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Wildlife Associated With Scoria Outcrops: Implications for Reclamation of Surface-Mined Lands

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Wildlife Associated With Scoria Outcrops: Implications for Reclamation of Surface-Mined Lands

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Abstract

Bird and mammal populations using scoria rock outcrop and adjacent sagebrush/grassland habitats were studied. Bird populations and bird species richness were greater in the outcrop habitats than in the surrounding sagebrush/grassland habitats. These differences were attributed to the structural features provided by the outcrops. Most, but not all, small mammal populations also were larger in outcrop habitats. Reclaiming surface-mined lands with rock outcrops would enhance wildlife habitat, especially for birds.

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Management Implications

Historically, habitat for wildlife has been declining because of such adjuncts of human development as building of roads, channelization of rivers, and expansion of towns and communities. Through reclamation of surface-mined lands, opportunities exist to create wildlife habitat to replace preexistent habitat or create new habitat that will benefit wildlife. Incorporating rock outcrops in reclamation will increase the number of species inhabiting an area and provide structural diversity to the sagebrush/grasslands typical of the coal mining region in the northern Great Plains.

Introduction

In the Powder River basin of Wyoming and Montana, scoria outcrops developed from burned-out coal seams near the surface. These outcrops support a unique plant community of relatively mesic shrub and tree species in this sagebrush/grassland habitat (Biggins et al. 1985). Such diversity in vegetation communities has been correlated with increased avian abundance and species diversity (Rotenberry and Weins 1980a, Roth 1976). Small mammal populations also vary with differing vegetation communities (Feldhamer 1979, MacCracken et al. 1985).

The federal Surface Mining Control and Reclamation Act (Public Law 95-97) and many state statutes require that reclamation practices restore mined land to its original productive state. Because wildlife habitat is considered a post-mine land use in most states where agriculture is not the primary post-mine land use, reclamation specialists have used various techniques to improve wildlife habitat. In the northern Great Plains, rocks, rock piles, and rock outcrops have been used to improve wildlife habitats on surface-mined land. However, little, if any, data exist regarding the effectiveness of this practice (Evans 1982). This paper describes bird and mammal communities associated with rock outcrop habitats in this region, and evaluates the habitat relationships of the fauna associated with outcrop and sagebrush/grassland habitats. This will help reclamation specialists evaluate which habitat characteristics to include in reclamation plans for sustaining or increasing post-mining wildlife productivity.

Study Area

This study was conducted in southeastern Montana, approximately 20 km north of Decker, on land leased or owned by the Decker Coal Company. Vegetation of the area was classified as ponderosa pine (*Pinus ponderosa*)-Savannah, which consists of broad expanses of northern mixed-grass prairie with scattered stands of ponderosa pine (Payne 1973). Scoria outcrops are locally abundant in the prairie areas and support a diverse and unique vegetation community of relatively mesic shrub species (Biggins et al. 1985, Rumble 1987).

Methods

Thirty-eight study sites were selected in a paired design, 19 in scoria outcrop habitats, and 19 in the surrounding sagebrush (*Artemisia* spp.)/grassland. Outcrop study sites were selected to represent the full range of available outcrop habitats in the area, from high to low densities of outcrops and small to large outcrops. Paired study sites were closer to each other than to the nearest replicate, but were far enough apart to ensure there was no overlap of individual territories between plots; most were at least 400 m apart. Sagebrush/grassland sites were selected in vegetation similar to the outcrop habitats.

Birds were counted on the study sites during the breeding season using variable circular plots (Reynolds et al. 1980). Counts were conducted for three consecutive mornings at 3-week intervals from mid-May through June in 1984 and 1985. Nine counts were conducted each year. After a l-minute waiting period, all birds seen or heard and estimated distance from the observer were recorded during a 6-minute census period. Distances were estimated to the nearest meter out to 30 m and to the nearest 5 m beyond that.

Bird densities (birds per 100 ha) on study sites were estimated using Fourier series procedures for estimating density from point transects (Burnham et al. 1980) for species for which adequate data were obtained. Densities of other species were estimated using the number of individuals within a 50-m radius of the sampling point.

Small mammals were sampled on 14 of the study sites: 7 in outcrop habitats and 7 in sagebrush/grassland habitats. On each of these sites an 8- by 8-trap grid of Sherman live-traps spaced at 10-m intervals was established. The trap grid was centered over the sample point used for bird counts. Trap sessions were conducted at 4-week intervals from May-August in 1984 and 1985. Each trap session was preceded by one night of prebaiting followed by 4 nights of trapping, a method proven adequate for censusing small mammal species richness and abundance in this region (C. Sieg, unpublished data, Rocky Mountain Forest and Range Experiment Station, Rapid City, SD). Traps were baited with rolled oats mixed with peanut butter, sunflower seeds, and millet.

Small mammal abundance was estimated using the total number of unique individuals captured over all trap sessions during the study. Abundance of lagomorphs on 10 of the study sites was estimated by counting the number of fecal pellets in circular plots (1 m^2 in area) spaced at 5-m intervals along four permanent transects radiating out from the center of the study site. All pellets were cleared from the plots during June 1984 and counts were conducted during July and August 1984. All pellets were removed as they were counted and species was determined based on the size of the pellets (Webb 1940). Lagomorph abundances were estimated as the mean number of pellets per site.

Vegetation and habitat descriptions were recorded for each study site. Percent canopy cover of herbaceous vegetation by species, as well as the categories total cover, grasses, forbs, shrubs, bare ground, and litter, were estimated from thirty, 20- by 40-cm quadrats spaced at 1-m intervals (Daubenmire 1959) along three transects on each site during each year of the study. Vegetation transects were established to radiate out from the center of each study site. The beginning of each transect was randomly selected within a 10-m radius of the plot center. Shrub densities (by species) were estimated by counting all shrubs in a 50- by 50-m plot centered over each site. Rocks and outcrops taller than 0.5 m were counted in a 50-m-radius circular plot; length, width, and height (volume) were measured and recorded to the nearest decimeter for all rocks tallied.

To reduce the number of habitat variables selected for evaluating species habitat relationships, all canopy cover variables that comprised less than 1% canopy cover (averaged across all sites) and all variables that were collinear with other variables at $r \geqslant 0.85$ were omitted.

Abundance of birds and mammals was compared between rock outcrop and sagebrush/grassland habitats using two-tailed paired t-tests. Bird species richness was estimated by counting the number of species that occurred on a site; species diversity was calculated using the Shannon-Weiner method. Differences in the abundance of birds and small mammals between years was evaluated during preliminary analyses. Pearson's product moment correlations of bird and mammal species abundance with vegetation and habitat variables were used to suggest habitat relationships of species.

Results

Birds

Twenty-four bird species were recorded within 50 m of the census points. Abundance of 13 species and species richness was compared between outcrop and sagebrush/grassland habitats (table 1); six species differed statistically ($P \leqslant 0.05$) between rock outcrop and sagebrush/grassland habitats. Lark sparrows (*Chondestres grammacus*) were the most abundant bird species; their density in the rock outcrops was nearly 20 times greater than in the sagebrush/grasslands. Rock wrens (*Salpinctes obsoletus*), rufous-sided towhees (*Pipilo erythrophthalmus*), and American robins (*Turdus migratorius*) occurred only in outcrop habitats and only in low densities. Rock outcrop habitats supported an average of 4.5 species per site as compared with 3.1 species per site in the surrounding sagebrush/grasslands. Although the total number of bird species was greater in the outcrop habitats than in the sagebrush/grasslands (23 versus 10, respectively), species diversity was higher in the sagebrush/ grasslands (2.70) than in the outcrops (1.89).

Vesper sparrows (Pooecetes gramineus) and grasshopper sparrows (Ammodramus savannarum) were the only bird species that occurred at statistically higher densities on sagebrush/grassland sites. Western meadowlarks (Sturnella neglecta) were the second most abundant bird species, and densities were slightly higher ($P = 0.11$) in the sagebrush/grasslands.

No differences occurred in the estimates of abundances of Brewer's sparrows (SpizeJJa brewerii), lark bunting (*Calamospiza melanocorys*), northern oriole (*Icterus galbula*), brownheaded cowbird (*Molothrus ater*), chipping sparrow (*Spizella passerina*), or mourning dove (*Zenaiduro macroura*).

Table 2 shows correlations between habitat variables and abundance of birds. No correlations were attempted for those species recorded on fewer than six sites.

Small Mammals

Two species of lagomorphs and six species of small rodents were recorded on the study sites; only four species of small rodents were abundant enough to compare statistically. Cottontails (*Sylvilagus nuttallii*) and deer mice (*Peromyscus maniculatus*) were more abundant ($P \leqslant 0.05$) in the outcrop habitats (table 3). Thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*) were more abundant ($P \leqslant 0.05$) in the sagebrush/grasslands. No differences were found in the abundance of white-tailed jackrabbits (*Lepus towsendii*), Wyoming pocket mice (*Perognathus fasciatus*), and prairie voles (*Microtus ochraster*) between the two habitats.

Eight vegetation or habitat variables were significantly correlated ($P \leqslant 0.05$) with the abundance of small mammals occurring on study sites; these correlations are given in table 4.

Discussion

Birds

Reclamation of coal surface-mined lands in this region generally results in adequate stands of herbaceous vegetation, but establishment of sagebrush and other shrubs has been less successful without cultural treatments (Bjugstad 1978, Bjugstad et al. 1981, Uresk and Yamamoto 1986). Scoria outcrops provide habitat for a unique and relatively mesic shrub community (Biggins et al. 1985) within the sagebrush-mixed grass prairie of this region. Both shrub and grassland communities should be established following mining to provide habitat

Table 1.—Average (±SE) densities of birds per hectare from scoria outcrop and sagebrush/grassland habitats in southeastern Montana (adapted from Rumble 1987).

Species	Scoria outcrop	Sagebrush/ grassland	Probability[1]
Lark sparrow	3.8 ± 0.43	0.2 ± 0.07	<0.01
Western meadowlark	0.3 ± 0.04	0.4 ± 0.08	0.11
Rock wren[2]	0.2 ± 0.03	0	<0.01
Brewer's sparrow	0.1 ± 0.04	0.2 ± 0.20	0.40
Vesper sparrow	≤0.1 ± 0.01	0.1 ± 0.04	0.04
Grasshopper sparrow	0.2 ± 0.02	0.2 ± 0.10	0.05
Lark bunting	0.2 ± 0.11	0.2 ± 0.16	0.53
Northern oriole	≤0.1 ± 0.30	0.1 ± 0.02	0.58
Brown-headed cowbird	0.1 ± 0.14	0	0.33
Rufous-sided towhee	0.1 ± 0.03	0	0.04
Chipping sparrow	0.1 ± 0.04	0	0.19
American robin	0.1 ± 0.07	0	0.09
Mourning dove	0.2 ± 0.07	0.1 ± 0.07	0.48
Species richness	4.5 ± 0.29	3.1 ± 0.31	<0.01

[1]*Probability of differences occurring between scoria outcrops and sagebrush/grasslands.*
[2]*Density estimates from line transect procedures.*

Table 2.—Significant correlations ($P \leq 0.05$) between habitat variables and estimated abundance of birds in scoria outcrop habitats and sagebrush grassland habitats in southeastern Montana (from Rumble 1987).

Habitat variables[1]	Lark sparrow	Meadow-lark	Rock wren	Brewer's sparrow	Grasshopper sparrow	Species richness
Canopy cover variables (%)						
Total grasses	− 0.32	--	0.32	--	+ 0.38	− 0.34
Western wheatgrass (*Agropyron smithii*)	− 0.41	--	− 0.47	--	--	--
Cheatgrass (*Bromus* spp.)	--	+ 0.41	--	--	+ 0.31	--
Sandberg's bluegrass (*Poa sandbergii*)	+ 0.38	− 0.34	− 0.39	--	--	--
Sixweeks fescue (*Festuca octoflora*)	--	--	− 0.31	--	--	− 0.37
Needle-and-thread grass (*Stipa comata*)	− 0.49	+ 0.41	− 0.30	--	+ 0.41	− 0.42
Plains pricklypear (*Opuntia polyacantha*)	− 0.40	--	− 0.38	--	--	--
Scurfpea (*Psoralea* spp.)	+ 0.38	--	+ 0.42	--	--	--
Hood's phlox (*Phlox hoodii*)	--	− 0.39	--	+ 0.40	--	--
Density skunkbush sumac (*Rhus trilobata*)	+ 0.68	--	+ 0.55	--	--	--
Density currant (*Ribes* spp.)	+ 0.43	--	--	--	--	--
Density sagebrush	--	--	--	+ 0.41	--	--
Volume of outcrop rocks	+ 0.65	--	+ 0.45	--	--	+ 0.52
Number of rocks > 0.5 m	+ 0.58	--	+ 0.77	--	--	+ 0.45
Average height of outcrops	+ 0.82	--	+ 0.52	--	-0.34	+ 0.43

[1]*Only variables with at least one significant ($P \leq 0.05$) correlation with the dependent variables are listed.*

diversity for the avian and mammal species that depend on each of these habitats. Several species of birds occurred only in the outcrop habitats, and estimates of total bird abundance were nearly five times greater in the shrub communities associated with the outcrops than in the surrounding sagebrush/grasslands (Rumble 1987).

Vegetative and wildlife diversity is often a desirable goal in reclamation of surface-mined lands. However, bird species diversity was greater in sagebrush/grassland habitats because of the uneven distribution of bird species in outcrop habitats (lark sparrows made up 80% of the avian population). This was evident even though average species richness per study site and total species richness summed across sites within habitats was greater in outcrops. Higher species diversity on the sagebrush/grasslands was due to the higher species evenness component of diversity (Pielou 1975:15) in the sagebrush/grassland (0.78) than in the outcrops (0.40). Because of

Table 3.—Average (±SE) estimates of abundance of small mammals in scoria outcrop and sagebrush/grassland habitats in southeastern Montana.[1]

Species	Outcrop	Sagebrush/ grassland	Probability[2]
Cottontail	162.8 ± 32.0	6.8 ± 3.3	0.01
White-tailed jackrabbit	13.0 ± 6.1	10.6 ± 3.3	0.74
Deer mouse	21.1 ± 3.5	8.2 ± 1.3	0.02
Wyoming pocket mouse	1.3 ± 0.5	3.9 ± 1.3	0.17
Thirteen-lined ground squirrel	0.1 ± 0.1	4.1 ± 0.8	<0.01
Prairie vole	1.1 ± 0.5	1.1 ± 0.4	1.00

[1]*Estimates of abundance for lagomorphs are fecal pellets/m^2; estimates for others from unique individuals captured per 1,024 trapnights on each grid.*
[2]*Probability of differences occurring between scoria outcrops and sagebrush/grasslands.*

Table 4.—Significant (P≤0.05) correlations between habitat variables and estimates of small mammals abundance in scoria outcrop and sagebrush/grassland habitats in southeastern Montana.

Habitat variables[1]	Cottontail	Deer mice	Wyoming pocket mice	Thirteen-lined ground squirrel	Prairie vole
Canopy cover variables (%)					
Blue grama (*Bouteloua gracilis*)	--	--	−0.61	--	--
Needle-and-thread grass	−0.77	--	+0.61	--	--
Total shrubs	--	--	--	--	−0.63
Density skunkbush sumac	+0.73	--	--	−0.61	--
Density currant	--	--	--	−0.57	--
Volume of outcrop rocks	+0.71	--	--	−0.59	--
Number of rocks > 0.5 m	--	--	--	−0.66	--
Average height of rocks	+0.61	+0.68	−0.81	--	--

[1]*Only variables with at least one significant (P≤0.05) correlation with the dependent variables are listed.*

this, species richness is probably a better index for monitoring successful reclamation from an avian wildlife perspective.

Recent literature argues the importance of plant species versus vegetation structure to avian communities (e.g., Cody 1985; Rice et al. 1980; Rotenberry and Weins 1980a, 1980b; Roth 1976). However, within a habitat type (Daubenmire 1968), structure is often provided by one or a few plant species. Increased vegetative structure provides both increased foraging and nesting sites for birds (Martin 1988). The dominant shrub providing habitat structure in outcrop habitats was skunkbush sumac. Sumac occurred in these habitats because of the ameliorating influences of the rock outcrops on various weather variables (Biggins et al. 1985) and was correlated (r≥0.70) with all the rock attributes measured. Many of the bird species found in the rock outcrop habitats demonstrated inseparable relationships between the rock and the associated shrub community. Significant correlations between habitat variables and abundance of bird species on study sites suggest, but do not conclude, cause and effect relationships between vegetative and physical characteristics of sites and selection of sites by the particular faunal species concerned. However, correlations do represent particular habitat features reclamation specialists could focus on in reclamation planning.

Lark sparrows used skunkbush sumac and currant for perching and nest sites; they also used rocks as perch sites on occasion. However, the correlations of lark sparrows with rocks was due to the relationships of skunkbush sumac and currant to the outcrops. Lark sparrows were not likely avoiding needle-and-thread grass or plains pricklypear, but these plants were more common on the grassland study sites where adequate habitat structure to support lark sparrows did not exist. Meadowlarks, on the other hand, were often found on grassland plots dominated by needle-and-thread, and thus were associated with high cover values of the dominant grass on the sagebrush/grassland sites. Meadowlarks tend to be a grassland species and use the grass for nest cover (Peterson 1961). In this study, meadowlarks were observed using the rocks on outcrop sites for singing perches. Rock outcrop habitats were generally limited in size, and some use of these habitats by meadowlarks may have been at the edges of territories established in grassland habitats. Rock wrens were found only in the outcrop habitats containing several large outcrops taller than 2.0 m. Therefore, it was not surprising that rock wrens were negatively associated with nearly all variables estimating herbaceous vegetation and positively associated with attributes of the rock outcrops. Sites supporting rock wrens on the average 80 rocks/ha taller than 0.5 m, 9 rocks/ha taller than 1.0 m, and 2.5 rocks/ha taller than 1.5 m. Rock outcrops were used for feeding, nesting, and singing perches by rock wrens. Brewer's sparrows were generally observed on study sites with substantial sagebrush cover. Brewer's sparrows rarely occurred on outcrop sites lacking sagebrush, probably because the outcrops and associated shrubs (skunkbush sumac) were too widely spaced to provide adequate cover (Rumble 1987). Brewer's sparrows do occupy habitats dominated by shrubs other than sagebrush when adequate cover is provided (Beaver 1976, Johnsguard and Rickard 1957), but they are often considered sagebrush obligates (Braun et al. 1976, Castrale 1982). Grasshopper sparrows were uncommon during this study, but were found on sites with high vegetative cover and grasses. They were not found in the outcrop habitats. Lark buntings were irregular visitors to several study sites. No nests were found and these habitat correlations represent characteristics of the study sites visited.

Rufous-sided towhees occurred on some study sites with tall dense shrub patches and/or shrub draws. These sites were located in outcrops on north-facing slopes that provided further moisture compensation, allowing shrubs to become denser and taller. Rufous-sided towhees are generally associated with habitats of high shrub densities (Faanes 1983, Hodorff et al. 1989). American robins inhabited sites with trees or large shrubs nearby. Both species could occur on reclaimed sites provided adequate tall shrubs such as chokecherry or trees were established.

Several species occurred on study sites as a result of the site's proximity to Tongue River Reservoir. Species such as northern orioles were observed feeding on skunkbush sumac berries on several occasions. These birds flew to study sites from cottonwood (*Populus deltoides*) woodlands along the reservoir for foraging but did not establish territories on study sites. Great blueherons were observed several times loafing on study sites. They had a rookery along the reservoir approximately 1.6 km from the study sites.

Species richness on study sites was positively correlated with structural characteristics of the habitats. Rock outcrops and/or the associated shrub community provided the necessary habitat for several species of birds not found in the sagebrush/grasslands. However, sagebrush/grassland sites with vertical and horizontal habitat diversity provided by the sagebrush species supported some additional species over those with only the herbaceous layer of vegetation. Increased patchiness of shrub vegetation has been associated with increased species richness (Roth 1976). Martin (1988) demonstrated that species richness increases with both increased vertical structure and habitat area.

Other species that occurred on the study sites, but for which there were no significant correlations, should not be construed as not having preferences for specific habitat features. Rather, the habitat variables measured in this study were not the habitat parameters those particular species were responding to in their selection of habitats.

Small Mammals

Cottontails and deer mice would benefit from the establishment of rock outcrops through reclamation. Cottontails prefer rocky and/or brushy habitats for cover (Andersen and Jones 1971, MacCracken and Hansen 1982, McKay and Verts 1978). The rocks and shrubs associated with the outcrops provided cover that was not available in the adjacent sagebrush/grassland sites. Deer mice are associated with the more open habitats as opposed to habitats with high herbaceous cover (Feldhamer 1979, Hingtgen and Clark 1984, Hodorff et al. 1989). Although differences in herbaceous vegetative cover between the outcrops and sagebrush/grasslands were minimal, the cracks and crevices at the base of and between rocks provided good nest sites for deer mice. In addition, the area beneath skunkbush sumac was usually bare or covered only with litter.

The data suggest that sagebrush/grasslands supported more Wyoming pocket mice than the rock outcrops but these differences were not consistent across all paired sites. Limited sample size (n = 6 for the paired design for small mammal data) may also have been a factor here.

Little is known of the habitat preferences of Wyoming pocket mice, but they have been captured frequently in Bouteloua/Stipa grasslands (Jones et al. 1983). The negative correlation of Wyoming pocket mice to blue grama could represent an artifact and needs further investigation. Wyoming pocket mice may require the better cover provided by the taller Stipa species in grassland habitats. The correlations observed indicate the preference of grassland habitats on the plains by Wyoming pocket mice. Reclamation practices in this region commonly include native grasses such as Stipa, thus meeting the requirements of this species.

Thirteen-lined ground squirrels were more common in sagebrush/grasslands and were captured on only one outcrop site that had a relatively high cover of grasses and density of sagebrush on it. Based on the correlations from this study, thirteen-lined ground squirrels were avoiding the rock outcrops, but showed no distinct preferences for shrubs or grasses in the adjacent sagebrush/grasslands. MacCracken et al. (1985) reported that captures of thirteen-lined ground squirrels were higher on sagebrush/grassland plots compared with plots in riparian areas and ponderosa pine (*Pinus ponderosa*) and that thirteen-lined ground squirrels were correlated with sagebrush abundance and several grasses. Nearly all of the shrubs on sagebrush/grassland sites and a large portion from outcrop site that had thirteen-lined ground squirrels were sagebrush. Sieg et al. (1986) also reported higher captures of thirteen-lined ground squirrels in sagebrush grasslands than on reclaimed and unreclaimed bentonite mine surfaces. Hingtgen and Clark (1984) reported increasing numbers of thirteen-lined ground squirrels on older reclaimed surfaces (3-5 years) and on unmined rangelands. Reclamation of surface-mined lands with native grasses and interspersed shrubs would meet the needs of thirteen-lined ground squirrels in this region. Prairie voles were uncommon in both habitats, and the only significant correlation suggests that grassland habitats are preferred. However, this relationship may be questionable because of the small number of captures. Hingtgen and Clark (1984) reported relatively low abundance of this species on reclaimed surfaces 3-5 years old and on unmined areas. MacCracken et al. (1985) reported positive correlations of prairie voles with most vegetation categories except plains pricklypear and bare ground. Prairie voles build extensive runway systems with vegetation and tend to be fossorial in habitats lacking taller dense species of vegetation (Jones et al. 1983). Total vegetative cover on these study sites averaged 42%, and thus may not be considered good prairie vole habitat. It also is possible that the resolution of sampling methods exceeded the size of microhabitats selected by meadow voles on these sites.

Conclusions

Reclamation of surface-mined lands with areas of rock outcrops can create diverse habitat beneficial for wildlife enhancement. Most species of birds and mammals that occurred in outcrop habitats also occurred in the sagebrush/grasslands, but at lower abundance. These data suggest that to maximize the reclamation of wildlife habitat, both sagebrush/grassland and outcrop habitats must be created. Correlations with habitat variables suggested that many of the species more abundant in outcrop habitats were selecting for increased availability of nesting, resting/perching, and feeding sites. On reclaimed lands, establishment of shrubs can be expensive and, in the case of sagebrush, difficult. Rock and rock outcrops facilitate the establishment of many relatively mesic shrub species that provide wildlife habitat diversity.

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