Modeling PalEON biomass

Wesley Brooks

UW-Madison

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Outline

Goal

- Produce a model of per-species biomass at time of settlement

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Data

- Computed from settlement-era survey
- Working with composition, biomass, and stem density

Models

There are two divisions for modeling biomass data:

Model			Estimation method: Splines	Estimation method: GMRF	Estimation method: GLM
	One-stage	Zero-inflated gamma			
		Tweedie			
	Two-stage	Bernoulli-Gamma			

Two-stage models

- First stage: zero/non-zero
  - Logistic regression
  - $Z \sim \text{Bernoulli}(\gamma)$
  - $\text{logit}(\gamma) = f(x, y, p_k)$
- Second stage: distribution of positive biomass
  - $Y|Z = 1 \sim \text{Gamma}(\alpha, \beta)$
  - $\text{E}(Y|Z = 1) = \mu = \alpha\beta = f(x, y, p_k)$

Two-stage models

Mean and variance of the two-stage model:

- $E(Y) = \gamma\mu$
- $\text{var}(Y) = \gamma\alpha\beta^2\left(1 + \alpha(1-\gamma)\right)$

Tweedie model

The Tweedie model is a Gamma-Poisson mixture.

- Draw $N \sim \text{Poisson}(\lambda)$
- Now make N iid draws: $V_\ell \sim \text{Gamma}(\alpha, \beta)$
- $Y = \sum_{\ell=1}^{N} V_\ell$

Tweedie model

With θ given, the Tweedie distribution is in the exponential family with natural parameter ν:

- $f(y) = \exp\left\{\phi^{-1}\left[y\nu - \kappa(\nu)\right] + c(y, \phi, \nu)\right\}$
- ϕ is a scale parameter
- $\nu = \mu^{1-\theta}/(1-\theta)$
- $\kappa(\nu) = \left[(1-\theta)\nu\right]^{(2-\theta)/(1-\theta)}/(2-\theta) = \mu^{2-\theta}/(2-\theta)$

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