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State of Kansas Big Game Connectivity Action Plan 2025

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KANSAS ACTION PLAN

For

Implementation of Department of the Interior Secretarial Order 3362: "Improving Habitat Quality in Western Big-Game Winter Range and Migration Corridors"

Introduction - Secretarial Order 3362 (Appendix A) was signed on February 9, 2018 (SO 3362) and it directs appropriate agencies within the Department of the Interior [U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), and Bureau of Land Management (BLM)] to work in close partnership with various states, including the state of Kansas to identify, enhance, and improve the quality of big-game winter range habitats and migration corridors in a way that recognizes state authority for conserving and managing big-game species and respects private property rights. Through research and land management actions, wildlife such as mule deer (*Odocoileus hemionus*; hereafter deer), pronghorn (*Antilocapra americana*; hereafter pronghorn), Rocky Mountain elk (*Cervus canadensis*; hereafter elk) and other wildlife and their habitats may benefit.

Conditions in the broader landscape may influence the function of migration corridors and sustainability of big game populations. Such conditions may include habitat fragmentation, land use patterns, resource management, or urbanization. The United States Department of Agriculture (USDA), through the USDA Forest Service (USFS) and USDA Natural Resource Conservation Service, will collaborate with DOI, the states, and other natural resource managers across the broader landscape when developing an all-lands approach to research, planning, and management, for ecological resources, to include migration corridors in a manner that promotes the welfare and populations of elk, deer, and pronghorn, as well as the ecological integrity of terrestrial ecosystems in the plan area.

Kansas has approximately 52.5 million acres of total land area, and approximately 52 million acres (99%) are in private landownership (Fig. 1). The single largest tract of public land in Kansas is found in the southwest corner of the state in the Cimarron National Grasslands (109,000 acres) managed by the USFS. The Kansas Department of Wildlife and Parks (KDWP) manages less than 400,000 acres of public land across the state of Kansas. Big game management in the grasslands of the Great Plains presents some unique challenges that are often not found in more western regions of the United States, especially related to public versus private land ownership. For example, Kansas is ranked 50th of all 50 states in the USA in terms of the percentage of public lands (<2% of the state is in public ownership), and a high percentage of private land ownership is common throughout the Great Plains region (Fig. 1). The growing populations of elk juxtaposed with the decline of mule deer and pronghorn over recent decades in Kansas and across the West has elevated management issues and concerns to Kansas Department of Wildlife and Parks (KDWP). The high percentage of private lands in Kansas emphasizes the

importance of collaborative state-private landowner partnerships that recognize and appropriately work together to manage crucial winter range and movement corridors for species of big-game wildlife with large home ranges and/or migratory behavior. Further, there is currently a dearth of data on big game movements in Kansas, as evidenced by the fact that only one study of elk has used GPS collars and no pronghorn have ever been marked with GPS collars in the state's history, although see (Combe et al. 2021) for recent GPS collaring work on mule deer and white-tailed deer (O. *virginianus*) in western Kansas. In fact, the last studies on pronghorn using collars in the 1990s all deployed VHF transmitters and elk have only been GPS collared on Fort Riley in eastern Kansas in the early 2000s (Conard and Gipson 2012, Conard et al. 2012). Several research projects were conducted during the 1990s on the pronghorn population in the Flint Hills region including behavior, home range, and habitat use (Simpson 1992), coyote (*Canis latrans*) home range and fawn predation (Jorgensen 1992), fawn behavior, home range, habitat use (Rothchild 1993), habitat utilization (Eccles 1995), and dietary selection (Ganey 1998). However, none of these older studies utilized GPS collar technology.

To achieve the objectives of SO 3362, the Department of Interior asked states to identify 3-5 priority migration corridors or winter range habitats for big game species in their respective state. Where information on specific migration corridors or winter range habitat is lacking, the DOI requested states to identify their top 2-3 research priorities to fill these data or knowledge gaps. The following summary outlines the Kansas response and justification for the selected corridors and priority research.

Corridor/Winter Range – Pronghorn, mule deer and elk occur in various regions of Kansas, but three major intact grasslands in Kansas (Flint Hills, Smoky Hills, western Kansas shortgrass/CRP mosaic region; Fig. 2) will be the focus of our work and prioritization for protecting and enhancing habitat connectivity for these three species. KDWP has a mission to conserve and enhance Kansas' natural grasslands, the associated wildlife and habitats to ensure future generations the benefits of the state's diverse grassland types. Several transition zones of various grasslands occur in Kansas. With most moisture (approximately 75-85% depending on location) falling as rain during warm months, and the remainder falling as snow, there is a large gradient east to west across the state with areas approaching 40-45 inches of moisture per year in the southeast part of Kansas down to less than 15-20 inches of moisture per year in western Kansas.

As a result, Kansas contains three broad classifications of North American grasslands: 1) tallgrass prairie (the most endangered ecosystem in North America with less than 4% of the original extent remaining). In fact, the largest intact, contiguous tract of tallgrass prairie in North America is the Flint Hills region of eastern Kansas; 2) the mixed grass prairie of central Kansas (e.g. the KDWP Smoky Hills priority area); and 3) the shortgrass/CRP mosaic region found in the western third of Kansas. As such the management goals and challenges vary across Kansas' grasslands.

The current goals/objectives in the grasslands of Kansas generally revolve around the

following three issues: 1) halt and reverse the transition of grasslands to eastern deciduous forest and other woody encroachment through the use of prescribed fire and mechanical brush removal; 2) re-establish warm-season native grasses in areas where non-natives (e.g. smooth brome) or invasive species (e.g. *Sericea lespedeza*, and Old World Bluestem) have been established; and 3) establish connectivity between various intact grassland habitats and enhance species diversity and composition in these critical grasslands (e.g. allow forb component of grasslands to be established vs monocultures of grass, particularly in crucial winter range for big game species). KDWP is partnering with private landowners, NGOs, and federal agencies such as NRCS (e.g. through the NRCS Great Plains Grassland Initiative-GPGI) to defend and grow the core of grassland strongholds in Kansas. There is also concern by KDWP that grassland acreage enrolled in federal programs such as the Conservation Reserve Program (CRP) through the USDA Farm Services Agency (FSA) are declining over the past 20-30 years and fewer acres of grassland habitats are available across the state on private lands; thus reducing grassland connectivity and amount of crucial fawning habitat and winter thermal cover for big game. For example, Kansas has lost more than 1.5 million acres (50%) of CRP since the highs of enrollment around 2007.

In the three broad grassland priority areas, two mule deer populations in western Kansas clearly stand out as meeting the need for prioritization based on SO 3362 (Figs. 2-4). In addition to these mule deer herds, two pronghorn herds have been identified as a priority from a conservation and economic value to Kansas. The two pronghorn herds selected for this action plan occur in western and eastern Kansas (Figs. 5-6), but, as with the mule deer herds, movement data and analyses are currently lacking to adequately identify corridors and crucial winter range for these herds. An issue KDWP proposes to address in this action plan and through our research projects.

<u>Pronghorn</u> –

Corridor/Movement #1 – Pronghorn Movement/Migration in Flint Hills Region

In the Flint Hills region of eastern Kansas, pronghorn (*Antilocapra americana*) were reintroduced in the late 1970s – early 1990s (Figs. 5-7). Historical accounts by Zebulon Pike in 1806 during his expedition of what is now Chase County, Kansas in the Flint Hills reported pronghorn were 'common' in the region (Sexson and Choate 1981) and the eastern extent of historical pronghorn range in North America appears to have been along the eastern edge of the state of Kansas (Simpson 1992; Fig. 7). Although documentation of declining pronghorn numbers from the Flint Hills region are limited, it appears they were extirpated from the area by 1874 (Sexson and Choate 1981). After nearly a century of absence, pronghorn reintroductions by the Kansas Department of Wildlife and Parks in the Flint Hills region of Chase County began in 1978 with additional releases taking place in 1979, 1982, 1983, 1991 and 1992 (Sexson and Choate 1981; Simpson 1992; Rothchild 1993).

One of the attractive attributes of this area for pronghorn reintroductions by KDWP was the intactness of the grassland habitat of the Flint Hills. The Flint Hills region is the largest intact, contiguous tallgrass prairie left in North America, where over 97% of original tallgrass prairies have been lost due to agriculture conversion and other factors (Smith

1992). The individuals for the first two releases of pronghorn in the Flint Hills originated from the Eden/Farson area of southwest Wyoming. The next three releases consisted of individual pronghorn that were captured near Lamar, Colorado, and the final release came from the US Department of Transportation (USDOT) railroad testing facility outside Pueblo, Colorado (KDWP, unpub. data). A total of 376 pronghorn were released in the eastern portion of Chase County, Kansas located in the Flint Hills region. The release site was bounded by the Cottonwood River to the north, I -35 (Kansas Turnpike) to the south/southeast, and the South Fork Cottonwood River to the west (Fig. 8). Currently there is concern that this population of pronghorn is limited in movement by an array of anthropogenic factors including fences and roads/highways. Rue and Ranglack (2025) inventoried habitat conditions and concluded bottom wire fence heights were inadequate across the Flint Hills from a landscape permeability perspective. This concern was further heightened by the fact that this population is thought to be isolated from other known established pronghorn populations in western Kansas by at least 300 km (Rue and Ranglack 2025), an idea that warrants further study (see proposed work below).

The uniqueness of the Flint Hills pronghorn population is significant on its own merit ecologically as a successful reintroduction occurring in large expanses of intact tallgrass prairie near the periphery of pronghorn historical range and isolated from other pronghorn populations. Additionally, this population represents the easternmost, free-ranging pronghorn population in North America and the only population living exclusively in tallgrass prairie. Thus, the protection and expansion of this pronghorn herd is a worthwhile goal from many different perspectives, including but not limited to, ecological, evolutionary, biodiversity, and intrinsic values of this wildlife species that is the only living member of its family that is also endemic to North America.

Risks or threats to this pronghorn population include: 1) conversion of native grassland habitat to eastern deciduous forest where large-scale fires occur in > 3-year intervals and this infrequency allows transition of prairie to forests; 2) eastern red cedar, elm, and locust tree encroachment in open grassland-steppe habitats that reduces the open habitats that pronghorn prefer for resource and habitat selection; 3) increasing constrictions in the migration/movements of pronghorn where non-wildlife friendly fences and roads (e.g. I-35) are expanding and reducing landscape permeability and habitat connectivity; 4) potential genetic inbreeding due to isolation from other pronghorn populations; and 5) dearth of movement data for pronghorn in the region inhibits appropriate management actions and lack of information on areas to target on the landscape.

Corridor/Movement #2 – Pronghorn in the shortgrass/CRP mosaic region of western Kansas

Western Kansas is comprised primarily of cropland interspersed within shortgrass prairie. Western Kansas has a much larger population of pronghorn than found in the Flint Hills of eastern Kansas. However, the higher fragmentation of native grasslands in western Kansas compared to the intact Flint Hills of eastern Kansas may be influencing movement behavior, habitat selection, and genetic diversity with respect to pronghorn, particularly

with recent changes in cropping systems. Similar to eastern Kansas, the vast majority of pronghorn habitat is in private landownership in western Kansas. The priority areas for pronghorn in western Kansas occur in two general regions (northwest Kansas centered on the counties of Logan, Wallace, and Gove; and southwest Kansas centered on the Cimarron National Grasslands in Morton and Stevens counties along with Clark County; Figs. 2 & 6).

Traditional cropping systems in western Kansas were largely winter wheat (*Triticum aestivum*)/fallow/grain sorghum (*Sorghum bicolor*; also known as milo). The cropping rotations have changed in the last 20 years in western Kansas with the development of GMO (Genetically Modified Organism) dryland corn (*Zea mays*) varieties that are adapted to low annual precipitation environments. GMO dryland corn has become an increasingly popular alternative to grain sorghum in western Kansas. One noticeable difference between corn vs grain sorghum is plant height. Pronghorn rely heavily on their keen eyesight to evade predators, preferring vegetation heights between 25 – 46 cm and will completely avoid areas > 76 cm in vegetation height (Yoakum et al. 2014). Since corn generally has taller vertical structure and denser canopies when compared to grain sorghum, it has the potential to become a visual/behavioral obstacle affecting pronghorn movement and hence landscape permeability/connectivity, an idea that warrants further attention in our proposed research (see below). Areas with extensive standing corn for prolonged periods could pose a significant barrier to pronghorn, thus limiting their ability to move across the landscape between blocks of native grasslands for up to several months, thereby potentially increasing habitat fragmentation and inhibiting pronghorn movements. Additionally, the major losses of Conservation Reserve Program (CRP) grasslands in Kansas (~ 446,500 ha) from FY 2010 – 2020 (USDA 2025) may also be affecting habitat connectivity for pronghorn and other grassland species. The end result is that the much larger population numbers of pronghorn of western KS may actually exist in even smaller, isolated groups than found in the smaller overall population of pronghorn found in the Flint Hills of eastern Kansas, an idea that will be studied by KDWP.

Risks or threats to this pronghorn population include: 1) conversion of native grassland habitats to cropland, particularly with a shift from wheat and grain sorghum production which pronghorn use to corn which pronghorn avoid, 2) loss of CRP grasslands due to declining enrollment rates with the FSA due to high commodity prices and low rental rates for CRP; 3) decline of grassland quality through expansion of trees and other woody encroachment; and 4) habitat fragmentation by I-70, state highways, and other roads in this highly fragmented landscape potentially leading to habitat patches falling below thresholds of size that pronghorn will use/select or move through.

<u>Mule deer</u> –

Corridor/Movement #1 – Mule deer Movement/Migration in Smoky Hills Region (DMUs 1-4)

Early reports indicate that deer were abundant in Kansas, although many early explorers

failed to distinguish species. The Lewis and Clark Expedition in 1804 noted "immense numbers of deer along the Missouri River near present day Kansas City and in 1818 a military detachment reported killing 2,000-3,000 deer between Atchison and Leavenworth Counties. Observations were widespread, as Zebulon Pike reported in 1805 observations of deer in modern day Chase, Coffey, Lyon, Morris and Woodson Counties and J.R. Mead in 1859 gave evidence of white-tailed deer in Barber and Commanche Counties. Written accounts of mule deer are less common, but Thomas Say notes mule deer were rather common over the greater part of Kansas in 1823 and J.R. Mead mentions mule deer between the Saline and Solomon Rivers in 1859.

By 1904 D. E. Lantz (1903-1904) listed white-tailed deer as extinct in Kansas and mule deer as entirely disappeared. In his "A Survey of Overpopulated Deer Ranges in the United States" Aldo Leopold (1947) called Kansas the "last deerless state", but this would quickly change. By 1962 documentation of accidently or illegally killed deer indicated approximately 12,000 deer in Kansas. In 1965 Kansas held its first modern deer hunting season and until 1994 only residents could hunt deer in the state. Kansas deer herds likely reestablished through growth of remnant populations, potential private stocking, escaped captive animals and resulting immigration from growing populations following neighboring states' translocation efforts. Recent historical records indicate white-tailed deer could be found statewide, but populations were initially larger in more eastern portions of Kansas. Mule deer at peak range in Kansas were recorded as regularly found as far east as Manhattan, KS in Riley County (Fig. 9).

Mule deer have been receding westward and are currently only regularly found in the western 1/3 of Kansas. Mule deer populations have also been in decline along with this range contraction since peak abundance occurred in the 1980s. In recent years mule deer population surveys have only provided large enough sample sizes in the west mule deer zone to be able to estimate density. Mule deer observations, while rare, still occur in the east zone but overall lack of data and limited distribution of available observations preclude population estimation in central Kansas. The declining population of mule deer required hunting opportunities be limited.

CWD represents the greatest threat to the Kansas mule deer herd. Unlike EHD, which when severe can rapidly reduce deer abundance after which populations typically recover quickly, CWD once established will continue to persist for decades and generally increases in severity over time. Once prevalence of CWD increases above certain thresholds deer herds will struggle to increase or maintain stability (Edmunds et al. 2016, Ketz et al. 2019), and could remain in a constant state of slow decline. This jeopardizes the long-term health of Kansas' deer herd, and thus threatens biological, social and economical benefits of deer to Kansans. Management actions to minimize the impact of CWD within our deer herd and efforts to reduce the spread and risk of future introductions require immediate attention. Currently there is a lack of data on mule deer movement behavior, corridors and connectivity in the grasslands of northcentral and northwest Kansas and how landscape/habitat connectivity will interact and influence mule deer movements, use of crucial winter habitats for thermal cover, impact the spread of CWD,

and thus population dynamics. Currently KDWP is reducing harvest levels of mule deer throughout their range in western Kansas due to declining populations over the long-term. These declines are driven by various factors (grassland habitat quality, quantity and spatial array/connectivity; drought, diseases such as CWD), though the role of habitat connectivity and mule deer movement is not well understood in this region (DMUs 1-4; Fig. 10) of western Kansas. Further, recent data suggests a surprising level of hybridization between mule deer and white-tailed deer in this region of Kansas (Combe et al. 2021).

Risks or threats to this mule deer population include: 1) conversion of native grassland habitats to cropland; 2) loss of CRP grasslands due to declining enrollment rates with the FSA due to high commodity prices and low rental rates for CRP; 3) decline of grassland quality through expansion of trees and other woody encroachment; 4) competition and hybridization with the more aggressive and expanding white-tailed deer population in the region; 4) drought and resulting loss of fawning and winter habitat due to associated emergency haying and grazing of grasslands during critical times of the year; and 5) habitat fragmentation by row crops, I-70, state highways, and other roads in this highly fragmented landscape potentially leading to habitat patches falling below thresholds of size that mule deer will use/select.

Corridor/Movement #2 – Mule deer Movement/Migration in Sand Sagebrush Region of Southwest Kansas (DMUs 16 and 18)

The mule deer, pronghorn, and elk herds in and around the Cimmaron National Grassland in Morton and Stevens counties in southwest Kansas are unique in the type of habitat they inhabit in Kansas. This region is in the sand sagebrush steppe and includes the single largest tract of public land in Kansas (109,000 acres of the National Grassland managed by the USFS). The region is made up of blowing sand dunes covered with sand sagebrush and short grass prairie with shallow rocky bluffs rising to the prairie uplands.

Located in the southwest corner of Kansas, in Morton and Stevens counties, it is one of only 20 national grasslands in the United States. The Grassland offers an abundance of prairie flowers and wildlife, including the federally listed lesser prairie-chicken for which protecting and enhancing habitat for big game will also protect critical habitat for the lesser prairie-chicken.

Following the most disastrous years of the infamous Dust Bowl of the 1930s, the federal government bought land and took it out of production in order to help control wind erosion that was ravaging the Great Plains. In 1954 this region was designated a national grassland and assigned to the Forest Service. The Soil Conservation Service developed new methods to control erosion by establishing vegetation that would provide protection. The mule deer, pronghorn and elk herds that call this region of Kansas home, migrate and

move between the three states (Kansas, Colorado and Oklahoma) in the tri-state border region. Though it is known that the elk herds calve in Kansas, little is understood about elk, pronghorn or mule deer movements and connectivity in the region.

Risks or threats to this mule deer population include: 1) loss of CRP grasslands due to declining enrollment rates with the FSA due to high commodity prices and low rental rates for CRP; 2) decline of grassland quality through expansion of salt-cedar in riparian areas and other woody encroachment that benefits white-tailed deer over mule deer; 4) competition and hybridization with the more aggressive and expanding white-tailed deer population in the region; 4) drought and resulting loss of fawning and winter cover due to associated emergency haying and grazing of grasslands during critical times of the year; and 5) impact of multiple use mandates (e.g. grazing of 5,000 head of cattle on Cimarron National Grasslands, off-road vehicle use of fawning and calving areas, natural gas field development and production and associated infrastructure in the region) on mule deer movements, connectivity and winter range use.

Research Needs – Mapping Crucial Migration Corridors and Winter Range for Pronghorn and Mule Deer in Kansas

KDWP seeks funding in the amount of $202,500 to collect GPS telemetry data for up to 25 mule deer and 25 pronghorn in 2 populations (pronghorn in the Flint Hills of eastern Kansas and the Smoky Hills/Sand Sage study areas in western KS) and 2 mule deer populations (Smoky Hills and Sand Sage study areas) to document migration corridors and analyze the data using Brownian Bridge Movement Models (or similar models). KDWP has limited knowledge and currently lacks specific information on migration corridors for any of our pronghorn herds that reside in eastern or western Kansas that are identified as top priorities for the state. Further, there is no data on resource or habitat selection and we will use location data to develop resource selection models (e.g. RSF, RSPF, or similar models) for both species. The general objectives are to capture up to 25 pronghorn and 25 mule deer in 2 key priority herds to attach GPS radio collars, and to analyze those data to understand migration patterns, stopover areas, and seasonal habitats for pronghorn and mule deer.

There is currently a dearth of data on big game movements in Kansas, as evidenced by the fact that a single study on elk and no pronghorn have ever been marked with GPS collars in the state's history, although there has been recent (beginning in 2018) GPS collar work on mule deer and white-tailed deer in western Kansas (see current activities below). In fact, the last studies on pronghorn using collars in the early 1990s all deployed VHF transmitters and elk have never been collared using any type of radio-collar in Kansas other than on Fort Riley military base.

Study Areas

The eastern Kansas study area lies within the southeastern portion of Chase County and the extreme western portion of Lyon County in the Flint Hills region of east-central Kansas (Figs. 6 & 8). The study area encompasses the entire known Flint Hills pronghorn range, is 100% private ownership with beef cattle the main grazing animal (Rue and Ranglack 2025). Intensive Early Stocking (IES) with yearling cattle along with rangeland burning are the primary grazing strategies used within the study area with an occasional stocking of cow/calf pairs. The climate in Chase County, Kansas is described as continental, subhumid consisting of warm summers and cool winters with a mean precipitation of 81 cm (Neill 1974). Topography varies from gentle to steep slopes from 1 – 50%, consisting of shallow to deep soils with an elevation ranging from 335 – 457 m above sea level (Neill 1974).

The western Kansas study area will be in Decatur, Gove, Graham, Logan, Morton, Norton, Sheridan, Stevens, and Wallace Counties (Figs. 6 & 10). These areas are a mix of cropland interspersed within native shortgrass prairie, sand sagebrush, and CRP grasslands (Figs. 2-4). The region has a semi-arid continental climate, with warm summers and cold winters. Average temperatures range from as low as -4°F during winter to around 95°F during summer months. Annual precipitation is relatively low, ranging from 11-15 inches per year, and the area typically receives slightly more rain in the spring than any other season. Snowfall is light to moderate throughout the winter months.

Methods

All pronghorn and mule deer will be captured after the end of deer hunting season and before the last trimester of pregnancy (late January and February). Commercial helicopter crews using net guns will select and capture pronghorn and deer (Krausman et al. 1985). Up to 25 adult female pronghorn and 25 adult mule deer will be captured. Captured deer will be hobbled, blindfolded, and transported via helicopter sling to a staging area for processing, while pronghorn will be processed at site of capture. Chemical sedation of female deer may be necessary for any uncontrollable individuals. If so, the capture crew will use a combination of 15 mg azaperone, 15 mg midazolam, 15 mg butorphanol, which is recommended for deer captured via helicopter (C. Anderson, Colorado Parks and Wildlife, pers. communication). Restraint from time of capture to release will be less than 30 minutes. Capture mortality using this method is expected to be <2%, which is lower than using remote chemical immobilization. Each deer and pronghorn will be fitted with a GPS collar. Blood samples (<20 ml, from jugular puncture) will be collected for disease testing and future genetic testing. Age determination of captured animals will be via teeth wear examination or tooth extraction for determination by cementum annuli. Female deer will be pregnancy tested using vaginal ultrasound (a technique not as reliable for pronghorn due to hollow hair follicles). Body mass, a series of morphometric measures, and body condition will be recorded for each captured animal. Rump fat thickness will be measured as primary index to body condition and habitat quality. Care for animals during the capture process will be under the direction of a contract on-site veterinarian. We will ear tag all captured animals for future identification. Standard livestock ear tags will be applied using conventional equipment and techniques. Animals will be released at the

processing site for deer as previous capture efforts found that animals rapidly returned to capture locations, or at capture locations for pronghorn.

We propose to capture and collar up to 25 pronghorn and 25 mule deer in 2 separate herds in eastern and western Kansas. The information from the GPS collars will be used to delineate migration corridors, stop-over locations, habitat selection (e.g. with RSF or similar analyses) and quantify the amount of time spent in crucial winter habitats. We will use Brownian Bridge Movement Models (Horne et al. 2007, Sawyer et al 2009) or equivalent methods to analyze the GPS telemetry data we collect on marked animals. To accomplish this goal, KDWP will use internal staff (e.g. Dr. Jon Beckmann, Levi Jaster, Matt Peek, Jeff Rue) and our partnership with various universities and the USGS Kansas Cooperative Fish and Wildlife Research Unit to analyze movement and location data upon project completion. The migration corridors, fawning areas, and winter range delineation will be used by KDWP to identify priority habitat and restoration projects. We will share these data and analyses with our federal partners and local wildlife conservation organizations to facilitate conservation efforts.

Budget and Justification

The overall projected budget request is $202,500 (Table 1). Line-item descriptions are as follows:

GPS collars and fees

We budget for GPS radio collars for up to 50 animals to be deployed in 2 distinct areas as a one-time, up-front cost. GPS radio-collar costs per animal and associated fees are an estimate based on previous studies and quotes received from various companies but remain subject to negotiated state contract prices. We anticipate some telemetry units may be redeployed in following years if an adequate amount of battery life remains on collar, or they may be refurbished and redeployed for a reduced fee.

Animal Capture

We budget for the capture of up to 50 pronghorn and mule deer in the first year of the study. Our contracted price includes capture crew costs and ferry time for helicopter capture services. We anticipate up to 10 additional animals annually may need to be captured to redeploy recovered or refurbished radio-collars.

Contract Services

We will contract a USGS Cooperative Fish and Wildlife Research Unit or other university 1-year Post-Doc to assist with field work involving collection of GPS radio collars, downloading of data, and analysis of the GPS telemetry data. We anticipate these costs to be $50,000 which includes salary and benefits and indirect costs at 17.5%.

(This project will be funded using America the Beautiful funds from NFWF awarded to KDWP in a multi-state grant managed by WG&F to meet objectives of SO3362)

Current Activities

Corridor #1 – Mule Deer Migration/Movement Smoky Hills Region

KDWP in partnership with the USGS Fish and Wildlife Cooperative Research Unit at Kansas State University has an on-going study examining mule deer and white-tailed deer demography and inter-specific interactions in northwest and northcentral Kansas in the Smoky Hills region. White-tailed deer have adapted to fragmented landscapes throughout the Great Plains, finding food resources almost everywhere (Sparrowe and Springer 1970) - including areas of woody cover, agricultural areas, suburban/urban development, and river bottoms (Mackie 1981). In turn, white-tailed deer have expanded their range westward in the Great Plains invading spaces never before occupied by the species (VerCauteren and Hygnstrom 2011). Additional information is needed to develop management strategies to stop or reverse the declining trend of mule deer abundance in Kansas. Furthermore, conservation planning for management on private lands requires an understanding of mule deer response to common land management practices throughout western Kansas (grazing management, USDA conservation programs, row-crop agriculture). Finally, the influence of landscape configuration and conformation on space use and vital rates of mule deer are needed to understand the role of spatial scale on population dynamics.

Of importance is addressing questions of the potential for white-tailed deer to be interspecific aggressors or are mule deer simply limited by some habitat component or cover type critical to their survival? Identifying available and selected resources by mule deer in the presence of white-tailed deer is essential in pinpointing their limiting factors that could be contributing to their decline. There is evidence for competitive exclusion of mule deer by expanding white-tailed deer populations. The prevailing hypotheses for the decline of mule deer and expansion of white-tailed deer are changes in land use and competitive dominance of white-tailed deer over mule deer (Mackie et al. 1998). Studies of sympatric white-tailed and mule deer all point to habitat segregation of the two species, with mule deer selecting higher elevations, more rugged terrain, and more open habitats, while white-tailed deer select lower elevations, riparian areas, agricultural crops, and closed canopies (Martinka 1968, Mackie et al. 1998, Brunjes et al. 2006). Few studies have been made on sympatric mule deer and white-tailed deer in the southern Great Plains that include private lands managed for agricultural purposes. Mackie et al. (1998) studied the species in Montana. Brunjes et al. (2006) examined the habitat use and selection of the two species in Texas. Improvements in techniques have allowed researchers to gather information on migratory patterns of mule deer in western states. Conservation planning for management on private lands necessitates an understanding of mule deer response to common land use practices throughout western Kansas (e.g., grazing management, Conservation Reserve Program, row-crop agriculture). Response to land use practices can be identified through space use and resource selection by mule deer. By identifying macrohabitat features (e.g., land cover type, slope, aspect, elevation) that influence resource selection by mule deer relative to white-tailed deer, management strategies can prioritize enhancement of land cover types to augment mule deer abundance. Investigating space use and resource selection by sympatric white-tailed deer and mule deer populations

in Kansas has the potential to provide important information to KDWP for managing deer and will contribute to the basic understanding of interactions between these two species (Fig. 11).

This project aims to understand survival and associated movement patterns, space use, and resource selection by deer. Deer movements are affected by temporal periods such as season of the year and daily periods (Sparrowe and Springer 1970, Walter et al. 2011, Simoneaux et al. 2016), perceived threats on the landscape (hunters or natural predators [Marantz et al. 2016]), and, most importantly, by the onset of rut (Ozoga and Verme 1985, Foley et al. 2015, Simoneaux et al. 2016). Home range area and placement can also be clues of limiting factors for mule deer. If there are sufficient food resources available within an animal's home range, then perhaps space or some other unperceived necessity is the limiting factor contributing to mule deer decline. In addition to home range area providing insight into available or limiting resources, mule deer movement trends may have broad applications for future harvest management. Effects of hunting and rut on male movement are largely understudied for sympatric populations of mule deer and white-tailed deer occupying only private land in the Great Plains. To comprehend complexities of adult male population movement dynamics, it is important to understand that the effects of rut are greater than only the summation of successful or unsuccessful breeding attempts.

Knowledge of survival rates, timing of mortality, source of mortality, space use, resource selection, and movements is important to surveil overall health of deer herds. The ability to balance age classes and sex ratios in alignment with Kansas management goals is only achievable with this information. Currently, no literature exists on estimated survival rates, sources of mortality, timing of mortality, movements, or space use of mule deer or white-tailed deer adults or fawns in Kansas. Without this information, state management is limited in developing strategies to accurately maintain socially acceptable herd sizes and sex ratios and unable to effectively model future population trajectories of male mule deer. This on-going study aims to address these issues.

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Table 1. Budget for mapping crucial range and pronghorn and mule deer movements in Kansas.

Category	Description	Cost per unit	Total Amount
25 Pronghorn GPS collars	GPS + Iridium Battery	$2,084	$52,100
25 Mule Deer GPS collars	GPS + Iridium Battery	$2,084	$52,100
Helicopter crew for captures	$1600/hr Flight time	$1,600	$38,400
Ferrying + Fuel truck	$150 per day + $1.50 per mile	$1,800	$1,800
Fuel for fuel truck and per diem	$1000 for fuel and $600 per day	$2,200	$2,200
Post-doc for data analyses	Salary and benefits post-doc	$47,800	$50,000
Computer and software for analyses	Computer and software	$5,900	$5,900
	Total		$202,500

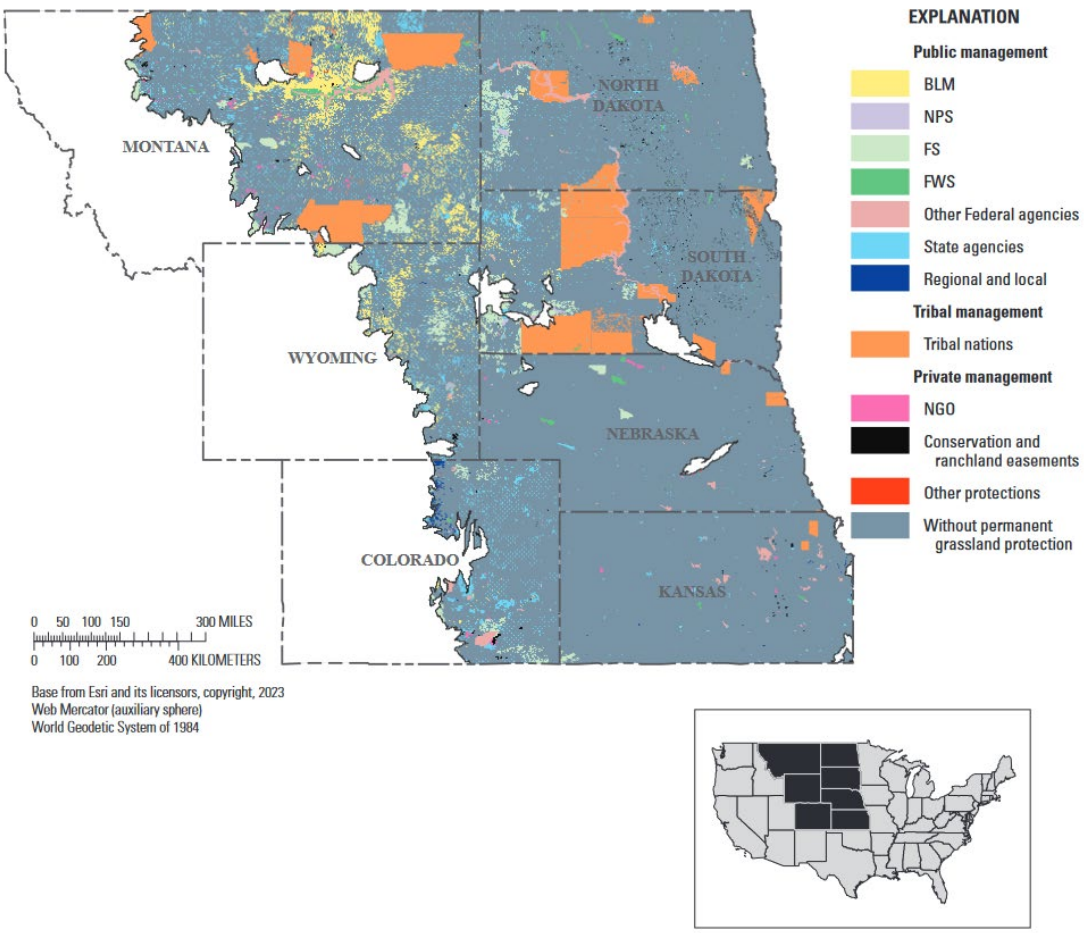

Figure 1. Location and amount of public and private lands in the northern grassland region of the Great Plains in the United States. Kansas (furthest state to the south and east in map image) has the highest percent of private land in the entire USA (gray-shaded areas; >98% of land) and the least amount of public lands by percent area in the United States at 133,546 hectares (330,000 acres), or approximately 1.9% of the land area. Figure modified from and used by permission from Miller Hesed, C.D., and Yocum, H.M. 2023. Grassland management priorities for the North Central Region: U.S. Geological Survey Open-File Report 2023–1037, 53 p., https://doi.org/10.3133/ofr20231037

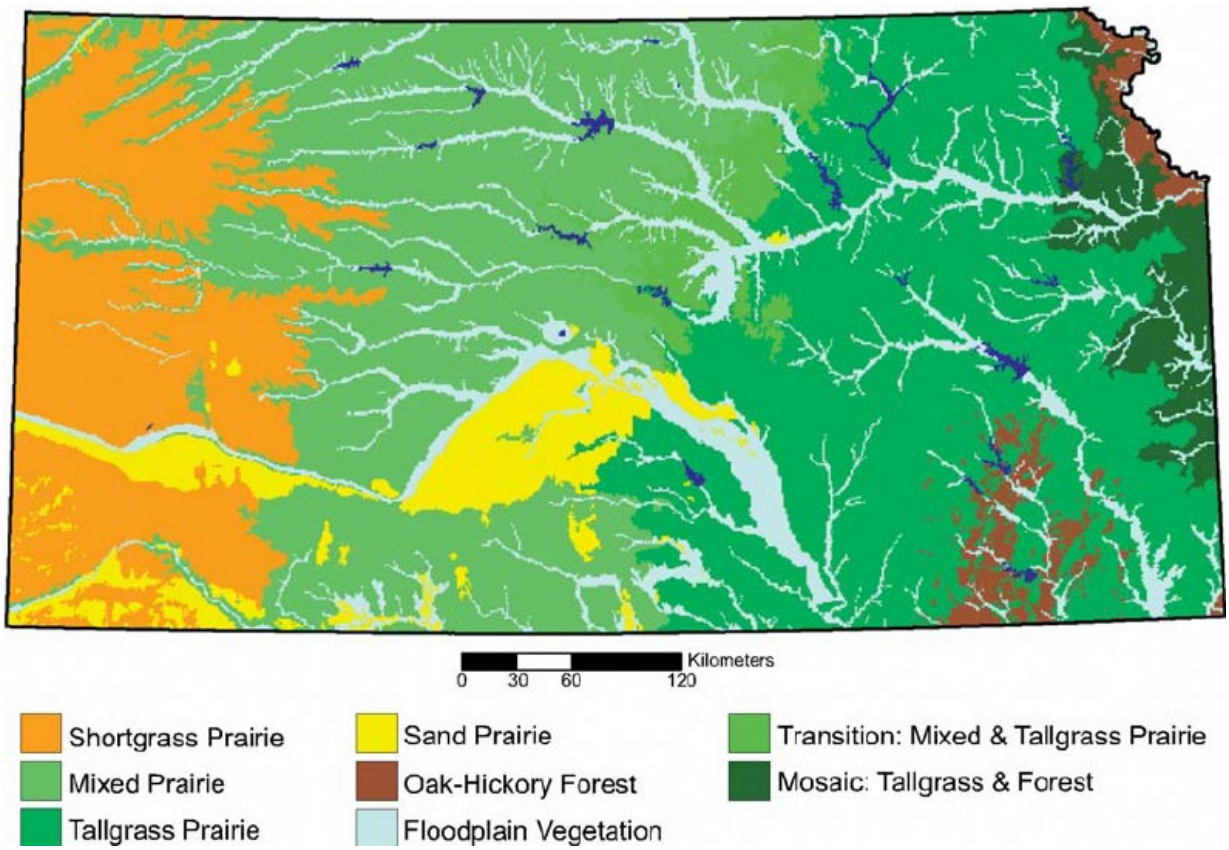

Figure 2. Natural vegetation type map of Kansas (modified from Kuechler 1974).

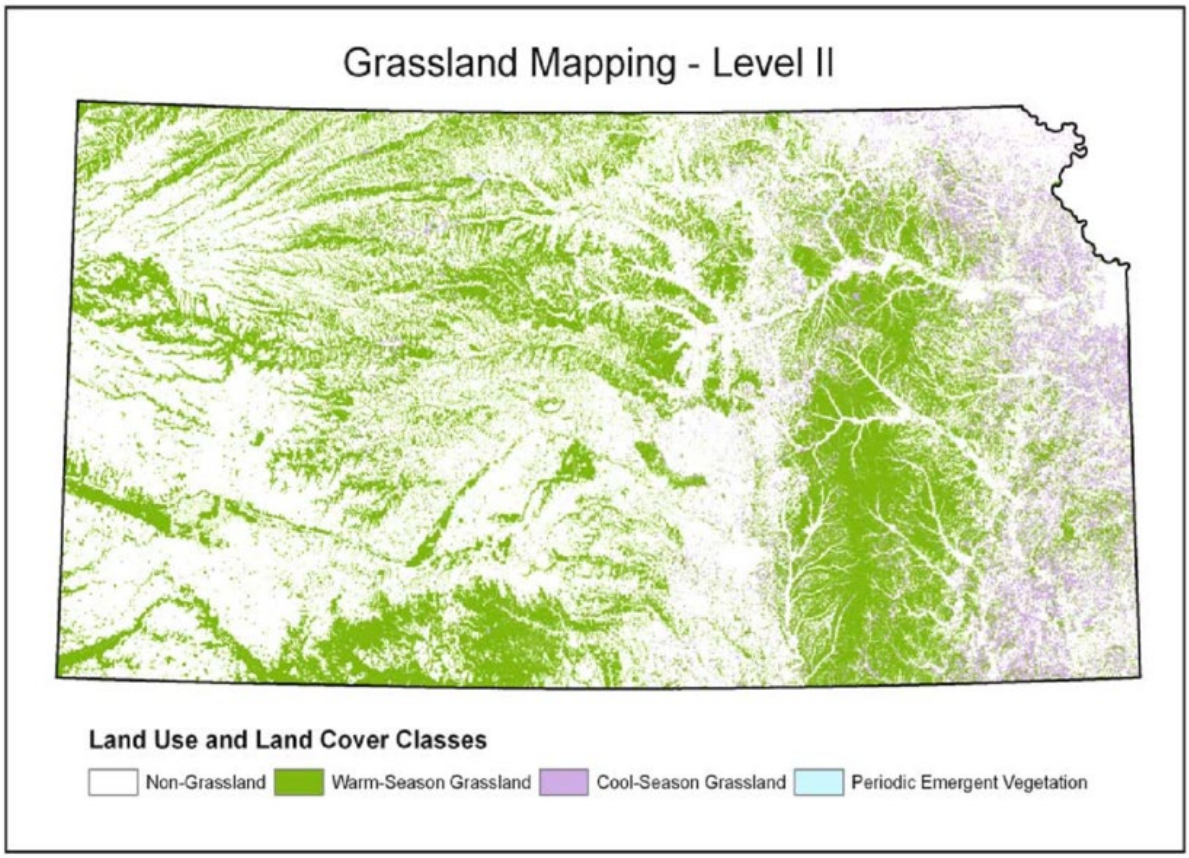

Figure 3. Location of intact native grasslands in Kansas.

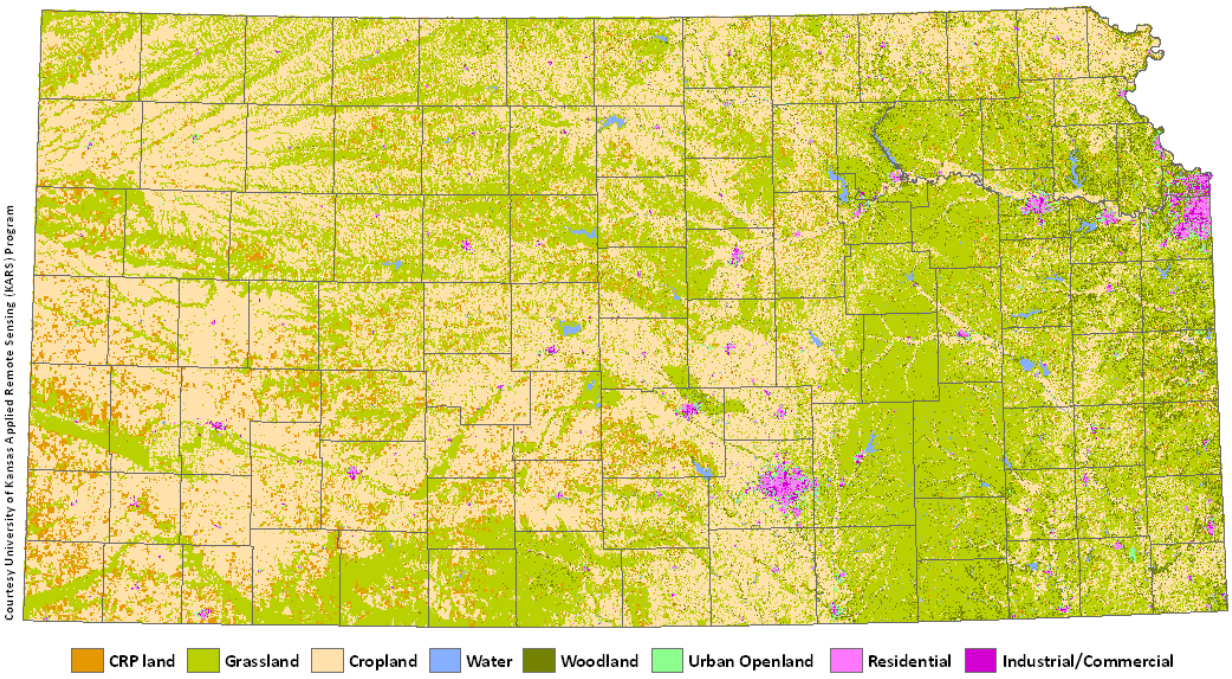

Figure 4. Kansas landcover patterns (University of Kansas Applied Remote Sensing (KARS) Program).

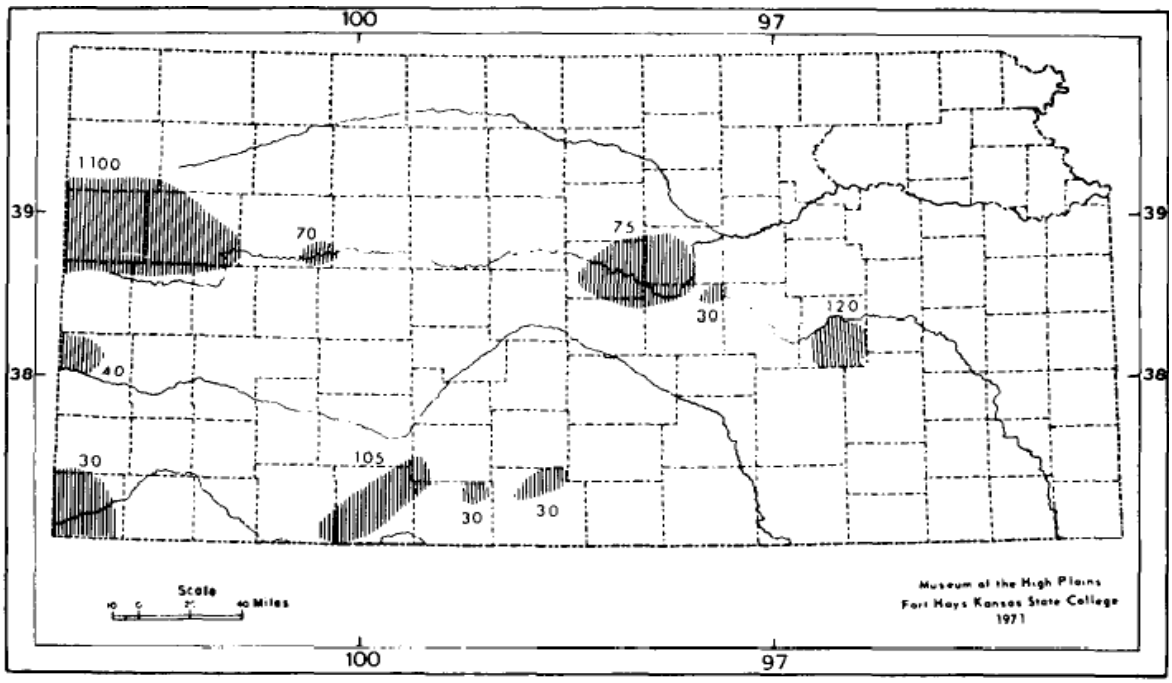

Figure 5. Distribution of pronghorn in Kansas in 1979 with an assessment of population sizes based on KDWP aerial survey efforts.

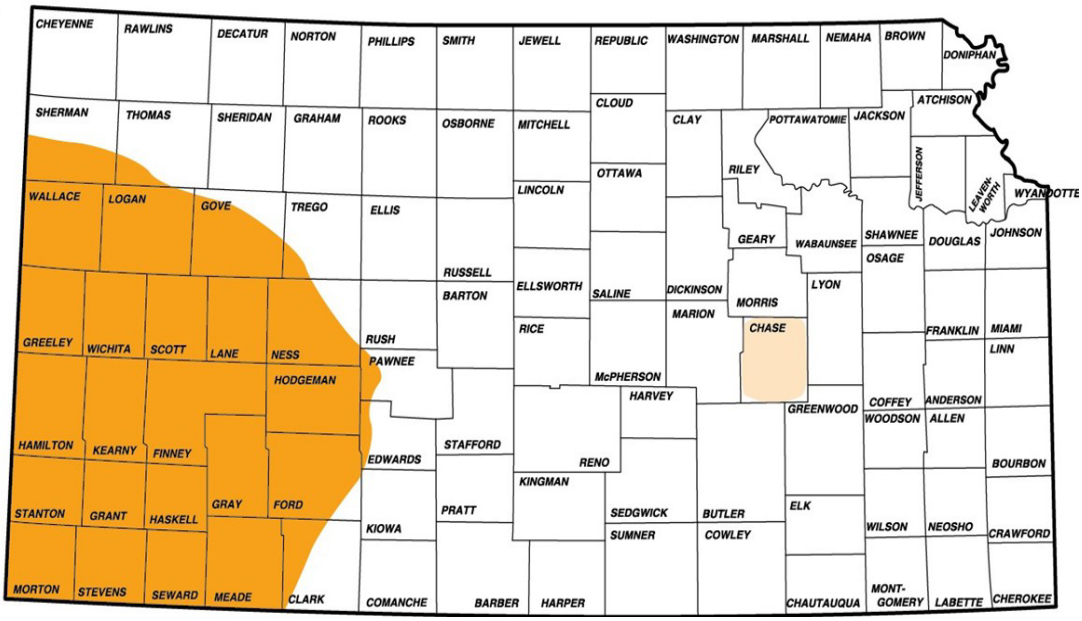

Figure 6. Distribution of pronghorn in Kansas in 2025.

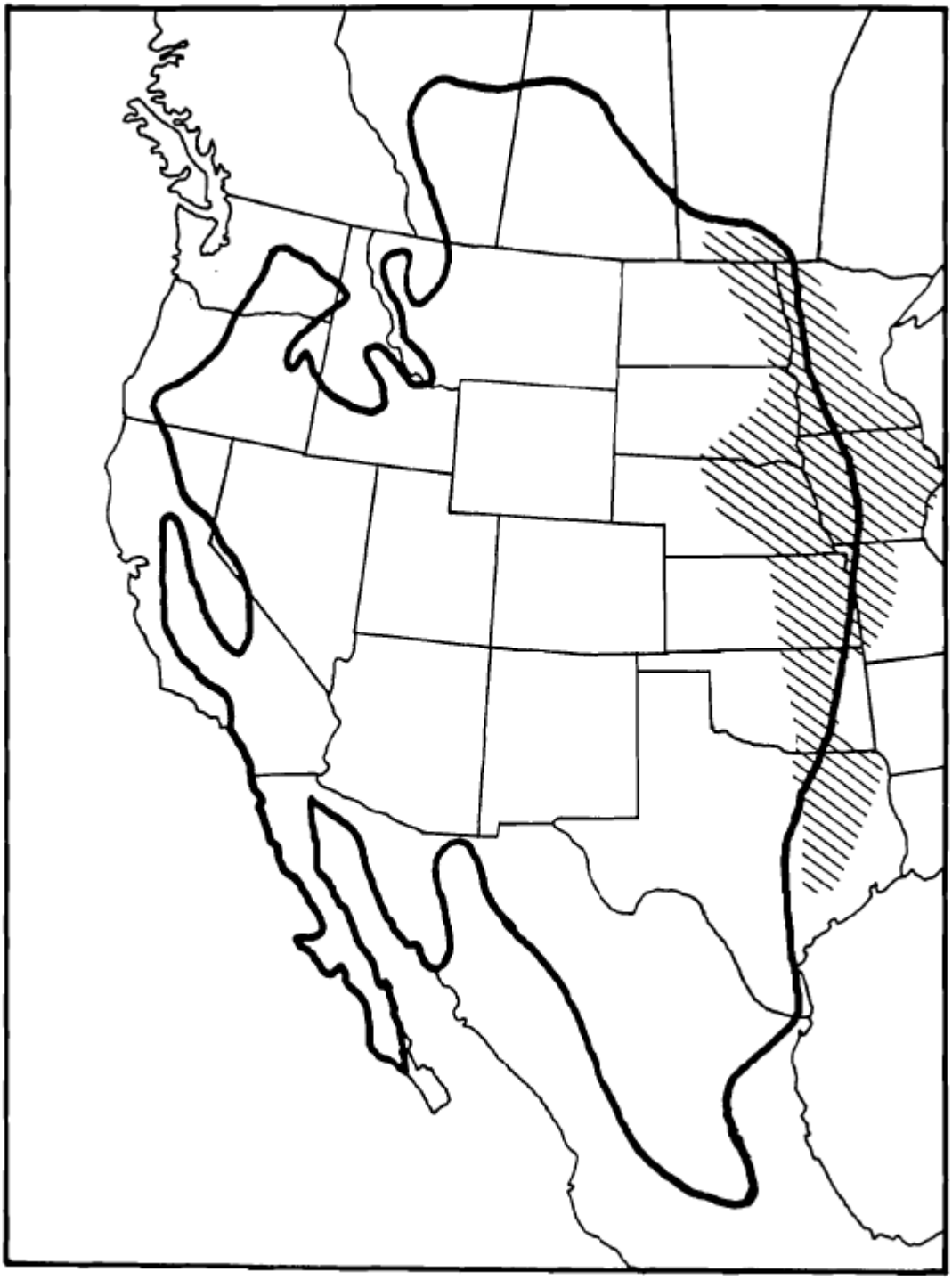

Figure 7. Historical range of pronghorn (solid line) and tallgrass prairie (shaded area) in North America (from Simpson 1992).

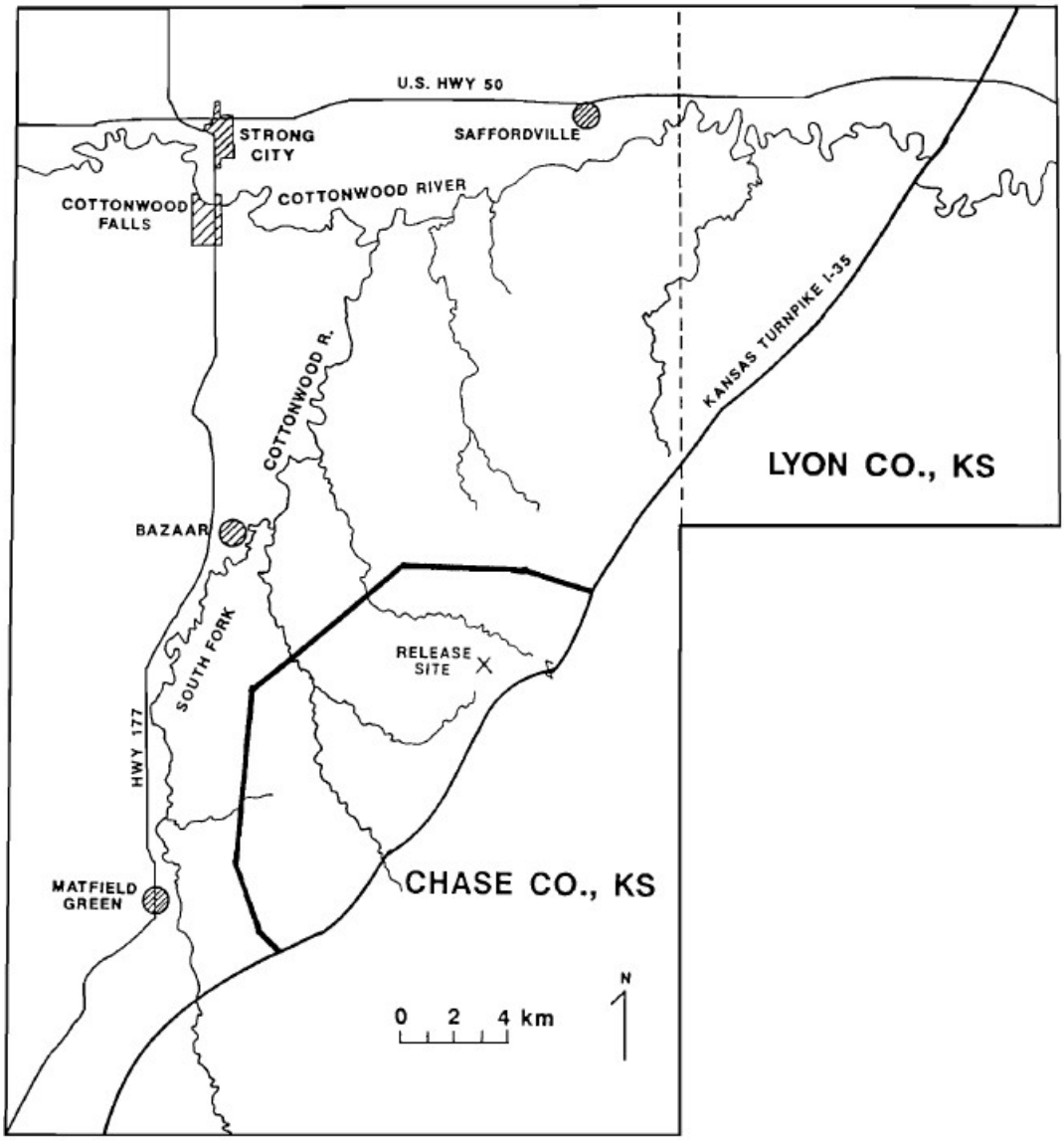

Figure 8. Eastern Kansas pronghorn study site in the Flint Hills Region of Chase and Lyon County, Kansas USA (from Rue and Ranglack 2025).

Figure 9. Historical Mule Deer Range in North America (WAFWA Mule Deer Working Group 2024)

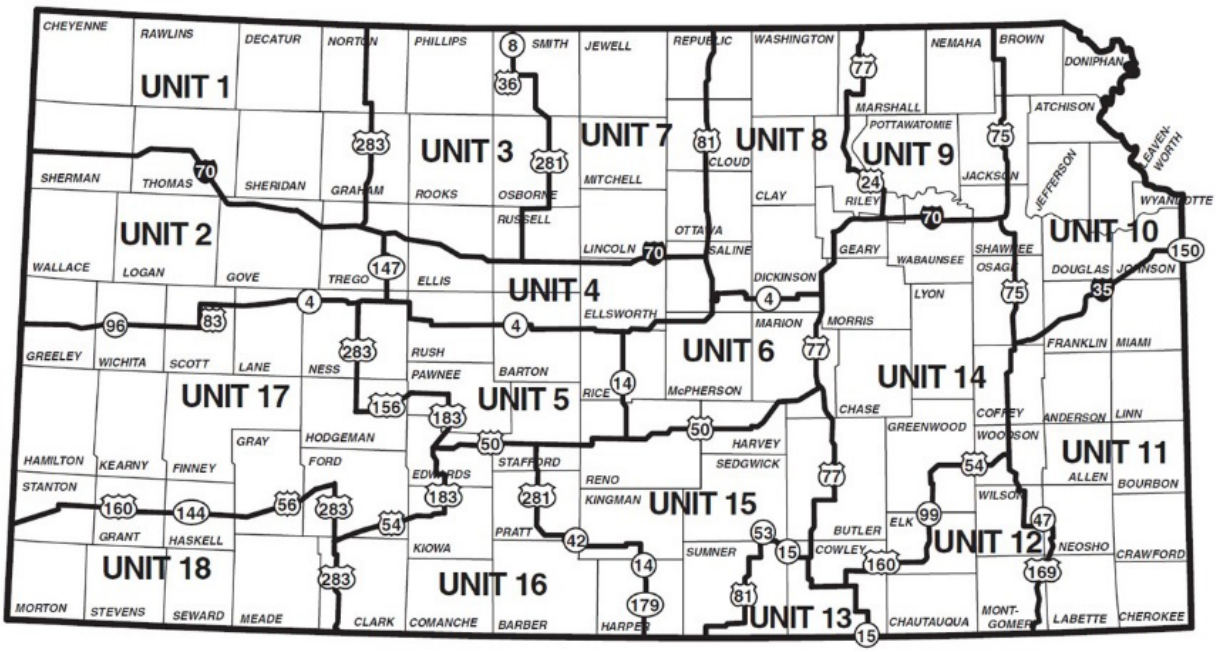

Figure 10. Deer Management Units in Kansas.

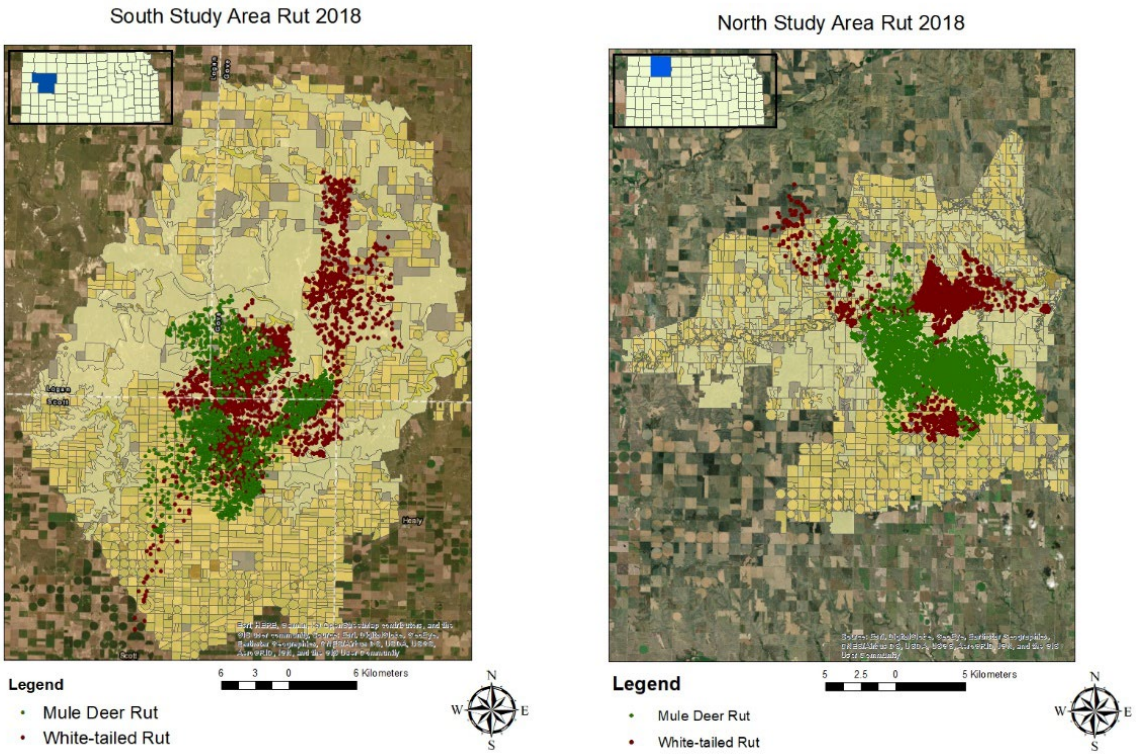

Figure 11. Maps of locations of adult male mule deer and white-tailed deer during the rut period (November 8 – November 17, 2018) based off peak movement rate in each study area (from Haukos and Ricketts 2020, Annual KDWP P-R Grant Performance Report).

Appendix A. Secretarial Order 3362

ORDER NO. 3362

Subject: Improving Habitat Quality in Western Big-Game Winter Range and Migration Corridors

Sec. 1 **Purpose**. This Order directs appropriate bureaus within the Department of the Interior (Department) to work in close partnership with the states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming to enhance and improve the quality of big-game winter range and migration corridor habitat on Federal lands under the management jurisdiction of this Department in a way that recognizes state authority to conserve and manage big-game species and respects private property rights.
Through scientific endeavors and land management actions, wildlife such as Rocky Mountain Elk (elk), Mule Deer (deer), Pronghorn Antelope (pronghorn), and a host of other species will benefit. Additionally, this Order seeks to expand opportunities for big-game hunting by improving priority habitats to assist states in their efforts to increase and maintain sustainable big game populations across western states.

Sec. 2 **Authorities**. This Order is issued under the authority of section 2 of Reorganization Plan No. 3 of 1950 (64 Stat. 1262), as amended, as well as the Department's land and resource management authorities, including the following:

a. Federal Land Policy and Management Act of 1976, as amended, 43 U.S.C. 1701, *et seq*.;

b. U.S. Geological Survey Organic Act, as amended, 43 U.S.C. 31, *et seq*.;

c. National Wildlife Refuge System Improvement Act of 1997, as amended, 16 U.S.C. 668dd *et seq*.; and

d. National Park Service Organic Act of 1916, as amended, 54 U.S.C. 100101, *et seq*.

Sec. 3 **Background**. The West was officially “settled” long ago, but land use changes continue to occur throughout the western landscape today. Human populations grow at increasing rates with population movements from east and west coast states into the interior West. In many areas, development to accommodate the expanding population has occurred in important winter habitat and migration corridors for elk, deer, and pronghorn. Additionally, changes have occurred across large swaths of land not impacted by residential development. The habitat quality and value of these areas crucial to western big-game populations are often degraded or declining.

The Bureau of Land Management (BLM) is the largest land manager in the United States (U.S.) with more than 245 million acres of public land under its purview, much of which is found in Western States. The U.S. Fish and Wildlife Service (FWS) and National Park Service (NPS) also manage a considerable amount of public land on behalf of the American people in the West. Beyond land management responsibilities, the Department has strong scientific capabilities in the U.S. Geological Survey (USGS) that can be deployed to assist State wildlife agencies and Federal land managers. Collectively, the appropriate bureaus within the Department have an opportunity to serve in a leadership role and take the initiative to work closely with Western States on their priorities and objectives as they relate to big-game winter range and migration corridors on lands managed by the Department.

Consistent with the American conservation ethic, ultimately it is crucial that the Department take action to harmonize State fish and game management and Federal land management of big-game winter range and corridors. On lands within these important areas, if landowners are interested and willing, conservation may occur through voluntary agreements.

Robust and sustainable elk, deer, and pronghorn populations contribute greatly to the economy and well-being of communities across the West. In fact, hunters and tourists travel to Western States from across our Nation and beyond to pursue and enjoy this wildlife. In doing so, they spend billions of dollars at large and small businesses that are crucial to State and local economies. We have a responsibility as a Department with large landholdings to be a collaborative neighbor and steward of the resources held in trust.

Accordingly, the Department will work with our State partners and others to conserve and/or improve priority western big-game winter range and migration corridors in sagebrush ecosystems and in other ecotypes as necessary. This Order focuses on the Western States of: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. These States generally have expansive public lands with established sagebrush landscapes along with robust big-game herds that are highly valued by hunters and tourists throughout the Nation.

The Department has broad responsibilities to manage Federal lands, waters, and resources for public benefit, including managing habitat to support fish, wildlife, and other resources. Secretary's Order 3356, "Hunting, Fishing, Recreational Shooting, and Wildlife Conservation Opportunities and Coordination with States, Tribes, and Territories," (SO 3356) was issued on September 15, 2017. SO 3356 primarily focused on physical access to lands for recreational activities, particularly hunting and fishing. This Order is focused on providing access to big game animals by providing direction regarding land management actions to improve habitat quality for big-game populations that could help ensure robust big-game populations continue to exist. Further, SO 3356 includes a number of directives related to working with States and using the best available science to inform development of guidelines, including directing relevant bureaus to:

a. Collaborate with State, tribal, and territorial fish and wildlife agencies to attain or sustain State, tribal, and territorial wildlife population goals during the Department's land management planning and implementation, including prioritizing active habitat management

projects and funding that contributes to achieving wildlife population objectives, particularly for wildlife that is hunted or fished, and identifying additional ways to include or delegate to States habitat management work on Federal lands;

b. Work cooperatively with State, tribal, and territorial wildlife agencies to enhance State, tribe, and territorial access to the Department's lands for wildlife management actions;

c. Within 180 days, develop a proposed categorical exclusion for proposed projects that utilize common practices solely intended to enhance or restore habitat for species such as sage grouse and/or mule deer; and

d. Review and use the best available science to inform development of specific guidelines for the Department's lands and waters related to planning and developing energy, transmission, or other relevant projects to avoid or minimize potential negative impacts on wildlife.

This Order follows the intent and purpose of SO 3356 and expands and enhances the specific directives therein.

Sec. 4 **Implementation**. Consistent with governing laws, regulations, and principles of responsible public stewardship, I direct the following actions:

a. With respect to activities at the national level, I hereby direct the BLM, FWS, and NPS to:

(1) Within 30 days, identify an individual to serve as the "Coordinator" for the Department. The Coordinator will work closely with appropriate States, Federal agencies, nongovernmental organizations, and/or associations to identify active programs focused on big-game winter range and/or migration corridors. The programs are to be organized and cataloged by region and other geographic features (such as watersheds and principles of wildlife management) as determined by the Deputy Secretary, including those principles identified in the Department's reorganization plan.

(2) Within 45 days, provide the Coordinator information regarding:

(i) Past and current bureau conservation/restoration efforts on winter range and migration corridors;

(ii) Whether consideration of winter range and corridors is included in appropriate bureau land (or site) management plans;

(iii) Bureau management actions used to accomplish habitat objectives in these areas;

(iv) The location of areas that have been identified as a priority for conservation and habitat treatments; and

(v) Funding sources previously used and/or currently available to the bureau for winter range and migration corridor conservation/restoration efforts.

(3) Within 60 days, if sufficient land use plans are already established that are consistent with this Order, work with the Coordinator and each regional Liaison (see section 4b) to discuss implementation of the plans. If land use plans are not already established, work with the Coordinator and each regional Liaison to develop an Action Plan that summarizes information collected in section 4 (a) (1) and (2), establishes a clear direction forward with each State, and includes:

(i) Habitat management goals and associated actions as they are associated with big game winter range and migration corridors;

(ii) Measurable outcomes; and

(iii) Budgets necessary to complete respective action(s).

b. With respect to activities at the State level, I hereby direct the BLM, FWS, and NPS to:

(1) Within 60 days, identify one person in each appropriate unified region (see section 4a) to serve as the Liaison for the Department for that unified region. The Liaison will coordinate at the State level with each State in their region, as well as with the Liaison for any other regions within the State. The Liaison will schedule a meeting with the respective State fish and wildlife agency to assess where and how the Department can work in close partnership with the State on priority winter range and migration corridor conservation.

(2) Within 60 days, if this focus is not already included in respective land management plans, evaluate how land under each bureau's management responsibility can contribute to State or other efforts to improve the quality and condition of priority big-game winter and migration corridor habitat.

(3) Provide a report on October 1, 2018, and at the end of each fiscal year thereafter, that details how respective bureau field offices, refuges, or parks cooperated and collaborated with the appropriate State wildlife agencies to further winter range and migration corridor habitat conservation.

(4) Assess State wildlife agency data regarding wildlife migrations early in the planning process for land use plans and significant project-level actions that bureaus develop; and

(5) Evaluate and appropriately apply site-specific management activities, as identified in State land use plans, site-specific plans, or the Action Plan (described above), that conserve or restore habitat necessary to sustain local and regional big-game populations through measures that may include one or more of the following:

(i) restoring degraded winter range and migration corridors by removing encroaching trees from sagebrush ecosystems, rehabilitating areas damaged by fire, or treating exotic/invasive vegetation to improve the quality and value of these areas to big game and other wildlife;

(ii) revising wild horse and burro-appropriate management levels (AML) or removing horses and burros exceeding established AML from winter range or migration corridors if habitat is degraded as a result of their presence;

(iii) working cooperatively with private landowners and State highway departments to achieve permissive fencing measures, including potentially modifying (via smooth wire), removing (if no longer necessary), or seasonally adapting (seasonal lay down) fencing if proven to impede movement of big game through migration corridors;

(iv) avoiding development in the most crucial winter range or migration corridors during sensitive seasons;

(v) minimizing development that would fragment winter range and primary migration corridors;

(vi) limiting disturbance of big game on winter range; and

(vii) utilizing other proven actions necessary to conserve and/or restore the vital big-game winter range and migration corridors across the West.

c. With respect to science, I hereby direct the USGS to:

(1) Proceed in close cooperation with the States, in particular the Western Association of Fish and Wildlife Agencies and its program manager for the Crucial Habitat Assessment Tool, prior to developing maps or mapping tools related to elk, deer, or pronghorn movement or land use; and

(2) Prioritize evaluations of the effectiveness of habitat treatments in sagebrush communities, as requested by States or land management bureaus, and identified needs related to developing a greater understanding of locations used as winter range or migration corridors.

d. I further hereby direct the responsible bureaus and offices within the Department to:

(1) Within 180 days, to update all existing regulations, orders, guidance documents, policies, instructions, manuals, directives, notices, implementing actions, and any other similar actions to be consistent with the requirements in this Order;

(2) Within 30 days, provide direction at the state or other appropriate level to revise existing Federal-State memorandums of agreement to incorporate consultation with State agencies on the location and conservation needs of winter range and migration routes; and

(3) Consult with State wildlife agencies and bureaus to ensure land use

plans are consistent and complementary to one another along the entire wildlife corridor in common instances where winter range or migration corridors span jurisdictional boundaries.

e. Heads of relevant bureaus will ensure that appropriate members of the Senior Executive Service under their purview include a performance standard in their respective current or future performance plan that specifically implements the applicable actions identified in this Order.

Sec. 5 **Management**. I hereby direct the Deputy Secretary to take is responsible for taking all reasonably necessary steps to implement this Order.

Sec. 6 **Effect of Order**. This Order is intended to improve the internal management of the Department. This Order and any resulting reports or recommendations are not intended to, and do not create any right or benefit, substantive or procedural, enforceable at law or equity by a party against the United States, its departments, agencies, instrumentalities or entities, its officers or employees, or any other person. To the extent there is any inconsistency between the provision of this Order and any Federal laws or regulations, the laws or regulations will control.

Sec. 7 **Expiration Date**. This Order is effective immediately. It will remain in effect until its provisions are implemented and completed, or until it is amended, superseded, or revoked.