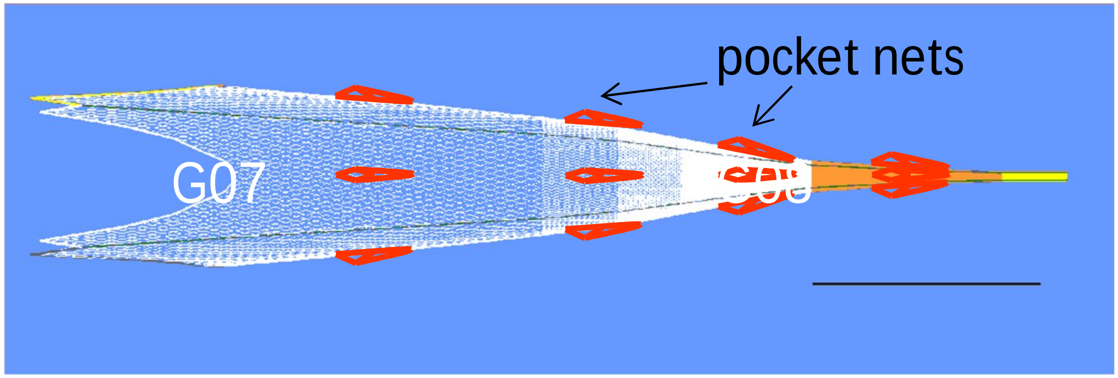
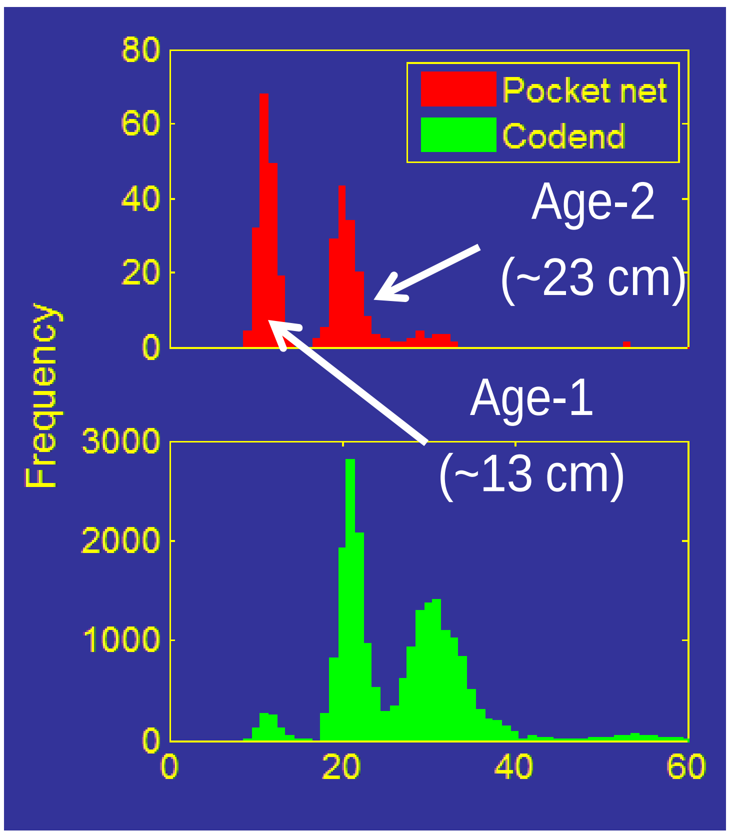
Trawl Selectivity Correction for Shelikof Strait Acoustic Survey

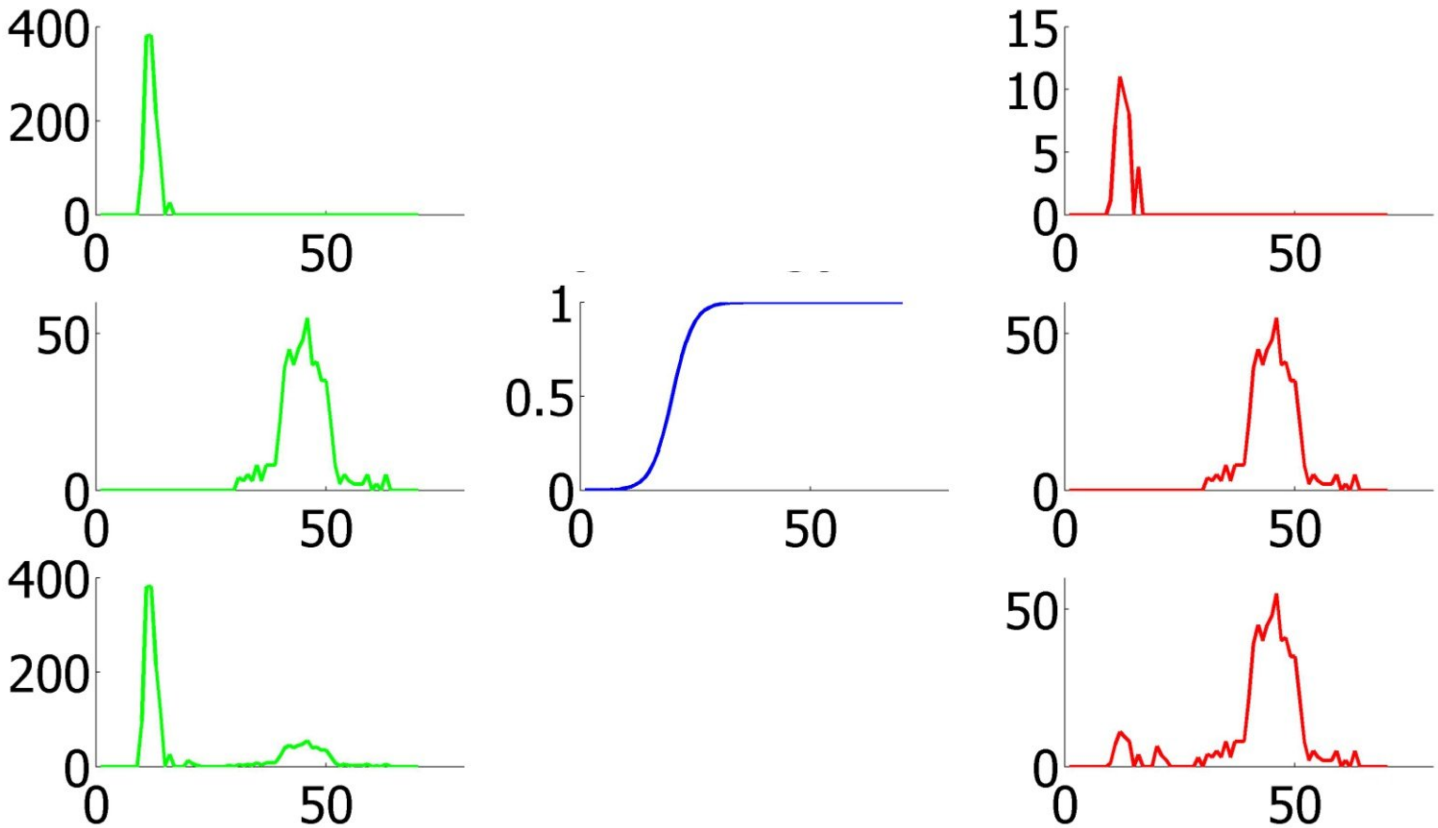
AWT Midwater Trawl



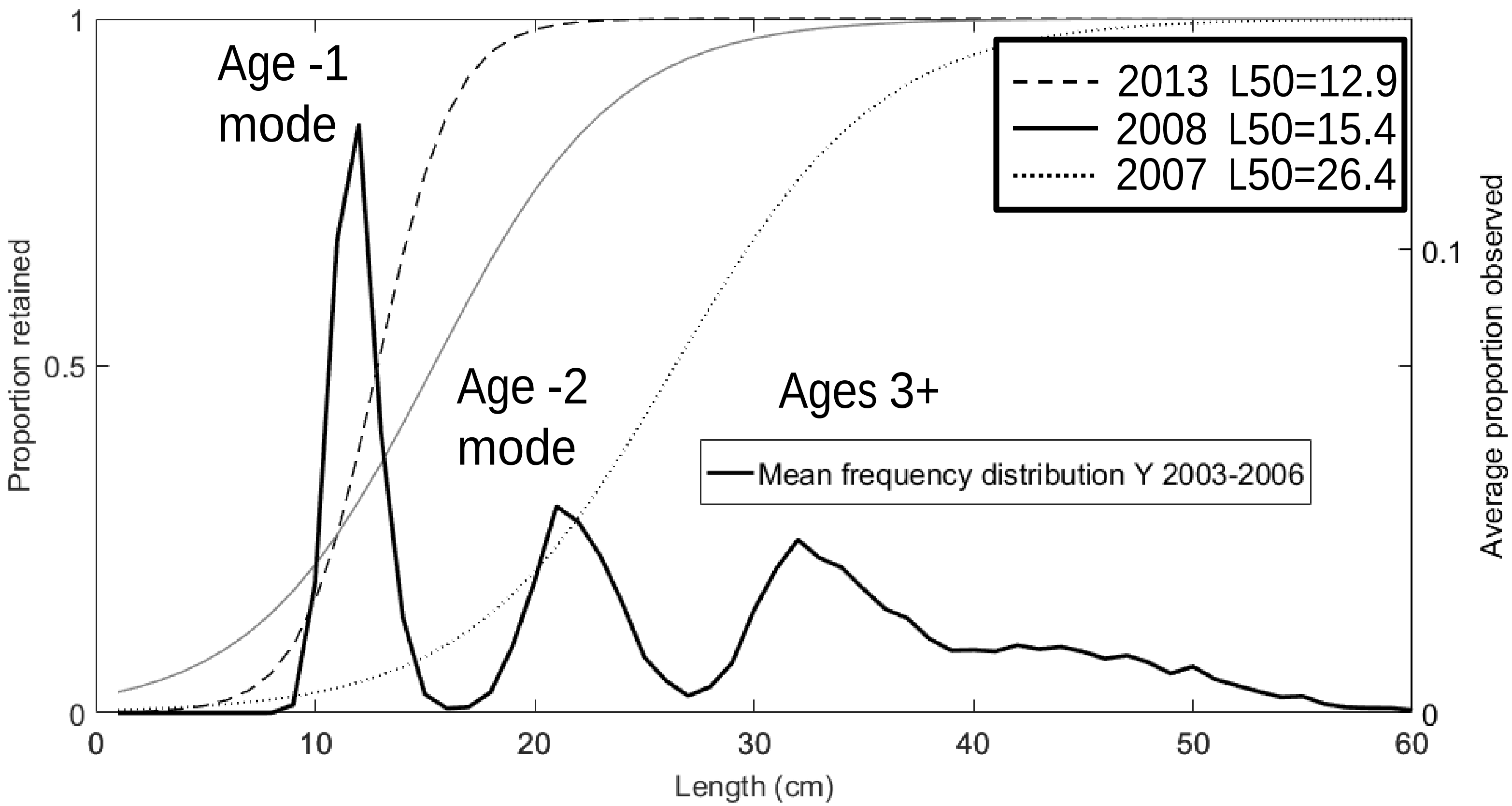


Role of trawl selectivity in acoustic surveys:

Population LF Selectivity Sample LF



AWT Selectivity Curves – dedicated experiments conducted at four specific locations in 2007 (1), 2008(1), and 2013(2)
- Lots of inter-experiment variability!



In 2013, samples were also taken throughout the survey area. In 2018, similar experiment with different pocket net materials.

Data Analysis for dedicated experiments

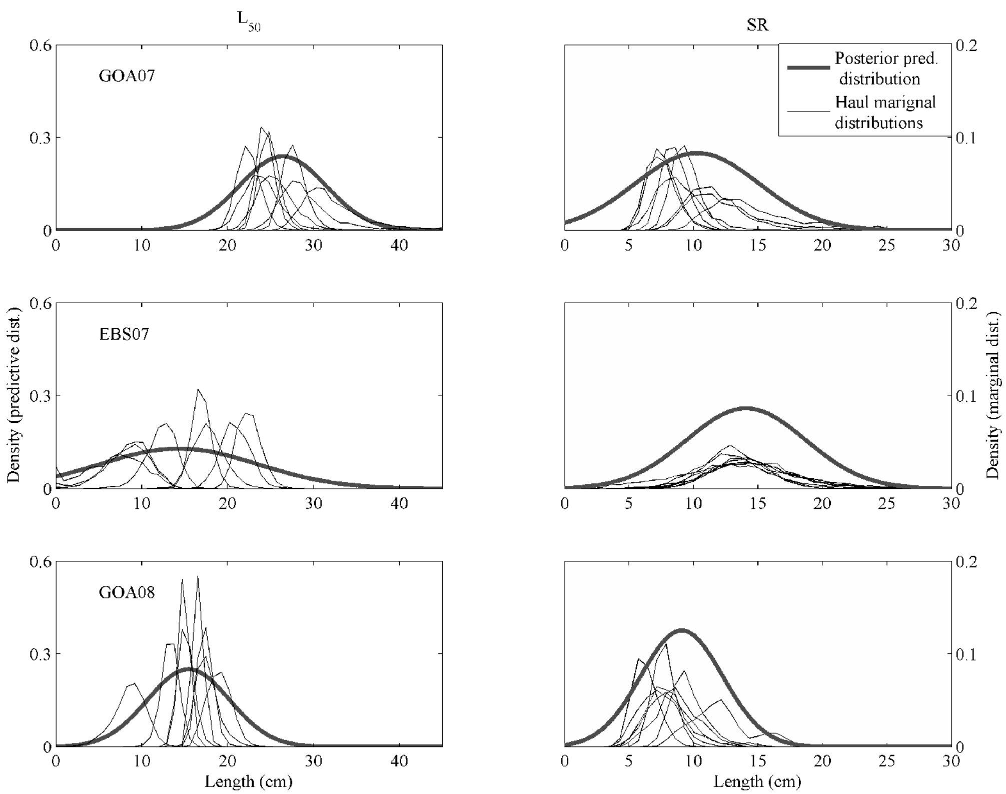
Selectivity function estimated using a Hierarchical Bayesian model (HBM)

Full posterior distributions estimated for hyperparameters (128 total parameters per run) (global "across haul" logistic curve parameters)

Model "predicts" pocket net catches, fit using Poisson likelihood

The good: - good estimate of true variability in estimate
- estimate of escapement pattern of fish from trawl

The bad: - only could fit dedicated "single site" trawl experiments, survey wide data would not fit
- MCMC estimation fairly cumbersome for "production"



Task: operationalize selectivity estimation

In-survey estimates probably best option

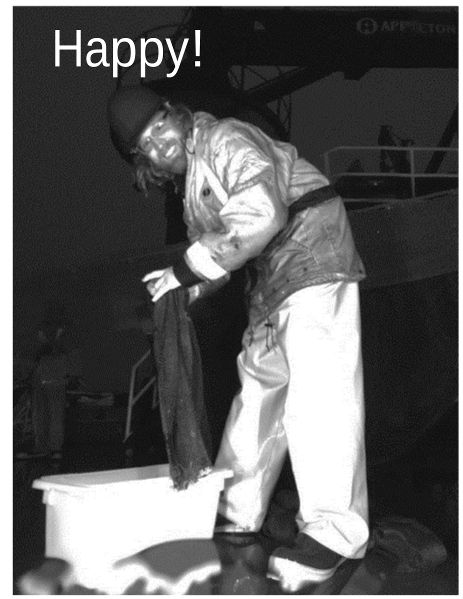
1. Methodological changes for data collection

Old way - random placement - attachment/removal of pocket nets a taxing process

New way - permanent placement and tougher materials much more efficient use of survey time

Old way
2008 - 2013

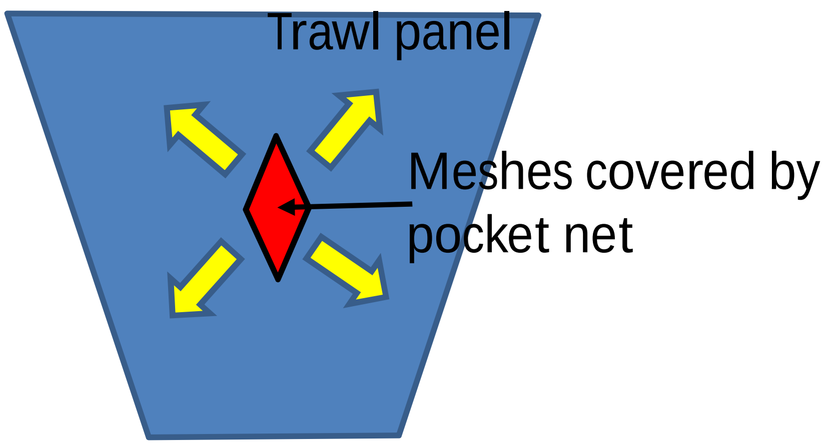
New way –
2018



2. New analysis framework

- Need a different method to fit non-dedicated, continuously collected pocket net data
- Focus on selectivity parameters and point estimates

For binomial type logistic models need to
estimate “total” escapement– extrapolation of escapement to full trawl surface

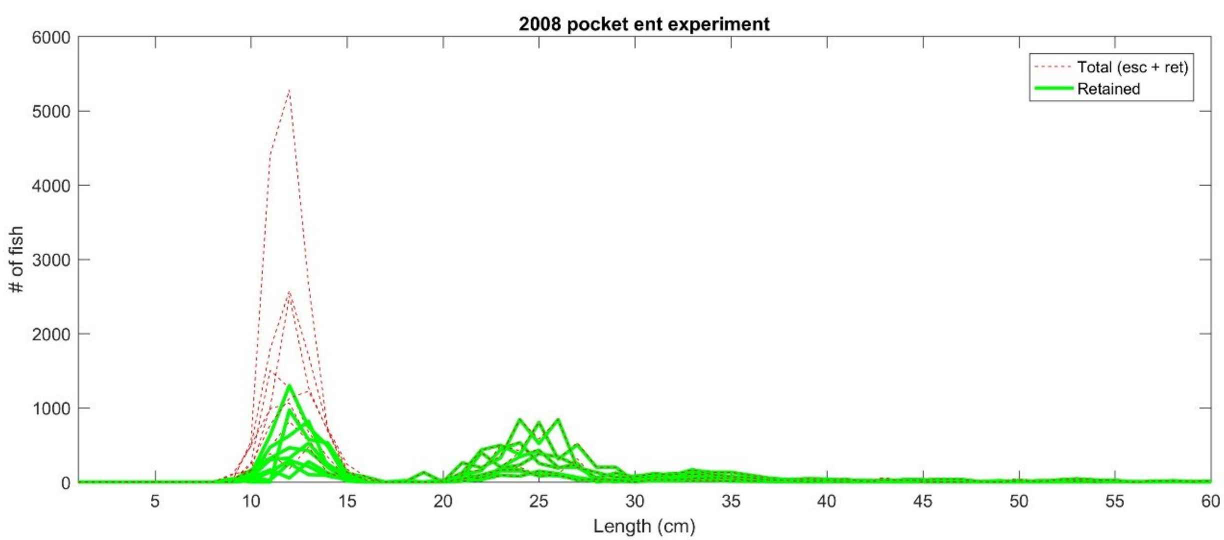


12 pocket net samples

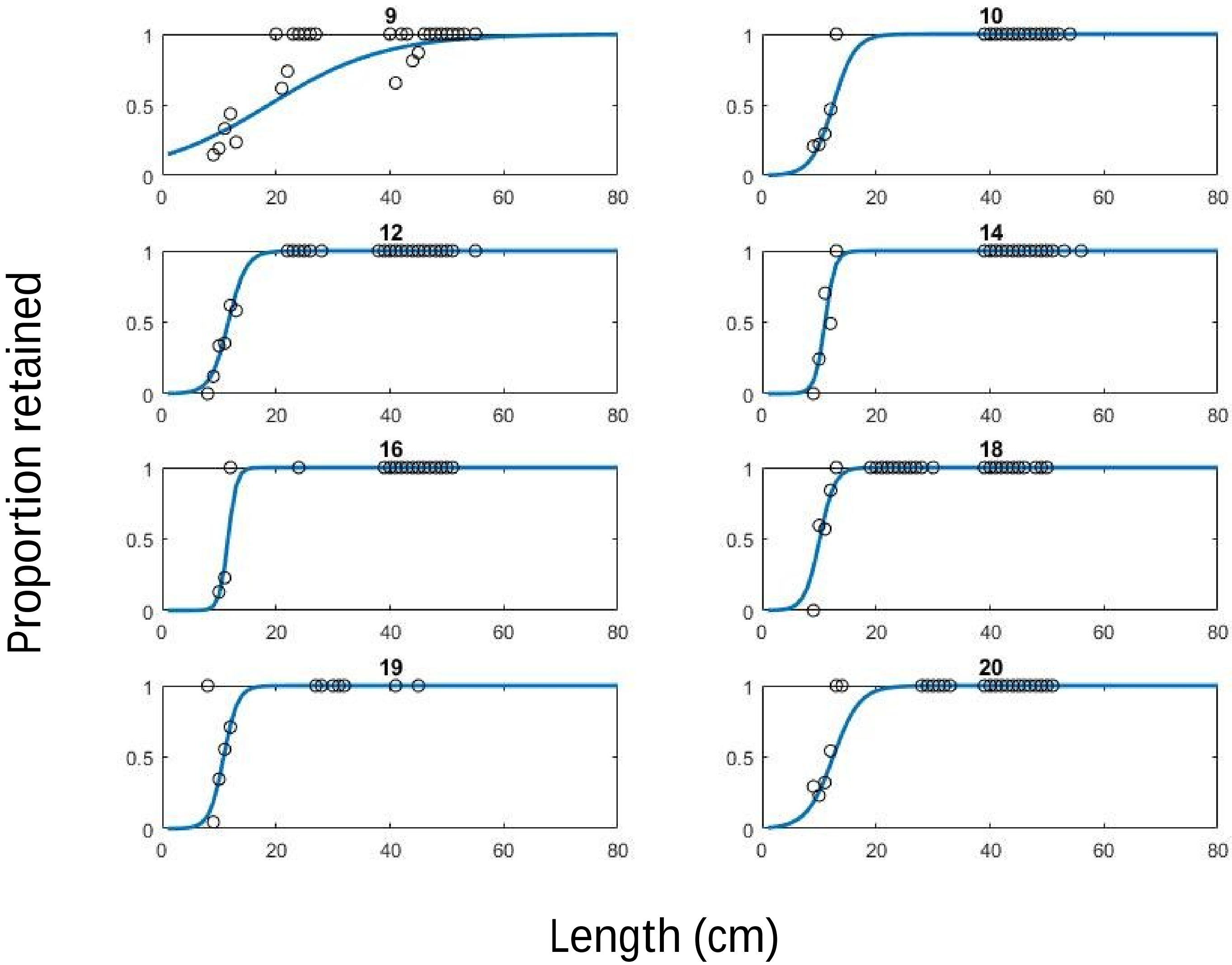
$$?_? = \left(1 + 9^{\left(\frac{(?_{??}?\,?)}{??}\right)}\right)^{??}$$

$$?_? = \sum_{?} ?_{?,?}\, ?_?$$

$$?_? = \frac{\#\,?\ ??h??\ ??\ ?????}{\#\,?\ ??h??\ ???????\ ??\ ??????}$$



2018 individual haul data fit by logistic glm



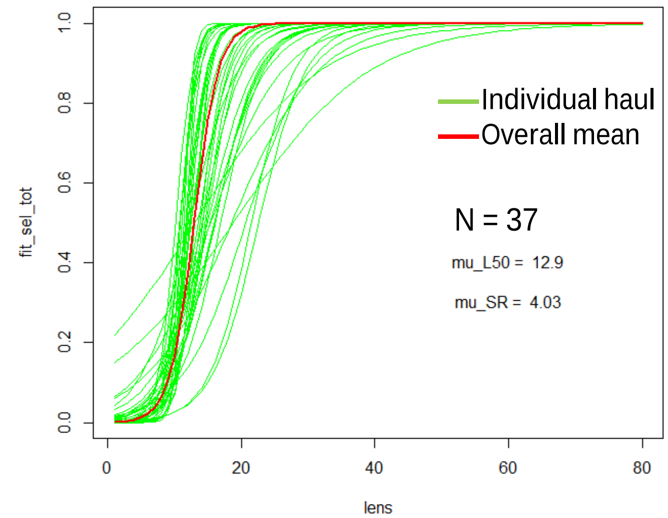
GLMM - mixed effects model based on a logistic glm

Model specification in R

```
mix_fit <- glmer(cbind(ret,esc) ~ length +
            (1+length|haul), family = binomial)
```

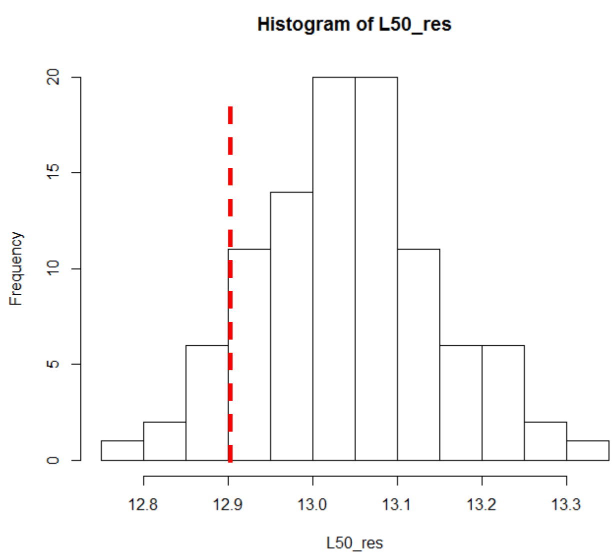
Randome effects on slope and intercept

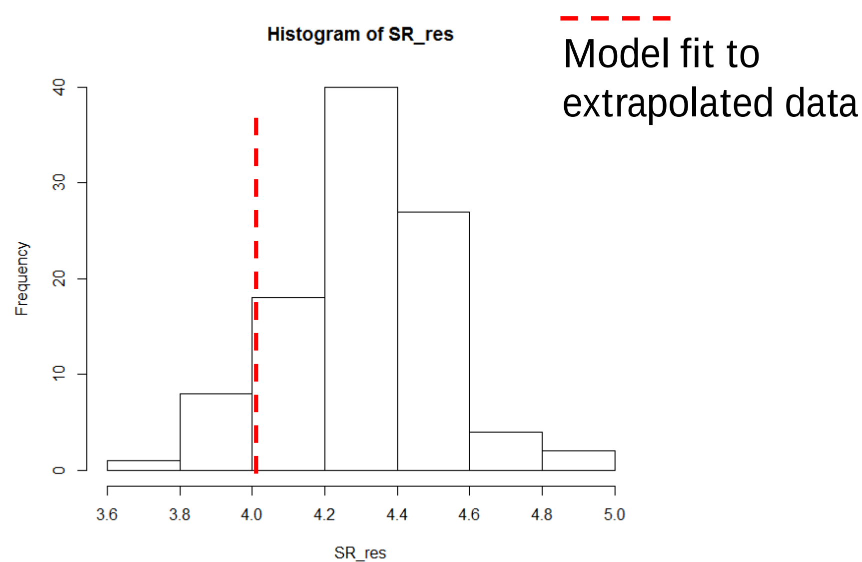
Combined Dyson pocket net data



Sampling error estimate: a preliminary simplistic stab

Use pocket net sample sizes to resample expanded escapee data and codend data





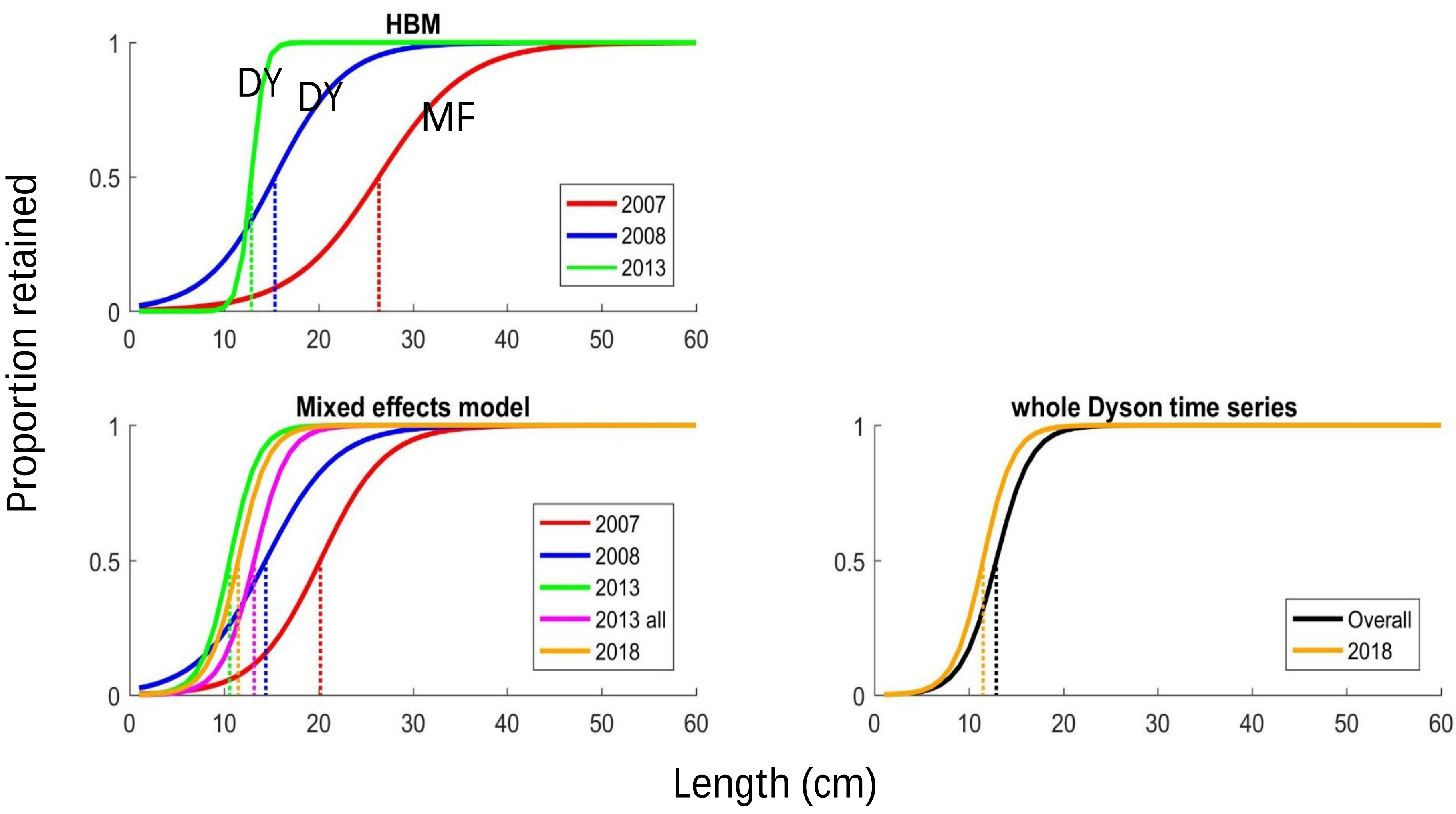
Conclusion: Selectivity varies by year

Mixed effects model provides robust fits with *mostly* similar means to HBM

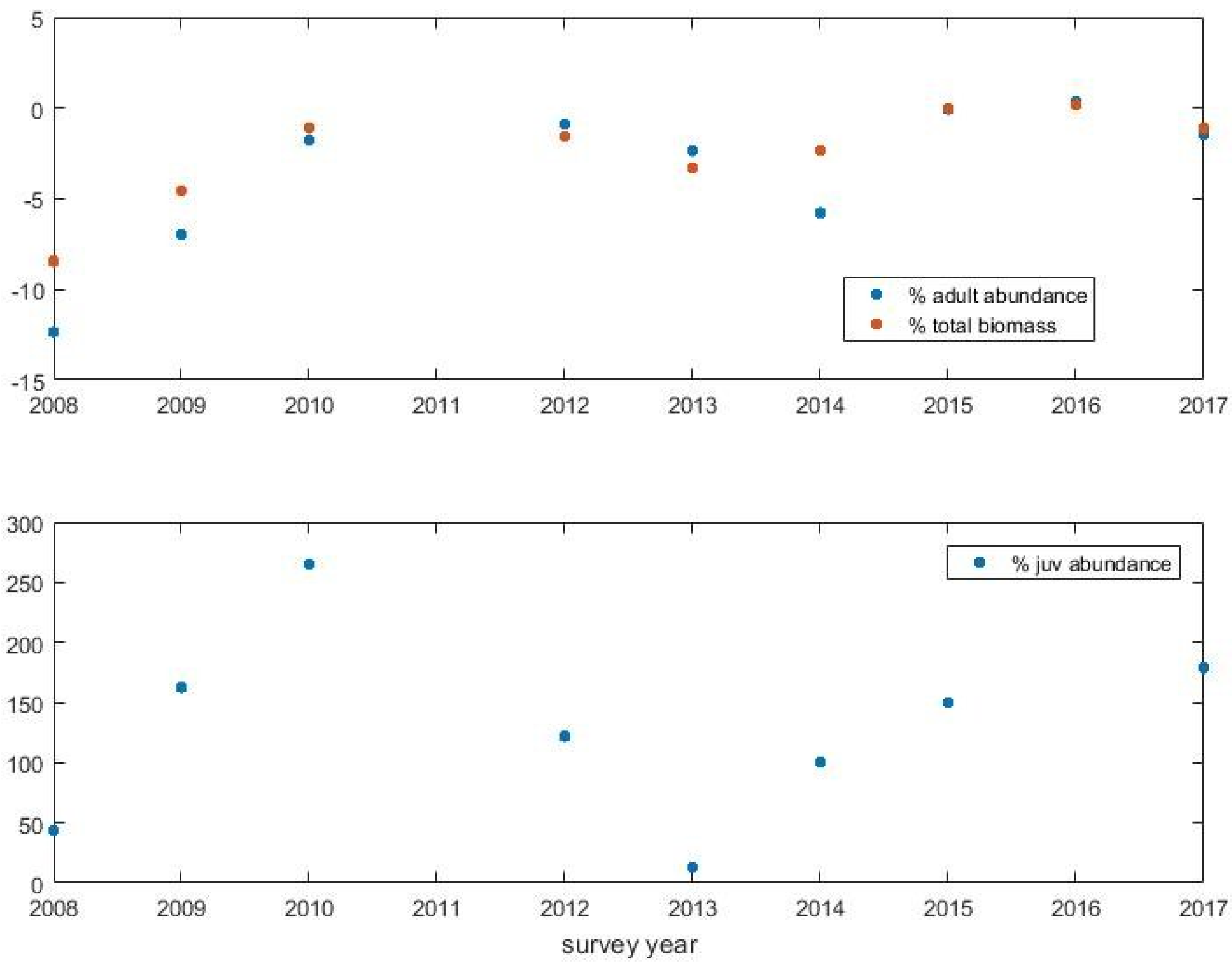
Plan to apply year-specific correction going forward

Correct Dyson time-series with collective data from all Dyson pocket net experiments

Miller freeman series (<2008) to remain uncorrected

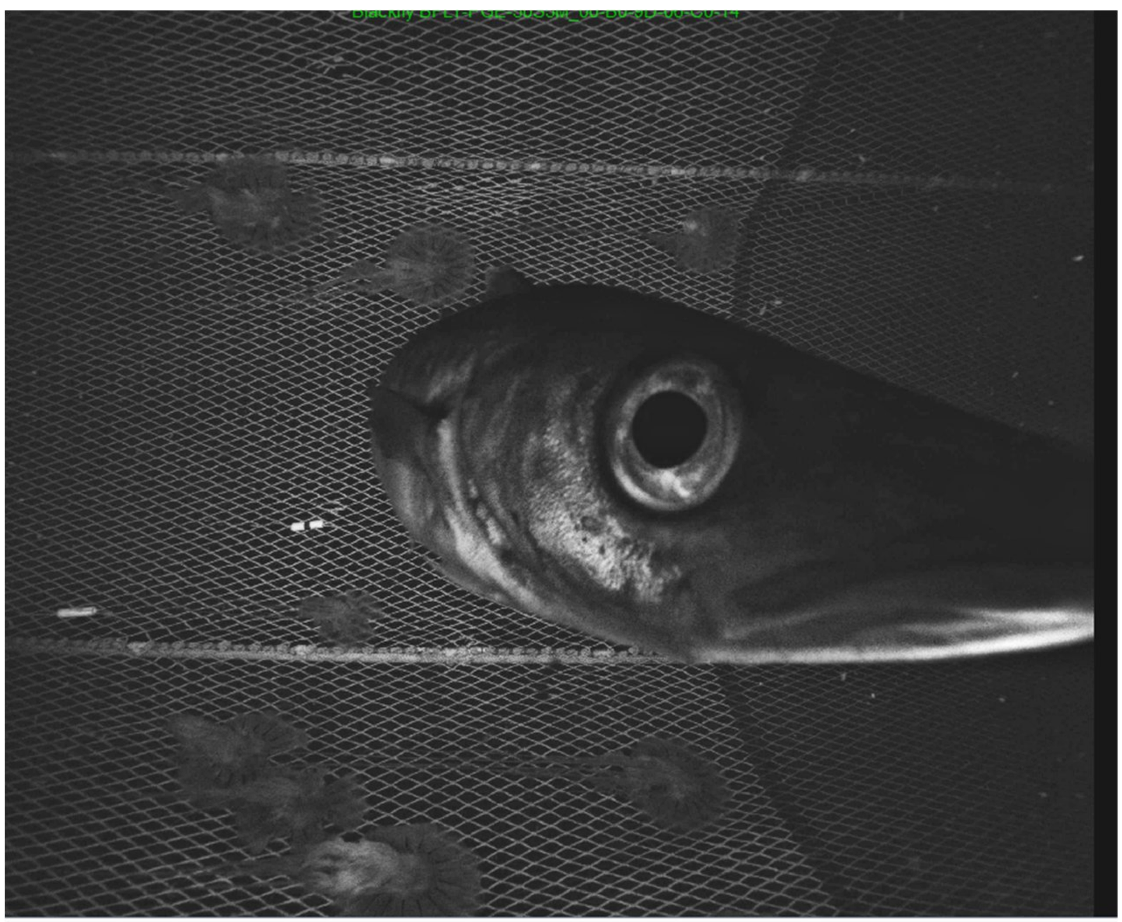


Effect of selectivity on survey estimates



Conclusions:

- New methodology for going forward with a year specific correction
- Corrections modest, important for Age 1 abundance
- Questions?



Bayesian hierarchical model (BHM)
Predict catch rates in individual pocket nets

12 pocket catches + codend = *j*= 13 samples
i = length (cm)

$$?_? = \left(1 + 9^{\left(\frac{(?_{??}? ?)}{??}\right)}\right)^{? ?}$$

$$Y_{i,j} = \mu_i * F_{i,j}$$

Prob. escaping from section
4-way multinomial

Fraction of section/panel
covered by pocket net

for j=1-12(pockets)

$$F_{i,j}=(1-S_i) * P_{sec(j)} * R_{sec(j),pnl(j)} * Q_{sec(j),pnl(j)}$$

for j=13(codend)

$$F_{i,j}=S_i * U$$

Prob. escaping through each
panel in section
4*3-way multinomial

2 selectivity parameters (L50, SR)+ 11 parameters for escape location = 13 per haul

BHM

Individual haul model

Poisson likelihood of observing catch

$$L(x \mid \mu, F) = \prod_i \prod_j \frac{(\mu_i F_{i,j})^{x_{i,j}} e^{-\mu_i F_{i,j}}}{x_{i,j}!}$$

After integrating out μ (negative log)

$$-\log \widehat{L}(x \mid \theta) \propto \sum_i \left(\sum_j \left[-x_{i,j} \log\{F_{i,j}\} \right] + \log\left[\sum_j F_{i,j} \right] \left[\sum_j x_{i,j} + 1 \right] \right)$$

$$\log L(\phi, \theta \mid data) \propto \sum_{h=1}^{n} \log L(data_h \mid \theta_h) + \log L(\phi \mid \theta) + \log L(\phi)$$