Bayesian comparison of spatial independence versus spatial dependence approaches to predicting weakfish counts in Pamlico Sound, North Carolina.

Samantha Binion and Sam Morris

Objective
To compare precision of predicted weakfish counts using two Poisson abundance models: (1) with iid random spatial effect and (2) with spatial dependence CAR prior.

Why Weakfish?
• Weakfish support large recreational and commercial fisheries along Atlantic Coast.
• There has been a decline in abundances, and in NC weakfish stock is currently listed as depleted.
• Finding a model with strong prediction power will allow managers to identify areas that support the largest weakfish populations and are the most critical to protect.

Data
• Collected by North Carolina Division of Marine Fisheries (NCDMF).
• Biannual (June and Sept.) trawl survey in Pamlico Sound, N.C.
• 7 spatial and depth strata.

Methodology
• Two chains were run a total of 500,000 iterations with a burn-in period of 1,000 and thinned by 5.
• For model comparison, the Gelfand and Ghosh (1998) criterion ($D_{GG}$) was used.

$$MPSE = \frac{1}{\sum_{i=1}^{L} n_i} \sum_{i=1}^{L} \sum_{j=1}^{n_i} [\log(y_{ij}^{mp} + 0.5) - \log(y_{ij} + 0.5)]^2$$
$$D_{GG} = E(MPSE | Y)$$

Convergence, Parameter Estimates and Model Selection

Table 1. Posterior summaries and credible sets for selected parameters.

<table>
<thead>
<tr>
<th>Param</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\beta_0)</td>
<td>4.1</td>
<td>8.4</td>
</tr>
<tr>
<td>(\beta_1)</td>
<td>1.2</td>
<td>5.5</td>
</tr>
<tr>
<td>(\beta_2)</td>
<td>2.4</td>
<td>-0.8</td>
</tr>
<tr>
<td>(\sigma^2)</td>
<td>6.3</td>
<td>20.5</td>
</tr>
<tr>
<td>(\sigma^2_\phi)</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

The spatial dependence model had a slightly better fit with a $D_{GG} = 3867.9$, while the iid random spatial effect model had a $D_{GG} = 3868.0$.

Weakfish Count Results

Conclusions and Recommendations
• Model convergence is highly sensitive to starting values.
• Convergence was only achieved after many (250,000+) iterations.
• Salinity and dissolved oxygen do not appear to be strong predictors of weakfish counts in Pamlico Sound.
• Possible other unknown ecological forces are driving recruitment fluctuations.
• With the use of multiple sampling gears targeting all life stages we might be able to achieve more precise estimates.
• Less time between sampling events, might provide more power to predict future catches.

Acknowledgements
We would like to thank Jason Rock, NCDMF, for providing us with the data analyzed for this project.