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ABSTRACT -- The greater prairie-chicken (*Tympanuchus cupido*) and lesser prairie-chicken (*Tympanuchus pallidicinctus*) have experienced considerable fluctuations in their range and distribution over time. Having current range maps would help wildlife managers and policy makers with decisions regarding prairie-chicken habitat. To create an updated and accurate map of the Kansas prairie-chicken range, a two-pronged approach was implemented. First, a map of potential habitat was created by using known habitat preferences and avoidance factors. Second, a preliminary map showing the distribution of greater and lesser prairie-chickens was created and mailed to regional experts for comments and edits. The returned edits were processed to produce a current and accurate map of prairie-chickens in Kansas that has been updated annually as necessary.

Key words: greater prairie-chicken, Kansas, lesser prairie-chicken, range maps, remote sensing, *Tympanuchus cupido*, *Tympanuchus pallidicinctus*.

Though greater prairie-chicken (*Tympanuchus cupido*) and lesser prairie-chicken (*Tympanuchus pallidicinctus*) use somewhat different grassland habitats, populations of both species have declined due to losses in habitat quantity and

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quality. Wildlife biologists have monitored these losses, but due to the seclusive nature of these birds during most of the year, keeping distribution maps current is difficult. Horak (1985) compiled historic distribution maps of Kansas prairie-chicken ranges for four time periods (pre-European settlement, 1950, 1962, and 1980) that showed range changes over time. Recognizing continued pressures on habitat, the Kansas Department of Wildlife and Parks and the Kansas Applied Remote Sensing program (KARS, a branch of the Kansas Biological Survey) worked together to create an updated map of greater and lesser prairie-chicken distribution in Kansas. The final product was an Arc shapefile available by request and later included in the online Wind Resource Planner GIS application (WRP 2008).

The greater prairie-chicken (GPC) has experienced a major reduction to its original range and population size. Once occurring from the east coast west to Colorado, and from Canada to Texas, it had a population in the late 1800's in the millions (mainly concentrated in Kansas, Nebraska, and South Dakota). At present, the GPC is extirpated in 15 states (Johnsgard 1973, Schroeder and Robb 1993, Robbins et al. 2002)

The lesser prairie-chicken (LPC) has lost much of its original population size and habitat due to the conversion of rangeland to cropland, improper grazing management, and human developments. Historically and currently, the LPC has the smallest population and most restricted distribution of all grouse species in North America (Giesen 1998). Presently, LPC occurs only in Colorado, Kansas, New Mexico, Oklahoma, and Texas (Applegate and Riley 1998). Habitat loss did not occur as quickly for the LPC as for the GPC because the more arid short and mixed-grass prairie and semi-arid shrublands of the western Great Plains were less attractive for agricultural development. According to Sexson (1983), sandsage-prairie habitats within the range of the LPC declined in the 1960's and 1970's when the introduction and spread of center-pivot irrigation facilitated widespread conversion of these prairies to irrigated croplands. Between the 1800's and 1980, LPC range decreased by 92%, with 78% of that occurring since 1963 (Taylor and Guthery 1980). In 1995, the United States Fish and Wildlife Service was petitioned to list the LPC as threatened under the Endangered Species Act. The species was not listed as threatened or endangered, but was placed on the list of candidate species.

Even though conversion of grasslands to cropland has been the primary threat to habitats of both GPC and LPC in Kansas, habitat degradation due to tree encroachment, oil and gas development, and other factors is a major concern. With increasing pressures on prairie-chicken habitat from proposed wind power facilities and other development, an updated map showing the current distribution of GPC and LPC throughout the state was needed.

METHODS

Because we were interested in mapping both potential and known prairie-chicken distributions in Kansas, two approaches were used. First, the potential prairie-chicken distribution was mapped by identifying and buffering suitable habitat by using a state landcover map. Second, known distributions were mapped by surveying regional experts across the state. Hereafter, these maps are respectively referred to as the "habitat-modeled" and "expert-delineated" maps. By employing this two-pronged approach, the two independently generated maps could be compared to identify areas of non-overlap that warrant future investigation.

Using ERDAS (2007) Imagine software to process the Kansas GAP vegetation map (Cully et al. 2002), we were able to identify eight vegetation communities (sandsage shrub land, tallgrass prairie, sand prairie, western wheatgrass, sandstone glade/prairie, mixed prairie, shortgrass prairie, and Conservation Reserve Program grasslands) (Lauver et al. 1999) that could be suitable for prairie-chicken habitat depending on the vegetation structure present. The eight classes were recoded to a single value (1) and subset, and then a clump and sieve procedure was used to remove patches smaller than 2 square miles, or 518 ha (1280 acres). This patch size was selected after a number of attempts using smaller patches, which, due to the highly interconnected nature of Kansas grasslands (fence rows and other narrow corridors), left too much geographic area (as opposed to calculated surface area) in the data set.

With the primary potential prairie-chicken habitat identified, two additional modifications were made. First, a 1.6 km (1-mile) buffer around grassland patches was added to account for movement and feeding patterns. This buffer distance was selected as a reasonable estimate of the regular movements. Second, an avoidance factor was added to account for land cover features that prairie-chickens are known to avoid and a one-sixteenth of 1.6 km (1mile) buffer was created around these negative associations. Land cover classes that were avoided included upland and riparian woodland classes, and urban area. The avoidance distance was adapted from those documented for overhead transmission lines (Robel et al. 2004, Pitman et al. 2005) as trees also serve as roosting sites for predators and would likely be similarly avoided. As a last step, the avoidance area was removed from the suitable habitat area.

Realizing it was not feasible to find and map every prairie-chicken lek, we used ESRI (2008) ArcGIS software, to create a draft map of the known distribution of prairie-chickens in Kansas by combining our own personal knowledge of prairie-chicken distributions in the state with the Kansas GAP landcover map onto a series of transparencies. These transparencies were scanned, geo-referenced, mosaiced, and digitized to create a digital outline of GPC and LPC distribution. This rough

delineation was used to create a map that was mailed to regional experts for comments and edits. A series of three maps were created by dividing the state into thirds (eastern, central, and western). Each region showed the draft prairie-chicken distributions overlaid on a generalized GAP vegetation map with ancillary data such as county boundaries and major highways to provide spatial reference. Draft maps were distributed in late winter so that recipients would have the option of conducting field assessments during the spring lek displays.

The edits were compiled onto a single new map that was then returned to KARS where the GIS vector layers of the GPC and LPC distribution ranges were edited to match the revised map. The revised map was then mailed out again to the same group of people for verification. Any additional edits were compiled and the necessary changes made to the GIS coverage.

RESULTS and DISCUSSION

We found that use of a mailing to regional experts to request the identification of known prairie-chicken habitat worked reasonably well. Of the 129 people that received regional maps for edits, 16 people responded with edited maps and 20 commented that no changes were necessary for their area. We speculate that many of the 93 persons who did not respond saw no need for changes for their areas of geographic familiarity. Once aggregated, the resulting information provided the necessary knowledge base to create an up-to-date expert-delineated map of the range of GPC and LPC in Kansas (Fig. 1).

Efforts to use the Kansas GAP vegetation map to identify suitable prairie-chicken habitat also appeared to be successful, with the resulting habitat-modeled map producing distributional patterns similar to those identified by the expert-delineated map (Fig. 2). By setting the clump-sieve threshold to 2 square miles, or 518 ha (1280 ac), many of the smaller parcels were eliminated from the map of suitable habitat, which would have resulted in a gross overestimation of suitable habitat. When finished, the expert-delineated map showed a range covering 2,903,364 ha (7,174,369 ac) for LPC while the habitat-modeled map showed 2,221,133 ha (5,488,539 ac) of LPC habitat. The expert-delineated map showed a range covering 8,078,847 ha (19,963,266 ac) for GPC while the habitat-modeled map showed only 4,655,941 ha (11,505,083 ac) of GPC habitat. When combined, the total expert-delineated range for GPC and LPC (accounting for overlap areas) was 10,064,883 ha (24,870,868 ac) and the total habitat-modeled map (including the buffered area) totaled 9,062,952 ha (22,395,042 ac), for a difference of 1,001,931 ha (2,475,826 ac).

Some of these differences in area can be explained by the generalized pattern of the expert-delineated range map, which included areas such as small riparian corridors, as suitable whereas the more-detailed habitat-modeled map identified such areas as being unsuitable. In addition to identifying and excluding unsuitable

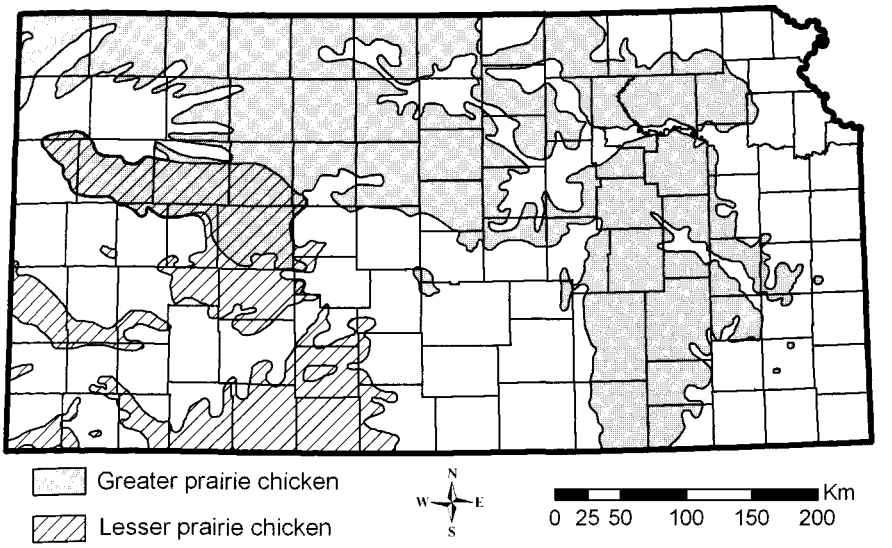

Figure 1. Greater and lesser prairie-chicken range in Kansas as delineated by expert opinion (2005).

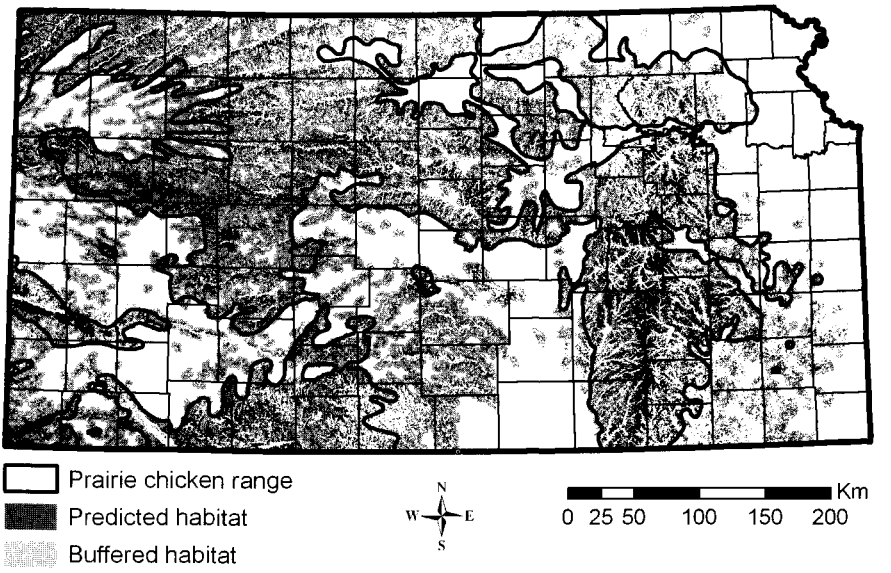

Figure 2. Map showing the delineated range (solid lines) and the modeled potential habitat (shaded area) for prairie-chickens in Kansas.

habitat, the habitat-modeled map included large areas of grassland habitat in far western, south central, and southeastern portions of the state that were not delineated by experts as currently occupied by prairie-chickens. Closer examination of these areas generally explained theses discrepancies. The habitat areas in southeastern and south central Kansas are highly fragmented by encroaching woody species and thus are not suitable for prairie-chickens. Conversely, extensive shortgrass prairie habitats in semi-arid western Kansas have insufficient structural and height diversity for these birds.

The prairie-chicken range maps have received a positive response from wildlife biologists and other parties interested in prairie-chicken conservation. In the two years since the initial map was created, the map has undergone only minor changes as additional information has become available. We suggest a survey of regional experts works well for species that are identified easily but often seclusive, like prairie-chickens, though the timing of the survey is important so that appropriate field observations can be made in areas of question.

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