A Length-Based Catch Curve for Mulitgear Fisheries

IO YFT Example

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Motivation

- Use length frequency data (as LBSPR with variable growth)
- Bayesian fitting
- Allow flexible selectivity functions and multiple gears

Assumptions

1. **The population has been in an approximate steady-state for a generation or more around when the length sampling takes place (No time series).**
2. Mean growth follows the von Bertalanffy growth curve.
3. Fish asymptotic size (L_∞) is Gamma distributed for individual fish which governs growth variability.
4. Mortality fixed within each length interval. It can vary arbitrarily between intervals.
5. **Length data are representative of the catch length composition and the relative total catch numbers for each selectivity group.**

MODEL DESCRIPTION

Population Model

The probability that fish will survive to length interval n with lower bound L_n is given by:

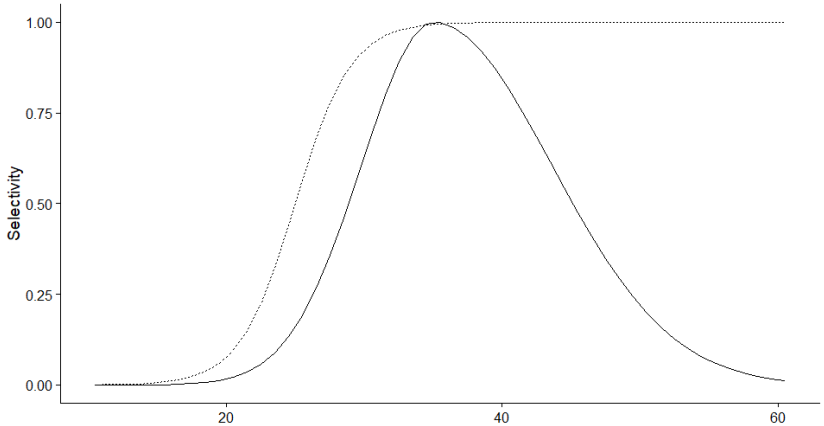
$$S_n = \int_{L_n}^{\infty} \frac{\beta^{\alpha}}{\Gamma(\alpha)} L_{\infty}{}^{\alpha-1} e^{-\beta L_{\infty}} (L_{\infty} - L_0)^{-Z_1} (L_{\infty} - L_n)^{Z_n} \prod_{i=1}^{n-1} (L_{\infty} - L_i)^{Z_i - Z_{i+1}} dL_{\infty}$$

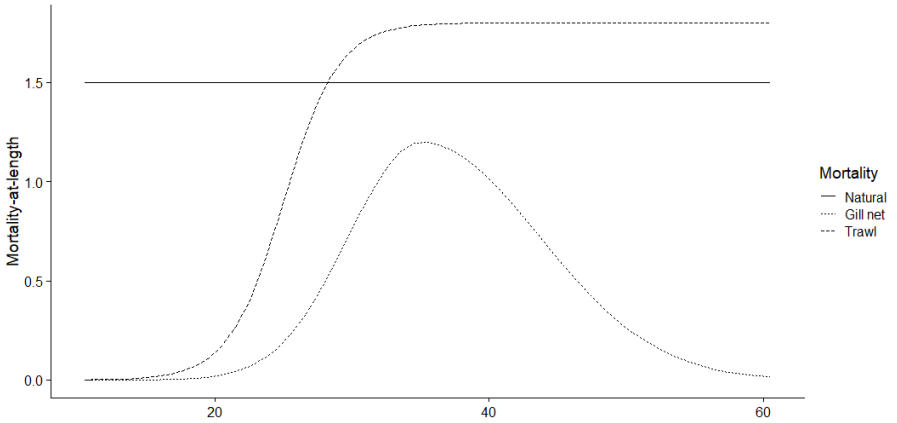
- $N_n = \frac{S_n - S_{n+1}}{Z_n}$

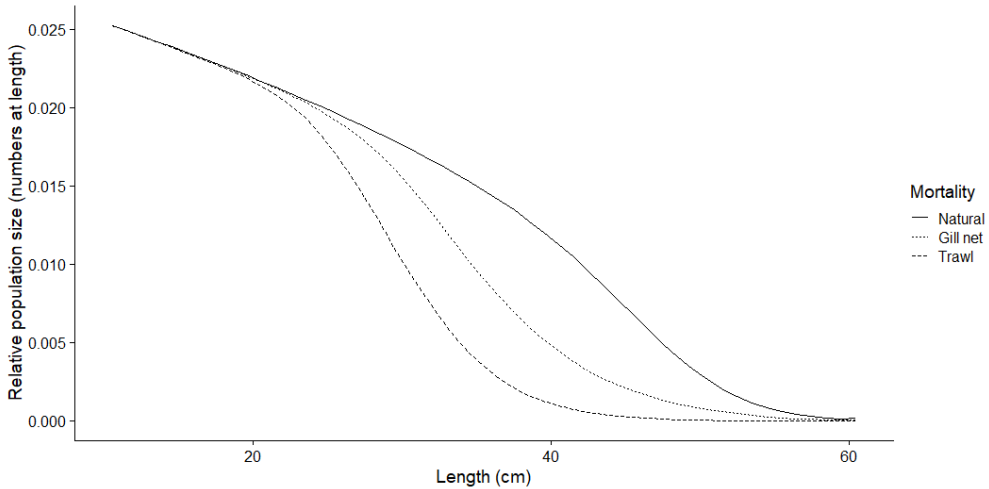
  $C_n = \frac{F_n}{Z_n}(S_n - S_{n+1})$
- F_n will reflect the selectivity pattern, can be split into multiple gears.

Gauss-Laguerre quadrature is used for numerical integration (fast and accurate in this case).

Multiple Gears







APPLICATION

Application R package: *fishblicc*

- Work-In-Progress
- Implements Bayesian length-based catch curve (in Stan)
- Selectivity models based on **simple mixtures** of logistic, normal, single-sided normal and double-sided normal
- Simulation testing suggests similar results to LBSPR for single gear logistic selectivity

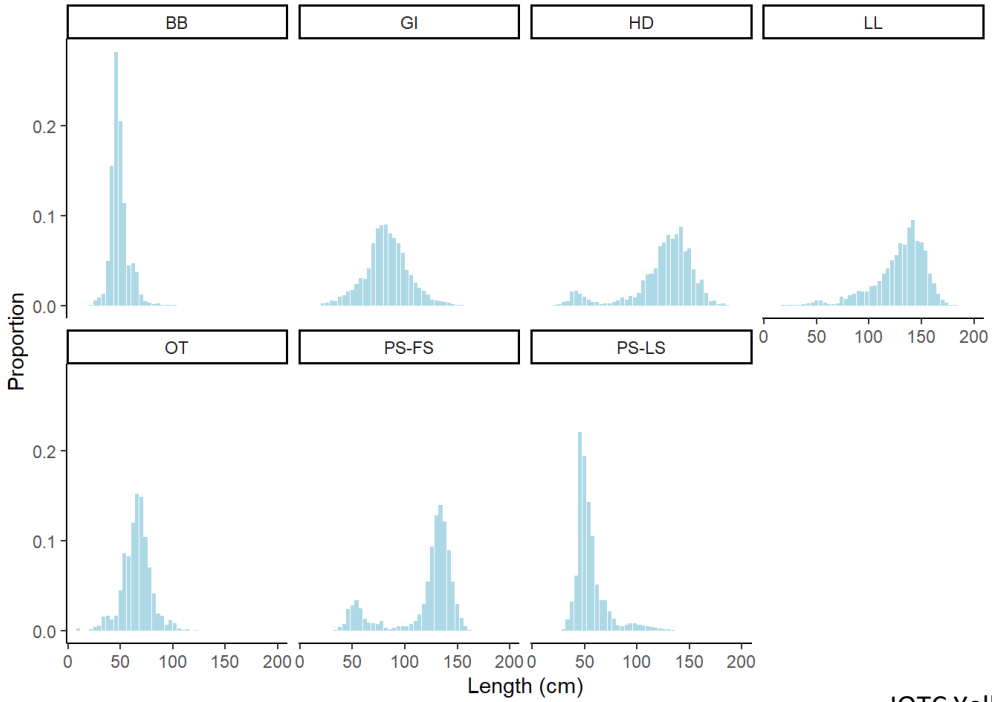
- R Package: https://github.com/**PaulAHMedley/fishblicc**

Priors

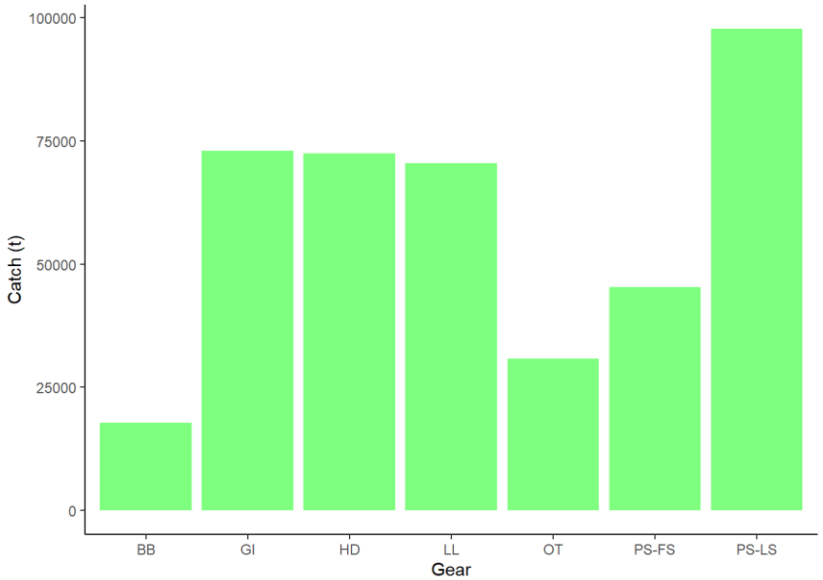
- Informative priors:
  - L_∞ is required - often available from Fishbase or elsewhere
  - Natural mortality: M ≈ 1.5 K
  - Growth CV (Galpha) - default 10%
  - K and t_0 not required
- Non-informative priors (usually)
  - Fishing mortality / selectivity parameters
  - Observation error

ILLUSTRATIVE EXAMPLE: IO YELLOWFIN

Yellowfin Length Frequency Data + Catches

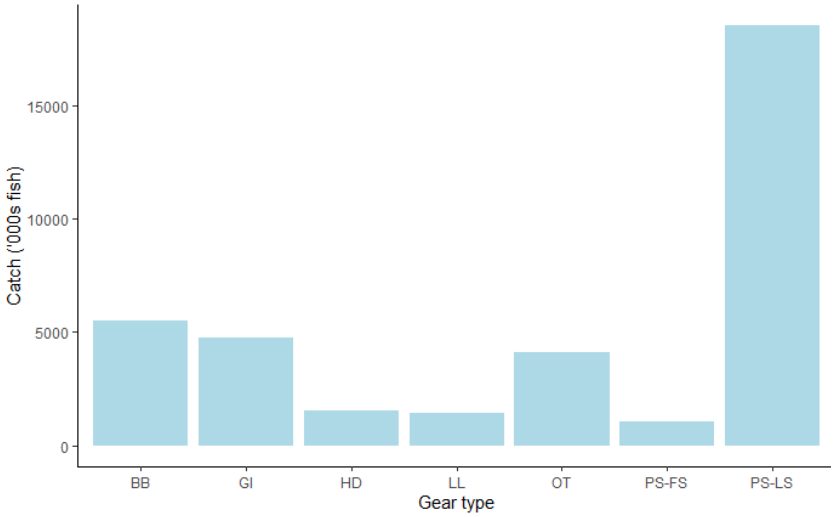


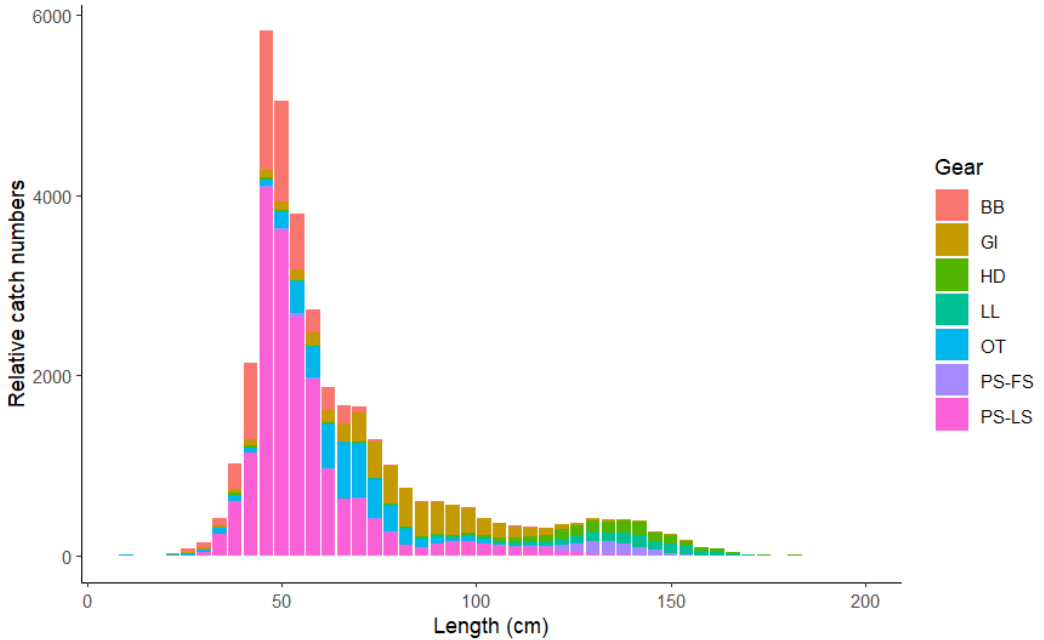
Aggregated 2014 – 2018



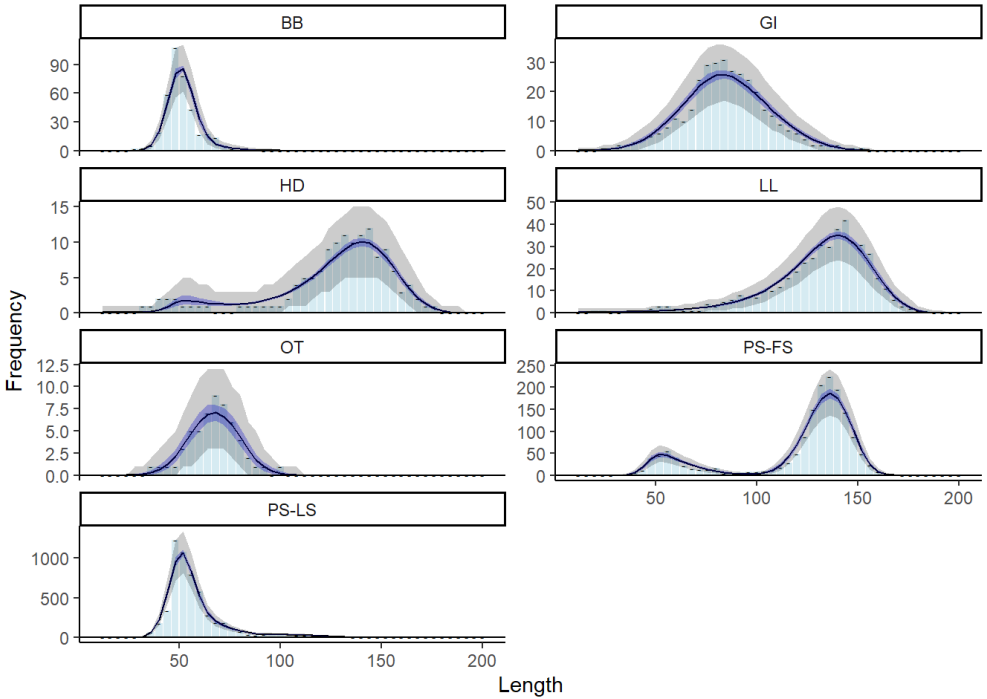
IOTC Yellowfin data used in the 2019 stock assessment SS3 V3.30
https://iotc.org/sites/default/files/documents/2019/09/IOTC-2019-WPTT21-DATA15-YFT_SA_0.zip#"Stock assessment inputs (SS3 and SCAA) for YFT"#"IOTC-2019-WPTT21-DATA15"

Catch Numbers



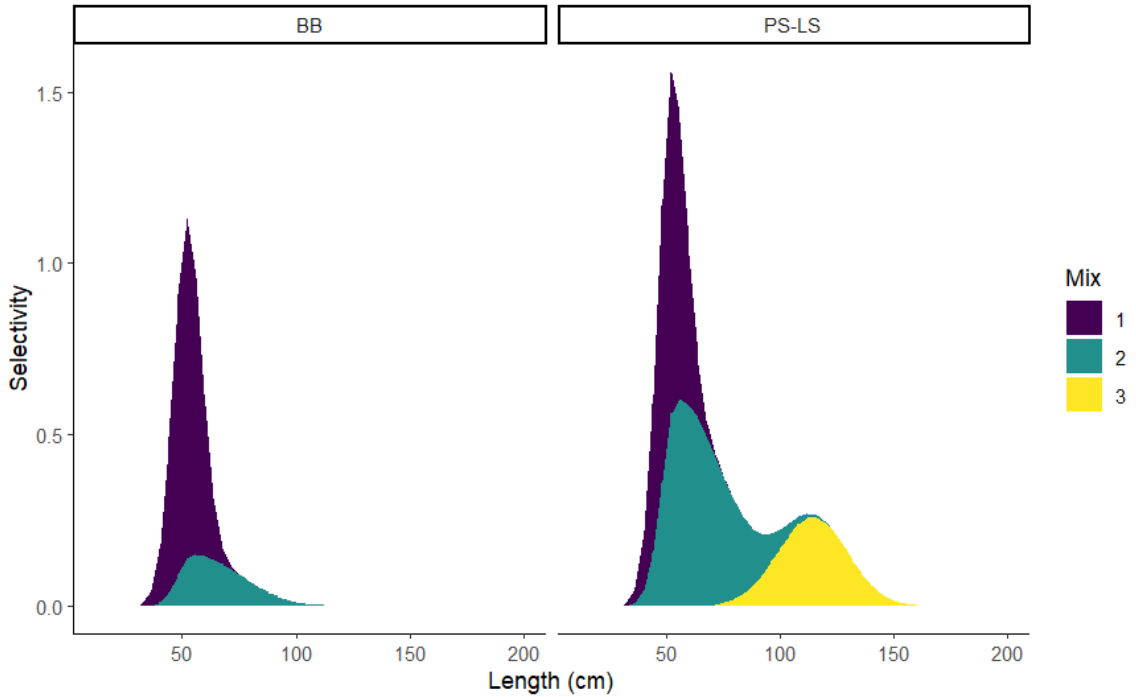


Fitted model



- Selectivity mixtures
- Length-inverse M
- Fishbase L_∞

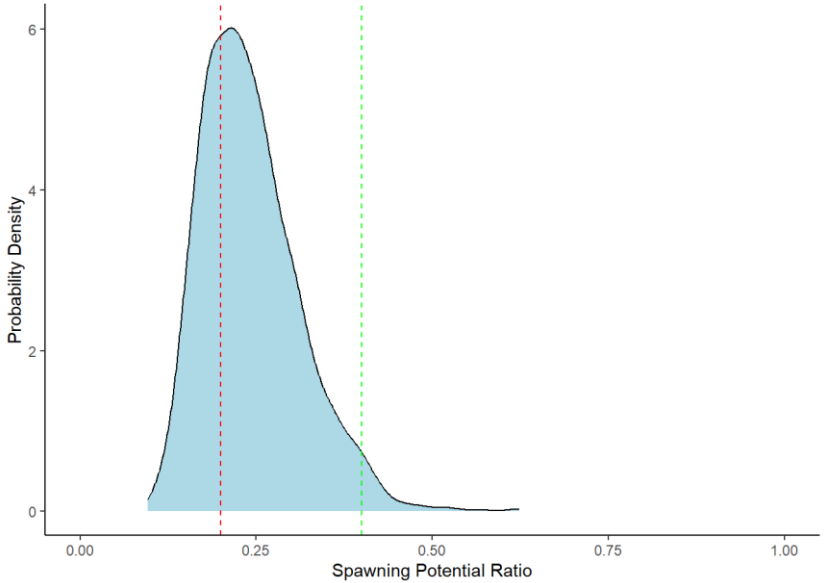
Selectivity Mixtures

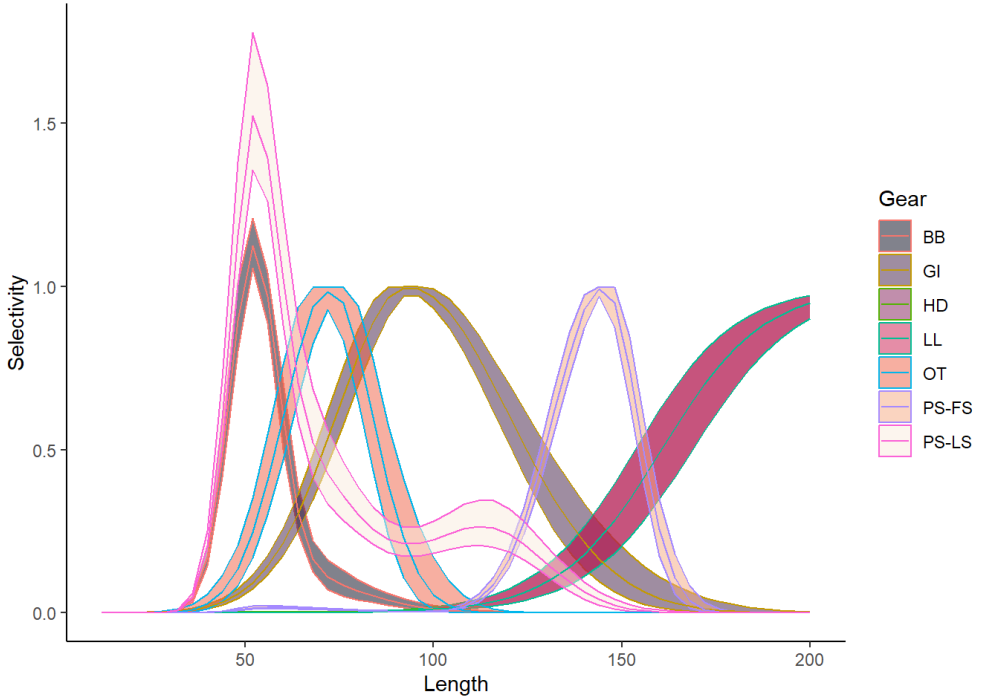


Model Flexibility

Scenario	L_∞	Galpha	M/K	SPR	lp	Decision
All domed single selectivity	166.67	73.17	4.00	0.80	-812.9	Rejected
Selectivity Mixture Model	179.06	133.28	1.61	0.21	-550.7	Accept
Allow Linf estimation	160.44	170.07	1.50	0.61	-549.6	Sensitivity
Length-inverse M	178.87	123.84	1.68	0.23	-547.6	Accept
Longline dome-shaped	184.30	98.14	1.48	0.80	-559.3	Rejected
SS3 parameters	148.16	164.54	0.73	0.48	-537.1	Sensitivity

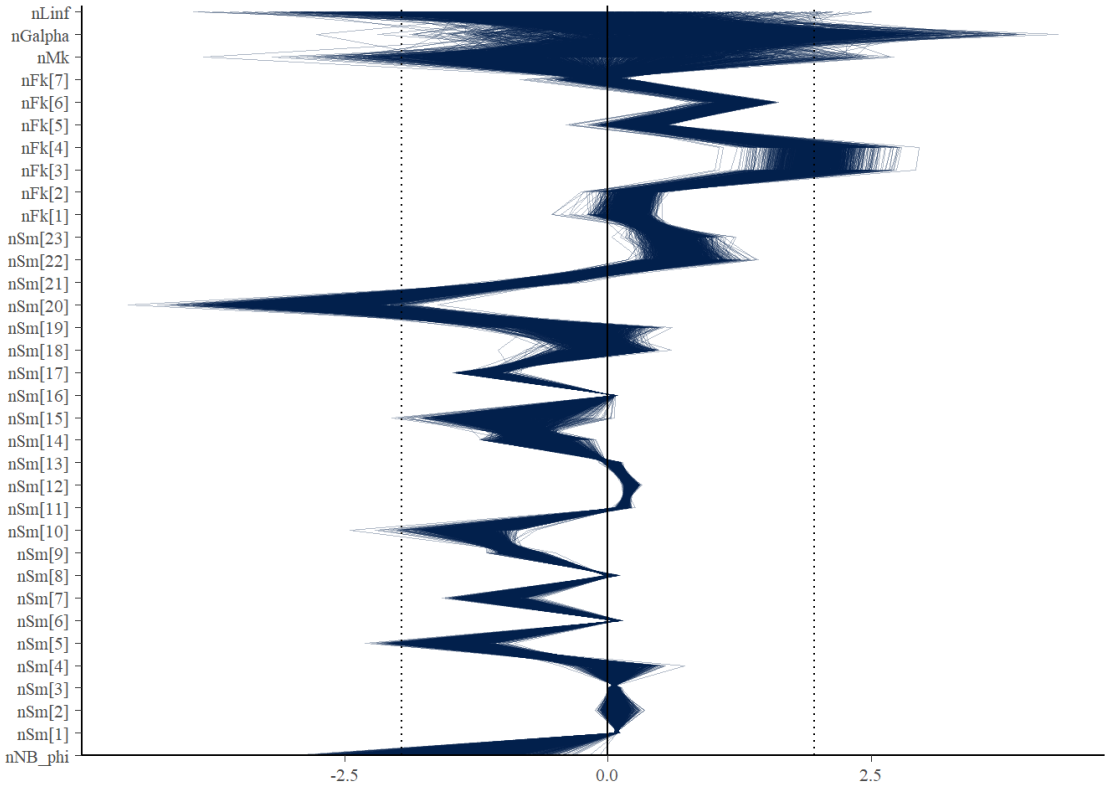
Results


Probability Density
0
2
4
6
0.00
0.25
0.50
0.75
1.00
Spawning Potential Ratio

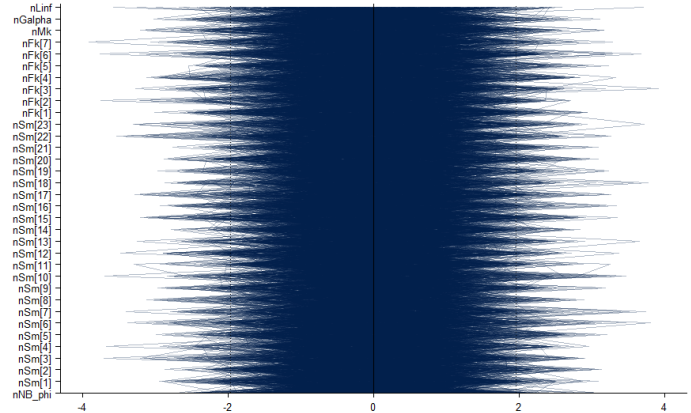

Selectivity
0.0
0.5
1.0
1.5
50
100
150
200
Length
Gear
BB
GI
HD
LL
OT
PS-FS
PS-LS

Parameter Estimates

Posterior



Prior



Conclusion

- Bayesian length-based catch curve with flexible modelling of mortality-at-length implemented in the *fishblicc* package
- *Key assumption* is population is in stationary state
- *Fits* single and multiple sample length frequency data
- *Estimates* F-at-length, selectivity, SPR, YPR etc.
- *Used* for data limited assessments + examine selectivity models
- *Caution* with overfitting (use sensitivities)