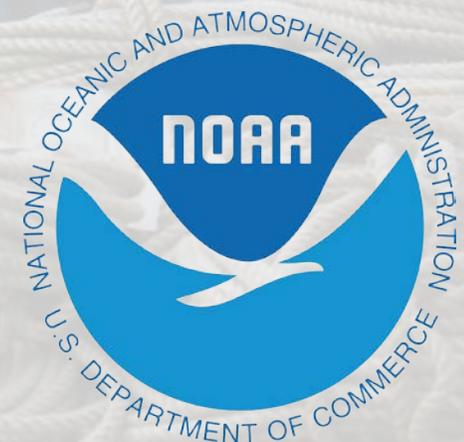


Standardizing sablefish catch-per-unit-effort (CPUE) across gear types and data sources

Matthew LH. Cheng, Cara Rodgveller, Joe Langan, Dan Goethel, Curry Cunningham

September Groundfish Plan Team 2022

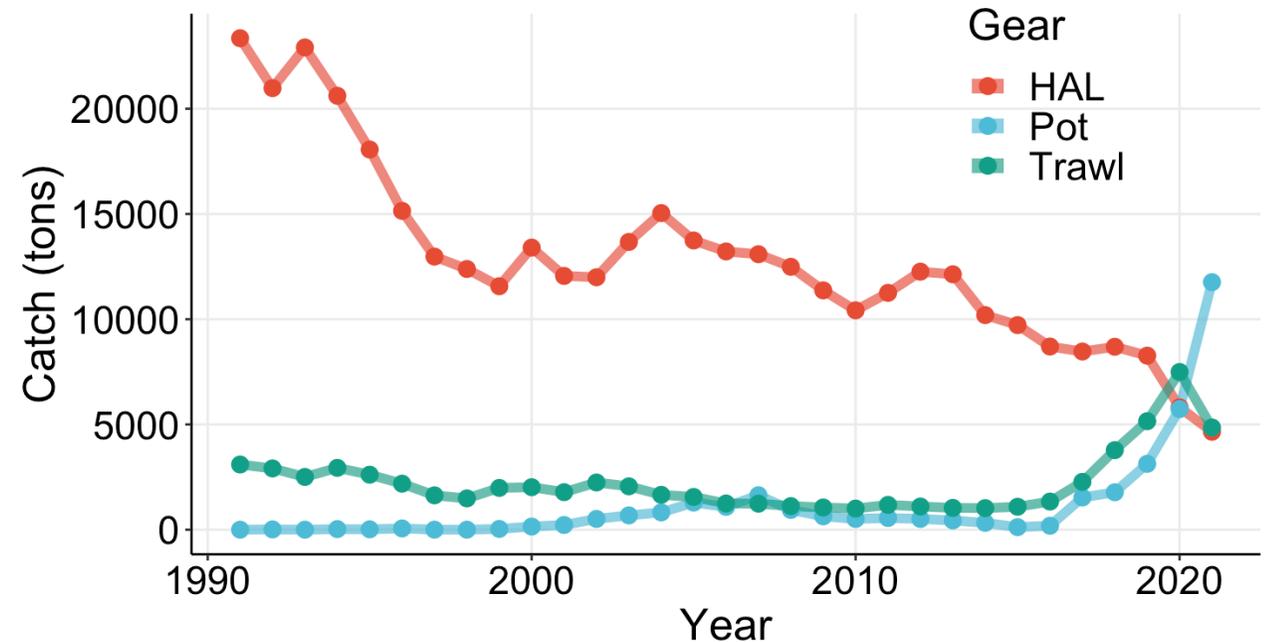


Acknowledgements

- Sablefish fishers and stakeholders
- International Pacific Halibut Commission (IPHC)
- National Oceanic and Atmospheric Administration Alaska Fisheries Science Center (NOAA AFSC)
- Cooperative Institute for Climate, Ocean, and Ecosystem Studies at the University of Alaska Fairbanks
- North Pacific Groundfish and Halibut Observers

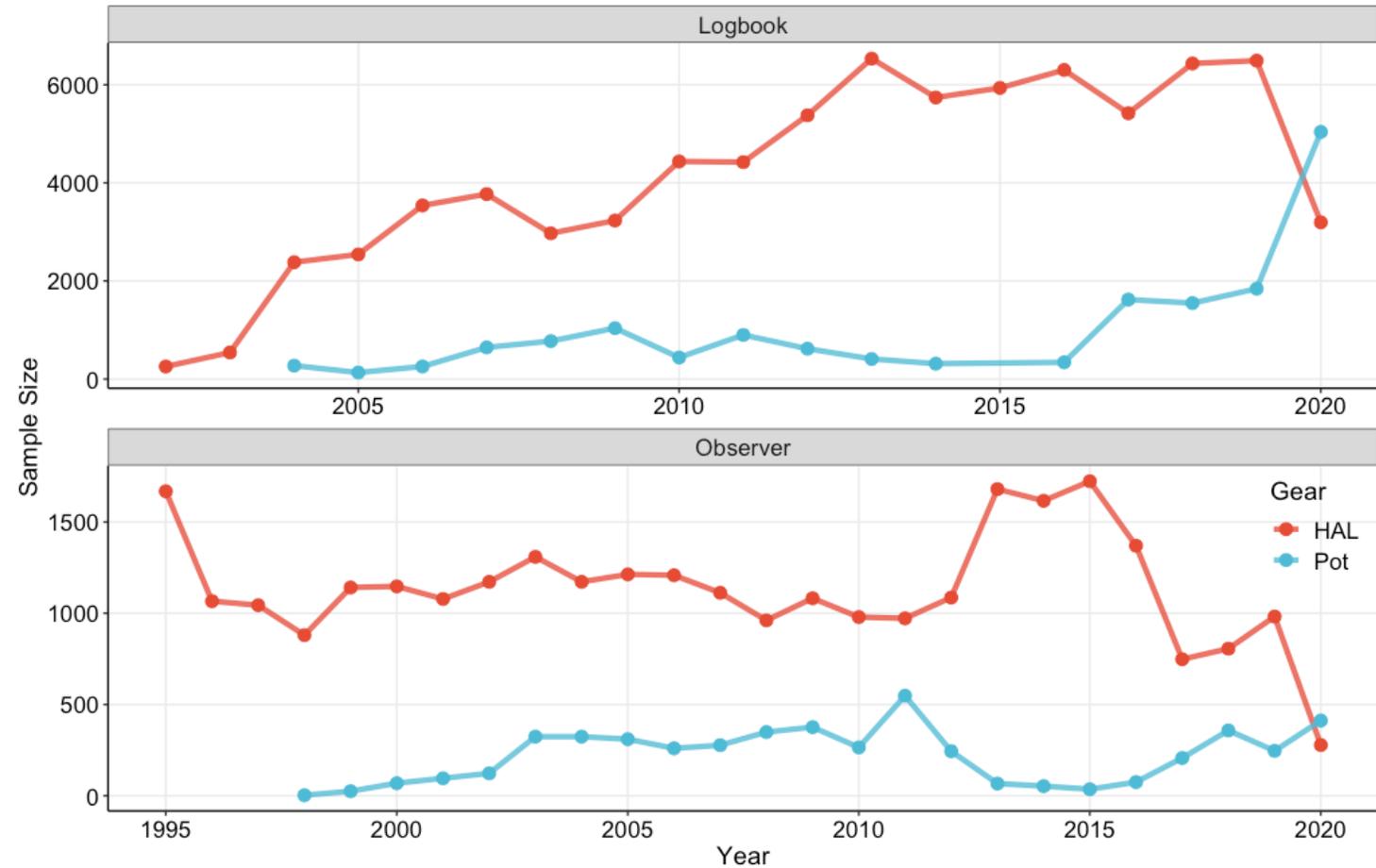
Motivation

- Adoption of pot gear fishing is rapidly expanding across the GOA
 - Removals from pot gear have surpassed hook-and-line (HAL) in recent years
- Current stock assessment is fit to a CPUE index
 - Only incorporates HAL data
 - Assumes a nominal CPUE index
 - Time-series: 1990 – 2019
 - Uses data pre-IFQ



Motivation

- Logbook sample sizes are larger relative to observer data
- Sample sizes from pot gear have been increasing since 2017 regulatory change



Objective

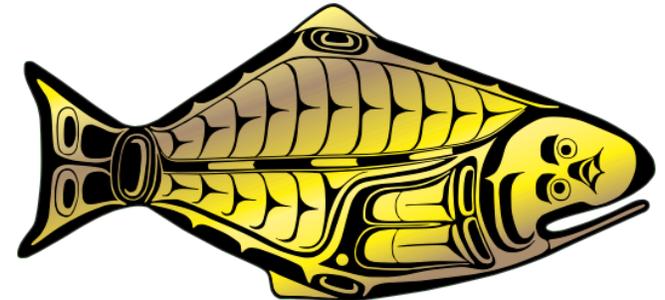
Assimilate hook-and-line and pot gear data from both observer and logbook records to develop a standardized index of abundance for Alaska sablefish



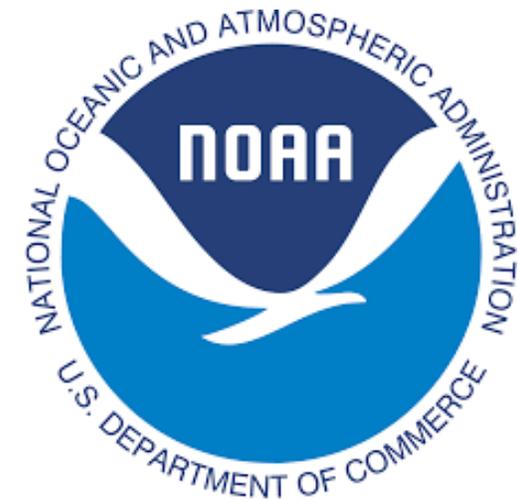
Methods: Data sources

- Vessel Logbooks – Joint NMFS IPHC program
 - $n = 95,715$
- Onboard observers – North Pacific Observer Program
 - $n = 34,540$
- HAL: $n = 109,009$; Pot: $n = 21,246$
- Model index time-series = 1995 – 2020
 - Does not use data during pre-IFQ period

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Methods: Analysis

- Generalized Additive Models (GAMs)
- 2 model variants explored:
 - HAL only model
 - HAL + Pot model
- Model selection:
 - BIC
 - AIC
 - 5-fold cross validation
 - Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and R^2

Methods: Model Structure (HAL only model)

- Incorporates catch and effort data from **ONLY hook-and-line gear**
- Assumed Tweedie-distributed errors (log-link)
- Effort treated as an offset
 - HAL CPUE = catch-per-hook

Full model considered:

$\log(\textit{weight})$

= $\textit{Year} + \textit{Data type} + \textit{Vessel length} + \textit{Area} + f(\textit{Day of year}) + f(\textit{Bottom depth})$
+ $f(\textit{Longitude, Latitude}) + \textit{offset}[\log(\textit{effort})] + \epsilon$

Methods: Model Structure (Pot + HAL model)

- Incorporates catch and effort data from **BOTH hook-and-line and pot gear**
- Assumed Tweedie-distributed errors (log-link)
- Effort treated as an offset
 - HAL CPUE = catch-per-hook
 - Pot CPUE = catch-per-pot

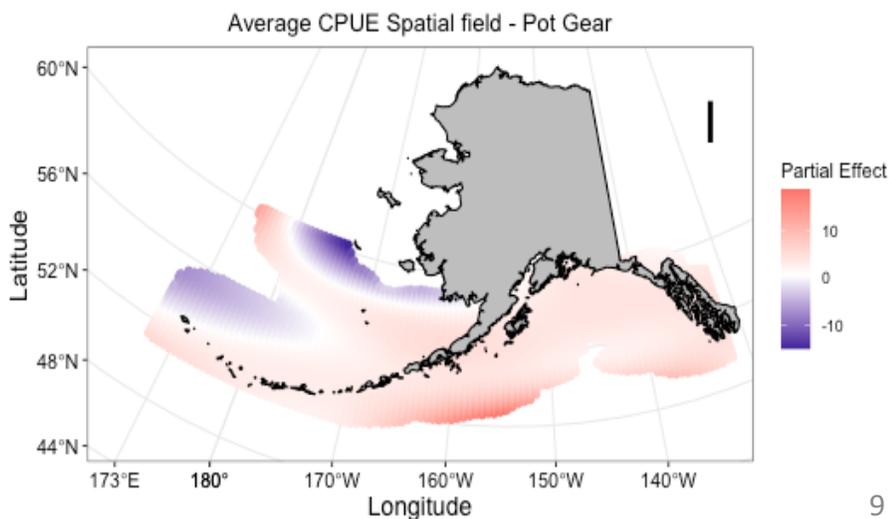
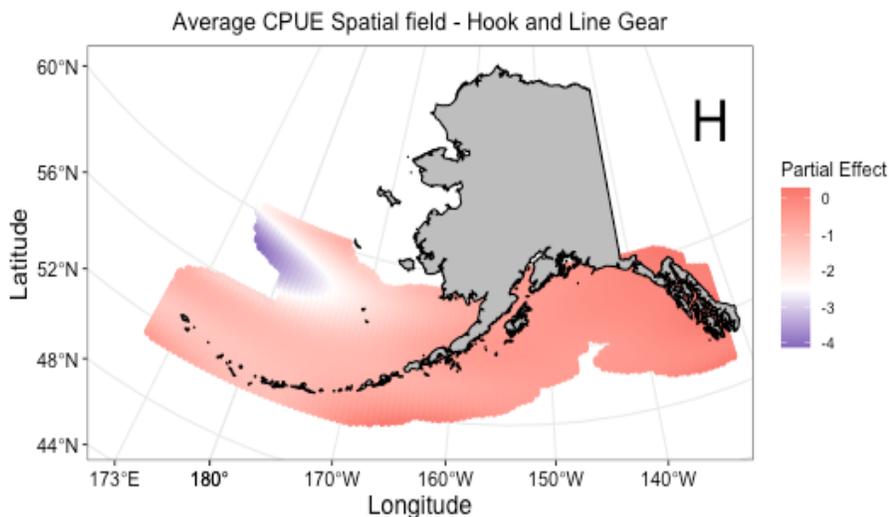
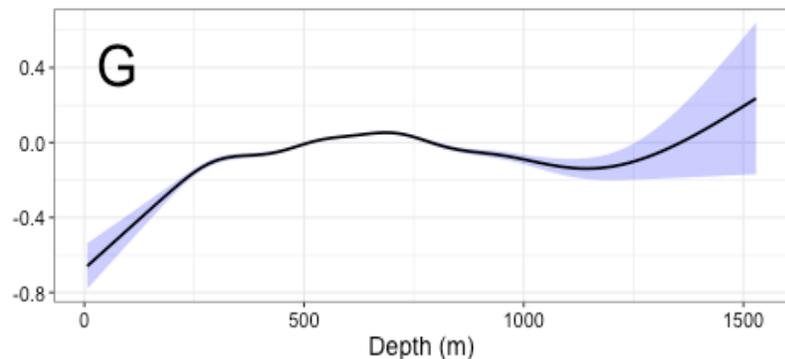
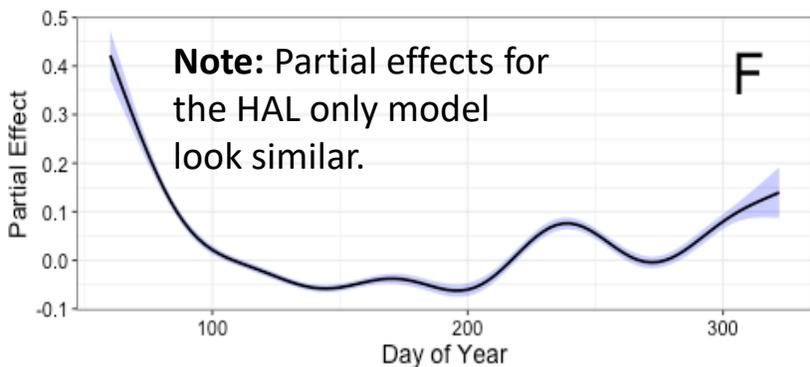
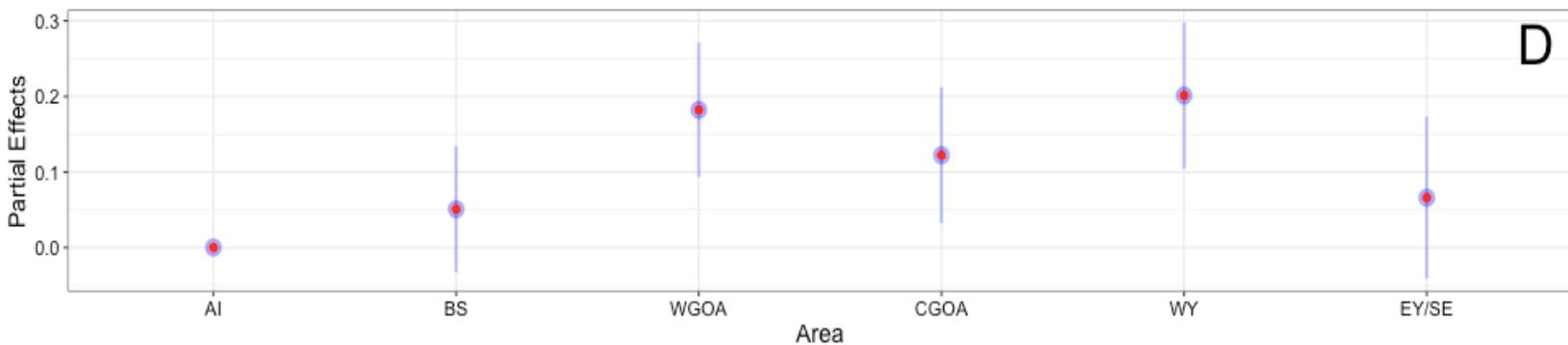
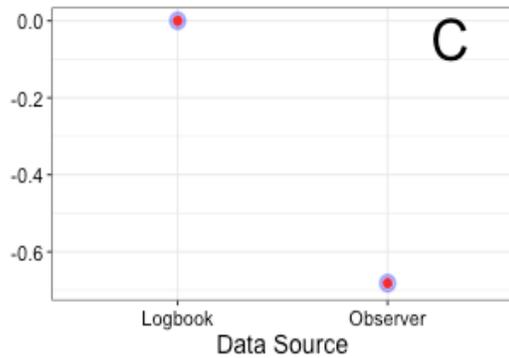
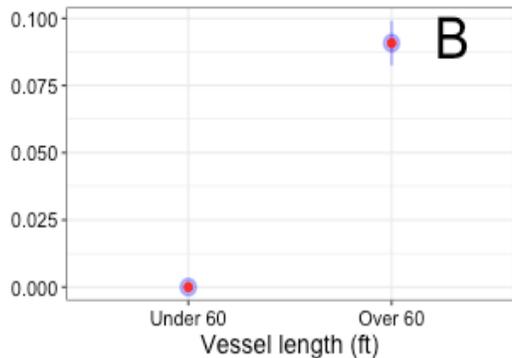
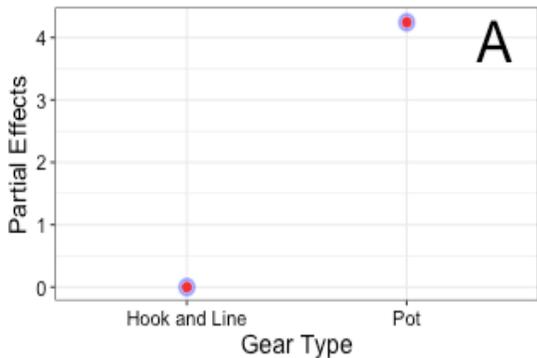
Full model considered:

$$\begin{aligned} & \log(\textit{weight}) \\ &= \textit{Year} + \textit{Gear type} + \textit{Data type} + \textit{Vessel length} + \textit{Area} + f(\textit{Day of year}) \\ &+ f(\textit{Bottom depth}) + f(\textit{Longitude, Latitude}) + f_{\textit{Gear type}}(\textit{Longitude, Latitude}) \\ &+ \textit{offset}[\log(\textit{effort})] + \epsilon \end{aligned}$$

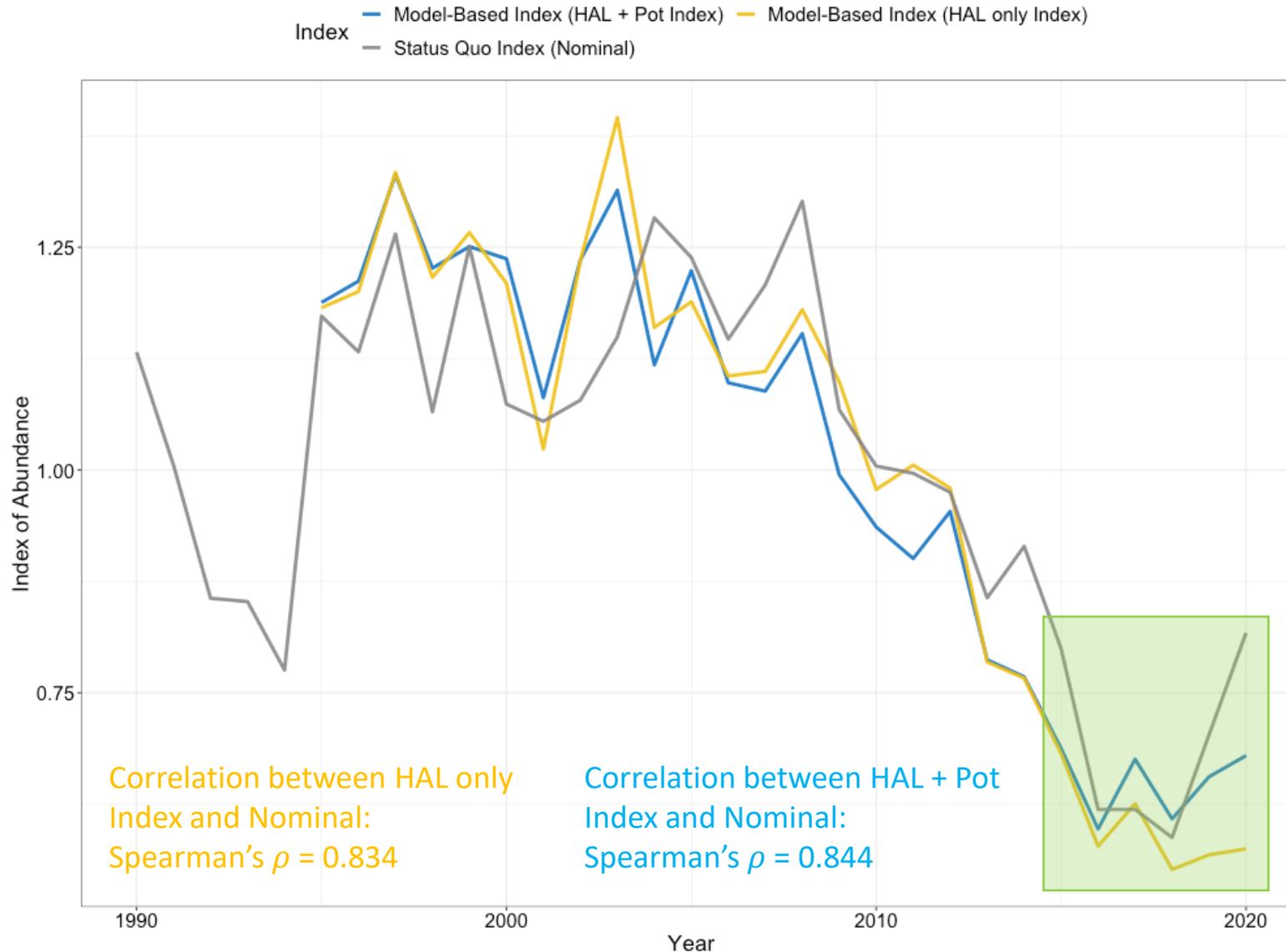
Results: CPUE standardization (Pot + HAL model)

Final model:

$$\log(\text{weight}) = \text{Year} + \text{Gear type} + \text{Data type} + \text{Vessel length} + \text{Area} + f(\text{Day of year}) + f(\text{Bottom depth}) + f(\text{Longitude, Latitude}) + f_{\text{Gear type}}(\text{Longitude, Latitude}) + \text{offset}[\log(\text{effort})]$$



Results: CPUE standardization, Year Index



Divergence among indices during recent years

could be a result of:

- Model-based methods control for spatial differences in fishing effort
- Shifts in effort/targeting due to high recruitment events could dampen the high recruitment signal

Conclusions

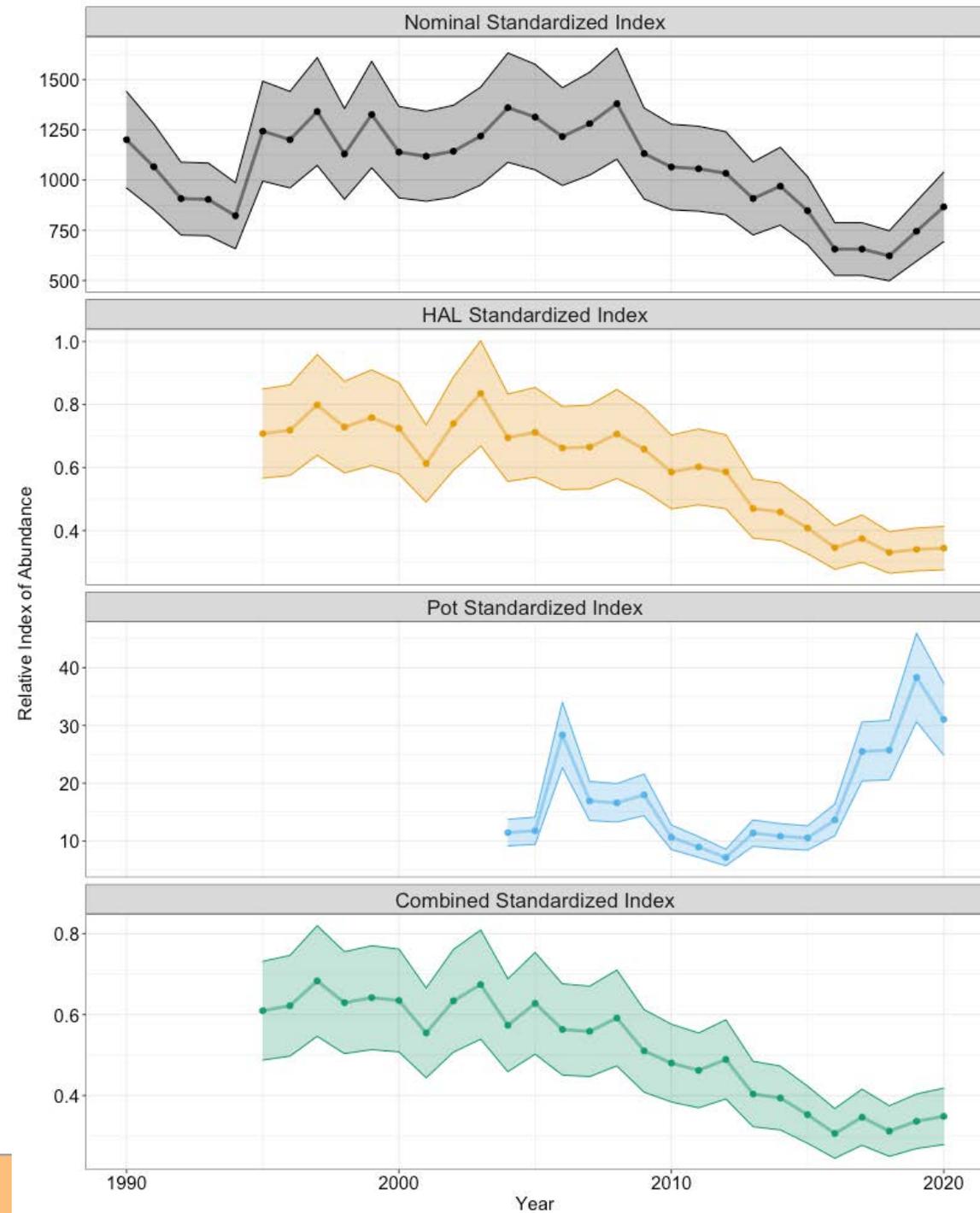
- HAL + Pot vs. HAL only models both provide comparable trends
 - However, pot gear use is rapidly increasing and there is benefit in developing indices based on both gears
- Model-based indices control for differences in how data are observed and units of effort in gear types
 - Trends are plausible
- Nominal index does not appear to differ drastically from both model-based indices, with exception of recent years (2020)



Future directions

Recommendations welcome

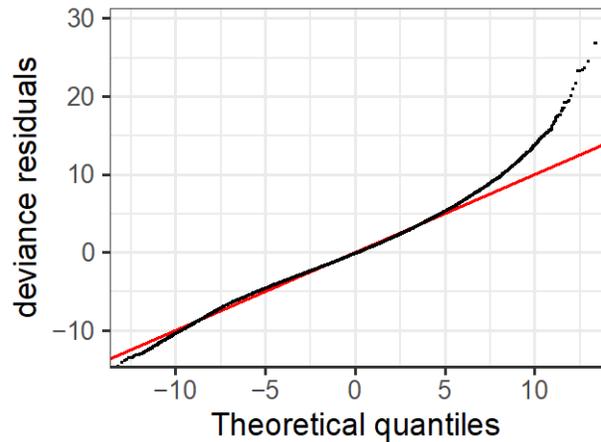
- **Incorporate combined (HAL + Pot) model-based index in 2023 SAFE**
 - Unsure how to appropriately incorporate uncertainty
 - Assume CV of 10% as in status-quo?
 - Multivariate log-normal error structure in assessment? (Account for non-independence of observations)
- **Explore model parameterizations that incorporate a new pot fleet and evaluate appropriate treatment of indices of abundance within the context of a new fishery fleet**
 - Recommendations on dealing with selectivity estimation under data-limited circumstances?



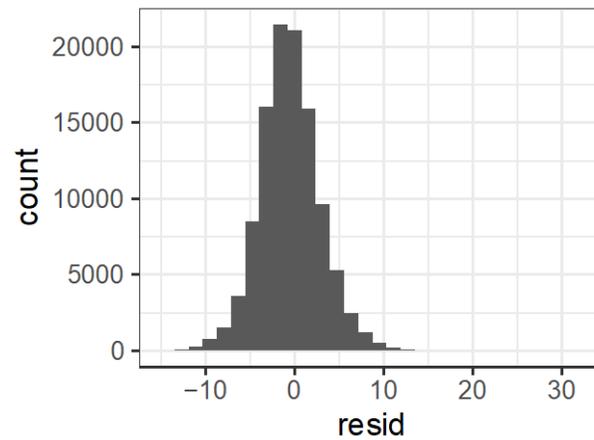
HAL only index diagnostics

HAL + Pot index diagnostics

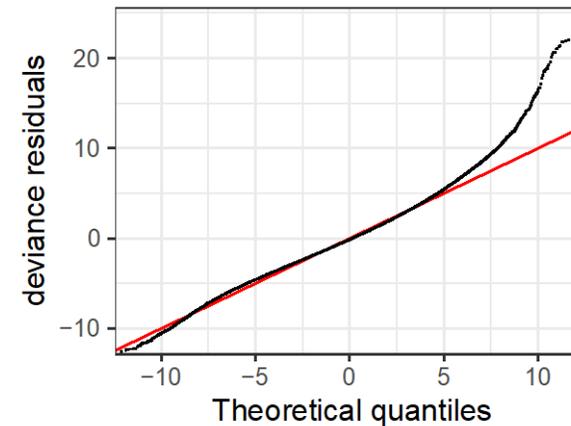
Q-Q Plot, method = simul1



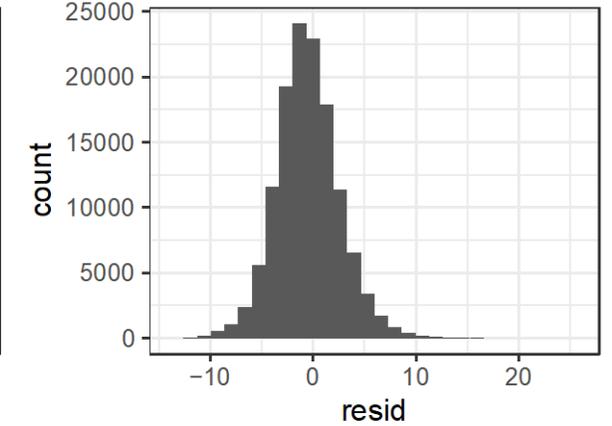
Histogram of residuals



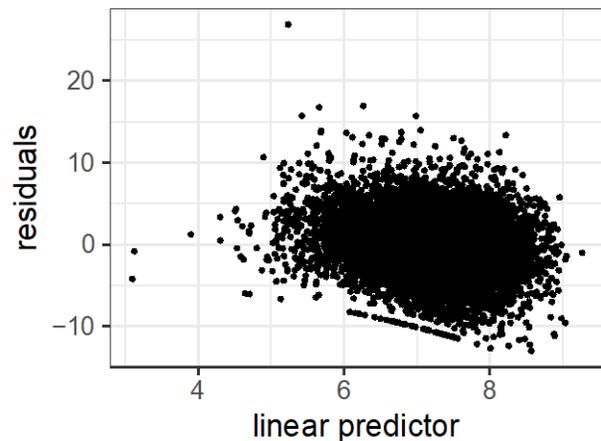
Q-Q Plot, method = simul1



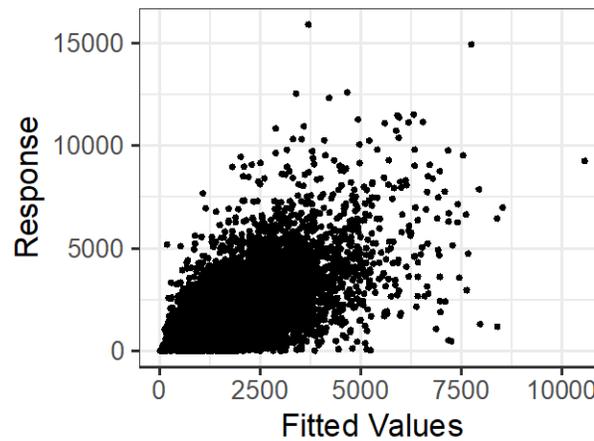
Histogram of residuals



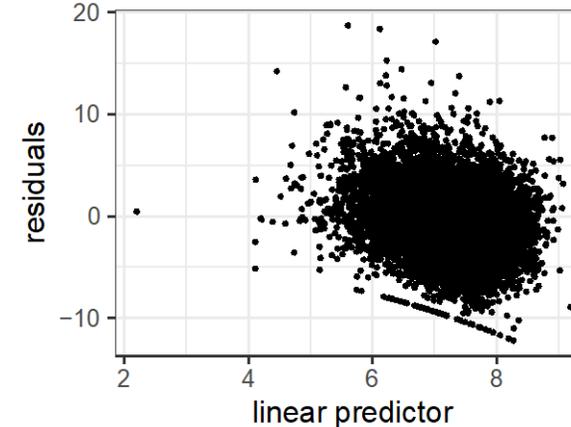
Resids vs. linear pred.



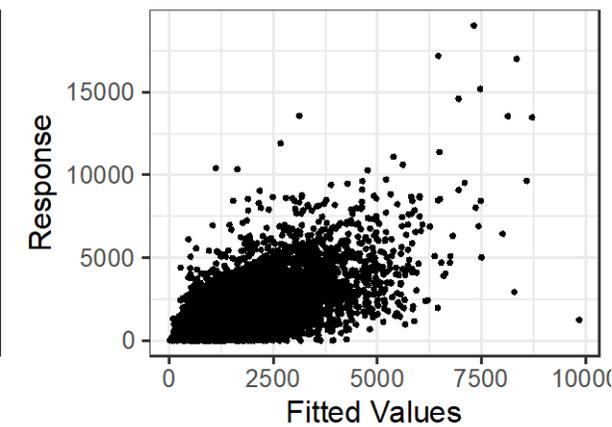
Response vs. Fitted Values

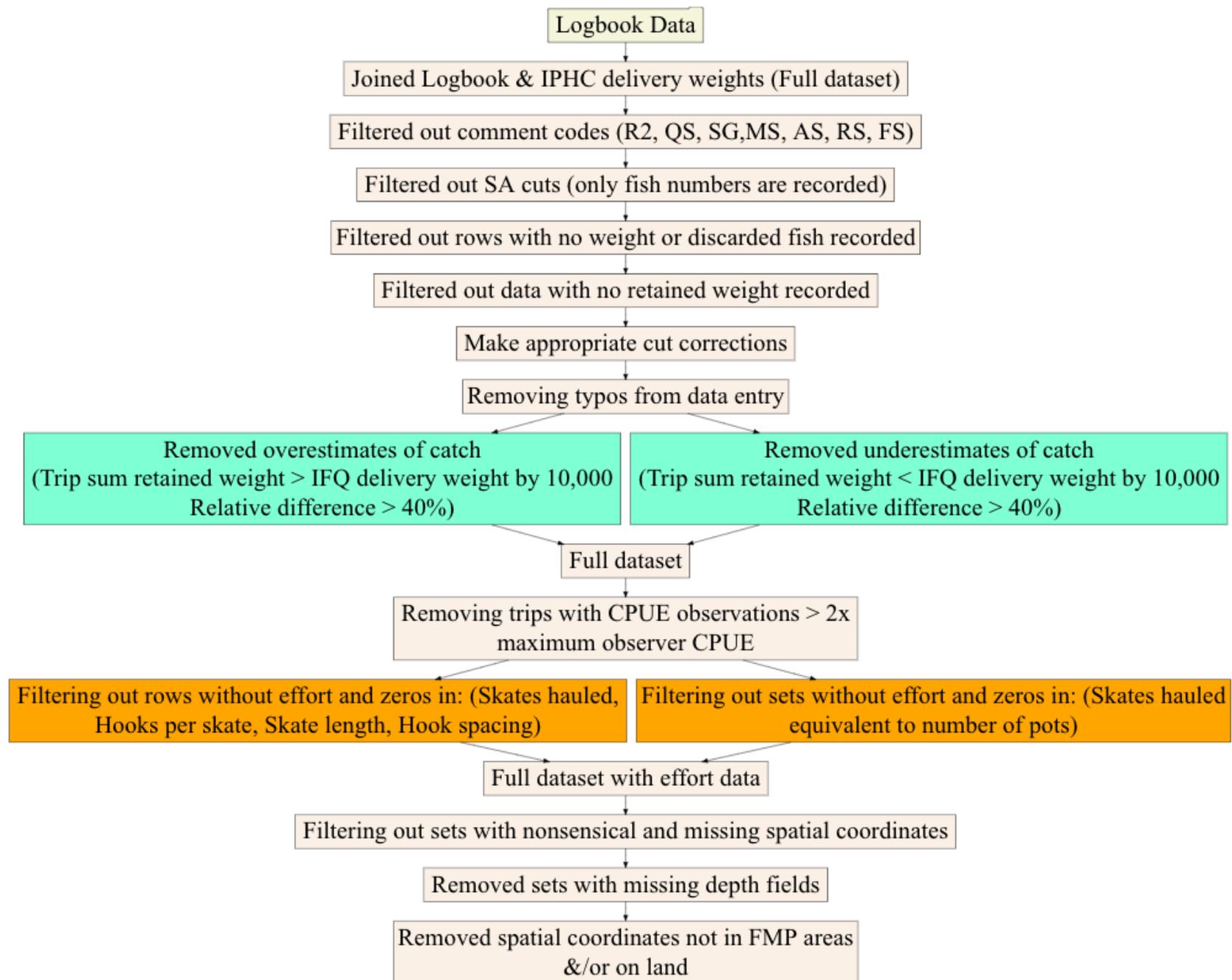


Resids vs. linear pred.



Response vs. Fitted Values





Pulled data for common species encountered in the sablefish fishery from AKFIN

Sablefish
Pacific Cod
Shortspine thornyhead
Pacific Halibut
Greeland Turbot
Shortraker rockfish
Rougheyeye rockfish
Yelloweye rockfish

Filtered to IFQ sets

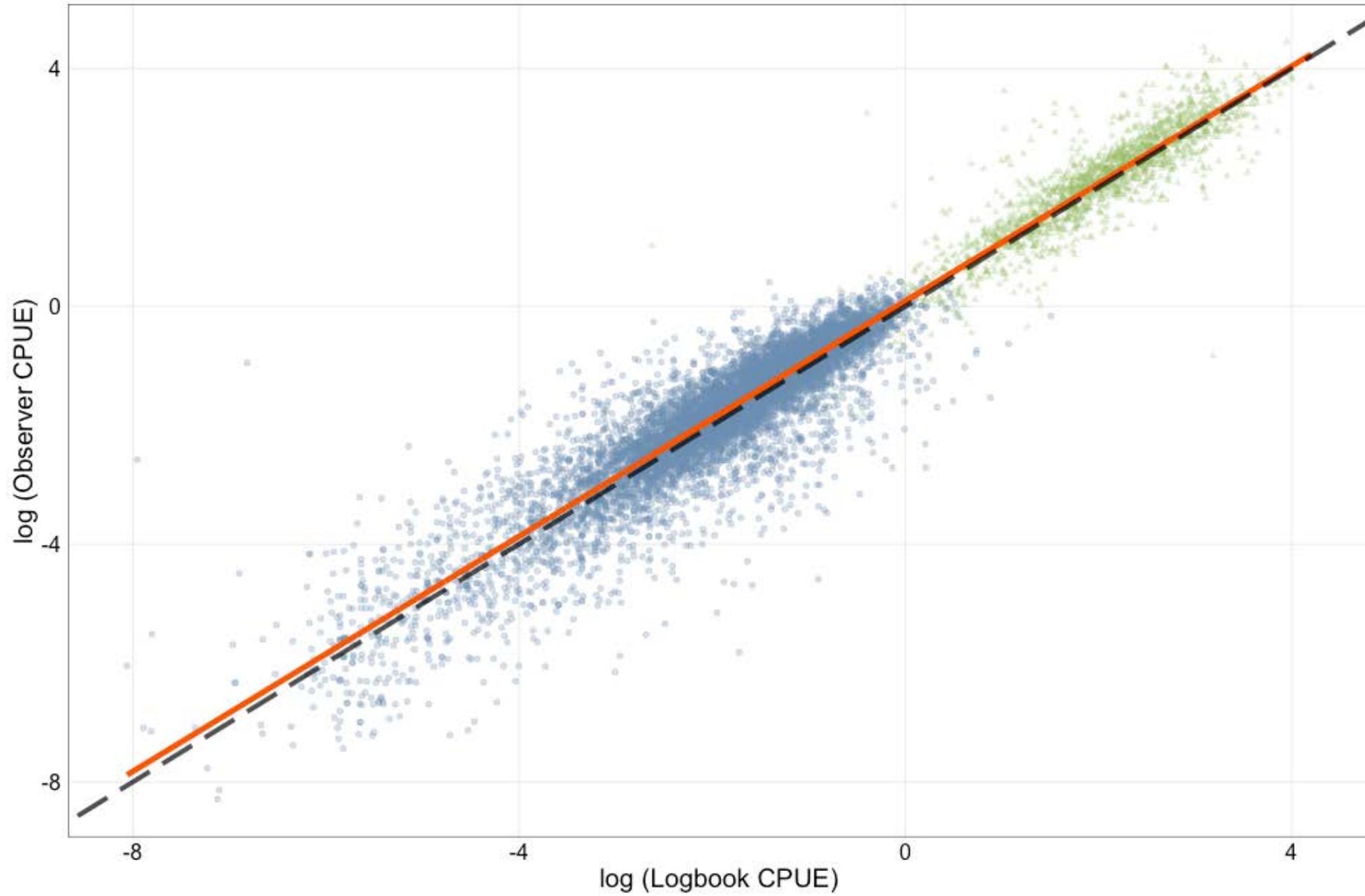
Combined rockfish complex to a common species field &
sum to get overall weight per haul

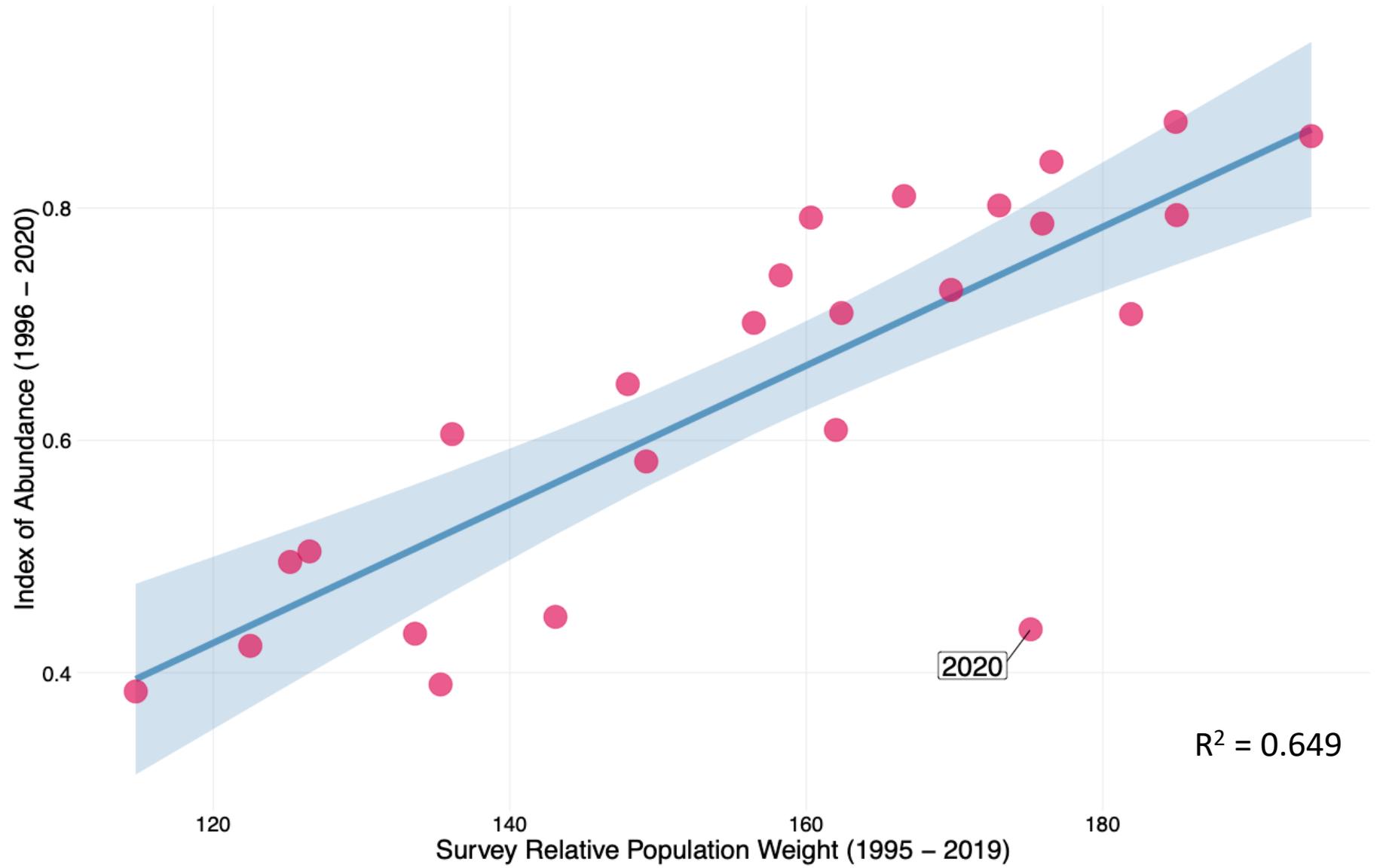
Determine target set: Target = species encountered w/ highest weight for a given set

Filtered to sets without any gear performance issues

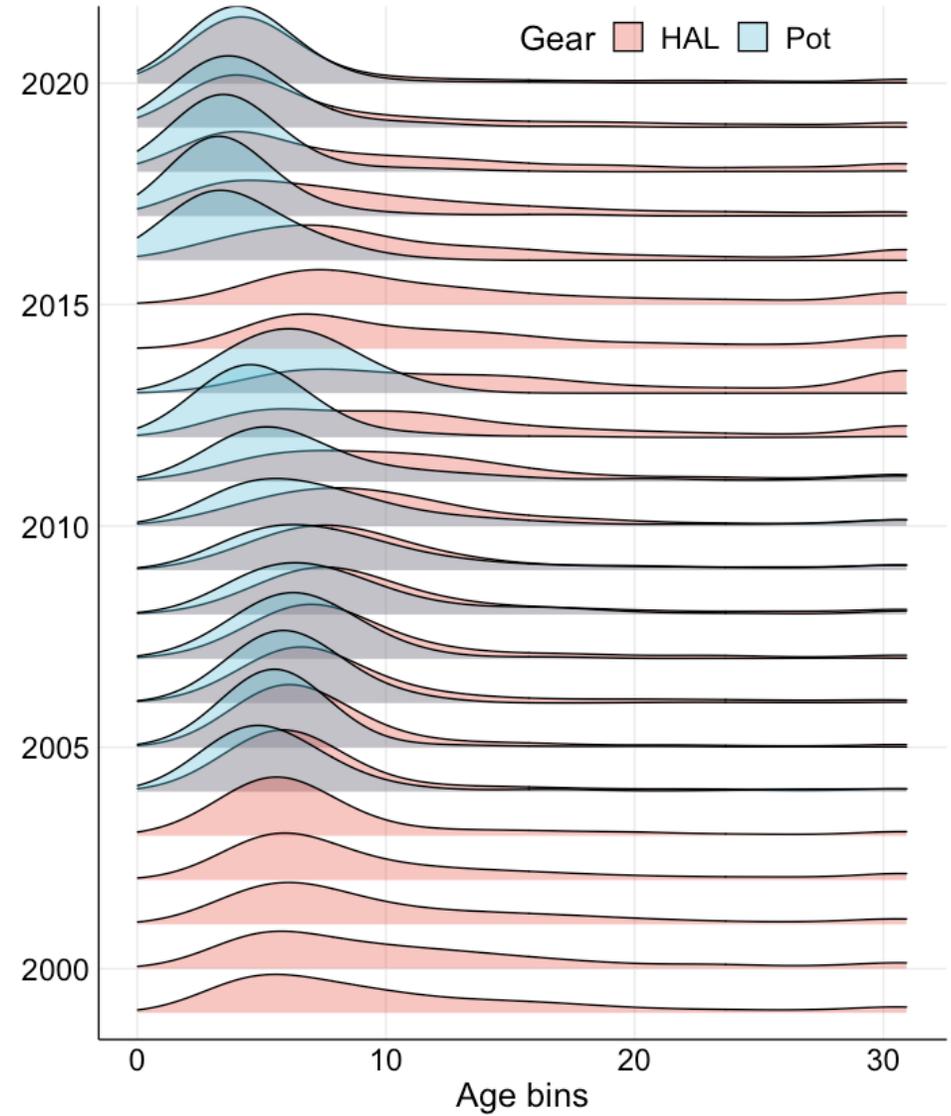
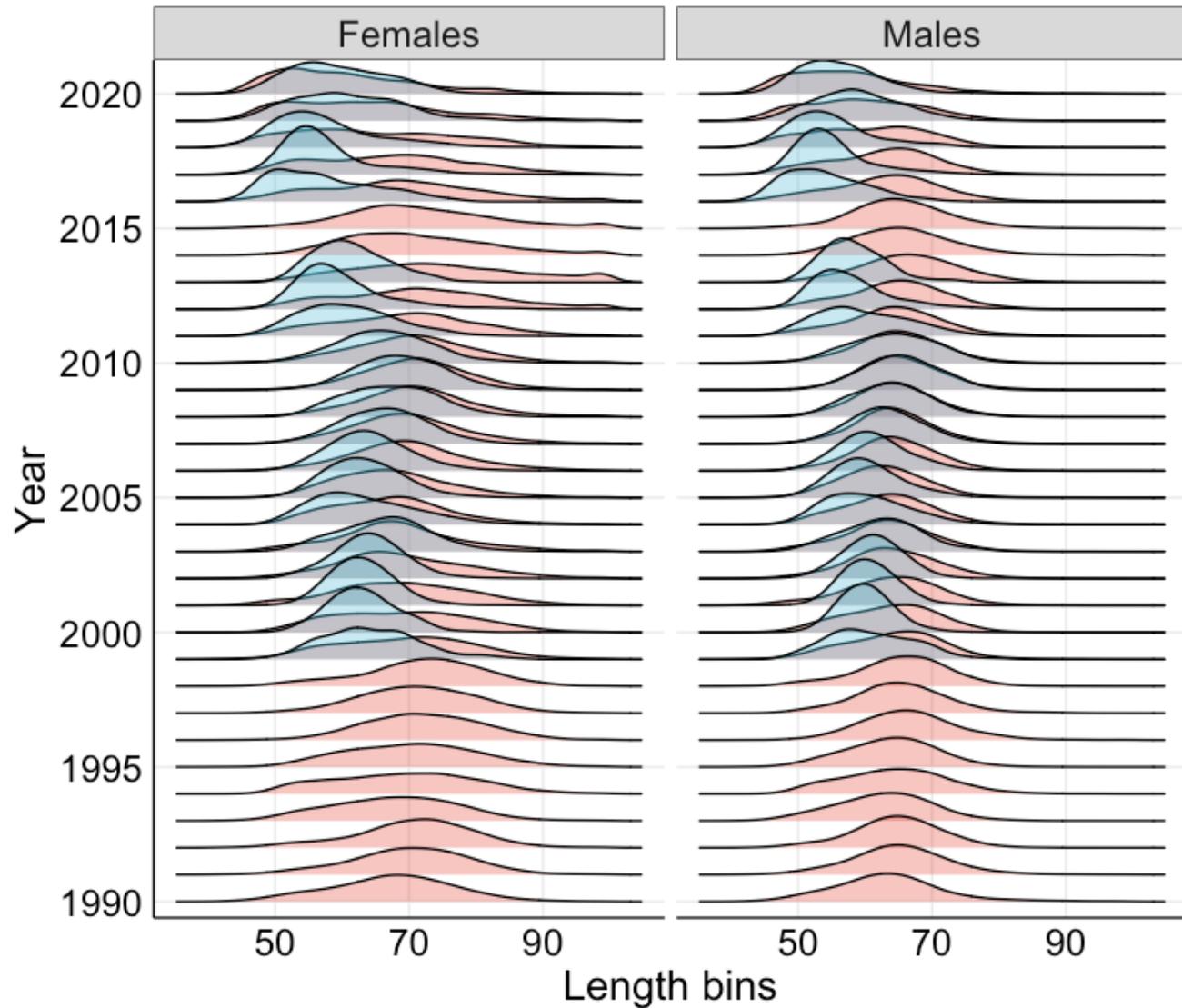
Removed anomalous/leverage points (depth < 7000m, duration fished < 5000 mins)

Gear Type • Hook-and-Line ▲ Pot

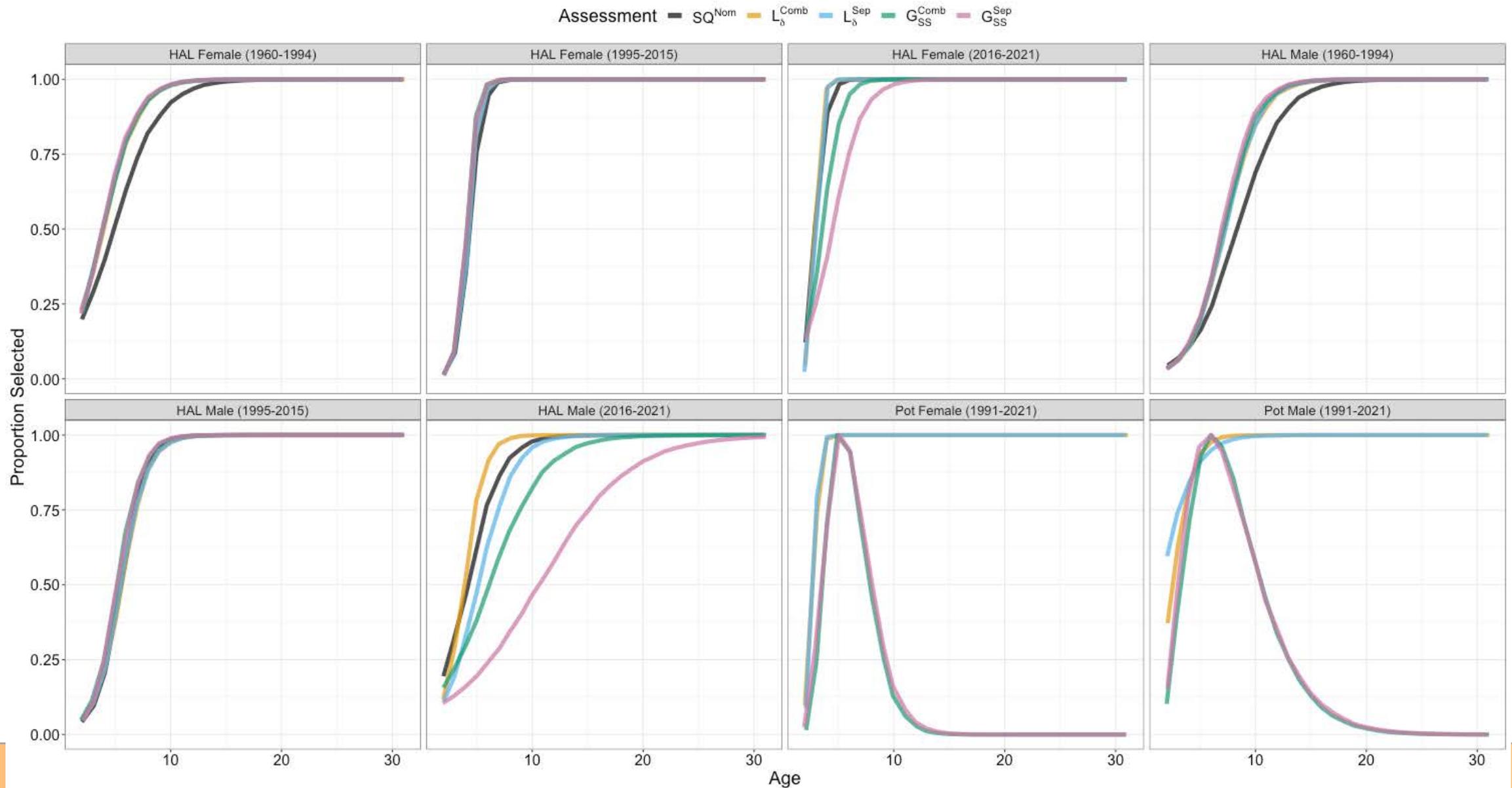




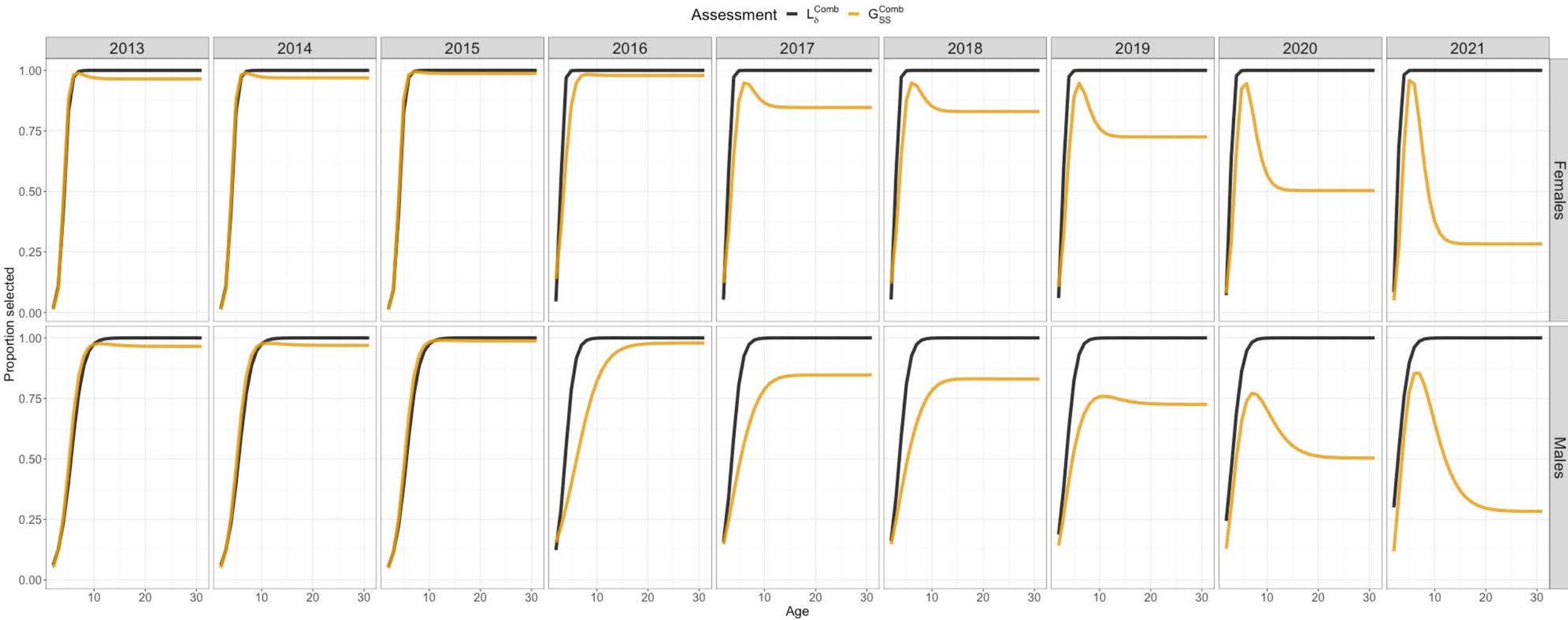
Pot fleet comp distributions



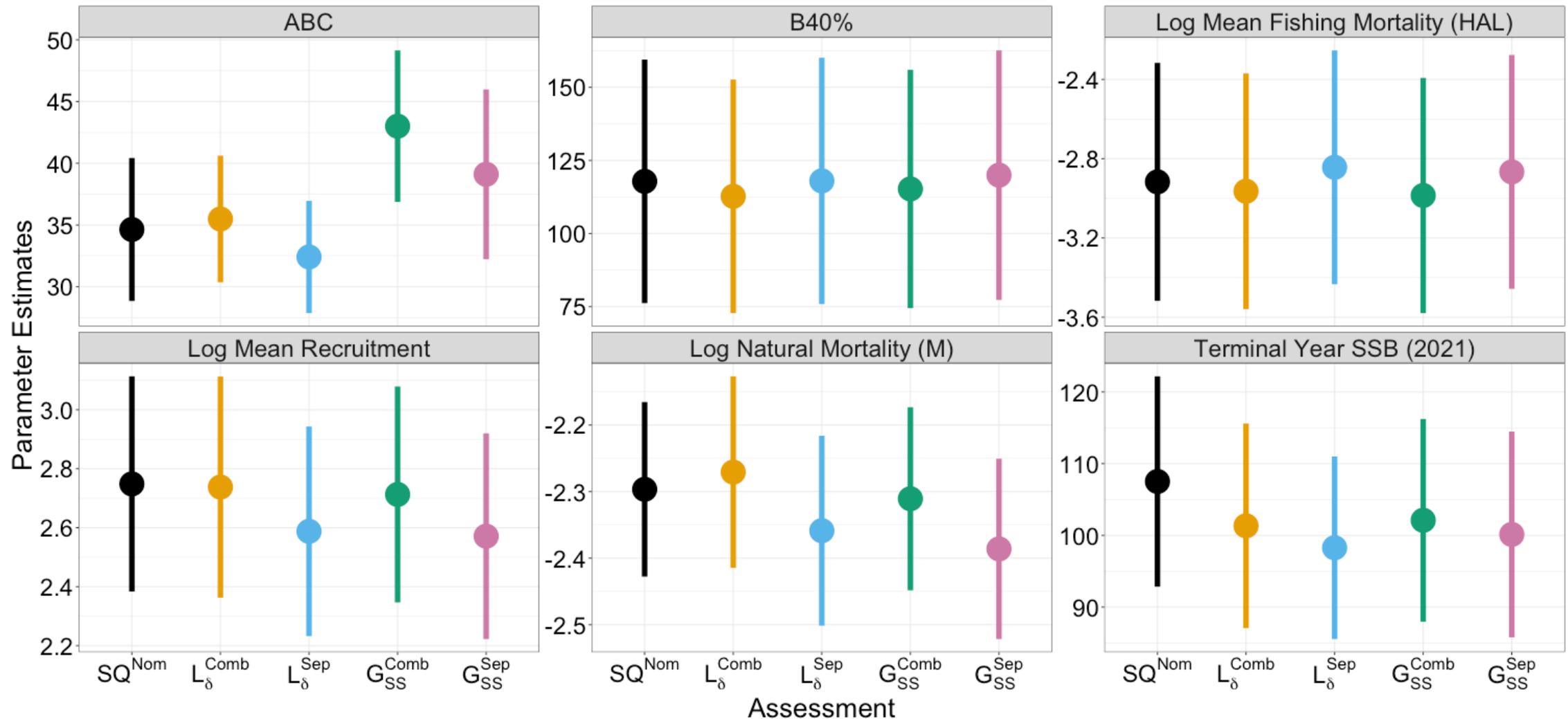
Estimated selectivity



Weighted average selectivity



Key parameters and management quantities



Average fits to age and length comps

