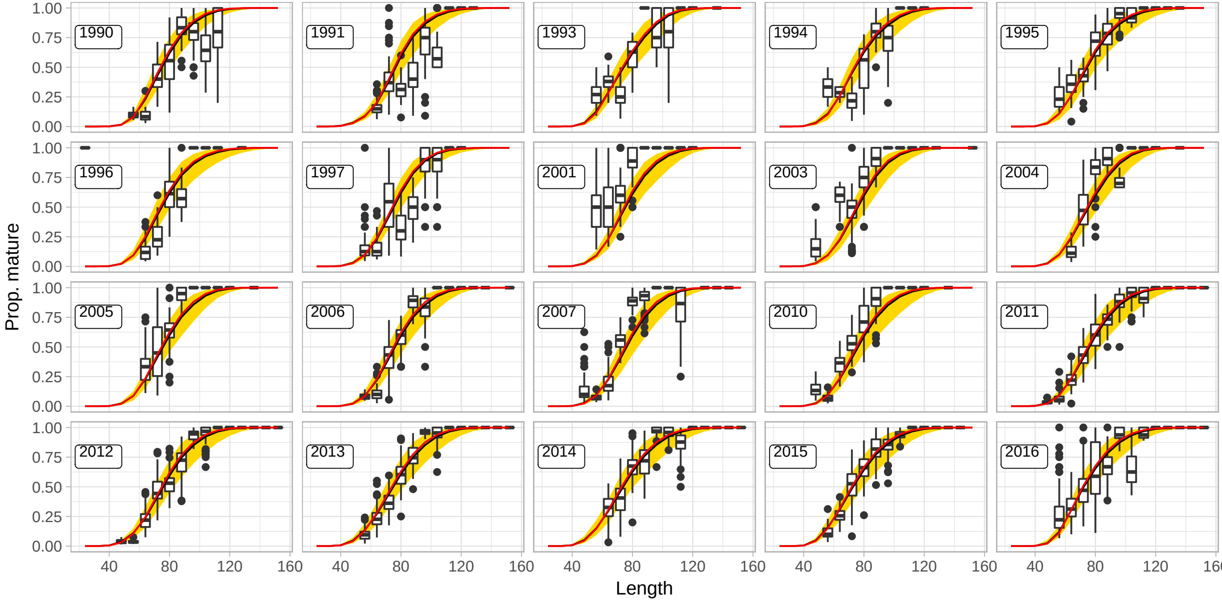
HAFRANNSOKNASTOFNUN

Fit to data – longline growth data



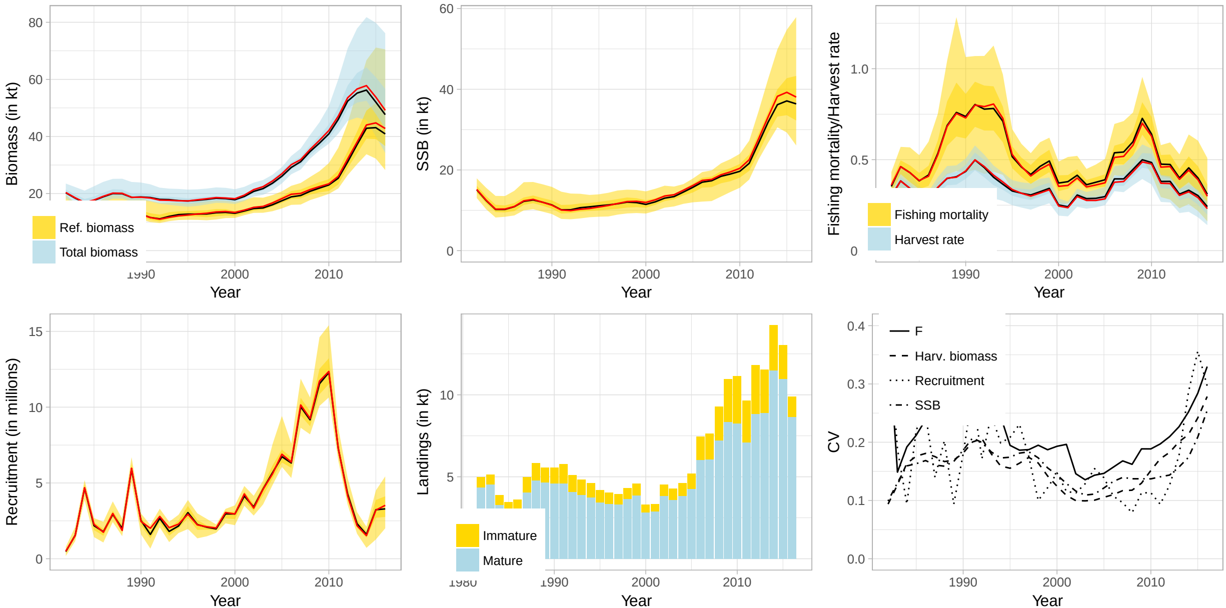
HAFRANNSOKNASTOFNUN

Fit to data – survey maturity



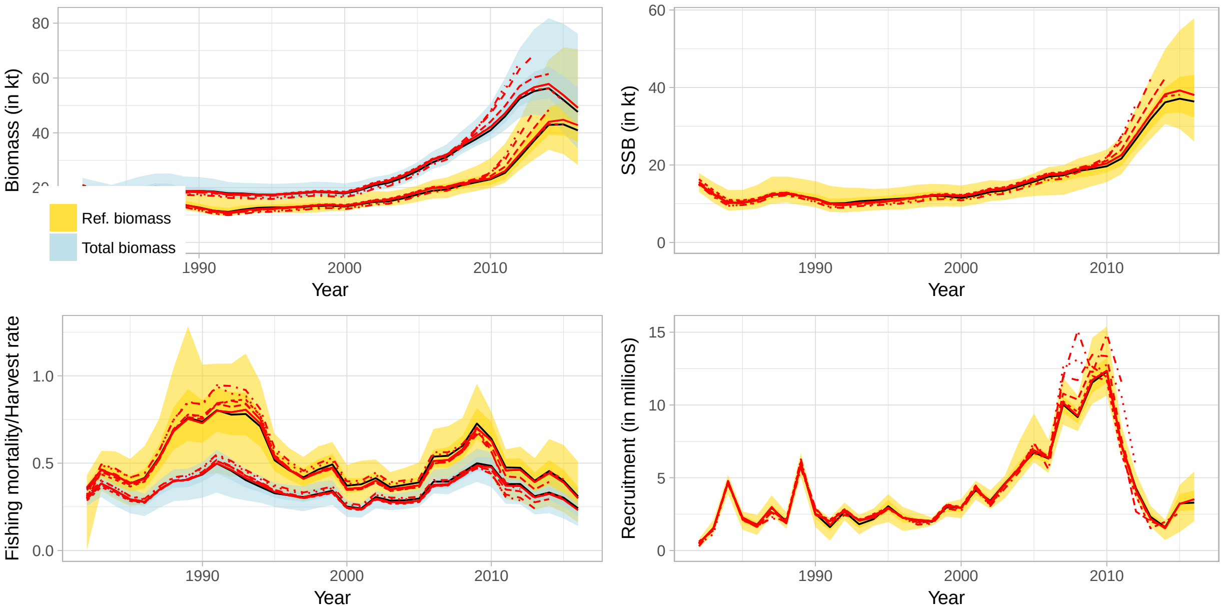
HAFRANNSOKNASTOFNUN

Assessment results



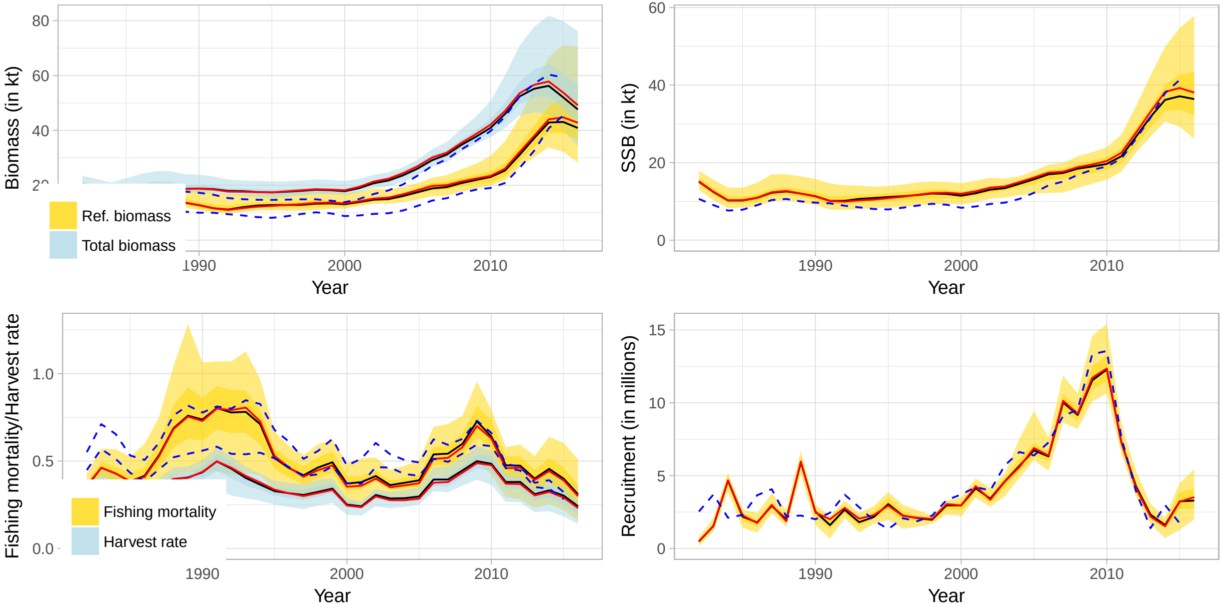
HAFRANNSOKNASTOFNUN

Analytical retrospective



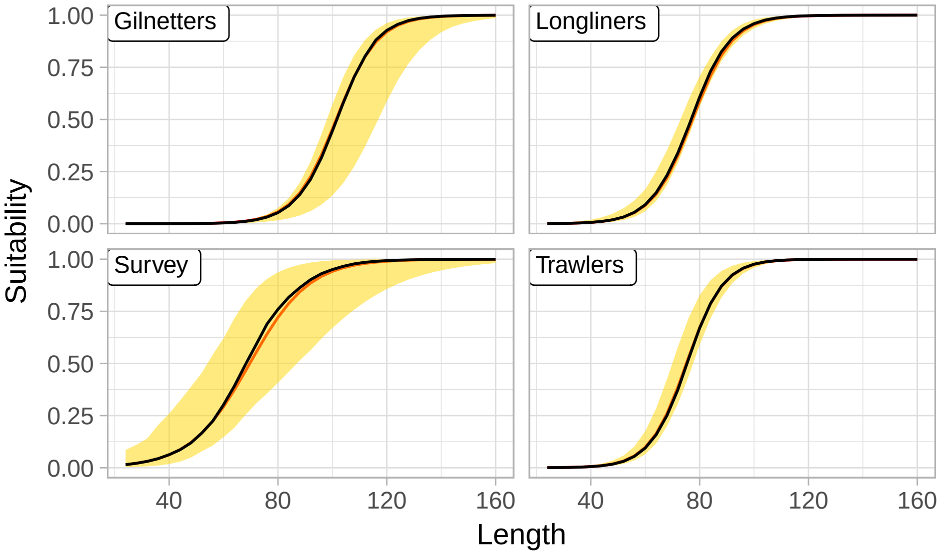
HAFRANNSOKNASTOFNUN

Comparison with previous assessment



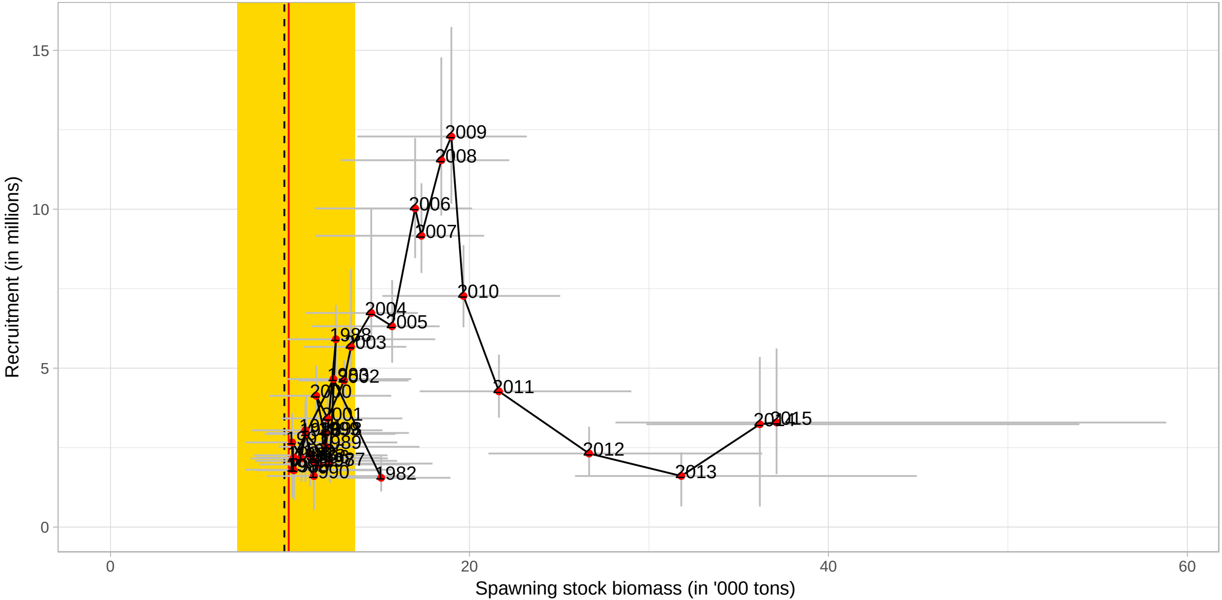
HAFRANNSOKNASTOFNUN

Fleet selection



HAFRANNSÓKNASTOFNUN

SSB-Rec relationship



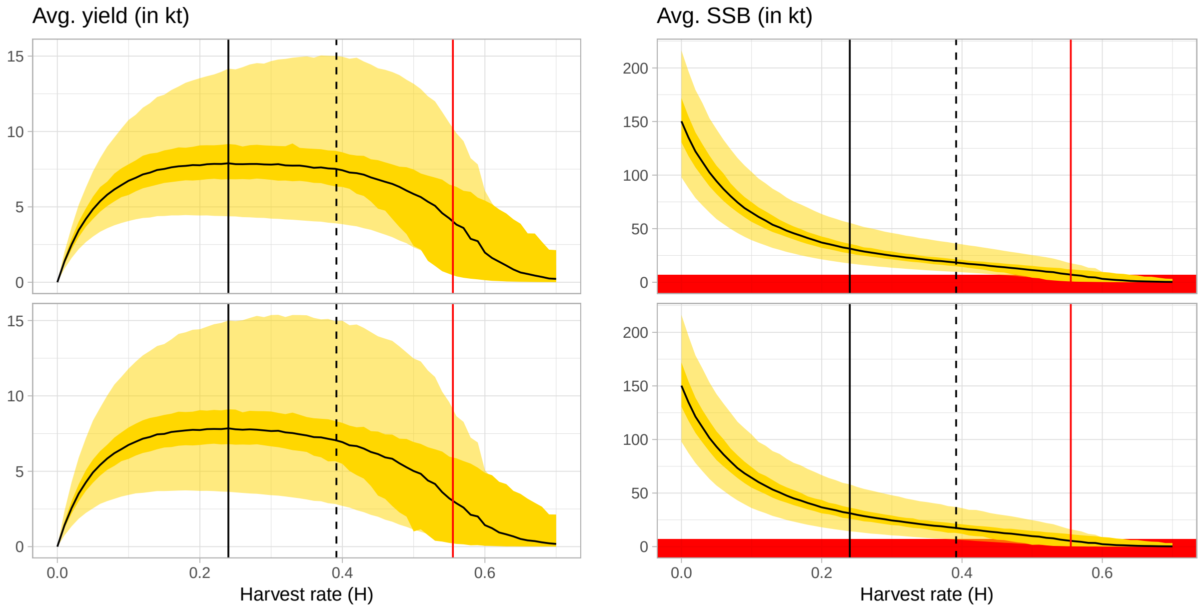
HAFRANNSOKNASTOFNUN

Derivation of reference points

- The proposed form for managment rule is $C_y = HB_{75cm^+}$
- No evidence of impaired recruitment and fishing mortality is considered to have been low
- $B_{loss} = 9.93kt$ is suggested as a candidate for B_{pa}
- $B_{lim} = B_{pa}/1.4 = 7.09$
- H_{lim} set as the harvest rate that has 50% chance of SSB being at B_{lim} via stochastic simulation without assessment error
- Variability in recruitment is based on a block bootstrap of estimated recruitment, block size of 6 consequtive years.
- F_{lim}, F_{pa} and H_{pa} are estimated based on the estimate of H_{lim}
- H_{msy} is based on simulation with assessment error (lognormal with $\rho = 0.8$, and σ as the CV of B_{75cm^+})

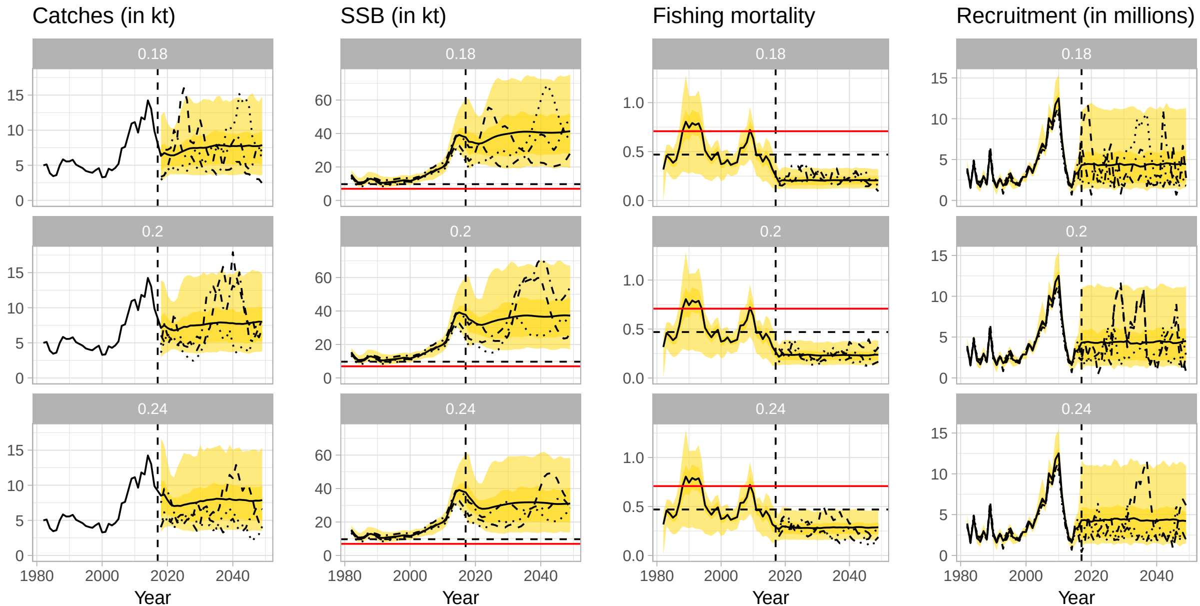
HAFRANNSÓKNASTOFNUN

Equilibrium yield and SSB



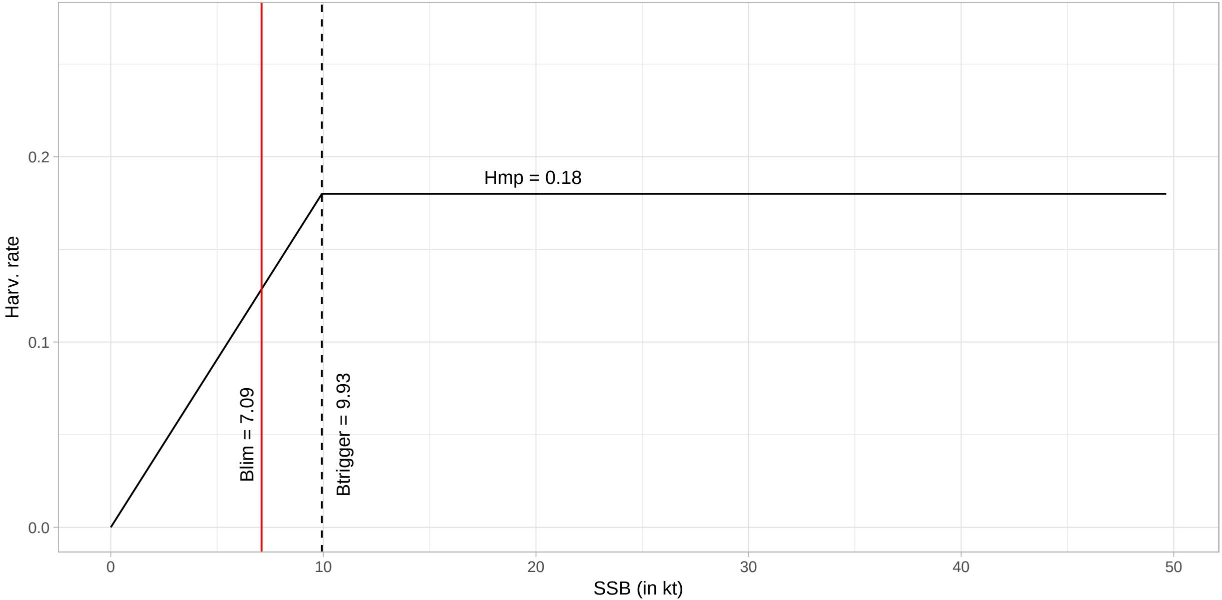
HAFRANNSOKNASTOFNUN

Projections



HAFRANNSOKNASTOFNUN

Proposed management plan



Tafla: Ling in 5a. Summary of reference point proposed for ling in 5a.

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	9.93 kt	B_{pa}
	H_{msy}	0.24	The harvest rate that maximises the median long-term catch in stochastic simulations with recruitment drawn from a block bootstrap of historical recruitment scaled according to a hockey stick recruitment function with B_{lim} as defined below.
	F_{msy}	0.284	The median fishing mortality when an harvest rate of H_{msy} is applied.
	$H_{p.\mathbf{05}}$	0.497	The harvest rate that has an annual probability of 5% of SSB $< B_l im$.
	$F_{p.\mathbf{05}}$	0.516	The median fishing mortality when an harvest rate of $H_{p.\mathbf{05}}$ is applied.
Precautionary approach	B_{lim}	7.09 kt	$B_{pa}/e^{\mathbf{1.645}\sigma}$ where $\sigma = 0.2$
	B_{pa}	9.93 kt	SSB(1992), corresponding to B_{loss}
	H_{lim}	0.56	H corresponding to 50% long-term probability of SSB $> B_{lim}$
	F_{lim}	0.70	F corresponding to H_{lim}
	F_{pa}	0.41	$F_{lim}/e^{\mathbf{1.645}\sigma}$ where $\sigma = 0.33$
	H_{pa}	0.35	H corresponding to F_{pa}
Management plan	H_{mp}	0.18	H such that $P(SSB < B_{pa}$|for any given year$) < 0.05$.

HAFRANNSÓKNASTOFNUN