Prepared in cooperation with the State of Nevada Sagebrush Ecosystem Program, Bureau of Land Management, Nevada Department of Wildlife, and California Department of Fish and Wildlife

Spatially Explicit Modeling of Greater Sage-Grouse (*Centrocercus urophasianus*) Habitat in Nevada and Northeastern California: A Decision Support Tool for Management

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U.S. Department of the Interior
U.S. Geological Survey

Cover: Photograph of a male greater sage-grouse performing a courtship display on a lek in Nevada. Photograph courtesy of Tatiana Gettleman.

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SALLY JEWELL, Secretary

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Conversion Factors and Datums

Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.4047	square hectometer (hm^2)

SI to Inch/Pound

Multiply	By	To obtain
	Length	
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
meter (m)	1.094	yard (yd)
	Area	
square meter (m^2)	0.0002471	acre
hectare (ha)	2.471	acre
square hectometer (hm^2)	2.471	acre
square meter (m^2)	10.76	square foot (ft^2)

Datums

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD83).

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88)"

Elevation, as used in this report, refers to distance above the vertical datum.

Acronyms and Abbreviations

AICc	Akaike's information criterion with second-order bias correction
ΔAICc	difference between model of interest and most parsimonious model
CDFW	California Department of Fish and Wildlife
GIS	Geographic Information System
GPS	Global Positioning System
HSI	habitat suitability index
K	number of parameters
κ	Cohen's kappa coefficient
LANDFIRE	Landscape Fire and Resource Management Planning Tools
MCP	Minimum Convex Polygon
PMU	population management unit
PTT	Platform Transmitter Terminal
NDOW	Nevada Department of Wildlife
r	correlation coefficient
RSF	resource selection function
SD	standard deviation
SUI	space use index
TPI	topographic position index
UTM	Universal Transverse Mercator

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Abstract

Greater sage-grouse (*Centrocercus urophasianus,* hereafter referred to as "sage-grouse") populations are declining throughout the sagebrush (*Artemisia* spp.) ecosystem, including millions of acres of potential habitat across the West. Habitat maps derived from empirical data are needed given impending listing decisions that will affect both sage-grouse population dynamics and human land-use restrictions. This report presents the process for developing spatially explicit maps describing relative habitat suitability for sage-grouse in Nevada and northeastern California. Maps depicting habitat suitability indices (HSI) values were generated based on model-averaged resource selection functions informed by more than 31,000 independent telemetry locations from more than 1,500 radio-marked sage-grouse across 12 project areas in Nevada and northeastern California collected during a 15-year period (1998–2013). Modeled habitat covariates included land cover composition, water resources, habitat configuration, elevation, and topography, each at multiple spatial scales that were relevant to empirically observed sage-grouse movement patterns. We then present an example of how the HSI can be delineated into categories. Specifically, we demonstrate that the deviation from the mean can be used to classify habitat suitability into three categories of habitat quality (high, moderate, and low) and one non-habitat category. The classification resulted in an agreement of 93–97 percent for habitat versus non-habitat across a suite of independent validation datasets. Lastly, we provide an example of how space use models can be integrated with habitat models to help inform conservation planning. In this example, we combined probabilistic breeding density with a non-linear probability of occurrence relative to distance to nearest lek (traditional breeding ground) using count data to calculate a composite space use index (SUI). The SUI was then classified into two categories of use (high and low-to-no) and intersected with the HSI categories to create potential management prioritization scenarios based on

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information about sage-grouse occupancy coupled with habitat suitability. This provided an example of a conservation planning application that uses the intersection of the spatially-explicit HSI and empirically-based SUI to identify potential spatially explicit strategies for sage-grouse management. Importantly, the reported categories for the HSI and SUI can be reclassified relatively easily to employ alternative conservation thresholds that may be identified through decision-making processes with stake-holders, managers, and biologists. Moreover, the HSI/SUI interface map can be updated readily as new data become available.

Introduction

Greater sage-grouse (*Centrocercus urophasianus*, hereafter referred to as “sage-grouse”) are considered an umbrella (Rich and Altman, 2001; Rich and others, 2005; Rowland and others, 2006) or indicator species for the ecological integrity of sagebrush (*Artemisia* spp.) ecosystems due to the dependence of sage-grouse on sagebrush habitat, as well as their propensity to occupy sagebrush habitat across large spatial scales during the course of seasonal self-maintenance needs and reproduction (Knick and Connelly, 2011). Sage-grouse populations have declined concomitantly with the loss, degradation, and fragmentation of sagebrush ecosystems (Knick and Connelly, 2011), and currently (circa 2014) occupy slightly more than one-half of their former range across Western North America (Schroeder and others, 2004; Miller and others, 2011). Accordingly, sage-grouse have been identified as a candidate species for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 2010).

Sage-grouse in Nevada and northeastern California represent more than 25 percent of the present range-wide distribution of the species. Hence, empirically-based analytical tools that inform management decisions within Nevada and California are needed, especially where state and local resource managers have site-specific information that could be incorporated into a data-driven analytical tool for managers. One approach to aid sage-grouse management would be to develop an analytical tool that uses data replicated across broad geographical ranges to inform landscape level decisions, but that also can then be downscaled to inform local management decisions.

Currently available computational tools now allow for greater quantification of probabilistic habitat use at multiple spatial scales. In particular, habitat suitability indices (HSIs) generated from resource selection functions (RSFs) are powerful empirical quantifications that simultaneously consider habitat characteristics with animal distribution. Furthermore, these values can be measured at multiple local sites and then be used to project the relative probability of species occurrence across broader and un-sampled areas as a function of habitat characteristics (Boyce and McDonald, 1999; Manly and others, 2002).

The utility of Geographic Information System (GIS)-derived HSIs for understanding sage-grouse ecology has been facilitated by the increased availability of remotely sensed imagery used to accurately classify vegetation types across large geographic areas in conjunction with the availability of large datasets of sage-grouse locations generated from monitoring radio-marked sage-grouse (Aldridge and others, 2012). Moreover, coupling HSI values with predictions of sage-grouse occurrence based on space use models and indices (for example, Doherty and others, 2010a; Coates and others, 2013) will assist managers in recognizing the relative importance of particular areas to sage-grouse. For example, an understanding of the distribution and density of breeding sage-grouse at lek sites (that is, traditional breeding grounds) can aid in region-wide management of sage-grouse by targeting actions in areas with high quality habitat coupled with information on how sage-grouse use the habitat spatially and seasonally.

This report describes the process used to develop a region-wide habitat suitability map for sage-grouse within the southwestern portion of sage-grouse range (that is, Nevada and northeastern California). Because, variation in habitat composition across the sage-grouse range influences sage-grouse populations, this map was generated using averaged parameter estimates from RSFs informed by telemetry location data across 12 project areas with data that range 15 years. We then describe a method for applying a quantitative approach to conservation planning based on the simultaneous consideration of objectively categorized HSI values and space use indices (SUIs) derived from lek location data. The goal was to employ empirical information to evaluate different management scenarios for areas where sage-grouse conservation is a management goal. These scenarios can take many forms. For example, quantification could help to identify core areas to conserve sagebrush habitat with an emphasis on areas occupied frequently by sage-grouse, or help to identify conservation priorities and management actions for less suitable habitat, or suitable yet unoccupied habitat. Importantly, the indices created through the analytical processes described can be reclassified easily to incorporate alternative thresholds for conservation such as those that arise through decision-making processes with stake-holders, managers, and biologists. This work was completed in partnership with the State of Nevada Sagebrush Ecosystem Technical Team, the Nevada Department of Wildlife (NDOW), the Bureau of Land Management, and the California Department of Fish and Wildlife (CDFW).

Methods and Results

Overview and Conceptual Models

The quantitative approach to develop a spatially explicit support tool for conservation planning consisted of multiple steps that we describe in detail below and outline in a conceptual model (fig. 1). The overall modeling framework comprised input data sets (blue rectangular boxes) that were subjected to a series of processing steps (black rounded boxes) to produce interim and final spatially explicit maps (red parallelograms) (fig. 1).

First, we compiled sage-grouse telemetry location data from multiple areas across Nevada and northeastern California, and divided these data into three independent sets for the purposes of model training (80 percent of locations), mapping classification (10 percent), and map validation (10 percent) (*see: 'Habitat Suitability Model Development'*). The training data set was linked spatially with corresponding environmental covariates to enable calculation of population-level RSFs (Manly and others, 2002) within 12 subregions with adequate data. To achieve this, we first identified the relevant spatial scale and linear relationships of environmental characteristics. Next, model-averaged parameter estimates for influential covariates among all candidate models were calculated to account for model selection uncertainty (Burnham and Anderson, 2002) (*see 'RSF Analyses'*). We then used those estimates to develop spatially explicit models reflecting the relative probability of selection at each subregion. For each of the 12 subregional RSF models, we: (1) transformed the model into an HSI; (2) extrapolated the HSI across the extent of the region; and (3) averaged the HSI predictions generated from each subregion to provide an unbiased region-wide HSI map. The independent classification telemetry data set was then used to extract the region-wide HSI predictions and categorize the continuous HSI value based on the mean and variance of the extracted data that resulted in a region-wide categorical habitat map grouped into four hierarchical classes of descending probability of selection. The third independent data set was used to validate the region-wide map by calculating the proportion of locations within each category. We calculated these proportions for telemetry data within each of the training subregions and telemetry data from multiple independent subregions (that is, non-RSF subregions). Data from independent subregions were used for the purpose of assessing the map in interpolated areas. Locations of active leks were used as an additional dataset for map validation (*see*: '*Region-wide Habitat Suitability Index and implementation for Conservation Planning*').

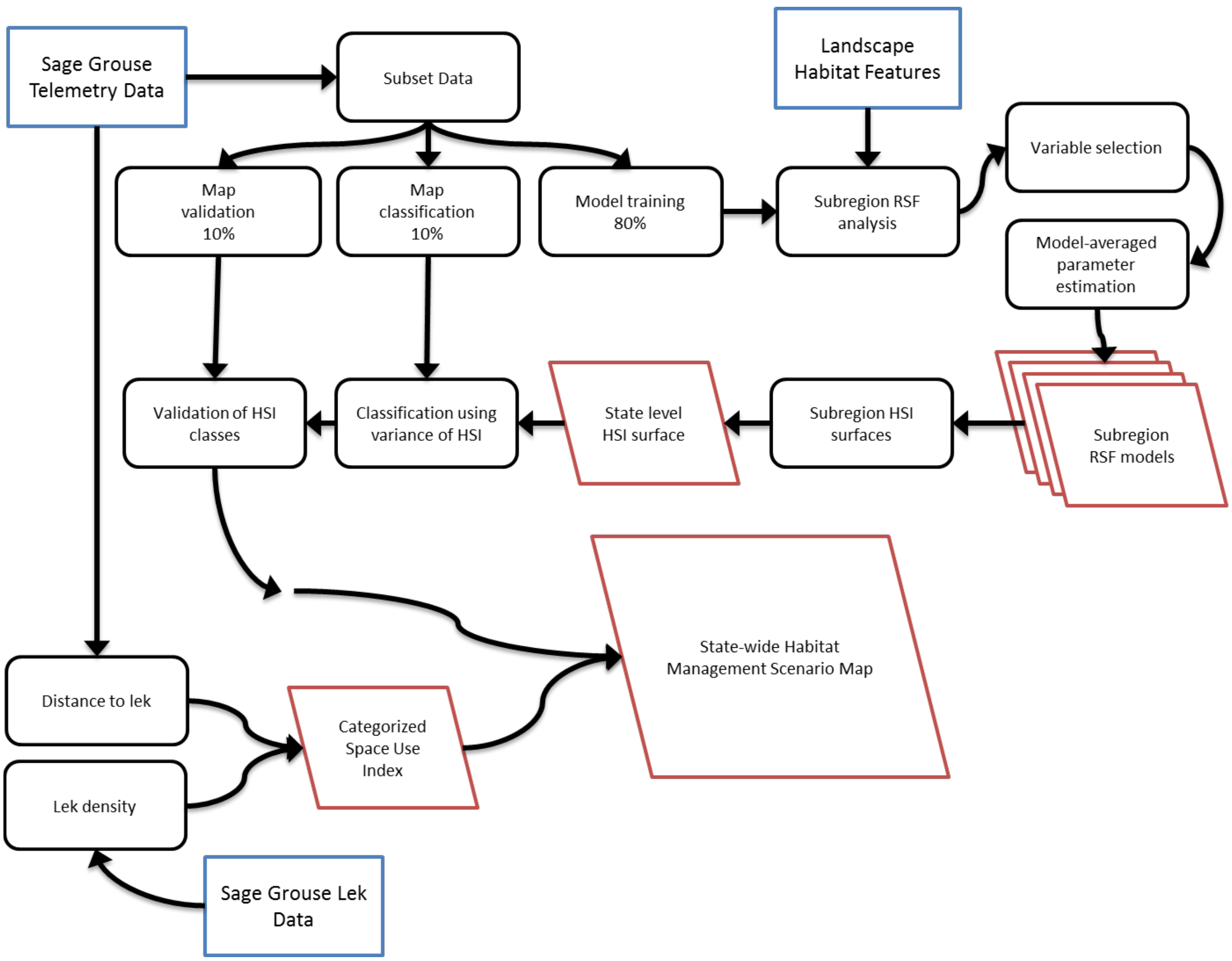

Figure 1. Diagram showing conceptual model for a statewide greater sage-grouse (*Centrocercus urophasianus*) habitat suitability model and habitat management scenario map, Nevada and northeastern California. Input datasets (blue rectangular boxes) were subjected to a series of processing steps (black rounded boxes) to produce interim and final spatially explicit maps (red parallelograms). HSI, habitat suitability index; RSF, resource selection function; %, percent.

From the RSFs, information about the probability of selection was produced solely on predicted associations of sage-grouse with environmental covariates. However, the model does not incorporate knowledge of sage-grouse abundance and density that represents space occupied currently by sage-grouse. Therefore, a SUI was created based on lek count data and existing information regarding how sage-grouse use space in relation to leks. Specifically, the SUI integrated information on lek density, lek size (that is, average number of males attending leks), and the non-linear relation between probability of space use and distance to lek, which was then used to create categories of high use or low-to-no use across the region. To provide a modeling tool that can aid conservation planning, the region-wide HSI (categorized into high, moderate, low, and non-habitat based on the variance distribution of HSI values) and high and low-to-no use SUI categories were combined into a single region-wide map. This map simultaneously reflects both the presence of sage-grouse and the presence of habitat features associated with sage-grouse occupancy, and can then be used to prioritize areas for different management scenarios. The strength of this map is to account for characteristics that describe the quality of the environment for sage-grouse as well as an index of population abundance. This technique can be used to aid decision-making processes across the landscape (*see 'Implementation of the Region-wide HSI map for Conservation Planning: An Example'*).

Habitat Suitability Model Development

Delineating the Region-Wide Scale.

The region-wide extent of the project area was defined by using the outer perimeter of all combined sage-grouse Population Management Units (PMU; Nevada Department of Wildlife, 2014) in Nevada and northeastern California plus a 10-km buffer (fig. 2). This approached yielded an area of 21.5 million hectares that approximated the total potential sage-grouse range in Nevada and California (excluding the Bi-State Distinct Population Segment on the eastern side of the central Sierra Nevada Mountains). The purpose of the buffers was to ensure adequate representation of available habitats to sage-grouse at and near the PMU boundaries. Floristically, the region was typical of the Great Basin with Wyoming big sagebrush (*Artemesia tridentata* ssp. *wyomingensis*) and black (*Artemesia nova*) and low (*Artemesia arbuscula*) sagebrush occurring at elevations below 2100 m, and with mountain big sagebrush (*Artemesia tridentata* ssp. *Vaseyana*) occurring more frequently at higher elevations. Common non-sagebrush shrubs included rabbitbrush (*Chrysothamnus* ssp.), Mormon tea (*Ephedra viridis*), snowberry (*Symphoricarpos* ssp.), western serviceberry (*Amelanchier alnifolia*), and antelope bitterbrush (*Purshia tridentata*). Conifer forests were most frequently comprised of single-leaf pinyon pine (*Pinus monophylla*) and Utah juniper (*Juniperus osteosperma*) (hereafter, "pinyon-juniper"). Non-native and highly invasive annual grasses included cheatgrass (*Bromus tectorum*) and medusahead rye (*Taeniatherum caput-medusae*). Native perennial grasses included needle and thread (*Hesperostipa comata*), Indian ricegrass (*Achnatherum hymenoides*), and squirreltail (*Elymus elymoides*).

Sage-Grouse Telemetry Data.

Data used in the study were generated from several sage-grouse telemetry studies across Nevada and northeastern California conducted from 1998 through 2013 by USGS, NDOW, CDFW, Idaho State University, University of Idaho, and University of Nevada-Reno. Field data collection protocols for tracking and locating sage-grouse were generally consistent across sites and years. Data were excluded from the analyses in situations where data collection procedures or supporting information differed substantially from norms. For example, telemetry data were removed from the analyses when a unique bird identifier or location date was absent or birds had less than two locations total.

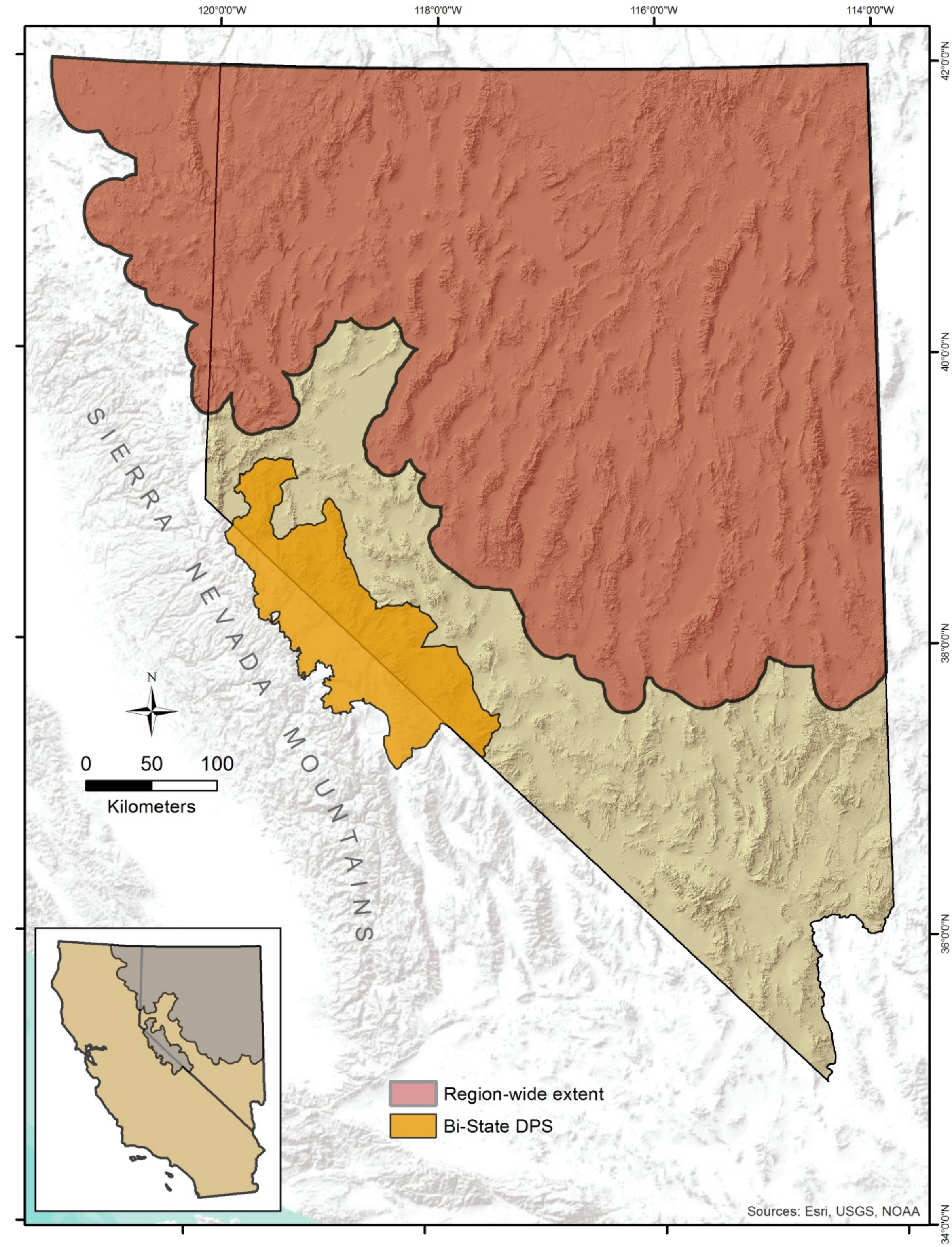

Figure 2. Map showing project area, which included the segment of greater sage-grouse (*Centrocercus urophasianus*) range in Nevada and northeastern California, excluding the Bi-State Distinct Population Segment (Bi-State DPS).

Generally, sage-grouse were captured in close proximity to leks in spring (March–April) and at various areas where sage-grouse congregate in autumn (October–December) using spotlighting techniques at night (Giesen and others, 1982; Wakkinen and others, 1992). Captured sage-grouse were outfitted with necklace-style VHF radio-transmitters (Kolada and others, 2009). Over the 15-year period (1998–2013), personnel across agencies and organizations conducted on-the-ground monitoring of sage-grouse. In lieu of VHF only radio-transmitters, a subsample of sage-grouse at some sites during 2012 and 2013 were outfitted with a combined Global Positioning Systems (GPS) - Platform Transmitter Terminals (PTTs; North Star Science and Technology, LLC, King George, Virginia) and VHF transmitter system. This system had a combined weight or less than 3 percent of sage-grouse body mass. The purpose of the GPS transmitter was to collect locations remotely, and the PTT transmitted stored location data via satellite communication to a central database. The VHF marked sage-grouse were relocated using hand-held radio receivers and antennas, whereby ground observers circled sage-grouse at a radius of 30–50 m and used the loudest signal method to minimize location error. Location coordinates for VHF-marked sage-grouse were obtained using a hand-held GPS (Universal Transverse Mercator, UTM).

Both VHF and GPS - PTT telemetry data were used in our analyses, and were screened for completeness and comparability prior to inclusion in models. GPS - PTT transmitters were programmed to collect 9–12 locations per day. To prevent autocorrelation among GPS - PTT location data, only a single random location per day (during daylight hours) was used in our analyses, and the remaining daily locations were removed. In total, 35,883 telemetry locations from 1,612 sage-grouse were compiled into a region-wide database for all analyses. The majority of locations from marked sage-grouse were obtained within a single year (that is, few unique grouse were marked across multiple years). All locations were generated from adult sage-grouse (that is, older than 1 year of age) of each sex across all seasonal life stages.

Sage-grouse telemetry locations were divided into three independent data subsets for use in different steps of model processing and validation. These data sets were considered independent in that no telemetry locations across sets were shared by the same individual. Thus, different sage-grouse were used for each data set. These data sets consisted of: (1) an RSF model training subset employing 80 percent of location data; (2) a classification subset employing 10 percent of location data to delineate areas of differing habitat quality; and (3) a validation subset employing 10 percent of location data from RSF subregions to assess predictiveness and consistency of habitat quality areas. Individual sage-grouse were randomly assigned to these three categories at the given proportions.

Delineating Subregions.

Spatial associations between marked sage-grouse and existing PMU boundaries (Nevada Department of Wildlife, 2014) were used as an initial starting point for delineating subregions for habitat selection analyses and naming conventions across Nevada and northeastern California (fig. 3). Ultimately, the data were partitioned into 19 subregions based on movement patterns of individual radio-marked sage-grouse for habitat analyses, with each grouse occupying one subregion only. Some subregions contained too few marked sage-grouse for sufficient training data to develop a habitat model, which resulted in the exclusion of seven subregions with fewer than 20 marked sage-grouse or less than 100 telemetry locations. However, data from these excluded 'non-RSF' subregions were sufficient to provide further validation of the region-wide model in areas that were not used to train the model (*see*

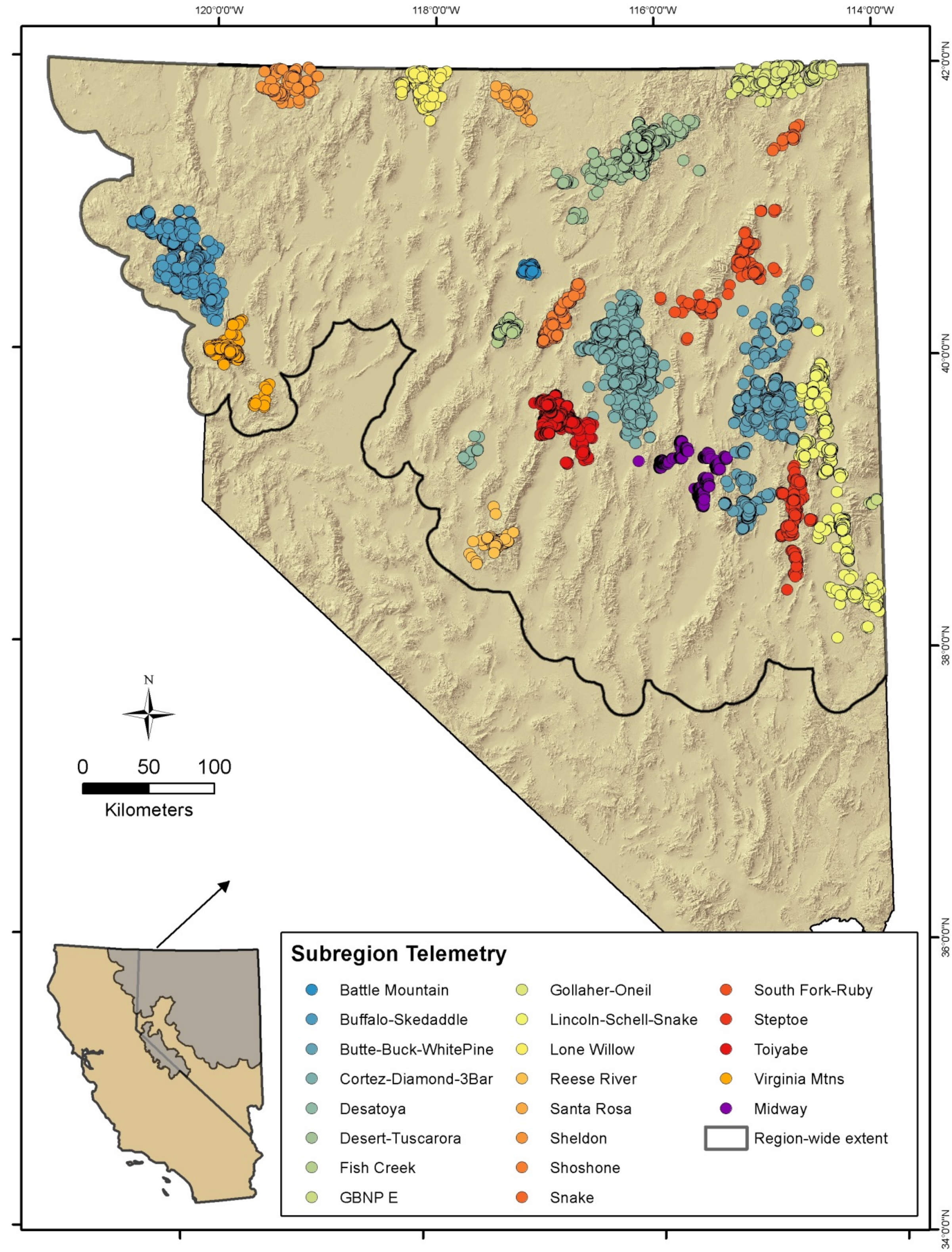

Figure 3. Map showing telemetry points (colored dots) comprising greater sage grouse (*Centrocercus urophasianus*) locations available for use in resource selection function modeling, Nevada and northeastern California. Names refer to locations associated with NDOW Population Management Units.

'HSI Classification and Validation'). After data-screening, we included telemetry data from 12 subregions in the habitat training models: Buffalo-Skedaddle, Butte-Buck-White Pine, Cortez, Desert-Tuscarora, Gollaher-O'Neil, Lincoln-Schell-Snake, Lone Willow, Midway, Sheldon, South Fork-Ruby Valley, Toiyabe, and Virginia Mountains (fig. 4). The spatial extent of habitat availability for use in habitat modeling was defined by first calculating a minimum convex polygon (MCP) that encompassed all telemetry locations within each subregion, and then buffering each MCP by the maximum average daily sage-grouse movement (1,451 m). Using the MCP to identify the study extent is a common and useful approach for habitat studies (Aebischer and others, 1993), and buffering by the maximum average daily movement helps ameliorate underestimation of habitat availability.

Classification of Landscape Habitat Features.

A broad suite of biotic and abiotic variables potentially associated with sage-grouse occurrence was quantified to provide inputs to estimated HSIs as spatially explicit environmental covariates. Land-cover types representing the dominant vegetation within 30 x 30 m pixels were classified into binary raster layers using existing mapping products. For Nevada, detailed land cover classes were derived from the Nevada SynthMap (Peterson, 2008). Land cover classes were then reclassified into broad habitat categories that were guided by classification levels from NatureServe (NatureServe, 2013), Landscape Fire and Resource Management Planning Tools (LANDFIRE) (2010), and The Nature Conservancy. Land cover classes for the northeastern California portion of the project area were derived from LANDFIRE, SageStitch (Comer and others, 2002), and California Department of Forestry and Fire Protection (2006) data sets. To facilitate region-wide compatibility across land cover classes, each data set was reclassified into the broadest categories used to reclassify the Nevada SynthMap, and then compared across pixels. Pixel values that matched for at least two of the data sets were chosen, whereas the reclassified LANDFIRE value was used when no agreement occurred. The final Nevada and northeastern California layers were then merged. The final set of non-sagebrush land cover classes used in the analysis comprised annual grass, perennial grass, lowland non-sagebrush shrub, upland non-sagebrush shrub, wet meadow, riparian, pinyon-juniper conifer, non-pinyon-juniper conifer (forest), agricultural cropland, and bare ground. All sagebrush species (for example, Wyoming big, mountain big, low, and three-tip [*Artemisia tripartita*]) were ultimately condensed into a single "sagebrush" land cover class for analysis (table 1).

Because variation in sage-grouse habitat selection can be strongly scale-dependent (Aldridge and Boyce, 2007; Doherty and others, 2008; Casazza and others, 2011; Aldridge and others, 2012), the analysis was performed on each land cover raster at three different spatial scales relevant to sage-grouse movement patterns. Specifically, the scale-dependent analysis used a circular moving window (neighborhood analysis tool, ArcGIS™ Spatial Analyst) with a radius of 167.9 m (8.7 ha), 439.5 m (61.5 ha), or 1,451.7 m (661.4 ha) that represented averages across sage-grouse of the minimum, mean, and maximum daily distance traveled by sage-grouse in this study, respectively, to calculate the proportion of a particular habitat within a respective spatial scale. Other land cover related variables measured at the three spatial scales included variety of land cover types (that is, the number of unique land cover types), variety of edge types (that is, the number of unique combinations of adjacent land cover types), and the amount of edge, quantified as the total number of pixels that represented interface of two adjacent cover types (hereafter, "edge effect") (table 1).

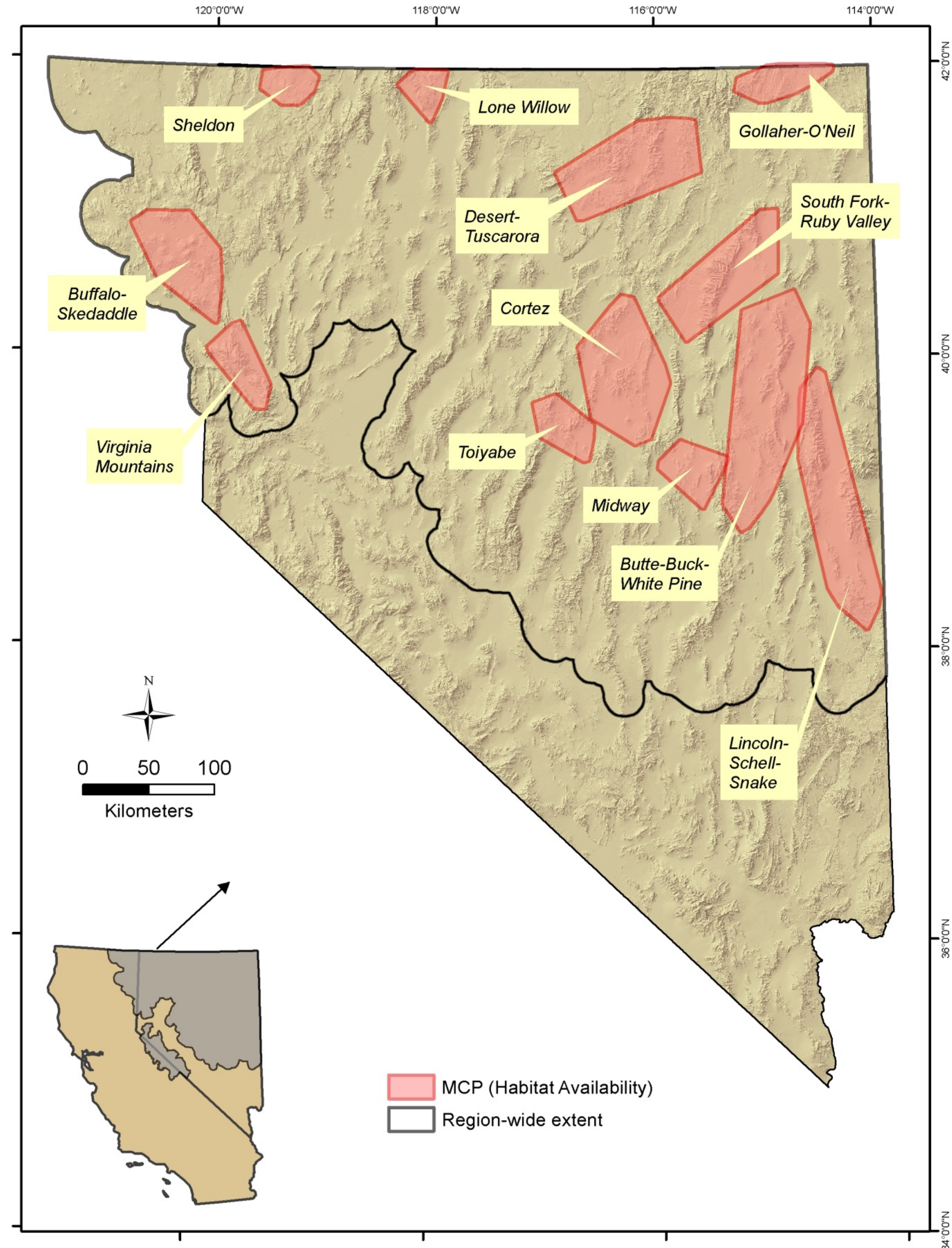

Figure 4. Map showing 12 subregions with suitable greater sage-grouse (*Centrocercus urophasianus*) location data for resource selection function analyses, Nevada and northeastern California.

Table 1. Proposed variables assessed in resource selection function model development for each subregion, Nevada and northeastern California.

[ha, hectare; m, meter]

Variable type	Scales		
Land cover			
Annual grass	8.7 ha	61.5 ha	661.4 ha
Agriculture	8.7 ha	61.5 ha	661.4 ha
Bare ground	8.7 ha	61.5 ha	661.4 ha
Sagebrush	8.7 ha	61.5 ha	661.4 ha
Forest	8.7 ha	61.5 ha	661.4 ha
Lowland shrubs	8.7 ha	61.5 ha	661.4 ha
Perennial grass	8.7 ha	61.5 ha	661.4 ha
Pinyon-juniper	8.7 ha	61.5 ha	661.4 ha
Riparian	8.7 ha	61.5 ha	661.4 ha
Upland shrubs	8.7 ha	61.5 ha	661.4 ha
Wet meadow	8.7 ha	61.5 ha	661.4 ha
Habitat configuration			
Edge effects	8.7 ha	61.5 ha	661.4 ha
Variety of edge types	8.7 ha	61.5 ha	661.4 ha
Variety of land cover types	8.7 ha	61.5 ha	661.4 ha
Distance to edge	Linear	Exponential decay	
Distance to agriculture	Linear	Exponential decay	
Water sources			
Any stream	Linear	Exponential decay	
Perennial stream	Linear	Exponential decay	
Intermittent stream	Linear	Exponential decay	
Spring	Linear	Exponential decay	
Water body	Linear	Exponential decay	
Wet meadow	Linear	Exponential decay	
Topography			
Elevation	Linear		
Roughness index	1 ha		
Topographic position index	510 m	2,010 m	

Distance Metrics, and Topographic Indices.

Distances to landscape features that may affect the probability of sage-grouse use were calculated from the GIS (table 1). These landscape features included various water features, agricultural development, and habitat edge (table 1). The influence of distance to water was measured using multiple landscape features from the National Hydrography Dataset (U.S. Geological Survey, 2014) that included perennial streams, intermittent streams, springs, and open water bodies. Distance to wet meadows was also measured, as identified by the land cover maps. For all landscape features, linear distance was calculated as a simple Euclidean distance from a used or available point using the Distance tool in Spatial Analyst (ArcGIS™ 10.1). Non-linear relationships were assessed with an exponential decay function, $e^{-d/\alpha}$, where d was the Euclidean distance from a used or available point to a landscape feature, and α was the mean linear distance from that feature. This decay function allowed estimation of the degree to which the effect of a habitat feature strengthened or weakened with increasing distance from that feature. A metric estimating the distance to road was also calculated but not included in the set of variables because the sage-grouse locations obtained by hand-held VHF were closer to roads than those obtained by GPS-PTT and could result in biased results across data sources (P.S. Coates, U.S. Geological Survey, unpub. data, 2014).

Topographic characteristics were calculated to assess the probability of sage-grouse use with several indices. Elevation and topographic roughness (within 30 x 30 m pixels) were determined from the National Elevation Dataset (U.S. Geological Survey, 2009). Topographic roughness, which measures variance in elevation change (Riley and others, 1999), was calculated using the Geomorphometry and Gradient Metrics Toolbox (Evans and Oakleaf, 2012) and normalized by dividing each pixel value by the maximum value. Topographic position indices (TPI; Jenness, 2006) were calculated as the difference between elevation at a central point and the surrounding average elevation within radii of 510 and 2,010 m. Positive and negative TPI values indicated central point elevations that were higher and lower than the surrounding area, respectively, and depressions or valleys can represent areas of increased moisture (De Reu and others, 2013).

Values of all landscape habitat features, distance metrics, and topographic indices were extracted from the GIS for input into the habitat selection analyses (*see ‘Subregional RSF Modeling’*) at used locations (telemetry data) and random locations. The purpose of generating random locations was to characterize the environment available to sage-grouse populations. Five random locations within the buffered MCP were generated for every used location to account for heterogeneity of available land cover types (Aldridge and others, 2012).

RSF Analyses

Subregional RSF Modeling.

Resource selection functions (RSFs) are calculated frequently using data from wildlife telemetry studies. Typically, selection and avoidance for particular landscape features are estimated by contrasting measurements at used locations (telemetry data) with measurements at random locations that represent areas available to all individuals within a population (Boyce and McDonald, 1999; Manly and others, 2002; Johnson and others, 2006). We estimated population-level RSFs using generalized linear models with a binomial error distribution and specified logit-link function (that is, logistic regression) in a mixed effects model framework, where environmental variables (described above) were modeled as explanatory covariates (predictors). The number of sample locations was not equal across individual sage-grouse. Therefore, the individual sage-grouse was treated as a random effect (that is, random intercept) to account for potential autocorrelation among locations associated with each individual (Gillies and others, 2006). Year was also included as a random effect for those subregions with more than 1 year of telemetry data to account for temporal intraclass correlation. A weight of 0.2 was specified in the model structure for each random location that was used to characterize available habitat. This value allowed equal influence by used (weight = 1) and random points because 5 random points were generated per actual grouse location. To avoid seasonal sampling bias, we also added an additional weight to each location based on the proportion of use occurring during spring/summer (March–August), fall (September–November), and winter (December–February). The seasonal weight allowed all seasons to be represented equally. We fit all models using the lme4 package (Bates and others, 2012) in Program R (R-Core-Team, 2012).

A two-part selection procedure was employed to reduce the number of covariates. This procedure relied on bias-corrected Akaike's information criterion (AIC_c) (Burnham and Anderson, 2002) to identify the most parsimonious RSF model for each subregion. In the first part, proposal covariates (table 1; appendixes A– L) were used to determine the spatial scale, distance function, or topographic index that best approximated the probability of selection for each corresponding covariate relative to a null model (that is, random effect only) in an information-theoretic framework. The most appropriate fit for percent cover estimated at the three spatial scales (8.7 ha, 61.5 ha, or 661.4 ha) was evaluated for each land cover type. The most relevant distance function (linear or exponential decay) was evaluated for water features, edge habitat, and agriculture. All topographic measures were evaluated relative to a null model. Candidate covariates from models that represented the best performing scale/distance function were then carried forward providing that the model also outperformed the null model by greater than 2.0 ΔAIC_c units (Burnham and Anderson, 2002).

The second part of model development comprised a series of additive models containing all possible 2-covariate combinations of our "candidate" covariates carried over from the first stage. Models in this set estimated the effect (slope) of a covariate on probability of selection while accounting for the presence of all other covariates. We sought to reduce multicollinearity by constructing correlation matrices and removing models with evidence of correlated effects ($r \geq |0.65|$). We then calculated model-averaged parameter estimates (βs; appendixes A–L) for each covariate across the set of additive models to account for model selection uncertainty (Burnham and Anderson, 2002). The purpose of this stage was not to develop the most parsimonious additive model with multiple covariates, but instead estimate the effect of each covariate and use the model-averaged parameter estimates to calculate an RSF. Covariates were excluded when their model-averaged 95 percent confidence intervals overlapped zero. The RSF took the form:

$$w(x) = exp(\beta_1 X_1 + \beta_2 X_2 +, \ldots, +\beta_k X_k) \tag{1}$$

where

$w(x)$ is the resource selection function (RSF), and

β is the averaged parameter estimate for each covariate $(X_1, \ldots, X_k)$ (Manly and others, 2002).

Although the RSF cannot be considered an absolute probability because unused areas were not known, the RSF is useful as a representation for the probability of selection (Manly and others, 2002).

Summary of Subregional RSF Results.

A total of 25 covariates were modelled in 12 subregional RSF analyses (table 2; appendixes A–L). Sixteen of these covariates were present in a majority of the subregional RSF models consisting of: (1) seven covariates characterizing land cover – sagebrush, lowland shrub, upland shrub, riparian, forest, pinyon-juniper, and perennial grass relative cover; (2) four covariates characterizing distance to water sources – nearest water body of any type, nearest spring, nearest wet meadow, and nearest perennial stream; and (3) six covariates characterizing land cover interfaces or abiotic features – amount of edge habitat, number of adjacent habitat types, topographic roughness, topographic position, and elevation.

While coefficient direction and magnitude for several covariates varied across subregions, some consistent patterns were evident in covariate coefficients that indicated use or avoidance of a covariate by sage-grouse (table 2; appendixes A–L). On average, 6.5 land cover covariates were present in final models for each subregion. The Sheldon subregion was the only notable exception, where just one cover type was retained in the final model. Sagebrush was selected by sage-grouse in all eleven subregions containing the sagebrush covariate, and pinyon-juniper and forest were avoided by sage-grouse in the subregions that contained those covariates (9 and 7 subregions, respectively). Strong correlations between pinyon-juniper and sagebrush did not occur among any subregions ($r < |0.65|$). Final RSF models in every subregion indicated selection for at least one type of water source. Some inconsistencies occurred among coefficients that represented relationships with agriculture across subregions, whereby use of agriculture ranged from selection, proportional use to availability, and avoidance. Effects related to either the amount of or distance to edge habitat were evident in RSFs for every subregion, but the magnitude of these effects varied among subregions. Edge types or land cover types were present in RSFs for all subregions except for the South Fork/Ruby Valley, and the direction of these effects were similar among subregions. A covariate that represented distance to some source of water was influential and, thus, included in every subregional RSF.

Table 2. Magnitude of significant model-averaged effects among 12 subregional resource selection function models for all proposed variables included in modeling of greater sage-grouse (*Centrocercus urophasianus*) habitat, Nevada and northeastern California.

[**Symbols**: +, positive RSF coefficient; -, negative RSF coefficient; 0, RSF coefficient confidence interval overlaps zero; V, topographic position index coefficient indicates selection for valleys]

		Subregion											
Group	Covariate	Buffalo-Skedaddle	Butte-Buck-White Pine	Cortez	Desert-Tuscarora	Gollaher - O'Neil	Lincoln-Schell-Snake	Lone Willow	Midway	Sheldon	South Fork-Ruby Valley	Toyiabe	Virginia
Land cover	Annual grass	0	0	0	-	0	0	0	-	0	-	-	+
	Bare ground	-	-	-	-	0	0	+	0	0	0	0	0
	Cropland	+	0	-	0	0	+	0	+	0	+	0	0
	Forest	-	-	0	-	-	-	0	-	0	-	0	0
	Lowland shrub	-	-	-	-	0	-	+	+	0	-	-	+
	Perennial grass	+	+	+	-	0	+	0	-	0	+	0	0
	Pinyon-juniper	-	-	-	-	0	-	0	-	0	-	-	-
	Riparian	-	+	-	-	-	-		-	0	0	+	-
	Sagebrush	+	+	+	+	+	+	+	+		+	+	+
	Upland shrub	-	+	-	-	-	-	-	0	-	0	+	0
	Wet meadow	-	0	0	0	0	0	0	0	0	0	0	0
Agriculture	Distance to cropland	0	+	0	+	0	0	0	0	0	0	-	-
Edge Effects	Edge effects	0	+	+	0	-	+	+	-	-	-	0	+
	Distance to edge	-	0	0	+	0	0	0	0	0	0	+	0
Landscape Variation	Variety of edge types	0	0	0	0	-	0	+	0	0	0	0	-

Group	Covariate	Subregion											
		Buffalo-Skedaddle	Butte-Buck-White Pine	Cortez	Desert-Tuscarora	Gollaher - O'Neil	Lincoln-Schell-Snake	Lone Willow	Midway	Sheldon	South Fork-Ruby Valley	Toyiabe	Virginia
	Variety of land cover types	-	+	+	-	0	+	0	+	-	0	+	0
Water Source	Distance to water body	+	+	+	+	+	+	+	+	+	-	+	-
	Distance to spring	-	-	+	+	-	+	+	+	0	-	+	+
	Distance to wet meadow	0	-	+	+	0	+	+	+	0	0	+	+
	Distance to nearest stream	0	0	0	-	0	0	0	0	0	+	0	0
	Distance to perennial stream	-	0	+	0	0	+	+	+	-	0	+	-
	Distance to intermittent stream	0	+	0	0	-	0	0	0	0	0	0	0
Topography	Roughness index	-	+	+	-	-	-	-	-	0	-	+	-
	Topographic position index	0	V	0	V	V	V	V	V	V	V	0	V
	Elevation	-	+	+	-	-	+	+	-	+	+	+	+

Region-Wide Habitat Suitability Index and Implementation for Conservation Planning

Region-Wide Average Habitat Suitability Surface Map.

The final RSF equation was applied for each subregion across all pixels in the region-wide extent using the Raster Calculator in Spatial Analyst. Because the subregional RSF consisted of extreme values, a monotonic transformation of the RSF was conducted, expressed as:

$$\text{HSI} = \frac{w(x)}{1+w(x)}, \tag{2}$$

that resulted in subregional HSI surfaces. These HSI surfaces provided a relative metric of habitat quality for any given pixel where habitat quality reflects range-wide mean propensity to be used by sage-grouse given the attributes of the pixel. The HSI equation is equivalent to a logistic transformation on the $\beta_k X_k$, for each covariate X_k. However, the function was used only to express relative influence among different RSF values by expressing influence as a value between 0 and 1. Although we did not assume that HSI values represent absolute probabilities, an increase in HSI corresponds to an increase in the probability of selection. The subregional HSIs were averaged across each pixel to calculate a single continuous surface for the region. This was an appropriate technique for developing a region-wide HSI because it reduces the potential for non-typical selection patterns at a local site to influence HSI values elsewhere within the region. Further refinement by averaging across subregions at smaller scales is possible; however, we suspect that representation from 12 subregions is not broad enough to warrant further delineation. Our end result was a region-wide HSI surface that accounts for variability in predicted HSI values from each of the subregional areas (fig. 5).

Implementation of the Region-Wide HSI Map for Conservation Planning—An Example

Effective conservation planning is an inherent stakeholder-driven process, and stakeholders may use quantitative tools to aid decision making. Here, an example is provided for how a HSI continuous surface map can be used as a tool to aid conservation planning and the decision-making process. In this example, two categorized sources of information are employed to identify spatially explicit management areas: (1) suitability of landscape characteristics; and (2) likelihood of sage-grouse occurrence.

HSI Classification and Validation—An Example

The relative suitability of habitat occurring in an area may be obtained directly from the region-wide HSI map. However, the continuous index at each 30 x 30 m pixel provided by the map is an unwieldy mechanism for decision-making related to distinct areas, especially at relatively large scales. Therefore, it can be valuable to categorize the region-wide HSI surface into classes that represent habitat quality at larger spatial scales. To do this, pixels that represented large bodies of water (for example, lakes and reservoirs) identified from Landsat land cover classifications (that is, SynthMap) were first masked from the region-wide HSI. The region-wide HSI was then objectively binned into four discrete categories in multiple steps. First, HSI values were extracted using the 10 percent of independent telemetry locations that were intentionally withheld from the data set used to develop subregion RSFs. This data set comprised the 'map classification data set', as it represented data that were statistically independent of RSF outcomes. Second, four suitability categories were developed using cutoff values based on the standard deviation (SD) from the mean HSI ($\bar{x}$) derived from the map classification data set. For these purposes, we assumed the data arose from a normal distribution. High suitability habitat was comprised of all HSI values greater than 0.5 SD below $\bar{x}$. This constituted a percentile rank range of 30.9–100.0 percent of HSI values (fig. 6). Moderate suitability habitat was comprised of HSI values between 1.0 and 0.5 SD below $\bar{x}$, constituting a percentile rank range of 15.0–30.9 percent (fig. 7). Low suitability habitat was comprised of HSI values between 1.5 and 1.0 SD below $\bar{x}$, constituting a percentile rank range of 6.7–15.0 percent (fig. 8). Non-suitable habitat was comprised of HSI values 1.5 SD below $\bar{x}$ (less than 6.7 percent; fig. 9). The cutpoint of 1.5 SD was identified as the most appropriate value to determine the lowest threshold (non-habitat vs. habitat) using an ancillary analysis. Specifically, habitat areas were generated using cutpoints from SD of 0.5, 1.0, 1.5, and 2.0 below $\bar{x}$. For each successive SD cutpoint, we then calculated the ratio of percent potential habitat area gained to the percent of RSF telemetry points added. A curvilinear line between this ratio (y-axis) and SD cutpoint (x-axis) was fitted, and the point where the line intercepted 1.0 on the y-axis was closest to the 1.5 SD. This analysis indicated that cutpoints beyond 1.5 SD incorporated disproportionately fewer telemetry points per unit area (fig. 10). As further rationale for 1.5 SD, this value represents the 6.7 percentile of the HSI distribution. Assuming that sage grouse locations are normally distributed in relation to habitat quality and sampling was random, this value roughly corresponds to the 5-10 percent of time that sage-grouse may spend moving between seasonal habitats.

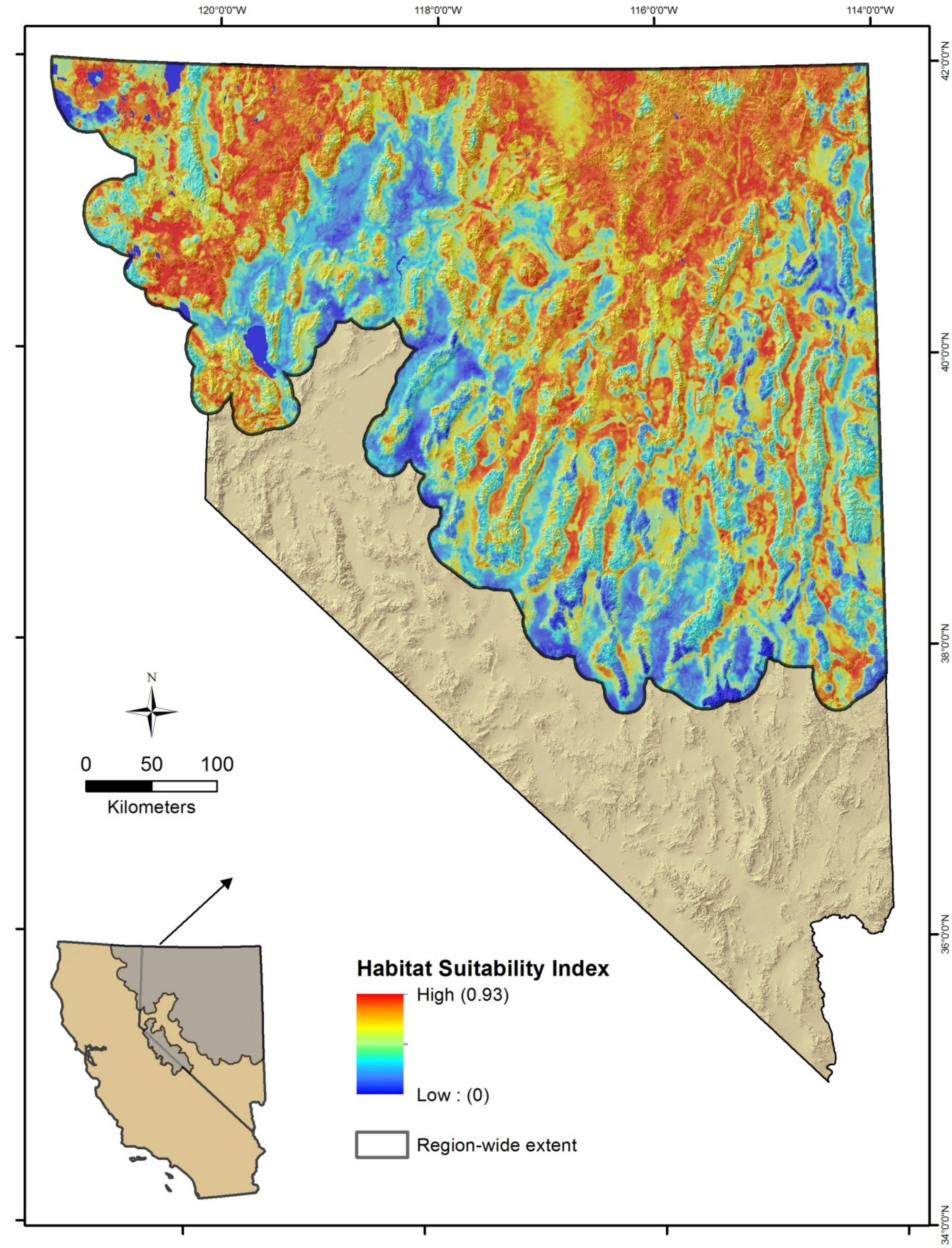

Figure 5. Map showing region-wide, model-averaged suitability map of greater sage-grouse (*Centrocercus urophasianus*) habitat derived from 12 subregions, Nevada and northeastern California.

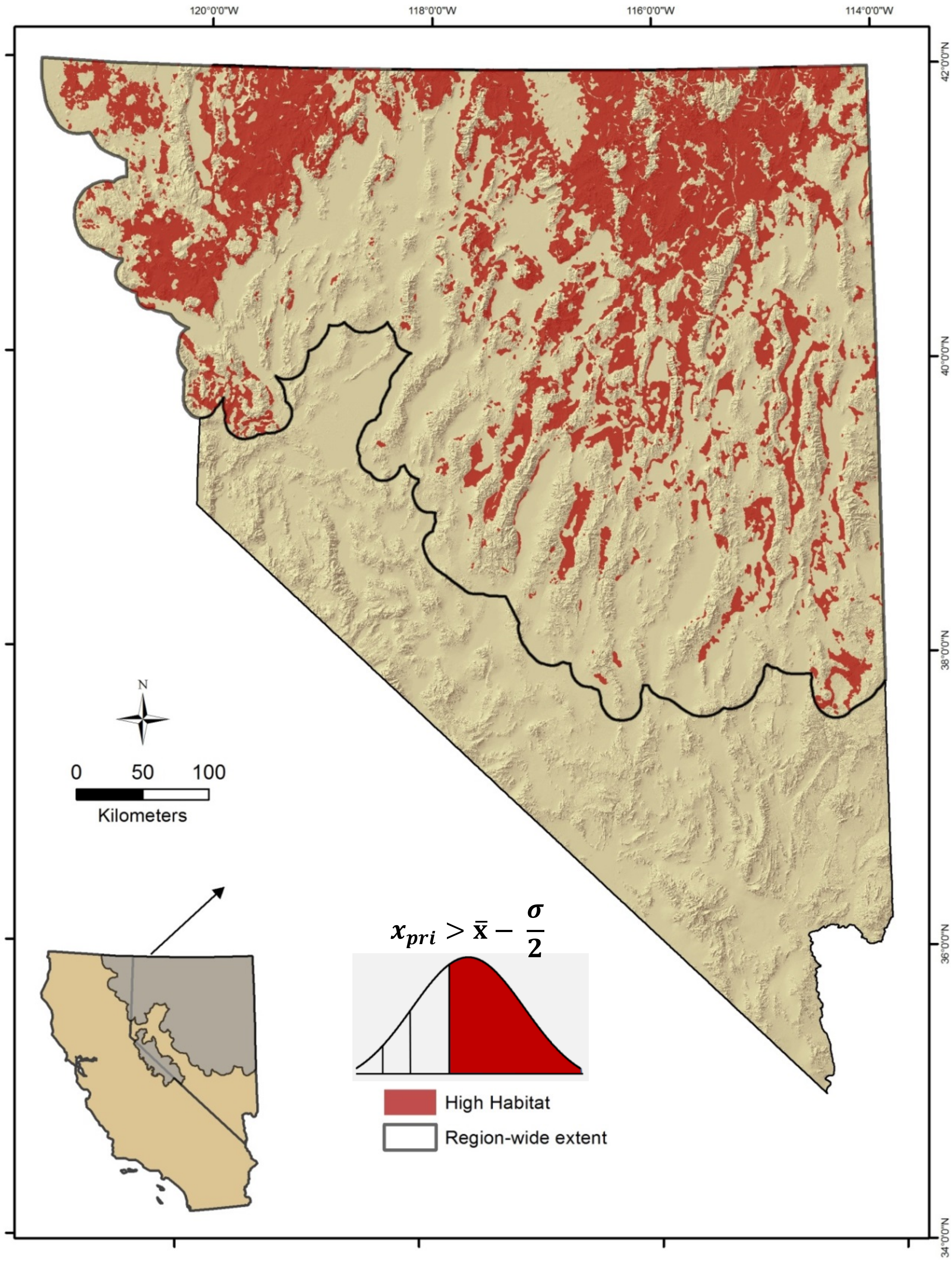

Figure 6. Map and graph (resource selection function [RSF] and probability distribution) showing example region-wide distribution of categorized high suitability habitat for greater sage grouse (*Centrocercus urophasianus*), Nevada and northeastern California. x_{pri} = classification as priority habitat; $\bar{x}$ = mean of the suitability values derived from classification data set; σ = standard deviation of suitability values derived from classification data set.

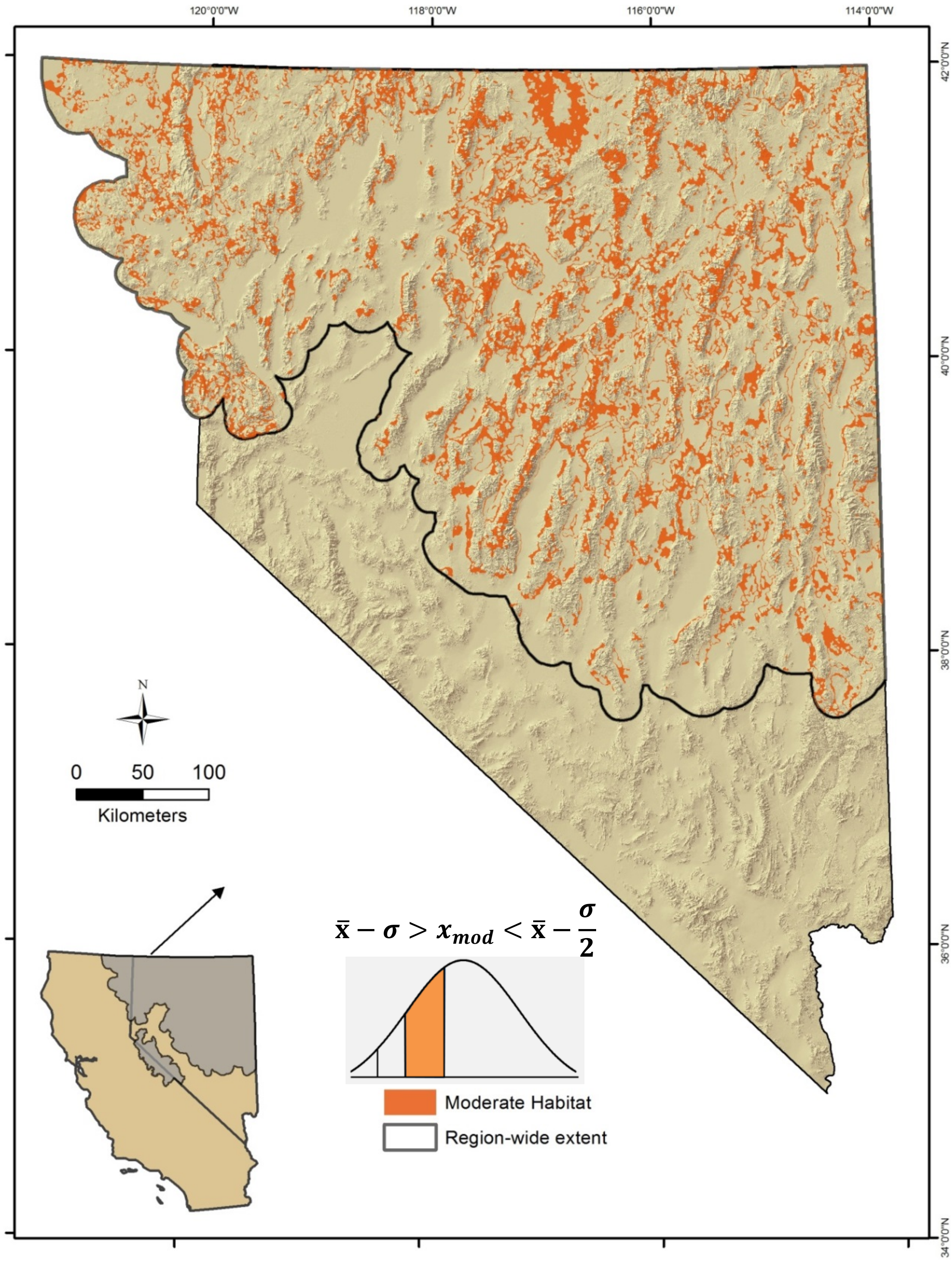

Figure 7. Map and graph (resource selection function [RSF] and probability distribution) showing example region-wide distribution of categorized moderate suitability habitat for greater sage grouse (*Centrocercus urophasianus*), Nevada and northeastern California. x_{mod} = classification as moderate habitat; $\bar{x}$ = mean of the suitability values derived from classification data set; σ = standard deviation of suitability values derived from classification data set.

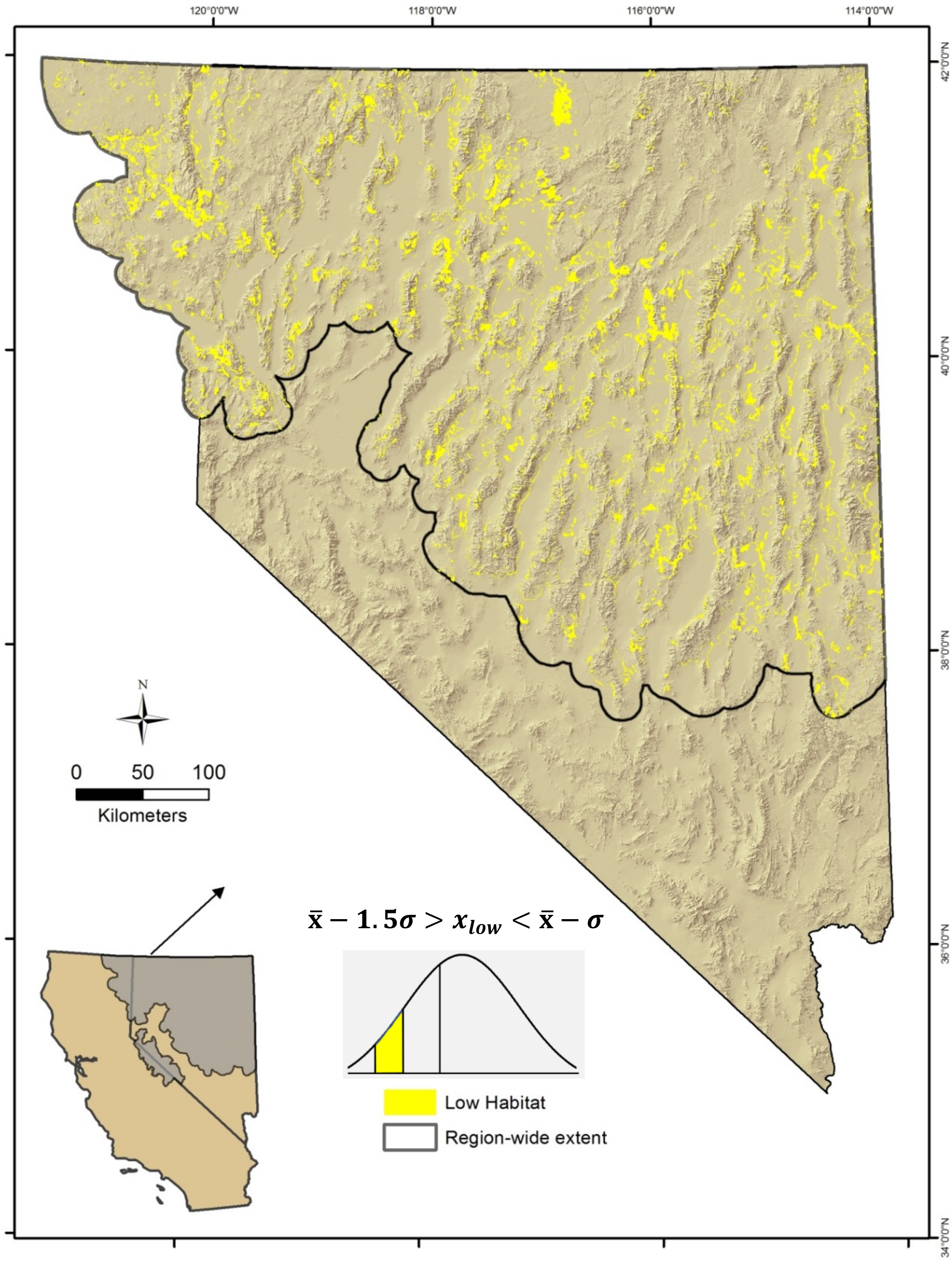

Figure 8. Map and graph (resource selection function [RSF] and probability distribution) showing example region-wide distribution of categorized low suitability habitat for greater sage grouse (*Centrocercus urophasianus*), Nevada and northeastern California. x_{low} = classification as low habitat; $\bar{x}$ = mean of the suitability values derived from classification data set; σ = standard deviation of suitability values derived from classification data set.

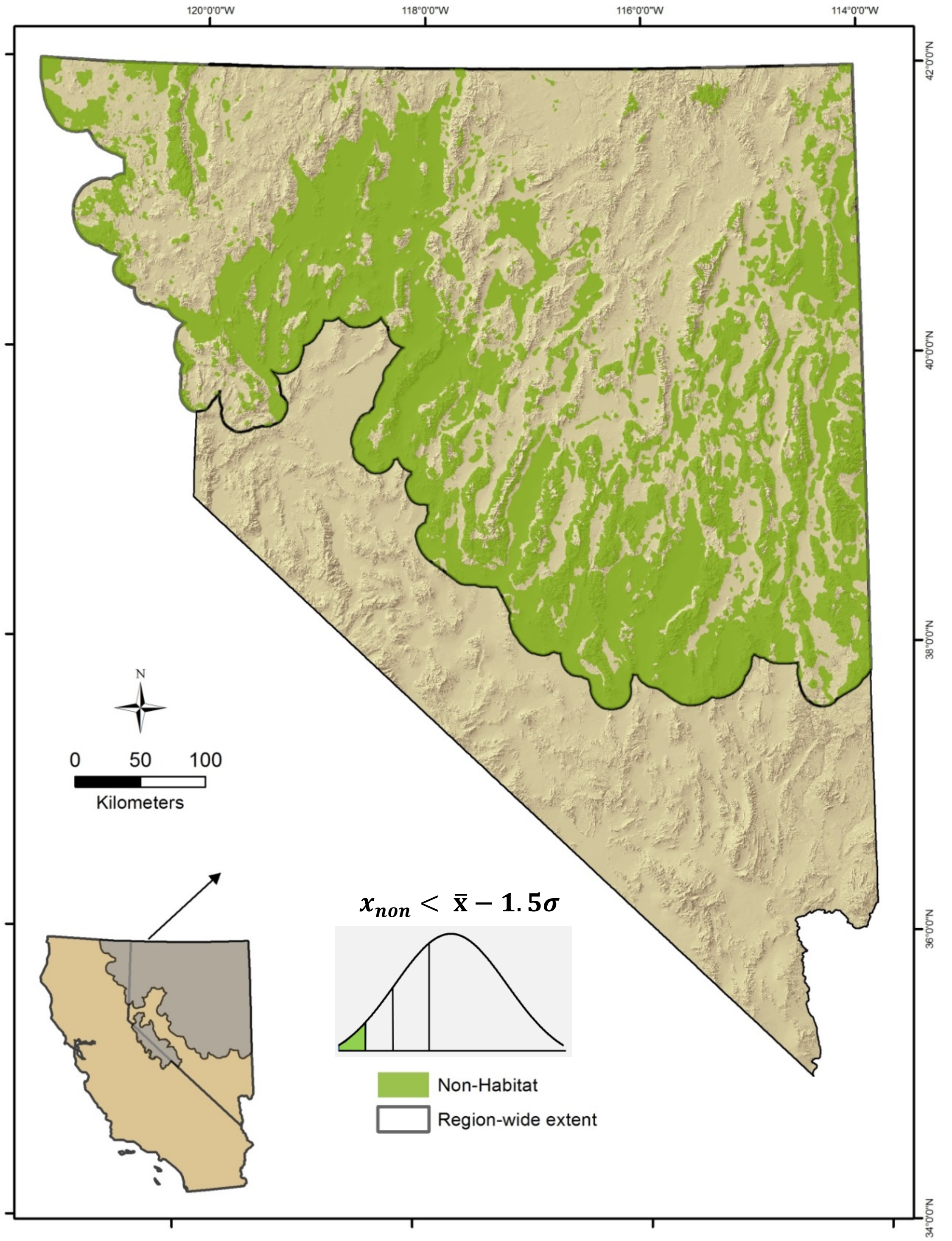

Figure 9. Map showing example region-wide distribution of categorized non-suitable habitat for greater sage grouse (*Centrocercus urophasianus*), Nevada and northeastern California. x_{non} = classification as non-habitat; $\bar{x}$ = mean of the suitability values derived from classification data set; σ = standard deviation of suitability values derived from classification data set.

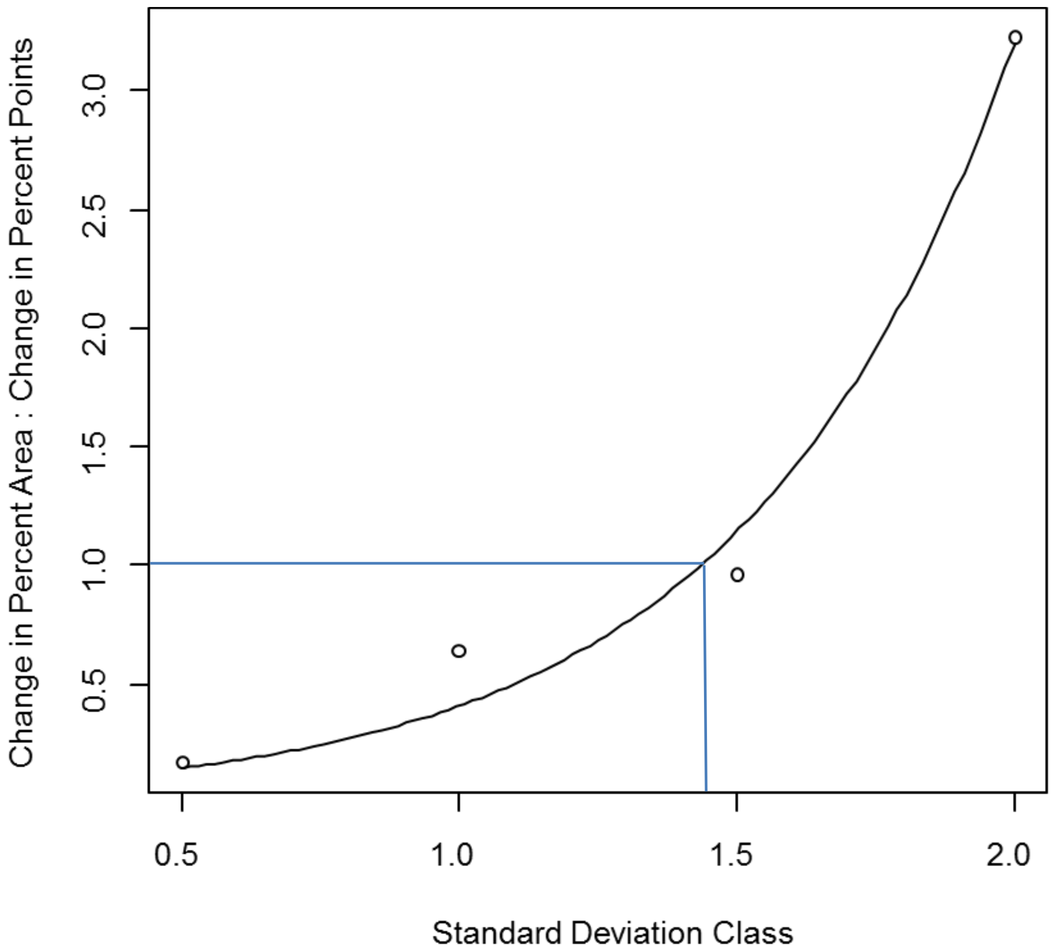

Figure 10. Relation between ratio of added potential habitat to added telemetry points validated and SD cutoff. SD, standard deviation

We used three data sets to assess the accuracy of the habitat suitability categories. The first set was comprised of locations from the 10 percent validation set within RSF regions (n = 3,124). The second set was comprised of all locations from non-RSF subregions with insufficient sample size for inclusion in the original RSF analyses (n = 609, subregions = 7). The third set was comprised of locations for active leks (see *Spatial Use Index* for data source). Locations from all validation sets were overlaid onto the categorized HSI map, and then evaluated for agreement between percentages of locations falling within each habitat category and SD percentile classes used for the habitat classification (fig. 11). In addition, Cohen's Kappa coefficient (κ) was used to assess agreement between the frequencies of observed (actual) validated HSI values versus expected values based on SD percentile bins. Cohen's Kappa is a more robust measure than a simple percentage of agreement because κ takes into account the agreement that can occur by chance alone. Values of κ greater than 0.75 constitute excellent agreement, 0.40–0.75 are acceptable, and less than 0.40 are poor (Fleiss, 1981). Relatively good agreement occurred among the validation data and habitat categories based on both percentages and κ (table 3). Agreement across all categories was exceptionally strong within the RSF subregion validation set, and acceptable for the non-RSF subregional set. On a cumulative basis, 79 percent, 94 percent, and 97 percent of leks occurred within the categories: (1) high only; (2) moderate and high; and 3) high, moderate, and low habitat, respectively. Acceptable agreement occurred for the lek validation set, but more leks occurred in high and moderate habitat than expected, and fewer leks occurred in low and non-habitat than expected.

Space Use Index

Habitat suitability categories provide a crucial piece of information to support decision-making. The second source of information that we used incorporated data regarding lek sites to estimate use of areas by sage-grouse across the landscape. We developed a composite SUI that combined the density of lek sites (breeding density) with the non-linear probability of space use relative to distance to lek (distance). Lek locations were the basis for both indices for multiple reasons. Leks are ideal locations to conduct space use analyses because they are considered hubs for nesting (Autenrich, 1985; Connelly and others, 2004) and generally are centered within seasonal use areas, meaning lek location provides an appropriate focal point for areas critical to all life phases of sage-grouse (Doherty and others, 2010a; Coates and others, 2013). Leks also are detectable using standard survey procedures and established protocols exist for counting male sage-grouse at these sites (Connelly and others, 2004), whereby males at leks were typically counted 3–4 times per season and the maximum count was recorded. Spatial coordinates for leks and associated data on sage-grouse abundance and activity were obtained from databases compiled by the NDOW and CDFW. Although 3–4 counts were typically conducted for counted leks, not all leks were counted every year across the project area. For our analyses, all included leks were classified by agency personnel as "active" (that is, leks with known male attendance) within the last 5–6 years (2009–2013) and "pending" (that is, leks with no males observed or leks that had not been surveyed adequately). Pending leks were included to allow for a more robust likelihood of sage-grouse occupancy across the landscape given the uncertainty associated with whether or not a pending lek had actually become inactive.

Table 3. Summary of habitat suitability model validation tests used to evaluate habit suitability classes for greater sage-grouse (*Centrocercus urophasianus*), Nevada and northeastern California.

[Three independent sets used for validation included: (1) radio telemetry data selected from within the subregions where RSFs (RSF subregions); (2) telemetry data outside the subregions (Non-RSF subregions); and (3) Active leks. Percent, %; Values for Cohen's kappa coefficient (κ) are in parentheses]

Habitat Suitability Classification	Expected %	Validation Sets		
		RSF subregions % (κ)	Non - RSF subregions % (κ)	Active leks % (κ)
High	69	68 (0.97)	56 (0.50)	79 (0.73)
Moderate	15	20 (0.83)	34 (0.37)	15 (0.98)
Low	9	7 (0.89)	3 (0.61)	3 (0.50)
Non-Habitat	7	5 (0.81)	7 (0.85)	3 (0.57)

To estimate density of lek sites (breeding density), we used a kernel density analysis (Silverman, 1986) and estimated the smoothing parameter (that is, bandwidth) using likelihood based cross-validation (Horne and Garton, 2006). Because substantial variation in lek size (number of attending males) existed among lek sites, individual leks were weighted by the most recent 5-year average for maximum male attendance per year. Therefore, breeding density was a function of lek distribution on the landscape (that is, proximity to each other) and lek size. Parameter estimation was conducted using Geospatial Modeling Environment (Beyer and others, 2010) and in Program R (R-Core-Team, 2012) with the 'ks' package (Duong, 2012).

The other component of the SUI consisted of adjusting for the use of space around lek sites (lek distance index), largely because leks are considered points on the landscape whereas sage-grouse use areas in relation to lek sites. Because the probability of occurrence is not likely to be a linear relationship with the Euclidean distance from a lek, we used a non-linear effect based on an average space use response curve derived by Coates and others (2013) from nearby populations of sage-grouse within the Bi-State Distinct Population Segment. Specifically, the curve was derived from quantification of the volume of population level utilization distribution (vUD) within a range of areas that varied in size and were centered on leks, up to a distance of 30 km. Utilization distributions were represented by an individual probability density function for each of 193 sage-grouse totaling nearly 11,878 sage-grouse locations. To obtain the distance index for our purposes, we simply subtracted the derived vUD value from one for every 30 m distance away from leks up to 30 km. Therefore, the lek point received a value of one, and as distance increased the value declined exponentially until it flattened at distances of 5–8 km. This calculated value provided a relative likelihood of occurrence based on previously published probability density functions from radio-telemetry data for sage-grouse. The curve developed for the Bi-State was appropriate to adopt for this analysis for multiple reasons because the curve: (1) accounted for seasonal patterns; (2) represented multiple isolated populations; (3) represented a relatively large spatial extent; and (4) likely represents other areas of the Great Basin because it consisted of substantial variation among populations as described in Coates and others (2013).

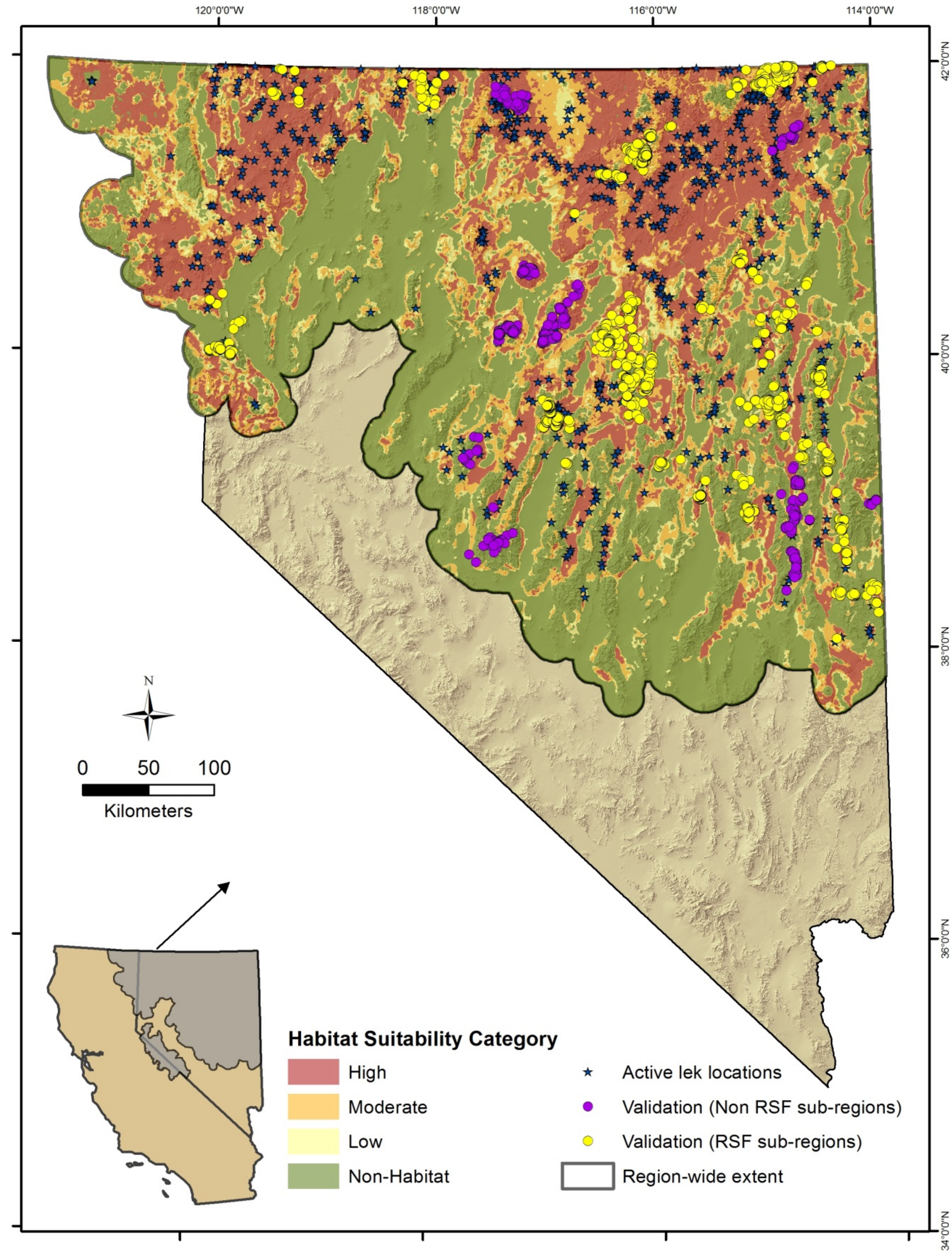

Figure 11. Map showing overlay of radio-telemetry data and lek locations used to validate habitat suitability classes for greater sage grouse (*Centrocercus urophasianus*), Nevada and northeastern California. RSF, resource selection function.

To create the SUI, grid-cell (30 x 30 m) values for lek density index and lek distance index were first normalized by dividing by the maximum of their respective index, and then averaged across all grid cells. The SUI, therefore, is a continuous, spatially explicit relative measure of sage-grouse occurrence weighted by local population size. For development of the example decision support tool, the SUI was categorized into two categories: “high use” and “low-to-no use” areas. High use areas consisted of areas that included up to 85 percent of the highest SUI density (cumulative density values). Low-to-no use areas of the landscape consisted of areas with less than 15 percent of the cumulative SUI density (fig. 12). The identification of high use regions allowed for spatial connectivity among areas of likely sage-grouse use and is consistent with previously used standards for sage-grouse breeding density (for example, Doherty and others, 2010b).

Developing a Decision-Support Tool—Combining RSF Categories with Space Use

To promote clear and effective policy decisions, it is often desirable to simplify a suite of important considerations regarding habitats or populations into a few non-overlapping classes, each of which are subject to specific rules, valuations, or interpretation for aiding in the decision-making process. The following is an example of how the intersection between habitat quality (a function of environmental attributes) and sage-grouse space use (a function of sage-grouse occurrence) can provide spatially explicit information to policymakers. Four habitat management classes were developed from the intersection of HSI and SUI categories (table 4). The rubric used to develop management classes and rationale is as follows:

1. Core Areas (fig. 13): Defined as the intersection between all suitable habitats (high, moderate, and low categories) and the high use SUI category. This habitat management class is intended to incorporate all suitable habitats that have relatively high certainty of current sage-grouse occupancy.

2. Priority Areas (fig. 13): Defined as both high suitability habitat that is present within the low-to-no use SUI category or non-suitable habitat occurring within the high use SUI category. This habitat management class encompasses: (1) high-quality habitats based on environmental covariates with a lower potential for occupancy given the current distribution of sage-grouse; and (2) sage-grouse incursion into areas of low quality habitat that is potentially important for local populations (for example, corridors of non-habitat connecting higher quality habitat).

3. General Areas (fig. 13): Defined as moderate and low habitat suitability that is present within the low-to-no use SUI category. This habitat management class represents areas with appropriate environmental conditions for sage-grouse, but are less frequently used by sage-grouse.

4. Non-habitat Areas (fig. 13): Defined as non-suitable habitat that is present within the low-to-no use SUI. This scenario represents habitat of marginal value to sage-grouse populations.

Table 4. Rubric for determining habitat management classes from habitat suitability and space use categories.

	Space Use Index Category	
Region-wide RSF Category	High Use Area	Low-to-No Use Areas
High Habitat Suitability	*Core Area*	*Priority Area*
Moderate Habitat Suitability	*Core Area*	*General Area*
Low Habitat Suitability	*Core Area*	*General Area*
Non-suitable Habitat	*Priority Area*	*Non Habitat Area*

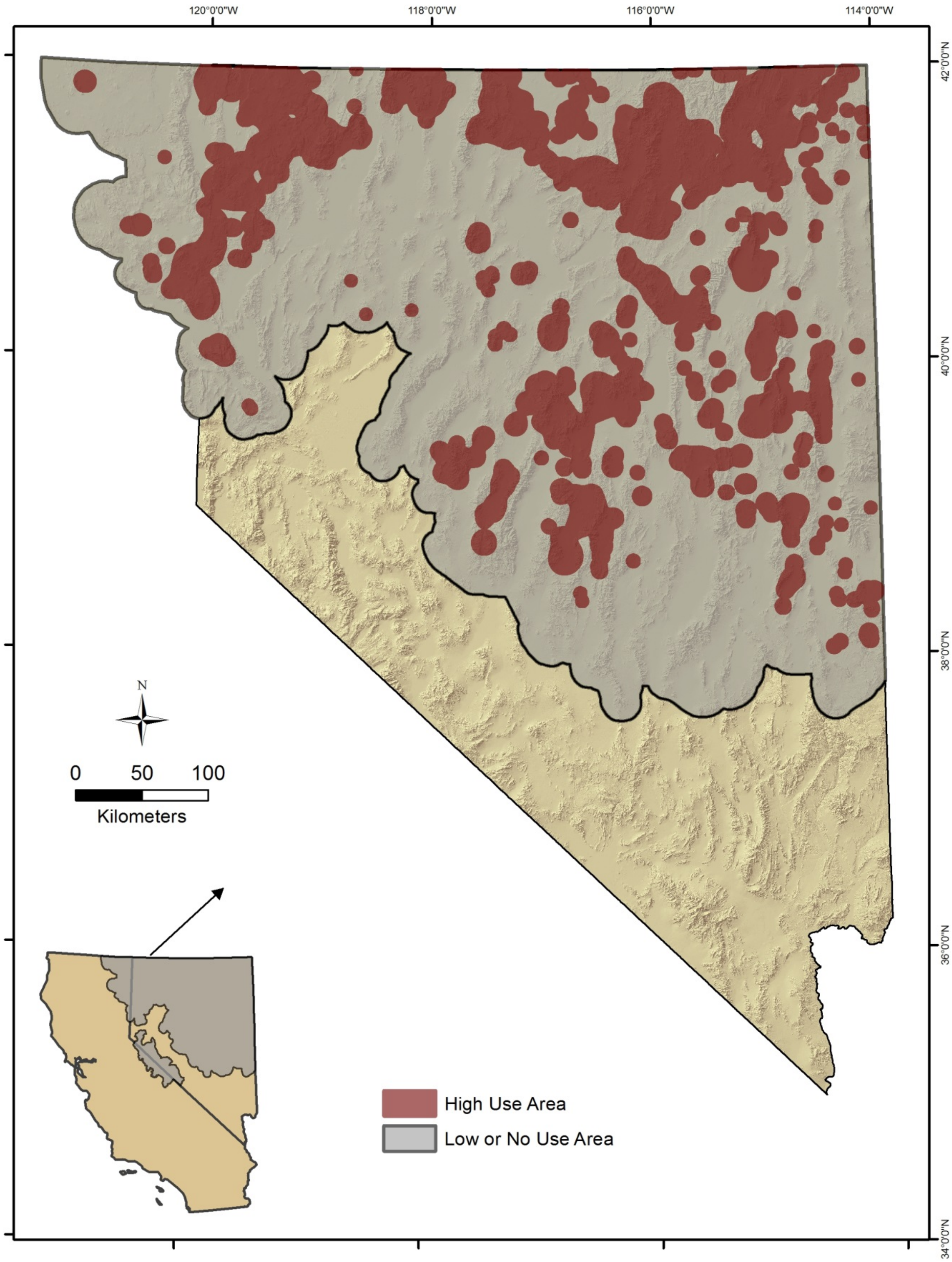

Figure 12. Map showing a space use index (SUI) that was developed compiling data on greater sage-grouse (*Centrocercus urophasianus*) use and distribution of leks, Nevada and northwestern California. Areas that contained 85 percent (%) of the total SUI density were identified as "high use" areas (reddish-brown).

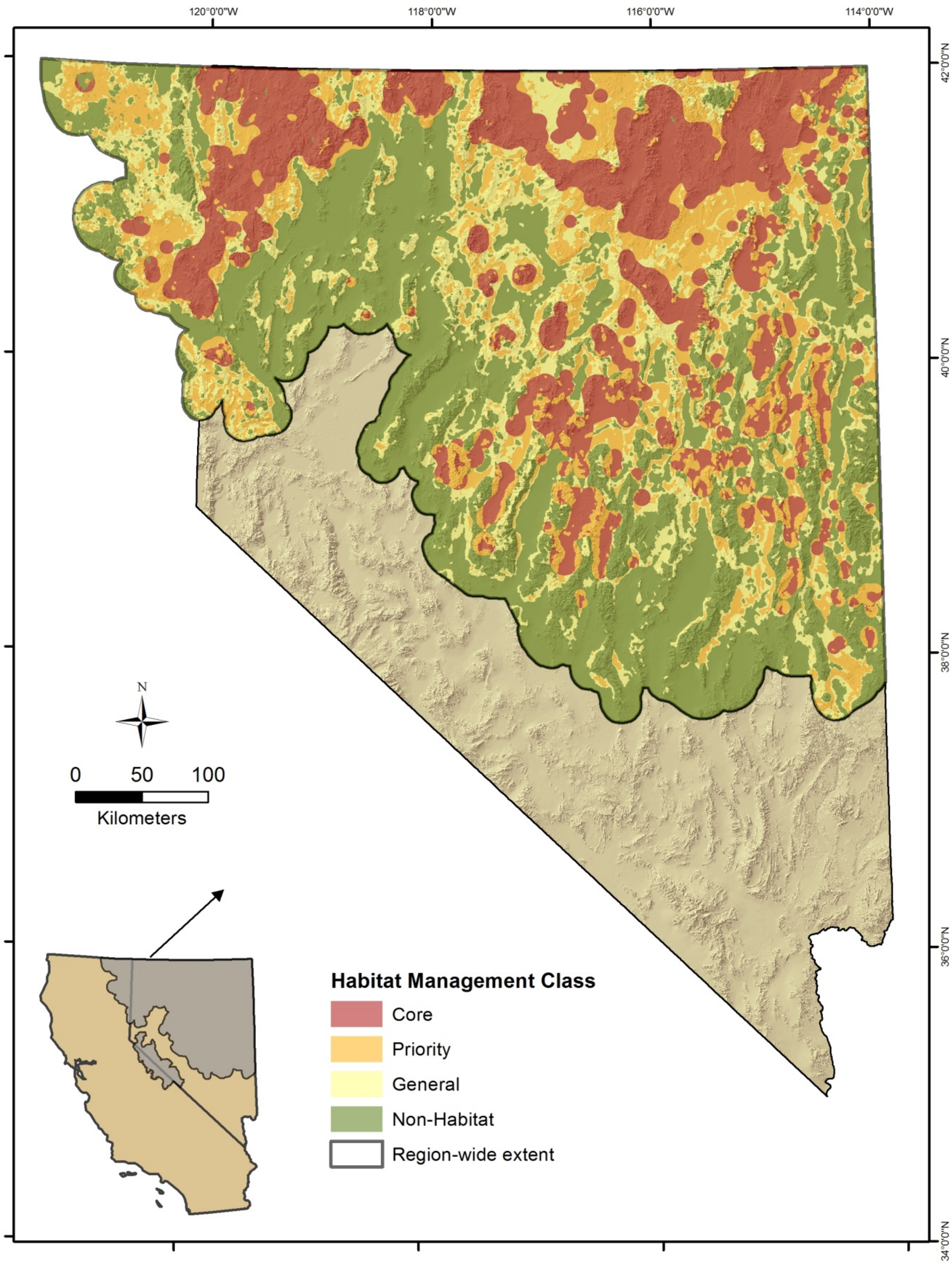

Figure 13. Map showing habitat management classes that can be determined based on the intersection of habitat suitability classes and space use index categories for greater sage grouse (*Centrocercus urophasianus*), Nevada and northeastern California.

Conclusion

This report presents a 'first of its kind' spatially explicit map of greater sage-grouse (*Centrocercus urophasianus*) habitat suitability across Nevada and northeastern California. Importantly, the map was informed by resource selection functions derived from data across multiple site-specific studies of sage-grouse and scaled up to a region-wide level as a habitat suitability index. The power of this approach rests within the map output that can be downscaled back to the local level that may help inform specific, "on the ground", habitat-management decisions. However, it is important to recognize that field data and other sources of information should be used in conjunction with inferences from this model.

The example of incorporating information about space use further improves the utility of the model for conservation planning. Merging sage-grouse space use with habitat characteristics helps to identify areas with the highest likelihood of occurrence coupled with suitable habitat so that biologically significant areas can receive conservation priority. However, it must be stressed that the habitat categories and management scenarios presented serve only as examples for the types of output that can be created with this conservation planning method. Levels of habitat suitability and frequency of space use can be reclassified readily, or other space use models could be employed (that is, other home range estimators) as might be deemed appropriate through a structured decision making process among various stakeholders in sage-grouse management. In addition, either the provided or newly generated map can be updated readily as new data become available. Further estimation of variance in habitat selection associated with life history specific habitat requirements (for example, nesting, brood rearing, overwinter) and anthropogenic disturbances (for example, power lines, energy development) would be beneficial and could also be incorporated into this model framework.

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Appendix A. Supplemental Material for Buffalo-Skedaddle RSF Modeling

Table A1. Variable selection results from the "proposal set" of variables from the Buffalo-Skedaddle subregion, Nevada and northeastern California.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Annual grass	661.4 ha	4	-34,181.4	0.0	1.0
		61.5 ha	4	-34,379.3	395.6	0.0
		Null	3	-34,400.9	436.9	0.0
		8.7 ha	4	-34,400.7	438.5	0.0
	Bare ground	61.5 ha	4	-34,387.8	0.0	1.0
		661.4 ha	4	-34,399.6	23.6	0.0
		Null	3	-34,400.9	24.1	0.0
		8.7 ha	4	-9,1626.0	114,476.3	0.0
	Cropland	661.4 ha	4	-33,830.5	0.0	1.0
		61.5 ha	4	-34,304.6	948.2	0.0
		8.7 ha	4	-34,348.4	1,035.8	0.0
		Null	3	-34,400.9	1,138.8	0.0
	Forest	661.4 ha	4	-33,470.6	0.0	1.0
		61.5 ha	4	-33,742.4	543.6	0.0
		8.7 ha	4	-33,948.6	956.1	0.0
		Null	3	-34,400.9	1,858.7	0.0
	Lowland shrub	661.4 ha	4	-34,374.1	0.0	0.93
		61.5 ha	4	-34,376.7	5.2	0.07
		8.7 ha	4	-34,388.6	28.9	0.0
		Null	3	-34,400.9	51.6	0.0
	Perennial grass	661.4 ha	4	-33,325.8	0.0	1.0
		61.5 ha	4	-34,014.7	1,377.9	0.0
		8.7 ha	4	-34,241.1	1,830.6	0.0
		Null	3	-34,400.9	2,148.3	0.0
	Pinyon-juniper	661.4 ha	4	-32,755.0	0.0	1.0
		61.5 ha	4	-32,976.5	443.1	0.0
		8.7 ha	4	-33,261.8	1,013.6	0.0
		Null	3	-34,400.9	3,289.8	0.0

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land- cover	Riparian	661.4 ha	4	-32,879.2	0.0	1.0
		61.5 ha	4	-33,578.4	1,398.5	0.0
		8.7 ha	4	-33,980.8	2,203.2	0.0
		Null	3	-34,400.9	3,041.5	0.0
	Sagebrush	8.7 ha	4	-33,784.8	0.0	0.98
		61.5 ha	4	-33,788.9	8.1	0.02
		661.4 ha	4	-34,245.8	921.9	0.0
		Null	3	-34,400.9	1,230.1	0.0
	Upland shrub	8.7 ha	4	-34,253.2	0.0	1.0
		61.5 ha	4	-34,338.3	170.2	0.0
		661.4 ha	4	-34,350.3	194.1	0.0
		Null	3	-34,400.9	293.4	0.0
	Wet meadow	8.7 ha	4	-34,193.4	0.0	0.8
		661.4 ha	4	-34,194.8	2.8	0.2
		61.5 ha	4	-34,212.9	39.1	0.0
		Null	3	-34,400.9	413.1	0.0
Agriculture	Distance to cropland	Expon. decay	4	-33,898.1	0.0	1.0
		Linear	4	-34,072.0	347.7	0.0
		Null	3	-34,400.9	1,003.6	0.0
Edge	Edge effects	661.4 ha	4	-31,631.3	0.0	1.0
		61.5 ha	4	-31,815.2	367.8	0.0
		8.7 ha	4	-32,406.5	1,550.4	0.0
		Null	3	-34,400.9	5,537.3	0.0
	Distance to edge	Expon. decay	4	-31,271.3	0.0	1.0
		Linear	4	-31,727.5	912.4	0.0
		Null	3	-34,400.9	6,257.1	0.0
Landscape variation	Variety of edge types	61.5 ha	4	-33,070.8	0.0	1.0
		8.7 ha	4	-33,230.3	318.9	0.0
		661.4 ha	4	-33,624.9	1,108.1	0.0
		Null	3	-34,400.9	2,658.1	0.0
	Variety of land cover types	61.5 ha	4	-32,507.1	0.0	1.0
		8.7 ha	4	-32,973.0	931.7	0.0
		661.4 ha	4	-33,854.0	2,693.7	0.0
		Null	3	-34,400.9	3,785.6	0.0
Water sources	Distance to spring	Linear	4	-30,963.6	0.0	1.0
	Distance to spring	Expon. decay	4	-31,349.9	772.6	0.0

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Distance to perennial stream	Expon. decay	4	-32,313.8	2,700.3	0.0
	Distance to perennial stream	Linear	4	-32,541.7	3,156.2	0.0
Water sources	Distance to intermittent stream	Expon. decay	4	-32,549.2	3,171.2	0.0
	Distance to intermittent stream	Linear	4	-33,156.8	4,386.5	0.0
	Distance to water body	Linear	4	-33,800.3	5,673.5	0.0
	Distance to nearest stream	Expon. decay	4	-33,835.4	5,743.5	0.0
	Distance to wet meadow	Linear	4	-34,196.7	6,466.2	0.0
	Distance to water body	Expon. decay	4	-34,210.3	6,493.5	0.0
	Distance to nearest stream	Linear	4	-34,284.3	6,641.4	0.0
	Distance to wet meadow	Expon. decay	4	-34,300.4	6,673.7	0.0
	Null	Null	3	-34,400.9	6,872.6	0.0
Topographic	Roughness index	1 ha	4	-28,466.5	0.0	1.0
	Elevation	Linear	4	-33,099.8	9286.3	0.0
	Topographic position index	510 m	4	-34,399.8	11,866.7	0.0
	Null		3	-34,400.9	11,866.8	0.0
	Topographic position index	2,010 m	4	-34,456.6	11,980.2	0.0

Table A2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the Buffalo-Skedaddle subregional resource selection function (RSF) model, Nevada and northeastern California.

Variable	Scale/distance function	Model averaged estimate (95-percent confidence interval)	Selection/Avoidance
Bare ground	61.5 ha	-2.89 (-3.63, -2.15)	Avoidance
Cropland	661.4 ha	1.59 (1.21, 1.97)	Selection
Forest	61.5 ha	-11.84 (-14.18, -9.51)	Avoidance
Lowland shrub	661.4 ha	-1.24 (-1.48, -1.00)	Avoidance
Perennial grass	661.4 ha	6.05 (5.30, 6.79)	Selection
Pinyon-juniper	661.4 ha	-2.47 (-2.73, -2.22)	Avoidance
Riparian	661.4 ha	-57.51 (-62.68, -52.34)	Avoidance
Sagebrush	8.7 ha	1.10 (1.03, 1.17)	Selection
Upland shrub	8.7 ha	-2.00 (-2.24, -1.75)	Avoidance
Wet meadow	8.7 ha	-11.93 (-13.69, -10.16)	Avoidance
Variety of land cover types	61.5 ha	-0.25 (-0.26, -0.24)	Avoidance
Distance to edge	Exponential decay	-1.77 (-1.85, -1.69)	Avoidance
Distance to perennial stream	Exponential decay	-1.89 (-1.99, -1.80)	Avoidance
Distance to spring	Linear	0.18 (0.17, 0.20)	Avoidance
Distance to water body	Linear	-0.07 (-0.09, -0.05)	Selection
Roughness index	1 ha	-12.68 (-13.00, -12.36)	Avoidance
Elevation	Linear	-1.53 (-1.70, -1.37)	Selection for lower elevations

Table A3. Buffalo-Skedaddle subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada and northeastern California.

Variable	Scale	Available habitats		Used habitats	
		Mean	Standard error	Mean	Standard error
Bare ground	61.5 ha	0.007	0.0003	0.004	0.0005
Cropland	661.4 ha	0.010	0.0004	0.024	0.0017
Forest	61.5 ha	0.014	0.0009	0.001	0.0002
Lowland shrub	661.4 ha	0.025	0.0009	0.020	0.0016
Perennial grass	661.4 ha	0.006	0.0002	0.017	0.0010
Pinyon-juniper	661.4 ha	0.068	0.0012	0.027	0.0021
Riparian	661.4 ha	0.003	0.0001	0.001	0.0001
Sagebrush	8.7 ha	0.823	0.0032	0.899	0.0058
Upland shrub	8.7 ha	0.015	0.0010	0.009	0.0015
Wet meadow	8.7 ha	0.007	0.0007	0.001	0.0003
Variety of land cover types	61.5 ha	3.80	0.0191	2.78	0.0371
Distance to edge	km	0.25	0.0035	0.54	0.0124
Distance to perennial stream	km	4.34	0.0003	5.88	0.0014
Distance to spring	km	2.69	0.0185	4.20	0.0468
Distance to water body	km	2.03	0.0001	1.60	0.0004
Roughness index	1 ha	0.14	0.0008	0.07	0.0014
Elevation	km	1.64	0.0001	1.57	0.0001

Appendix B. Supplemental material for Butte-Buck-White Pine RSF Modeling

Table B1. Variable selection results from the “proposal set” of variables from the Butte-Buck-White Pine subregion, Nevada.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land-cover	Annual grass	661.4 ha	4	-43,980.9	0.0	1.0
		61.5 ha	4	-44,106.0	250.1	0.0
		8.7 ha	4	-44,167.1	372.3	0.0
		Null	3	-44,236.7	509.5	0.0
	Bare ground	8.7 ha	4	-44,224.4	0.0	1.0
		61.5 ha	4	-44,234.4	20.0	0.0
		Null	3	-44,236.7	22.6	0.0
		661.4 ha	4	-44,236.2	23.7	0.0
	Cropland	661.4 ha	4	-43,256.3	0.0	1.0
		61.5 ha	4	-43,551.9	591.3	0.0
		8.7 ha	4	-43,802.2	1,091.8	0.0
		Null	3	-44,236.7	1,958.8	0.0
	Forest	8.7 ha	4	-44,185.5	0.0	1.0
		61.5 ha	4	-44,220.9	71.0	0.0
		661.4 ha	4	-44,232.5	94.1	0.0
		Null	3	-44,236.7	100.4	0.0
	Lowland shrub	61.5 ha	4	-43,475.8	0.0	1.0
		8.7 ha	4	-43,584.9	218.2	0.0
		661.4 ha	4	-43,619.9	288.1	0.0
		Null	3	-44,236.7	1,519.7	0.0
	Perennial grass	61.5 ha	4	-44,168.3	0.0	1.0
		661.4 ha	4	-44,202.2	67.7	0.0
		8.7 ha	4	-44,214.0	91.5	0.0
		Null	3	-44,236.7	134.7	0.0
	Pinyon-juniper	61.5 ha	4	-37,257.8	0.0	1.0
		8.7 ha	4	-37,911.6	1,307.6	0.0
		661.4 ha	4	-38,225.0	1,934.5	0.0
		Null	3	-44,236.7	13,955.7	0.0
	Riparian	661.4 ha	4	-44,052.0	0.0	1.0
		61.5 ha	4	-44,193.9	283.7	0.0
		8.7 ha	4	-44,235.5	366.9	0.0

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
		Null	3	-44,236.7	367.2	0.0
	Sagebrush	661.4 ha	4	-37,390.3	0.0	1.0
		61.5 ha	4	-37,804.4	828.2	0.0
		8.7 ha	4	-38,632.4	2,484.2	0.0
		Null	3	-44,236.7	13,690.6	0.0
	Upland shrub	661.4 ha	4	-44,126.9	0.0	1.0
		61.5 ha	4	-44,198.1	142.5	0.0
		8.7 ha	4	-44,224.4	195.2	0.0
		Null	3	-44,236.7	217.6	0.0
	Wet meadow	661.4 ha	4	-44,078.5	0.0	1.0
		61.5 ha	4	-44,173.1	189.2	0.0
		8.7 ha	4	-44,200.2	243.5	0.0
		Null	3	-44,236.7	314.3	0.0
Agriculture	Distance to cropland	Expon. decay	4	-41,961.8	0.0	1.0
		Linear	4	-42,223.4	523.0	0.0
		Null	3	-44,236.7	4,547.6	0.0
Edge	Edge effects	661.4 ha	4	-43,957.8	0.0	1.0
		61.5 ha	4	-44,118.4	321.2	0.0
		8.7 ha	4	-44,224.8	534.1	0.0
		Null	3	-44,236.7	555.8	0.0
	Distance to edge	Linear	4	-44,235.3	0.0	0.44
		Null	3	-44,236.7	0.8	0.29
		Expon. decay	4	-44,235.7	0.9	0.27
Landscape variation	Variety of edge types	61.5 ha	4	-44,075.0	0.0	1.0
		8.7 ha	4	-44,164.9	179.7	0.0
		661.4 ha	4	-44,231.6	313.1	0.0
		Null	3	-44,236.7	321.2	0.0
	Variety of land cover types	661.4 ha	4	-43,246.1	0.0	1.0
		61.5 ha	4	-44,174.6	1857.0	0.0
		8.7 ha	4	-44,221.9	1,951.5	0.0
		Null	3	-44,236.7	1,979.1	0.0
Water sources	Distance to intermittent stream	Linear	4	-42,153.8	0.0	1.0
	Distance to nearest stream	Linear	4	-42,219.2	130.9	0.0
	Distance to intermittent stream	Expon. decay	4	-42,781.3	1,255.0	0.0
	Distance to perennial stream	Expon. decay	4	-42,821.9	1,336.2	0.0
	Distance to nearest stream	Expon. decay	4	-42,879.6	1,451.7	0.0

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Distance to spring	Exponential decay	4	-43,134.6	1,961.7	0.0
Water sources	Distance to perennial stream	Linear	4	-43,253.8	2,200.0	0.0
	Distance to spring	Linear	4	-43,784.2	3,260.8	0.0
	Distance to wet meadow	Linear	4	-44,144.7	3,981.8	0.0
	Distance to water body	Linear	4	-44,164.5	4,021.4	0.0
	Distance to water body	Expon. decay	4	-44,189.3	4,071.1	0.0
	Distance to wet meadow	Expon. decay	4	-44,218.7	4,129.9	0.0
	Null	Null	3	-44,236.7	4,163.7	0.0
Topographic	Roughness index	1 ha	4	-43,199.6	0.0	1.0
	Topographic position index	510 m	4	-44,159.3	1,919.3	0.0
	Elevation	Linear	4	-44,202.1	2,005.0	0.0
	Topographic position index	2010 m	4	-44,236.7	2,072.1	0.0
	Null		3	-44,243.3	2,087.3	0.0

Table B2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the Butte-Buck-White Pine subregional resource selection function (RSF) model, Nevada.

Variable	Scale/distance function	Model averaged estimate (95% confidence interval)	Selection/Avoidance
Bare ground	8.7 ha	-3.48 (-4.43, -2.54)	Avoidance
Forest	8.7 ha	-1.50 (-1.81, -1.19)	Avoidance
Lowland shrub	61.5 ha	-3.66 (-3.80, -3.51)	Avoidance
Perennial grass	61.5 ha	14.90 (13.94, 15.85)	Selection
Pinyon-juniper	61.5 ha	-4.17 (-4.26, -4.07)	Avoidance
Riparian	661.4 ha	40.74 (38.74, 42.74)	Selection
Sagebrush	661.4 ha	5.47 (5.37, 5.57)	Selection
Upland shrub	661.4 ha	8.37 (7.83, 8.91)	Selection
Edge effect	661.4 ha	11.47 (11.12, 11.82)	Selection
Variety of land cover types	661.4 ha	0.50 (0.49, 0.51)	Selection
Distance to cropland	Exponential decay	2.24 (2.17, 2.31)	Selection
Distance to intermittent stream	Linear	-2.42 (-2.50, -2.34)	Selection
Distance to spring	Exponential decay	2.84 (2.76, 2.91)	Avoidance
Distance to water body	Linear	-0.10 (-0.11, -0.10)	Selection
Distance to wet meadow	Linear	0.04 (0.03, 0.04)	Avoidance
Roughness index	1 ha	2.28 (2.04, 2.52)	Selection
Topographic position index	510 m	0.009 (0.007, 0.01)	Selected ridges / Avoided valleys
Elevation	Linear	1.57 (1.49, 1.65)	Selection for higher elevation

Table B3. Butte-Buck-White Pine subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada.

Variable	Scale	Available habitats		Used habitats	
		Mean	Standard error	Mean	Standard error
Bare ground	8.7 ha	0.002	0.0002	0.0004	0.0002
Edge effect	661.4 ha	0.117	0.0005	0.150	0.0013
Forest	8.7 ha	0.009	0.0006	0.007	0.0006
Lowland shrub	61.5 ha	0.076	0.0018	0.036	0.0020
Perennial grass	61.5 ha	0.003	0.0002	0.009	0.0005
Pinyon-juniper	61.5 ha	0.316	0.0033	0.072	0.0036
Riparian	661.4 ha	0.010	0.0001	0.012	0.0003
Sagebrush	661.4 ha	0.558	0.0026	0.754	0.0040
Upland shrub	661.4 ha	0.009	0.0003	0.018	0.0007
Distance to cropland	Km	5.30	0.0325	3.54	0.0663
Variety of land cover types	661.4 ha	5.39	0.0147	6.65	0.0381
Distance to intermittent stream	Km	0.32	0.0033	0.17	0.1207
Distance to spring	Km	5.41	0.0327	3.18	0.0639
Distance to wet meadow	Km	10.34	0.0538	9.12	0.1207
Distance to water body	Km	4.16	0.0227	3.38	0.0438
Roughness index	1 ha	0.16	0.0008	0.13	0.0015
Topographic position index	510 m	-0.02	0.1430	1.37	0.2656
Elevation	Km	2.06	0.0018	2.13	0.0062

Appendix C. Supplemental Material for Cortez RSF Modeling

Table C1. Variable selection results from the “proposal set” of variables from the Cortez subregion, Nevada.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Annual grass	661.4 ha	4	-77,225.4	0.0	1.0
		61.5 ha	4	-77,774.8	1,098.8	0.0
		8.7 ha	4	-77,904.0	1,357.2	0.0
		Null	3	-78,138.5	1,824.1	0.0
	Bare ground	661.4 ha	4	-75,612.3	0.0	1.0
		61.5 ha	4	-75,973.4	722.1	0.0
		8.7 ha	4	-76,322.2	1,419.7	0.0
		Null	3	-78,138.5	5,050.3	0.0
	Cropland	661.4 ha	4	-77,406.3	0.0	1.0
		61.5 ha	4	-77,572.6	332.7	0.0
		8.7 ha	4	-77,674.5	536.3	0.0
		Null	3	-78,138.5	1,462.4	0.0
	Forest	61.5 ha	4	-78,008.3	0.0	1.0
		8.7 ha	4	-78,089.1	161.6	0.0
		661.4 ha	4	-78,092.0	167.4	0.0
		Null	3	-78,138.5	258.4	0.0
	Lowland shrub	661.4 ha	4	-76,255.9	0.0	1.0
		61.5 ha	4	-76,781.9	1,052.0	0.0
		8.7 ha	4	-77,006.2	1,500.7	0.0
		Null	3	-78,138.5	3,763.2	0.0
	Perennial grass	61.5 ha	4	-78,125.2	0.0	1.0
		8.7 ha	4	-78,136.3	22.1	0.0
		Null	3	-78,138.5	24.5	0.0
		661.4 ha	4	-78,137.7	24.9	0.0
	Pinyon-juniper	61.5 ha	4	-76,096.2	0.0	1.0
		661.4 ha	4	-76,108.8	25.0	0.0
		8.7 ha	4	-76,324.8	457.1	0.0
		Null	3	-78,138.5	4,082.5	0.0
	Riparian	661.4 ha	4	-77,558.5	0.0	1.0
		61.5 ha	4	-77,626.5	136.1	0.0
		8.7 ha	4	-77,766.0	415.1	0.0
		Null	3	-78,138.5	1,158.0	0.0

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Sagebrush	661.4 ha	4	-74,476.9	0.0	1.0
		61.5 ha	4	-74,551.1	148.3	0.0
		8.7 ha	4	-74,759.7	565.5	0.0
		Null	3	-78,138.5	7,321.1	0.0
	Upland shrub	8.7 ha	4	-77,990.3	0.0	1.0
		61.5 ha	4	-78,029.8	78.9	0.0
		661.4 ha	4	-78,137.4	294.1	0.0
		Null	3	-78,138.5	294.3	0.0
	Wet meadow	661.4 ha	4	-78,057.5	0.0	1.0
		Null	3	-78,138.5	160.0	0.0
		8.7 ha	4	-78,137.7	160.3	0.0
		61.5 ha	4	-78,137.7	160.4	0.0
Agriculture	Distance to cropland	Expon. decay	4	-78,091.8	0.0	1.0
		Linear	4	-78,128.9	74.2	0.0
		Null	3	-78,138.5	91.4	0.0
Edge	Edge effects	661.4 ha	4	-77,328.9	0.0	1.0
		61.5 ha	4	-77,743.5	829.2	0.0
		8.7 ha	4	-77,918.1	1,178.5	0.0
		Null	3	-78,138.5	1,617.1	0.0
	Distance to edge	Linear	4	-77,676.7	0.0	1.0
		Expon. decay	4	-77,838.2	323.0	0.0
		Null	3	-78,138.5	921.5	0.0
Landscape variation	Variety of edge types	661.4 ha	4	-77,168.2	0.0	1.0
		61.5 ha	4	-77,887.7	1,439.0	0.0
		8.7 ha	4	-78,062.8	1,789.2	0.0
		Null	3	-78,138.5	1,938.6	0.0
	Variety of land cover types	661.4 ha	4	-77,243.7	0.0	1.0
		8.7 ha	4	-78,116.6	1,745.8	0.0
		61.5 ha	4	-78,128.4	1,769.4	0.0
		Null	3	-78,138.5	1,787.6	0.0
Water sources	Distance to perennial stream	Linear	4	-74,243.3	0.0	1.0
	Distance to perennial stream	Expon. decay	4	-74,549.4	612.2	0.0
	Distance to spring	Expon. decay	4	-75,276.4	2,066.3	0.0
	Distance to spring	Linear	4	-75,799.1	3,111.6	0.0
	Distance to nearest stream	Linear	4	-76,307.6	4,128.5	0.0
	Distance to intermittent stream	Linear	4	-76,628.3	4,770.0	0.0

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Distance to nearest stream	Expon. decay	4	-77,301.1	6,115.6	0.0
	Distance to intermittent stream	Expon. decay	4	-77,626.9	6,767.1	0.0
	Distance to wet meadow	Expon. decay	4	-77,768.8	7,051.0	0.0
	Distance to wet meadow	Linear	4	-77,955.0	7,423.5	0.0
	Distance to water body	Linear	4	-77,985.9	7,485.2	0.0
	Distance to water body	Expon. decay	4	-78,132.4	7,778.2	0.0
	Null	Null	3	-78,138.5	7,788.4	0.0
Topography	Elevation	Linear	4	-75,718.7	0.0	1.0
	Roughness index	1 ha	4	-77,228.9	3,020.4	0.0
	Topographic position index	510 m	4	-78,136.9	4,836.3	0.0
	Null		3	-78,138.5	4,837.5	0.0
	Topographic position index	2010 m	4	-78,284.9	5,132.3	0.0

Table C2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the Cortez subregional resource selection function (RSF) model, Nevada

Variable	Scale/distance function	Model averaged estimate (95% confidence interval)	Selection/Avoidance
Bare ground	661.4 ha	-15.24 (-16.00, -14.48)	Avoidance
Cropland	661.4 ha	-6.39 (-6.83, -5.94)	Avoidance
Lowland shrub	661.4 ha	-6.27 (-6.47, -6.06)	Avoidance
Perennial grass	61.5 ha	0.71 (0.55, 0.87)	Selection
Pinyon-juniper	61.5 ha	-2.89 (-2.96, -2.82)	Avoidance
Riparian	661.4 ha	-33.51 (-34.93, -32.09)	Avoidance
Sagebrush	661.4 ha	2.35 (2.29, 2.41)	Selection
Upland shrub	8.7 ha	-6.13 (-6.89, -5.38)	Avoidance
Edge effect	661.4 ha	4.84 (4.68, 4.99)	Selection
Variety of edge types	661.4 ha	0.12 (0.116, 0.123)	Selection
Distance to perennial stream	Linear	-0.14 (-0.15, -0.14)	Selection
Distance to spring	Expon. decay	2.05 (2.01, 2.10)	Selection
Distance to water body	Linear	-0.09 (-0.10, -0.09)	Selection
Distance to wet meadow	Linear	-2.19 (-2.27, -2.11)	Selection
Roughness index	1 ha	3.76 (3.63, 3.90)	Selection
Elevation	Linear	3.26 (3.19, 3.33)	Selection for higher elevations

Table C3. Cortez subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada

Variable	Scale	Available habitats Mean	Available habitats Standard error	Used habitats Mean	Used habitats Standard error
Bare ground	661.4 ha	0.048	0.0012	0.003	0.0003
Cropland	661.4 ha	0.020	0.0006	0.004	0.0003
Lowland shrub	661.4 ha	0.050	0.0007	0.015	0.0007
Perennial grass	61.5 ha	0.020	0.0005	0.015	0.0009
Pinyon-juniper	61.5 ha	0.135	0.0018	0.034	0.0018
Riparian	661.4 ha	0.006	0.0001	0.004	0.0001
Sagebrush	661.4 ha	0.686	0.0019	0.855	0.0025
Upland shrub	8.7 ha	0.003	0.0003	0.0006	0.0001
Edge effect	661.4 ha	0.116	0.0006	0.127	0.0013
Variety of edge types	661.4 ha	6.98	0.0285	7.45	0.0607
Distance to perennial stream	Km	7.43	0.0309	5.55	0.0602
Distance to spring	Km	3.07	0.0150	2.50	0.0294
Distance to water body	Km	4.97	0.0208	5.09	0.0374
Distance to wet meadow	Km	9.56	0.0290	10.03	0.0558
Roughness	1 ha	0.14	0.0007	0.16	0.0011
Elevation	Km	1.92	0.0013	1.99	0.0032

Appendix D. Supplemental Material for Desert-Tuscarora RSF Modeling

Table D1. Variable selection results from the "proposal set" of variables from the Desert-Tuscarora subregion, Nevada.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land-cover	Annual grass	661.4 ha	4	-52,893.7	0.0	1.0
		61.5 ha	4	-54,780.3	3,773.1	0.0
		8.7 ha	4	-55,275.5	4,763.6	0.0
		Null	3	-56,394.5	6,999.5	0.0
	Bare ground	661.4 ha	4	-56,239.7	0.0	1.0
		61.5 ha	4	-56,353.4	227.4	0.0
		8.7 ha	4	-56,385.8	292.2	0.0
		Null	3	-56,394.5	307.5	0.0
	Cropland	661.4 ha	4	-55,243.5	0.0	1.0
		61.5 ha	4	-55,675.4	863.9	0.0
		8.7 ha	4	-55,832.3	1,177.5	0.0
		Null	3	-56,394.5	2,299.9	0.0
	Forest	61.5 ha	4	-55,515.5	0.0	1.0
		661.4 ha	4	-55,542.9	54.8	0.0
		8.7 ha	4	-55,597.7	164.3	0.0
		Null	3	-56,394.5	1,755.9	0.0
	Lowland shrub	661.4 ha	4	-56,172.6	0.0	1.0
		61.5 ha	4	-56,273.9	202.6	0.0
		8.7 ha	4	-56,308.7	272.3	0.0
		Null	3	-56,394.5	441.8	0.0
	Perennial grass	661.4 ha	4	-56,115.9	0.0	1.0
		61.5 ha	4	-56,245.4	258.9	0.0
		8.7 ha	4	-56,324.8	417.8	0.0
		Null	3	-56,394.5	555.1	0.0
	Pinyon-juniper	61.5 ha	4	-55,831.4	0.0	1.0
		661.4 ha	4	-55,880.9	99.0	0.0
		8.7 ha	4	-55,968.8	274.8	0.0
		Null	3	-56,394.5	1,124.1	0.0
	Riparian	661.4 ha	4	-56,344.3	0.0	1.0
		61.5 ha	4	-56,362.0	35.2	0.0
		8.7 ha	4	-56,384.9	81.1	0.0
		Null	3	-56,394.5	98.2	0.0

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Sagebrush	8.7 ha	4	-56,373.7	0.0	0.9986
		61.5 ha	4	-56,380.3	13.2	0.0014
		661.4 ha	4	-56,392.9	38.5	0.0
		Null	3	-56,394.5	39.6	0.0
	Upland shrub	661.4 ha	4	-56,242.2	0.0	1.0
		61.5 ha	4	-56,383.6	282.7	0.0
		Null	3	-56,394.5	302.5	0.0
		8.7 ha	4	-1,466,256	2,820,027.0	0.0
	Wet meadow	661.4 ha	4	-56,280.8	0.0	1.0
		8.7 ha	4	-56,390.7	219.7	0.0
		61.5 ha	4	-56,391.7	221.7	0.0
		Null	3	-56,394.5	225.3	0.0
Agriculture	Distance to cropland	Linear	4	-54,776.6	0.0	1.0
		Expon. Decay	4	-54,809.9	66.5	0.0
		Null	3	-56,394.5	3,233.7	0.0
Edge	Edge effects	61.5 ha	4	-56,239.3	0.0	1.0
		8.7 ha	4	-56,273.1	67.5	0.0
		661.4 ha	4	-56,300.9	123.1	0.0
		Null	3	-56,394.5	308.2	0.0
	Distance to edge	Linear	4	-56,201.2	0.0	1.0
		Expon. Decay	4	-56,393.3	384.2	0.0
		Null	3	-56,394.5	384.6	0.0
Landscape variation	Variety of edge types	61.5 ha	4	-56,274.4	0.0	1.0
		8.7 ha	4	-56,307.5	66.2	0.0
		661.4 ha	4	-56,376.0	203.2	0.0
		Null	3	-56,394.5	238.0	0.0
	Variety of land cover types	61.5 ha	4	-56,339.6	0.0	1.0
		661.4 ha	4	-56,365.3	51.4	0.0
		8.7 ha	4	-56,370.0	60.8	0.0
		Null	3	-56,394.5	107.8	0.0
Water sources	Distance to wet meadow	Linear	4	-48,894.1	0.0	1.0
	Distance to nearest stream	Linear	4	-53,448.4	9,108.5	0.0
	Distance to wet meadow	Expon. Decay	4	-53,712.7	9,637.2	0.0
	Distance to nearest stream	Expon. Decay	4	-54,668.6	11,548.9	0.0
	Distance to intermittent stream	Expon. Decay	4	-55,166.7	12,545.2	0.0
	Distance to intermittent stream	Linear	4	-55,269.2	12,750.2	0.0
	Distance to spring	Linear	4	-55,453.6	13,118.9	0.0

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Water sources	Distance to water body	Expon. Decay	4	-55,500.6	13,213.0	0.0
	Distance to perennial Stream	Expon. Decay	4	-55,548.7	13,309.1	0.0
	Distance to spring	Expon. Decay	4	-56,185.9	14,583.5	0.0
	Distance to perennial stream	Linear	4	-56,315.5	14,842.7	0.0
	Distance to water body	Linear	4	-56,353.2	14,918.3	0.0
	Null	Null	3	-56,394.5	14,998.7	0.0
Topography	Roughness index	1 ha	4	-53,854.4	0.0	1.0
	Elevation	Linear	4	-56,043.5	4,378.1	0.0
	Topographic position index	510 m	4	-56,190.2	4,671.6	0.0
	Null		3	-56,394.5	5,078.1	0.0
	Topographic position index	2010 m	4	-56,429.1	5,149.3	0.0

Table D2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the Desert-Tuscarora subregional resource selection function (RSF) model, Nevada.

Variable	Scale/distance function	Model averaged estimate (95% confidence interval)	Selection/Avoidance
Annual grass	661.4 ha	-42.68 (-44.82, -40.55)	Avoidance
Bare ground	661.4 ha	-40.89 (-46.19, -35.58)	Avoidance
Forest	61.5 ha	-10.67 (-11.30, -10.03)	Avoidance
Lowland shrub	661.4 ha	-3.21 (-4.21, -2.20)	Avoidance
Perennial grass	661.4 ha	-6.51 (-7.10, -5.92)	Avoidance
Pinyon-juniper	61.5 ha	-6.24 (-6.61, -5.86)	Avoidance
Riparian	661.4 ha	-3.34 (-3.83, -2.86)	Avoidance
Sagebrush	8.7 ha	0.65 (0.60, 0.70)	Selection
Upland shrub	661.4 ha	-18.16 (-19.99, -16.33)	Avoidance
Variety of edge types	61.5 ha	-0.09 (-0.09, -0.08)	Avoidance
Distance to cropland	Linear	-0.17 (-0.18, -0.16)	Selection
Distance to edge	Linear	-0.74 (-0.84, -0.64)	Selection
Distance to nearest stream	Linear	2.69 (2.61, 2.77)	Avoidance
Distance to spring	Linear	-0.10 (-0.11, -0.09)	Selection
Distance to water body	Expon. Decay	-2.56 (-2.64, -2.48)	Selection
Distance to wet meadow	Linear	-0.13 (-0.14, -0.13)	Selection
Roughness index	1 ha	-5.49 (-5.69, -5.29)	Avoidance
Topographic position index	510 m	0.009 (0.009, 0.01)	Selected ridges / Avoided valleys
Elevation	Linear	-2.24 (-2.33, -2.14)	Selection for Lower Elevations

Table D3. Desert-Tuscarora subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada.

Variable	Scale	Available habitats		Used habitats	
		Mean	Standard error	Mean	Standard error
Annual grass	661.4 ha	0.014	0.0003	0.004	0.0001
Bare ground	661.4 ha	0.002	0.0001	0.0008	0.0000
Forest	61.5 ha	0.015	0.0005	0.003	0.0003
Lowland shrub	661.4 ha	0.004	0.0002	0.0004	0.0002
Perennial grass	661.4 ha	0.027	0.0002	0.026	0.0004
Pinyon-juniper	61.5 ha	0.022	0.0004	0.013	0.0005
Riparian	661.4 ha	0.023	0.0003	0.027	0.0005
Upland shrub	661.4 ha	0.003	0.0001	0.001	0.0001
Sagebrush	8.7 ha	0.854	0.0019	0.845	0.0050
Distance to cropland	Km	2.30	0.0129	1.78	0.0279
Variety of edge types	61.5 ha	3.83	0.0197	3.63	0.0427
Distance to edge	Km	0.14	0.0013	0.14	0.0022
Distance to nearest stream	Km	0.20	0.0012	0.30	0.0038
Distance to spring	Km	2.00	0.0130	1.72	0.0169
Distance to water body	Km	3.23	0.0168	3.36	0.0266
Distance to wet meadow	Km	13.22	0.0654	6.96	0.0614
Roughness index	1 ha	0.20	0.0006	0.16	0.0012
Topographic position index	510 m	-0.07	0.1459	2.69	0.2543
Elevation	Km	1.93	0.0015	1.90	0.0022

Appendix E. Supplemental Material for Gollaher-O'Neil RSF Modeling

Table E1. Variable selection results from the "proposal set" of variables from the Gollaher-O'Neil subregion, Nevada.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Annual grass	661.4 ha	4	-40,679.6	0.0	1.0
		61.5 ha	4	-40,836.8	314.4	0.0
		8.7 ha	4	-40,845.8	332.4	0.0
		Null	3	-40,861.0	360.9	0.0
	Bare ground	661.4 ha	4	-40,238.0	0.0	1.0
		61.5 ha	4	-40,756.0	1,035.9	0.0
		8.7 ha	4	-40,832.0	1,187.9	0.0
		Null	3	-40,861.0	1,244.0	0.0
	Cropland	661.4 ha	4	-39,985.7	0.0	1.0
		61.5 ha	4	-40,535.5	1,099.6	0.0
		8.7 ha	4	-40,635.0	1,298.6	0.0
		Null	3	-40,861.0	1,748.7	0.0
	Forest	661.4 ha	4	-39,276.3	0.0	1.0
		61.5 ha	4	-39,770.1	987.6	0.0
		8.7 ha	4	-40,176.3	1,800.0	0.0
		Null	3	-40,861.0	3,167.5	0.0
	Lowland shrub	661.4 ha	4	-39,179.8	0.0	1.0
		61.5 ha	4	-39,803.7	1,247.8	0.0
		8.7 ha	4	-40,216.0	2,072.4	0.0
		Null	3	-40,861.0	3,360.4	0.0
	Perennial grass	661.4 ha	4	-40,102.6	0.0	1.0
		8.7 ha	4	-40,573.1	941.1	0.0
		61.5 ha	4	-40,611.8	1,018.4	0.0
		Null	3	-40,861.0	1,514.9	0.0
	Pinyon-juniper	661.4 ha	4	-39,837.9	0.0	1.0
		61.5 ha	4	-40,733.0	1,790.2	0.0
		8.7 ha	4	-40,825.3	1,974.8	0.0
		Null	3	-40,861.0	2,044.3	0.0
	Riparian	661.4 ha	4	-39,795.3	0.0	1.0
		61.5 ha	4	-39,817.2	43.7	0.0
		8.7 ha	4	-40,116.6	642.5	0.0
		Null	3	-40,861.0	2,129.4	0.0

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Sagebrush	661.4 ha	4	-39,375.7	0.0	1.0
		61.5 ha	4	-39,429.8	108.1	0.0
		8.7 ha	4	-39,809.8	868.0	0.0
		Null	3	-40,861.0	2,968.6	0.0
	Upland shrub	661.4 ha	4	-40,728.1	0.0	1.0
		61.5 ha	4	-40,784.0	111.9	0.0
		8.7 ha	4	-40,829.4	202.7	0.0
		Null	3	-40,861.0	263.9	0.0
Agriculture	Distance to cropland	Linear	4	-38,573.2	0.0	1.0
		Expon. decay	4	-40,091.9	3,037.4	0.0
		Null	3	-40,861.0	4,573.7	0.0
Edge	Edge effects	61.5 ha	4	-39,709.7	0.0	1.0
		661.4 ha	4	-39,792.5	165.6	0.0
		8.7 ha	4	-40,109.4	799.4	0.0
		Null	3	-40,861.0	2,300.6	0.0
	Distance to edge	Expon. decay	4	-39,801.5	0.0	1.0
		Linear	4	-40,179.1	755.1	0.0
		Null	3	-40,861.0	2,117.0	0.0
Landscape variation	Variety of edge types	661.4 ha	4	-39,413.5	0.0	1.0
		61.5 ha	4	-39,572.8	318.6	0.0
		8.7 ha	4	-39,738.0	649.0	0.0
		Null	3	-40,861.0	2,893.1	0.0
	Variety of land cover types	8.7 ha	4	-39,554.7	0.0	1.0
		61.5 ha	4	-39,741.3	373.3	0.0
		661.4 ha	4	-40,614.3	2,119.2	0.0
		Null	3	-40,861.0	2,610.7	0.0
Water source	Distance to intermittent stream	Linear	4	-37,343.6	0.0	1.0
	Distance to intermittent stream	Expon. decay	4	-37,854.2	1,021.3	0.0
	Distance to wet meadow	Linear	4	-38,690.8	2,694.4	0.0
	Distance to nearest stream	Linear	4	-38,705.3	2,723.4	0.0
	Distance to nearest stream	Expon. decay	4	-39,289.1	3,891.0	0.0
	Distance to wet meadow	Expon. decay	4	-39,427.8	4,168.4	0.0
	Distance to spring	Expon. decay	4	-40,084.8	5,482.5	0.0
	Distance to water body	Linear	4	-40,368.7	6,050.2	0.0
	Distance to spring	Linear	4	-40,501.4	6,315.6	0.0
	Distance to water body	Expon. decay	4	-40,638.4	6,589.6	0.0

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Distance to perennial stream	Linear	4	-40,758.3	6,829.3	0.0
	Null	Null	3	-40,861.0	7,032.9	0.0
	Distance to perennial stream	Expon. decay	4	-40,861.0	7,034.9	0.0
Topography	Elevation	Linear	4	-39,028.3	0.0	1.0
	Roughness Index	1 ha	4	-39,744.7	1,432.8	0.0
	Topographic position index	2010 m	4	-40,600.8	3,144.9	0.0
	Topographic position index	510 m	3	-40,803.9	3,551.3	0.0
	Null		4	-40,861.0	3,663.5	0.0

Table E2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the Gollaher-O'Neil subregional resource selection function (RSF) model, Nevada.

Variable	Scale/distance function	Model averaged estimate (95% confidence interval)	Selection/Avoidance
Forest	661.4 ha	-19.56 (-20.62, -18.49)	Avoidance
Riparian	661.4 ha	-21.72 (-22.55, -20.89)	Avoidance
Sagebrush	661.4 ha	9.09 (8.75, 9.42)	Selection
Upland shrub	661.4 ha	-12.09 (-13.62, -10.57)	Avoidance
Edge effects	61.5 ha	-4.59 (-4.78, -4.39)	Avoidance
Variety of edge types	661.4 ha	-0.21 (-0.21, -0.20)	Avoidance
Distance to cropland	Linear	-0.34 (-0.35, -0.33)	Selection
Distance to intermittent stream	Linear	2.81 (2.74, 2.88)	Avoidance
Distance to spring	Exponential decay	-1.06 (-1.15, -0.98)	Avoidance
Distance to water body	Linear	-0.12 (-0.14, -0.11)	Selection
Roughness index	1 ha	-5.66 (-5.90, -5.43)	Avoidance
Topographic position index	2010 m	0.005 (0.004, 0.005)	Selected ridges / Avoided valleys
Elevation	Linear	-1.99 (-2.08, -1.90)	Selection for Lower Elevations

Table E3. Gollaher-O'Neil subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada.

Variable	Scale	Available habitats		Used habitats	
		Mean	Standard error	Mean	Standard error
Forest	661.4 ha	0.023	0.0007	0.003	0.0003
Riparian	661.4 ha	0.026	0.0004	0.012	0.0004
Sagebrush	661.4 ha	0.890	0.0012	0.933	0.0010
Upland shrub	661.4 ha	0.005	0.0001	0.004	0.0003
Edge effects	61.5 ha	0.12	0.0010	0.08	0.0018
Variety of edge types	661.4 ha	5.96	0.0287	4.77	0.0490
Distance to cropland	Km	2.49	0.0188	1.58	0.0202
Distance to intermittent stream	Km	0.25	0.0023	0.39	0.0078
Distance to spring	Km	2.49	0.0163	2.62	0.0336
Distance to water body	Km	2.07	0.0127	1.95	0.0212
Roughness index	1 ha	0.18	0.0008	0.16	0.0015
Topographic position index	2010 m	-0.27	0.3952	6.17	0.6330
Elevation	Km	1.94	0.0023	1.84	0.0037

Appendix F. Supplemental Material for Lincoln-Schell-Snake RSF Modeling

Table F1. Variable selection results from the “proposal set” of variables from the Lincoln-Schell-Snake subregion, Nevada.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Annual grass	661.4 ha	4	-13,552.1	0.0	1.0
		61.5 ha	4	-13,568.1	31.9	0.0
		8.7 ha	4	-13,581.8	59.4	0.0
		Null	3	-13,606.5	106.7	0.0
	Bare ground	661.4 ha	4	-13,171.4	0.0	1.0
		61.5 ha	4	-13,244.4	146.0	0.0
		8.7 ha	4	-13,383.1	423.4	0.0
		Null	3	-13,606.5	868.2	0.0
	Cropland	661.4 ha	4	-11,792.0	0.0	1.0
		61.5 ha	4	-12,162.7	741.4	0.0
		8.7 ha	4	-12,383.0	1,181.9	0.0
		Null	3	-13,606.5	3,626.9	0.0
	Forest	661.4 ha	4	-12,920.6	0.0	1.0
		61.5 ha	4	-13,036.1	231.0	0.0
		8.7 ha	4	-13,135.5	429.9	0.0
		Null	3	-13,606.5	1,369.8	0.0
	Lowland shrub	8.7 ha	4	-13,544.2	0.0	1.0
		61.5 ha	4	-13,554.5	20.7	0.0
		Null	3	-13,606.5	122.6	0.0
		661.4 ha	4	-13,606.4	124.5	0.0
	Perennial grass	661.4 ha	4	-12,535.4	0.0	1.0
		61.5 ha	4	-12,692.8	314.8	0.0
		8.7 ha	4	-13,009.3	947.7	0.0
		Null	3	-13,606.5	2,140.1	0.0
	Pinyon-juniper	61.5 ha	4	-11,412.7	0.0	1.0
		8.7 ha	4	-11,520.4	215.5	0.0
		661.4 ha	4	-11,559.2	293.0	0.0
		Null	3	-13,606.5	4385.5	0.0
	Riparian	661.4 ha	4	-13,262.4	0.0	1.0
		8.7 ha	4	-13,372.6	220.5	0.0
		61.5 ha	4	-13,389.6	254.4	0.0
		Null	3	-13,606.5	686.1	0.0

Group	Variable	Scale/distance function	K	Log Likelihood	ΔAICc	Model Weight
	Sagebrush	661.4 ha	4	-12,227.2	0.0	1.0
		61.5 ha	4	-12,597.8	741.2	0.0
		8.7 ha	4	-12,703.4	952.4	0.0
		Null	3	-13,606.5	2,756.5	0.0
	Upland shrub	61.5 ha	4	-13,545.1	0.0	1.0
		8.7 ha	4	-13,561.6	33.0	0.0
		661.4 ha	4	-13,573.6	57.1	0.0
		Null	3	-13,606.5	120.8	0.0
	Wet Meadow	661.4 ha	4	-12,561.4	0.0	1.0
		61.5 ha	4	-13,063.7	1,004.5	0.0
		8.7 ha	4	-13,385.3	1,647.8	0.0
		Null	3	-13,606.5	2,088.2	0.0
Agriculture	Distance to cropland	Expon. decay	4	-11,806.1	0.0	0.98
		Linear	4	-11,810.3	8.3	0.02
		Null	3	-13,606.5	3,598.7	0.0
Edge	Edge effects	661.4 ha	4	-13,348.6	0.0	1.0
		61.5 ha	4	-13,575.3	453.4	0.0
		8.7 ha	4	-13,603.1	509.0	0.0
		Null	3	-13,606.5	513.8	0.0
	Distance to edge	Expon. decay	4	-13,574.8	0.0	0.64
		Linear	4	-13,575.3	1.1	0.36
		Null	3	-13,606.5	61.5	0.0
Landscape variation	Variety of edge types	661.4 ha	4	-13,013.2	0.0	1.0
		61.5 ha	4	-13,371.7	717.1	0.0
		8.7 ha	4	-13,563.4	1,100.4	0.0
		Null	3	-13,606.5	1,184.6	0.0
	Variety of land cover types	661.4 ha	4	-12,769.2	0.0	1.0
		61.5 ha	4	-13,455.1	1,371.8	0.0
		8.7 ha	4	-13,571.8	1,605.2	0.0
		Null	3	-13,606.5	1,672.5	0.0
Water source	Distance to water body	Linear	4	-11,831.9	0.0	1.0
	Distance to water body	Expon. decay	4	-11,945.6	2,27.3	0.0
	Distance to wet meadow	Expon. decay	4	-12,845.2	2,026.5	0.0
	Distance to wet meadow	Linear	4	-13,198.9	2,733.8	0.0
	Distance to perennial stream	Linear	4	-13,441.2	3,218.4	0.0
	Distance to spring	Linear	4	-13,473.8	3,283.7	0.0
	Distance to intermittent stream	Expon. decay	4	-13,546.7	3,429.5	0.0

Group	Variable	Scale/distance function	K	Log Likelihood	ΔAICc	Model Weight
	Distance to Spring	Expon. decay	4	-13,547.5	3,431.0	0.0
	Distance to Perennial Stream	Expon. decay	4	-13,552.0	3,440.1	0.0
	Distance to Nearest Stream	Expon. decay	4	-13,585.8	3,507.8	0.0
	Distance to Nearest Stream	Linear	4	-13,603.9	3,543.9	0.0
	Null	Null	3	-13,606.5	3,547.1	0.0
	Distance to Intermittent Stream	Linear	4	-13,606.3	3,548.7	0.0
Topography	Roughness Index	1 ha	4	-12,298.3	0.0	1.0
	Elevation	Linear	4	-13,001.8	1,380.5	0.0
	Topographic Position Index	510 m	4	-13,590.3	2,583.9	0.0
	Null		3	-13,606.5	2,614.4	0.0
	Topographic Position Index	2010 m	4	-13,635.4	2,674.3	0.0

Table F2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the Lincoln-Schell-Snake subregional resource selection function (RSF) model, Nevada.

Variable	Scale/distance function	Model averaged estimate (95% confidence interval)	Selection/Avoidance
Cropland	661.4 ha	21.42 (20.58, 22.26)	Selection
Forest	661.4 ha	-5.96 (-6.35, -5.56)	Avoidance
Lowland shrub	8.7 ha	-1.35 (-1.45, -1.25)	Avoidance
Perennial grass	661.4 ha	37.62 (35.99, 39.26)	Selection
Pinyon-juniper	61.5 ha	-3.79 (-3.97, -3.61)	Avoidance
Riparian	661.4 ha	-8.25 (-9.72, -6.78)	Avoidance
Sagebrush	661.4 ha	4.68 (4.53, 4.84)	Selection
Upland shrub	61.5 ha	-4.27 (-5.01, -3.52)	Avoidance
Edge effects	661.4 ha	12.58 (11.97, 13.18)	Selection
Variety of land cover types	661.4 ha	0.47 (0.45, 0.49)	Selection
Distance to perennial stream	Linear	-0.12 (-0.13, -0.11)	Selection
Distance to spring	Linear	-0.17 (-0.18, -0.16)	Selection
Distance to water body	Linear	-0.57 (-0.59, -0.55)	Selection
Distance to wet meadow	Exponential decay	3.41 (3.28, 3.54)	Selection
Roughness index	1 ha	-10.87 (-11.28, -10.45)	Avoidance
Topographic position index	510 m	0.005 (0.003, 0.007)	Selected ridges / Avoided valleys
Elevation	Linear	-1.21 (-1.31, -1.11)	Selection for Higher Elevations

Table F3. Lincoln-Schell-Snake subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada.

Variable	Scale	Available habitats		Used habitats	
		Mean	Standard error	Mean	Standard error
Cropland	661.4 ha	0.008	0.0005	0.115	0.0045
Forest	661.4 ha	0.081	0.0026	0.012	0.0016
Lowland shrub	8.7 ha	0.138	0.0049	0.115	0.0083
Perennial grass	661.4 ha	0.005	0.0003	0.047	0.0026
Pinyon-juniper	61.5 ha	0.314	0.0059	0.033	0.0044
Riparian	661.4 ha	0.017	0.0004	0.011	0.0007
Sagebrush	661.4 ha	0.405	0.0045	0.563	0.0093
Upland shrub	61.5 ha	0.013	0.0010	0.005	0.0011
Edge effects	661.4 ha	0.11	0.0009	0.15	0.0022
Variety of land cover types	661.4 ha	5.39	0.0289	7.39	0.0810
Distance to perennial stream	Km	4.62	0.0512	3.58	0.0814
Distance to spring	Km	3.43	0.0404	2.51	0.0624
Distance to water body	Km	4.03	0.0353	1.75	0.0555
Distance to wet meadow	Km	11.90	0.1191	7.38	0.2442
Roughness index	1 ha	0.18	0.0016	0.10	0.0021
Topographic position index	510 m	-0.53	0.3133	0.70	0.3097
Elevation	Km	2.11	0.0053	1.94	0.0088

Appendix G. Supplemental Material for Lone Willow RSF Modeling

Table G1. Variable selection results from the “proposal set” of variables from the Lone Willow subregion, Nevada.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Annual grass	661.4 ha	4	-3,066.1	0.0	1.00
		61.5 ha	4	-3,113.8	95.4	0.00
		8.7 ha	4	-3,131.2	130.2	0.00
		Null	3	-3,188.5	242.8	0.00
	Bare ground	61.5 ha	4	-3,170.1	0.0	0.90
		661.4 ha	4	-3,172.2	4.3	0.10
		8.7 ha	4	-3,180.1	20.1	0.00
		Null	3	-3,188.5	34.8	0.00
	Cropland	661.4 ha	4	-3,116.0	0.0	1.00
		61.5 ha	4	-3,129.4	26.9	0.00
		8.7 ha	4	-3,131.7	31.5	0.00
		Null	3	-3,188.5	143.0	0.00
	Forest	8.7 ha	4	-3,174.2	0.0	0.56
		661.4 ha	4	-3,174.7	1.0	0.34
		61.5 ha	4	-3,176.0	3.5	0.10
		Null	3	-3,188.5	26.6	0.00
	Lowland shrub	661.4 ha	4	-3,120.4	0.0	1.00
		61.5 ha	4	-3,157.8	74.9	0.00
		8.7 ha	4	-3,161.9	83.0	0.00
		Null	3	-3,188.5	134.2	0.00
	Perennial grass	661.4 ha	4	-3,121.1	0.0	1.00
		61.5 ha	4	-3,158.4	74.6	0.00
		8.7 ha	4	-3,177.5	112.8	0.00
		Null	3	-3,188.5	132.7	0.00
	Pinyon-juniper	661.4 ha	4	-3,146.9	0.0	1.00
		61.5 ha	4	-3,180.9	67.9	0.00
		Null	3	-3,188.5	81.1	0.00
		8.7 ha	4	-3,188.5	83.1	0.00
	Riparian	61.5 ha	4	-3,186.1	0.0	0.47
		8.7 ha	4	-3,186.4	0.5	0.37
		Null	3	-3,188.5	2.7	0.12
		661.4 ha	4	-3,188.5	4.7	0.04

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Sagebrush	661.4 ha	4	-3,149.4	0.0	1.00
		8.7 ha	4	-3,158.4	18.0	0.00
		61.5 ha	4	-3,167.6	36.3	0.00
		Null	3	-3,188.5	76.1	0.00
	Upland shrub	661.4 ha	4	-3,097.0	0.0	1.00
		61.5 ha	4	-3,130.7	67.4	0.00
		8.7 ha	4	-3,154.4	114.9	0.00
		Null	3	-3,188.5	180.9	0.00
	Wet meadow	661.4 ha	4	-3,129.0	0.0	1.00
		61.5 ha	4	-3,168.9	79.9	0.00
		8.7 ha	4	-3,184.0	110.0	0.00
		Null	3	-3,188.5	117.0	0.00
Agriculture	Distance to cropland	Linear	4	-3,184.2	0.0	0.91
		Expon. decay	4	-3,187.0	5.7	0.05
		Null	3	-3,188.5	6.6	0.03
Edge	Edge effects	661.4 ha	4	-2,930.4	0.0	1.00
		61.5 ha	4	-3,062.3	263.7	0.00
		8.7 ha	4	-3,114.0	367.1	0.00
		Null	3	-3,188.5	514.1	0.00
	Distance to edge	Expon. decay	4	-3,129.3	0.0	0.63
		Linear	4	-3,129.8	1.1	0.37
		Null	3	-3,188.5	116.3	0.00
Landscape variation	Variety of edge types	661.4 ha	4	-3,034.4	0.0	1.00
		61.5 ha	4	-3,090.4	112.0	0.00
		8.7 ha	4	-3,101.5	134.3	0.00
		Null	3	-3,188.5	306.2	0.00
	Variety of land cover types	661.4 ha	4	-3,049.3	0.0	1.00
		8.7 ha	4	-3,115.6	132.6	0.00
		61.5 ha	4	-3,134.2	169.7	0.00
		Null	3	-3,188.5	276.3	0.00
Water source	Distance to wet meadow	Linear	4	-3,002.3	0.0	1.00
	Distance to spring	Linear	4	-3,014.1	23.7	0.00
	Distance to spring	Expon. decay	4	-3,024.5	44.4	0.00
	Distance to wet meadow	Expon. decay	4	-3,046.5	88.5	0.00
	Distance to water body	Linear	4	-3,076.2	147.9	0.00
	Distance to water body	Expon. decay	4	-3,108.7	212.9	0.00
	Distance to perennial stream	Linear	4	-3,129.7	254.8	0.00
	Distance to perennial stream	Expon. decay	4	-3,134.8	265.1	0.00

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Distance to nearest stream	Expon. decay	4	-3,181.5	358.5	0.00
	Distance to intermittent stream	Expon. decay	4	-3,182.6	360.7	0.00
	Null	Null	3	-3,188.5	370.4	0.00
	Distance to nearest stream	Linear	4	-3,188.4	372.3	0.00
	Distance to intermittent stream	Linear	4	-3,188.5	372.4	0.00
Topography	Elevation	Linear	4	-2,759.4	0.0	1.00
	Topographic position index	2010 m	4	-3,144.6	770.3	0.00
	Roughness index	1 ha	4	-3,181.1	843.3	0.00
	Topographic position index	510 m	4	-3,186.7	854.6	0.00
	Null		3	-3,188.5	856.1	0.00

Table G2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the Lone Willow subregional resource selection function (RSF) model, Nevada.

Variable	Scale/distance function	Model averaged estimate (95% confidence interval)	Selection/Avoidance
Annual grass	661.4 ha	-1.26 (-1.70, -0.82)	Avoidance
Bare ground	61.5 ha	5.29 (3.63, 6.94)	Selection
Lowland shrub	661.4 ha	2.28 (1.25, 3.31)	Selection
Sagebrush	661.4 ha	4.72 (4.16, 5.29)	Selection
Upland shrub	661.4 ha	-1.59 (-3.04, -0.13)	Avoidance
Edge effects	661.4 ha	7.52 (6.47, 8.57)	Selection
Variety of edge types	661.4 ha	0.13 (0.11, 0.15)	Selection
Distance to perennial stream	Linear	-0.09 (-0.11, -0.08)	Selection
Distance to spring	Linear	-0.21 (-0.27, -0.15)	Selection
Distance to water body	Linear	-0.27 (-0.33, -0.22)	Selection
Distance to wet meadow	Linear	-0.20 (-0.26, -0.13)	Selection
Roughness index	1 ha	-1.28 (-2.07, -0.48)	Avoidance
Topographic position index	2010 m	-0.003 (-0.005, -0.002)	Avoided ridges / Selected valleys
Elevation	Linear	4.06 (3.70, 4.43)	Selection for Higher Elevations

Table G3. Lone Willow subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada.

Variable	Scale	Available habitats		Used habitats	
		Mean	Standard error	Mean	Standard error
Annual grass	661.4 ha	0.107	0.0059	0.039	0.0064
Bare ground	61.5 ha	0.007	0.0009	0.011	0.0031
Edge effects	661.4 ha	0.129	0.0020	0.174	0.0037
Lowland shrub	661.4 ha	0.034	0.0028	0.014	0.0032
Sagebrush	661.4 ha	0.693	0.0070	0.749	0.0094
Upland shrub	661.4 ha	0.018	0.0012	0.037	0.0036
Variety of edge types	661.4 ha	7.38	0.0975	8.82	0.1664
Distance to perennial stream	Km	4.89	0.1048	3.82	0.2056
Distance to spring	Km	1.98	0.0376	1.40	0.0632
Distance to water body	Km	2.38	0.0378	1.86	0.0597
Distance to wet meadow	Km	1.91	0.0369	1.28	0.0571
Roughness index	1 ha	0.17	0.0025	0.17	0.0047
Topographic position index	2010 m	-0.95	1.4400	13.77	3.1791
Elevation	Km	1.68	0.059	1.84	0.0110

Appendix H. Supplemental Material for Midway RSF Modeling

Table H1. Variable selection results from the "proposal set" of variables from the Midway subregion, Nevada.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land- cover	Annual grass	61.5 ha	3	-8,485.2	0.0	0.9582
		8.7 ha	3	-8,488.7	6.9	0.0303
		Null	2	-8,491.1	9.7	0.0074
		661.4 ha	3	-8,490.7	11.0	0.0040
	Bare ground	8.7 ha	4	-8,489.0	0.0	0.4243
		Null	2	-8,491.1	0.1	0.4034
		61.5 ha	4	-8,490.3	2.7	0.1115
		661.4 ha	4	-8,490.9	3.9	0.0609
	Cropland	661.4 ha	4	-7,629.6	0.0	0.9992
		61.5 ha	4	-7,636.7	14.1	0.0008
		8.7 ha	4	-7,858.7	458.1	0.0000
		Null	2	-8,491.1	1,718.9	0.0000
	Forest	61.5 ha	3	-8,356.3	0.0	1.0000
		8.7 ha	3	-8,399.8	87.0	0.0000
		661.4 ha	3	-8,435.0	157.5	0.0000
		Null	2	-8,491.1	267.6	0.0000
	Lowland shrub	661.4 ha	3	-7,753.5	0.0	1.0000
		61.5 ha	3	-8,246.8	986.5	0.0000
		8.7 ha	3	-8,276.4	1,045.7	0.0000
		Null	2	-8,491.1	1,473.1	0.0000
	Perennial grass	61.5 ha	3	-8,486.2	0.0	0.9108
		661.4 ha	3	-8,488.9	5.4	0.0618
		Null	2	-8,491.1	7.6	0.0199
		8.7 ha	3	-8,491.0	9.6	0.0074
	Pinyon-juniper	661.4 ha	3	-7,115.7	0.0	1.0000
		61.5 ha	3	-7,143.4	55.5	0.0000
		8.7 ha	3	-7,388.0	544.6	0.0000
		Null	2	-8,491.1	2,748.7	0.0000
	Riparian	61.5 ha	3	-8,400.8	0.0	1.0000
		8.7 ha	3	-8,438.7	75.7	0.0000
		661.4 ha	3	-8,475.7	149.8	0.0000
		Null	2	-8,491.1	178.5	0.0000
	Sagebrush	661.4 ha	4	-8,457.8	0.0	1.0000

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
		8.7 ha	4	-8,478.5	41.4	0.0000
		61.5 ha	4	-8,481.8	48.0	0.0000
		Null	2	-8,491.1	62.5	0.0000
	Upland shrub	61.5 ha	3	-8,429.7	0.0	1.0000
		8.7 ha	3	-8,466.1	72.6	0.0000
		661.4 ha	3	-8,488.0	116.5	0.0000
		Null	2	-8,491.1	120.6	0.0000
	Wet meadow	661.4 ha	3	-7,922.4	0.0	1.0000
		61.5 ha	3	-8,313.6	782.4	0.0000
		8.7 ha	3	-8,490.0	1,135.2	0.0000
		Null	2	-8,491.1	1,135.3	0.0000
Agriculture	Distance to cropland	Expon. decay	3	-8,341.2	0.0	1.0000
		Linear	3	-8,371.7	61.0	0.0000
		Null	2	-8,491.1	297.8	0.0000
Edge	Edge effects	661.4 ha	3	-,8442.5	0.0	1.0000
		8.7 ha	3	-8,480.3	75.5	0.0000
		61.5 ha	3	-8,486.5	88.0	0.0000
		Null	2	-8,491.1	95.1	0.0000
	Distance to edge	Expon. decay	3	-8,449.5	0.0	1.0000
		Linear	3	-8,474.7	50.4	0.0000
		Null	2	-8,491.1	81.2	0.0000
Landscape variation	Variety of edge types	61.5 ha	3	-8,452.1	0.0	0.9989
		661.4 ha	3	-8,459.0	13.8	0.0010
		8.7 ha	3	-8,462.0	19.8	0.0001
		Null	2	-8,491.0	75.8	0.0000
	Variety of land cover types	661.4 ha	3	-8,222.5	0.0	1.0000
		8.7 ha	3	-8,374.2	303.4	0.0000
		61.5 ha	3	-8,377.6	310.1	0.0000
		Null	2	-8,491.1	535.1	0.0000
Water sources	Distance to perennial stream	Expon. decay	3	-6,874.0	0.0	1.0000
	Distance to perennial stream	Linear	3	-6,898.7	49.2	0.0000
	Distance to water body	Expon. decay	3	-7,302.3	856.5	0.0000
	Distance to water body	Linear	3	-7,519.7	1,291.3	0.0000
	Distance to spring	Expon. decay	3	-8,227.0	2,706.0	0.0000
	Distance to spring	Linear	3	-8,312.4	2,876.7	0.0000
	Distance to wet Meadow	Expon. decay	3	-8,330.9	2,913.8	0.0000
	Distance to Wet Meadow	Linear	3	-8,348.9	2,949.7	0.0000

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Distance to Nearest Stream	Linear	3	-8,361.8	2,975.4	0.0000
	Distance to Nearest Stream	Expon. decay	3	-8,418.1	3,088.2	0.0000
	Distance to Intermittent Stream	Linear	3	-8,445.9	3,143.7	0.0000
	Distance to Intermittent Stream	Expon. decay	3	-8,480.2	3,212.4	0.0000
	Null	Null	2	-8,491.1	3,232.0	0.0000
Topography	Roughness Index	1 ha	3	-7,521.8	0.0	1.0000
	Elevation	Linear	3	-7,983.2	922.8	0.0000
	Topographic Position Index	2010 m	3	-8,392.4	1,741.1	0.0000
	Topographic Position Index	510 m	3	-8,486.5	1,929.5	0.0000
	Null		2	-8,491.1	1,936.5	0.0000

Table H2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the Midway subregional resource selection function (RSF) model, Nevada.

Variable	Scale/distance function	Model averaged estimate (95% confidence interval)	Selection/Avoidance
Annual grass	61.5 ha	-6.32 (-11.82, -0.82)	Avoidance
Cropland	661.4 ha	14.20 (12.94, 15.47)	Selection
Forest	61.5 ha	-42.07 (-51.78, -32.37)	Avoidance
Lowland shrubs	661.4 ha	1.92 (1.75, 2.09)	Selection
Perennial grass	Linear	-7.82 (-10.95, -4.69)	Avoidance
Pinyon-juniper	Linear	-13.63 (-14.57, -12.68)	Avoidance
Riparian	Linear	-2.68 (-4.38, -0.98)	Avoidance
Sagebrush	661.4 ha	0.98 (0.8, 1.15)	Selection
Edge effects	661.4 ha	-7.51 (-8.43, -6.58)	Avoidance
Distance to edge	Expon. Decay	-0.37 (-0.50, -0.24)	Avoidance
Variety of land cover types	661.4 ha	0.26 (0.24, 0.28)	Selection
Distance to perennial stream	Expon. Decay	5.21 (5, 5.43)	Selection
Distance to spring	Expon. Decay	3.91 (3.70, 4.13)	Selection
Distance to water body	Expon. Decay	3.95 (3.76, 4.15)	Selection
Distance to wet meadow	Expon. Decay	17.86 (16.21, 19.50)	Selection
Roughness index	1 ha	-14.59 (-15.37, -13.81)	Avoidance
Topographic position index	2010 m	-0.006 (-0.007, -0.004)	Avoided Ridges / Selected Valleys
Elevation	Linear	-4.06 (-4.32, -3.79)	Selection for Lower Elevations

Table H3. Midway subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada.

Variable	Scale	Available habitats		Used habitats	
		Mean	Standard error	Mean	Standard error
Annual grass	61.5 ha	0.001	0.0002	0.0007	0.0001
Cropland	661.4 ha	0.006	0.0005	0.038	0.0016
Forest	61.5 ha	0.010	0.0009	0.0003	0.0001
Lowland shrubs	661.4 ha	0.169	0.0034	0.347	0.0072
Perennial grass	61.5 ha	0.003	0.0003	0.004	0.0005
Pinyon-juniper	661.4 ha	0.177	0.0033	0.014	0.0012
Riparian	61.5 ha	0.004	0.0002	0.010	0.0011
Sagebrush	661.4 ha	0.624	0.0039	0.584	0.0067
Edge effects	661.4 ha	0.13	0.0007	0.14	0.0017
Distance to edge	Km	0.15	0.0025	0.13	0.0054
Variety of land cover types	661.4 ha	5.24	0.0206	6.16	0.0755
Distance to perennial stream	Km	8.49	0.0656	3.71	0.1068
Distance to spring	Km	4.72	0.0341	3.82	0.0795
Distance to water body	Km	4.42	0.0407	2.25	0.0611
Distance to wet meadow	Km	10.55	0.1796	6.85	0.0656
Roughness index	1 ha	0.15	0.0012	0.09	0.0015
Topographic position index	2010 m	-0.63	0.5626	-8.80	0.4314
Elevation	Km	2.00	0.0027	1.90	0.0055

Appendix I. Supplemental Material for Sheldon RSF Modeling

Table I1. Variable selection results from the "proposal set" of variables from the Sheldon subregion, Nevada.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Annual grass	61.5 ha	4	-712.8	0.0	0.2921
		661.4 ha	4	-712.9	0.1	0.2722
		Null	3	-713.9	0.3	0.2527
		8.7 ha	4	-713.2	0.9	0.1830
	Bare ground	8.7 ha	4	-711.2	0.0	0.6708
		661.4 ha	4	-712.5	2.7	0.1724
		Null	3	-713.9	3.5	0.1150
		61.5 ha	4	-713.9	5.6	0.0418
	Cropland	661.4 ha	4	-709.1	0.0	0.9649
		Null	3	-713.9	7.7	0.0203
		61.5 ha	4	-713.2	8.4	0.0147
		8.7 ha	No Cropland at 9ha scale			
	Forest	61.5 ha	4	-712.0	0.0	0.5465
		Null	3	-713.9	1.9	0.2084
		8.7 ha	4	-713.2	2.4	0.1617
		661.4 ha	4	-713.8	3.8	0.0834
	Lowland shrub	Null	3	-713.9	0.0	0.4027
		661.4 ha	4	-713.4	1.0	0.2415
		61.5 ha	4	-713.7	1.6	0.1811
		8.7 ha	4	-713.8	1.7	0.1746
	Perennial grass	8.7 ha	4	-712.3	0.0	0.3720
		61.5 ha	4	-712.7	0.9	0.2396
		661.4 ha	4	-712.9	1.3	0.1945
		Null	3	-713.9	1.3	0.1939
	Pinyon-juniper	661.4 ha	4	-712.6	0.0	0.3884
		Null	3	-713.9	0.6	0.2875
		61.5 ha	4	-713.2	1.1	0.2199
		8.7 ha	4	-713.9	2.6	0.1042
	Riparian	Null	3	-713.9	0.0	0.3553
		8.7 ha	4	-713.2	0.6	0.2573
		661.4 ha	4	-713.3	0.8	0.2382
		61.5 ha	4	-713.8	1.7	0.1492

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Sagebrush	661.4 ha	4	-712.8	0.0	0.3451
		Null	3	-713.9	0.2	0.3163
		8.7 ha	4	-713.3	0.9	0.2241
		61.5 ha	4	-713.9	2.2	0.1145
	Upland shrub	661.4 ha	4	-711.0	0.0	0.6913
		8.7 ha	4	-712.6	3.3	0.1359
		Null	3	-713.9	3.9	0.0963
		61.5 ha	4	-713.2	4.4	0.0766
	Wet meadow	Null	3	-713.9	0.0	0.3135
		8.7 ha	4	-713.0	0.1	0.2931
		61.5 ha	4	-713.3	0.8	0.2127
		661.4 ha	4	-713.5	1.1	0.1807
Agriculture	Distance to cropland	Expon. decay	4	-711.6	0.0	0.6977
		Null	3	-713.9	2.6	0.1876
		Linear	4	-713.4	3.6	0.1147
Edge	Edge effects	661.4 ha	4	-706.4	0.0	0.9193
		61.5 ha	4	-709.0	5.1	0.0729
		8.7 ha	4	-711.4	9.9	0.0065
		Null	3	-713.9	13.0	0.0014
	Distance to edge	Expon. decay	4	-710.8	0.0	0.8100
		Null	3	-713.9	4.3	0.0960
		Linear	4	-712.9	4.3	0.0940
Landscape variation	Variety of edge types	8.7 ha	4	-707.7	0.0	0.5500
		661.4 ha	4	-708.0	0.5	0.4326
		61.5 ha	4	-711.4	7.3	0.0144
		Null	3	-713.9	10.4	0.0030
	Variety of land cover types	8.7 ha	4	-704.9	0.0	0.9954
		661.4 ha	4	-710.7	11.7	0.0029
		61.5 ha	4	-711.4	13.1	0.0014
		Null	3	-713.9	16.1	0.0003
Water source	Distance to perennial stream	Expon. decay	4	-709.2	0.0	0.4544
	Distance to water body	Expon. decay	4	-710.1	1.8	0.1830
	Distance to water body	Linear	4	-710.9	3.4	0.0833
	Distance to spring	Expon. decay	4	-710.9	3.4	0.0819
	Distance to wet meadow	Linear	4	-711.2	4.0	0.0608
	Distance to spring	Linear	4	-711.8	5.2	0.0329
	Distance to perennial stream	Linear	4	-711.8	5.3	0.0317
	Distance to wet meadow	Expon. decay	4	-712.5	6.6	0.0165

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Null	Null	3	-713.9	7.5	0.0106
	Distance to intermittent stream	Expon. decay	4	-713.7	9.0	0.0051
	Distance to nearest stream	Expon. decay	4	-713.7	9.1	0.0048
	Distance to intermittent stream	Linear	4	-713.9	9.5	0.0040
	Distance to nearest stream	Linear	4	-713.9	9.5	0.0038
Topography	Topographic position index	2010 m	4	-707.6	0.0	0.8649
	Elevation	Linear	4	-709.6	4.0	0.1175
	Roughness index	1 ha	4	-712.1	9.0	0.0098
	Null		3	-713.9	10.7	0.0041
	Topographic position index	510 m	4	-713.0	10.9	0.0037

Table I2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the Sheldon subregional resource selection function (RSF) model, Nevada.

Variable	Scale/distance function	Model averaged estimate (95% confidence interval)	Selection/Avoidance
Upland shrubs	661.4 ha	-5.25 (-8.31, -2.19)	Avoidance
Edge effects	661.4 ha	-5.11 (-7.48, -2.75)	Avoidance
Variety of land cover types	8.7 ha	-0.39 (-0.55, -0.22)	Avoidance
Distance to perennial stream	Exponential decay	-1.15 (-1.86, -0.44)	Avoidance
Distance to water body	Exponential decay	0.77 (0.21, 1.33)	Selection
Topographic position index	2010 m	0.01 (0.005, 0.015)	Selected ridges/ Avoided valleys
Elevation	Linear	4.52 (2.87, 6.16)	Selection for Higher Elevations

Table I3. Sheldon subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada.

Variable	Scale	Available habitats		Used habitats	
		Mean	Standard error	Mean	Standard error
Upland shrubs	661.4 ha	0.021	0.0028	0.017	0.0052
Edge effects	661.4 ha	0.063	0.0029	0.058	0.0057
Variety of land cover types	8.7 ha	1.59	0.0425	1.48	0.0836
Distance to perennial stream	Km	8.31	0.1930	8.80	0.3469
Distance to spring	Km	3.25	0.0980	3.23	0.2042
Distance to water body	Km	1.82	0.0669	1.66	0.1500
Topographic position index	2010 m	0.26	1.234	6.09	3.1746
Elevation	Km	1.84	0.0052	1.87	0.0042

Appendix J. Supplemental material for South Fork-Ruby Valley RSF modeling

Table J1. Variable selection results from the “proposal set” of variables from the South Fork-Ruby Valley subregion, Nevada.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Annual grass	661.4 ha	4	-4,771.8	0.0	1.0000
		61.5 ha	4	-4,806.2	68.8	0.0000
		8.7 ha	4	-4,815.9	88.0	0.0000
		Null	3	-4,879.6	213.5	0.0000
	Bare ground	661.4 ha	4	-4,524.7	0.0	1.0000
		61.5 ha	4	-4,697.9	346.5	0.0000
		8.7 ha	4	-4,762.2	475.0	0.0000
		Null	3	-4,879.6	707.8	0.0000
	Cropland	8.7 ha	4	-4,858.7	0.0	1.0000
		661.4 ha	4	-4,875.0	32.6	0.0000
		61.5 ha	4	-4,877.5	37.5	0.0000
		Null	3	-4,879.6	39.7	0.0000
	Forest	661.4 ha	4	-4,676.0	0.0	0.9999
		61.5 ha	4	-4,685.4	18.7	0.0001
		8.7 ha	4	-4,697.6	43.1	0.0000
		Null	3	-4,879.6	405.1	0.0000
	Lowland shrub	661.4 ha	4	-4,792.9	0.0	1.0000
		61.5 ha	4	-4,807.1	28.4	0.0000
		8.7 ha	4	-4,820.7	55.7	0.0000
		Null	3	-4,879.6	171.4	0.0000
	Perennial grass	661.4 ha	4	-4,839.3	0.0	1.0000
		61.5 ha	4	-4,871.9	65.1	0.0000
		8.7 ha	4	-4,872.8	67.0	0.0000
		Null	3	-4,879.6	78.5	0.0000
	Pinyon-juniper	61.5 ha	4	-4,723.8	0.0	1.0000
		661.4 ha	4	-4,759.7	71.8	0.0000
		8.7 ha	4	-4,767.9	88.2	0.0000
		Null	3	-4,879.6	309.5	0.0000
	Riparian	661.4 ha	4	-4,756.2	0.0	1.0000
		61.5 ha	4	-4,788.6	64.9	0.0000
		8.7 ha	4	-4,842.3	172.1	0.0000
		Null	3	-4,879.6	244.7	0.0000

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Sagebrush	661.4 ha	4	-4,329.6	0.0	1.0000
		61.5 ha	4	-4,387.8	116.4	0.0000
		8.7 ha	4	-4,411.1	163.0	0.0000
		Null	3	-4,879.6	1097.9	0.0000
	Upland shrub	8.7 ha	4	-4,751.7	0.0	1.0000
		661.4 ha	4	-4,762.3	21.2	0.0000
		61.5 ha	4	-4,826.4	149.3	0.0000
		Null	3	-4,879.6	253.7	0.0000
	Wet meadow	61.5 ha	4	-4,858.7	0.0	0.9982
		661.4 ha	4	-4,865.0	12.6	0.0018
		8.7 ha	4	-4,875.1	32.8	0.0000
		Null	3	-4,879.6	39.8	0.0000
Agriculture	Distance to cropland	Expon. decay	4	-4,877.6	0.0	0.5677
		Linear	4	-4,878.6	1.9	0.2180
		Null	3	-4,879.6	1.9	0.2143
Edge	Edge effects	661.4 ha	4	-4,666.1	0.0	1.0000
		61.5 ha	4	-4,779.4	226.5	0.0000
		8.7 ha	4	-4,796.0	259.6	0.0000
		Null	3	-4,879.6	424.9	0.0000
	Distance to edge	Linear	4	-4,863.8	0.0	0.5357
		Expon. decay	4	-4,863.9	0.3	0.4643
		Null	3	-4,879.6	29.6	0.0000
Landscape variation	Variety of edge types	8.7 ha	4	-4,825.0	0.0	0.9801
		61.5 ha	4	-4,828.9	7.8	0.0199
		661.4 ha	4	-4,861.4	72.7	0.0000
		Null	3	-4,879.6	107.1	0.0000
	Variety of land cover types	8.7 ha	4	-4,772.8	0.0	1.0000
		61.5 ha	4	-4,818.2	90.7	0.0000
		661.4 ha	4	-4,874.0	202.4	0.0000
		Null	3	-4,879.6	211.6	0.0000
Water source	Distance to water body	Expon. decay	4	-4,760.0	0.0	1.0000
	Distance to nearest stream	Expon. decay	4	-4,787.2	54.4	0.0000
	Distance to spring	Linear	4	-4,836.6	153.2	0.0000
	Distance to water body	Linear	4	-4,839.3	158.6	0.0000
	Distance to nearest stream	Linear	4	-4,844.4	168.9	0.0000
	Distance to intermittent stream	Linear	4	-4,846.1	172.2	0.0000
	Distance to intermittent stream	Expon. decay	4	-4,847.0	174.1	0.0000

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Distance to wet meadow	Linear	4	-4,856.5	192.9	0.0000
	Distance to spring	Expon. decay	4	-4,866.1	212.1	0.0000
	Distance to perennial stream	Expon. decay	4	-4,873.8	227.6	0.0000
	Distance to wet meadow	Expon. decay	4	-4,877.6	235.2	0.0000
	Null	Null	3	-4,879.6	237.2	0.0000
	Distance to perennial stream	Linear	4	-4,879.4	238.9	0.0000
Topography	Roughness index	1 ha	4	-4,788.5	0.0	1.0000
	Elevation	Linear	4	-4,843.9	111.0	0.0000
	Topographic position index	2010 m	4	-4,871.7	166.5	0.0000
	Null		3	-4,879.6	180.2	0.0000
	Topographic position index	510 m	4	-4,879.1	181.2	0.0000

Table J2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the South Fork-Ruby Valley subregional resource selection function (RSF) model, Nevada.

Variable	Scale/distance function	Model averaged estimate (95% confidence interval)	Selection/Avoidance
Annual grass	661.4 ha	-18.77 (-22.97, -14.57)	Avoidance
Cropland	8.7 ha	0.74 (0.41, 1.08)	Selection
Forest	661.4 ha	-3.98 (-5.16, -2.80)	Avoidance
Lowland shrubs	661.4 ha	-0.86 (-1.57, -0.15)	Avoidance
Perennial grass	661.4 ha	2.13 (0.84, 3.42)	Selection
Pinyon-juniper	61.5 ha	-17.31 (-21.23, -13.39)	Avoidance
Sagebrush	661.4 ha	3.77 (3.50, 4.04)	Selection
Distance to nearest stream	Exponential decay	0.94 (0.76, 1.13)	Selection
Distance to spring	Linear	0.01 (0.002, 0.020)	Avoidance
Distance to water body	Exponential decay	-0.35 (-0.59, -0.11)	Avoidance
Roughness index	1 ha	-2.34 (-2.94, -1.73)	Avoidance
Topographic position index	2010 m	-0.002 (-0.002, -0.001)	Avoided ridges / Selected valleys
Elevation	Linear	0.44 (0.22, 0.67)	Selection for higher elevations

Table J3. South Fork-Ruby Valley subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada.

Variable	Scale	Available habitats		Used habitats	
		Mean	Standard error	Mean	Standard error
Annual grass	661.4 ha	0.0233	0.0024	0.0034	0.0007
Cropland	8.7 ha	0.0624	0.0074	0.0357	0.0114
Forest	661.4 ha	0.0575	0.0033	0.0150	0.0025
Lowland shrubs	661.4 ha	0.0725	0.0055	0.0209	0.0047
Perennial grass	661.4 ha	0.0334	0.0019	0.0176	0.0031
Pinyon-juniper	61.5 ha	0.0375	0.0045	0.0046	0.0016
Sagebrush	661.4 ha	0.6043	0.0088	0.8105	0.0142
Edge effects	661.4 ha	0.17	0.0029	0.13	0.0045
Distance to water body	Km	2.50	0.0716	2.95	0.0641
Distance to nearest stream	Km	0.45	0.0096	0.55	0.0222
Distance to spring	Km	5.24	0.1617	6.15	0.4236
Roughness index	1 ha	0.16	0.004	0.12	0.0055
Topographic position index	2010 m	-1.94	2.1853	-8.00	2.2769
Elevation	Km	2.00	0.0110	1.94	0.0101

Appendix K. Supplemental Material for Toiyabe RSF Modeling

Table K1. Variable selection results from the “proposal set” of variables from the Toiyabe subregion, Nevada.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Annual grass	8.7 ha	4	-48,876.8	0.0	1.0000
		61.5 ha	4	-48,886.9	20.2	0.0000
		661.4 ha	4	-48,892.2	30.8	0.0000
		Null	3	-48,901.5	47.5	0.0000
	Bare ground	661.4 ha	4	-48,735.8	0.0	1.0000
		61.5 ha	4	-48,752.3	32.9	0.0000
		8.7 ha	4	-48,844.0	216.3	0.0000
		Null	3	-48,901.5	329.5	0.0000
	Cropland	61.5 ha	4	-48,818.2	0.0	0.9999
		8.7 ha	4	-48,827.9	19.4	0.0001
		661.4 ha	4	-48,899.5	162.7	0.0000
		Null	3	-48,901.5	164.6	0.0000
	Forest	661.4 ha	4	-48,840.4	0.0	1.0000
		8.7 ha	4	-48,860.8	40.8	0.0000
		61.5 ha	4	-48,884.4	88.0	0.0000
		Null	3	-48,901.5	120.3	0.0000
	Lowland shrub	661.4 ha	4	-45,850.6	0.0	1.0000
		61.5 ha	4	-46,806.1	1,911.1	0.0000
		8.7 ha	4	-47,254.2	2,807.2	0.0000
		Null	3	-48,901.5	6,099.9	0.0000
	Perennial grass	61.5 ha	4	-48,849.8	0.0	1.0000
		8.7 ha	4	-48,867.4	35.2	0.0000
		661.4 ha	4	-48,897.0	94.4	0.0000
		Null	3	-48,901.5	101.4	0.0000
	Pinyon-juniper	61.5 ha	4	-44,548.9	0.0	1.0000
		661.4 ha	4	-44,793.6	489.4	0.0000
		8.7 ha	4	-45,162.5	1,227.2	0.0000
		Null	3	-48,901.5	8,703.3	0.0000
	Riparian	61.5 ha	4	-48,453.7	0.0	1.0000
		661.4 ha	4	-48,582.4	257.4	0.0000
		8.7 ha	4	-48,621.0	334.6	0.0000
		Null	3	-48,901.5	893.7	0.0000
	Sagebrush	661.4 ha	4	-44,570.0	0.0	1.0000

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
		61.5 ha	4	-45,334.9	1,529.8	0.0000
		8.7 ha	4	-46,099.1	3,058.1	0.0000
		Null	3	-48,901.5	8,661.0	0.0000
	Upland shrub	661.4 ha	4	-47,877.1	0.0	1.0000
		61.5 ha	4	-48,675.2	1,596.1	0.0000
		8.7 ha	4	-48,737.9	1,721.6	0.0000
		Null	3	-48,901.5	2,046.9	0.0000
	Wet meadow	61.5 ha	4	-48,805.2	0.0	1.0000
		661.4 ha	4	-48,845.9	81.2	0.0000
		8.7 ha	4	-48,877.2	143.9	0.0000
		Null	3	-48,901.5	190.6	0.0000
Agriculture	Distance to cropland	Linear	4	-46,777.2	0.0	1.0000
		Exponential decay	4	-47,546.0	1,537.5	0.0000
		Null	3	-48,901.5	4,246.6	0.0000
Edge	Edge effects	661.4 ha	4	-47,995.8	0.0	1.0000
		61.5 ha	4	-48,023.2	54.7	0.0000
		8.7 ha	4	-48,142.1	292.6	0.0000
		Null	3	-48,901.5	1,809.4	0.0000
	Distance to edge	Linear	4	-47,791.3	0.0	1.0000
		Exponential decay	4	-48,112.6	642.6	0.0000
		Null	3	-48,901.5	2,218.5	0.0000
Landscape variation	Variety of edge types	661.4 ha	4	-48,121.7	0.0	1.0000
		61.5 ha	4	-48,141.7	40.0	0.0000
		8.7 ha	4	-48,277.1	310.8	0.0000
		Null	3	-48,901.5	1,557.7	0.0000
	Variety of land cover types	661.4 ha	4	-47,448.5	0.0	1.0000
		61.5 ha	4	-48,161.9	1,426.8	0.0000
		8.7 ha	4	-48,425.5	1,954.1	0.0000
		Null	3	-48,901.5	2,904.2	0.0000
Water source	Distance to spring	Linear	4	-43,299.1	0.0	1.0000
	Distance to spring	Expon. decay	4	-43,787.5	976.8	0.0000
	Distance to wet meadow	Linear	4	-44,519.0	2,439.7	0.0000
	Distance to wet meadow	Expon. decay	4	-45,892.0	5,185.8	0.0000
	Distance to perennial stream	Linear	4	-46,280.0	5,961.9	0.0000
	Distance to water body	Linear	4	-46,990.7	7,383.2	0.0000
	Distance to water body	Expon. decay	4	-47,811.0	9,023.9	0.0000
	Distance to perennial stream	Expon. decay	4	-48,196.7	9,795.2	0.0000

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Distance to intermittent stream	Linear	4	-48,727.5	10,856.9	0.0000
	Distance to nearest stream	Linear	4	-48,829.5	11,060.8	0.0000
	Distance to intermittent stream	Expon. decay	4	-48,858.0	11,117.8	0.0000
	Distance to nearest stream	Expon. decay	4	-48,893.2	11,188.2	0.0000
	Null	Null	3	-48,901.5	11,202.9	0.0000
Topography	Elevation	Linear	4	-46,678.2	0.0	1.0000
	Roughness index	1 ha	4	-48,509.2	3,662.1	0.0000
	Topographic position index	510 m	4	-48,899.1	4,441.8	0.0000
	Null		3	-48,901.5	4,444.7	0.0000
	Topographic position index	2010 m	4	-48,918.4	4,480.4	0.0000

Table K2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the Toiyabe subregional resource selection function (RSF) model, Nevada.

Variable	Scale/distance function	Model averaged estimate (95% confidence interval)	Selection/Avoidance
Annual grass	8.7 ha	-1.85 (-2.20, -1.49)	Avoidance
Lowland shrubs	661.4 ha	-35.06 (-36.84, -33.28)	Avoidance
Pinyon-juniper	61.5 ha	-6.16 (-6.32, -6.00)	Avoidance
Riparian	61.5 ha	14.08 (13.43, 14.72)	Selection
Sagebrush	661.4 ha	4.73 (4.62, 4.84)	Selection
Upland shrubs	661.4 ha	15.36 (14.81, 15.91)	Selection
Distance to cropland	Exponential decay	-0.21 (-0.22, -0.20)	Avoidance
Distance to edge	Linear	-2.66 (-2.74, -2.59)	Selection
Variety of land cover types	661.4 ha	0.40 (0.39, 0.41)	Selection
Distance to perennial stream	Linear	-0.24 (-0.24, -0.23)	Selection
Distance to spring	Linear	-0.57 (-0.59, -0.56)	Selection
Distance to water body	Linear	-0.21 (-0.22, -0.21)	Selection
Distance to wet meadow	Linear	-0.18 (-0.18, -0.18)	Selection
Roughness index	1 ha	8.61 (8.38, 8.85)	Selection
Elevation	Linear	4.21 (4.11, 4.31)	Selection for Higher Elevations

Table K3. Toiyabe subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada.

Variable	Scale	Available habitats		Used habitats	
		Mean	Standard error	Mean	Standard error
Annual grass	8.7 ha	0.0043	0.0004	0.0025	0.0006
Lowland shrubs	661.4 ha	0.0417	0.0009	0.0018	0.0002
Pinyon-juniper	61.5 ha	0.193	0.0023	0.055	0.0015
Riparian	61.5 ha	0.013	0.0002	0.035	0.0015
Sagebrush	661.4 ha	0.727	0.0020	0.842	0.0023
Upland shrubs	661.4 ha	0.008	0.0002	0.032	0.0010
Variety of land cover types	661.4 ha	5.08	0.0130	6.12	0.0264
Distance to edge	Km	0.23	0.0022	0.10	0.0024
Distance to cropland	Km	4.54	0.0230	3.34	0.0316
Distance to perennial stream	Km	5.48	0.0317	2.86	0.0339
Distance to spring	Km	3.27	0.0213	1.34	0.0188
Distance to water body	Km	6.05	0.0235	5.13	0.0389
Distance to wet meadow	Km	12.83	0.0442	8.59	0.0820
Roughness index	1 ha	0.17	0.0007	0.21	0.0013
Elevation	Km	2.08	0.0015	2.25	0.0041

Appendix L. Supplemental Material for Virginia Mountains RSF Modeling

Table L1. Variable selection results from the "proposal set" of variables from the Virginia Mountains, Nevada.

[The top-ranked variable in each set was retained in the suite of candidate variables for resource selection function (RSF) modeling if they performed better than the null model and if confidence intervals around estimated mean effects did not overlap zero]

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
Land cover	Annual grass	661.4 ha	4	-2,086.4	0.0	1.0000
		61.5 ha	4	-2,155.5	138.3	0.0000
		8.7 ha	4	-2,186.3	199.9	0.0000
		Null	3	-2,452.4	730.0	0.0000
	Bare ground	661.4 ha	4	-2,347.4	0.0	1.0000
		61.5 ha	4	-2,419.7	144.6	0.0000
		8.7 ha	4	-2,421.1	147.4	0.0000
		Null	3	-2,452.4	207.9	0.0000
	Cropland	661.4 ha	4	-2,322.6	0.0	1.0000
		61.5 ha	4	-2,384.8	124.3	0.0000
		8.7 ha	4	-2,412.1	179.0	0.0000
		Null	3	-2,452.4	257.5	0.0000
	Forest	661.4 ha	4	-2,429.1	0.0	1.0000
		Null	3	-2,452.4	44.5	0.0000
		8.7 ha	4	-2,451.8	45.4	0.0000
		61.5 ha	4	-2,452.1	46.0	0.0000
	Lowland shrub	8.7 ha	4	-2,435.4	0.0	0.9958
		61.5 ha	4	-2,440.8	10.9	0.0042
		661.4 ha	4	-2,448.9	27.0	0.0000
		Null	3	-2,452.4	31.9	0.0000
	Perennial grass	8.7 ha	4	-2,445.1	0.0	0.6819
		661.4 ha	4	-2,445.9	1.5	0.3162
		Null	3	-2,452.4	12.5	0.0013
		61.5 ha	4	-2,452.2	14.3	0.0005
	Pinyon-juniper	8.7 ha	4	-2,422.1	0.0	0.9999
		61.5 ha	4	-2,431.5	18.9	0.0001
		661.4 ha	4	-2,442.4	40.7	0.0000
		Null	3	-2,452.4	58.6	0.0000
	Riparian	8.7 ha	4	-2,439.6	0.0	0.9921
		61.5 ha	4	-2,444.7	10.0	0.0066
		661.4 ha	4	-2,446.3	13.3	0.0013
		Null	3	-2,452.4	23.4	0.0000

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Sagebrush	8.7 ha	4	-2,429.8	0.0	0.9574
		61.5 ha	4	-2,432.9	6.2	0.0425
		661.4 ha	4	-2,439.4	19.1	0.0001
		Null	3	-2,452.4	43.1	0.0000
	Upland shrub	61.5 ha	4	-2,443.7	0.0	0.9928
		661.4 ha	4	-2,448.7	10.1	0.0065
		Null	3	-2,452.4	15.3	0.0005
		8.7 ha	4	-2,452.1	16.7	0.0002
	Wet meadow	8.7 ha	4	-2,438.4	0.0	0.9922
		661.4 ha	4	-2,443.2	9.7	0.0077
		61.5 ha	4	-2,450.8	24.8	0.0000
		Null	3	-2,452.4	26.0	0.0000
Agriculture	Distance to cropland	Expon. decay	4	-2,349.8	0.0	1.0000
		Linear	4	-2,388.7	77.6	0.0000
		Null	3	-2,452.4	203.0	0.0000
Edge	Edge effects	661.4 ha	4	-2,004.1	0.0	1.0000
		61.5 ha	4	-2,174.7	341.1	0.0000
		8.7 ha	4	-2,302.1	595.9	0.0000
		Null	3	-2,452.4	894.5	0.0000
	Distance to edge	Linear	4	-2,236.0	0.0	1.0000
		Expon. decay	4	-2,364.6	257.2	0.0000
		Null	3	-2,452.4	430.7	0.0000
Landscape variation	Variety of edge types	8.7 ha	4	-2,331.8	0.0	1.0000
		61.5 ha	4	-2,360.1	56.8	0.0000
		661.4 ha	4	-2,447.6	231.7	0.0000
		Null	3	-2,452.4	239.2	0.0000
	Variety of land cover types	8.7 ha	4	-2,424.0	0.0	0.9997
		61.5 ha	4	-2,432.3	16.6	0.0003
		Null	3	-2,452.4	54.7	0.0000
		661.4 ha	4	-2,452.2	56.5	0.0000
Water source	Distance to spring	Expon. decay	4	-2,322.0	0.0	1.0000
	Distance to spring	Linear	4	-2,364.5	85.1	0.0000
	Distance to wet meadow	Linear	4	-2,399.1	154.2	0.0000
	Distance to water body	Expon. decay	4	-2,403.7	163.5	0.0000
	Distance to perennial stream	Expon. decay	4	-2,416.7	189.5	0.0000
	Distance to intermittent stream	Linear	4	-2,417.9	191.9	0.0000

Group	Variable	Scale/distance function	K	Log likelihood	ΔAICc	Model weight
	Distance to water body	Linear	4	-2,426.8	209.6	0.0000
	Distance to perennial stream	Linear	4	-2,429.2	214.4	0.0000
	Distance to wet meadow	Expon. decay	4	-2,439.6	235.2	0.0000
	Distance to nearest stream	Expon. decay	4	-2,445.1	246.3	0.0000
	Distance to nearest stream	Linear	4	-2,449.6	255.3	0.0000
	Distance to intermittent stream	Expon. decay	4	-2,450.3	256.7	0.0000
	Null	Null	3	-2,452.4	258.8	0.0000
Topography	Elevation	Linear	4	-2,112.4	0.0	1.0000
	Topographic position index	2010 m	4	-2,320.7	416.7	0.0000
	Topographic position index	510 m	4	-2,424.7	624.6	0.0000
	Roughness index	1 ha	4	-2,437.1	649.5	0.0000
	Null		3	-2,452.4	677.9	0.0000

Table L2. Model averaged parameter estimates and 95-percent confidence intervals for candidate variables included in the Virginia Mountains subregional resource selection function (RSF) model, Nevada.

Variable	Scale/distance function	Model averaged estimate (95% confidence interval)	Selection/Avoidance
Annual grass	661.4 ha	5.42 (4.80, 6.03)	Selection
Lowland shrubs	8.7 ha	0.68 (0.42, 0.94)	Selection
Pinyon-juniper	8.7 ha	-3.67 (-4.00, -3.33)	Avoidance
Riparian	8.7 ha	-20.31 (-26.14, -14.48)	Avoidance
Sagebrush	8.7 ha	0.72 (0.52, 0.92)	Selection
Distance to cropland	Exponential decay	-1.24 (-1.60, -0.87)	Avoidance
Edge effects	661.4 ha	17.91 (16.65, 19.17)	Selection
Variety of edge types	8.7 ha	-0.22 (-0.3, -0.13)	Avoidance
Distance to perennial stream	Exponential decay	-2.90 (-3.26, -2.54)	Avoidance
Distance to spring	Exponential decay	1.06 (0.71, 1.41)	Selection
Distance to water body	Exponential decay	-2.88 (-3.26, -2.49)	Avoidance
Distance to wet meadow	Linear	-0.07 (-0.10, -0.04)	Selection
Roughness index	1 ha	-1.30 (-2.2, -0.39)	Avoidance
Topographic position index	2010 m	0.008 (0.007, 0.009)	Selected ridges/ Avoided valleys
Elevation	Linear	5.05 (4.70, 5.40)	Selection for higher elevations

Table L3. Virginia Mountains subregional resource selection function (RSF) variable means and standard errors within all available habitats and habitats used by greater sage-grouse (*Centrocercus urophasianus*), Nevada.

Variable	Scale	Available habitats		Used habitats	
		Mean	Standard error	Mean	Standard error
Annual grass	661.4 ha	0.038	0.0013	0.321	0.0051
Lowland shrubs	8.7 ha	0.150	0.0052	0.015	0.0038
Pinyon-juniper	8.7 ha	0.235	0.0058	0.211	0.0100
Riparian	8.7 ha	0.005	0.0005	0.003	0.0006
Sagebrush	8.7 ha	0.416	0.0065	0.354	0.0097
Edge effects	661.4 ha	0.14	0.0011	0.27	0.0018
Variety of edge types	8.7 ha	1.35	0.0179	2.37	0.0351
Distance to cropland	Km	3.62	0.0385	4.77	0.0575
Distance to perennial stream	Km	5.51	0.0618	4.91	0.0999
Distance to spring	Km	2.51	0.0300	1.12	0.0224
Distance to water body	Km	2.63	0.0269	2.29	0.0454
Distance to wet meadow	Km	5.26	0.0480	3.90	0.0467
Roughness index	1 ha	0.20	0.0017	0.22	0.0022
Topographic position index	2010 m	0.59	0.9103	31.65	2.5552
Elevation	Km	1.57	0.0049	2.03	0.0079

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