Distribution and Status of Mule Deer (*Odocoileus hemionus*) in Oklahoma: an Analysis of Harvest Data

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Distribution records of mule deer (*Odocoileus hemionus*) in the southern Great Plains are well documented with the exception of Oklahoma, where verified records are few. To estimate the distribution and status of mule deer in Oklahoma, we surveyed harvest records (2001-2008) from 93 Oklahoma Department of Wildlife Conservation harvest regions in western Oklahoma. Mule deer were reported from 37 harvest regions. Annual harvests varied among harvest regions. Consistent annual harvests for each harvest region indicated stable populations, potentially due in part to steady immigration from permanent populations in the panhandle regions of Texas and Oklahoma and western Kansas. Abundance of mule deer reports followed a northwest to southeast gradient, highest in the northwest. Variation in mule deer abundance, based on harvests, was associated with the distribution of optimal, suitable, and marginal habitats. Our results verify mule deer in western Oklahoma and give an approximated range boundary and help to identify specific regions where future research efforts might add to our knowledge of the species.

INTRODUCTION

Mule deer (*Odocoileus hemionus*) occur over western portions of North America. The eastern edge of the species' range extends from Yukon Territory and Saskatchewan, Canada southward through the Great Plains transecting North and South Dakota, Nebraska, Kansas, Oklahoma, Texas, and into western Mexico. Isolated occurrences outside the defined species' range are reported from Minnesota, Iowa, and Missouri. Gaps in geographic distribution are in the Mojave and Sonoran desert regions of southern Nevada, southeastern California, and southwestern Arizona respectfully, as well as the central valley of California, and the Great Salt Lake region of Utah (Cowan, 1956; Wallmo, 1981).

Distribution of mule deer in the southern Great Plains is well documented with exception of Oklahoma, where verified records are few. Caire et al. (1989) presented a summary of mule deer records for the state in four western counties. Tyler and Donelson (1996) cited additional anecdotal reports of mule deer in southwestern Oklahoma including four in Comanche County, the easternmost records for the state.

Due to mule deer status as a game species, populations are monitored and managed in many regions including Texas and Kansas (Schmidly, 2004). However, empirical population data is scarce for Oklahoma and the species is not managed, further contributing to a lack of basic information on the species locally. The goal of this project was to determine distribution of the mule deer and estimate status of the species in Oklahoma. Results presented here are based on documentation by technicians with knowledge of deer species.

METHODS

In 2009, we surveyed deer harvest data from files archived by the Oklahoma Department of Wildlife Conservation (ODWC).

Data included hunter-killed deer identified at hunter check stations throughout the western half of Oklahoma between 2001 and 2008 (data unavailable for 2005). The western half of the state is subdivided into 93 ODWC harvest regions. We identified regions where mule deer have been harvested, determined total harvest per harvest region, and calculated mule deer harvest means for each harvest region between 2001 and 2008. We plotted harvest totals and means on a map of western Oklahoma ODWC harvest regions. We log-transformed annual harvest counts for each harvest region to normalize data and used ANOVA (PAST 1.91, 2009) to determine: (1) if annual harvests varied significantly among harvest regions and (2) if annual harvests varied significantly among years for each harvest region. K-means clustering analysis (PAST 1.91, 2009) was used to classify harvest regions in western Oklahoma using harvest means as a proxy for mule deer abundance. Results of clustering analysis were used to create a map of mule deer abundance in Oklahoma. We compared mule deer distribution based on harvest data to distribution of optimal, suitable, and marginal habitats from published GIS data. Distribution records from harvest data were fitted to those known for Texas and Kansas to depict an overall pattern of distribution for the species in the southern Great Plains.

RESULTS

A total of 1,401 mule deer were harvested in 37 of 93 (39%) western Oklahoma harvest regions between 2001 and 2008. Annual harvests differed among the 37 harvest regions ($P < 0.001$), declining from northwest to southeast (Fig. 1). Year to year variation in deer harvest was not significant ($P = 0.96$) for each harvest region (i.e., annual harvests were consistent). Results of K-means clustering indicated 3 major areas of variation in mule deer abundance (Fig 2a). Variation in mule deer abundance coincided with the distribution of optimal, suitable, and marginal habitats (Fig 2b). Harvest records presented here confirm the species in regions western Oklahoma where voucher-based verification has remained absent. The eastern range boundary for the species in Oklahoma is also presented here (Fig. 3).

DISCUSSION

Results here establish the eastern range boundary for mule deer locally in Oklahoma and regionally for the southern Great Plains. Harvest data suggest that mule deer occur over the western one-third of the state and abundance is variable along a general northwest to southeast gradient. It is unclear if the historical paucity of records is due to a former absence of the species in western Oklahoma, spatial and temporal fluctua-

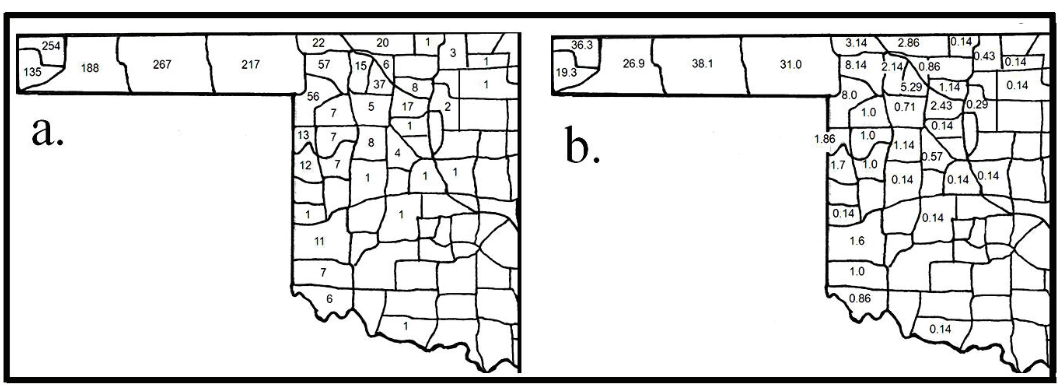

Figure 1. Map of ODWC harvest regions in western Oklahoma with mule deer harvest (2001 – 2008): (a) total harvests (b) mean harvests / year.

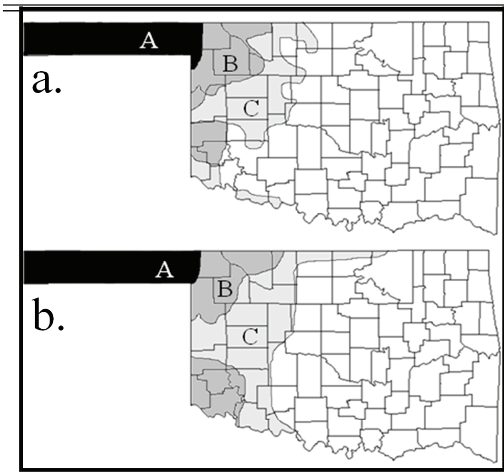

Figure 2. (2a) Mule deer abundance regions based on k-means clustering analysis of mean harvest per year (2001-2008) among 37 ODWC harvest regions in western Oklahoma: (A) common, (B) occasional, (C) rare. (2b) GIS based distribution of (A) optimal, (B) suitable, (C) marginal habitats (Fisher and Gregory 2001; Utah State University Extension 2009).

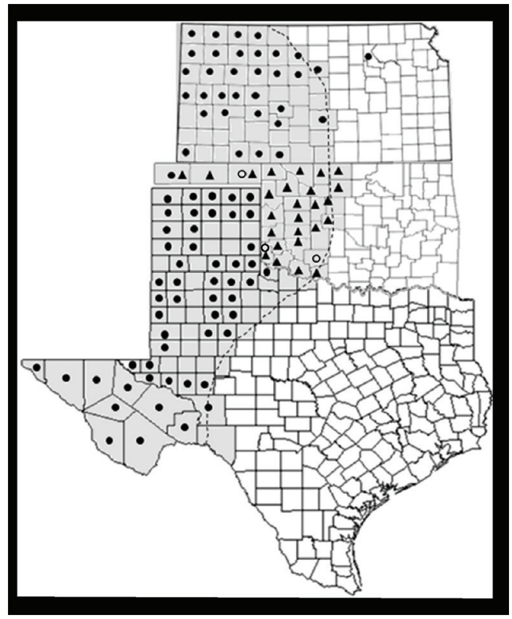

Figure 3. Mule deer distribution in the southern Great Plains based on Schmidly (2004), Kansas State University (online), Caire et al. (1989), and ODWC harvest data (2001-2008). Triangles = ODWC harvest records, closed circles = specimen records, open circles = sight records.

tions of populations, lack of sampling and documentation, or a combination of these factors. Mule deer populations do shift geographically (Garrott et al., 1987; Gilbert et al., 1970; Zalunardo, 1965), which can change the species' status temporally at local and regional scales. Mule deer are influenced by numerous ecological factors; the effects of such factors on populations will vary on local scales, resulting in regional variations in mule deer populations (Unsworth et al. 1999). Harvest data can serve as a baseline to which future data can be compared to examine patterns in mule deer biogeography at local and regional scales.

Due to consistency of annual harvest for each harvest region, it appears that populations in western Oklahoma were stable between 2001 and 2008. This may be due in part to steady immigration from regions of relative high abundance in the Oklahoma / Texas Panhandles and Western Kansas. These areas are characterized by continuity of optimal habitat and thus could function as source population habitats. Mule deer in western Oklahoma may display metapopulation dynamics similar to those observed by Sanchez-Rojas and Gallina (2000) in peripheral mule deer populations in Mexico. Previous studies suggest that mule deer stray into western Oklahoma from the Texas panhandle (Caire et al., 1989; Stangl et al., 1992) and can travel significant distances for breeding and dispersal (Bunnel and Harestad, 1983). Gray (2010) reported that mule deer populations in the Texas Panhandle have been expanding since 1980. Such expansion could produce an excess of dispersing individuals that move into western Oklahoma. Regions of low mule deer abundance identified here are characterized by marginal habitat (Fig 2). Mule deer inhabiting these marginal environments likely occur as scattered ephemeral sink populations where population status at any time is a balance between local extinction and re-colonization.

Western Oklahoma marks a sympatric zone for mule deer and white-tailed deer (*Odocoileus virginianus*). It has been suggested that interspecific interactions have influenced mule deer distribution in areas of sympatry along respective western and eastern range margins for the two con-generic species (Wiggers and Beason, 1986). However, the species do coexist in many areas of sympatry with only subtle evidence of resource partitioning (Brunjes et al., 2009). Interspecific dynamics between the two species are poorly understood for western Oklahoma. Dalquest et al. (1990) and Roehrs et al. (2008) noted that due to large-scale habitat changes, such as woody encroachment and increase of edge habitats, advancing white-tailed populations have displaced mule deer populations in the Oklahoma Panhandle. Similar patterns of displacement have been observed in Texas (Baker, 1984; Wiggers and Beasom, 1986; Carr et al., 1986).

Hybridization between mule deer and white-tailed deer has been recorded in regions of sympatry in Texas (Stubblefield et al., 1986; Carr et al., 1986; Derr, 1991; Bradley et al., 2003). Hybrid zones between the two species are usually associated with ecological parameters (Derr, 1991) and have been linked to landscape-level habitat alterations (Hornbeck and Mahoney, 2000). Hybridization is thought to be an additional limiting factor for mule deer populations since mule deer have been displaced along hybrid zones. Mating of hybrids back to the white-tailed deer parental population (introgression) could further limit the parental mule deer population occurring adjacent to hybrid zones (Schmidly, 2004) although direction and degree of hybridization is variable throughout the species' range (Carr and Hughes 1993). If white-tailed deer have a higher reproductive rate than mule deer, as suggested by Kramer (1971), then introgression along hybrid zones could be a significant limiting factor for mule deer populations in sympatric environments (Whittaker and Lindzey, 2001) such as those in western Oklahoma.

Results presented here indicate that mule occur in variable numbers across western Oklahoma. Future efforts should be made towards specimen-based documentation of mule deer distribution in Oklahoma. Along with such documentation, more detailed analyses of hunter-killed and road-killed individuals (i.e., specimen location and habitat, taxonomic identification, body condition, age, reproductive status) will contribute to understanding basic mule deer biology in the region (i.e., diet, reproduction, mortality). Research focused on habitat use, spatial dynamics, and interspecific interactions will allow for a better understanding of ecological mechanisms and genetic processes that influence mule deer populations.

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