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Habitat Assessment for Nebraska's At-risk Species: Descriptions of Species Models used in the CHAT (Crucial Habitat Assessment Tool) Species of Concern Data Layer

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Introduction

As part of an effort across the western U.S. states led by the Western Governors' Association, the Nebraska Game and Parks Commission synthesized information related to habitat for at-risk native species and natural plant communities. The result, submitted to the WGA in the fall of 2013, is coarse-scale, landscape-level information that can be used by anyone for land-use planning. The product of this west-wide collaboration is called the Crucial Habitat Assessment Tool (CHAT). The information, provided through an online GIS-mapping tool, is non-regulatory and gives project planners and the general public access to credible scientific data on a broad scale for use in project analysis, siting, and planning.

In the CHAT data and map product, the landscape is divided into one-square-mile hexagons, and values ranging from 1-6 are assigned. The value for the hexagons is based on the values from five contributing data layers, representing large intact blocks of habitat, wetlands, natural communities, and species of concern, respectively. The values for each one-square-mile hexagon in each of the contributing data sets are also available in the CHAT product.

This document focuses on the Species of Concern data layer and specifically on models which were incorporated into the data layer. While documented occurrences of species of concern were used when available, survey data is limited. Distribution models were used to help fill in the gaps between survey locations. The models help identify areas which may have suitable habitat and may be occupied by at-risk species.

The purpose of this document is to convey to how the species models were generated for the CHAT product, what the models represent, and the completeness of the data with respect to the geographic range of a species.

A second purpose is to assist potential users of the individual species models themselves. The data may be useful and appropriate to certain applications outside of the CHAT. However, the models created

here were specifically designed for use in the Nebraska CHAT itself, and in the context of some other applications the data may be misleading or useless. Therefore, potential users of individual models should be careful to understand the context in which the models were created and to consider whether a given model is appropriate to their own purpose. NGPC strongly advises potential users of the data to contact staff biologists to assess whether a given species model may be helpful for a given application.

The intention of the CHAT was to prioritize areas for at-risk species, as opposed to capturing every location at which a species occurs or might occur. Users of the modeled data will need to understand that in many cases the species models are not 'distribution models' but instead help identify some areas that appear, based on readily available information, to provide relatively more suitable conditions for the species. The models are not substitutes for field surveys.

To create the WGA product, models were converted to binary form, where the two values possible correspond to 'relatively more suitable conditions present' or 'relatively more suitable conditions absent.' Most of the models created in-house were already in binary form because they were based on the presence or absence of suitable land cover classes in a land cover data set or by streams from stream data sets. In several cases we were able to draw on previously published models, most of which were on a continuous scale. In these cases we reclassified the continuous data to two categories. Sources used are indicated in the descriptions of the species models below, as well as in the Appendix. In no case have the models used in the WGA CHAT been validated using statistical methods, though model validation was conducted for several of the published models that were used as source data.

In the context of the WGA CHAT project we were not in most cases overly concerned with the problem of false negatives in the models, i.e., locations where the species occurs but which weren't classified as such. There were several reasons this was not a major concern in the context of the CHAT project. The most important was that individual species information was not presented in the CHAT. Second, documented occurrence data was used. If a hex had an observation but the model did not predict suitable habitat for the location, the hex was still flagged as important. In fact, areas with documented occurrences were ranked higher (more important). Third, a high rank (high importance) for any one species meant that the hexagon got a high rank. Specifically, if a hex was not flagged for one species there was no effect on the overall result as long as the hexagon was flagged for another species with the same or higher (more imperiled) G-rank. Finally, in most cases if even just 1 percent of a hex was occupied by the model, the hex was flagged for the species.

Nebraska Game and Parks Commission biologists provided the expertise necessary to produce the models and range maps incorporated into the Nebraska CHAT data. Lead biologists for the various taxa were Mike Fritz (insects, reptiles, amphibians, mammals, fish), Joel Jorgensen (birds), Jeff Lusk (Greater Prairie-chicken), Steve Schainost (fish, mussels), Gerry Steinauer (plants), and Sam Wilson (Swift Fox, River Otter). For several species, we were fortunate to be able to incorporate models created by biologists outside of the agency. We appreciate access to models created by the following: Jessica Jurzenski, University of Nebraska-Lincoln (American Burying Beetle in Sandhills region), Shelly McPherron, University of Nebraska at Kearney (American Burying Beetle in Loess Hills), Rana Tucker, Chadron State University (Rocky Mountain Bighorn Sheep). Our work was funded in part by a

Department of Energy grant to the Western Governors' Association [DOE Grant # DE-OE0000422 "Resource Assessment and Interconnection-Level Transmission Analysis and Planning (for the Western Interconnect)"]. The grant also funded the production of several species models (Ferruginous Hawk, Golden Eagle, Greater Prairie-chicken, Long-billed Curlew, and Burrowing Owl) by the Rainwater Basin Joint Venture, and we appreciate the work of RWBJV staff including Andy Bishop, Roger Grosse, Ele Nugent, Laura Achterburg, and Chris Jorgenson. We also appreciate access to a statewide land cover data set produced and maintained by the RWBJV. This data set was the basis for many of the habitat suitability models.

Model Descriptions

For each model a common name, scientific name, and element code (a species identifier used by Natural Heritage Programs and NatureServe) is given, followed by a description of the model. The 'Modeled Area' description indicates the extent of the modeled area as compared to the range of the species. Range maps were created based on locations of documented occurrences and expert knowledge of NGPC staff biologists. In the development of the CHAT Species of Concern Data layer both models and documented occurrences were clipped to the current species range through an automated process. Range maps are updated as new information becomes available, and models can be processed accordingly.

In a limited number of cases the modeled area is actually smaller than the full range of the species. In general the reason for this was that modeling could only provide a useful result, in the context of the CHAT project, for a portion of the range. Specific reasons varied among taxa. In some cases the reason was that the species has a wide geographic range and/or wide range of suitable habitats, but most of the reproducing individuals occur in an identifiable portion of the range. That area was identified as the area to focus on for the CHAT. In other cases the reason was that the spatial data necessary to create a useful model was simply not available range-wide.

In the model descriptions below, species are grouped by large taxonomic group (invertebrates, fish, mammals, reptiles and amphibians, and plants). Within each group, species are in order by common name.

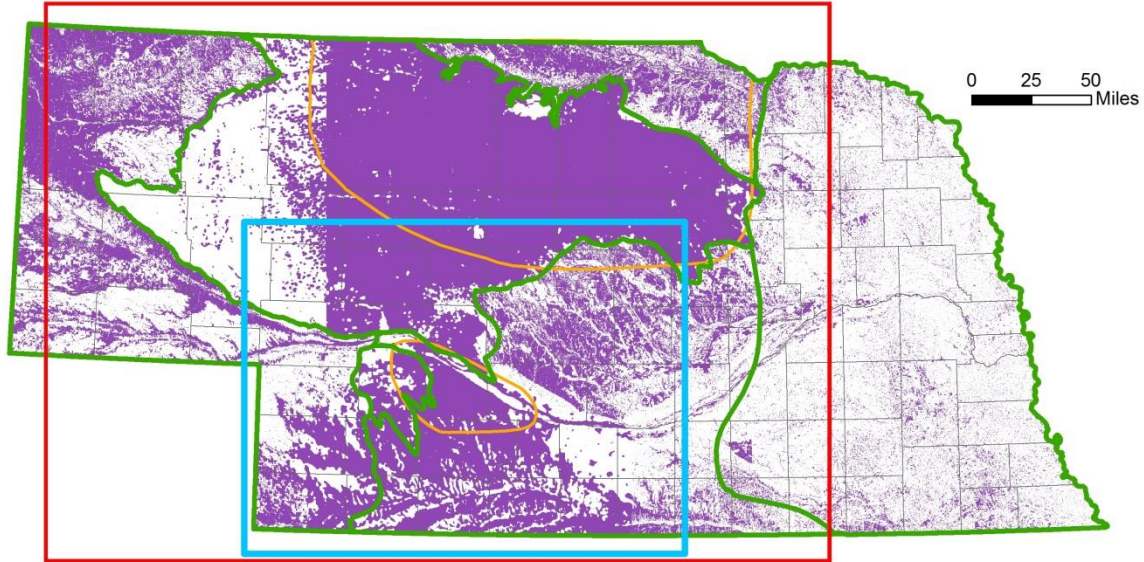
INVERTEBRATES

American Burying Beetle (*Nicrophorus americanus*) IICOL42010

The model is a raster which combines information from two statistical models for parts of the range treated by those models and information about suitable land cover types for the remaining part of the range. Both models were created based on statistical correlations of positive and negative survey locations with land cover and environmental variables. The Jurzenski model (Jurzenski, J. August 1,

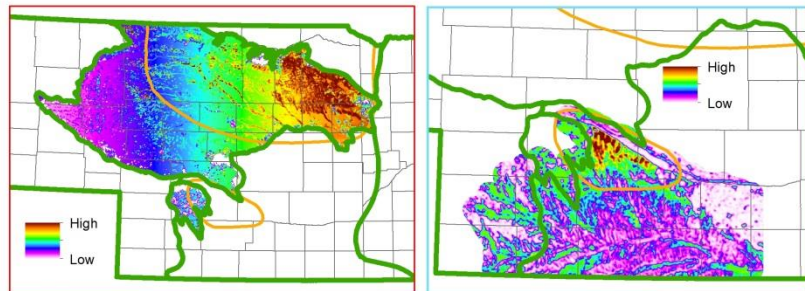
2012. Factors affecting the distribution and survival of endangered American burying beetles, *Nicrophorus americanus* Olivier. Dissertations and student research in entomology. Paper 20. <http://digitalcommons.unl.edu/entomology/20>. University of Nebraska-Lincoln, Lincoln, NE.) pertains primarily to the northern part of the range. Values for that model were on a continuous scale from 0 to 1. Values under 0.3 were reclassified to 0 (relatively less suitable) and values 0.3 or above were reclassified to 1 (relatively more suitable). The McPherron model (McPherron, M.M. 2011. A model of *Nicrophorus* species occurrence in the Nebraska Loess Canyons and effects of different grasses on burial behavior. MS. Thesis. University of Nebraska at Kearney, Kearney, NE.) pertains to the southern part of the range. Values for that model were on a continuous scale from 0 to 1. Values under 0.1 were reclassified to 0 (relatively less suitable) and values 0.1 or above were reclassified to 1 (relatively more suitable). For a small part of the southern portion of the range, information from both models was available. In the area of overlap, the model developed specifically for the south took precedence (i.e., the value based on that model was assigned). Finally, for part of the range (outside of the Loess Canyons and outside of the Sandhills ecoregion), no model was available. For that part, if the land cover (using a modified statewide land cover data set from the Rainwater Basin Joint Venture) category was grass (71,73,75,77,87,91) or Wet Meadow (247), a value of 1 was assigned, and otherwise a value of 0 was assigned.

Modeled Area: Model is statewide (however, note that two of the 3 sources of data used to create the model were specific to a portion of the range).



Large map shows American Burying Beetle range (orange), the model (prior to clipping by range) used for the WGA CHAT (purple), and ecoregions (green).

Smaller maps show the extent of the areas treated by the Jurzenski model (left) and the McPherron model (right).



Colorado Rita Dotted Blue (*Euphilotes rita coloradensis*) IILEPG2047

The model is a raster consisting of patches (at least 10 acres in size) of suitable habitat. Suitable habitat was represented as grasslands [types Mixedgrass (71), Sand Sage (87), Shortgrass (75), Sandhills (73)] in a modified landcover data set from the Rainwater Basin Joint Venture. Groups of contiguous pixels under 10 acres in size were removed.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Married Underwing (*Catocala nuptialis*) IILEY89740

The model is a raster representing documented suitable habitat. Documented suitable habitat consisted of plant communities of certain types and qualities documented through on-the-ground surveys. Types included were tallgrass prairie, eastern sandhills needlegrass prairie, loess mixed-grass prairie, sandhills wet mesic tallgrass prairie, loess bluff prairie, sandhills dry valley prairie, and southern sand-gravel

mixed-grass prairie. Prairies with a rounded quality rank of A or B, as well as those with a rank of BD and those with rank E (Extant), were included. Communities with a last observation date of 1974 or earlier were excluded. Documented suitable habitat was used in the modeling instead of land cover because, given the specific host-plant requirements of the species, a model based on land cover would have vastly over-estimated suitable locations. However, most prairies have not been documented and therefore this current model under-represents the possible locations for the species.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Salt Creek Tiger Beetle (*Cicindela nevadica lincolniana*) IICOL02173

The model consists of areas identified as Category 1 Saline wetlands in the saline wetland database created by the NGPC Wetlands Program (Lead biologist: Ted LaGrange)

Modeled Area: Model includes all Category 1 Saline Wetlands both inside and outside current species range.

Scaleshell (*Leptodea leptodon*) IMBIV24020

A raster was created from polygon and line features represented as perennial streams by the National Hydrography Dataset and supplemented by 1) polygon feature representing the Missouri River from Sioux City to the south developed in-house and incorporating large oxbows known to have large-river fish and 2) a polygon feature representing Lewis and Clark Lake (source: NGPC Lakes Data). Following CHAT development it was noted that north of Sioux City, the NHD represents the Missouri River only as a line feature. Therefore an improvement to the model could be made by better representing this stretch of river.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Tawny Crescent (*Phyciodes batesii*) IILEPK3040

The model is a raster representing suitable habitat within the breeding range. Suitable habitat is represented by the land cover classes Forest and Woodland (Upland) (61), Ponderosa Pine (60, 63, 69), Mixedgrass Prairie (71) in a modified statewide landcover data set from the Rainwater Basin Joint Venture.

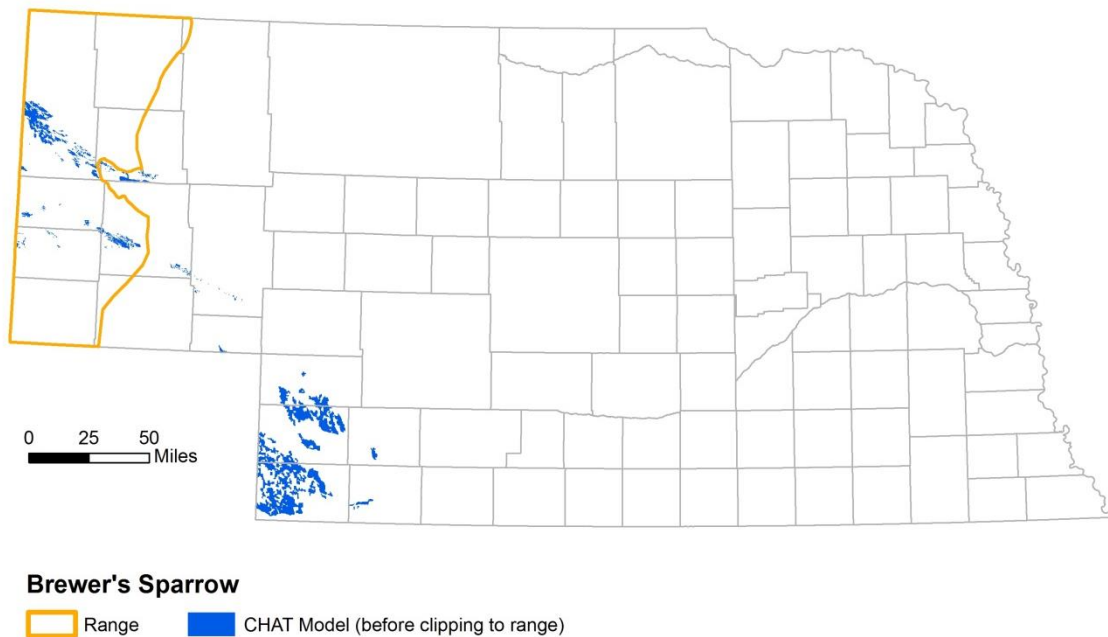
Modeled Area: Model extent is limited to the breeding range.

BIRDS

Brewer's Sparrow (*Spizella breweri*) ABPBX94040

The model is a raster representing suitable habitat. The raster was created by combining ground and desktop survey locations (collected in 2007 by Bob Steinauer under a contract to NGPC) for the sandsage plant community. Ground survey data was used for places where it was available (primarily the Wildcat Hills north) and elsewhere desktop survey data was used. Areas identified by Steinauer as sandsage/western mixed grass prairie transition were not included in the model.

Modeled Area: Model is statewide but restricted to areas identified as sandsage in the source data.



Burrowing Owl (*Athene cunicularia*) ABNSB10010

The model, in raster format, is a binary version of a suitability index for nesting habitat based on soil type, land cover type, depth to water table, and presence/absence of wetlands. The suitability index, (Bishop, A. et al. 2012. Prairie dog and burrowing owl habitat analysis throughout Nebraska. Rainwater Basin Joint Venture, Grand Island, NE), created under contract to NGPC, is categorical, with values corresponding to Unsuitable, Marginal, Suitable, Very Suitable, and Highly Suitable. To derive the model used in the WGA CHAT, areas that had been classified as Highly Suitable, Very Suitable, or Suitable were included. Then areas categorized as crop were removed (this was done because a new crop data layer had become available since the time that the RWBJV produced the original model).

Modeled Area: Model extent is statewide but not reliable as a predictor of species occurrence even rangewide. For the CHAT Species of Concern Layer, the model was clipped to the portion of western

Nebraska where the species is still commonly found (a portion of the entire range). This was done because the statewide model would vastly overpredict where the species is found. This is because although soils, land cover etc are suitable in many places, the species occurrence is tied to prairie dog towns, which have been eliminated by human activities (poisoning, etc), for which spatial data is not available.

Chestnut-collared Longspur (*Calcarius ornatus*) ABPBXA6040

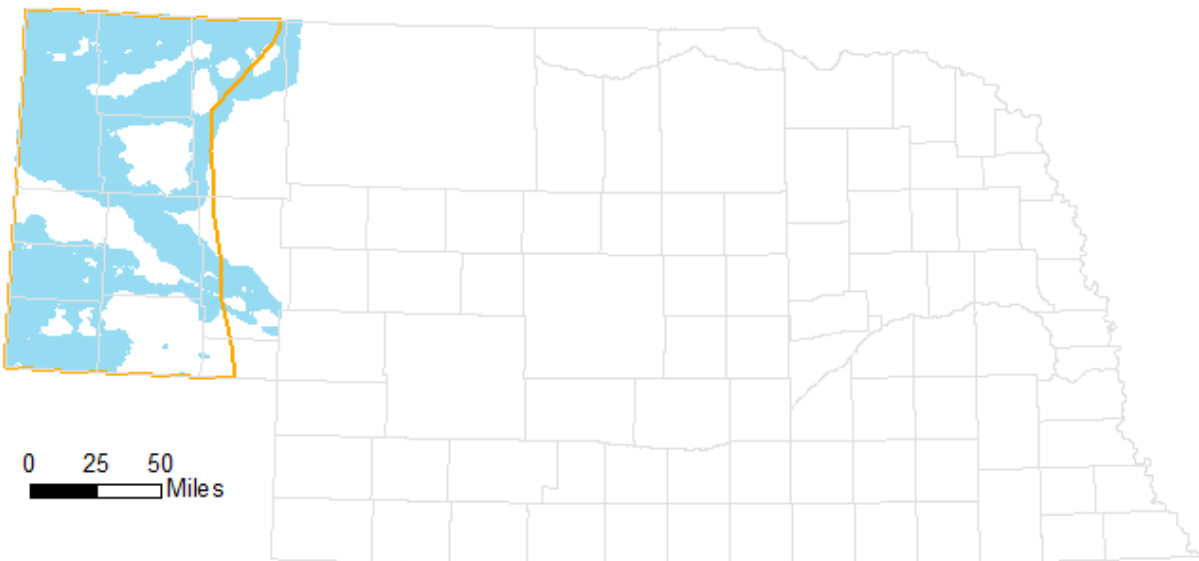
The model is a raster representing suitable habitat in the breeding range. Suitable habitat is represented by the land cover classes Mixedgrass (71) and Shortgrass (75) in a modified statewide landcover data set from the Rainwater Basin Joint Venture.

Modeled Area: Model extent is limited to the breeding range.

Ferruginous Hawk (*Buteo regalis*) ABNKC19120

The model is a binary version of a suitability index for nesting habitat based on topographic ruggedness and the percent of the surrounding landscape that is grassland and undeveloped respectively. The original version of the suitability index, created by the Rainwater Basin Joint Venture under contract to NGPC (Bishop, A. et al. 2012. Ferruginous hawk and golden eagle habitat suitability indices. Rainwater Basin Joint Venture, Grand Island, NE), is continuous and has values between 0 and 1 (with 1 being most suitable). For the WGA product, the model area consisted of areas with values of .6 or above.

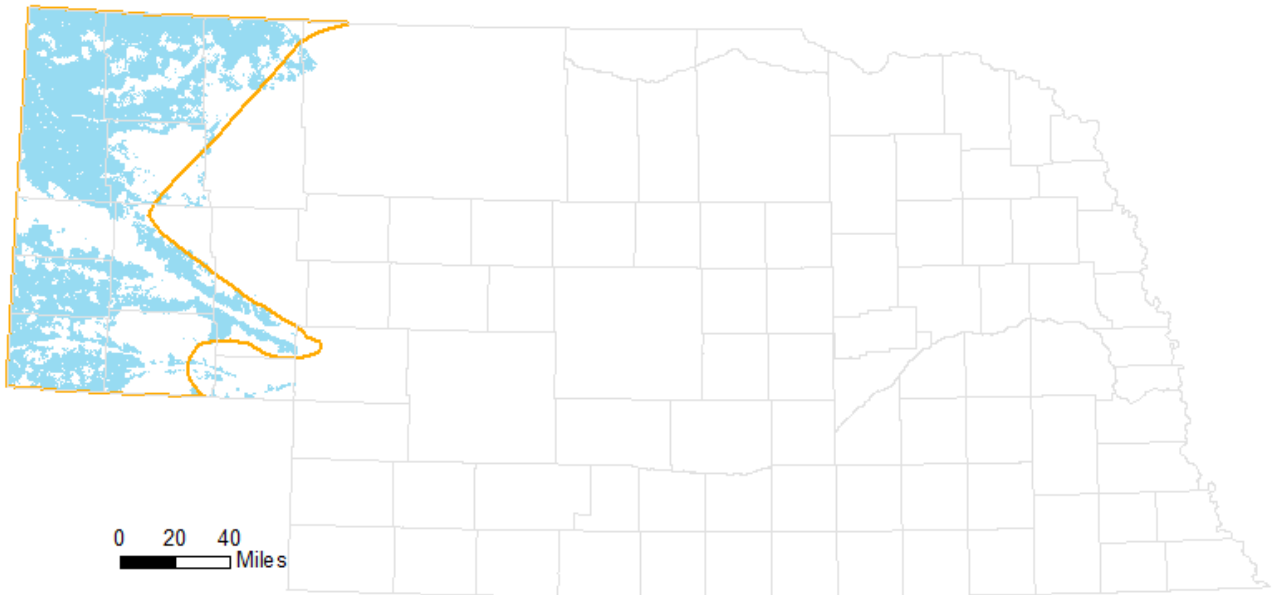
Modeled Area: Model extent is western Nebraska (inclusive of the breeding range).

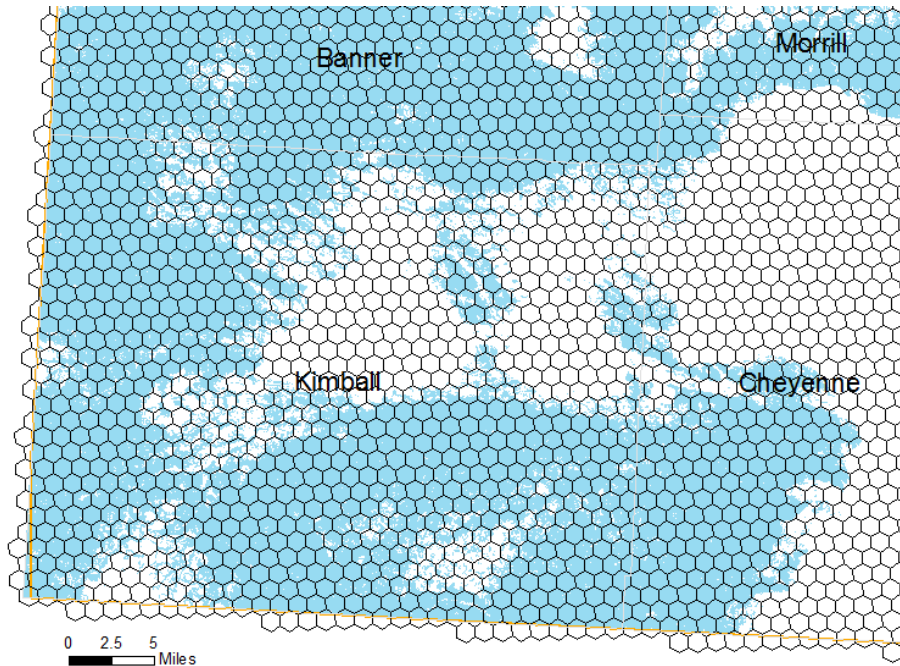


Golden Eagle (*Aquila chrysaetos*) ABNKC22010

The model is a binary version of a suitability index for nesting habitat based on topographic ruggedness (a measure of the change in topography) and the percent of the surrounding landscape that is grassland and undeveloped respectively. The original version of the suitability index, created by the Rainwater Basin Joint Venture under contract to NGPC (Bishop, A. et al. 2012. Ferruginous hawk and golden eagle habitat suitability indices. Rainwater Basin Joint Venture, Grand Island, NE), is continuous and has values between 0 and 1 (with 1 being most suitable); for the WGA product, the model consisted of areas with values of .6 or above.

Modeled Area: Model extent is western Nebraska (inclusive of the breeding range).

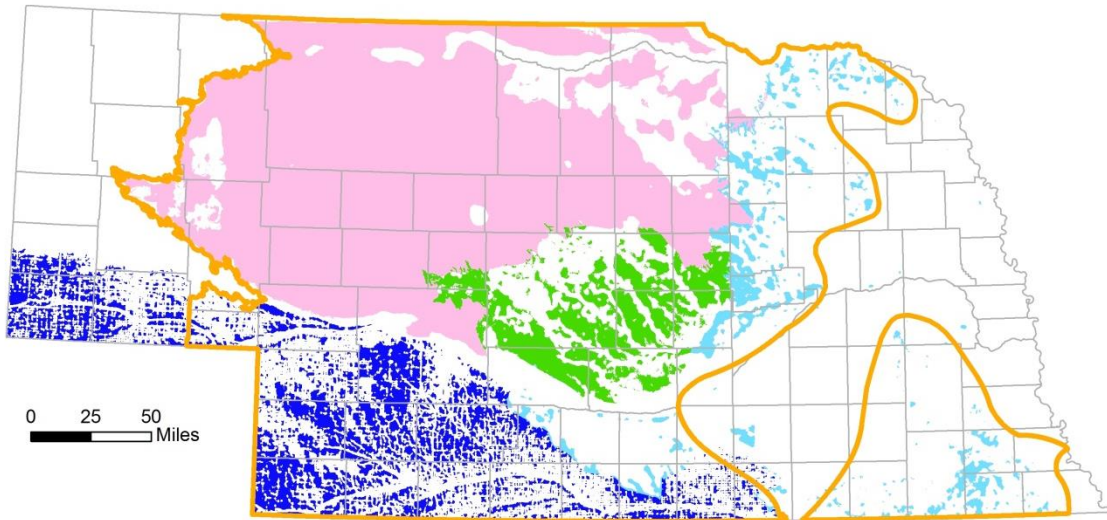




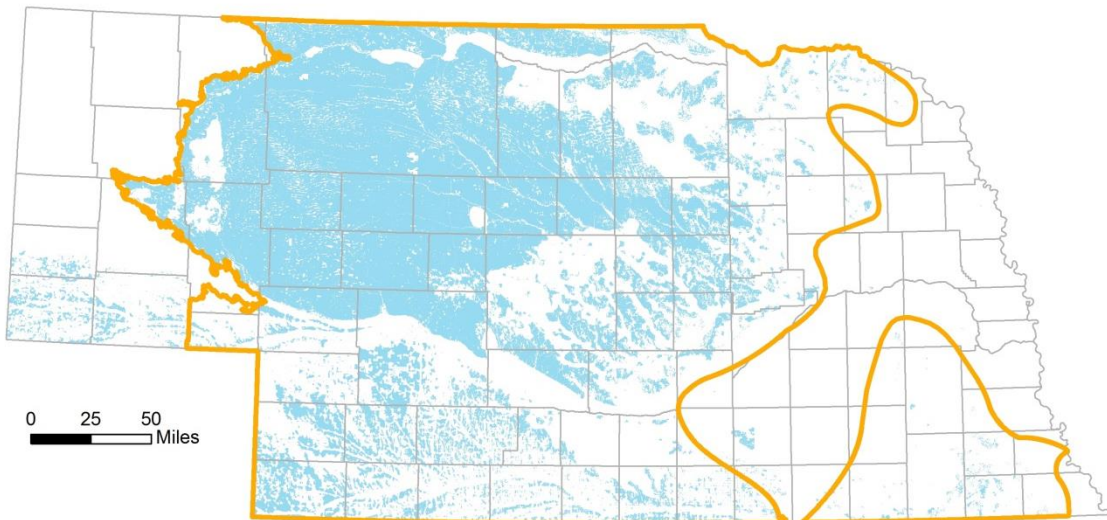
Greater Prairie-chicken (*Tympanuchus cupido*) ABNLC13010

The model is a raster derived from a set of models based on statistical correlations of positive and negative survey locations with land cover variables. The models, created under contract to NGPC, are documented in: The Rainwater Basin Joint Venture. 2012. Assessing species occupancy and distribution throughout Nebraska. Rainwater Basin Joint Venture, Grand Island, NE. Models were developed independently for each of four regions (eastern Nebraska, the Sandhills, the Loess Canyons, and the Loess Hills). Values for each model were on a continuous scale from 0 to 1, with 1 representing the most suitable habitat. To derive the model used in the CHAT Species of Concern layer, the top-performing model for each separate region was used. Values under 0.5 were reclassified to 0 (relatively less suitable) and values 0.5 or above were reclassified to 1 (relatively more suitable). Regional models were combined by identifying the maximum value for each location (in case there was overlap of pixels at boundary edges). Then some areas were removed from the relatively more suitable category. Areas removed were those not categorized as grass [i.e., not among land cover categories CRP Grass (31), Mixedgrass (71), Sandhills Grasslands (73), Shortgrass (75), Tallgrass (77), Sand Sage (87), or Probable Native (91)] in a modified land cover from the RWBJV. This was done because the original model was landscape-level (i.e., the value at a given location was based on the surrounding area), and therefore at a particular given location there might not be suitable habitat.

Modeled Area: Model extent is the state minus the Panhandle (inclusive of the breeding range).



Greater Prairie-chicken range (orange) and top models from RWBJV for each of four regions, after reclassifying to 0 (<.5, white) or 1 (.5 or greater, shaded)



Greater Prairie-chicken
 Range CHAT Model

Henslow's Sparrow (*Ammodramus henslowii*) ABPBXA0030

The model is a raster representing suitable habitat in patches of 500 acres or larger. Suitable habitat was represented by the land cover classes CRP Grass (31), CRP Wetland (34), CRP Not Further Classified (39), Tallgrass Prairie (77), and Potential Native (91) in a modified statewide landcover data set from the

Rainwater Basin Joint Venture. Patches of contiguous pixels of suitable land cover types that were under 500 acres were removed.

Modeled Area: Model extent is limited to breeding range.

Interior Least Tern (*Sterna antillarum athalassos*) ABNNM08102

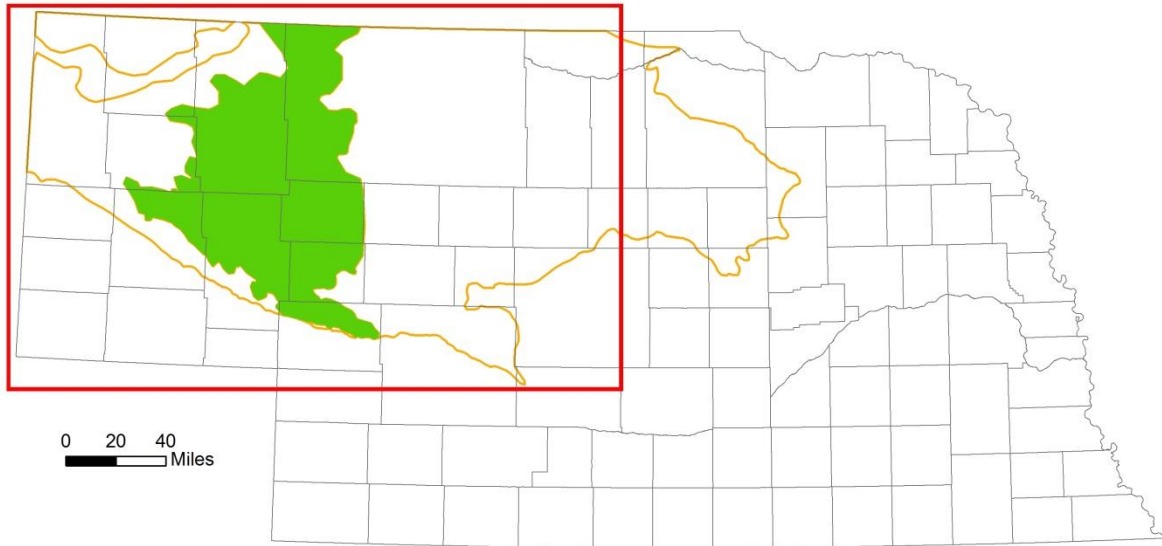
The modeled area is represented as a vector data set consisting of hexagons intersected by rivers and lakes within the range of the species, as well as sandpits located near rivers.

Modeled Area: Model extent is limited to breeding range.

Long-billed Curlew (*Numenius americanus*) ABNNF07070

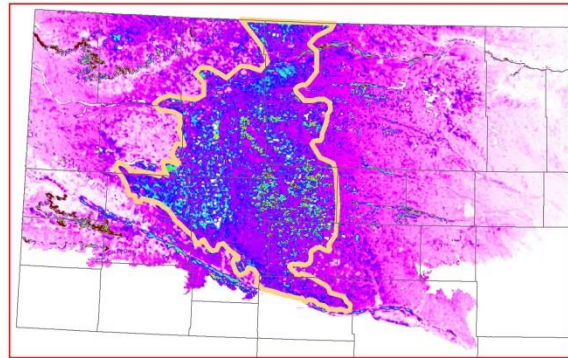
A model in the conventional sense does not exist for the species. The area treated in the WGA CHAT as modeled for the species is an area in which there are higher concentrations of the species based on expert opinion from NGPC Nongame Bird Program Manager and on a model created by the Rainwater Basin Joint Venture under contract to NGPC (Rainwater Basin Joint Venture. 2012. Assessing species occupancy and distribution throughout Nebraska. Rainwater Basin Joint Venture, Grand Island, NE). The CHAT 'model' is a raster and all locations within the delineated area have a value of 1. All other areas have a value of 0.

Modeled Area: Model only treats the portion of the range in which the species occurs at higher concentrations, and all locations within that area are treated as positive for the species.



Top map shows Long-billed Curlew range (orange) and area of concentration (green). Concentration area was treated as 'modeled' area in the WGA CHAT.

Curlew concentration area boundary was delineated based on a statistical model, shown at right, correlating known locations with land cover and geographical variables. That model was produced by the RWBJV under contract to NGPC.



Mccown's Longspur (*Calcarius mccownii*) ABPBXA6010

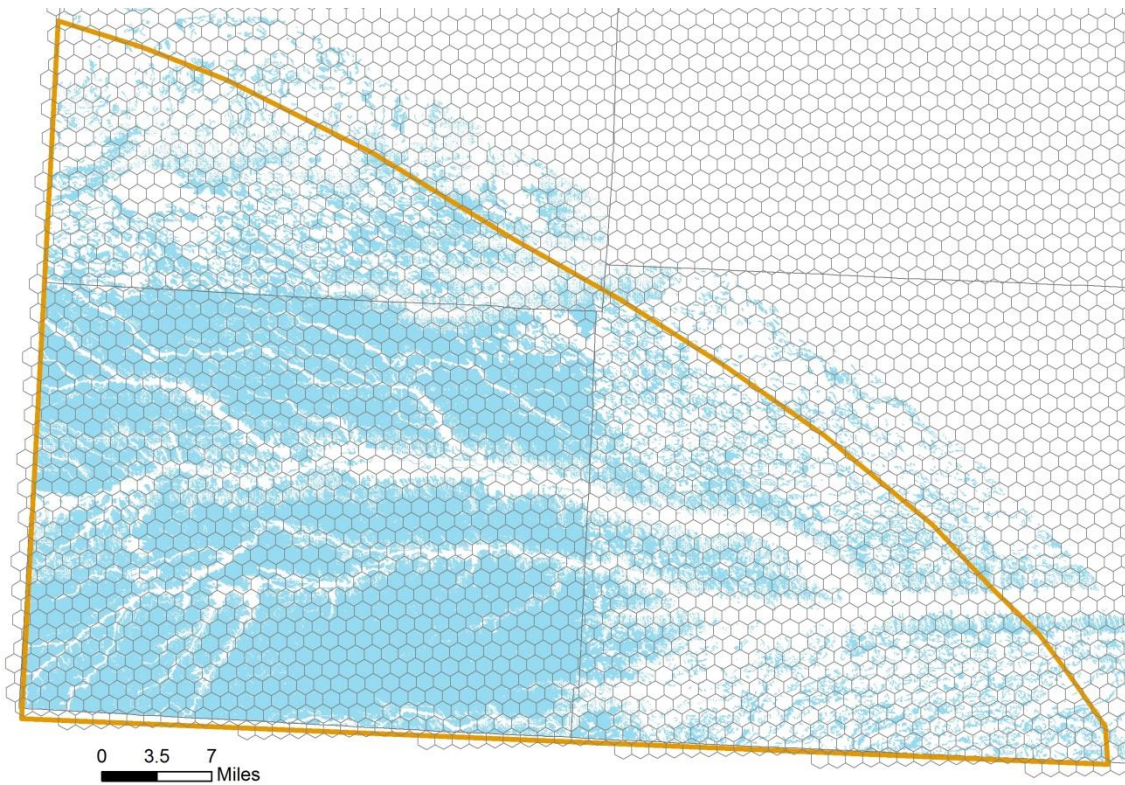
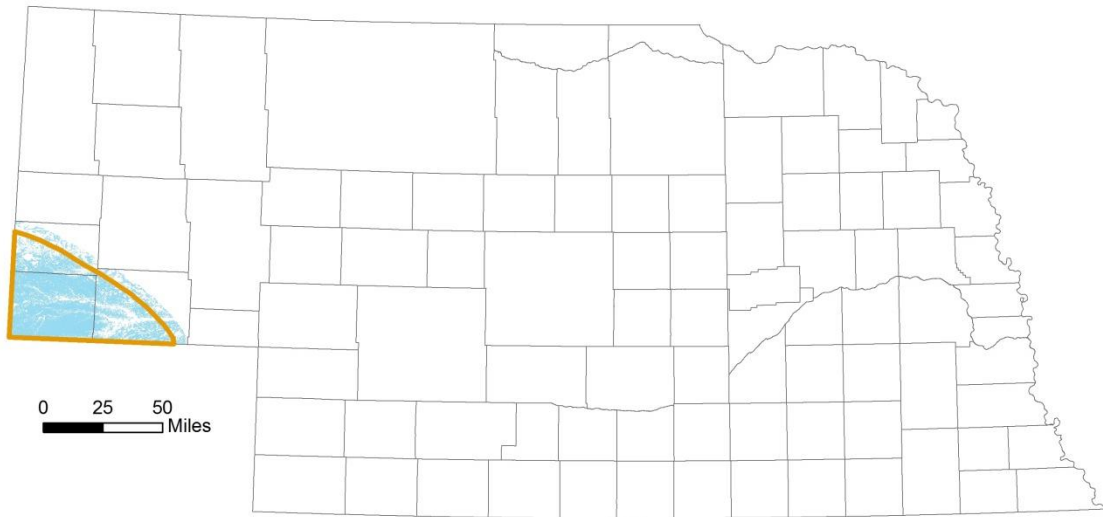
The model is a raster representing suitable habitat within the breeding range. Suitable habitat is represented by the land cover classes Mixedgrass (71), Shortgrass (75), Sandhills (73) in a modified statewide landcover data set from the Rainwater Basin Joint Venture.

Modeled Area: Model extent is limited to the breeding range.

Mountain Plover (*Charadrius montanus*) ABNNB03100

The model is in raster format and represents suitable habitat based on soil and slope data. Soil types representative of flat tablelands for the three counties within the species's range were identified based primarily on expert input from a soils scientist (Dan Shurtliff, Assistant State Soil Scientist, NRCS-Nebraska). Areas with slopes of greater than 8% were removed. Source of soil data was the USGS SSURGO Data set. Slope data was created by NENHP based on USGS 30 m DEM.

Modeled Area: Model extent is the 2013 range plus a buffer.



Piping Plover (*Charadrius melodus*) ABNNB03070

The model is a vector data set consisting of hexagons intersected by rivers and lakes within the range of the species, as well as sandpits located near rivers.

Modeled Area: Model extent is limited to breeding range.

Trumpeter Swan (*Cygnus buccinator*) ABNJB02030

The model is a raster representing freshwater lakes inside the breeding range. The source of the lake features was landcover class 101 (Freshwater Lake) from a modified statewide landcover data set from the Rainwater Basin Joint Venture. [Note that for CHAT Species of Concern layer as a whole, documented occurrences for wintering sites anywhere in the state were included.]

Modeled Area: Model extent is limited to breeding range.

Whooping Crane (*Grus americana*) ABNMK01030

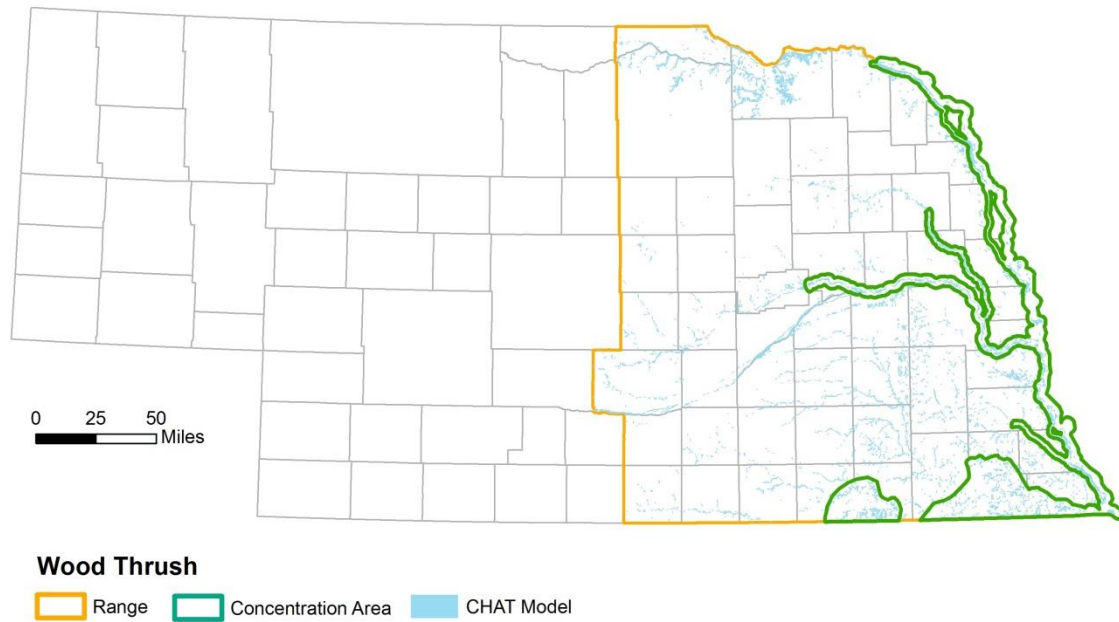
No model for this species was created or used in the CHAT. Instead, for the CHAT Species of Concern data layer, data from the 'Nebraska Wind and Wildlife' map was incorporated. Areas considered high priority for the species in the data used to create the 'Nebraska Wind and Wildlife' map received a value of 3 (on a scale of 1 to 6 with 1 being best), and areas considered medium priority received a value of 4. These areas cover only a portion of the species's range, and within the areas all locations were treated identically, regardless of suitable habitat and the likelihood of occurrence.

Modeled Area: n/a

Wood Thrush (*Hylocichla mustelina*) ABPBJ19010

The model is a raster representing suitable habitat in patches 40 acres or more within the breeding range. Suitable habitat was represented by Riparian Canopy (241), Forest and Woodland (Upland) (61) land cover classes in a modified statewide landcover data set from the Rainwater Basin Joint Venture. Patches of contiguous pixels of suitable land cover types that were under 40 acres were removed.

Modeled Area: Model extent is the breeding range. For the CHAT Species of Concern Layer, the model was clipped to the area in which the species is more concentrated.



FISH

Blacknose Shiner (*Notropis heterolepis*) AFCJB28530

A raster was created from two line feature data sets representing streams, one from the Nebraska Department of Natural Resources and one from the National Hydrography Dataset (Perennial Streams Flowlines).

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Blue Sucker (*Cyprinus elongatus*) AFCJC04010

A raster was created from polygon and line features represented as perennial streams by the National Hydrography Dataset and supplemented by polygon feature representing the Missouri River developed in-house and incorporating large oxbows known to have large-river fish. Raster was then processed to remove contiguous groups of 50 pixels or less. Following CHAT development it was noted that north of Sioux City, the NHD represents the Missouri River only as a line feature. Therefore an improvement to the model could be made by better representing this stretch of river.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Finescale Dace (*Phoxinus neogaeus*) AFCJB31040

A raster was created from 2 line feature data sets representing streams, one from the Nebraska Department of Natural Resources and one from the National Hydrography Dataset (Perennial Streams Flowlines).

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Lake Sturgeon (*Acipenser fulvescens*) AFCAA01020

A raster was created from polygon and line features represented as perennial streams by the National Hydrography Dataset and supplemented by polygon feature representing the Missouri River developed in-house and incorporating large oxbows known to have large-river fish. Raster was then processed to remove contiguous groups of 50 pixels or less. Following CHAT development it was noted that north of Sioux City, the NHD represents the Missouri River only as a line feature. Therefore an improvement to the model could be made by better representing this stretch of river.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Northern Redbelly Dace (*Phoxinus eos*) AFCJB31020

A raster was created from 2 line feature data sets representing streams, one from the Nebraska Department of Natural Resources and one from the National Hydrography Dataset (Perennial Streams Flowlines).

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Pallid Sturgeon (*Scaphirhynchus albus*) AFCAA02010

A raster was created from polygon and line features represented as perennial streams by the National Hydrography Dataset and supplemented by 1) polygon feature representing the Missouri River developed in-house and incorporating large oxbows known to have large-river fish and 2) a polygon feature representing Lewis and Clark Lake (source: NGPC Lakes Data). Following CHAT development it was noted that north of Sioux City, the NHD represents the Missouri River only as a line feature. Therefore an improvement to the model could be made by better representing this stretch of river.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Plains Topminnow (*Fundulus sciadicus*) AFCNB04170

A raster was created from 2 line feature data sets representing streams, one from the Nebraska Department of Natural Resources and one from the National Hydrography Dataset (Perennial Streams Flowlines).

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Sicklefin Chub (*Macrhybopsis meeki*) AFCJB53030

A raster was created from polygon and line features represented as perennial streams by the National Hydrography Dataset and supplemented by 1) polygon feature representing the Missouri River developed in-house and incorporating large oxbows known to have large-river fish and 2) a polygon feature representing Lewis and Clark Lake (source: NGPC Lakes Data). Following CHAT development it was noted that north of Sioux City, the NHD represents the Missouri River only as a line feature. Therefore an improvement to the model could be made by better representing this stretch of river.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Sturgeon Chub (*Macrhybopsis gelida*) AFCJB53020

A raster was created from polygon and line features represented as perennial streams by the National Hydrography Dataset and supplemented by polygon feature representing the Missouri River developed in-house and incorporating large oxbows known to have large-river fish. Raster was then processed to remove contiguous groups of 50 pixels or less. Following CHAT development it was noted that north of Sioux City, the NHD represents the Missouri River only as a line feature. Therefore an improvement to the model could be made by better representing this stretch of river.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Topeka Shiner (*Notropis topeka*) AFCJB28960

A raster was created from 3 line feature datasets representing streams, one from the Nebraska Department of Natural Resources, one from the Nebraska Game and Parks Commission (Nebraska Comprehensive Streams Data), and one from the National Hydrography Dataset (Perennial Streams Flowlines).

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

MAMMALS

Bailey's Eastern Woodrat (*Neotoma floridana baileyi*) AMAFF08011

The model is a raster representing suitable habitat. Suitable habitat was represented by the land cover classes Eastern Red Cedar (59), Ponderosa Pine (60, 63, 69), and Forest and Woodland (Upland) (61) in a modified statewide land cover data set from the Rainwater Basin Joint Venture.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Eastern Pipistrelle (*Pipistrellus subflavus*) AMACC03020

The model is a raster representing suitable habitat in patches of 100 acres or larger. The woodland/forest features were represented by Riparian Canopy (241) and Forest/Woodland (Upland) (61) land cover classes in a modified statewide landcover data set from the Rainwater Basin Joint Venture. Patches of contiguous pixels of suitable land cover types that were under 100 acres were removed.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Fringe-tailed Myotis (*Myotis thysanodes pahasapensis*) AMACC01091

The model is a raster representing suitable habitat consisting of areas that met slope and land cover criteria. Suitable landcover types were Ponderosa Pine (60, 63, 69), Badlands/Cliffs/Outcrops (51), Forest/Woodland (Upland) (61), grassland (71,73,75,77, 87, 91) from a modified statewide landcover data set from the Rainwater Basin Joint Venture. Areas were excluded if the slope was under 11 degrees (approximately 20%).

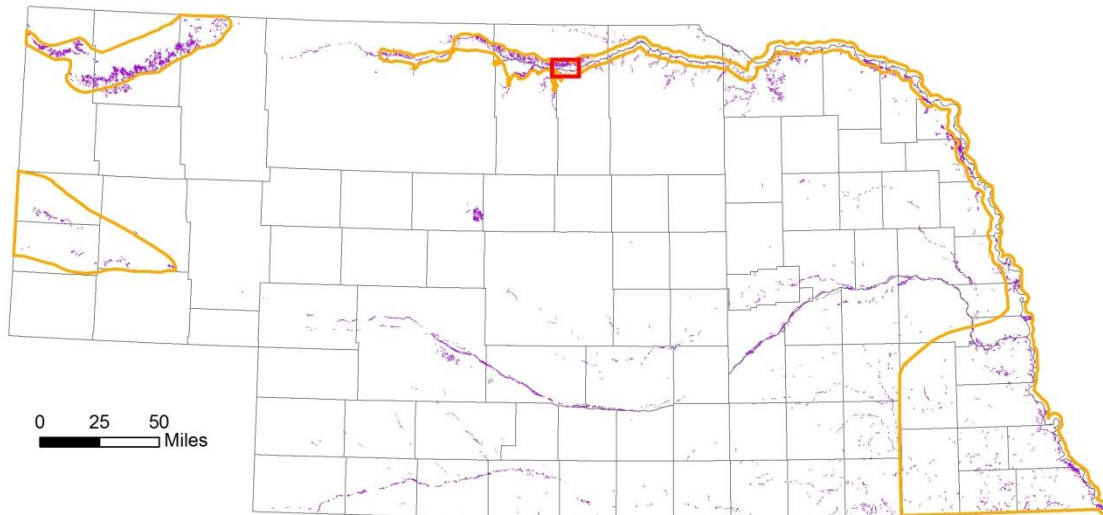
Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Little Brown Myotis (*Myotis lucifugus*) AMACC01010

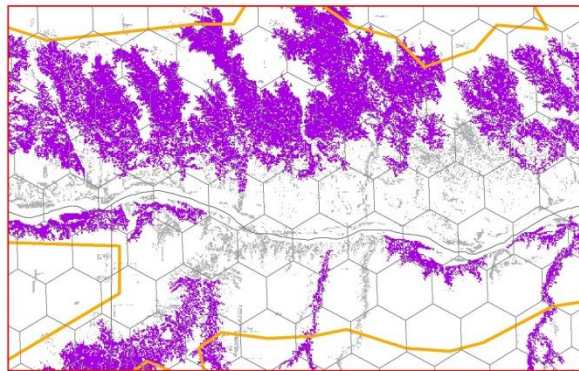
The model is a raster representing suitable habitat (woodland/forest) in patches of 100 acres or larger. The woodland/forest features were represented by Riparian Canopy (241), Forest/Woodland (Upland)

(61), Ponderosa Pine (60, 63, 69), and Juniper (66) land cover classes in a modified statewide landcover data set from the Rainwater Basin Joint Venture. Patches of contiguous pixels of suitable land cover types that were under 100 acres were removed.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).



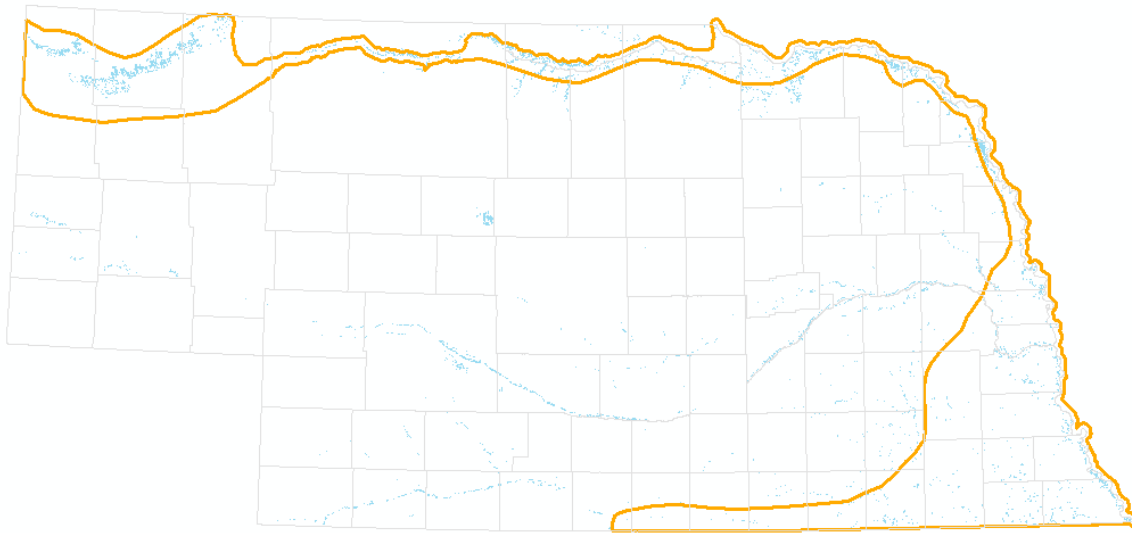
Little Brown Myotis range (orange) and model (purple). Model consists of patches of contiguous pixels larger than 100 acres. Inset map shows 1-square mile hexagons and patches smaller than 100 acres (in gray).



Northern Long-eared Myotis (*Myotis septentrionalis*) AMACC01150

The model is a raster representing suitable habitat (woodland/forest) in patches of 100 acres or larger. The woodland/forest features were represented by Riparian Canopy (241), Forest/Woodland (Upland) (61), Ponderosa Pine (60, 63, 69), and Juniper (66) land cover classes in a modified statewide landcover data set from the Rainwater Basin Joint Venture. Patches of contiguous pixels of suitable land cover types that were under 100 acres were removed.

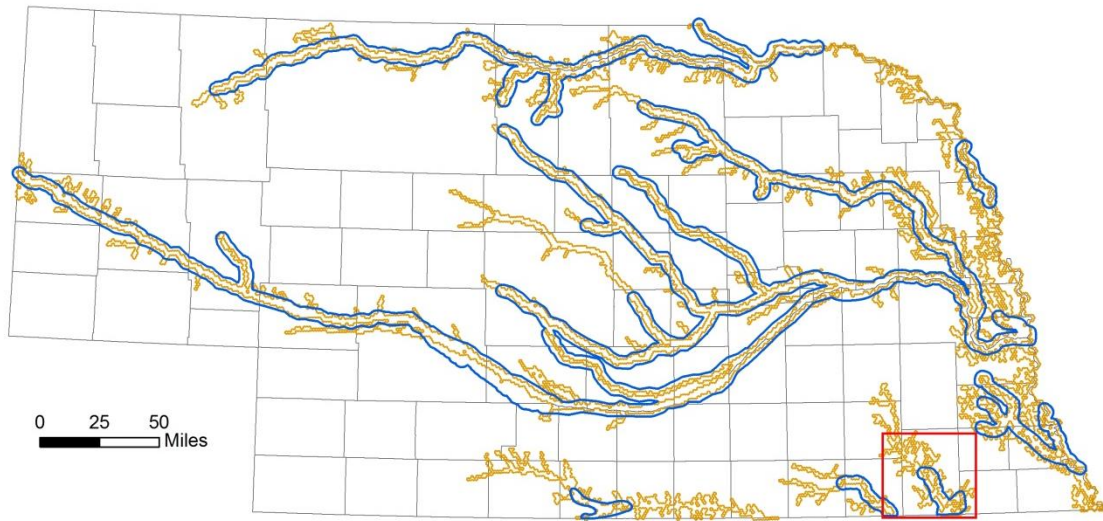
Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).



River Otter (*Lutra canadensis*) AMAJF10010

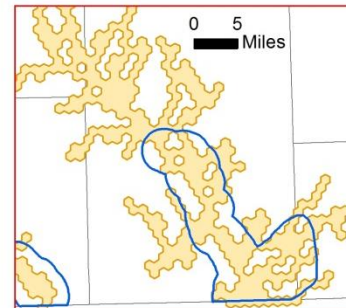
The model is a vector feature class consisting of 1-square-mile hexagons that intersect with suitable habitat in the range of the species, incorporating possible range expansion over the next 3-5 years (from 2013, when the model was created). Suitable habitat included streams, rivers, lakes, and sandpits. Following is a more detailed explanation of the model development. The range was modified based on expert knowledge from NGPC Carnivore and Furbearer Program Manager. Stream segments that intersected with this range were identified, and the hexes that intersected with those streams were selected and included in the model. Hexes that were within 1/2 mile of mapped stream segments representing the Platte River, Elkhorn River, Niobrara, and Loup (Upper, Middle, and Lower) Rivers were added. Hexes intersecting with Harlan Reservoir, Lake McConaughy, Calamus Reservoir, and Lewis and Clarke Lake were also added. River Otters may travel from streams to nearby lakes, so steps were taken to incorporate these areas as well. First, sandpit lakes (using a layer developed by the NGPC Nongame Bird Program) within 1/2 kilometer of those rivers were exported to a data set. Second, sandpit lakes within 100 m of that data set were added to it. Third, any sandpit lakes within 100 m of that data set were added to it. Hexes that intersected with the resulting set of sandpit lakes were added to the River Otter modeled area.

Modeled Area: Model is limited to range plus areas of possible range expansion over 3-5 year period.



River Otter model was created for the CHAT in 2013 and incorporated possible range expansion over a 3-5 year time period.

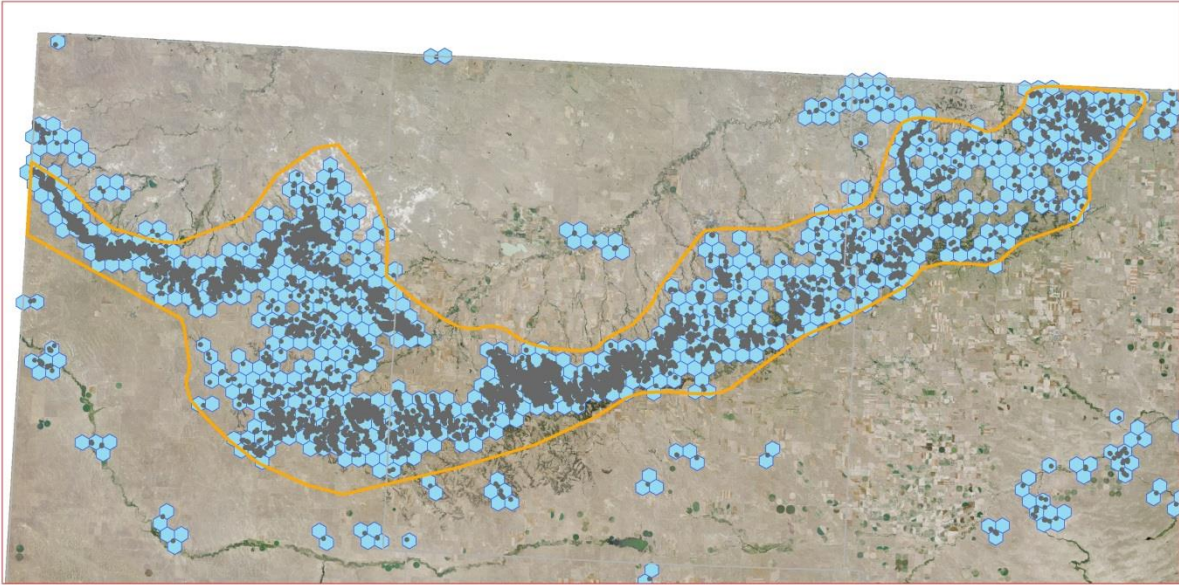
- Current range as depicted in 2014 E&T range map
- Modeled area used in CHAT



Rocky Mountain Bighorn Sheep (*Ovis canadensis*) AMALE04010

The model is a vector data set consisting of 1-square-mile hexagons which intersect with a previously published vector data set representing a conceptual model for the distribution of Bighorn Sheep (Tucker, R. A. 2011. Evaluating the use of the escape terrain and buffer model to depict northwestern Nebraska's bighorn sheep habitat. MS thesis. Chadron State College, Chadron, NE). In the Tucker model, habitat (named 'Statewide Habitat' in the Tucker data set) includes areas with a slope of at least 40 degrees and all locations within 300 meters of those areas.

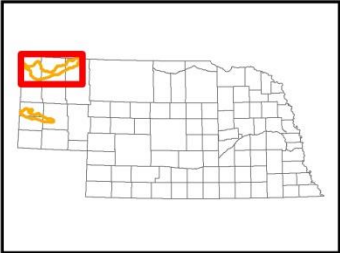
Modeled Area: Model is statewide.

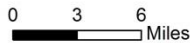
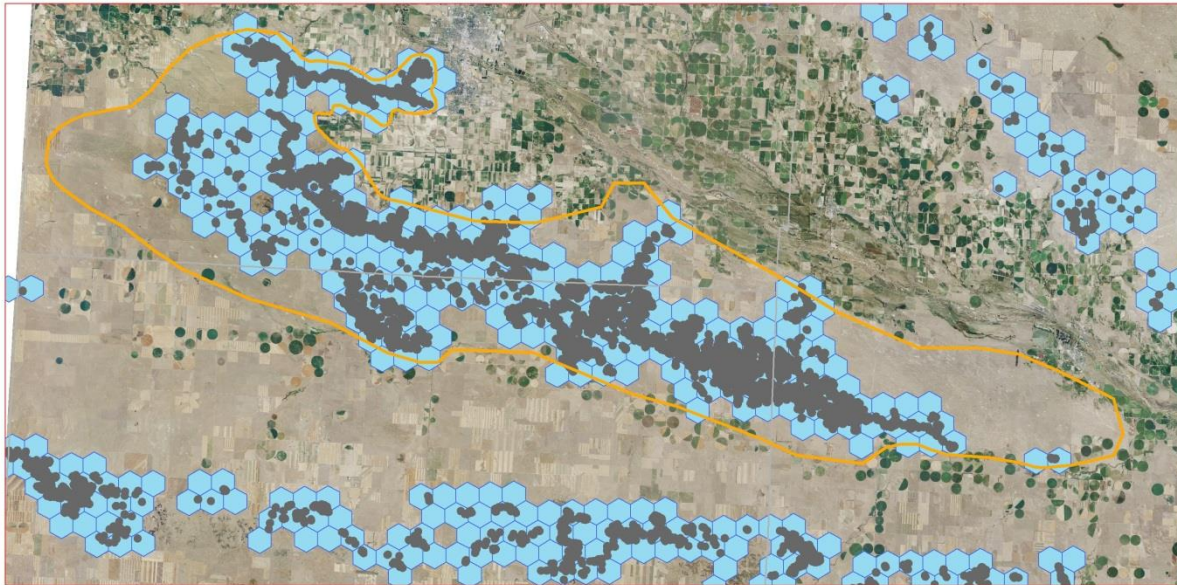


0 5 10
Miles

Rocky Mountain Bighorn Sheep - Pine Ridge portion of range

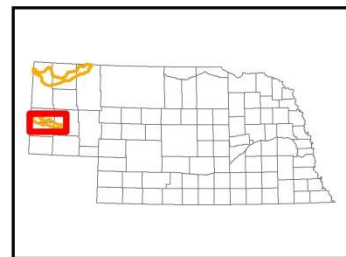
- Range
- CHAT Model (before clipping to range)
- Tucker model





Rocky Mountain Bighorn Sheep - Wildcat Hills portion of range

- Range
- CHAT Model (before clipping to range)
- Tucker model



Southern Flying Squirrel (*Glaucomys volans*) AMAFB09010

The model is a raster representing areas dominated by suitable habitat. Suitable habitat types were identified using landcover types Forest and Woodland (Upland) (61), and Eastern Red Cedar (59) in a modified landcover data set from the Rainwater Basin Joint Venture. Areas with these landcover types were buffered (using the 'Expand' function in ArcGIS Spatial Analyst) by one 30-meter pixel, and from the resulting patches those under 640 acres were removed. The purpose of the buffering was to avoid excluding areas of woodland bisected by small roads.

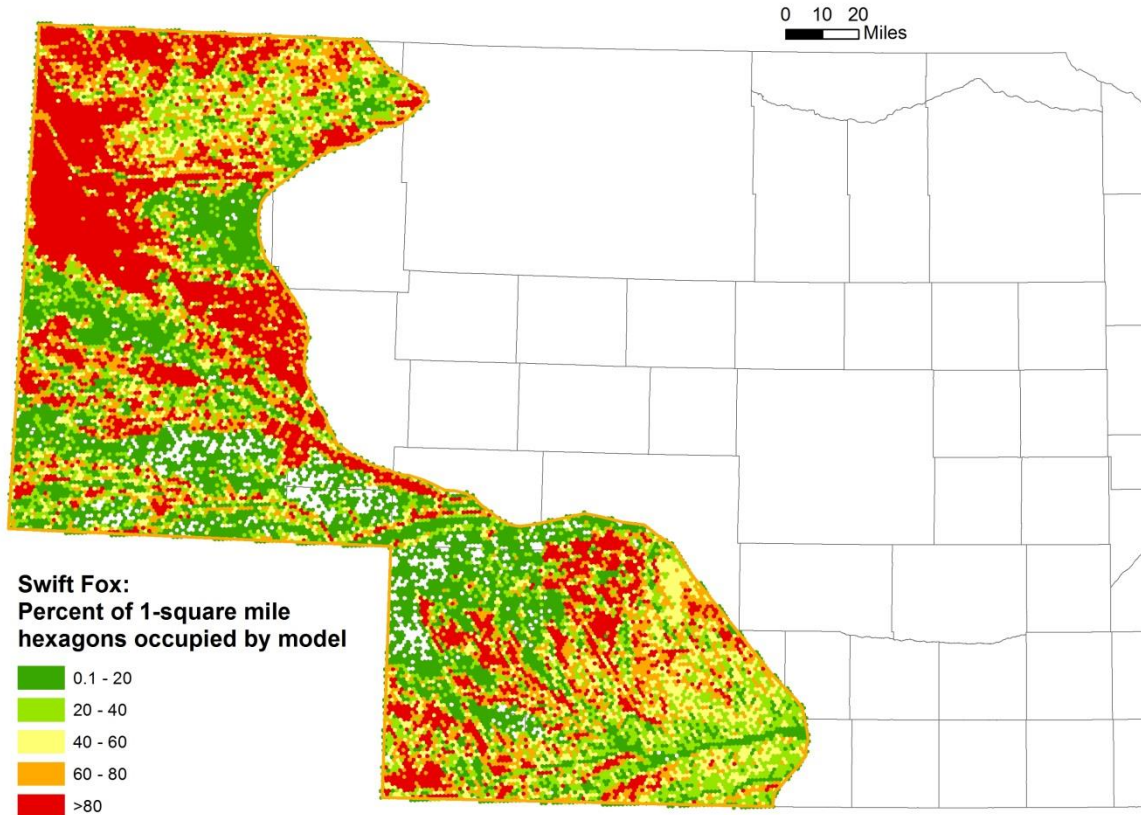
Modeled Area: Model extent is limited to breeding range.

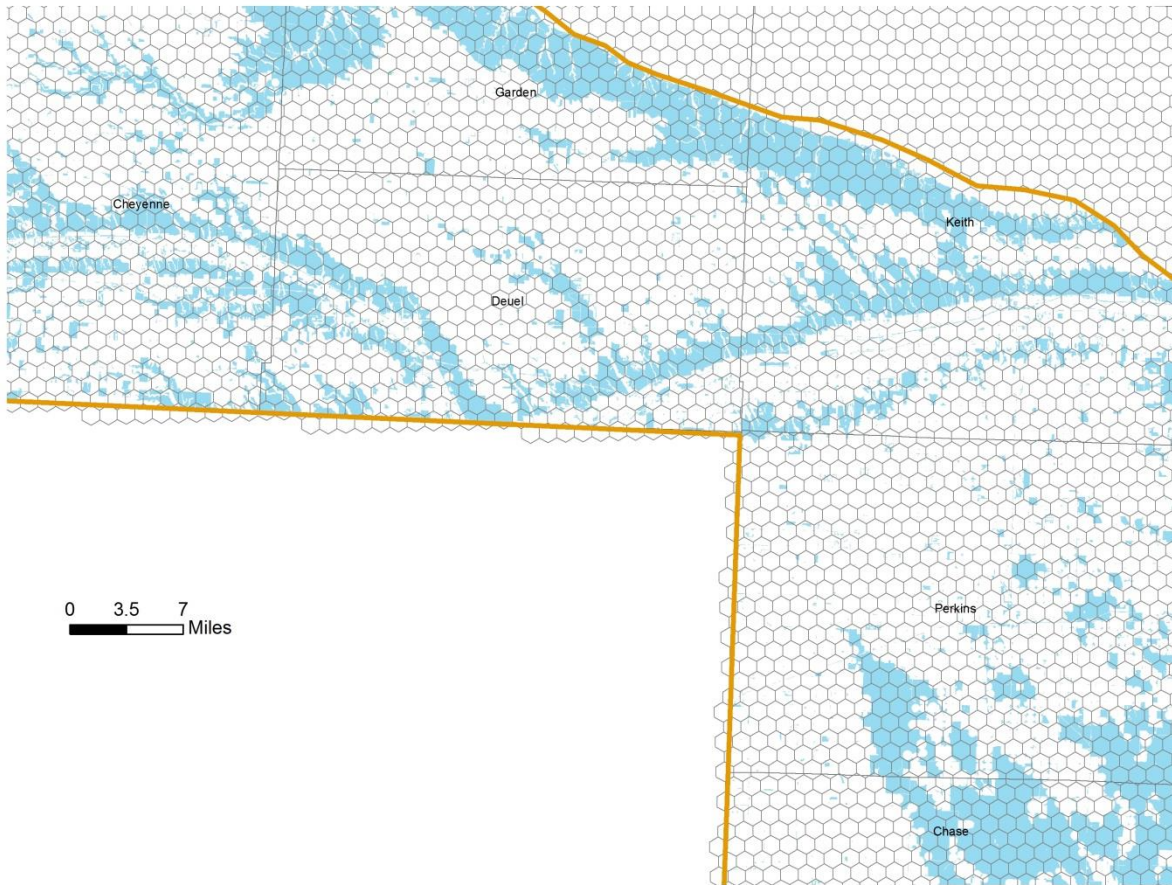
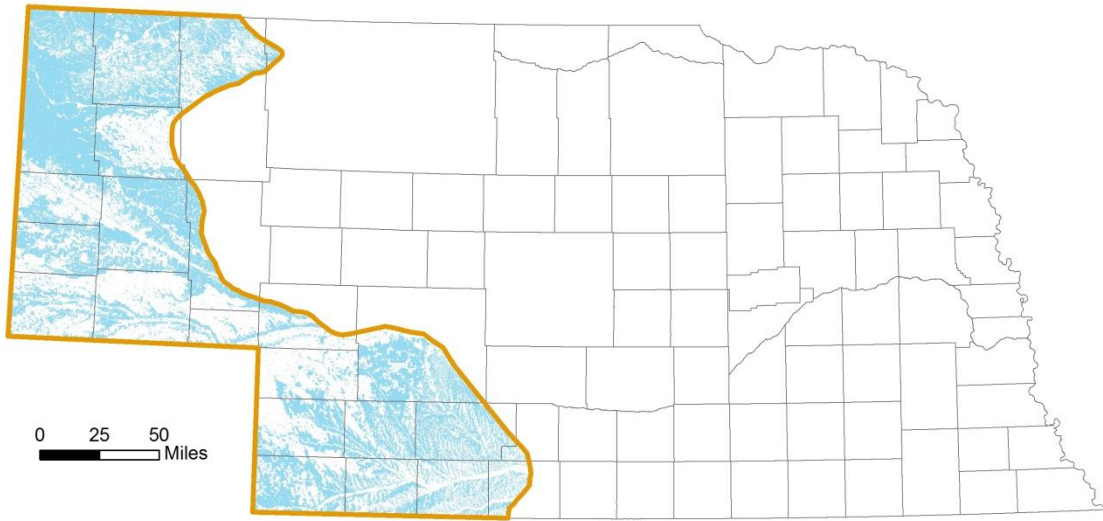
Swift Fox (*Vulpes velox*) AMAJA03030

The model is a raster representing suitable habitat within the range. Suitable habitat types were identified using landcover types Mixedgrass (71), Shortgrass (75), Sand Sage (87), and Sandhills (73) in a modified landcover data set from the Rainwater Basin Joint Venture. Any locations which were classified

as suitable habitat were included in the model. Note that for the development of the CHAT Species Of Concern data layer, for a hexagon to be classified as positive for the modeled distribution, at least 20% of the hex had to be occupied by the modeled area (whereas for all other species the threshold was set at 1%).

Modeled Area: Model extent is limited to the range.





REPTILES AND AMPHIBIANS

Blanding's Turtle (*Emydoidea blandingii*) ARAAD04010

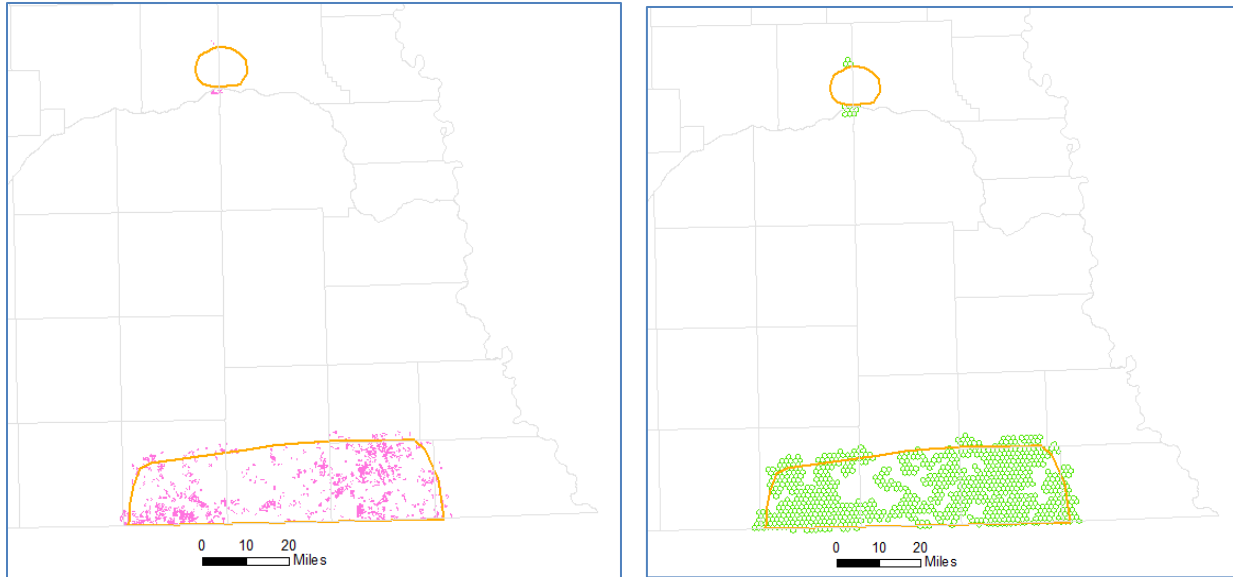
A raster representing suitable habitat was created. For the portion of the range within and west of the Sandhills ecoregion, suitable landcover types (floodplain marsh, emergent marsh, and lake) from a statewide landcover (a modified version of landcover produced by the Rainwater Basin Joint Venture) were included. For the entire state, stream features and suitable landcover types within 1 mile of the stream features were included. The stream features were 1) line and polygon features represented as perennial streams by the National Hydrography Dataset, 2) a polygon feature representing the Missouri River developed in-house, and 3) a line feature representing the Niobrara River from the Nebraska Department of Natural Resources. Following CHAT development it was noted that north of Sioux City, the NHD represents the Missouri River only as a line feature. Therefore an improvement to the model could be made by better representing this stretch of river.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Western Massasauga (*Sistrurus catenatus tergeminus*) ARADE03010

The model is a vector data set consisting of 1-square-mile hexagons in the range of the species or within 2 miles of the range, which contain patches of suitable habitat, and which are within 60 meters of particular water features. Also available is a vector data set consisting of the polygon features used to identify the relevant hexes (i.e. a set of polygon features representing the patches of suitable habitat within 60 meters of particular water features). To create the model, first, patches of suitable habitat were identified. Suitable habitat types were represented by landcover types Tallgrass Prairie (77), Sandhills Grassland (73), Potential Native Grassland (91), Emergent Marsh (152), Wet Meadow (247), Floodplain Marsh (248) in a modified landcover data set from the Rainwater Basin Joint Venture. Areas with these landcover types were buffered (using the 'Expand' function in ArcGIS Spatial Analyst) by one 30-meter pixel, and from the resulting patches those under 100 acres were removed. The purpose of the buffering was to avoid excluding areas of suitable habitat bisected by small roads. Once these areas that constitute patches of 100 acres or more were identified, unsuitable landcover (which had been added in during the buffering procedure) was removed from them. These areas were converted from raster to vector format. Next, the areas which met the criteria for distance to water were identified. Suitable water features were represented by landcover types Reservoir (104), Stock Pond (106), and Water Not Further Identified (1). These areas were converted from raster to vector format. Habitat features which were more than 60 meters from the water features were removed (result below, left). Last, one-square-mile hexagons which intersect with the remaining habitat features were identified (below, right)

Modeled Area: Model extent is limited to the range plus a 2-mile buffer. Note that although the model was run for the northern portion of the range, no areas inside the range met the criteria (the patches were either too small or too far from water). A few areas within the 2-mile buffer met the criteria, and a few intersecting hexes fell partly within the range.



Sagebrush Lizard (*Sceloporus graciosus*) ARACF14030

The model is a raster representing suitable habitat. Suitable habitat was represented by the Badlands/Cliffs/Outcrops (51) land cover class in a modified statewide landcover data set from the Rainwater Basin Joint Venture.

Modeled Area: Model extent is statewide.

PLANTS

American ginseng (*Panax quinquefolius*) PDARA09010

The model is a raster representing suitable habitat in patches 5 acres or larger within the range. Suitable habitat was represented by the Forest and Woodland (Upland) (61) land cover class in a modified statewide landcover data set from the Rainwater Basin Joint Venture. Patches of contiguous pixels of suitable land cover types that were under 5 acres were removed.

Modeled Area: Model extent is limited to the range. The range was limited to the area within 2 miles west of the boundary between the bluffs and the floodplain of the Missouri River.

Barr's Milk-vetch (*Astragalus barrii*) PDFAB0F150

The model is a raster representing locations classified in the Natural Resource Conservation Service's (NRCS) Soil Survey Geographic Database (SSURGO) as "Orella-Badland complex, 3 to 50 percent slopes" (soil code 6048). This is the soil type on which the species has been found in the state.

Modeled Area: The model extent is Sioux and Dawes County (inclusive of the species range). These are the counties in which SSURGO code of 6048 is used.

Colorado butterfly-plant (*Oenothera coloradensis ssp. coloradensis*) PDONA080F1

The model is a vector data set consisting of hexagons which are within the range and which may have suitable habitat. The hexagons were identified by selecting stream segments (using Nebraska DNR streams data set) in the range, buffering them by 50 meters, selecting those hexagons that intersect with the result, and eliminating any hexes outside of the range.

Modeled Area: Model extent is limited to the range.

Dog-parsley (*Lomatium nuttallii*) PDAPI1B1B0

A raster was created by combining ground and desktop survey locations (collected in 2007 by Bob Steinauer under a contract to NGPC) for badlands and rock outcrops. Ground survey data was used for places where it was available (primarily the Wildcat Hills north) and elsewhere desktop survey data was used. Areas identified as a mosaic of western mixed grass prairie and rock outcrop were excluded.

Modeled Area: The model was clipped to the range during post-processing. Users should be aware that the model did not cover the northern part of the range, because information for the features used for the model were not available in the data sources used.

Nodding Pogonia (*Triphora trianthophoros var trianthophoros*) PMORC2F051

The model is a raster representing suitable habitat in patches 5 acres or larger within the range. Suitable habitat was represented by the Forest and Woodland (Upland) (61) land cover class in a modified statewide land cover data set from the Rainwater Basin Joint Venture. Patches of contiguous pixels of suitable land cover types that were less than 5 acres were removed.

Modeled Area: Model extent is limited to the range. The range was limited to certain areas within 2 miles west of the boundary between the bluffs and the floodplain of the Missouri River.

Mat Prickly-phlox (*Linanthus caespitosus*) PDPLM08010

A raster was created by combining ground and desktop survey locations (collected in 2007 by Bob Steinauer under a contract to NGPC) for badlands and rock outcrops. Ground survey data was used for places where it was available (primarily the Wildcat Hills north) and elsewhere desktop survey data was used. Areas identified as a mosaic of western mixed grass prairie and rock outcrop were excluded.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Prairie Moonwort (*Botrychium campestre*) PPOPH010W0

The model is a raster representing suitable habitat. Suitable habitat was represented by the land cover classes Forest and Woodland (Upland) (61), Ponderosa Pine Forest and Woodland (60, 63, 69), Eastern Red Cedar (59) in a modified statewide land cover data set from the Rainwater Basin Joint Venture.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Saltwort (*Salicornia rubra*) PDCHE0J020

The model is a raster representing areas identified as Category 1 Saline wetlands in the saline wetland database created by the NGPC Wetlands Program (Lead biologist: Ted LaGrange).

Modeled Area: Model includes all Category 1 Saline Wetlands both inside and outside current species range.

Sandhill Goosefoot (*Chenopodium cycloides*) PDCHE090G0

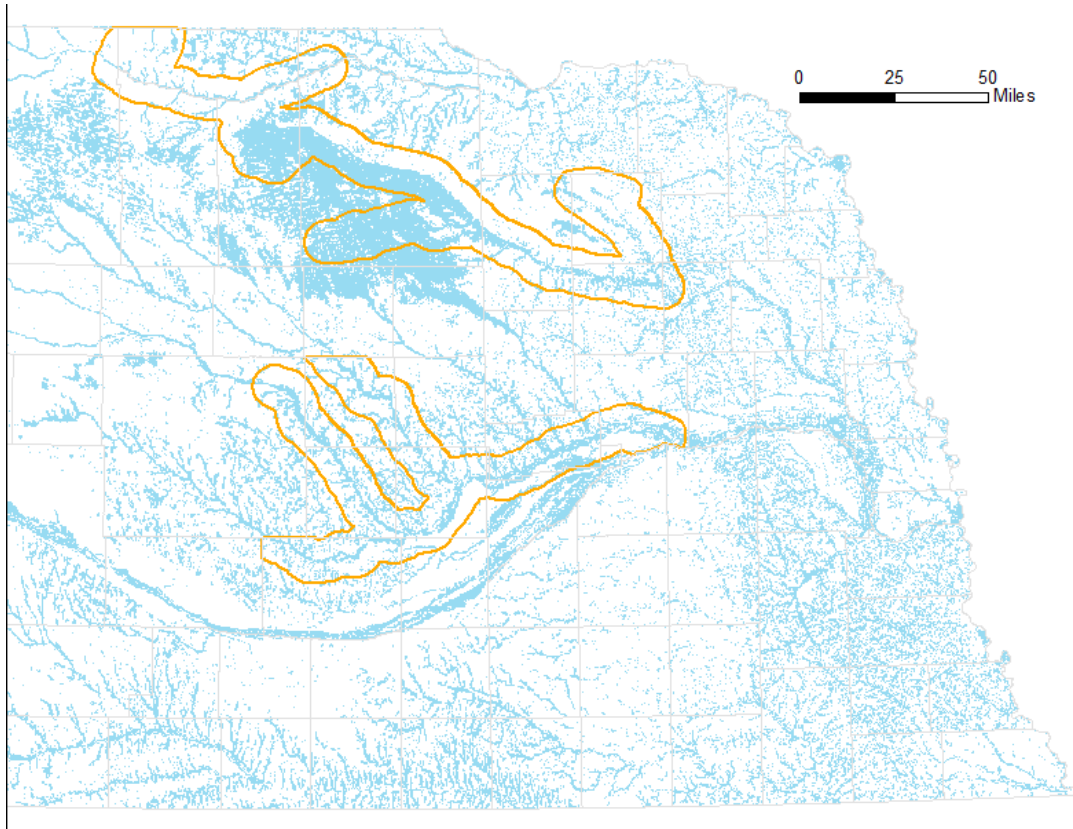
The model is a raster representing suitable habitat. Suitable habitat was represented by the land cover class Sand Sage (87) in a modified statewide land cover data set from the Rainwater Basin Joint Venture.

Modeled Area: Model extent is limited to the range.

Small White Lady's-Slipper (*Cypripedium candidum*) PMORCOQ050

A raster representing wet meadow was created using landcover class 247 (wet meadow) from a modified statewide landcover data set from the Rainwater Basin Joint Venture.

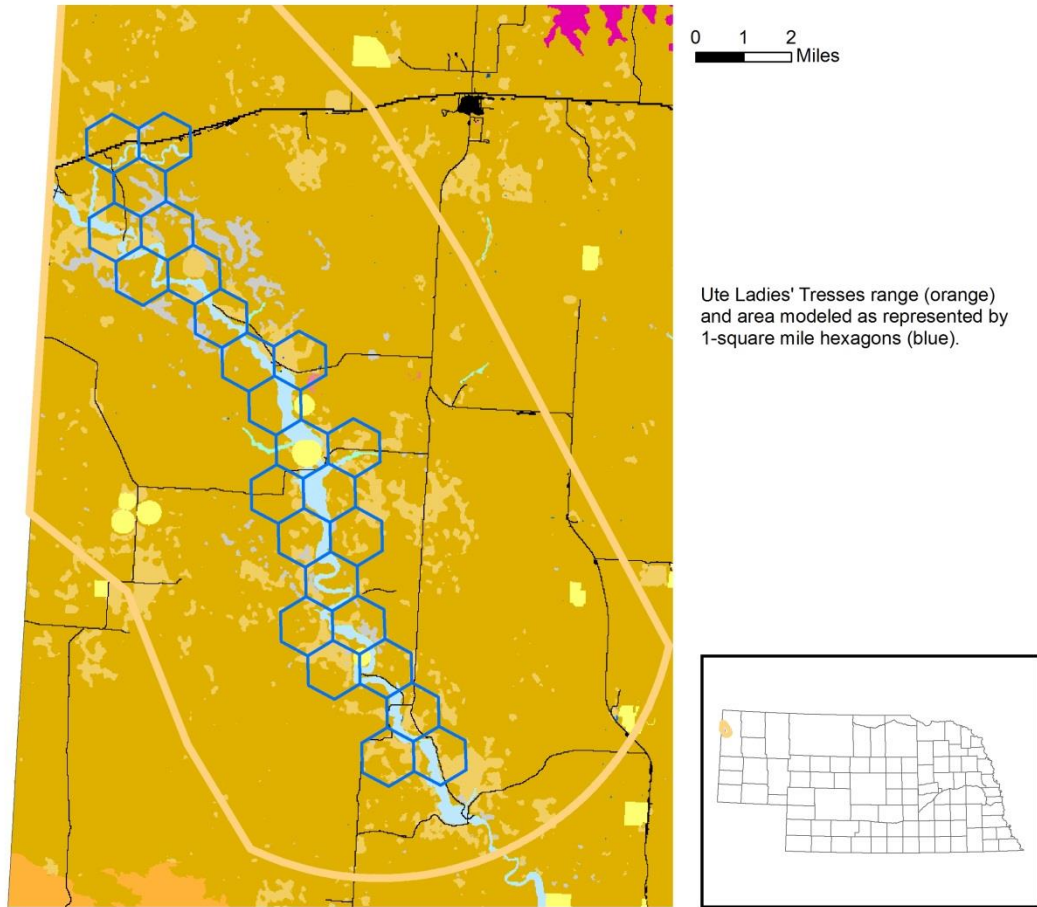
Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).



Ute Ladies'-tresses (*Spiranthes diluvialis*) PMORC2B100

The model is a raster representing suitable habitat within the range. In the event that this level of detail is considered too high for a listed species with a limited distribution, the model is also available as a vector data set consisting of hexagons that contain suitable habitat in the range. The plant community type in which the species is found is alkaline meadow. For the model, suitable habitat was represented by Saline Wetland (153) in a modified landcover data set from the Rainwater Basin Joint Venture. This land cover type was used because in the RWBJV land cover data set, areas assigned that value include alkaline meadow.

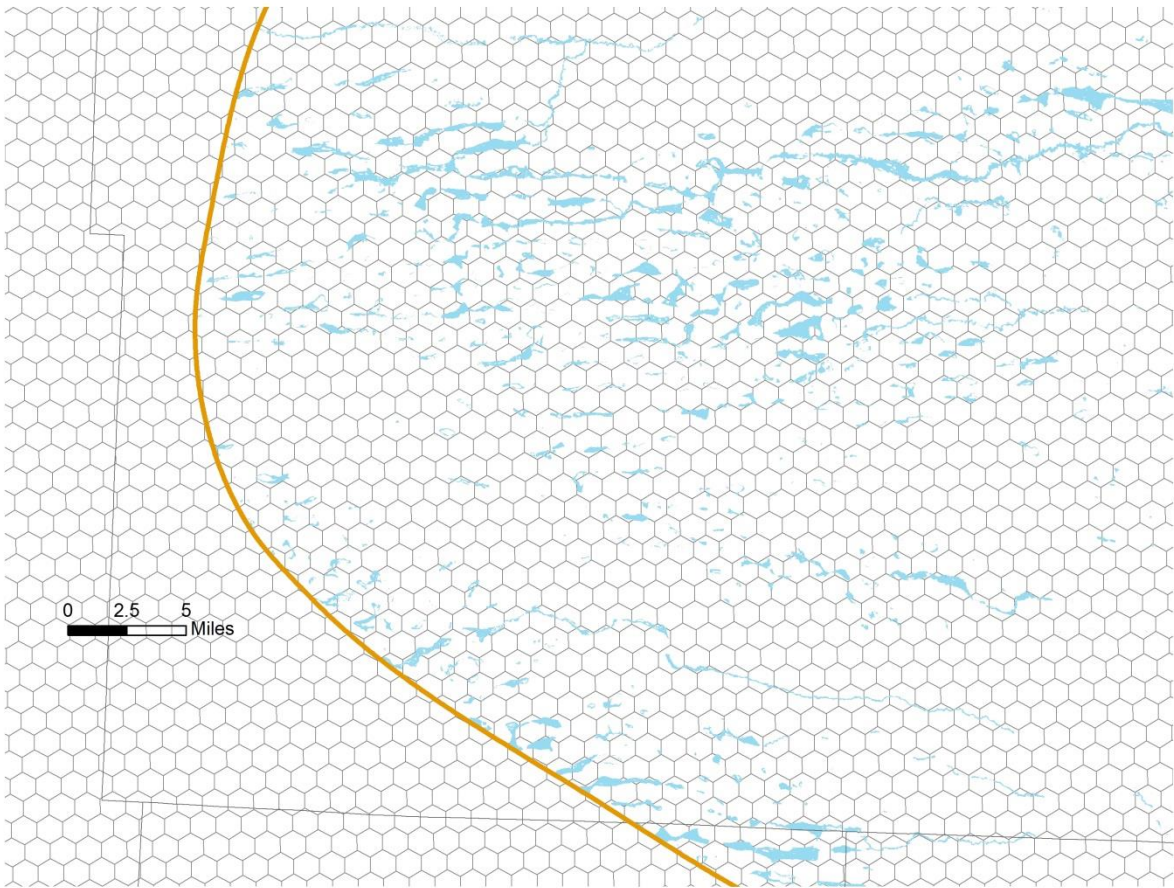
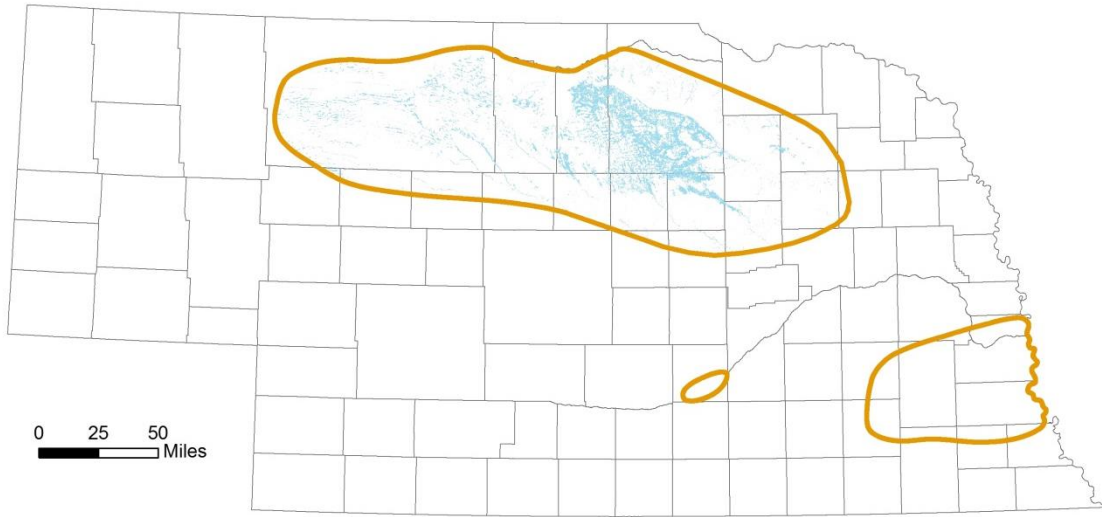
Modeled Area: Model extent is limited to the range.



Western Prairie Fringed Orchid (*Platanthera praeclara*) PMORC1Y0S0

The model is a raster representing suitable habitat in one of the three parts of the species range. The other two areas were not amenable to modeling. Suitable habitat was represented by Wet Meadow (247) land cover class in a modified statewide landcover data set from the Rainwater Basin Joint Venture.

Modeled Area: Model extent is limited to a portion of the range (the Sandhills).



Wolf's Spikerush (*Eleocharis wolfii*) PMCYP091Z0

The model is a raster representing suitable habitat. Suitable habitat was represented by the land cover classes Sandhills Wetland (13), Emergent Marsh (152), and Wet Meadow (247) in a modified statewide land cover data set from the Rainwater Basin Joint Venture.

Modeled Area: Model extent is statewide (model was clipped to range during later steps in the development of the WGA CHAT Species Of Concern Data Layer).

Appendix: List of the major data sources used in the models.

Dataset	Description	Data Steward
Nebraska Land Cover. 2013. Rainwater Basin Joint Venture.	<i>Methods documented in</i> Bishop, A., A. Barenberg, N. Volpe, and R. Grosse. 2011. Nebraska Land Cover Development. Rainwater Basin Joint Venture Report. Grand Island, NE.	Rainwater Basin Joint Venture
Nebraska Natural Heritage Program Range Maps for SGCN Species. 2013.	Range maps for listed and other SGCN species	NGPC NENHP
Distribution model for Rocky Mountain bighorn sheep in northeastern Nebraska. 2011.	<i>Methods documented in</i> R. A. Tucker. 2011. Evaluating the use of the escape terrain and buffer model to depict northwestern Nebraska's bighorn sheep habitat. MS thesis. Chadron State College, Chadron, NE.	NGPC and R. Tucker
Distribution model for greater prairie-chicken. 2012.	<i>Methods documented in</i> Rainwater Basin Joint Venture. 2012. Assessing species occupancy and distribution throughout Nebraska. Rainwater Basin Joint Venture, Grand Island, NE.	NGPC
Distribution model for ferruginous hawk and golden eagle. 2012.	<i>Methods documented in</i> A. Bishop et al. 2012. Ferruginous hawk and golden eagle habitat suitability indices. Rainwater Basin Joint Venture, Grand Island, NE.	NGPC
Distribution model for burrowing owl. 2012.	<i>Methods documented in</i> A. Bishop et al. 2012. Prairie dog and burrowing owl habitat analysis throughout Nebraska. Rainwater Basin Joint Venture, Grand Island, NE.	NGPC
U.S. Geological Survey in cooperation with U.S. Environmental Protection Agency, USDA Forest Service,	Feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system.	USGS

and other Federal, State and local partners. 2009. National Hydrography Dataset. U.S. Geological Survey, Reston, VA.

Wind energy and Nebraska's wildlife: an index of the sensitivity of wildlife habitats to wind energy development, based on selected at-risk species. 2011.

Nebraska Game and Parks Commission, Lincoln, Nebraska.

Distribution model for American burying beetle in the Sandhills. 2012.

Distribution model for American burying beetle in the Loess Canyons. 2011.

Map showing relative sensitivity, on a landscape-scale, of wildlife habitats to wind energy development, based on selected at-risk species. URL: <http://outdoornebraska.ne.gov/wildlife/pdfs/wildlifewind.pdf>

NGPC

Methods documented in Jurzenski, J. August 1, 2012.

Factors affecting the distribution and survival of endangered American burying beetles, *Nicrophorus americanus* Olivier. Dissertations and student research in entomology. Paper 20.

<http://digitalcommons.unl.edu/entomology/20>. University of Nebraska-Lincoln, Lincoln, NE.

J. Jurzenski

Methods documented in McPherron, M.M. 2011. A model of *Nicrophorus* species occurrence in the Nebraska Loess Canyons and effects of different grasses on burial behavior. MS. Thesis. University of Nebraska at Kearney, Kearney, NE.

M. McPherron