EVALUATING HABITAT SUITABILITY FOR LESSER PRAIRIE-CHICKEN REINTRODUCTIONS

2019 ANNUAL REPORT

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2019 Annual Report
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Executive Summary

This report summarizes the progress made in the first year of a two-year study that focuses on evaluating habitat suitability for potential reintroductions of lesser prairie-chickens in the southern mixed-grass prairie ecoregion. Goals for this research are to: 1) identify and prioritize potential habitat for potential lesser prairie-chicken recovery in the mixed-grass ecoregion of southern Kansas and northern Oklahoma, and 2) evaluate the relative improvement in available habitat provided by recent tree removal in areas previously occupied by lesser prairie-chickens. Current objectives under these goals include:

1. Identify and quantify potential habitat patches for lesser prairie-chickens in the mixed-grass ecoregion of southern Kansas and northern Oklahoma.
2. Assess the relative connectivity of existing lesser prairie-chicken populations to potential habitat patches.
3. Estimate the potential population size of lesser prairie-chickens that the Z Bar Ranch could potentially support.
4. Quantify changes in available lesser prairie-chicken habitat resulting from recent habitat improvements at the Z Bar Ranch.
5. Evaluate and quantify the amount of available fine-scale habitat at the Z Bar Ranch.

Efforts this year (2019) focused on developing a research proposal that outlines our goals and objectives of the project, the intended methodology we will use to accomplish those goals, and a review of the existing literature related to prairie grouse population ecology and restorations (see attached draft of Research Proposal). For objectives 1–4, we developed methods based on a resource selection

framework in a used (1) versus available (0) study design to predict lesser prairie-chicken occurrence in the mixed-grass prairie ecoregion at the population level. We will develop a probabilistic model of stable lek occurrence by quantifying habitat characteristics around stable leks (used) and random (available) locations using either 1) regression approaches to build a resource selection function (RSF) model, or 2) a classification and tree analysis paired with bootstrap aggregates to build a Random Forest (RF) model. Both predictive models will evaluate first-order habitat selection as a function of several large-scale habitat characteristics. We will measure habitat characteristics within a 5 km buffer of both stable lek and random locations. Stable lek locations will be identified using range-wide lek survey data provided by the Kansas Department of Wildlife, Parks, and Tourism and the Oklahoma Department of Wildlife Conservation.

Models will be compared and evaluated for their relative accuracy to one another and the most predictive model will be employed to further accomplish objectives 1–4. To identify and quantify habitat patches for lesser prairie-chicken reintroduction (objective 1), we will extrapolate our top resource selection model to the historical range of lesser prairie-chickens using GIS. We will also assess the relative connectivity of potential habitat patches to existing populations (objective 2) by combining our top resource selection model with a least-cost path analysis. To estimate the potential number of lesser prairie-chickens that the Z Bar Ranch might support (objective 3), we will use a habitat-based estimate that is based on the ratio of the population size and the relative probability of use for the current occupied range. Finally, we will quantify changes in available habitat resulting from recent habitat improvements at the Z Bar Ranch (objective 4) by using our top resource selection model to compare current habitat conditions to habitat conditions prior to restorative management actions (e.g., tree removal). Habitat patches will be prioritized for lesser prairie-chicken reintroduction based on habitat patch size, total available lesser prairie-chicken habitat, and the relative connectivity of potential habitat patches to existing populations.

Potential habitat characteristics we may measure for model development were identified by conducting an extensive review of the literature. In particular, we found the literature consistently recognized grass cover, tree canopy cover, cropland cover, and distance to and density of human infrastructure to be the greatest indicators of lesser prairie-chicken habitat selection. For objective 5, we identified vegetative structure and composition to be the greatest predictors of habitat use and adult, brood, and nest survival. The literature also identified increased forb cover and invertebrate abundance as indicators of brood habitat selection.

Administration and Reporting:

Please note that the attached Research Proposal is only a draft and not our final product. We will further develop specific objectives and methods for our fine-scale analysis of the Z Bar Ranch in the following quarter.

We hired Morgan J. Solomon as a graduate research assistant for this project on August 1st, 2019 and she began working on August 26th, 2019.

A presentation outlining our Research Proposal was given to the Department of Animal and Range Sciences—Montana State University and Turner Enterprises, Inc. staff on December 3rd.

Additionally, a request for range-wide lesser prairie-chicken lek survey data for the mixed-grass prairie ecoregion was sent to the Kansas Department of Wildlife, Parks and Tourism and the Oklahoma Department of Wildlife Conservation and we are currently awaiting its arrival.

Objective 1: Identifying and quantifying potential habitat patches for lesser prairie-chicken reintroductions.

2019 Accomplishments:

Efforts this year focused on reviewing the literature and developing our methodology for model production. Two avenues for producing a resource selection model to predict lesser prairie-chicken occurrence were identified and include 1) using regression approaches to build resource selection functions, and 2) fitting classification trees iteratively with machine learning using a Random Forest package.

Resource selection function models have been extensively used in research to link species' occurrence and abundance to resources, risks, and environmental conditions, as well as to predict species abundance and occurrence in new areas. Resource selection functions use regression approaches to evaluate habitat characteristics affecting species habitat use by comparing habitat characteristics at used versus available locations (Boyce et al. 2002, Manly et al. 2002). Alternatively, Random Forest models use machine learning to predict species occurrence and distribution in new areas by using classification and regression trees paired with bootstrap aggregates. This method develops a set of tree-structured weak learners where each tree contributes to the prediction of an animal using a set of available resources (Breiman 2001, Evans et al. 2011). Random Forest models are desirable because they account for several issues associated with spatial data that can cause complications during statistical analysis such as, unexplained variability between data samples (noise) and non-independence between data samples (autocorrelation).

We will develop our resource selection models by using stable lek locations as used locations and randomly generated points as available locations. Stable leks will be identified using range-wide lek survey data provided by the Kansas Department of Wildlife, Parks and Tourism and the Oklahoma Department of Wildlife Conservation. Stable leks will be used to represent landscapes that support stable lesser prairie-chicken populations. This is based on the assumption that if a lek is stable over time, the habitat conditions within that area are at or above the level of habitat conditions required to sustain a viable lesser prairie-chicken population. Thus, stable leks could be defined as any lek having 10 or more birds for 10 consecutive years in the same geographical location.

Geospatial analyses will be conducted to measure large-scale habitat characteristics within a 5 km buffer radius at both stable lek locations and at random points. This will allow us to compare habitat characteristics at used (stable lek locations) versus available (random points) locations for model development. The significance of the buffer size comes from the fact that the majority (+/- 95%) of lesser prairie-chicken activity, including breeding and nonbreeding activities, occurs within 5 km of a breeding lek (Applegate and Riley 1998, Pitman et al. 2005, Patten et al. 2011, Pirius et al. 2013).

We will compare our best Resource Selection Function model with our best Random Forest model to evaluate their relative accuracy to one another. We will first individually assess each model's predictive accuracy by using k-fold validation or some other out-of-bag approach, which will withhold a portion of the original stable lek data from model development to use for validation (Boyce et al. 2002). The model that most accurately predicts known locations of stable leks from the withheld data set will then be extrapolated to the historical range of lesser prairie-chickens using GIS. This will allow us to produce predictive maps that depict the relative probability of lesser prairie-chicken use across the mixed-grass prairie ecoregion not currently occupied and identify potential habitat patches for the potential reintroduction of lesser prairie-chickens.

We conducted an extensive review of the literature to identify potential large-scale habitat characteristics that affect lesser prairie-chicken habitat use and survival. All habitat characteristics we are currently considering for model development and their potential sources have been collated and organized into Table 1. Overall, we found large-scale differences in vegetative cover and land-use to be the most consistent indicators of prairie grouse habitat use and persistence. Increased grass cover was generally found to be positively associated with greater lesser prairie-chicken habitat use and abundance, while increased cropland and tree cover were found to be negatively associated (Woodward et al. 2001, Lautenbach et al. 2017). We also found lesser prairie-chicken habitat selection and persistence to be negatively affected by exurban and energy development. For example, habitat use by lesser prairie-chickens has been shown to decrease with distance to buildings, powerlines, roads, and oil wells. The literature attributed the displacement of lesser prairie-chicken populations by human activity and development to the species' behavioral propensity to avoid tall structures and their general neophobic dislike for anything new (Pitman et al. 2005, Hagen et al. 2011, Plumb et al. 2019). However, evidence from the literature also suggests that the effects of human development on lesser prairie-chicken habitat use may depend on the spatial configuration and density of related features, and the level of activity associated. Large-scale ecological drivers such as mean annual precipitation and mean annual temperature were also found to be indicative of lesser prairie-chicken occurrence and survival (Giesen 2000, Grisham et al. 2013). For a more in-depth discussion on lesser prairie-chicken habitat selection in relation to large-scale habitat characteristics, please refer to the attached draft of our Research Proposal.

To prioritize potential habitat patches for reintroduction, a general criterion was developed and includes 1) habitat patch size, 2) total amount of available lesser prairie-chicken habitat within potential habitat patches, and 3) the relative connectivity of potential habitat patches to existing lesser prairie-chicken populations.

Goals For Next Quarter

Next quarter we will acquire lek data from state wildlife agencies in Kansas and Oklahoma and begin evaluating the relationships between habitat characteristics and lesser prairie-chicken lek persistence. We will present our proposed study and any preliminary results at the Montana Chapter of the Wildlife Society's Annual Conference in Butte, MT from February 3rd-7th. Additionally, we will select committee members for the Graduate Student Committee to guide Morgan J. Solomon's coursework and research. A plan for her graduation that outlines her program of study will also be developed.

Objective 2: Assessing the relative connectivity of existing lesser prairie-chicken populations to potential habitat patches.

2019 Accomplishments:

This years' efforts focused on developing methods to assess the relative connectivity of existing lesser prairie-chicken populations to potential habitat patches. We will use our top resource selection model combined with a least-cost path analysis. Least cost-path analysis assumes that the cost for an animal to move between habitat patches is inversely related to the probability of use, or in our research the probability of a stable lek occuring (Chetkiewicz and Boyce 2009). Our top resource selection model will be used to identify source habitat patches of exisiting populations and potential habitat patches for lesser prairie-chicken reintroduction. We will then use our resource selection model values as a cost path function in GIS to identify corridors between source patches for lesser prairie-chicken movement.

See Objective 1 for accomplishments pertaining to model development.

Goals For Next Quarter:

See Objective 1.

Objective 3: Estimate the potential population size of lesser prairie-chickens that the Z Bar could support.

2019 Accomplishments:

Efforts this year focused on developing methods to predict the number of lesser prairie-chickens that the Z Bar Ranch could potentially support. We will use an approach similar to Boyce and McDonald (1999) and link our top resource selection model to an existing population of lesser prairie-chickens within their current distribution. Provided we know the estimated number of lesser prairie-chickens within the current range in the mixed-grass ecoregion, we will calculate the total predicted area required to support the current population using our resource selection model. We will then be able to use the ratio of the existing habitat patch size and the associated current population to predict the potential numbers of lesser prairie-chickens in any given habitat patch by using the following equation:

$$\frac{\sum X\ current}{N\ current} = \frac{\sum X\ potential}{N\ potential}$$

where $N_{current}$ is the lesser prairie-chicken population estimate for the existent population in the mixed-grass prairie ecoregion, $X_{current}$ is the relative probability of a stable lek occurring for the resource selection model for the existent population, and $X_{potential}$ is the relative probability of a stable lek occurring for a potential lesser prairie-chicken habitat patch (Boyce and McDonald 1999, Boyce and Waller 2003).

See Objective 1 for accomplishments pertaining to model development.

Goals For Next Quarter:

We will sum up the latest estimated population size for the mixed-grass prairie ecoregion from the range-wide lek survey data provided by the Kansas Department of Wildlife, Parks & Tourism and the Oklahoma Department of Wildlife Conservation.

See Objective 1 for goals related to model development.

Objective 4: Quantify the changes in available lesser prairie-chicken habitat resulting from recent habitat improvements at the Z Bar Ranch.

2019 Accomplishments:

We identified general methods to quantify the changes in available lesser prairie-chicken habitat resulting from recent habitat improvements at the Z Bar Ranch. We will extrapolate our top resource selection model and apply it to the Z Bar to quantify the amount of available lesser prairie-chicken habitat currently available. We will then upload shapefiles of landcover data of the Z Bar prior to tree removal into a GIS database and use our resource selection models to sum up the total amount of available habitat prior to tree removal. We will then calculate the change in total available habitat (C) using this equation:

$$C = \Sigma X_{current} - \Sigma X_{pre\text{-}tree\ removal}$$

where $X_{current}$ is the current amount of available lesser prairie-chicken habitat at the Z Bar, and $X_{pre\text{-}tree\ removal}$ is the amount of available lesser prairie-chicken habitat prior to tree removal.

See Objective 1 for accomplishments pertaining to model development.

Goals For Next Quarter:

See Objective 1.

Objective 5: Evaluate fine-scale habitat conditions at the Z Bar Ranch.

2019 Accomplishments:

We conducted an extensive review of the literature to identify fine-scale habitat characteristics that have been shown to influence lesser prairie-chicken habitat selection and survival. Vegetative structure and composition were two factors found to be the greatest predictors of habitat use and adult, brood, and nest survival. We found vertical obstruction reading (VOR), a measure of nest concealment, to be a consistent correlate of nest survival across studies. We found nest-site selection and survival often exhibited a quadratic relationship with VOR, presumably due to a life-history tradeoff between nest success and female survival (Pitman et al. 2005, Lautenbach et al. 2019). For example, denser cover was found to enhance nest concealment but decrease the ability of the female to escape predation (Wiebe and Martin 1998, McNew et al. 2013). Additionally, higher measurements of concealment were linked to higher survival rates in female adult lesser prairie-chickens (Patten et al. 2005). Species composition at nest sites varied depending on regional differences in available vegetation but was typically made up of shrub and grass species that provided the greatest concealment (Larsson et al. 2013, Lautenbach et al. 2019). We also found increased forb cover to be a large influence on brood habitat selection and fitness. Increased forb cover coincides with greater invertebrate densities and invertebrates are a chief food source for broods (Jamison et al. 2002, Hagen et al. 2005). Thus, increased invertebrate densities likely correlates to higher chick survival in lesser prairie-chickens. Please see the attached draft of our research proposal for a complete discussion on lesser prairie-chicken habitat selection in relation to fine-scale habitat characteristics.

Goals For Next Quarter:

This upcoming quarter will focus on developing clear objectives and a vegetation sampling protocol to quantify the amount of available fine-scale habitat on the Z Bar Ranch. We will also assess the utility of sampling invertebrates to estimate the amount of available food for lesser prairie-chickens on the Z Bar Ranch. Research tools and materials needed for fine-scale habitat sampling will be acquired or constructed during this quarter, as well.

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Table 1: Description of potential habitat characteristics to use for predicting lesser prairie-chicken habitat use in the mixed-grass prairie ecoregion

Name	Potential sources	Description	Justification/Reference
Grassland cover	LANDFIRE, NLCD, Rangeland Analysis Platform	Proportion of grid cells classified as grass/herbaceous	Identified positive relationship b/w increased grassland cover and LPC abundance (Woodward et al. 2001).
Tree cover	Falkowski et al. 2017 or Rangeland Analysis Platform	Proportion of grid cells classified as tree cover	Identified negative relationship b/w increased tree cover and LPC abundance (Lautenbach et al. 2017).
Gross primary production	LANDFIRE, NLCD, Rangeland Analysis Platform	Indicator of early brood habitat.	Identified positive relationship b/w increased forb cover and brood habitat selection (Hagen et al. 2005).
Agriculture cover	NASS	Proportion of grid cells as tilled agriculture	Identified negative relationship b/w increased cropland cover and LPC abundance (Woodward et al. 2001).
Oil and gas wells	IHS Oil & Well Database	Density of oil and gas well locations	Identified negative relationship b/w greater oil well densities and LPC habitat selection (Hagen et al. 2011, Plumb et al. 2019).
Transmission lines	Kansas Corporation Commission, Oklahoma Corporation Commission	Distance to/density of transmission lines	Identified negative relationship b/w density of and distance to transmission lines and LPC habitat

			selection (Hagen et al. 2011, Plumb et al. 2019).
Roads (major and county)	Kansas GIS & Data & Support Center, see Sullins et al.2019	Distance to/density of roads	Identified negative relationship b/w density of and distance to roads and LPC habitat selection (Hagen et al. 2011, Plumb et al. 2019).
Buildings	Kansas GIS & Data & Support Center, see Sullins et al.2019	Distance to/density of buildings	Identified negative relationship b/w density of and distance to buildings and LPC habitat selection (Pitman et al. 2005, Hagen et al. 2011).
Mean annual temperature	USDA (https://www.wcc.nrcs.usda.gov/gis/precip.html)	—	Identified negative relationship between greater mean annual temperatures and LPC reproductive success and survival (Grisham et al. 2014).
Mean annual precipitation	USDA (https://www.wcc.nrcs.usda.gov/gis/precip.html)	—	Large scale ecological driver influencing grassland production. Carry over effects for LPC survival (Geisen 2000).
Roughness	National Elevation Data (NED)	Standard deviation of elevation w/in a grid cell	Identified negative relationship b/w lesser prairie-chicken habitat use and rough terrain (Butler et al. 2017).