

# The Value of Rocky Mountain Juniper (*Juniperus scopulorum*) Woodlands in South Dakota as Small Mammal Habitat<sup>1</sup>

Carolyn Hull Sieg<sup>2</sup>

Native woodlands constitute only a small percentage of the total land area in the Northern Great Plains, yet they provide critical habitat for many wildlife species. Isolated woodlands provide a sharp contrast with adjacent grasslands, increasing available cover, vertical structure, and habitat interspersions, and, hence, the number of potential niches available for wildlife. Research on the value of native woodlands as wildlife habitat has focused mainly on wildlife use of deciduous woodlands (Faanes 1984, Gaines and Kohn 1982, Hopkins et al. 1986, Uresk 1982), although the importance of Rocky Mountain juniper woodlands for mule deer (*Odocoileus hemionus*) has been documented (Severson 1981, Severson and Carter 1978). Information on small mammals associated with Rocky Mountain juniper stands is limited to brief studies conducted in North Dakota (Hansen et al. 1980, Hopkins 1983, Seabloom et al. 1978).

Native woodlands in the Northern Great Plains are limited to areas of increased moisture, such as along streams and rivers, and to areas with

increased topographic variation. Rocky Mountain juniper is restricted to areas of steep topography, such as the "Badlands" of North and South Dakota, the Black Hills, areas along drainageways of major rivers, and areas on high limestone plateaus in South Dakota and Wyoming. It is more likely to occur on steep, north-facing slopes, and is often associated with soils that are calcareous, poorly developed, and shallow (Fowells 1965).

The purpose of this study was to characterize small mammal species composition and distribution in Rocky Mountain juniper woodlands and in adjacent mixed-grass rangelands in the Badlands National Park, southwestern South Dakota. The objectives were to determine if the presence of isolated juniper woodlands increased mammal species richness of the area, and to form preliminary hypotheses as to how these woodlands function as small mammal habitat.

## Study Area and Methods

The study area is in Pennington County, South Dakota, approximately 15 km south of the town of Wall, in Sage Creek Basin, Badlands National Park. Elevation ranges from 950 to 1000 m above sea level. Annual precipitation averages 36 cm, most of which is received in May, June, and July. The terrain in Bad-

**Abstract.**—Small mammals and vegetation were sampled over two years in Rocky Mountain juniper woodlands and adjacent grasslands in South Dakota. Juniper woodlands provided specialized habitat for two woodland species, white-footed mice and bushy-tailed woodrats, and attracted a number of species generally associated with grasslands.

lands National Park is typically rough and irregular, with steep bluffs rising above floodplains onto upland grasslands. Dense stands of Rocky Mountain juniper occur on steep, north-facing slopes and in draws. Upland grasslands are dominated by western wheatgrass (*Agropyron smithii*), green needlegrass (*Stipa viridula*), buffalograss (*Buchloe dactyloides*), and blue grama (*Bouteloua gracilis*).

Eight study sites were established, four in Rocky Mountain juniper woodlands on north-facing slopes in draws, and four on adjacent grasslands. Vegetation and relative abundance of small mammals were sampled on a regular basis for 2 years. Plant canopy cover on grasslands and understory cover in the juniper woodlands were sampled in June and August of both sampling years. Plant canopy cover, by species, was estimated in 150, 0.1-m<sup>2</sup> quadrats spaced at 1-m intervals along three permanent 50-m transects on each site (Daubenmire 1959). Overstory vegetation in Rocky Mountain juniper study sites was sampled in eight, 7- by 7-m macroplots spaced at 30-m intervals on each site. Tree densities, heights, diameters (d.b.h.), and crown heights of all trees were measured.

Small mammal abundance was sampled monthly from June through October in both years. Forty Sherman live traps, spaced at 10-m intervals along two permanent 200-m

<sup>1</sup>Paper presented at symposium, Management of Amphibians, Reptiles, and Small Mammals in North America. (Flagstaff, AZ, July 19-21, 1988.)

<sup>2</sup>Carolyn Hull Sieg is Research Wildlife Biologist, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, located at Rapid City, South Dakota. Headquarters is in Fort Collins, in association with Colorado State University.

transects, were set on each study site for four consecutive nights, after one night of prebaiting. Total trap effort was 6400 trap nights per vegetation type per year. Rolled oats mixed

with peanut butter were used as bait. Captured animals were identified by species and assigned a unique 4-digit number by toe clipping (Taber and Cowan 1971).

Differences in small mammal numbers and vegetation between the two vegetation types were tested with repeated measures analyses of variance (SPSS 1986). Both years were combined for analyses. Total unique small mammals and numbers of each species were analyzed separately: trap session and year were within-subject factors; vegetation type was the between-subject factor. Total plant canopy cover was the vegetation parameter analyzed: sampling session and year were within-subject factors; vegetation type was the between-subject factor. Homogeneity of variances was tested with Bartlett's Box F test; variables with heterogeneous variances were log-transformed.

## Results

### Vegetation

Overstory vegetation in juniper woodlands was nearly a monoculture of Rocky Mountain juniper, although an occasional green ash (*Fraxinus pennsylvanica*) tree was observed. Tree density averaged 260 trees/ha ( $\pm 117$  SD), and ranged from an average of 160 to 380 trees/ha on the four sites. Tree heights ranged from a mean of 2.8 to 3.1 m, and the crowns extended nearly to the ground, averaging approximately 2.3 m in height. The diameters of the juniper trees were small, ranging from a mean of 4.8 cm to 7.6 cm.

Total plant canopy cover of understory vegetation in the juniper woodlands was lower ( $P < 0.01$ ) than on grasslands. Total cover in the juniper woodlands averaged 25% (table 1). Yellow sweetclover (*Melilotus officinalis*) was the most common understory plant, then stonyhills muhly (*Muhlenbergia cuspidata*) and littleseed ricegrass (*Oryzopsis micrantha*). Shrubs were uncommon in juniper woodlands; chokecherry (*Prunus virginiana*), western wild rose (*Rosa woodsii*), western snowberry (*Sym-*

**Table 1.—Two-year average percent ( $\pm$  SD) canopy cover of dominant species in four Rocky Mountain juniper woodlands and four grassland sites, Badlands National Park, South Dakota.**

Category	Juniper	Grassland
Total cover	24.5 $\pm$ 5.5	52.8 $\pm$ 4.9
Litter cover	44.6 $\pm$ 11.3	39.5 $\pm$ 10.2
Bareground	36.7 $\pm$ 11.8	15.8 $\pm$ 8.3
Forbs		
Yellow sweetclover ( <i>Melilotus officinalis</i> )	8.7 $\pm$ 4.9	1.2 $\pm$ 1.0
Russian thistle ( <i>Salsola kali</i> )	< 1 $\pm$ < 1	2.4 $\pm$ 2.8
Scarlet globemallow ( <i>Sphaeralcea coccinea</i> )	< 1 $\pm$ < 1	2.9 $\pm$ 1.8
Grasses		
Western wheatgrass ( <i>Agropyron smithii</i> )	1.4 $\pm$ 1.4	9.7 $\pm$ 7.5
Blue grama ( <i>Bouteloua gracilis</i> )	< 1 $\pm$ < 1	5.4 $\pm$ 4.0
Cheatgrass ( <i>Bromus tectorum</i> )	< 1 $\pm$ < 1	2.5 $\pm$ 1.5
Buffalograss ( <i>Buchloe dactyloides</i> )	< 1 $\pm$ < 1	3.4 $\pm$ 3.5
Threadleaf sedge ( <i>Carex filifolia</i> )	1.3 $\pm$ 2.1	3.3 $\pm$ 4.2
Sun sedge ( <i>Carex heliophila</i> )	< 1 $\pm$ < 1	3.0 $\pm$ 1.5
Stonyhills muhly ( <i>Muhlenbergia cuspidata</i> )	3.4 $\pm$ 3.2	0
Littleseed ricegrass ( <i>Oryzopsis micrantha</i> )	1.5 $\pm$ 1.4	0
Needleandthread grass ( <i>Stipa comata</i> )	< 1 $\pm$ < 1	6.5 $\pm$ 9.0

**Table 2—Two-year average number ( $\pm$  SD) of small mammals captured per site in four Rocky Mountain juniper woodlands and four adjacent grassland sites, Badlands National Park, South Dakota.**

Species	Juniper	Grassland
Meadow vole ( <i>Microtus pennsylvanicus</i> )	< 1 $\pm$ 1.1 <sup>a</sup>	14.8 $\pm$ 17.2 <sup>b</sup>
House mouse ( <i>Mus musculus</i> )	< 1 $\pm$ 0.4 <sup>a</sup>	0 <sup>a</sup>
Bushy-tailed woodrat ( <i>Neotoma cinerea</i> )	1.0 $\pm$ 1.2 <sup>a</sup>	0 <sup>a</sup>
Northern grasshopper mouse ( <i>Onychomys leucogaster</i> )	1.0 $\pm$ 1.1 <sup>a</sup>	4.9 $\pm$ 3.3 <sup>b</sup>
Plains pocket mouse ( <i>Perognathus flavescens</i> )	1.0 $\pm$ 1.8 <sup>a</sup>	1.0 $\pm$ 1.8 <sup>a</sup>
Hispid pocket mouse ( <i>Perognathus hispidus</i> )	1.0 $\pm$ 0.9 <sup>a</sup>	2.1 $\pm$ 2.0 <sup>a</sup>
White-footed mouse ( <i>Peromyscus leucopus</i> )	20.4 $\pm$ 12.7 <sup>b</sup>	1.6 $\pm$ 2.2 <sup>a</sup>
Deer mouse ( <i>Peromyscus maniculatus</i> )	44.5 $\pm$ 24.9 <sup>a</sup>	35.9 $\pm$ 27.4 <sup>a</sup>
Western harvest mouse ( <i>Reithrodontomys megalotis</i> )	< 1 $\pm$ 1 <sup>a</sup>	2.9 $\pm$ 3.5 <sup>b</sup>
Thirteen-lined ground squirrel ( <i>Spermophilus tridecemlineatus</i> )	< 1 $\pm$ 1 <sup>a</sup>	11.0 $\pm$ 6.9 <sup>b</sup>
Total	68.5 $\pm$ 27.4 <sup>a</sup>	74.1 $\pm$ 21.9 <sup>a</sup>

<sup>1</sup>Means in a row followed by the same superscript were not significantly ( $P > 0.1$ ) different.

*phoricarpus occidentalis*), and skunkbush sumac (*Rhus aromatica*) each comprised less than 1% of the total canopy cover. Litter cover in the juniper woodlands averaged 45% and bare ground 30%.

Total plant canopy cover on grasslands averaged 53% (table 1). Western wheatgrass was the most common plant species, then needleandthread grass (*Stipa comata*), blue grama, and buffalograss. Scarlet globemallow (*Sphaeralcea coccinea*) was the most common forb. Shrub species were limited to fringed sage (*Artemisia frigida*) and dwarf sagebrush (*A. cana*), each comprising a small percentage of the total cover on grasslands. Mean litter cover was 40% and bare ground 16% over the two sampling years.

### Small Mammals

Average numbers of small mammals were similar ( $P = 0.4$ ) on the two vegetation types; however, species composition differed between juniper woodlands and adjacent grasslands (table 2). Deer mice (*Peromyscus maniculatus*) were the most common species captured in both juniper woodlands and on grasslands, constituting 66% of the total capture in juniper woodlands and 48% on grasslands. Number of deer mice captured was similar ( $P = 0.4$ ) in both vegetation types, averaging 42 and 36 individuals per site in juniper woodlands and grasslands, respectively. White-footed mice (*P. leucopus*) were the next most abundant small mammal species captured in juniper woodlands, constituting approximately 29% of the total captures; their numbers were much lower ( $P = 0.04$ ) on grassland sites. Bushy-tailed woodrats (*Neotoma cinerea*) were captured in small numbers in the juniper woodlands but were absent from grasslands. Average numbers of meadow voles (*Microtus pennsylvanicus*) ( $P = 0.03$ ), thirteen-lined ground squirrels (*Spermophilus*

*tridecemlineatus*) ( $P = 0.03$ ), northern grasshopper mice (*Onychomys leucogaster*) ( $P = 0.06$ ), and western harvest mice (*Reithrodontomys megalotis*) ( $P = 0.08$ ) were higher on grasslands than in juniper woodlands. Small numbers of plains pocket mice (*Perognathus flavescens*) and hispid pocket mice (*P. hispidus*) were captured in both vegetation types. One house mouse (*Mus musculus*) was captured in a juniper woodland.

### Discussion

Rocky Mountain juniper stands did not support significantly higher numbers of small mammals than did adjacent grasslands, but enhanced small mammal diversity by providing specialized habitat for white-footed mice and bushy-tailed woodrats. White-footed mice prefer and are commonly restricted to riparian forests and shrubby habitats in this region (Armstrong 1972, Seabloom et al. 1978), and were a common species in Rocky Mountain juniper woodlands in North Dakota (Hopkins 1983). White-footed mice forage (M'Closkey 1975) and nest (Wolff and Hurlbutt 1982) in trees and show a tendency to use woody vegetation as escape routes (Barry and Francq 1980). Their preferred habitat is often characterized by dense woody understory (Yahner 1982). Rocky Mountain juniper woodlands lack vertical layering provided by shrubs, but the dense tree canopy and presence of branches nearly to the ground may substitute for shrub layers found in other woodlands. Further, juniper woodlands may function as dispersal pathways for woodland species such as white-footed mice. Turner (1974) postulated that riparian habitats along major drainageways allowed the western expansion of the white-footed mouse.

Bushy-tailed woodrats are often restricted to rocky areas in this region (Jones et al. 1983), and their

presence has been documented in deciduous woodlands in northwestern South Dakota (Hodorff et al. In Press). Bushy-tailed woodrats were captured in ponderosa pine (*Pinus ponderosa*) stands, toe slopes, hilly scoria, and upland breaks in western North Dakota (Seabloom et al. 1978). Juniper stands likely provide den sites, which grasslands lacked. Middens constructed of juniper branches were observed in three of four Rocky Mountain juniper sites in this study.

Three species—deer mice, plains pocket mice, and hispid pocket mice—apparently showed no preference between grasslands or juniper woodlands. The high proportion of deer mice in the total capture on both grasslands and in juniper woodlands is not uncommon on the Northern Great Plains. Deer mice are a ubiquitous species, occurring in nearly every habitat in this region (Jones et al. 1983). Deer mice were the most commonly captured species in green ash woodlands in northwestern South Dakota (Hodorff et al. In Press), and were abundant in both green ash and Rocky Mountain juniper woodlands in western North Dakota (Hopkins 1983). Rocky Mountain juniper woodlands in South Dakota are probably not critical habitat for deer mice, but when available, will be exploited by this adaptive species.

Hispid pocket mice apparently prefer rocky areas, where a variety of shrubs, forbs, and yucca (*Yucca* spp.) grow (Jones et al. 1983). Plains pocket mice are considered rare mammals in South Dakota (Houtcooper et al. 1985); hence little is known about the distribution and habitat preferences of this species in the state. Hodorff et al. (In Press) captured low numbers of both plains and hispid pocket mice in green ash woodlands in northwestern South Dakota. Haufler and Nagy (1984) captured plains pocket mice in pinyon pine (*Pinus edulis*)-Utah juniper (*J. osteosperma*) woodlands in Colorado, and reported that juniper comprised 17% of the pocket mouse's diet. The small captures of

both species of pocket mice make generalizations about habitat preference suspect, but Rocky Mountain juniper woodlands likely provided habitat interspersed and food resources for these species.

Juniper woodlands, with sparse understory cover, are atypical habitat for grassland inhabitants such as meadow voles, thirteen-lined ground squirrels, northern grasshopper mice, and western harvest mice. Meadow voles, in particular, are generally associated with dense stands of grass (Birney et al. 1976). However, Rocky Mountain juniper woodlands in southwestern North Dakota supported meadow voles in some areas (Seabloom et al. 1978) and prairie voles (*M. ochrogaster*) on other sites (Hopkins 1983).

The ability of North Dakota juniper woodlands to support microtines was attributed to differences in plant community attributes. Littleseed ricegrass and mosses dominated the understory and total plant cover averaged over 60% (vs. 25% in South Dakota) in most juniper stands sampled by Hopkins (1983) (Hansen et al. 1984). The more dense understory of the North Dakota woodlands, which South Dakota woodlands lacked, apparently provided adequate cover for microtines.

Thirteen-lined ground squirrels were most frequently captured in northwestern South Dakota in roadways and fencerows in shortgrass prairies (Andersen and Jones 1971). Northern grasshopper mice are generally restricted to shortgrass and desert sites (McCarty 1978), in areas with adequate dust-bathing sites (Egoscue 1960). Western harvest mice were occasionally captured in pinyon-juniper woodlands in southeastern Colorado, but were associated with dense herbaceous cover lacking tree canopy cover (Ribble and Samson 1987). Rocky Mountain juniper woodlands may provide supplemental food resources for small mammals generally restricted to grasslands.

## Conclusion

Rocky Mountain juniper woodlands enhance small mammal richness of the generally treeless Northern Great Plains by providing specialized habitat for at least two species, bushy-tailed woodrats and white-footed mice. Juniper woodlands lack well-developed shrub layers, but the dense canopy of the juniper trees and crowns that extend nearly to the ground may provide foraging and nesting substrates for woodland mammals. Further, Rocky Mountain juniper woodlands may function as dispersal pathways for these two species. Juniper woodlands lack dense herbaceous understories necessary to support microtines such as meadow voles, but likely serve as food resource supplemental areas for a variety of mammals associated with grasslands. Adaptable species such as the deer mouse may not require juniper woodlands, but will exploit this habitat when available. Finally, Rocky Mountain juniper woodlands may figure into the habitat needs of pocket mice, but low captures of two species preclude clear definition of preferred habitat.

## Acknowledgments

Critical reviews by Dan Uresk, Deb Paulson, Dick Hansen, and Bill Clark were helpful in improving this manuscript. Personnel at Badlands National Park were most cooperative during this study. Deb Paulson and Bob Hodorff helped with field work.

## Literature Cited

Andersen, Kenneth W., and J. Knox Jones, Jr. 1971. Mammals of northwestern South Dakota. University of Kansas Museum of Natural History 19:361-393.

Armstrong, David M. 1972. Distribution of mammals in Colorado. 415 p. Monograph No. 3, Museum

of Natural History, University of Kansas, Lawrence, KS.

- Barry, Ronald E., Jr., and Edward N. Francq. 1980. Orientation to landmarks within the preferred habitat by *Peromyscus leucopus*. *Journal of Mammalogy* 61:292-303.
- Birney, Elmer C., W.E. Grant, and Donna Day Baird. 1976. Importance of vegetation cover to cycles of *Microtus* populations. *Ecology* 57:1043-1051.
- Daubenmire, R. 1959. A canopy-coverage method of vegetation analysis. *Northwest Science* 33:43-64.
- Egoscue, H. J. 1960. Laboratory and field studies of the northern grasshopper mouse. *Journal of Mammalogy* 51:622-623.
- Faanes, Craig A. 1984. Wooded islands in a sea of prairie. *American Birds* 38:3-6.
- Fowells, H.A. 1965. Rocky Mountain Juniper (*Juniperus scopulorum* Sarg.). In *silvics of Forest trees of the United States*. Agricultural Handbook No. 271. p. 217-222. Washington, D.C.
- Gaines, Ronald C., and Stanley C. Kohn. 1982. Raptor use of hardwood draws in central North Dakota. *Prairie Naturalist* 14:55-58.
- Hansen, Paul L., George R. Hoffman, and Ardell J. Bjugstad. 1984. The vegetation of Theodore Roosevelt National Park, North Dakota: a habitat type classification. General Technical Report RM-113. 35 p. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.
- Hansen, Paul L., Ricky B. Hopkins, and George R. Hoffman. 1980. An ecological study of the habitat types and their animal components at Theodore Roosevelt National Park, North Dakota. 182 p. Department of Biology, Vermillion, University of South Dakota.
- Haufler, Jonathan B., and Julius G. Nagy. 1984. Summer food habits of a small mammal community in the pinyon-juniper ecosystem. *Great Basin Naturalist* 44:145-150.

- Hodorff, Robert A., Carolyn Hull Sieg, and Raymond L. Linder. In Press. Wildlife response to stand structure of deciduous woodlands. *Journal of Wildlife Management*.
- Hopkins, Rick B. 1983. Small mammal component of habitat types in Theodore Roosevelt National Park. *Prairie Naturalist* 15:45-46.
- Hopkins, Rick B., Frank J. Cassel, and Ardell J. Bjugstad. 1986. Relationships between breeding birds and vegetation in four woodland types of the Little Missouri Grasslands. Research Paper RM-270. 12 p. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.
- Houtcooper, Wayne C., David J. Ode, John A. Pearson, and George M. Vandell, III. 1985. Rare animals and plants of South Dakota. *Prairie Naturalist* 17:143-165.
- Jones, J. Knox, Jr., David M. Armstrong, Robert S. Hoffman, and Clyde Jones. 1983. *Mammals of the Northern Great Plains*. 379 p. Lincoln, NE: University Nebraska Press.
- McCarty, Richard. 1978. *Onychomys leucogaster*. *Mammal Species* 87:1-6. American Society of Mammalogists.
- M'Closkey, Robert T. 1975. Habitat dimensions of white-footed mice, *Peromyscus leucopus*. *American Midland Naturalist* 93:158-167.
- Ribble, David O., and Fred B. Samson. 1987. Microhabitat associations of small mammals in south-eastern Colorado, with special emphasis on *Peromyscus* (Rodentia). *Southwestern Naturalist* 32:291-303.
- Seabloom, Robert W., Richard D. Crawford, and Michael G. McKenna. 1978. Vertebrates of southwestern North Dakota: amphibians, reptiles, birds, mammals. Research Report 24, 549 p. Grand Forks, ND: University of North Dakota; Institute of Ecological Studies.
- Severson, Kieth E. 1981. Plains habitat. In Wallmo O.C. Mule and black-tailed deer in North America. p. 459-468. Lincoln, NE: University of Nebraska Press and Washington, D.C., Wildlife Management Institute.
- Severson, Kieth E., and Arthur V. Carter. 1978. Movements and habitat use by mule deer in the Northern Great Plains, South Dakota. p. 466-468. In D.N. Hyder, editor. Proceedings of the First International Rangeland Congress. [Denver, CO, August 14-18, 1978] Society for Range Management. Peerless Printing, Denver, CO.
- SPSS. 1986. SPSSX user's guide. 988 p. New York, N.Y. McGraw-Hill Book Company.
- Taber, Richard D., and McT. I. Cowan. 1971. Capturing and marking wild animals. p. 277-317. In *Wildlife Management Techniques*, 3rd edition. R.H. Giles Jr., editor. Washington, D.C., Wildlife Society.
- Turner, Ronald W. 1974. *Mammals of the Black Hills of South Dakota and Wyoming*. Miscellaneous Publication No. 60, 178 p. Lawrence, KS: University of Kansas, Museum of Natural History.
- Uresk, Daniel W. 1982. Importance of woodlands to wildlife and livestock use on the Northern High Plains. p. 7-12. In North Platte, NE: Proceedings of the Great Plains Agricultural Council.
- Wolff, Jerry O., and Bethia, Hurlbutt. 1982. Day refuges of *Peromyscus leucopus* and *Peromyscus maniculatus*. *Journal of Mammalogy* 63:666-668.
- Yahner, Richard H. 1982. Microhabitat use by small mammals in farmstead shelterbelts. *Journal of Mammalogy* 63:440-445.