MOVEMENTS AND RESOURCE USE BY MOOSE IN TRADITIONAL AND NONTRADITIONAL HABITATS IN NORTH DAKOTA

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ABSTRACT: In the past several decades, moose (*Alces alces*) have expanded their range in North Dakota from primarily forested areas to the prairie/agriculture mosaic of the state. As a result, moose are now well-established in a large portion of North Dakota, yet little is known about their ecology in the state. We examined the home ranges, habitat selection, and diets of moose in both traditional (forested) and nontraditional ranges (prairie/agricultural) and inferred whether range expansion is the result of agriculture-related landscape changes. From 2004 to 2006, we placed GPS radio-collars on a total of 14 moose in two study areas: Turtle Mountains (forested) and Lonetree (prairie/agricultural). Total and seasonal home ranges were larger for Lonetree moose, and moose in both study areas selected strongly for wooded habitat. In both study areas seasonal diets ranged from 65 to 99% woody browse, with forbs 15% of summer diets. In the Lonetree area row crops made up the second highest consumed forage in fall (12%) and winter (29%) diets. Larger home ranges in the Lonetree area may reflect the low availability and scattered distribution of wooded habitat. Further, the strong selection for planted woodlands and the high proportion of woody browse and row crops in the diet of Lonetree moose suggests that conversion of the native prairie to agriculture has facilitated range expansion by moose in North Dakota.

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Key Words: *Alces alces*, browse, cropland, diet, habitat selection, home ranges, North Dakota, prairie, woodland

INTRODUCTION

Moose (*Alces alces*) are native to North Dakota with their traditional range encompassing the aspen (*Populus tremuloides*) and bur oak (*Quercus macrocarpa*) forests of the Turtle Mountains and Pembina Hills along the northern edge of the state (Knue 1991). While moose were extirpated from North Dakota by the late 1800s, they had begun to re-establish a population in the state by the 1960s. After re-colonizing their historic range, by the 1980s moose had expanded their range to include large expanses of former tall and mixed grass prairie that had been greatly modified by conversion to agriculture and widespread planting of tree rows to reduce wind erosion subsequent to the Dust Bowl years of the 1930s (Knue 1991, Licht 1997).

The colonization and range expansion by moose in North Dakota are likely the result of conversion of the native prairie landscape to an agricultural mosaic that provides suitable cover and forage otherwise absent in unaltered tall or mixed grass prairie habitats. Although moose are known to persist in other landscapes modified by humans such as clear-cuts and agricultural areas within forested landscapes (Leptich and Gilbert 1989, Rempel et al. 1997, Schneider and Wasel 2002), the agriculture-dominated landscape of the northern Great Plains represents a unique habitat for the species that was not occupied prior to human-induced habitat change. While numerous prior efforts have provided insight into moose movements and resource use in traditional habitats (Kearney and Gilbert 1976, Leptich and Gilbert 1989, Cederlund and Sand 1994, MacCracken et al. 1997, Labonte et al. 1998), the ecology and behavior of moose in the prairie ecoregions of North America is relatively unknown.

The purpose of this project was to investigate the ecology of moose in both traditional woodland habitats and the recently colonized prairie region of North Dakota, including how this species may be taking advantage of landscape alterations to extend its range. The specific objectives were to 1) examine seasonal and annual movements and habitat use of moose in the prairie and woodland regions of North Dakota, 2) investigate the diet of moose in prairie and woodland regions of North Dakota, and 3) compare movements, habitat use, and diets of moose in these two regions. To meet these objectives, we selected study areas that were representative of traditional and more recently colonized habitats. First, the forested Turtle Mountains comprise a major portion of the historic range of moose in North Dakota and was one of the areas first recolonized upon their return (Knue 1991, Seabloom et al. 2011). Second, the Lonetree Wildlife Management Area (WMA) is an agricultural mosaic characteristic of the habitats more recently colonized by moose. It is representative of most of the landscape of eastern and central North Dakota, which now comprises much of the primary range of this species in the state.

STUDY AREA

The Turtle Mountains (48° 57′ N, 99° 53′ 00" W; Fig. 1) are located along the Canadian border and are characterized by hilly wooded terrain and numerous small lakes and wetlands with interspersed agricultural fields, pastureland, and hay fields, especially near the southern edge of the area. The forest of the Turtle Mountains is comprised primarily of aspen and bur oak along with green ash (*Fraxinus pennsylvanica*), paper birch (*Betula papyrifera*), balsam poplar (*Populus balsamea*) , and box elder (*Acer negundo*), with an understory of chokecherry (*Prunus virginiana*), hazel (*Corylus cornuta*), and several species of willow (*Salix* spp.). Typical herbaceous species include sarsaparilla (*Aralia nudicaulis*), alfalfa (*Medicago sativa*), brome (*Bromus* spp.), fescue (*Festuca* spp.), wheatgrass (*Agropyron* spp.), sedges (*Carex* spp.), baneberry (*Actea* spp.), false lily of the valley (*Maianthemum canadensis*), wild vetch (*Vicia americana*), and Virginia anemone (*Anemone virginiana*) (Stevens 1966, Bakke 1980, ND Forest Service 2003).

The Lonetree WMA is large, encompassing 134 km^2 in the central part of the state (47°30′ N, 100°15′ W; Fig. 1). It consists of farmland initially purchased by the U.S. Bureau of Reclamation to be used as part of the Missouri River Garrison Diversion Project (Garrison Diversion Project 2019). Following the cancellation of that portion of the project, management of the land was turned over to the North Dakota Game and Fish Department. Habitats include native mixed grass prairie, corn (*Zea mays*) and sunflower (*Helianthus annuus*) food plots (range = 6–31 ha), numerous seasonal and semi-permanent wetlands, small impoundments along the Sheyenne River, and planted woodlands in the form of linear tree rows or larger block plantings (Smith et al. 2007). The surrounding area is comprised primarily of pasture and hay land

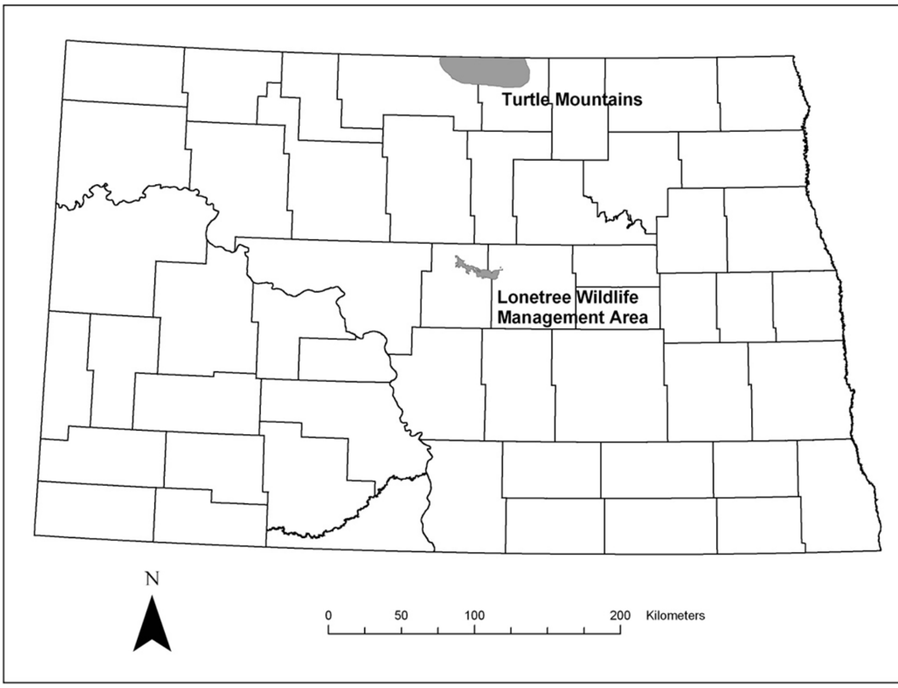

Fig. 1. Location of the Lonetree Wildlife Management Area and Turtle Mountains study areas in North Dakota, USA. Boundaries delineate North Dakota counties.

as well as crop fields consisting mostly of small grains. Planted tree rows and woodlots are present with some natural woodlands occurring in woody draws along the Missouri Escarpment that marks the border between the Northern Glaciated Plains and Missouri Coteau ecoregions (USEPA 1996). Typical grassland plants found in the area include prairie junegrass (*Koeleria macrantha*), indiangrass *(Sorghastrum nutans*), needle and thread grass (*Hesperostipa comata*), brome, wheatgrass, and alfalfa. Common tree species in planted and/or native woodlands include green ash, box elder, American elm (*Ulnus americana*), Russian olive (*Elaeagnus angustafolia*), plum (*Prunus* spp.), apple (*Malus* spp.), chokecherry, fireberry hawthorn *(Crataegus chrysocarpa*), serviceberry (*Amelanchier alnifolia*), and willow.

METHODS

Study animals

Global positioning system (GPS) radio-collars (Lotek Wireless Inc. Newmarket, Ontario, Canada) were placed on 14 adult moose (5 cows, 1 bull in the Lonetree WMA; 4 cows, 4 bulls in the Turtle Mountains) in January 2004–2006. Only moose in the Lonetree WMA study area were captured in 2004, with subsequent expansion to the Turtle Mountains in 2005 and 2006. Moose were captured from helicopter with the use of a net gun. Capture operations were performed by Leading Edge Aviation (Lewiston, Idaho, USA), and all methods were approved by the University of North Dakota (IACUC Project #0506-3). Collars were set to acquire a location every 4 h, and location data were stored on board. After ~ 52 weeks, radio-collars were recovered when moose were recaptured or after they dropped off via timed-release mechanisms. Moose were periodically monitored by aerial and ground-based VHF telemetry.

Home range estimation

Total and seasonal moose home range sizes (km^2) were estimated with a 95% fixed-kernel estimator, with seasons defined as winter (1 January–30 April), summer (1 May–31 August), and fall (1 September–31 December) for all analyses. We carried out these calculations using all available locations for non-dispersing moose, with dispersal defined as locations for a moose that deviated from other grouped relocations for that animal (Dodge et al. 2004). Seasonal home range sizes were estimated for each moose for all seasons for which at least 30 locations were available, and total home ranges were estimated for moose with at least 30 locations in every season (Seaman et al. 1999). Moose were considered to exhibit seasonal migrations if < 25% of their seasonal home ranges overlapped (Dodge et al. 2004). Location data were input into ArcMap 9.2 (ESRI Inc., Redlands, California, USA) and home range calculations were performed using the Home Range Extension (Rodgers and Carr 1998).

At the time of our study, least squares cross validation (LSCV) was the most recommended technique to determine the optimal smoothing parameter for fixed-kernel home range estimation (Worton 1995, Seaman and Powell 1996, Seaman et al. 1999). However, we experienced similar problems with this method as reported by others (Silverman 1986, Hemson et al. 2005); LSCV was unable to calculate a smoothing parameter for most sets of locations, and if it did, the multi-modal nature of the locations produced home ranges that were dramatically under-smoothed. To deal with these problems, we used biased cross validation (BCV) to calculate the smoothing parameters for all fixed-kernel home range estimations (Wand and Jones 1995, Rodgers and Carr 1998). Although BCV has not been commonly applied to estimate the smoothing parameters for home range estimates, the statistical literature has demonstrated its utility in selecting kernel bandwidth, as well as its potential superiority to LSCV (Sain et al. 1994, Wand and Jones 1995, Rodgers and Carr 1998). We compared total home range sizes between study sites with a two-sample *t*-test. For all moose with home range estimates for all seasons, we also compared seasonal home range sizes among seasons and study sites with repeated-measures ANOVA. When necessary, home range sizes were natural log transformed to meet the assumptions of parametric tests. All statistical comparisons were performed in the statistical package *R 2.6* (R Core Development Team 2007).

Habitat selection

We first estimated the extent of the area available to moose in each study area by constructing 99% fixed-kernel home ranges for each moose, and then combined the home ranges for each study site into a single polygon. We then used land cover data from the United States Geological Survey's Gap Analysis Program (GAP) compiled from 1992 to 1999 (Strong et al. 2005) as well as National Wetland Inventory 1:24,000 digital quadrangles (USFWS 2000) to determine habitat types available to moose. To make the comparison of habitat use between study sites possible, land cover data were collapsed into 4 habitat types using Spatial Analyst in ArcMap 9.2 (ESRI Inc., Redlands, California, USA). These were defined as woodland (all planted and naturally occurring woodlands), wetland (temporary, seasonal, permanent, and semi-permanent wetlands), grasslands (planted non-native grasses, hay fields, old fields, and planted or naturally occurring prairie), and crops (all planted row crops or grains).

Next, because preliminary analysis indicated that the coarse spatial resolution (30-m) of the GAP data were insufficient to detect small areas of habitat, we improved the resolution of terrestrial habitat layers by re-digitizing data based on 1-m resolution aerial photos of each study site (National Agricultural Imagery Program, USDA-FSA 2005). We did this by overlaying GAP habitat layers onto the aerial photos in ArcMap, then manually re-digitizing the GAP layers to conform to the habitat boundaries indicated on the photos. We modified the wetland habitat layer by considering all temporary and seasonal wetlands to be part of the terrestrial habitat in which they were imbedded, as these wetlands are typically inundated only during the spring and do not provide a source of emergent or submergent aquatic vegetation (USFWS 2000). We also adjusted wetland habitat availability to account for the presence of several larger lakes in the 2 study areas. Because the deep-water areas in these lakes were unlikely available to moose, we created a 100 m buffer layer that extended from the shoreline into each lake. This distance was chosen as a conservative estimate of the extent of the littoral zone, where water depth was shallow and emergent and submergent plants would occur. The area of this buffer layer was considered the amount of lake habitat available to moose. We measured the area of each habitat type in each study area using the X-Tools extension for ArcMap 9.2 (ESRI Inc., Redlands, California, USA) and then determined the proportional availability of each habitat (Table 1).

All locations for individual moose at each study site were separated into seasons. We then calculated Manly's standardized selection ratios for each moose with ≥30 locations in a season (Manly et al. 2002, Osko et al. 2004). This method produces selection ratios that represent the probability of a moose using a particular habitat if all habitats were equally available, and the selection ratios for all habitats sum to 1. Because there were four habitat types in this study, a selection ratio of 0.25 indicates non-selection (not different than by chance), while a selection ratio >0.25 represent positive selection for a habitat type.

Table 1. Proportional availability of each of the four major habitat types in the Lonetree and Turtle Mountains study areas in North Dakota, USA.

	Woodland	Wetland	Grass	Crop
Lonetree	0.025	0.053	0.400	0.522
Turtle Mountains	0.451	0.170	0.252	0.127

Diet

In 2005–2006 we collected 5 samples of fresh moose feces monthly from each study area by searching several locations distributed across each study site, with no more than 2 samples/month collected from a single location (e.g., from the same clear-cut). Samples were combined to generate a series of 2-month composite fecal samples. Samples were sent to the Wildlife Habitat and Nutrition Laboratory at Washington State University (Pullman, Washington, USA) for microhistological determination of plant fragments and estimates of diets to the genus and species level (Van Vuren 1984). Forage plants were classified into 5 categories: woody browse, grasses and sedges, forbs, crops, and other (fruits, nuts, aquatic vegetation). Results of this diet analysis were grouped by season based on the same criteria used for home range and habitat use analyses.

RESULTS

Home range and movement

A high rate of collar failure in 2005 prevented the calculation of all seasonal and annual home ranges. Estimates of home range size (95% fixed kernel method) ranged from 59.2 to 262.6 km^2 (n = 5) in the Lonetree WMA study area which were larger than in the Turtle Mountains (9.6–47.7 km^2, n = 4; $t_{5.3}$= 3.7, P = 0.01; mean number of locations = 2709). Seasonal home range estimates were also larger in Lonetree than the Turtle Mountains ($F_{1,25}$ = 13.3, P = 0.0012, mean number of locations = 807), ranging from 18.8 to 292.8 km^2 and 1.0 to 44.7 km^2, respectively. Home range size did not differ among seasons ($F_{2, 25}$ = 0.1, P = 0.91). One moose was excluded from comparisons because its 30 locations occurred in a single month.

None of the moose exhibited seasonal migrations. One dispersed from the Lonetree WMA in March 2004, with the 5 others remaining in the general vicinity. Radio-collars were recovered successfully from 7 animals (the 8th failed) in the Turtle Mountains; all remained in the Turtle Mountains throughout the study.

Habitat use

Moose strongly selected for wooded habitat in all seasons in both study areas; conversely, no selection for cropland or grassland habitats was measured in either study area. Moose in the Turtle Mountains also selected for wetland habitats during the summer (Table 2).

Moose diets

Moose consumed mostly woody plants in both the Lonetree (≥65%) and Turtle Mountains (≥83%) areas in all seasons of the year (Fig. 2). Consumption of woody browse was particularly high in the Turtle Mountains; for example, moose consumed 99% woody browse during winter, primarily aspen (36%) and willow (20%). Willow and aspen were also important components of the diets in the Turtle Mountains during summer (15 and 12%) and fall (19 and 23%). Bur oak stems and leaves were also common forage items in these seasons, representing 20% and 23% of summer and fall diets, respectively. In the Lonetree area, Russian olive was the most common woody browse consumed in all seasons and was 50% of the fall diet, followed by willow (10% in summer) and cottonwood (11% in winter). Row crops (primarily corn) were also a major component of the diets in the Lonetree area during fall (12%) and winter (29%; Fig. 2). In contrast, row crops were absent from samples collected in the Turtle Mountains, although alfalfa was an important component in summer and fall diets (13%), representing 90% of forbs consumed in these seasons. Grasses (≤3%) and fruits and nuts (≤1%) were minor components of the diet in both study areas, while emergent and submergent aquatic vegetation were ≤1% of the diet during the open water seasons of summer and fall.

Table 2. Mean Manly's standardized selection ratios (SE) for four habitat types based on data from 13 GPS-collared moose in the Lonetree and Turtle Mountains study areas in North Dakota, USA. Bold numbers indicate positive selection (> 0.25) for a habitat type.

Study site	Season	*n*	Woodland	Wetland	Crop	Grassland
Lonetree	Winter	6	**0.95(0.008)**	0.013(0.005)	0.013(0.003)	0.024(0.004)
	Summer	6	**0.89(0.016)**	0.048(0.018)	0.024(0.006)	0.034(0.005)
	Fall	5	**0.84(0.033)**	0.067(0.017)	0.051(0.017)	0.038(0.009)
Turtle Mountains	Winter	7	**0.76(0.01)**	0.16(0.021)	0.031(0.017)	0.048(0.012)
	Summer	4	**0.56(0.06)**	**0.30(0.039)**	0.015(0.007)	0.13(0.068)
	Fall	4	**0.54(0.1)**	0.21(0.052)	0.10(0.040)	0.15(0.085)

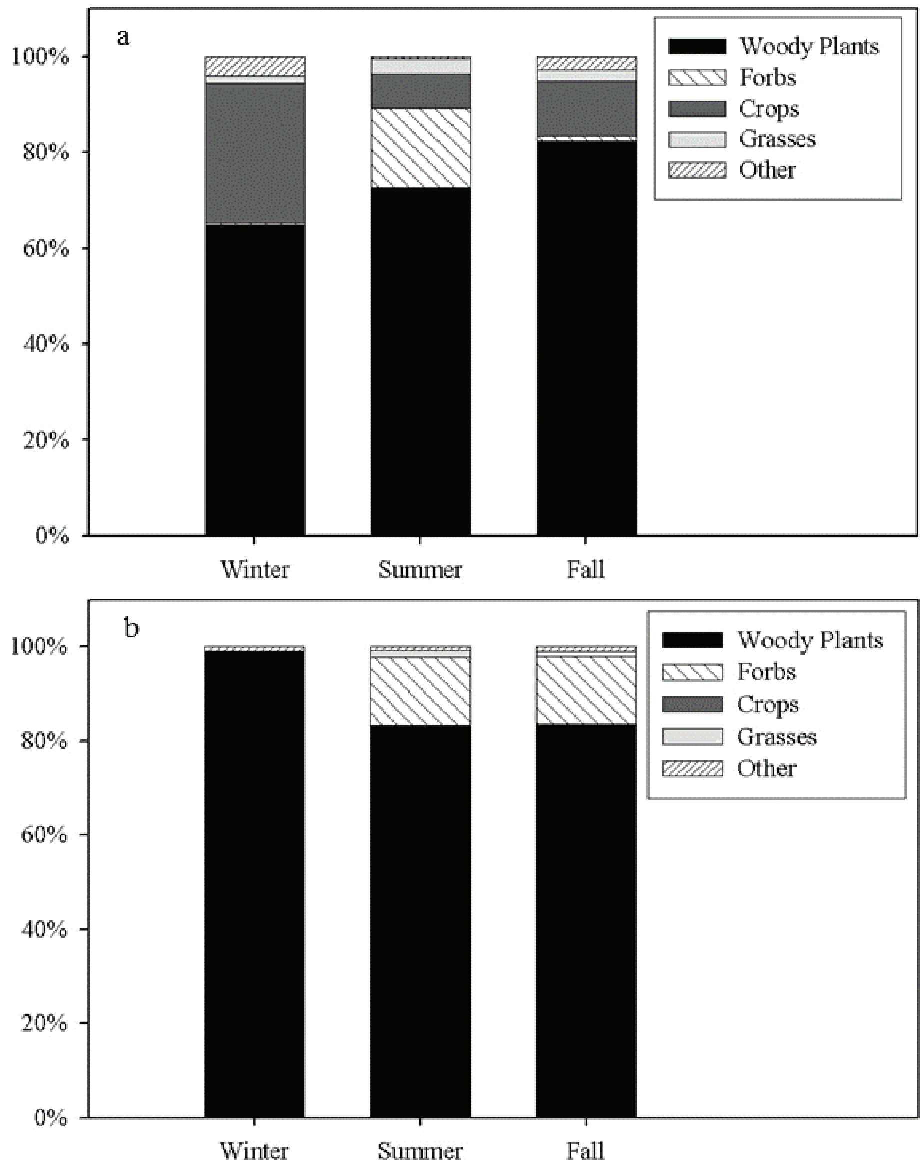

Fig. 2. Seasonal diet composition (%) of moose in the Lonetree (a) and Turtle Mountains (b) study areas in North Dakota, USA.

DISCUSSION

Sample size and radio-collar performance

The low density of moose limited the number of animals that could be studied in the Lonetree WMA. Observations from fixed-wing aircraft indicated that only 5 moose were in the vicinity in 2004, and all were successfully captured and radio-collared that year; likewise, in subsequent years we successfully radio-collared nearly every known moose in the area. Radio-collar failures limited our ability to make comparisons between moose in their traditional range and the prairie habitats. Overall, 9 of 22 radio-collars failed prematurely, with 6 of 10 in the Turtle Mountains including 4 of 5 deployed in 2005. We do not believe that these failures generated any obvious sources of bias within our data. More importantly, we radio-collared a large proportion of the moose in the study areas and our results provide novel information about habitat and forage use in the North Dakota landscape.

Migration and dispersal

Our results indicate that moose in North Dakota are largely non-migratory. Elsewhere, moose may migrate to avoid deep snows at high elevation or to seek conifer forests that provide thermal cover or reduced snow depth (Pierce and Peek 1984, Ballard et al. 1991, Hundertmark 1998, Thompson and Stewart 1998, Poole and Stuart-Smith 2006). Because moose range in North Dakota lacks these characteristics, elevational differences do not lead to variability in snowfall or depth, and conifer forests are absent. Additionally, habitat selection and diet composition of moose in both study areas indicated that moose selected for wooded habitats and consumed primarily woody browse in all seasons. Other habitats such as croplands realized increased seasonal use, but these habitats were interspersed within the mosaic of woodland patches used year-round by moose. As a result, moose did not need to migrate to gain access to seasonally preferred forage.

Home range

Detailed comparisons of home range sizes across studies are difficult because of differences in the number of locations collected and the variety of estimators used. However, home range size is expected to be a function of the energetic requirements of an animal and the spatial distribution of necessary resources (McNab 1963, Elchuk and Weibe 2003, Mitchell and Powell 2004). Thus, where required resources are widely dispersed, home range size will be larger. Mean total home range size (160.5 km^2, SE = 38.9) for Lonetree moose was near the upper range of averages reported for non-migratory moose (174–290 km^2; Grauvogel 1984, Ballard et al. 1991, Stenhouse et al. 1995). Ballard et al. (1991) attributed large home ranges to the high proportion of unavailable habitat within home ranges. Similarly, 92% of the landscape in the Lonetree WMA consisted of grassland and cropland habitats that moose mostly avoided, while the wooded habitats that moose selected for comprised only 2.5% of the landscape. In contrast, in the Turtle Mountains with a high proportion of woodland habitat (45.1%), moose had smaller total home ranges ($\bar{x}$ = 27.7 km^2, SE = 10.0) similar to those (2–43 km^2) for other predominantly wooded areas in eastern North America (Phillips et al. 1973, Addison et al. 1980, Leptich and Gilbert 1989, Garner and Porter 1990, Dodge et al. 2004).

We did not observe significant differences in home range size among seasons, but seasonal home-range size varied considerably among moose. Although energy constraints associated with moving through deep snow or predator avoidance may result in smaller home ranges during winter (Phillips et al. 1973, Thompson and Vukelich 1981, Dussault et al. 2005), snow depths considered limiting to moose are rare (> 70 cm; Hundertmark 1998) and large predators are absent in North Dakota. Thus, seasonal home ranges were more likely determined by the distribution of seasonally-important forage resources (Doerr 1983, Lynch and Morgantini 1984, Leptich and Gilbert 1989). As such, the differences in size of seasonal home ranges among moose likely reflected the spatial pattern of available seasonal resources where moose resided.

Habitat selection and diet

While the characterization of habitat types was general in order to facilitate comparisons between the study areas, the habitat selection analyses nevertheless provided important insight into how moose utilized available habitats in North Dakota. Numerous researchers have demonstrated the importance of a variety of types of woody habitats in providing forage and/or cover for moose (e.g., Peek et al. 1976, Peek 1998, Courtois et al. 2002). Therefore, it was not surprising that moose in North Dakota exhibited a strong selection for woody habitats in all seasons in both study areas. In adjacent Minnesota and many areas of Canada, moose inhabited early successional forest created by periodic fire or insect outbreaks and that are now maintained largely by forest harvesting (Peterson 1955, Phillips et al. 1973, Peek et al. 1976). The forests that cover nearly half of the Turtle Mountains study area represent this "typical" moose habitat, and the tree plantings on and around the Lonetree WMA, though more scattered across the landscape, also appear to provide important forest habitat for moose.

Woody browse dominated the diets of moose in both study areas, similar to prior research demonstrating the importance of woodlands in providing forage for moose (Belovsky 1981, Renecker and Schwartz 1998). Diets in the Turtle Mountains consisted in large part of browse species such as aspen, willow, birch, juneberry, and cherry that are typically considered common forage items of moose. In addition to many of these traditional browse species, the Turtle Mountains also had an abundance of bur oak which was a major component of summer and fall diets. In the Lonetree area, the most common woody plants (except willow) are not typically found in traditional moose range, and this was reflected in the local diet. For example, Russian olive is a common shrub in tree plantings and was the most abundant browse item (25% of overall diets), and green ash and box elder, also commonly planted, were ~11% of the winter and summer diets.

Woodlands was the only habitat moose selected for in all seasons, but seasonal changes in diet and the use of croplands and wetlands suggest that moose also selectively used seasonally available forage in other habitat types. Thus, selection ratios may not entirely reflect the importance of habitats other than woodlands. For example, while moose avoided grassland habitats in both study areas, alfalfa was 13% of the summer and fall diets in the Turtle Mountains, indicating that this forb was an important supplemental seasonal forage. Likewise, moose exhibited negative selection for croplands in all seasons, even though its use was greater in fall than in other seasons and corn was an important part of the fall and winter diets of Lonetree moose. This apparent lack of selection may reflect the different composition of croplands in the two study areas. Crops in the Turtle Mountains consisted almost entirely of small grains (wheat, barley) that were not expected to serve as moose forage, and in Sheridan and Wells Counties where Lonetree WMA is located, ~26% of the total land area was planted in wheat and barley in 2005 with only 2% corn and 3% sunflowers (USDA 2005). In contrast, if habitat selection analyses were confined to the boundary of the Lonetree WMA where the only croplands were corn and sunflower food plots, then moose would show an overall positive selection for cropland habitats (Manly's standardized selection ratio = 0.29).

Moose avoided wetlands in most seasons, possibly due to avoidance of open areas during warm daytime temperatures (Olson et al. 2016). However, relative to winter, we observed an increase in wetland use during summer and fall which was primarily driven by Turtle Mountain moose; use of wetlands was low year-round for Lonetree moose (Table 2). The increased use of wetlands was not reflected in the diets, as aquatic vegetation was a minor component (≤1%) of summer and fall diets in both study areas. However, these plants likely play an important role because it is believed moose consume aquatic plants for their critical minerals (De Vos 1958, Belovsky and Jordan 1981) and high digestibility (MacCracken et al. 1997). The latter may represent a potential limitation of this study because it may cause underrepresentation of aquatic plants in fecal samples. Alternatively, the relative increase in wetland use in summer and fall may have been independent of forage requirements and triggered by thermoregulatory behavior or to avoid insects (De Vos 1958, Belovsky and Jordan 1981).

The combined results of home range, habitat use, and diet analyses provide insight into the factors influencing space use by moose in both traditional and prairie habitats in North Dakota. While wooded habitats appear to be critical for moose throughout their range in North Dakota, other seasonally available resources such as corn and alfalfa may provide supplemental food sources. Further, the strong selection for planted woodlands and use of crops as a food source in the Lonetree WMA support the hypothesis that range expansion by moose is the direct result of landscape modifications occurring since European settlement.

Management implications

Moose are a prized big game species in North Dakota, with >15,000 hunters applying annually for a once-in-a-lifetime license (North Dakota Game and Fish Department 2019). This study provides ecological information about the state's moose population that will help managers make informed decisions to maintain and enhance this unique wildlife resource. While moose have expanded their range to include areas of North Dakota that were historically prairie, the woodland habitats that they depend on constitute a very small proportion of the overall landscape in these areas, thereby requiring moose to have large home ranges to acquire sufficient resources. As a result, managers should recognize that prairie habitats are likely capable of supporting fewer moose than forested areas, and that the continued persistence of prairie populations of moose will be dependent on the maintenance of forest habitat. Additionally, the planted woodlands and food plots of the Lonetree WMA may make this area particularly attractive to prairie moose. The continued management of this and other WMAs to provide food and cover for wildlife should help support the state's moose population in non-traditional range where availability of preferred habitats is limited.

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