NORTH ATLANTIC LANDSCAPE CONSERVATION COOPERATIVE GRANT 2012 PROGRESS REPORT

Quarter: (circle one) 2013 1st (2013 2nd) 2013 3rd 2013 4th

Grant Number and Title: NALCC 2011 (11) Mapping Marine Birds NW Atlantic: Phase 1

Grant Receipt/Organization: NCSU

Grant Project Leader: Gardner

Were planned goals/objectives achieved last quarter? Yes

NALCC Conservation Need Addressed:

Progress Achieved: (For each Goal/Objective, list Planned and Actual Accomplishments)

1. Develop models for estimation of sea bird distributions, particularly in regards to potential areas of aggregation
   Planned Goal – Accommodate both the extreme counts and the zero-inflation in the data, expand the spatial domain, run the models for different species.
   Accomplished – We expanded the study area from a restricted 8x6 4x4km Nantucket Sound grid to 15984 4x4km grid that covers most of the Atlantic coast. Long computation times in estimating so many spatial random effect parameters led us to use dimension-reduction methods on the spatial covariance matrix. The model we have chosen and are currently fitting to the data is explained below. This model is currently being tested on several species including the Common Eider, Common Loon, Long-tailed duck, and Northern Gannett.

2. Determine statistically appropriate models for assessing risk
   Planned Goal – Determine the spatial model we wish to move forward with, and create variables for risk.
   Accomplished – After testing and fitting several hierarchical random effects models, including the implementation of CAR priors in a Bayesian framework, we have determined that a three-component mixture model is appropriate for the data if we want to capture both the zero-inflation and the extreme counts. We define three parameters that will enable us to easily interpret risk. For each site, we model Pz = the probability of being a zero count, Pe = the probability of being an extreme count, and M = the estimated mean of the count distribution.

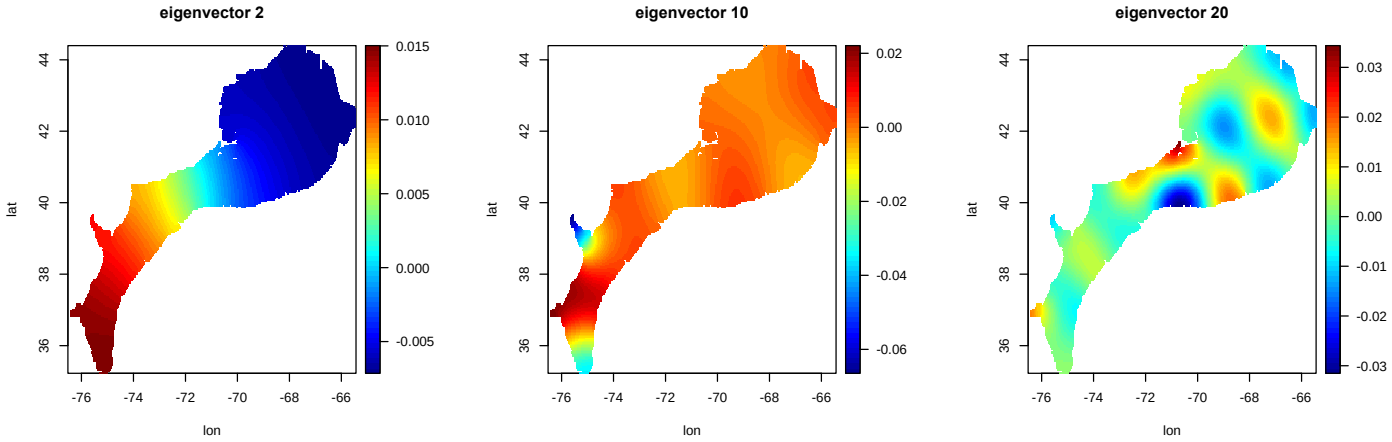
Summary of Progress: (Provide a paragraph describing progress, work to come, and timelines)

To accomplish goals 1 and 2, we combined a zero-inflated negative-binomial distribution with a generalized-Pareto distribution that models the extreme counts above a certain threshold. A nonspatial version with covariates was fitted first to assess convergence and stability. A spatial version requires the modeling of a spatial random effects parameter, which entails the modeling of a covariance matrix. Here, we give the random

effects a CAR prior because we are dealing with discrete grid cells and want to use the neighborhood information to account for spatial heterogeneity. Because we have expanded the study area to 15984 sites, the spatial covariance matrix has too many parameters to estimate within a reasonable amount of time. Thus, we employed a dimension-reduction technique by taking the eigen-decomposition of the CAR inverse-covariance matrix. We then choose the first several eigenvectors that account for much of the variability in the data, and use them as additional predictors in our linear models that already contain site-level covariate information. If theta is the parameter of interest and Phi is a canonical link function, then

$$\Phi(\theta) = \mathbf{X}\boldsymbol{\beta} + \mathbf{V}\boldsymbol{\alpha} + \mathbf{e}$$

where X is the matrix of covariates and V is the matrix containing the eigenvectors we wish to use to account for spatial correlation. We use these linear regressions to model logit(Pz), logit(Pe), and log(M). For illustration, the plots below of the second, tenth, and twentieth eigenvectors show how each captures spatial variability. The second eigenvector captures more large-scale variability while the twentieth eigenvector captures more small-scale variability.



Difficulties Encountered:

- The choice of threshold value for extreme counts is difficult to determine and may differ between species.
- Capturing the most extreme counts of the distribution.
- How many eigenvectors is needed to capture enough spatial variability.
- Convergence and model selection for different species.

Activities Anticipated Next Quarter:

- Present research at an Institute of Mathematical Statistics conference, the Joint Statistical Meetings conference, and the NALCC webinar.
- Draft a paper for journal publication.
- Model diagnostics.
- Determine new ideas for modeling.
- Predictive maps for different species.

Expected End Date: 12/31/2013

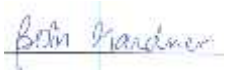
Costs:

Funds Expended to Previous to this Report: 46458.61

Amount of NALCC Funds Requested within this Report: 19597.91
Total Approved Budgeted NALCC Funds: 115,000.00

Are you within the approved budget plan? yes

Are you within approved budget categories? yes

Signature: 

Date: 07/08/2013