Assessing Species Probability of Occurrence and Distribution for Greater Prairie-Chicken, Sharp-tailed Grouse, and Long-billed Curlew Throughout Nebraska: Summary

Rainwater Basin Joint Venture Report. 2012.

Andy Bishop[1], Roger Grosse[1], Ele Nugent[1], and Christopher Jorgensen[1,2]
[1]Rainwater Basin Joint Venture, 2550 North Diers Ave, Grand Island, NE 68801
[2]Nebraska Cooperative Fish and Wildlife Research Unit, 422 Hardin Hall, 3310 Holdrege Street, Lincoln, NE 68583

Introduction

As conservation resources become increasingly limited, effective planning efforts are critical in order to prioritize species and their habitats in need of conservation. Yet, developing such plans often requires understanding of where species occur and how individuals make habitat decisions. Once it is clear what habitat characteristics are important for a species, as well as what spatial scale individuals are responding to, we can begin to address and predict species occurrence throughout a region. Furthermore, decision support tools can be developed to aid decision makers and managers during the conservation planning stages of the Strategic Habitat Conservation framework.

Species Distribution Models (SDMs) are one tool in the land manager's toolbox which can facilitate an informed decision-making process on where and how to reach management goals given the surrounding landscape and can be implemented in a decision support system. Here we describe a method for developing a spatial model of probability of occurrence for three species found in the Great Plains.

We describe the methods used to develop SDMs of species occurrence for three native grassland-dependent birds in Nebraska, the Greater Prairie-Chicken (GRPC), Sharp-tailed Grouse (STGR), and Long-billed Curlew (LBCU), using presence-absence data recently collected during roadside surveys. Habitat relationships were identified by using landscape-level variables derived from the 2010 Nebraska Landcover developed by the Rainwater Basin Joint Venture.

Methods

Regional Landscapes

High land-use variability throughout the state may influence model performance; therefore we divided the state into five regions based on Major Land Resource Areas (MLRA) from the Natural Resource Conservation Service. By producing spatial models within defined land-use regions, we were able to include habitat variables that are unique to a region and prevented highly correlated variables from driving the model fit. The Southwest Playas and Republican Breaks/Loess Canyon regions are considered independent regions but were combined into a single region due to lack of sampling distribution across the Southwest Playa region.

Landcover Indices

Five primary landscape-level indices were created from the Nebraska Landcover. The five indices include: developed, cropland, woodland, grassland, and wetland. Alternative indices were created for certain regions. Conservation Reserve Program (CRP) grassland was separated from the general "grassland" category in the East and Loess Canyons regions where this program is widely implemented.

Grouse Data Collection

Survey Data were provided by Nebraska Game and Parks Commission and affiliated contacts. Survey intensity for STGR and GRPC varied over study period and geographic regions. Leks were sampled using consistent route survey protocol. Survey routes were distributed throughout the various geographic regions, where a set of survey stops were spaced one mile apart within the route. At each survey stop, observers recorded lek presence-absence, route name, stop ID, date, and surveyor. Additional lek samples were provided by U.S. Fish and Wildlife Service, U.S. Forest Service, and other sources, which ultimately were not used for modeling due to inconsistent sampling procedures. To keep the models relative to current landcover conditions (2006-2010), no route information prior to 2006 was used to produce lek probability of occurrence models.

We utilized a geographic information system (GIS) to compile all route data into a geodatabase. Once route and lek locations were compiled into a single database, we extracted habitat index values to each survey point. Landcover indices were summarized as a percentage of the landscape at 800m, 1600m and 5000m scale radii. We randomly selected and withheld a quarter of the data for model validation, creating a training and testing dataset.

Long-billed Curlew Data Collection

Survey data were provided by Nebraska Game and Parks Commission, which was completed by Cory Gregory, from Iowa State University. Surveys were conducted via roadside survey and each survey route consisted of roughly 40 stops spaced 800m apart. Survey routes were chosen randomly throughout the curlew's range in western Nebraska. Curlews were searched for by sight and sound for 5 minutes from outside the vehicle at each stop location. Surveys were conducted in April prior to nest incubation when displaying curlews are easier to detect. All surveys took place between 2008 and 2009.

We used the original GPS coordinates of all stop locations. All datasets were converted to feature classes with the following information: species, presence/absence listed as 1 = present, 0 = absent, number of curlews spotted, route name, source of data, year(s) survey took place. Landcover index values were extracted to each survey point. A quarter of the data were randomly selected from the dataset and withheld for model validation, to create a training and testing dataset.

Statistical Analysis
We developed an *a priori* set of models using habitat indices measured at various spatial extents based on the biology of the species and the region. We fitted a binomial generalized linear model (GLM) for each model in the model set and used an information-theoretic criterion to determine model selection. The model with the lowest AICc value was considered the best fit model. The logistic regression equation from the top fitted model was applied to the index layers in a GIS to generate spatial outputs (e.g., Fig. 1).

We validated each model using an independent testing dataset obtained by withholding a quarter of the data prior to fitting the model. Raster values from each of the spatial outputs were extracted to testing datasets. ROC (receiver-operator characteristic) plots were created for each spatial model by assessing the ratio of true positives to false positives for all possible thresholds. AUC (area under the curve) values were calculated from the ROC plots, indicating the chance that a randomly chosen plot with an observed value of present will have a predicted probability higher than that of a randomly chosen plot with an observed value of absent. A high AUC value near 1.0 indicates good overall model performance.

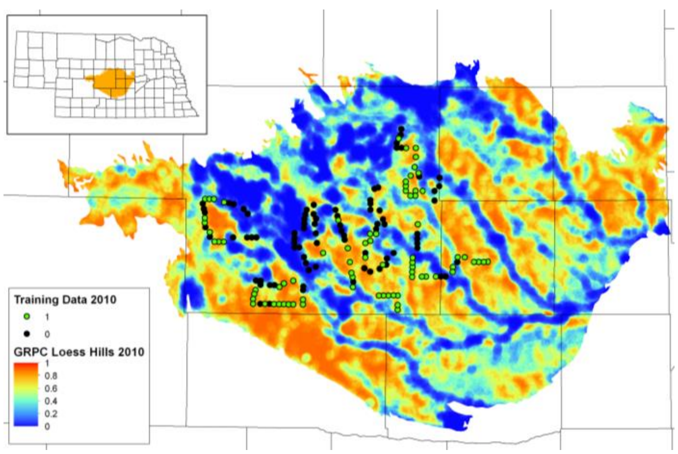

Fig 1. Greater Prairie-Chicken probability of occurrence model for the Loess Hills region, Nebraska. Model is based on 2010 data.

Discussion
Based on our model validation process, in general the spatial models of probability of occurrence for Greater Prairie-Chicken and Long-billed Curlew performed well. The model for Greater Prairie-Chicken occurrence in eastern Nebraska was determined to have the best performance overall. In the east, southwest and Loess Hills regions, development and woodland were the strongest limiting factors on species occurrence. In the Sandhills, however, development was positively associated with Greater Prairie-Chicken occurrence. This relationship may be explained by greater grazing intensities in areas where development occurs, particularly when habitat relationships for Greater Prairie-Chicken in the region are best explained at the 5000m radius spatial scale. In the Sandhills region, livestock may introduce heterogeneity in the local habitat condition conducive to Greater Prairie-Chickens. The Long-billed Curlew spatial model of occurrence also performed well. Habitat relationships best explained Long-billed Curlew occurrence at the 800m radius spatial scale.

Of the three species we modeled, the Sharp-tailed Grouse spatial model failed at adequately predicting species occurrence. Based on the AUC calculation for the Sharp-tailed Grouse, there is an equally likely chance a model of random values would predict leks as well as the spatial model we produced. This is a concern, since considerable effort and resources went into data collection and the modeling process. The poor performance of the Sharp-tailed Grouse model was likely due to the zero-inflated dataset (non-detections were highly inflated). In general, Sharp-tailed Grouse are more difficult to detect than other species such as Greater Prairie-Chicken. Separating detection error from the ecological processes driving the presence or absence of a species has been a true challenge for ecologists in the past. However, if in the future surveys are repeated during the survey period (at least 2 visits per season), we can utilize an occupancy modeling approach, which separates out detection error from the ecological processes influencing the true species occupancy. Once we understand what habitat characteristics truly influence species occurrence, we can better predict where less-detectable species, such as the Sharp-tailed Grouse, occur within a region.

In order to improve spatial models of species occurrence in the future, survey methods need to be conducive for the types of analysis being conducted. There is a need for a standardized sampling approach in order to limit the effects of spatial autocorrelation and to maximize the range of habitat values conducive to the species of interest. For example, survey sites located only in areas where a species will likely occur will have a narrow range of habitat values associated with them. Alternatively, if samples are taken in areas just outside and throughout its range, we can begin to identify complicated, non-linear habitat relationships that explain not only where a species occurs, but where it does not occur.

Predictive species occurrence models and other species distribution models are becoming increasingly important to the conservation community. In designing new conservation initiatives, ecologists are starting to think about how the landscape may influence the management outcome rather than strictly taking the Field of Dreams, “if you build it, they will come” approach. By identifying how the landscape constrains, or alternatively magnifies land management efforts for a species is critical in the conservation planning stages. Once we begin to understand how a species will react to particular habitat attributes in the landscape and at what spatial scale, we can utilize species distribution models to produce decision support tools meant to prioritize areas of the greatest conservation need, or alternatively, those that have the greatest potential to succeed, given the management actions under consideration.

For additional information regarding the analysis, results and discussion consult the full document.