NIWA

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Climate, Freshwater & Ocean Science

IOYFT CASAL/Casal2 Simulation

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CASAL/Casal2 - Overview

- Spatially explicit, can include multiple spawning stocks that are separate, i.e., multiple stock recruitment relationships
- Space expressed via user defined category definitions, i.e., Eastern.female, Western.female etc. Limited by data and/or computation constraints
- Most spatially explicit stock assessments in New Zealand assume natal fidelity, i.e., fish spawned from a given stock will return to their natal spawning ground
- Can account for tag releases and recaptures by length.
- Current spatial stock assessments

1. Antarctic toothfish – Continuous tag release and recapture studies
2. Snapper (SNA1) - three areas three stocks natal fidelity model with periods of mixing. Two large scale tag-release recapture experiments
3. Hoki - Four areas and two separate spawning stocks, natal fidelity model with separate stock spawning grounds
4. Kahawai – Fleets-as-areas model

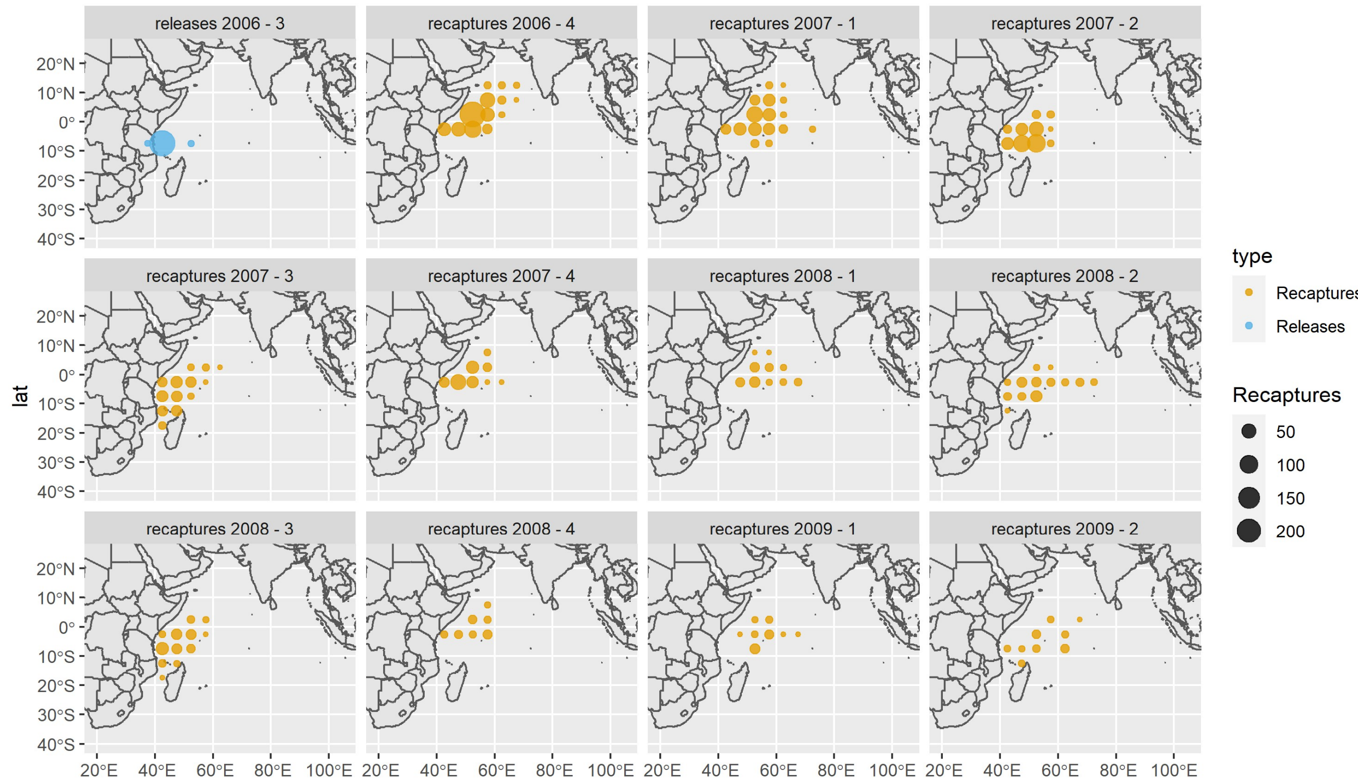
Project overview/approach

1. Characterisation to understand the fishery and available data
2. Model development (general approach was to start simple and build complexity)

- Today: Present models and decisions that we have made to date and discuss next steps

1) Characterisation – tagging data

- Tag releases spatially unbalanced i.e., limited movement information, other than movement from the release region
- Indicated seasonal patterns in recaptures



1) Characterisation – Tag-recapture observations in CASAL/Casal2

CASAL/Casal2's can include tag recapture by length observations.
This assumes the length frequency of the recaptured tagged fish (m_l) and scanned fish (n_l) are known.

$$m_l \sim QuasiBinomial(p_l,\ n_l, \emptyset)$$

$$p_l = \frac{M_l}{N_l}$$

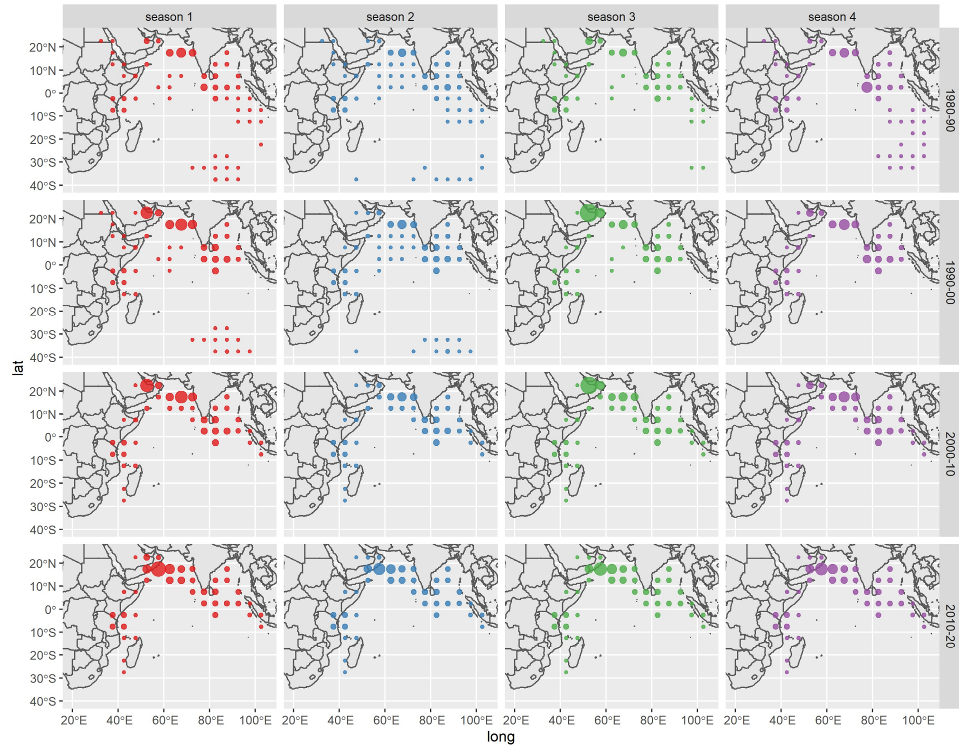
M_l = model predicted tagged fish in length bin l
N_l = model predicted untagged fish in length bin l
m_l = observed recaptures in length bin l
p_l = mark rate for length bin l
n_l = fish scanned in length bin l
$\emptyset$ = overdispersion parameter

1) Characterisation – tag-recapture observations in CASAL/Casal2

- Tag recapture observations are essentially Peterson estimators for each length bin
- Mainly used to inform biomass, growth and movement
- Because recaptures are not tied to a fishing process, there is no (limited) information on F
- Due to the above, tag-recapture was not included in single area model. Spatial models could use the tagging data for movement and local biomass but the spatially unbalanced nature of the release data is problematic.

1) Characterisation – Catch

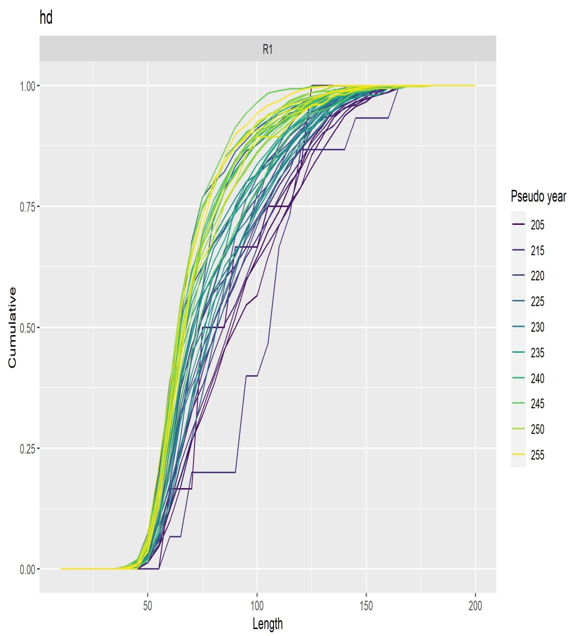
- No effort data for fisheries other than longline (via CPUE). When visualising catch spatial distributions we assumed they were the result of changes in available (exploitable) abundance, not change in effort
- Spatial distributions showed changes in trends over time i.e., gill fishing south in early periods and not in later periods, as well as seasonal patterns i.e., purse seine fishery.



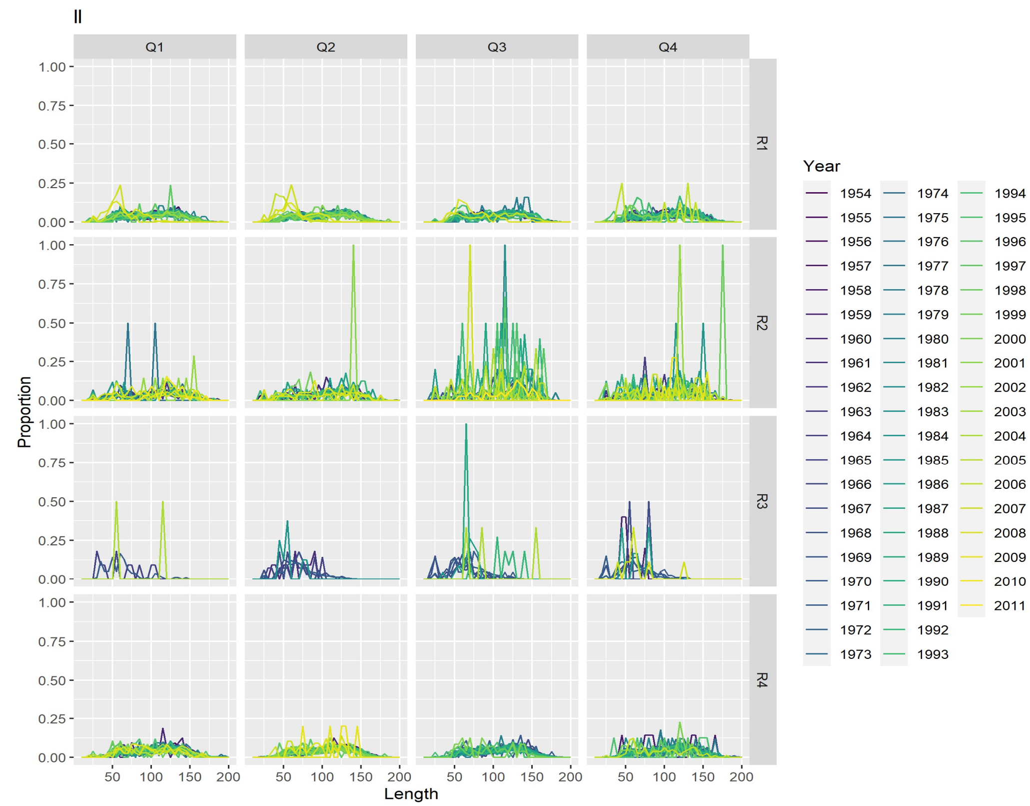
Gill net catch by season (cols) and decade (rows)

1) Characterisation – Length frequency

- trends over time (i.e., hand line fishing)
- Identified sparsity issues (spiky LFs)



Hand line cumulative length frequency over time



Long line length frequency by quarter (cols) and area (rows)

2) Model development

1. Single area model
2. Fleets as areas model
3. Four area model (not fully investigated to date)

2) Model development - Single area model

- How to deal with time? i.e., pseudo year vs annual year with seasons

1. Initial models were set up in CASAL, had a limitation of only one spawning/recruitment event per year. Casal2 can overcome this.
2. Pseudo year out of convenience given known biology for that time-interval

- Should we include “season” in the fisheries?

1. Initially ignored season (start simple) we were unsure if the data would support this complexity.

- Age-based vs Length-based partition

1. CASAL has the ability to model numbers at length (length-based) instead of numbers at age (age-based). Numerous length frequency data no age frequency data. Rationale for using length-based models is they don’t require internal age-length conversions. We decided to explore both age-based and length based single area models in Casal2

2) Model development - Fleets-as-areas model

- The most practical "spatial" model which uses fisheries to proxy space
- How to set up fisheries

1. Whether to incorporate seasonality? Initially assumed no seasonality in selectivities

- Catchability assumptions on abundance indices

1. Whether to have area specific q vs global q? Explored both global and fleet specific q's options

2) Model development - Four area model

- Lower priority due to the following Issues

1. Tag release data spatially unbalanced difficult to estimate movement parameters
2. Sparsity of LFs by method, area and season

2) Model development - **Single area model (Age based)**

- Starting assumptions

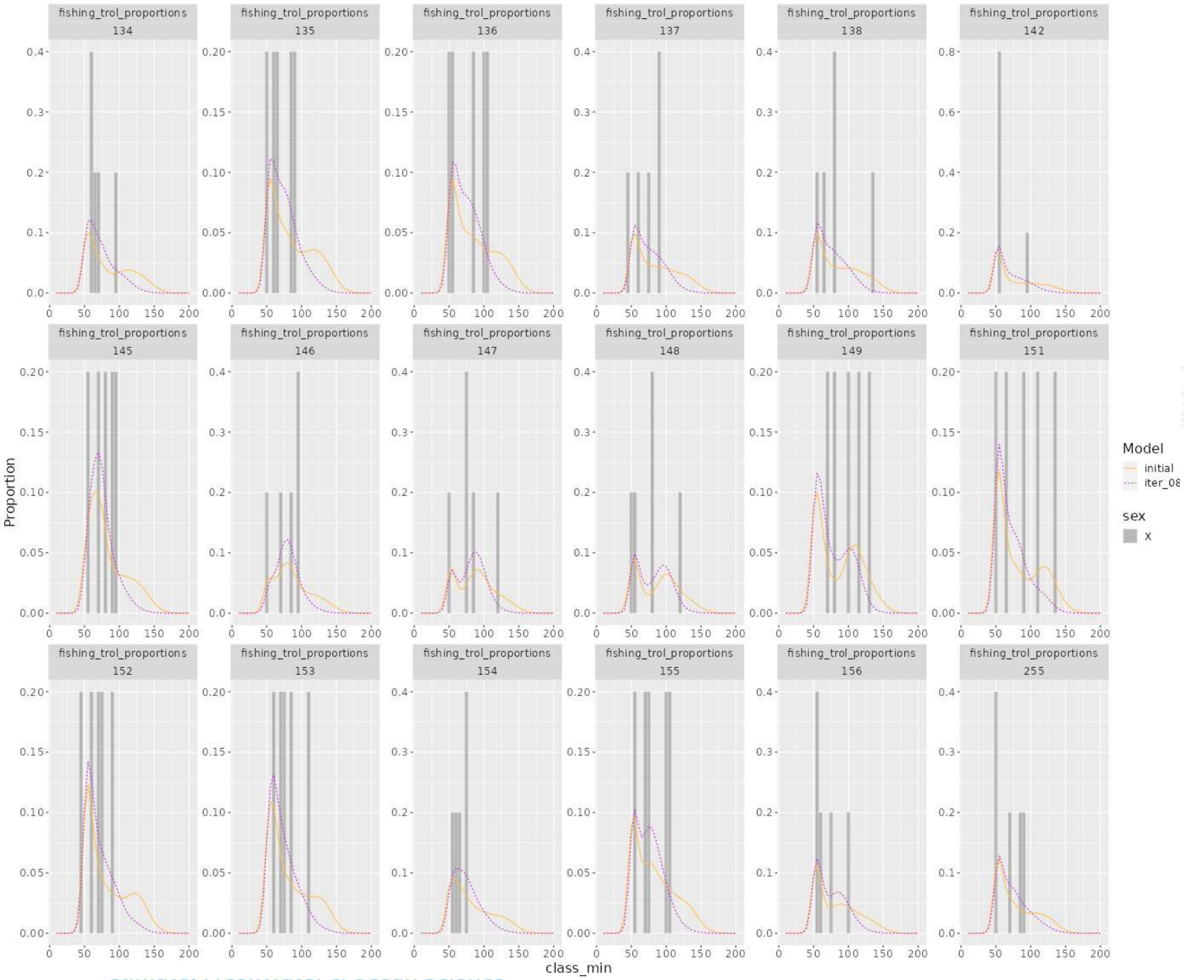
1. Biology set to OM info
2. Diagnostics – CPUE used residuals, LF data used aggregated observed and expected due to sparsity issues with zeros
3. Used likelihood comparisons with diagnostics to alter model assumptions

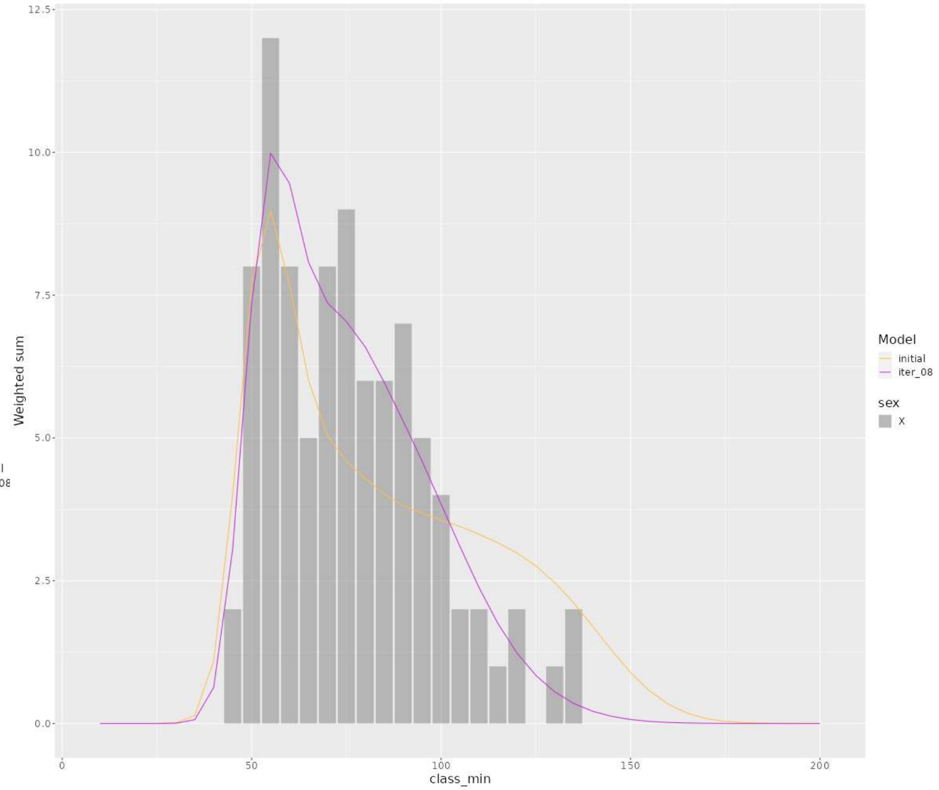
- Main explorations

1. Changing selectivities model likelihood improvement and fitting diagnostics (without data reweighting)

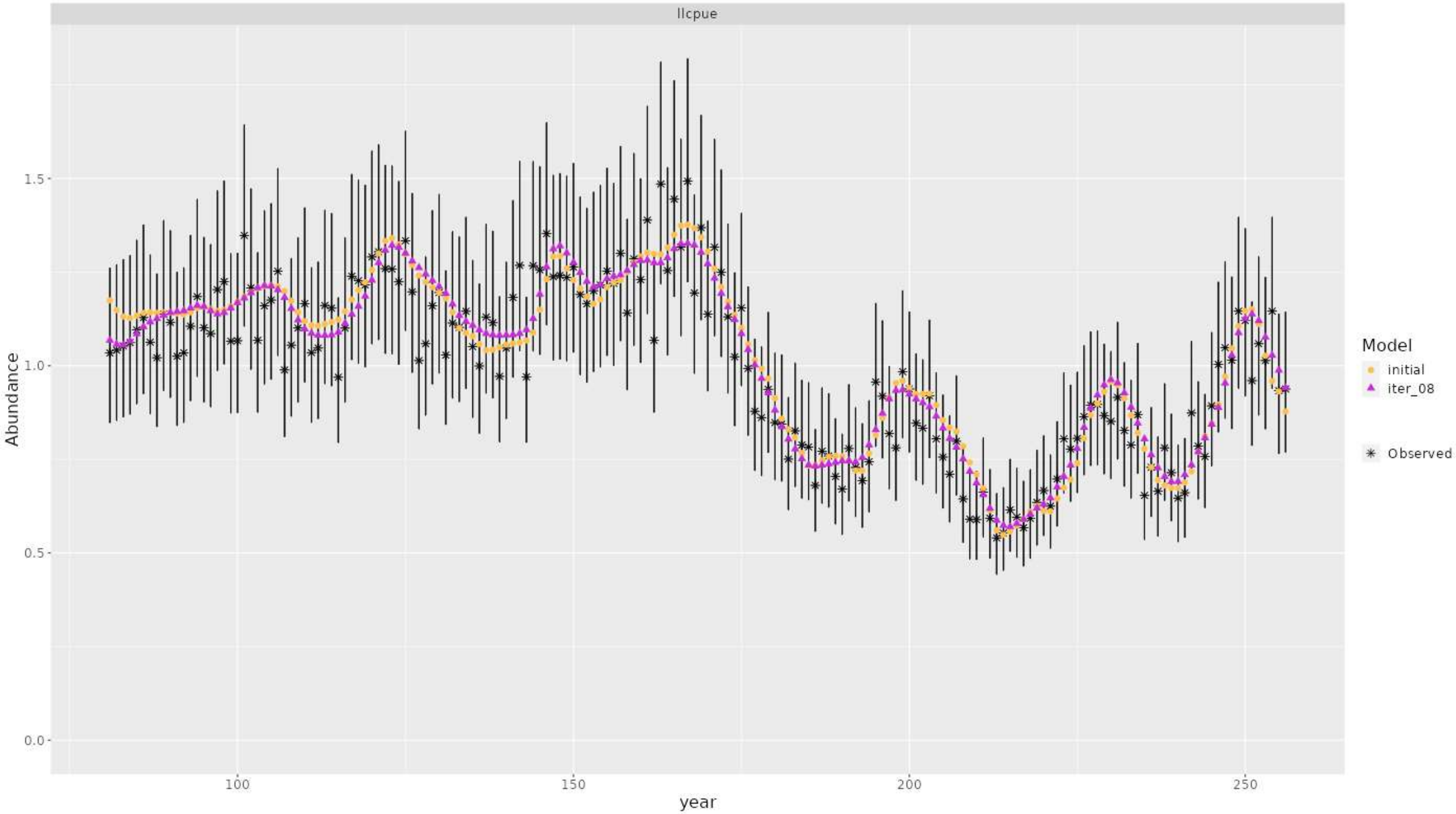
- Final model was then reweighted using Francis T A1.8 method

Single area trol length composition data

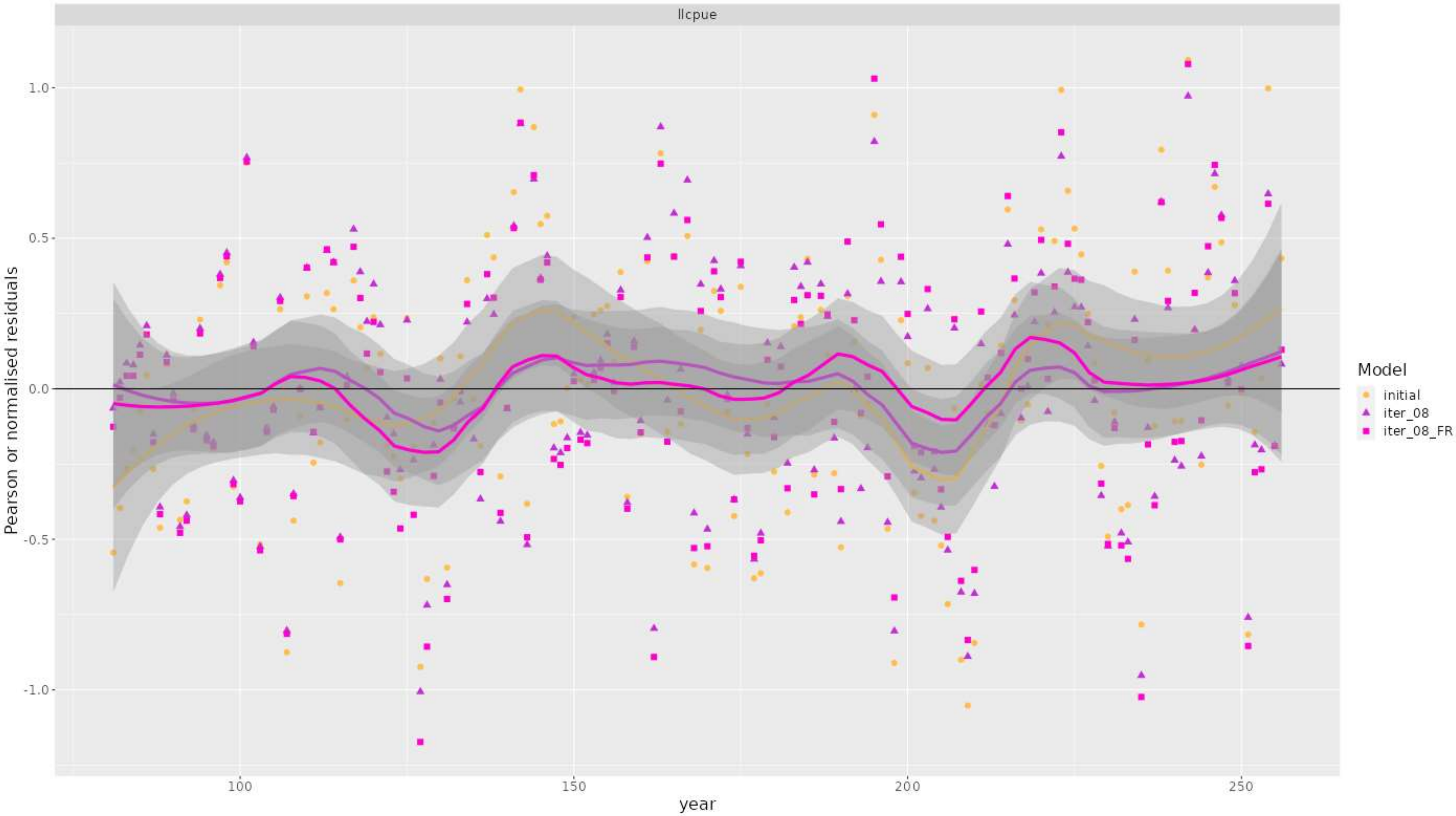




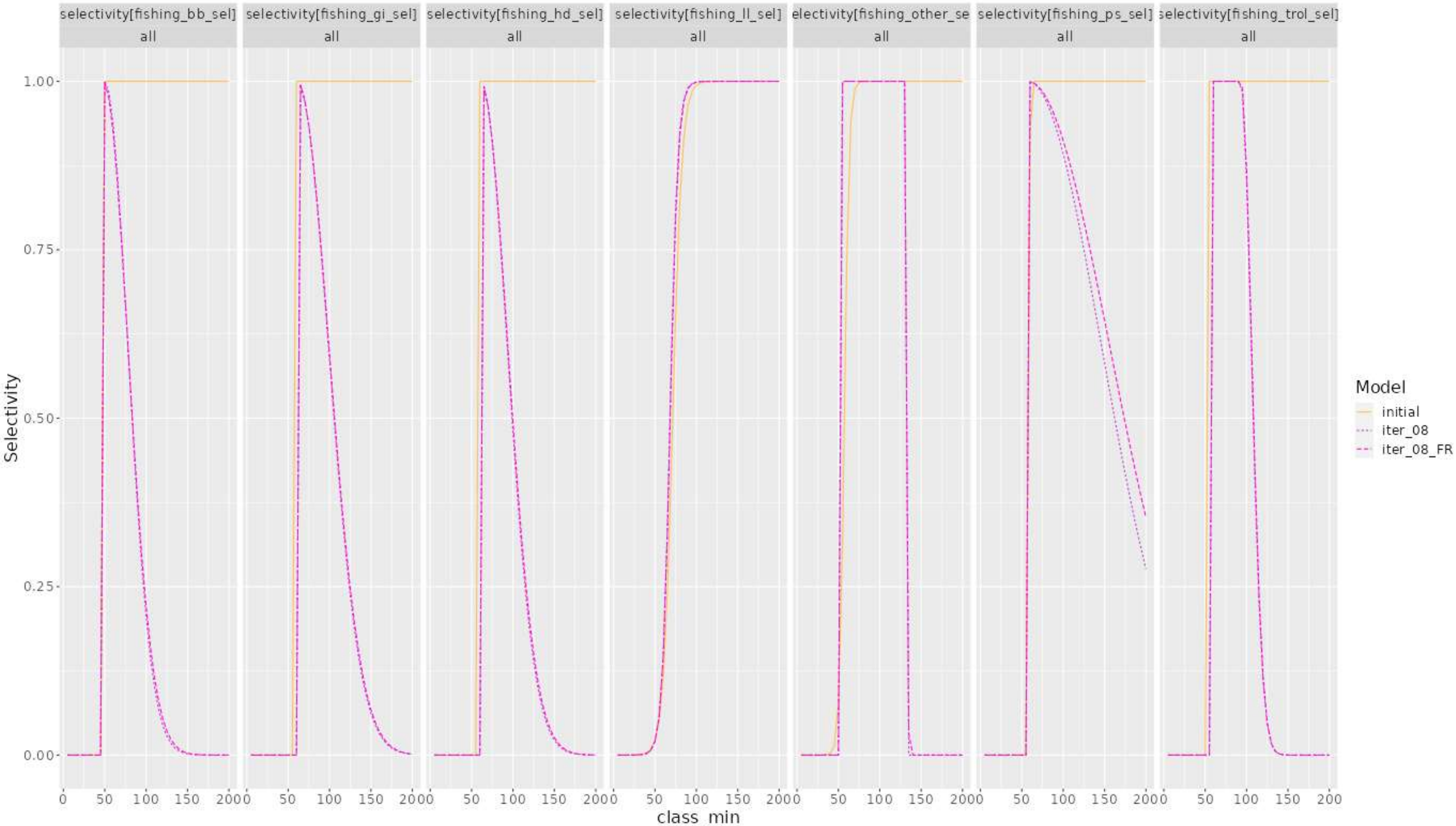
1A ll CPUE index



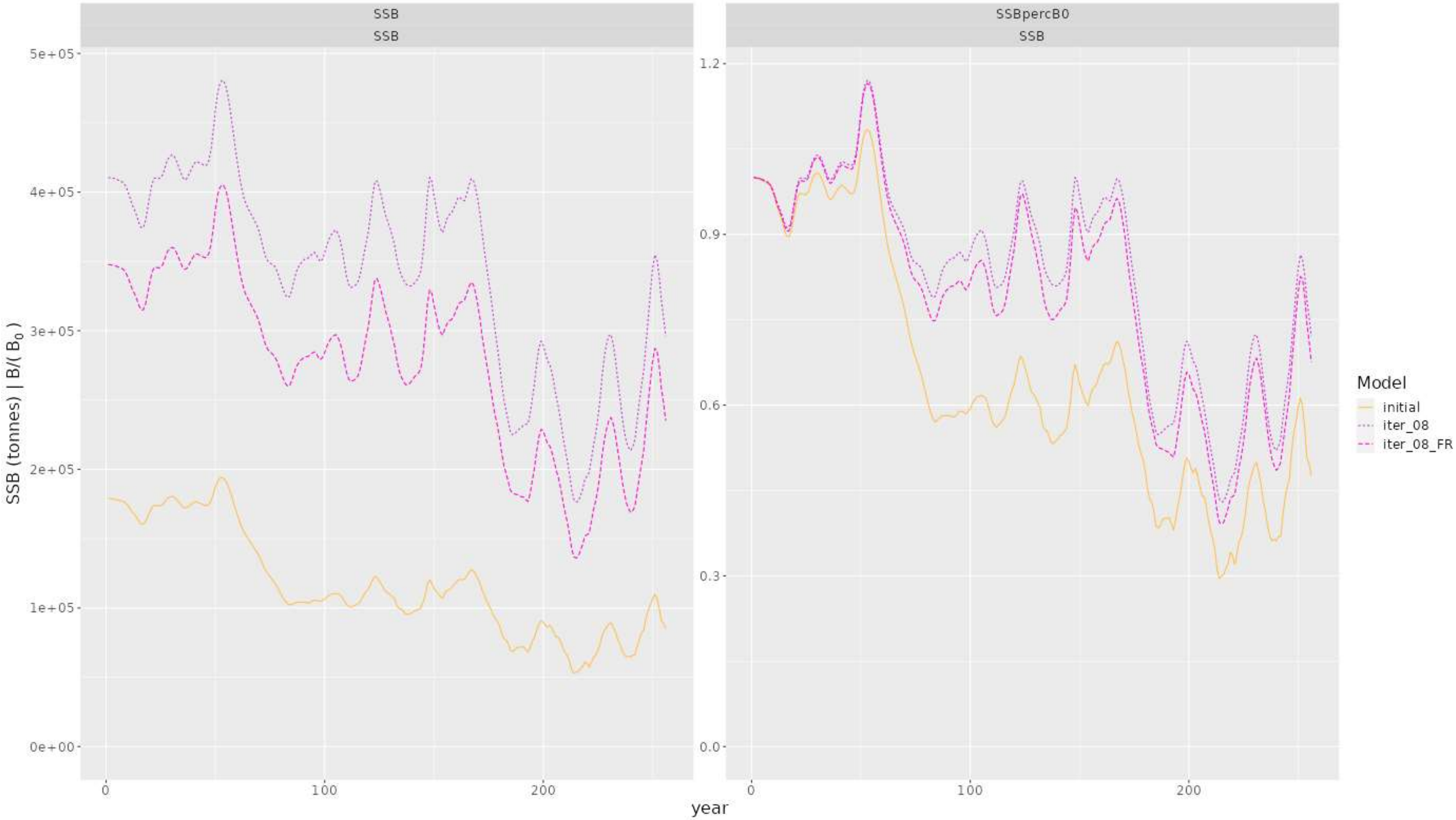
1A ll CPUE index residuals



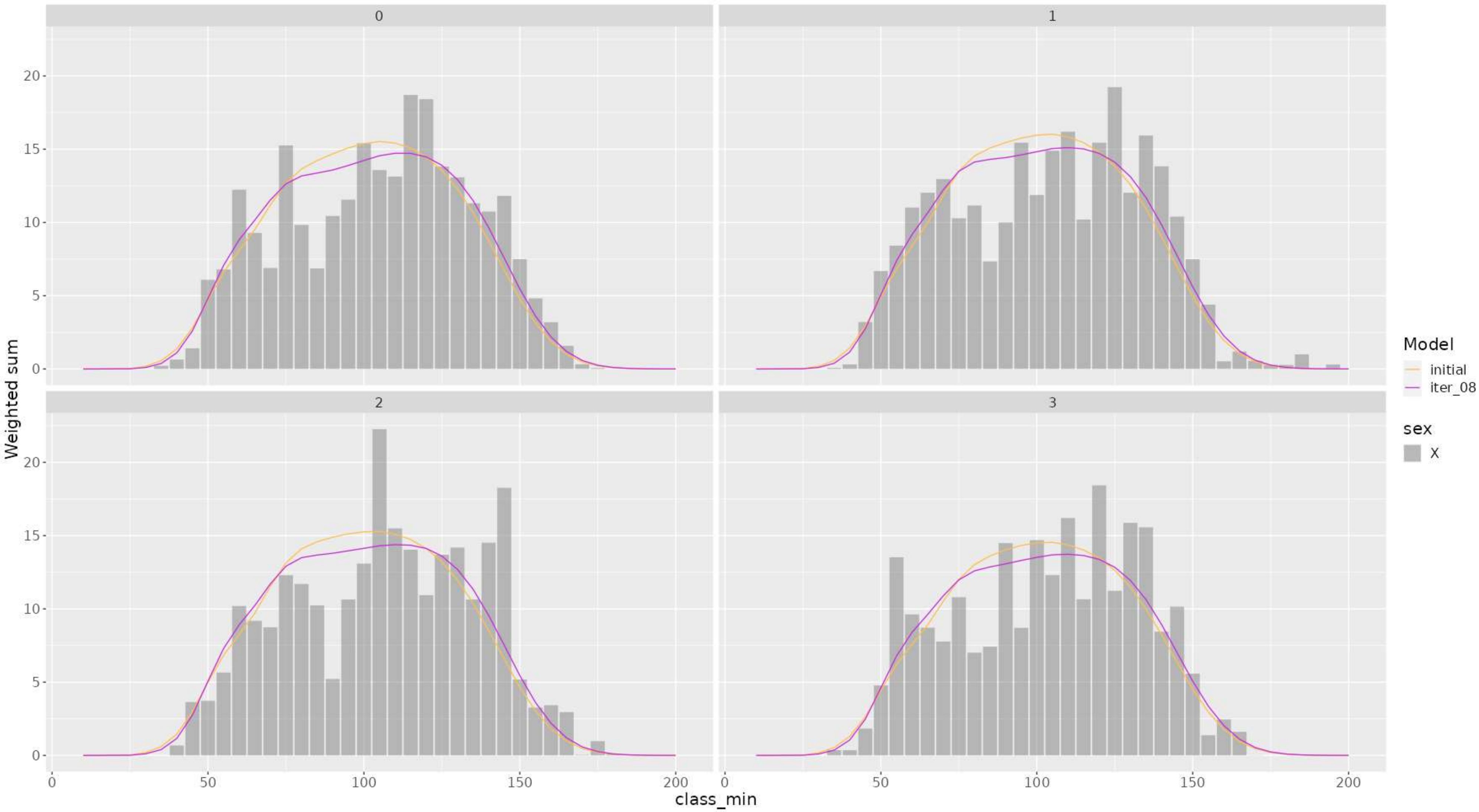
1A fishery selectivity



1A SSB and depletion



1A seasonal summary of ll length composition data



Single area model (Length based) - investigation

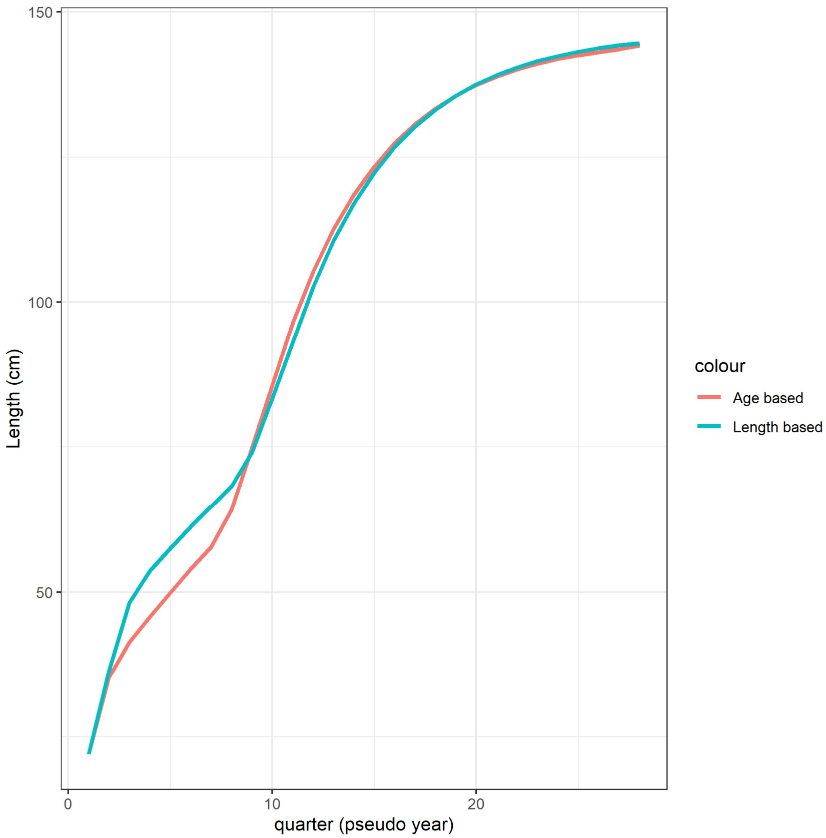
- Starting assumptions

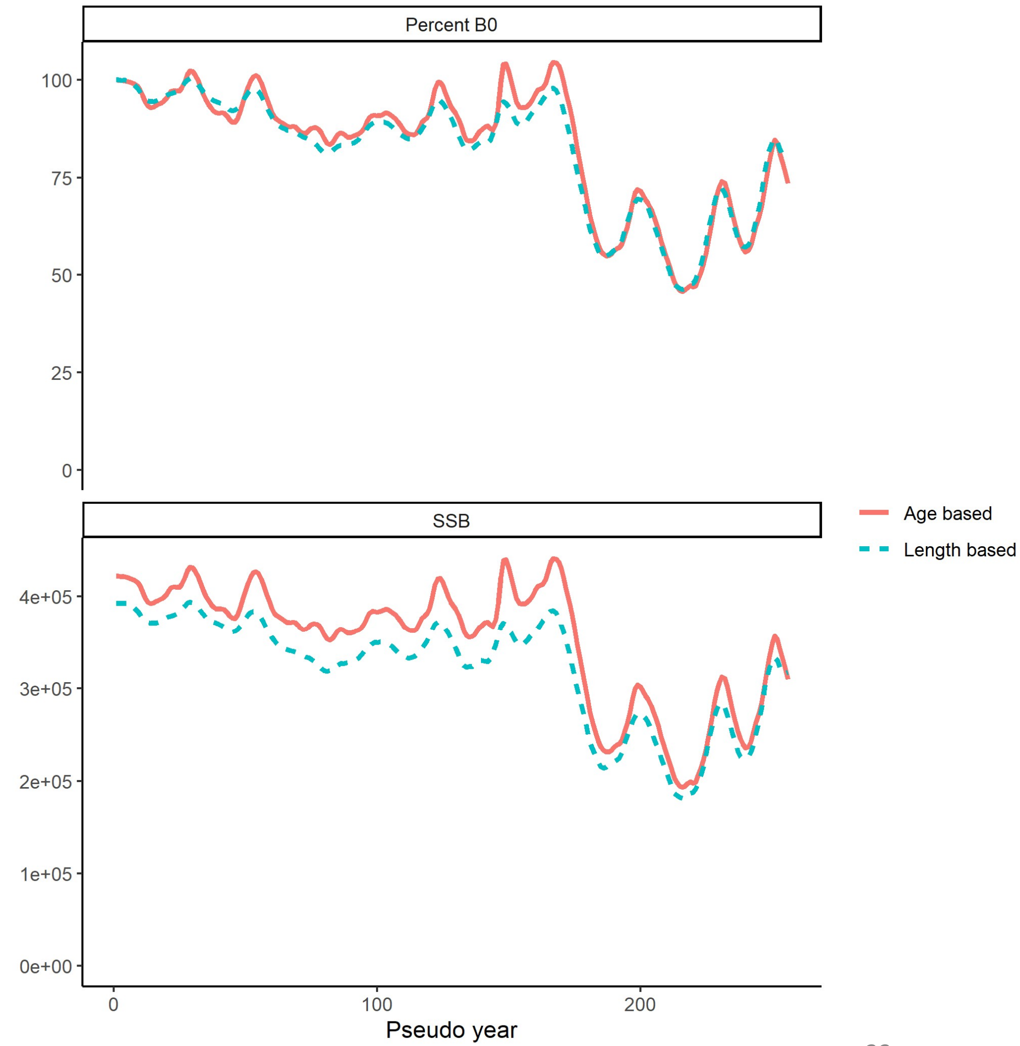
1. Biology had to deviate, needed a growth increment model, M by length, maturity by length
2. Process order same as age-based
3. Diagnostics – same as previous
4. Used likelihood comparisons to compare with age-based model

- Main explorations

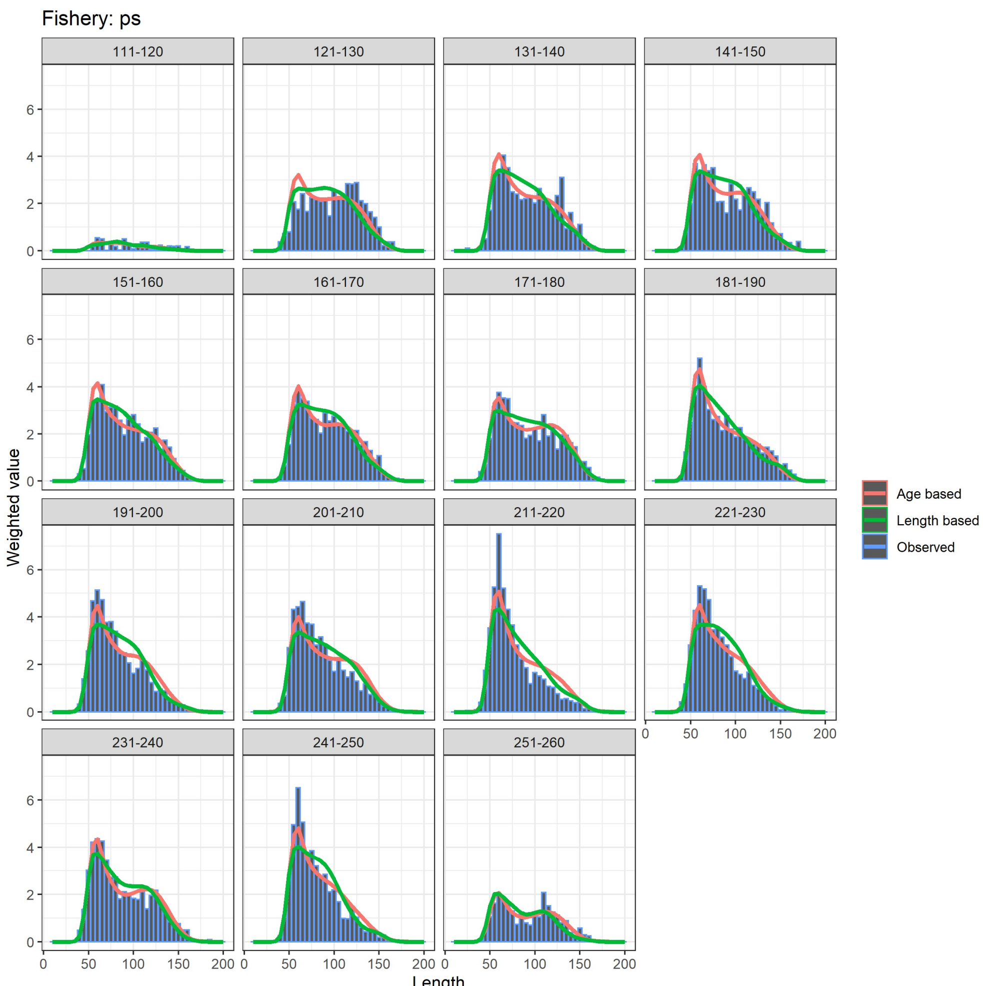
1. Mainly set up as a sensitivity

Compare age with length





Log-likelihood preferred age-based model



Aggregated observed and expected length frequency by decade for the PS fishery

Fleets-as-areas (FAA) area model (Age based) - investigation

- Starting assumptions

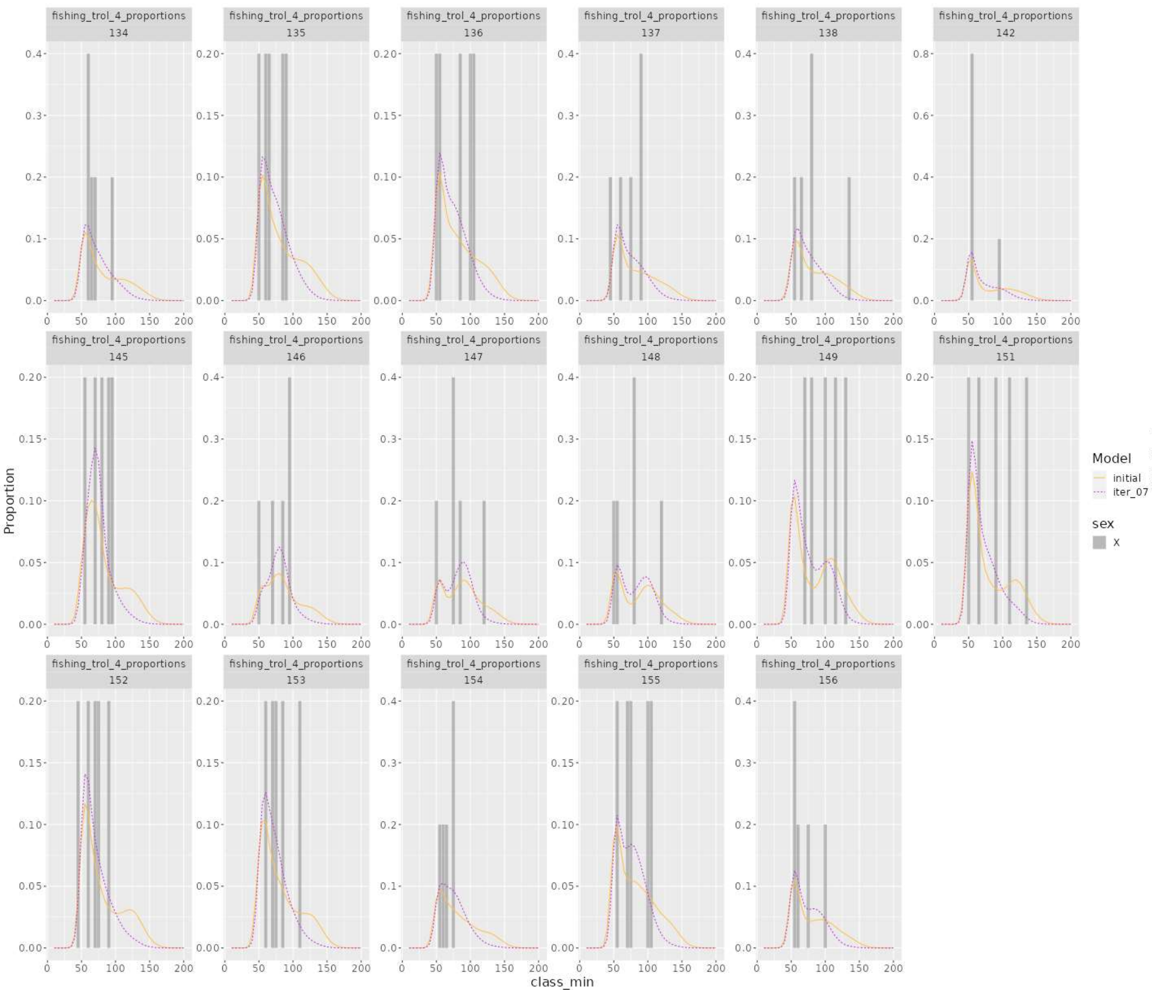
1. Biology set to OM info
2. Diagnostics –same as previous models
3. Used likelihood comparisons for assumption decisions

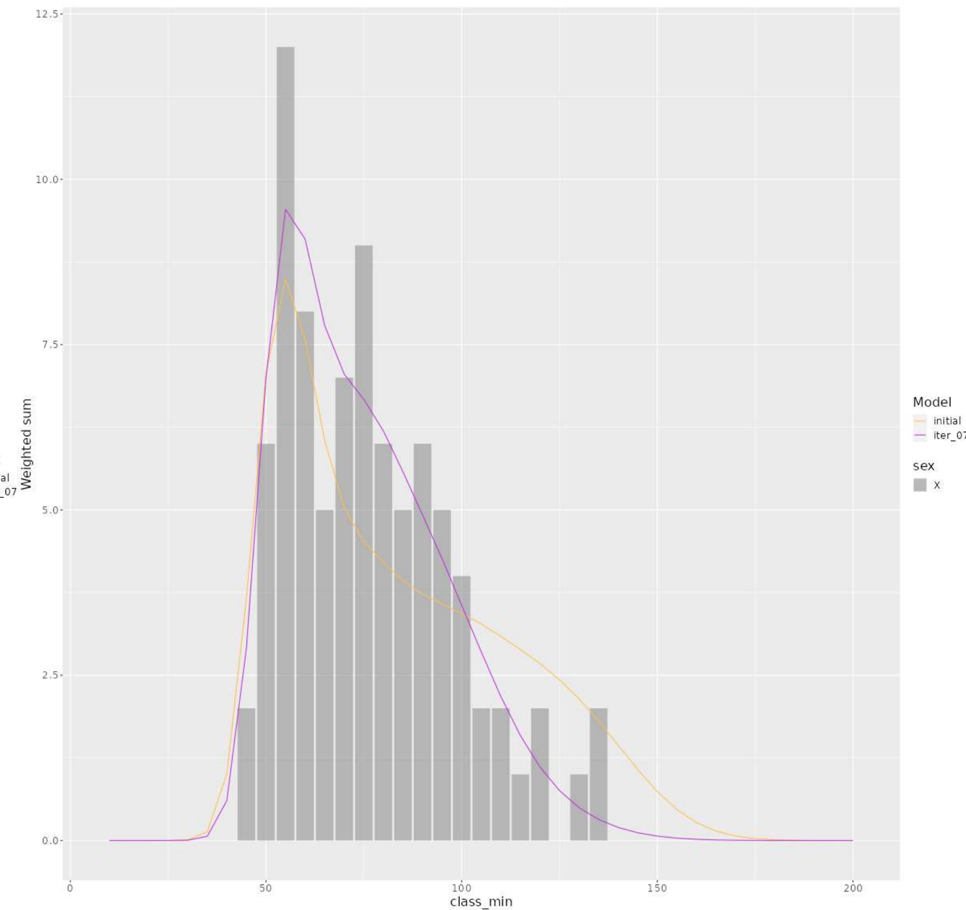
- Main explorations

1. Selectivities and catchabilities (q)

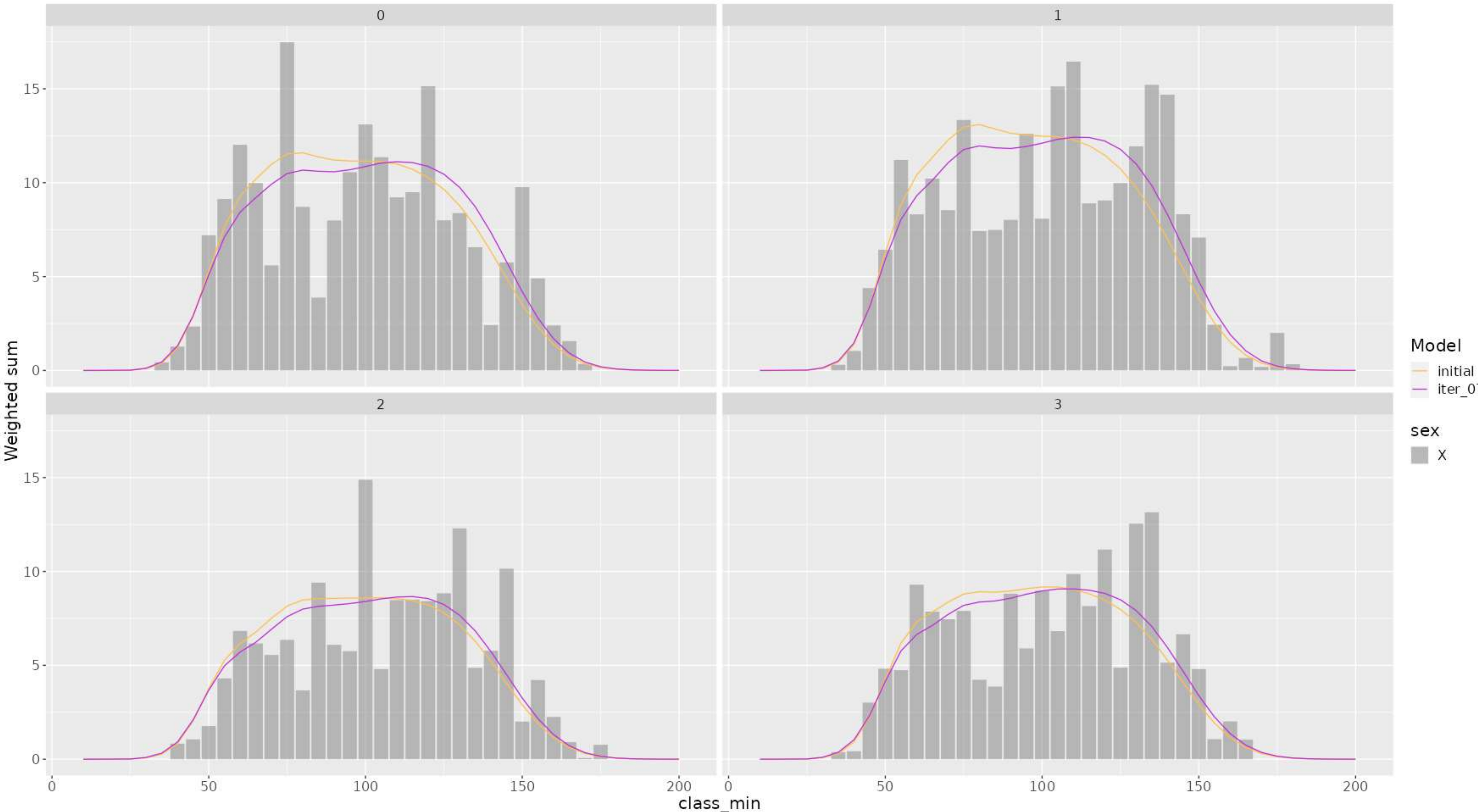
- Latest model was reweighted using Francis TA 1.8 method for simulation runs

FAA trol 4 length composition data

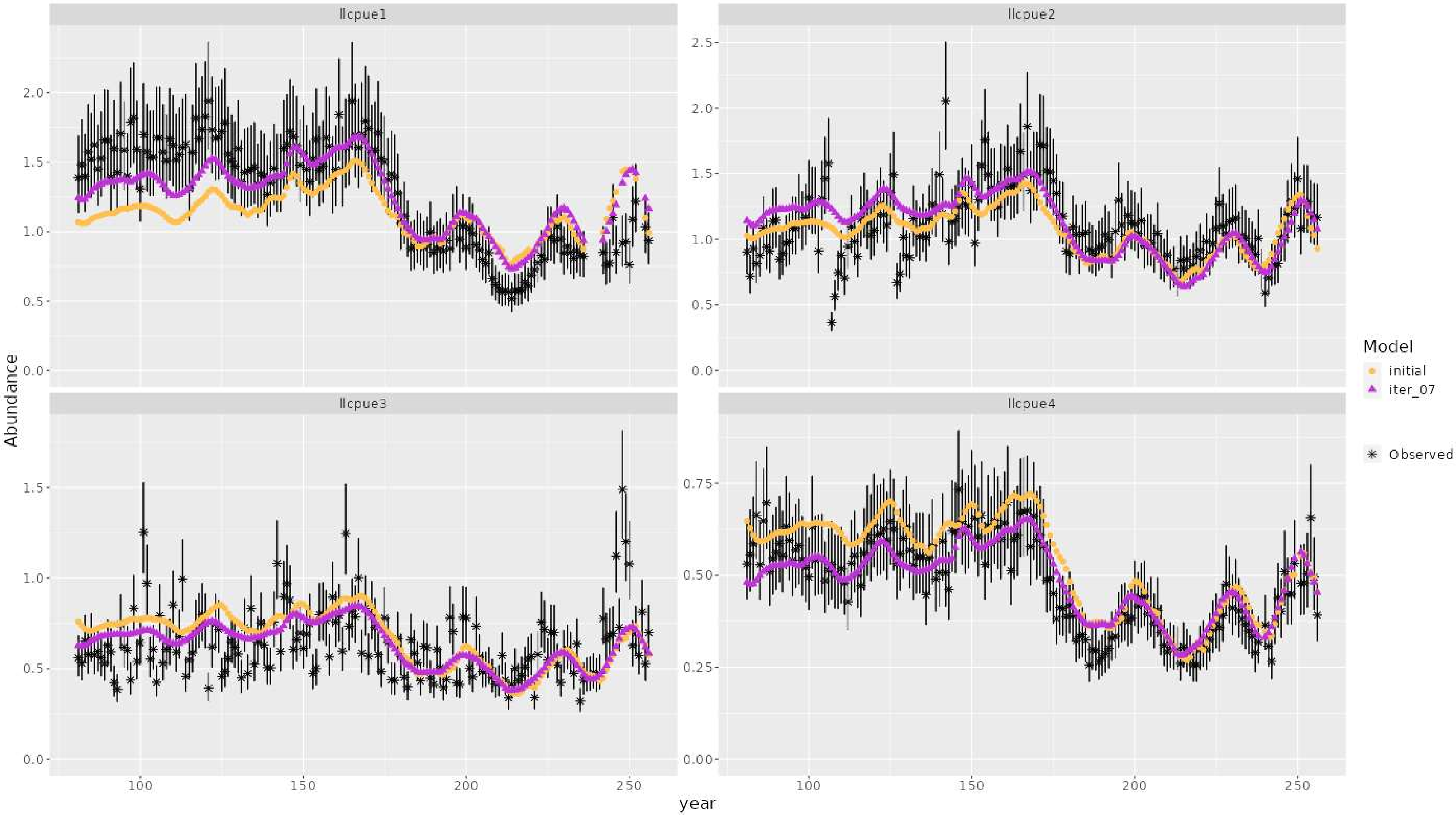




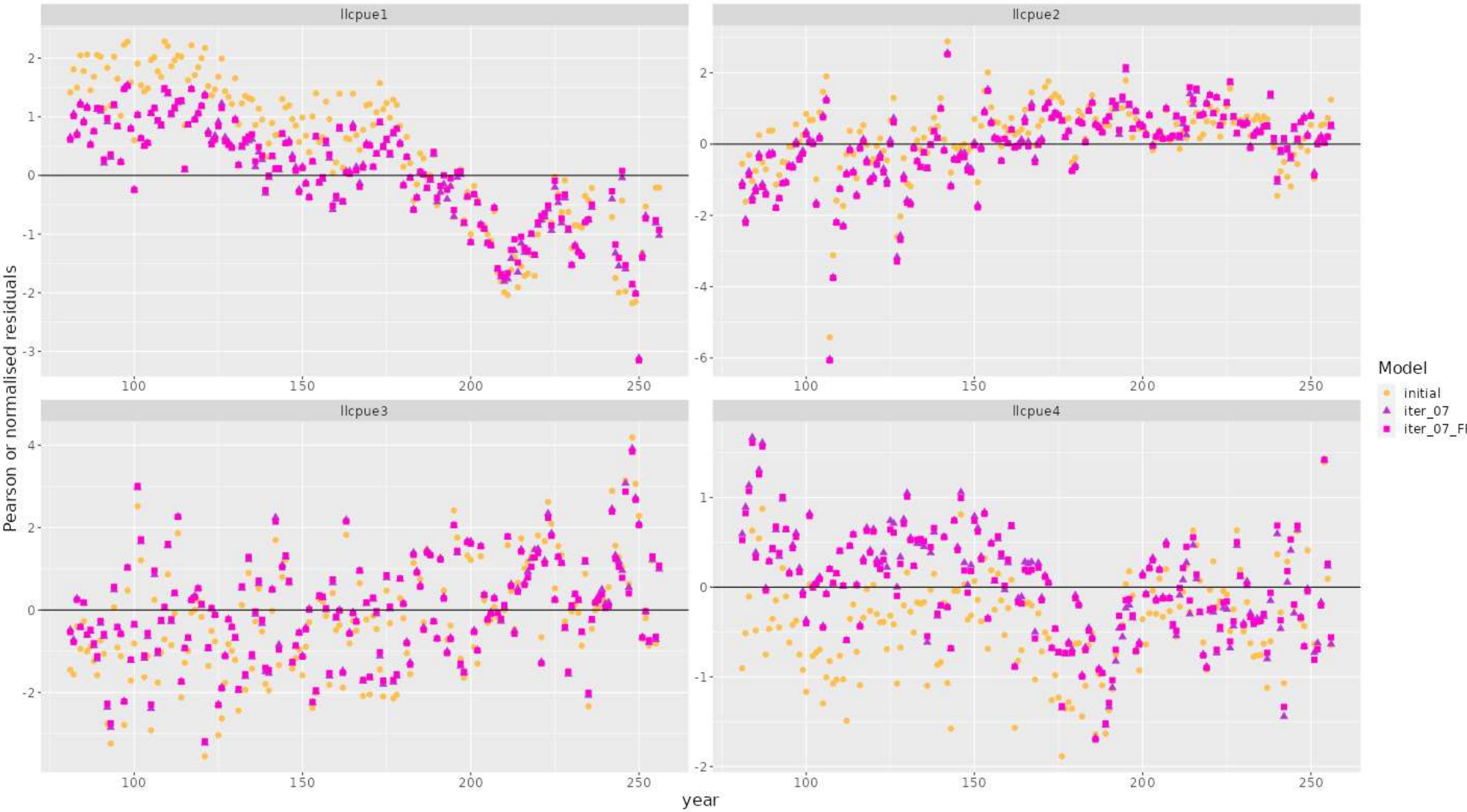
FAA seasonal summary of ll 1 length composition data



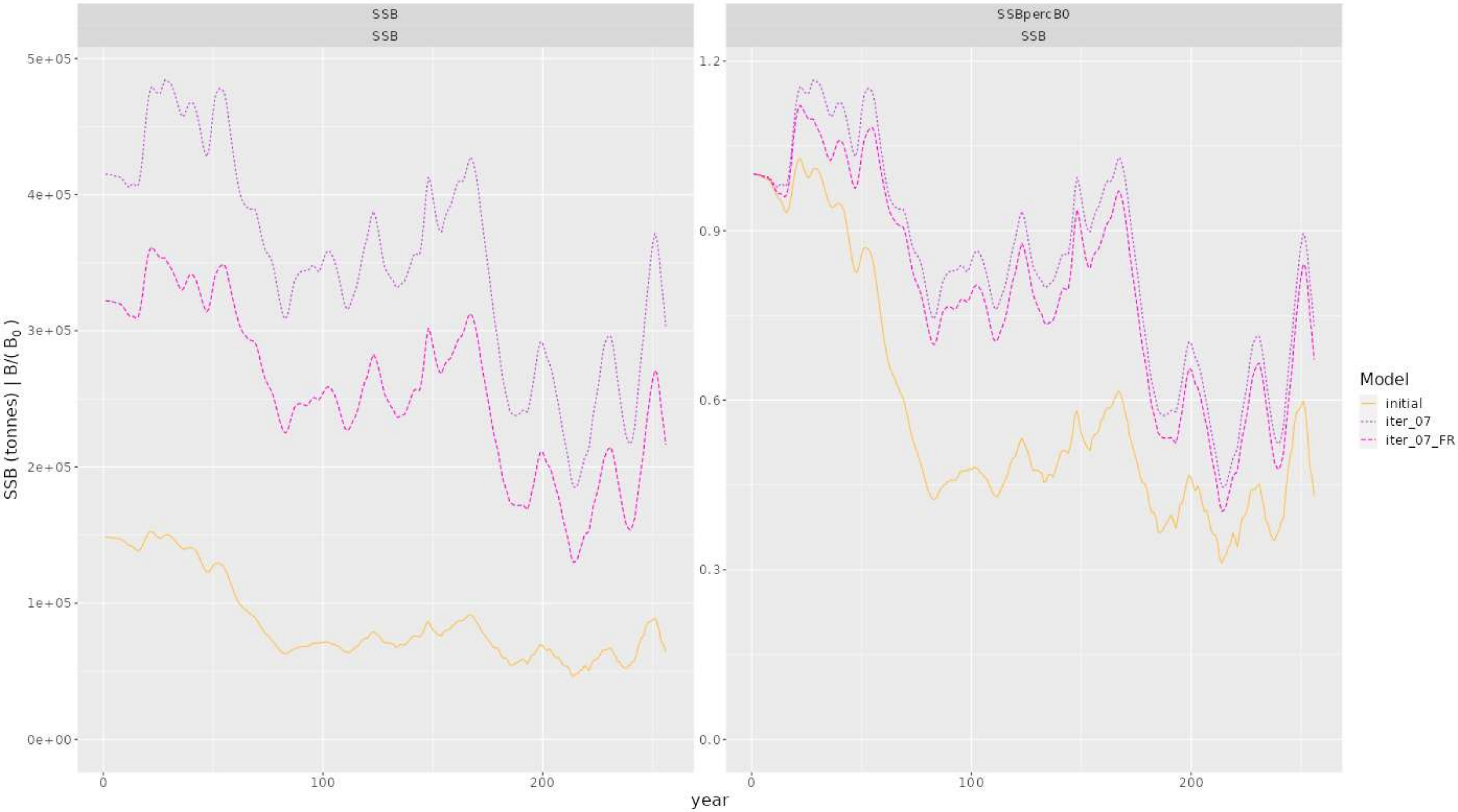
FAA ll CPUE index



FAA ll CPUE index residuals



FAA SSB and depletion



Possible next steps

1. Spitting the cpue and time series to account for possible changes or catchability.

2. Add seasonal dimension into the FAA model to investigate season/area interaction

3. Restructure the models to be a true annual model with 4 explicit seasonal time steps

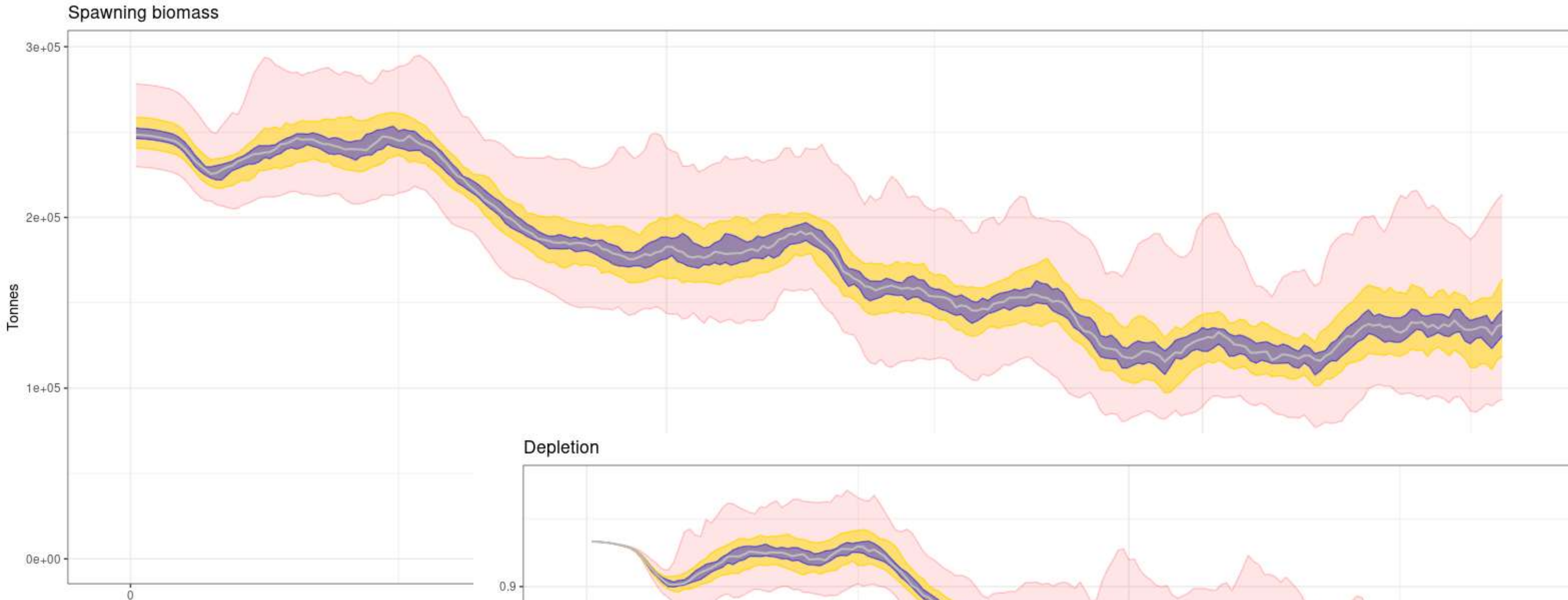
We suspect the models are currently estimating significantly more recruitment parameters than the composition data can likely resolve. The fact that the models achieve very good fits to the CPUE series suggest that YCS estimation is primarily driven by the abundance not the compositional data

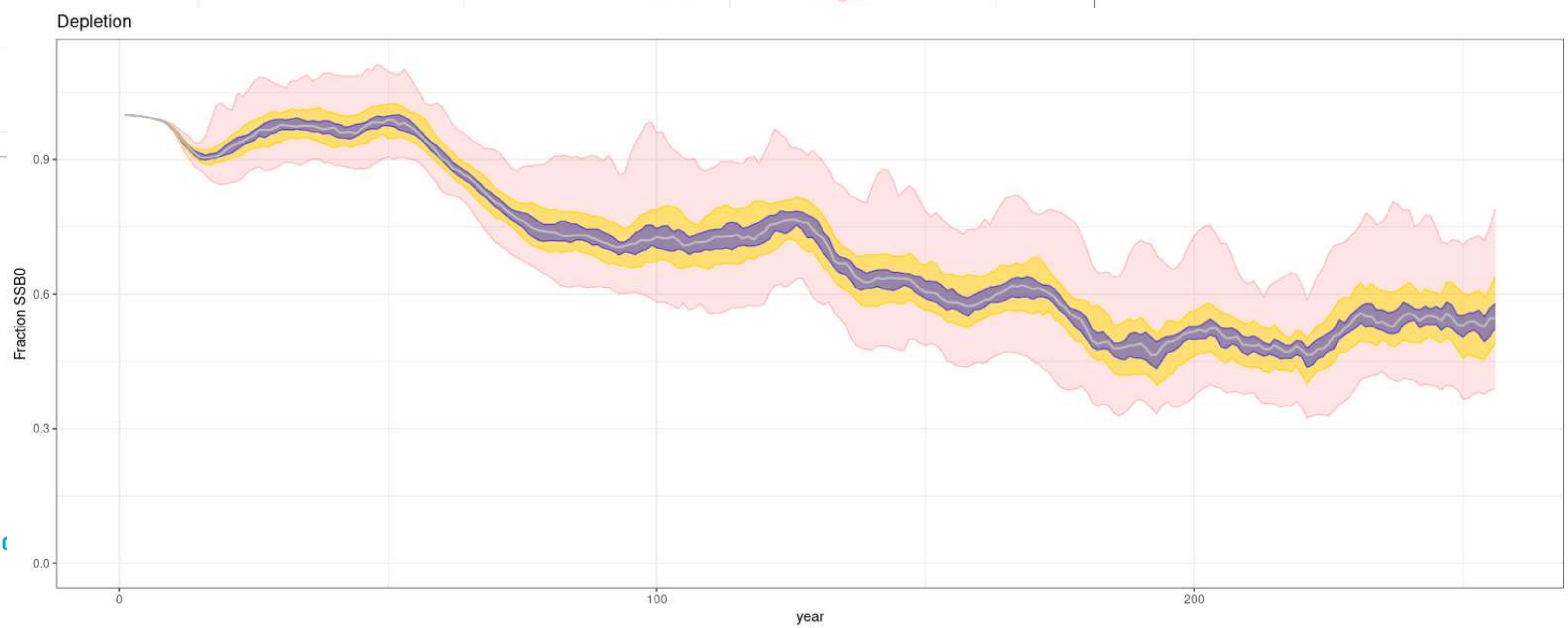
Conclusions

- Neither the 1A nor the FAA model assessments in their current state would “pass muster” under a New Zealand stock assessment review process. Patterns seen in the composition data fits from both models suggest model misspecification in either the selectivity parameterisations or a model structural inability to account for underlying spatial heterogeneity.
- The FAA model appears to fit the composition data better as would be expected as this model is structurally more capable of dealing with the underlying spatial heterogeneity.
- However, patterns seen in the FAA longline area-specific CPUE series suggest this model is still not adequately accounting for the underlying temporal dynamics.

Summary of fits to the 100 simulated datasets

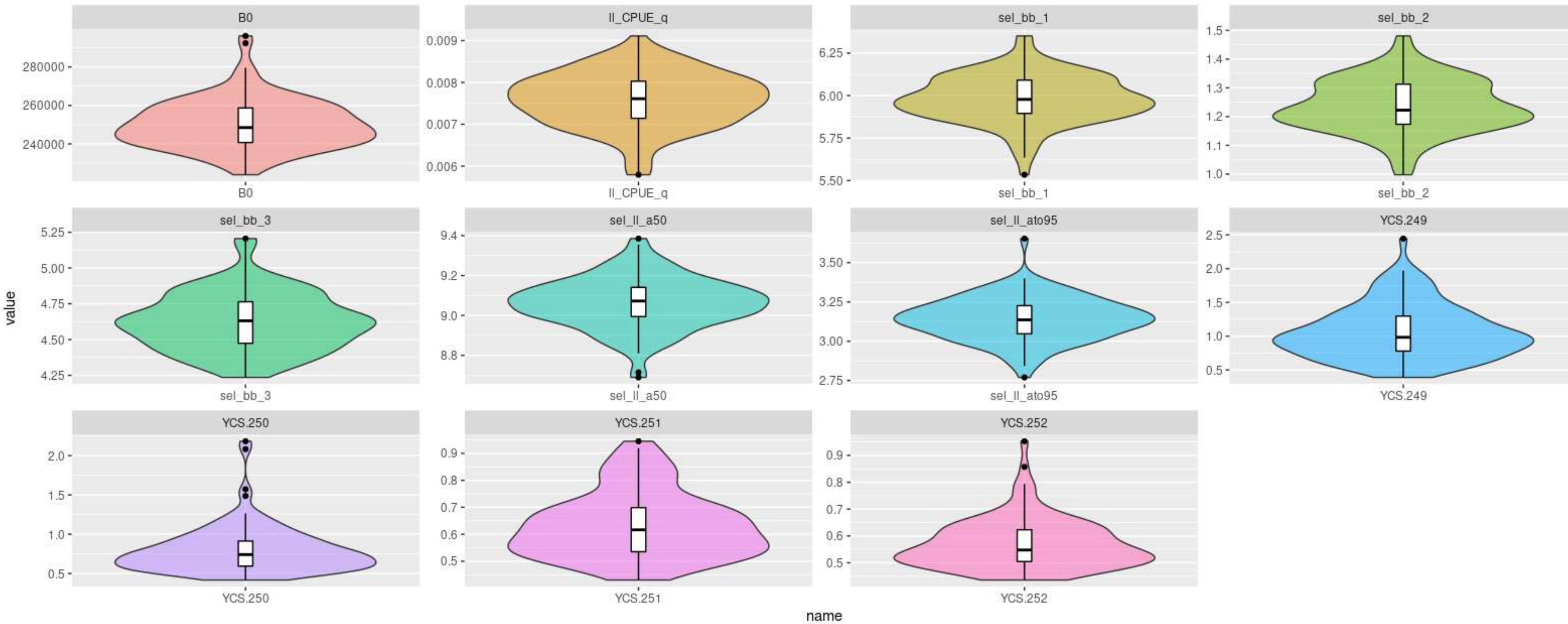
Results – single area (1A)





Results – single area (1A)

Subset of estimated parameters



Thanks

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