An Exploratory Analysis of Biotic and Abiotic Factors Affecting Mortality and Recruitment of Monument River Alewife (*Alosa pseudoharengus*)

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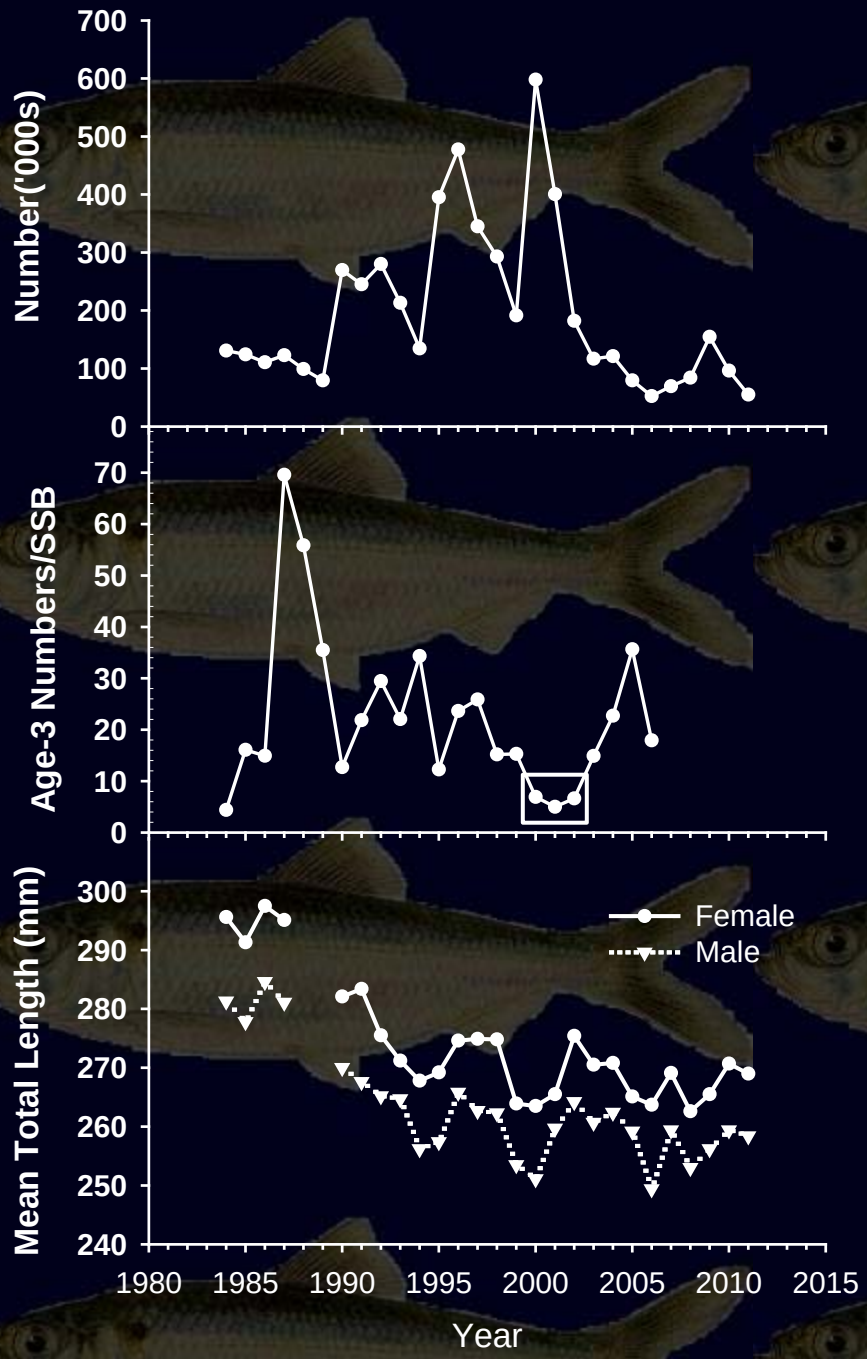
SPORT FISH RESTORATION



- Decline in escapement counts of Monument River alewife (*Alosa pseudoharengus*) after 2000
- Population model showed very low survival for 1997-1999 year classes
- Decline in mean total length (and age) over time
  - Increased Mortality?

Incorporating Covariates in Mortality and Recruitment Equations of Stock Assessment Model

Estimate

$$\hat{M}_y = \hat{M}_0 \exp\left(\sum_k \hat{\beta}_k I_k\right)$$

Estimate

$$\hat{R}_y = \hat{R}_0 \exp\left(\sum_k \hat{\beta}_k I_k + \hat{e}_y - 0.5\hat{\sigma}^2\right)$$

Factors

- **Predators** (coast-wide stock assessments)
  - Striped Bass (R & M: ages 6-12 abundance)
  - Bluefish (R: ages 0 & 1; M: ages 2+ abundance)
  - Spiny dogfish (M: biomass)
  - Gray Seal (M: abundance)
  - Cormorants (R and M: number of breeding pairs)

- **Atlantic Herring Fishery Bycatch** (R and M – NOAA landings as proxy of bycatch amounts)

- **Prey Resources** (NOAA plankton surveys)
  - Euphausiids (R (first winter at-sea) & M from GOM and SNE)
  - Copepods (R & M for GOM and SNE)
  - Amphipods (R & M from GOM and SNE)
  - Mysids (R & M from GOM and SNE)

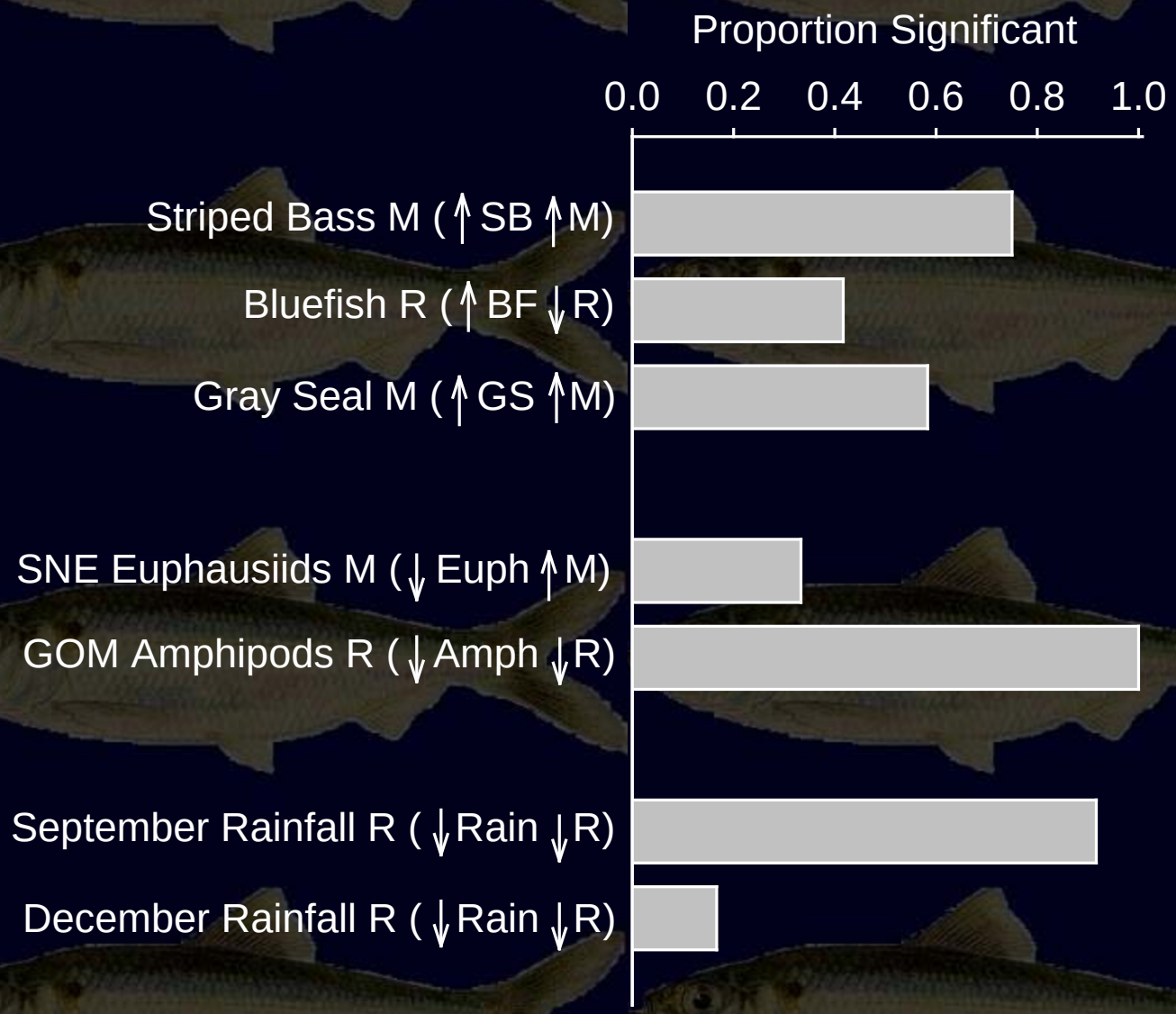
- **Winter SS temperature** (NOAA Buoy)
  - R (first winter at-sea) from GOM and SNE

- **Rainfall** (MA DCR Onset, MA)
  - R: monthly from July to December

Methods

- Significance of single covariates determined using randomization test
- “Best” multi-covariate formulation determined using Burnham and Anderson’s Information-Theoretic approach using AICc
- Consistency of significance of single and “best” multi-covariate formulations explored using 3 models with different terminal years of data (2011, 2010,2009) and different data weightings and their retrospective peels back to 2007
- Predicted total run size one-year-ahead by using models with covariates (used Burnham and Andersen model averaging approach on predictions from all possible multi-covariate formulations for the 3 models and their retrospective peels)

Consistency of Single Covariate Significance
(Out of 12 Models/Peels)

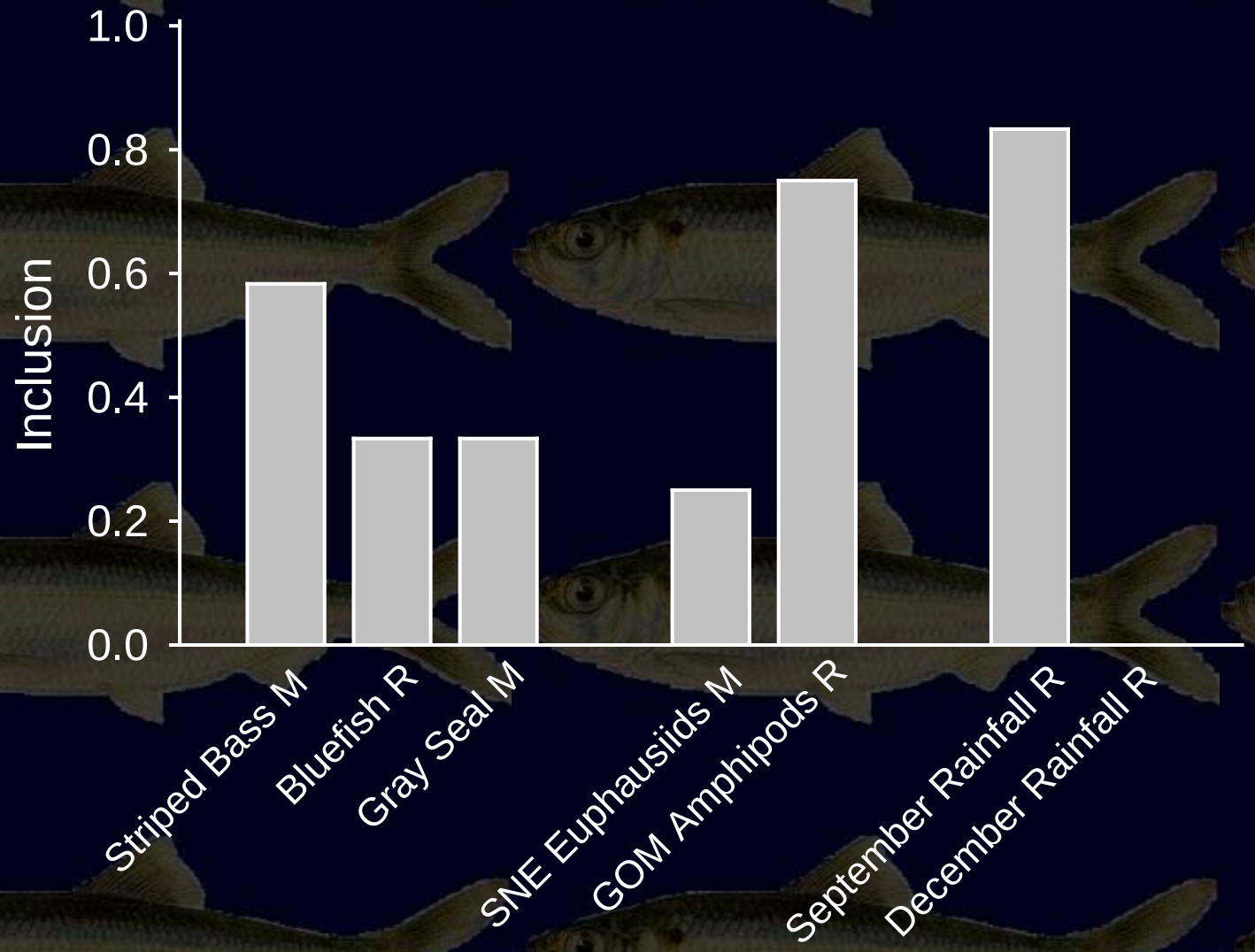


Multi-Covariate Formulations

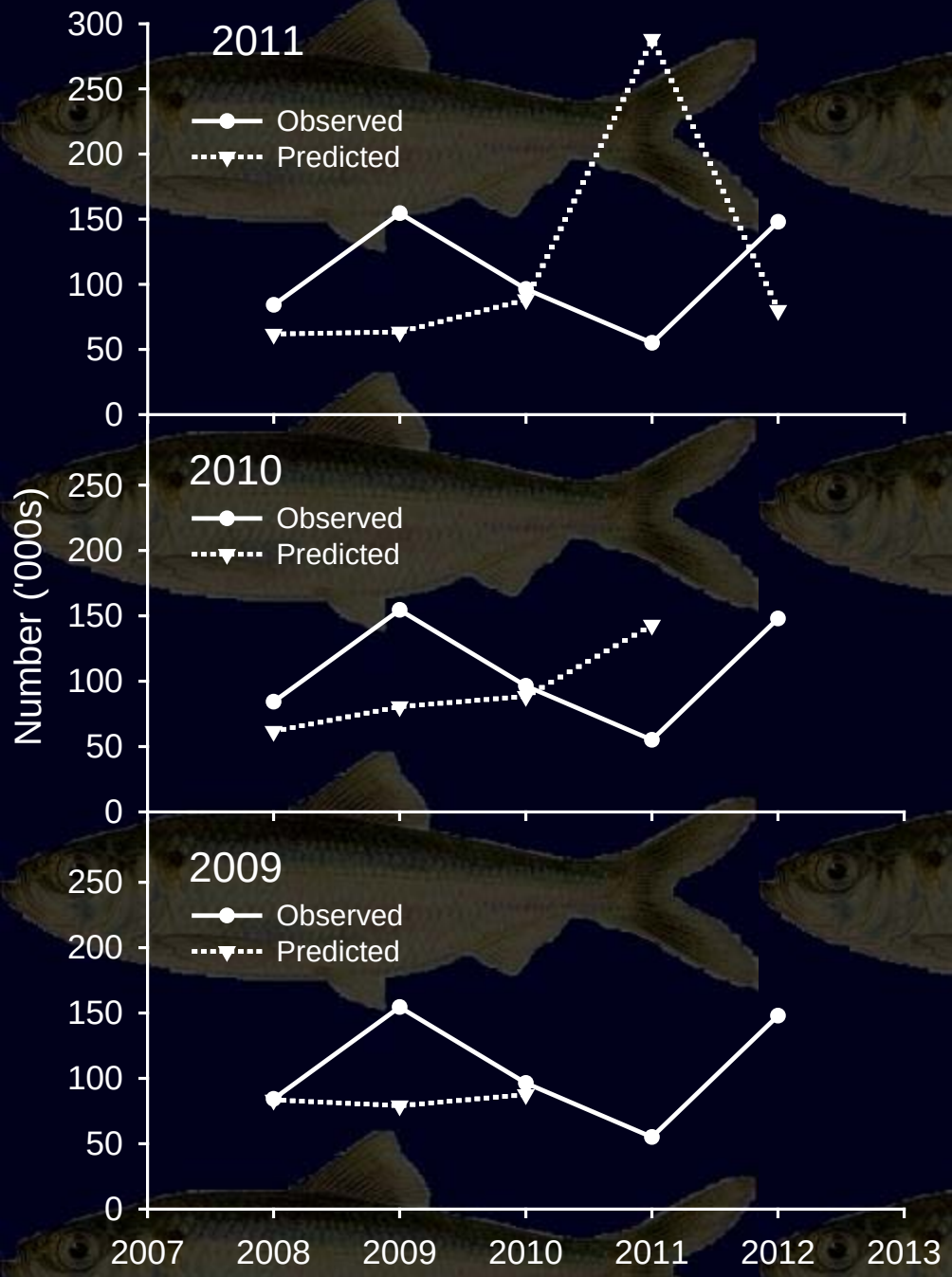
Sequential Randomization Test of "Best" Model

Model	Covariate	P
1984-2011	Striped Bass M	0.036
	SB M, GOM Amphipods R	0.001
1984-2010	Striped Bass M	0.036
	SB M, Bluefish R	0.001
	SB M, BF R, GOM Amphipods R	0.015
	SB M, BF R,GOM Amph R, Sept Rain R	0.030
1984-2009	Striped Bass M	0.040
	SB M, Bluefish R	0.000
	SB M, BF R, GOM Amphipods R	0.015
	SB M, BF R,GOM Amph R, Sept Rain R	0.023

Inclusion of Covariates in “Best” Multifactor Models from 12 Models/Peels



One-Year-Ahead Predictions of Total Run Size



- Predictions for 2008 and 2010 regardless of model were close to the observed run size, but were different for the remaining years

- Overall, the trends were different indicating little predictive power

Summary

- Seven covariates significantly improved model fits to the alewife data
- However, covariate significance and “best” multi-covariate model not always consistent across models and peels (year of data and data weighting important)
- Three covariates (September Rainfall R, GOM Amphipods R and Striped Bass M) appeared important since they were significant most frequently as single covariates and occurred most frequently in “best” multi-covariate formulations
- One-year-ahead predictions of total run size were very poor because only small amounts of total variation were accounted for by inclusion of covariates