Bigelow-Albatross Calibration for Skate Complex

Skate Plan Development Team

Beta-Binomial Model

- Binomial model at each station for number captured by Bigelow conditional on number captured by Both (Bigelow + Albatross)

$$N_{Bi}(L) \sim Bin\left(N_i(L), p_i(L)\right)$$

- Probability parameter is random across stations according to beta distribution

$$p_i(L) \sim Beta\left(\pi(L), \phi(L)\right)$$

Mean Model from CRD 10-05 (Model 1)

$$\log\left(\frac{\pi}{1-\pi}\right)=\log(\rho)$$

- π is the (mean) probability of capture by the Bigelow
- $\rho = E(C_B)/E(C_A)$ is the calibration factor

Length Models (2 and3)

$$\log\left(\frac{\pi(L)}{1-\pi(L)}\right)=\log\left[\rho(L)\right]+\log\left(SA_B/SA_A\right)+\log\left(SF_B/SF_A\right)$$

- $\pi(L)$ is the (mean) probability of capture by the Bigelow
- $\rho(L)$ is the relative catch efficiency (B/A)
- SA is the swept area
- SF is the sampling fraction
- Based on $E(C)=q\times SA\times D$

Dispersion Models (2 and 3)

- For orthogonal polynomial and penalized smoothers,

$$\log\left[\phi(L)\right] = \alpha_1 \log\left(SA_B / SA_A\right) + \alpha_2 \log\left(SF_B / SF_A\right) + \varphi(L)$$

- For the gamma-based beta-binomial model,

$$\log\left[\phi(L)\right] = \log\left[SF_A SA_A + \rho(L) SF_B SA_B\right] + \varphi(L)$$

Smoothers for Length Models (2 and3)

$$\log\left[\rho(L)\right] = \sum_{i=0}^{D} \beta_i g_i(L) \qquad \varphi(L) = \sum_{i=0}^{D} \beta_i g_i(L)$$

- The more terms, the less smooth the fit can be.
- For orthogonal polynomial, D is the degree of the polynomial and $g_i(L)$ are uncorrelated
  - D ranges from 0 to 12 for both relative catch efficiency and dispersion parameter
- For penalized smoothers $g_i(L)$ are basis components and D is the number of columns of the basis
  - The number parameters is estimated via a penalty term.

Season and Region (Model 3)

- "Season" is whether the data were obtained during the spring or fall surveys or during non-survey tows conducted during summer and fall (site-specific).
  - Models accounting for season estimated parameters specific to each season
- North and South Regions were defined: North side of Georges Bank and Gulf of Maine or everything below
  - Strata are given in Table 4
  - Models accounting for region also accounted for season.
  - Estimated parameters were region and season specific
- We intended to further consider depth categories (Table 5) but data were insufficient for some season/region/depth subsets

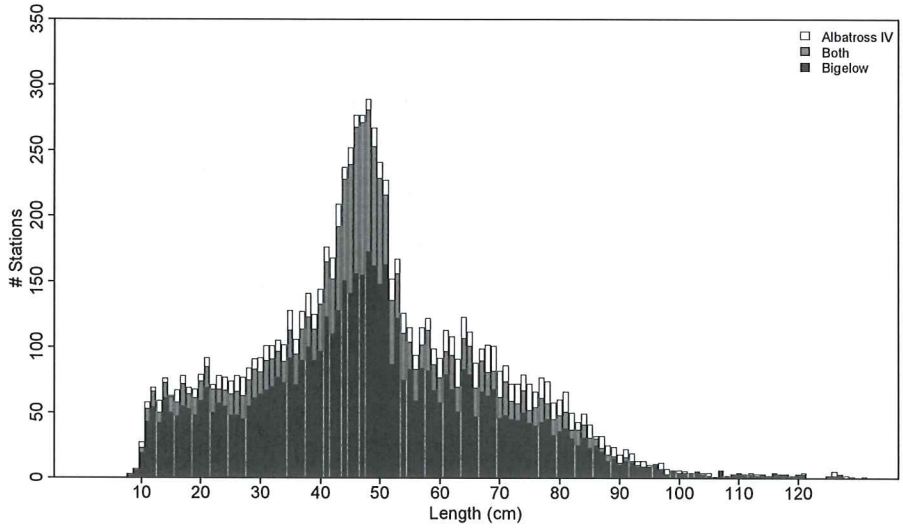
Determining a final Model 2 and 3

- The suite of fitted models with different smoothers types and numbers of parameters were compared using AIC_c to determine a final Model 2.
- The same type of smoother as the final Model 2 was used for fitting models by season and region.
- Used AIC_c to compare the fitted seasonal and regional models to each other and Model 2

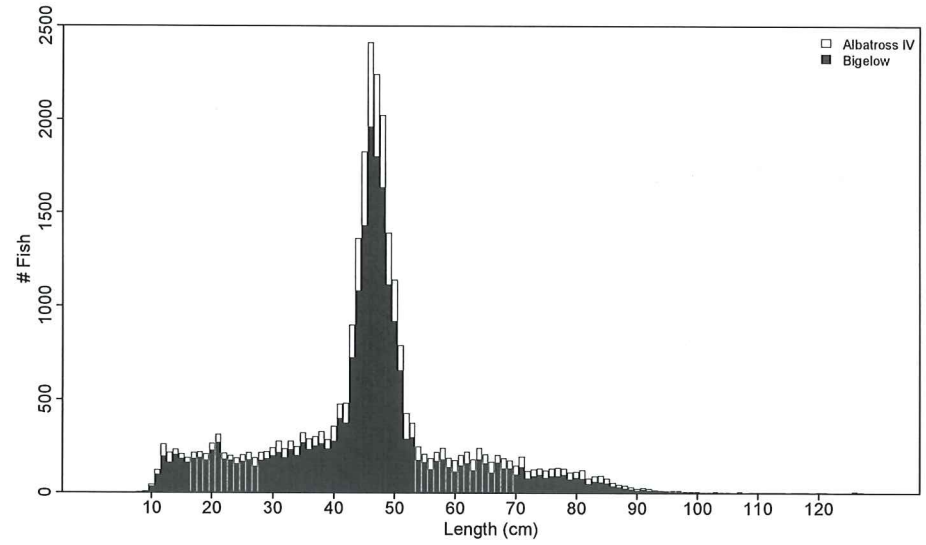
Calibration Data

- For Model 1 (CRD 10-05), the data are numbers per tow for each vessel by species
- For Models 2 and 3 data are numbers per tow per 1 cm length class of all species combined.
- After preliminary analyses for Model 2 the PDT decided to pool information for skates greater than 94 cm.
  - Assigned 107 cm (average of lengths in this pool).

Presence in trawl



Number captured



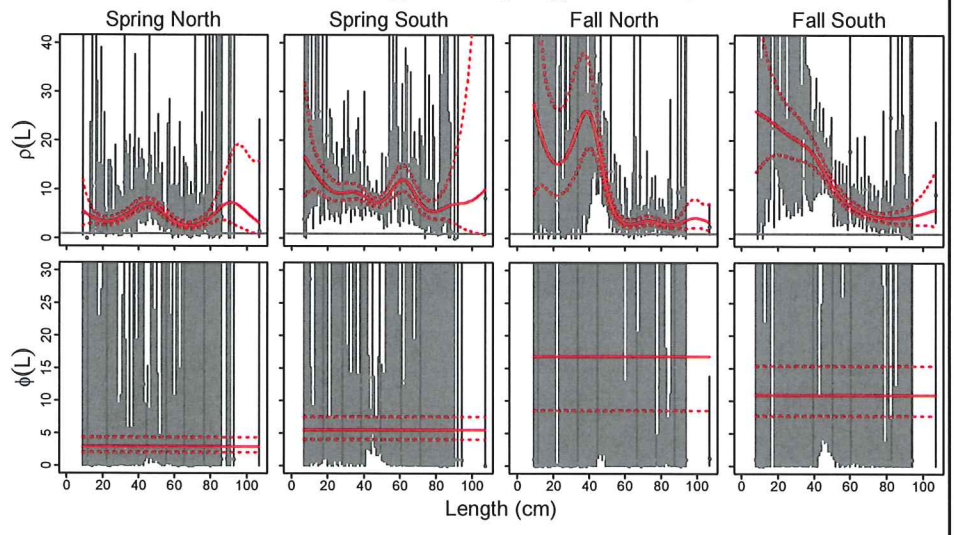
Model 1 Results (Table 1)

Species	Calibration Coefficient (Std Err)	Comment
Little *Leucoraja erinacea*	2.785519 (0.32)	Spring Survey
Winter *Leucoraja ocellata*	2.174334 (0.31)	Fall Survey
Barndoor *Dipturus laevis*	3.661128 (0.51)	Fall Survey
Thorny *Amblyraja radiate*	3.626359 (0.58)	Fall Survey
Smooth *Malacoraja senta*	4.449518 (0.67)	Fall Survey
Clearnose *Raja eglanteria*	6.189401 (0.81)	Fall Survey
Rosette *Leucoraja garmani*	8.813973 (0.98)	Based on the calibration coefficient for little skate in the fall survey comparisons

Comparison of Models in classes 2 and 3(Table 6)

Rank	Model Type	# ρ df	# φ length parameters	φ Covariates	# Total parameters	-LL	AIC_c	(AIC_c)
1	SP(Season,Region)	37.02	5	SF	46.02	-7359.32	14811.18	0.00
2	SP(Season)	15.56	4	SF	23.56	-7423.64	14894.53	83.36
3	SP	6.80	1	SF	8.80	-7522.98	15063.58	252.40
4	OP	9	1	SF	11	-7520.85	15063.73	252.55
5	OP	10	1	SF	12	-7520.35	15064.74	253.57
6	OP	9	2	SF	12	-7520.49	15065.01	253.83
7	SP	6.54	10.24	SF	16.78	-7515.75	15065.14	253.96
8	SP	6.81	1	SF, SA	9.81	-7522.88	15065.42	254.24
9	OP	9	1	SF, SA	12	-7520.76	15065.56	254.38
10	OP	10	2	SF	13	-7520.00	15066.04	254.87
11	OP	9	7	SF	17	-7516.00	15066.07	254.90
12	OP	11	1	SF	13	-7520.24	15066.51	255.34

Length-based Calibration by Season and Region (Figure 3)



Issues with converting previous Albatross indices into Bigelow Equivalents

- Potential biases due to changes in length composition if length-based methods not used
- Potential biases if length-weight relationships vary over time and data are not available to estimate them
- Re-calculation of reference points required
- Poorer precision of indices induced by conversion may translate into greater CVs in reference point algorithm
- Biases of conversion when zeros observed by Albatross (e.g., barndoor)
- All of this would imply the peer-review process would be appropriate for this change in reference point methodology