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NOTES: BED-SITE SELECTION BY NEONATAL WHITE-TAILED DEER IN CENTRAL NORTH DAKOTA

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NOTES

BED-SITE SELECTION BY NEONATAL WHITE-TAILED DEER IN CENTRAL NORTH DAKOTA—Understanding bed-site selection and vegetation characteristics provides valuable information for population management (Verme 1977, Huegel et al. 1985*a*, Nelson and Woolf 1987). Predation and other natural-caused mortalities of white-tailed deer (*Odocoileus virginianus*) neonates are most likely to occur within the first 60 days of life; a time period when selected habitat characteristics are vital to survival (Verme 1977, Huegel et al. 1985*a*, Nelson and Woolf 1987, Grovenburg et al. 2010). Prior to the study of Grovenburg et al. (2010), limited research had been completed on bed-site selection of neonatal white-tailed deer in the grasslands of the Northern Great Plains. In north-central South Dakota, increase in vertical height of vegetation was the most important habitat characteristic at bed sites, which likely pertained directly to protection from predation and thermal insulation (Grovenburg et al. 2010, 2012*a*). Our objective was to describe the physical and vegetative characteristics of bed sites selected by neonatal white-tailed deer in the grassland dominated landscape of central North Dakota. We hypothesized that neonatal white-tailed deer would select bed sites characterized by relatively high understory vegetation to moderate ambient temperatures resulting in favorable microclimates for maintaining thermal neutrality while providing concealment from predators.

We studied neonatal white-tailed deer in Burleigh County in central North Dakota, which comprised an area of 2,652 km². The study area was located within the Northwestern Glaciated Plains level III Ecoregion (Bryce et al. 1998) and was characterized by significant surface irregularity and high concentration of wetlands (United States Department of Agriculture 2011). Long-term (30-year) mean summer temperatures ranged from 13.1° C to 27.5° C and mean (30-year) annual precipitation was 44.9 cm (North Dakota State Climate Office 2012). Nearly all land within the region was used for agricultural purposes. Grasslands and croplands dominated the landscape at 66.2% and 21.0%, respectively. Additionally, wetlands and water comprised 7.4%, developed land 5.2%, and other land uses <1% of the landscape (United States Department of Agriculture 2011). Furthermore, Burleigh County had 4,884 ha in Wildlife Management Areas, 6,844 ha in National Wildlife Refuges, and 4,546 ha in Waterfowl Production Areas (C. Penner, North Dakota Game and Fish Department, personal communication).

Native vegetation occurring on the study area included western wheatgrass (*Pascopyrum smithii*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), needle and thread (*Stipa comata*), green needlegrass (*S. viridula*), prairie cordgrass (*Spartina pectinata*), northern reedgrass (*Calamagrostis stricta)*, plains muhly (Muhlenbergia cuspidata), prairie muhly (*M. cuspidata*), prairie junegrass (*Koeleria macrantha*), blue grama (*Bouteloua gracilis*), and saltgrass (*Distichlis spicata*; nomenclature follows Johnson and Larson [1999]). Cultivated crops in the region included wheat, sunflowers, corn, soybeans, canola, flaxseed, barley, peas, oats, dry beans, potatoes, sorghum, triticale, millet, rye, lentils, mustard, and safflower (United States Department of Agriculture 2011).

From 20 May to 30 June 2011, we captured neonatal white-tailed deer by intensively searching areas where we observed females exhibiting distinct postpartum behavior. These behaviors included adult females exhibiting isolation and only fleeing short distances after being approached by personnel (Downing and McGinnes 1969, White et al. 1972, Huegel et al. 1985*b*). Upon capture, we manually restrained neonates, determined sex, and recorded weight to the nearest gram using a 4.8-mm mesh bag suspended from a digital scale. We fitted captured neonates with M4210 expandable breakaway radiocollars (Advanced Telemetry Systems, Isanti, MN, USA). To help minimize stress and reduce capture-related mortality, we minimized handling time, processed fawns at capture sites, wore sterile rubber gloves, stored radiocollars and other equipment for 6 weeks before capture in natural vegetation commonly found in the area, kept noise to a minimum, and rubbed fawns with native vegetation before release (Grovenburg et al. 2010, 2012*b*). Although we did not estimate age of neonates, previous captures of 204 neonates in the Dakotas (Grovenburg et al. 2011, 2012*b*) indicated that 96% were less than 10 days of age (older neonates were able to flee from capture personnel).

We obtained subsequent bed-site locations by relocating radiocollared neonates (Grovenburg et al. 2010). We used omnidirectional antennas and hand-held 4-element Yagi antennas (Advanced Telemetry Systems) to "home in" on radiocollared neonates and locate bed sites. We took precautions not to disturb bedded neonates; however, if the neonate did leave the area, we collected vegetation measurements. If neonates were located without being disturbed, we marked bed sites a set distance and cardinal direction from the site and returned 1–4 days later to collect vegetation measurements. We located and recorded 1–5 bed-site locations for each radiocollared individual through 30 June 2011. Our animal handling methods were approved by the Institutional Animal Care and Use Committee at South Dakota State University (Approval no. 10-006E) and followed recommendations of the American Society of Mammalogists (Sikes et al. 2011).

We collected vegetation data at paired sites: neonatal bed sites and randomly selected sites. Random sites were located within the same cover type and less than 250 m from neonatal bed sites; sites were located by traveling in a random direction and distance from the bed site while remaining within the cover type. Each bed site was classified in one of the following cover types: grasslands, Conservation Reserve Program grasslands (CRP), forest, alfalfa hay, or wetlands. We

used a modified Robel pole (Robel et al. 1970) with 10-cm increments to measure vertical height of overstory and understory vegetation at each bed and random site. Measurements were collected at the center of paired sites and at four locations 2 m from the bed site along transects radiating out from bed and random sites in the four cardinal directions (Robel et al. 1970). We recorded an ocular estimation of percent cover using 5% increments for forbs, grasses, shrubs, rock, bare ground, slash, litter, cultivated crops, water, alfalfa, trees, and wheat in 24, 1.0-m² Daubenmire (1959) plots spaced at 1-m intervals along two perpendicular transects originating at the center of bed and random sites. We estimated tree canopy cover at the center of bed and random sites, and at 6 m north, south, east, and west of sites using a spherical densitometer (Geographic Resource Solutions, Arcata, CA, USA; Uresk et al. 1999). We estimated tree basal area (BA) at the center of bed and random sites using a 10-factor prism (Jim-Gem® Square Prisms, Forestry Suppliers, Inc., Jackson, MS, USA; Sharpe et al. 1976).

To test for potentially confounding relationships, we evaluated collinearity between predictor variables using Pearson's correlation coefficient ($r < |0.6|$). We used multivariate analysis of variance (MANOVA) to compare mean parameters of bed and random sites. We used a Likelihood Ratio Chi-Square to determine if habitat-specific selection occurred at the landscape level. We used vegetation height at bed-site locations to test the grassland bed-site model developed for neonates in north-central South Dakota; a logistic model was developed, which indicated that vegetation height was the best habitat metric for predicting bed sites of neonates (Grovenburg et al. 2010). We used the SCORE statement to calculate predicted values for presence (p_1) and absence (p_0) for each observation (SAS Institute 2009).

We captured and radiocollared 13 fawns (7 M, 5 F, 1 unknown) between 28 May and 23 June 2011. At capture, mean weight was 3.84 kg (SE = 0.27, $n = 11$) and ranged from 2.49 kg to 5.17 kg. We collected data at 28 bed sites and 28 random sites used by radiocollared neonates from 28 May to 30 June 2011. We located 13 (46.4%) bed sites in grasslands, 7 (25%) in CRP grasslands, 7 (25%) in forest cover, and 1 (3.6%) in alfalfa; habitat-specific selection was not detected ($\chi^2_5 = 4.46$, $P = 0.486$) at the landscape level. Percent cover estimates indicated that the most abundant cover at bed and random sites was grass at 69.5% and 66.7%, respectively (Table 1). Mean micro-habitat measurements at bed sites were 87.3 cm (SE = 4.93, $n = 28$) for vertical height of overstory vegetation, 43.1 cm (SE = 43.07, $n = 28$) for vertical height of understory vegetation, 9.9% (SE = 3.93, $n = 28$) for tree canopy cover, and 0.1 m²/ha (SE = 0.08, $n = 28$) for tree basal area; micro-habitat characteristics did not differ (Wilk's lambda: $F_{16,39} = 0.69$, $P = 0.789$) between bed and random sites. Predicted probability of presence (p_1) and absence (p_0) of neonatal bed sites in North Dakota using the vertical height of grassland model of Grovenburg et al. (2010) was 0.683 (SE = 0.02) and 0.317 (SE = 0.02), respectively; predicted probability of presence and absence of random sites in North Dakota was 0.651 (SE = 0.03) and 0.349 (SE = 0.03), respectively.

We realize that our data were temporally limited and were collected on a small number of neonates. Consequently, potential biases exist relative to effects of annual variability in weather conditions and predator densities on our results as well as the true sample size (Hurlbert 1984) used in our analyses. Despite these limitations, our findings were consistent with those of Grovenburg et al. (2010) who evaluated bed-site selection in a region of South Dakota that was comparable, relative to available habitats, to our study area in North Dakota. Therefore, we believe that our results represent a credible, albeit limited, assessment of bed-site selection in central North Dakota.

Our results regarding micro-habitat analysis of bed and random sites differed from that reported by Huegel et al. (1986). In Iowa, mean percent of tall grass at bed sites was less than at random sites and 77% of bed sites were in forested cover. Grovenburg et al. (2010) reported similar results to those of Uresk et al. (1999) for fawns in the Black Hills of South Dakota where neonates selected for bed sites that exhibited greater height of vegetation within forested cover. We, however, documented that neonatal bed sites contained grassland vegetation of similar height to that of random sites.

We used our bed-site observations to validate the grassland bed-site model for north-central South Dakota where probability of neonatal bed-site selection increased with increase of vertical height of vegetation (Grovenburg et al. 2010). Although the fit of our data was acceptable, the model was only 68% accurate at predicting bed-site locations of neonates based on vertical height of overstory vegetation, which might have been due to the quality of grasslands available to fawns in North Dakota. Mean vertical height of bed–site vegetation in North Dakota was 87.3 cm whereas Grovenburg et al. (2010) documented mean height of CRP-tall grass habitats of 76.6 cm. Mean vertical height of vegetation at random locations in North Dakota (83.9 cm; Table 1) was similar to that at bed sites of female (80.1 cm) but higher than at bed sites of male neonates (56.1 cm) in north-central South Dakota (Grovenburg et al. 2010). Furthermore, pasture habitat in north-central South Dakota had mean vertical height of 34.8 cm (Grovenburg et al. 2010), which was well below that of CRP-tall grass habitats. If fawns select for vegetation height to enhance thermal cover and concealment from predators as has been hypothesized (Huegel et al. 1986, Grovenburg et al. 2010, 2012a), the greater availability of suitable cover in North Dakota would allow fawns a variety of available habitats meeting minimal requirements for selection.

In south-central Iowa (Huegel et al. 1986) and Texas (Hyde et al. 1987) density of understory vegetation was an important micro-habitat characteristic of neonatal bed sites. Similar to Grovenburg et al. (2010) in north-central South

Table 1. Mean and SE microhabitat characteristics for neonate bed sites for 13 radiocollared neonate white-tailed deer (*Odocoileus virginianus*) in central North Dakota, USA, 2011.

Habitat[a]	Use (n = 28)		Random (n = 28)	
	$\overline{x}$	SE	$\overline{x}$	SE
Grass (%)	69.51	4.00	66.72	4.34
Forb (%)	12.83	2.75	11.07	2.49
Shrub (%)	0.79	0.42	0.37	0.24
Row Crops (%)	0.64	0.64	0.00	0.00
Rock (%)	0.36	0.22	0.00	0.00
Bare ground (%)	0.32	0.17	0.12	0.06
Slash (%)	1.23	0.47	0.86	0.43
Litter (%)	5.35	1.37	9.52	2.28
Water (%)	4.23	2.81	0.86	0.86
Alfalfa (%)	4.69	2.47	4.96	2.53
Trees (%)	0.99	0.81	1.06	0.89
Wheat (%)	0.80	0.80	0.80	0.80
Vertical height (cm)	87.29	4.93	83.88	4.86
Density (cm)	43.07	2.94	38.19	3.35
Tree canopy cover (%)	9.93	3.93	9.93	3.98
Tree basal area (m²/ha)	0.08	0.08	0.00	0.00

[a] There was no statistical significance between use and random bed sites for any microhabitat characteristic ($P < 0.05$).

Dakota, our radiocollared neonates did not select bed sites relative to density of understory vegetation. In warmer climates, such as experienced in south-central Iowa and Texas, neonates select for bed sites with dense understory vegetation for thermal characteristics, which protects them from overheating and maintains water balance (Ockenfels and Brooks 1994). In cooler climates, such as in north-central South Dakota (Grovenburg et al. 2010) and in the Black Hills of South Dakota (Uresk et al. 1999), we speculate that neonates select for microclimates that minimize heat loss while providing high visual obstruction from predators.

Many factors have influenced the decrease of enrolled hectares in CRP across the United States (United States Department of Agriculture 2007, Fargione et al. 2009). By 2010, the Food, Conservation, and Energy Act of 2008 reduced CRP to 12.9 million ha. This legislation mandated a maximum number of hectares that can be enrolled, which stabilize at 12.2 million in 2013 (Fargione et al. 2009, United States Department of Agriculture 2009). The Northern Great Plains is experiencing an increased demand for biofuel production, which has caused native grassland habitat to be converted into crop production (Secchi and Babcock 2007, Searchinger et al. 2008, Fargione et al. 2009). This increased demand

for land to produce corn in the United States resulted in 4.9 million ha converted from grassland to cropland from 2005 to 2008. Habitat loss on this scale has the potential to have direct effects on wildlife populations (Fargione et al. 2009). Increased demand for agricultural production in the Northern Great Plains is one of the leading causes of grassland habitat conversion (Fargione et al. 2009). Despite the high quality of grassland habitat available to neonatal white-tailed deer during our study, future loss of grasslands could result in competition for suitable fawning sites and negatively influence survival of white-tailed deer neonates in central North Dakota.

In central North Dakota, grasslands offer the greatest vertical height of understory vegetation to neonates which in turn provides them with protection from predators. Abundant quality grassland habitat across the landscape provided options for neonates during our research. Nevertheless, survival of neonates occupying our study area (0.61; Schaffer 2013) was lower than the mean estimate of survival reported by Grovenburg et al. (2012*a*; ~ 0.78) despite high availability of tall grasslands available for bed sites. Our estimate of survival was, however, higher than the estimate of 0.54 generated during a year of loss of significant grassland habitat (Grovenburg et al. 2012). Other factors (e.g., predator densi-

ties, severe winter weather) likely interact with habitat availability to affect neonatal survival. Thus, long-term reductions in habitat quality have the potential to cause landscape-level changes that would affect bed-site selection and further decrease the survival of fawns in central North Dakota. We suggest that more research be conducted on neonatal bed-site selection throughout the Northern Great Plains.

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