

DEN CHARACTERISTICS OF UPLAND AND LOWLAND STRIPED SKUNKS ALONG THE MISSOURI RIVER FLOODPLAIN—Striped skunks (*Mephitis mephitis*) are opportunistic with respect to habitat use (Bixler and Gittleman 2000), inhabiting an array of landscapes in the proximity of a permanent water supply, such as forest borders, old-fields, fencerows, and open grassy fields broken by wooded ravines (Schwartz and Schwartz 1981, Larivière and Messier 2000). Food quantity and accessibility are major factors determining the quality of striped skunk habitat (Larivière et al. 1999) and are important in the den site selection.

Dens play an important role in skunk survival and reproduction due to the warmth, predator protection, and safe location for parturition they provide (Hwang et al. 2007). Underground dens can be dug by striped skunks, or consist of buildings and abandoned dens originally dug by other mammals (Verts 1967, Bixler et al. 2000). During late fall, winter, and early spring, striped skunks use underground dens exclusively; however, females with young may continue using underground dens throughout late spring and summer (Wade-Smith et al. 1982).

Several studies have focused on skunks living in the grasslands of Canada (Larivière and Messier 1998a, b, Larivière et al. 1999, Larivière and Messier 2000, 2001, Hwang et al. 2007); we present data on skunks living along a major river system (Missouri River), including skunks inhabiting the unique upland grassland-woodland habitats of the Loess Hills of western Iowa. In this study we describe den characteristics of striped skunks living along the Missouri River and compare den characteristics between upland Loess Hills habitat and lowland floodplain areas.

This study was conducted from 2010–2011 at two managed sites (DeSoto National Wildlife Refuge and Hitchcock Nature Center) within and adjacent to the Missouri River floodplain in eastern Nebraska and western Iowa. DeSoto National Wildlife Refuge encompasses 3,383 ha consisting of restored lowland tallgrass prairie (22.5%), forest (40.6%), cropland (22.0%), lake (10.5%), and wetland (4.5%). Hitchcock Nature Center, located 12.9 km from DeSoto Refuge, is a 405 ha preserve in the Loess Hills of western Iowa consisting primarily (>80%) of upland mesic oak woodland forest interspersed with patches of tallgrass prairie and riparian habitats. The Loess Hills are a range of bluffs bordering the Missouri River alluvial plain from northern Iowa to north-west Missouri formed by the deep (~20–75 m) accumulation of wind-blown silt during the Illinoian and Wisconsin glacial periods (Stambaugh et al. 2006).

Over the course of 1,240 trap nights (Aug 2010 to Aug 2012) we captured four adult female striped skunks using 40 Tomahawk #204 and #201 live traps (Tomahawk Live Trap Co., Tomahawk, WI, USA) baited with oil-packed sardines or cat food. We placed traps throughout the refuges, but concentrated them along pathways with high skunk traffic (roadways, streambeds, animal trails), and we opened traps before

dusk and checked traps the following morning. After capture, we anesthetized skunks with isoflurane (Larivière et al. 1996a), followed by an intramuscular injection of Telazole® (4.7 mg/kg; Larivière et al. 1996b). Following immobilization, we sexed, aged (juvenile or adult), weighed (to nearest 0.1 g), measured (body length and tail length in cm), and fitted skunks with a VHF radio-collar (model MI-2, Holohil Systems Ltd., Ontario, Canada). We returned skunks to the trap and allowed them to recover from anesthesia before releasing them at the site of capture.

We located dens diurnally using homing techniques for hand-held antennas, and marked their locations using a handheld GPS unit. For each den, we recorded the size of the opening, condition of the opening, and aspect. All work was performed under an approved University of Nebraska at Omaha animal care and use committee protocol (#10-017-05-FC) and followed guidelines of the American Society of Mammalogists (Sikes et al. 2011).

We identified a total of 24 striped skunk dens during the study: 16 lowland and 8 upland. We located dens throughout the year, including 11 dens found in fall, 9 found in spring, and two each in summer and winter. Among the lowland dens, 13 dens (81.3%) were underground, 2 (12.5%) were located in buildings, and 1 (6.2%) was aboveground under a fallen tree. Upland dens consisted of 3 (37.5%) underground, 1 (12.5%) building, and 4 (50.0%) in woodpiles. We located most striped skunk dens in edge habitat (54%), followed by farmsteads (25%), grassland (12%), cropland (4%), and woodland (4%). For dens in which there was an opening that faced a particular direction (all but the single above ground den), 39% of openings faced south-southeast, 33% faced south-southwest, 17% faced northeast, and 11% faced east.

Skunk dens are typically located underground, but might also be in a stump, woodpile, cave, rock pile, or cliff crevice, and typically face away from prevailing winter (north-west) winds (Larivière and Messier 1998b). In this study, den sites were found primarily as underground burrows (75% of dens) and were found primarily within edge habitat (54%), farmsteads (25%), or in abandoned or rarely used buildings (12%). Dens were used during fall and winter and faced south-southeast (39%), south-southwest (33%), northeast (17%), or east (11%). Larivière and Messier (1998b) found that skunks preferred to construct dens with openings facing away from cold northern and western winds, and it is possible the skunks in this study followed this pattern. The heavy use of edge and farmstead habitats as den sites signifies the importance of these habitats to striped skunk survival due to the availability of food resources (Philips et al. 2004) or simply because edge habitat provided more den habitat. Because striped skunks often do not dig their own dens, the number of dens used was likely dependent on the number of dens available within the animal's home range (Houseknecht and Tester 1978).

While edge habitats provide foraging opportunities (Larivière and Messier 2000), farmsteads offer abandoned buildings that make excellent den sites due to the low energy

costs and thermoregulatory advantages they bestow (Larivière and Messier 1998b). In the prairies of Canada, skunks often used buildings and other man-made structures as dens, especially in winter. Larivière and Messier (1998b) discovered that striped skunks preferred farmsteads and wetlands for dens and resting sites. Buildings with access beneath enclosed floorboards are commonly used by striped skunks as maternal and winter dens in farmsteads (Larivière et al. 1999). Farmsteads often provide large quantities of insects and small mammals (Larivière and Messier 2000), abandoned buildings for dens with little human interference, and are common near cropland and grassland habitats (Larivière et al. 1999).

More than one den was recorded for most skunks, indicating that striped skunks make use of many different dens, and may switch dens as often as every 1–2 days (Houseknecht and Tester 1978); perhaps due to the accumulation of parasites and feces, to move closer to food sources, or to avoid disturbances (Larivière and Messier 1998b). Larivière and Messier (1998b) discovered that over 40% of females participated in switching of natal dens, while Shirer and Fitch (1970) noted the average occupancy of a den used by skunks to be 2.2 days. Many natal dens (located in close proximity to each other) may be used following parturition, and these dens are often located near prime foraging areas, resulting in smaller female home ranges (Larivière and Messier 1998b).

Striped skunks are an important ecological component of grassland communities and also play an important role for humans as disease vectors. Both lowland and upland skunks used buildings and underground burrows as dens; however, upland skunks also used woodpiles as dens. Therefore, if abandoned buildings happen to be on management land (e.g., old barns) then managers should consider retaining these buildings for winter use as dens by female skunks.

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