



A Bayesian Model Averaging Approach For Improving Catch Estimation Methods.



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1. Introduction

Effective management of exploited fish populations requires accurate estimates of commercial fisheries catches to inform monitoring and assessment efforts. In California, the high degree of heterogeneity in the species composition of many groundfish fisheries, particularly those targeting rockfish (genus *Sebastes*), leads to challenges in sampling all potential strata, or species, adequately. Limited resources and increasingly complex stratification of the sampling system inevitably leads to gaps in sample data. In the presence of sampling gaps, current methods for speciating commercial landings provide ad-hoc point estimates of species compositions in unsampled strata by “borrowing” data across adjacent stratum in time and space. Due to complex interactions between biogeography and market category sorting dynamics, it is not possible to be certain about optimal a’priori pooling strategies. Here we introduce a Bayesian Model Averaging (BMA) method for discovering quantitatively justifiable pooling strategies by averaging across exhaustive sets of spatially partitioned models. In combination with Bayesian hierarchical modeling, these methods allow us to infer pooling strategies from port sampling data. Furthermore these methods allow for a complete statistical summary of several major sources of uncertainty.

2. Model

Likelihood:

$$y_{ijklm\eta} \sim BB(\mu(\theta_{ijklm\eta}), \sigma^2(\theta_{ijklm\eta}, \rho); n_{ijklm\eta})$$

$$\theta_{ijklm\eta} = \beta_0 + \beta_j^{(s)} + \beta_k^{(p)} + \beta_l^{(g)} + \beta_{m\eta}^{(y:q)}$$

Prior:

$$\beta_0 \propto 1 \quad \beta_{j,k,l}^{(s,p,g)} \sim N(0, 32^2) \quad \beta_{m\eta}^{(y:q)} \sim N(0, v)$$

$$\text{logit}(\rho) \sim N(0, 2^2) \quad v \sim IG(1, 2 \times 10^3)$$

3. Model Exploration

Number of Partitioned Models:

$$B_K = \sum_{\kappa=0}^K \frac{1}{\kappa!} \left(\sum_{j=0}^{\kappa} (-1)^{\kappa-j} \binom{\kappa}{j} j^K \right).$$

Spatial Constraints:

\bar{B}_K : Groupings are **small** (≤ 3 Ports)
 \hat{B}_K : Groupings are **contiguous**
 $\hat{\hat{B}}_K$: Groupings are **small** and **contiguous**

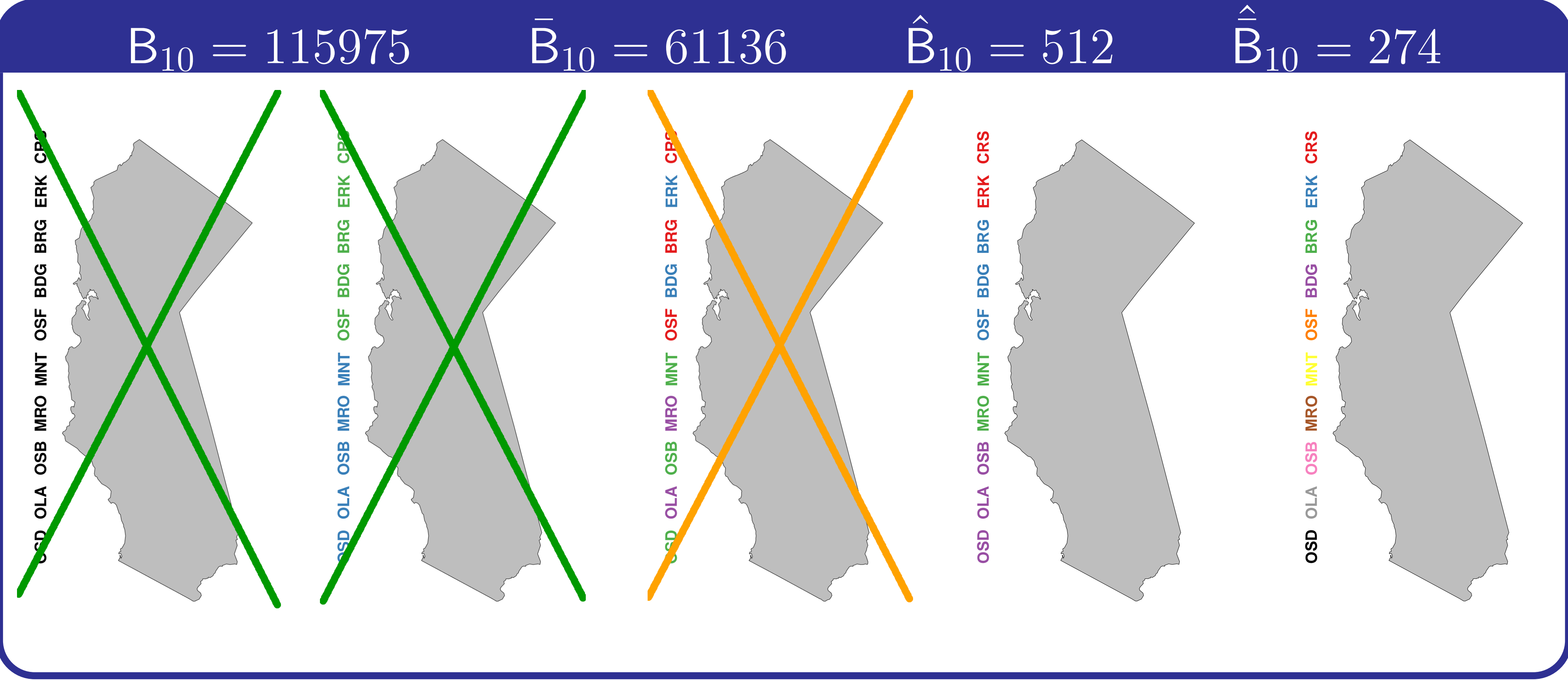
4. Bayesian Model Averaging

$$\omega_i = Pr(M_i|y) = \frac{p(y|M_i)p(M_i)}{\sum_i p(y|M_i)p(M_i)}$$

$$\bar{p}(\theta|y) = \sum_i \omega_i p(\theta|y, M_i)$$

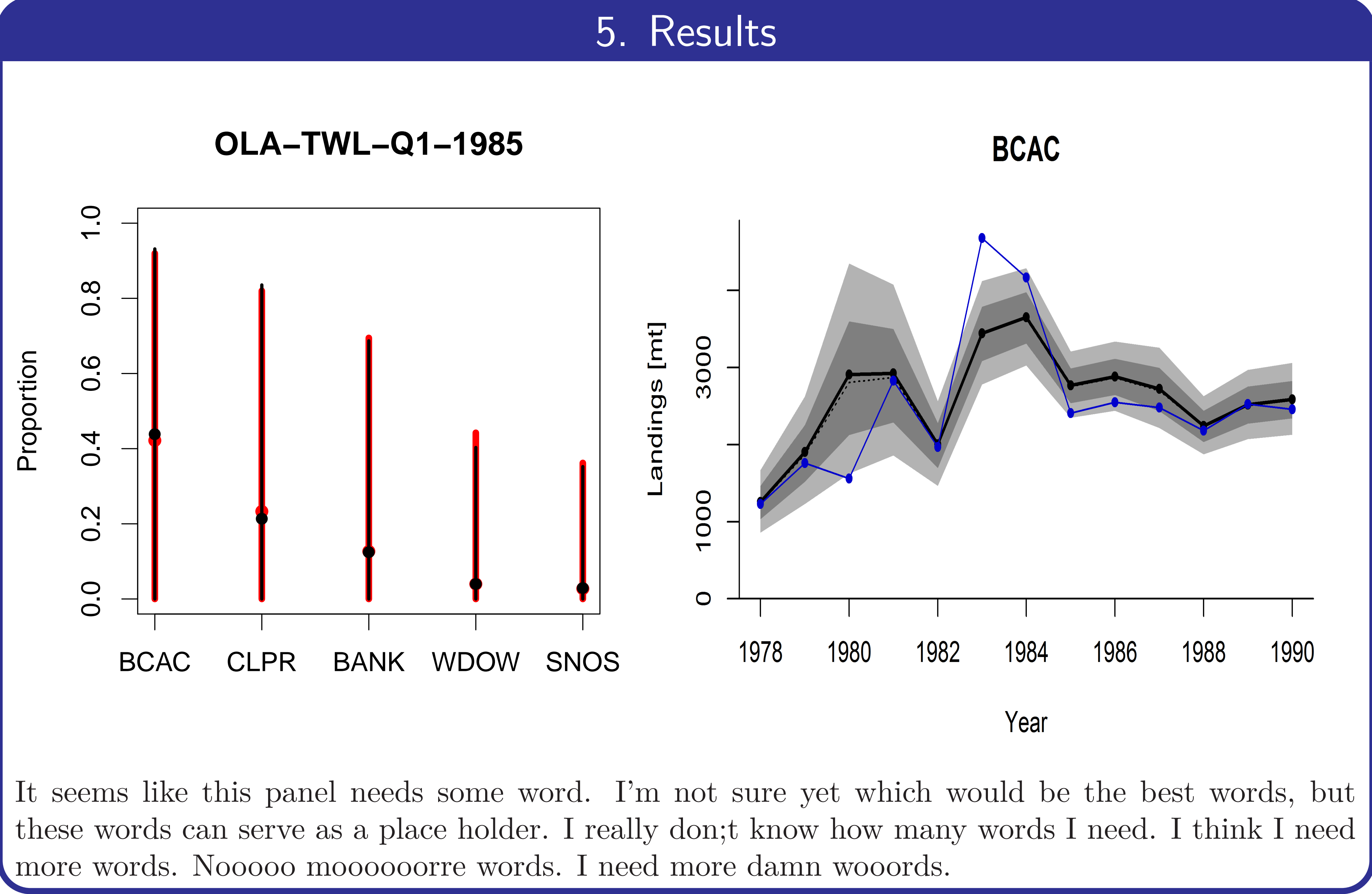
$$\bar{p}(y^*|y) = \int BB(y^*|\theta) \bar{p}(\theta|y) d\theta$$

Species Composition:

$$\pi_{jklm\eta}^* = \frac{y_{jklm\eta}^*}{\sum_j y_{jklm\eta}^*} \quad y_{jklm\eta}^* \neq 0.$$


Group Bocaccio/Chili: 1983-1990

	MCAT 956				
ω	0.26	0.21	0.19	0.11	0.10
CRS					
ERK					
BRG					
BDG					
OSF					
MNT					
MRO					
OSB					
OLA					
OSD					



6. Conclusion