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STRIP-MINING AND SMALL MAMMALS IN SOUTHERN IOWA[1]

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Strip-mining and Small Mammals in Southern Iowa[1]

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ABSTRACT

Small mammal presence, diversity and reproduction were compared from August 1975 to June 1976 on abandoned coal strip-mine spoils and unmined land in southern Iowa. More species were snap-trapped on the unmined area, while the relative dominance of *Peromyscus* spp. on mined land was increased. *Peromyscus* populations on mined land exhibited a shorter breeding season than on unmined land. Other population parameters did not show clear differences between the areas.

Introduction

Approximately 4500 ha have been strip-mined for coal in Iowa, mostly in the southeastern part of the state. Strip mining eradicates the soil profile and plant and animal life by piling overburden in a series of long, parallel, steep ridges and narrow draws. The surface of the spoils is often characterized by high acidity (due to the oxidation of pyrites), unusual chemical concentrations, large temperature changes, low soil moisture and severe erosion; a generally harsh environment for mammals and other organisms prevails.

Lists of mammal species and estimates of their abundances on Illinois coal spoils were compiled by Yeager (1942) and Verts (1959). Verts (1957) and Wetzel (1958) found *Peromyscus maniculatus* dominant on younger Illinois spoils where weeds and grasses dominated the vegetation, while *P. leucopus* was dominant on older spoils with more shrubs and trees. Similar patterns were found in Indiana, but there was no correlation between species distribution and spoil age or soil conditions, since the nature of the spoils varied independently of age (Sly, 1976). Mumford and Bramble (1969) reported high densities of *Peromyscus* spp. and very low densities of other species on Indiana spoils. DeCapita and Bookhout (1975) found capture rates of several species (e.g. *Peromyscus* spp., *Sylvilagus floridanus*) comparable to or higher than those on mined land.

Most accounts of Iowa mammals are species lists and distributions, with little reference to population data. This study was undertaken to compare small mammal populations of abandoned Iowa coal spoils and nearby unmined land, in terms of species diversity, abundance and reproduction.

Study area. The abandoned strip-mined area was the Wilcox Wildlife Preserve, SE Marion Co., about 250 ha mined between 1952 and 1962. The unmined site was the area of the Iowa Coal Project Demonstration Mine No. 1, in SW Mahaska Co., about 15 km east of the mined site.

The area has a rolling topography (elevation range approx. 180-300 m) drained by the Des Moines River system. Soils in the area are alluvial in the valleys and river bottoms, Kansan till on the slopes and loess on the hill-tops. Bottomlands and lower slopes were originally vegetated with forest, and are now covered with secondary woods and brush; some of the wider bottomlands are now in crops. The original tall-grass prairie on the upper slopes has been replaced by crops and pasture.

The climate of the area is characterized by cold winters and hot summers. Mean annual temperature is 11° C; mean January temperature is -5° C and mean July temperature is 25° C. Mean annual precipitation at nearby Knoxville, Iowa (279 m elev.) is 830 mm, 70% of which falls in the six months from April to September. The mean frost-free period is 170 days. During this study, winter snow cover was lower than usual, and winter temperatures were warmer than normal.

Methods

Small mammal populations were sampled approximately monthly from August 1975 to July 1976 by snap-traps baited with peanut butter and oatmeal. Traplines of fifteen stations with two traps each were run five nights, except in September and October 1975, when only ten stations of three traps each were run four nights, at the unmined site only. Animals were checked for reproductive condition and age.

Results

Abundance and diversity. Table 1 lists species abundance. *Peromyscus leucopus* was the most abundant species both off and on coal spoils, followed by *P. maniculatus*. These species had a combined relative abundance of 56.1% off the spoils, and 86.9% on the spoils. The importance of *Peromyscus* spp. on the spoils is illustrated by a high concentration of dominance, as measured by Simpson's Index (Simpson 1949). The on-spoil index was 0.40, the off-spoil index was 0.22.

Eight other species were trapped in off-spoil habitats, and five others in on-spoil habitats (Table 1). *Mus musculus*, *Cryptotis parva* and *Zapus hudsonius*, found in off-spoil areas, were not captured on the spoils; however, presence of *Mus* and *Cryptotis* was indicated by examination of long-eared owl (*Asio otus*) pellets (Voight and Glenn-Lewin, in press).

Grassy habitats both off and on the spoils had a higher diversity of mammals than wooded habitats. *P. maniculatus* was the dominant species in grassy habitats of both areas (35.2% of the off-spoil capture, 48.1% of the on-spoil). In wooded habitats, *P. leucopus* was the most common species: 81.0% of the capture off the spoils, and 92.2% of the capture on the spoils. The wooded habitat at the unmined area was relatively young and open. Thus, some open-area species (e.g., *P. maniculatus*, *Reithrodontomys megalotis*) were found there.

Along spoil ridges, *P. maniculatus* constituted 54.8% of the capture, while *P. leucopus* made up 37.4%. Trapping in draws resulted in 61.7% *P. leucopus*, with 30.0% *P. maniculatus*. Thirty-nine percent of all *Microtus pennsylvanicus* were captured on ridges, although only 15% of the trap effort was exerted there. On spoil areas, *Reithrodontomys* occurred only in well-vegetated draws and on small unmined remnant areas within the spoils. Other species were captured in habitats expected for those species.

Seasonal fluctuations in capture rates were found in both mined and unmined areas (Table 2). Capture rates peaked in December, fell through March, reached a secondary peak in May, and declined into summer. The total unmined area capture rate was slightly lower than the on-spoil rate (Table 1), although montly rates on the unmined area were somewhat higher in September and from December through March (Table 2).

Reproduction. Both species of Peromyscus had shorter breeding seasons on the coal spoils than in off-spoil habitats. In off-spoil areas, males of both species were found with scrotal testes in all months (with captures). On spoils, no scrotal testes were found in male P. leucopus from November or December, and none in P. maniculatus from November through February. No pregnant or lactating females were found in off-spoil areas between November and February. In on-spoil areas, no female P. leucopus were pregnant or lactating from November through April; no P. maniculatus females appeared to be breeding from November through March.

There was no difference between proportions of pregnant and lactating females on the two sites for either Peromyscus spp. ($p > 0.05$). Overall, 27.8% of the adult female P. leucopus were pregnant on the spoils, 22.0% were pregnant off the spoils. Of adult female P. maniculatus, 34.3% were pregnant on the spoils, 25.0% off the spoils.

Litter sizes were compared between the areas, but the samples were small. Thirteen pregnant P. leucopus from on-spoil habitats averaged 4.9 embryos; five from off-spoil habitats averaged 3.6. Embryo counts ranged from two to eight. Seventeen P. maniculatus on the spoils had an average embryo count of 3.7, while three from unmined areas averaged 4.3 embryos. The P. maniculatus embryo count ranged from one to five. These differences are not significant ($p > 0.05$).

No significant differences in Peromyscus spp. age ratios were found between the two areas. Immatures were 23.5% of the P. leucopus population and 28.5% of the P. maniculatus population on the spoils area. Off the spoils area, immatures were 25.4% of the P. leucopus population and 28.1% of the P. maniculatus population. The presence of immatures in the trap sample during the winter non-breeding months was probably due to carry-over of fall young.

Other parameters. The on-spoil sample of P. leucopus contained 58.4% males, the off-spoil population contained 47.4% males ($x^2 = 4.12$, $p < 0.05$). Sex ratios of P. maniculatus from on and off spoil habitats were not significantly different from an even ratio, nor from each other (on-spoils 53.0% males, off-spoils 56.1% males). Of 53 immature P. leucopus taken on the spoils, 61.8% were male; 39.3% of 28 off-spoil immatures were male. Too few immature P. maniculatus were taken for comparison.

There was no difference in average Peromyscus spp. body length, compared by sex, between the mined and unmined areas. The same holds for average body weights, except that the average body weight of P. leucopus males was significantly less on the spoils (25.8g) than on unmined land (27.5g; $p < 0.05$).

Discussion

Abundance and Diversity. As is typical of early successional stages in eastern North America (Beckwith, 1954; Pearson, 1959, Shure, 1970, Kirkland, 1976 and others), the two *Peromyscus* spp. are the dominant species on Iowa coal spoils, much more so than on off-spoil sites. Similar results have been reported by Yeager (1942), Verts (1957; 1959), Wetzel (1958), Mumford and Bramble (1969), De Capita and Bookhout (1975) and Sly (1976).

The two *Microtus* species show unexpected habitat affinities on the spoils. *M. ochrogaster* was expected to be more abundant, especially on dry ridges, but *M. pennsylvanicus* was found more often. Normally, *M. ochrogaster* is expected in drier habitats (Miller, 1969; Lewin, 1968). In off-spoil areas, normal habitat segregation of *Microtus* spp. was observed.

Species distribution was related to vegetational type. Habitat preference of *P. leucopus* for vertically structured areas and of *P. maniculatus* for open areas has been well documented (Dice, 1922; Blair, 1940; Jameson, 1949; Getz, 1961; Iverson *et al*, 1969 and others). In this study, *P. leucopus* were taken primarily near trees, fenceposts or rock outcroppings. The abundance of *P. leucopus* in draws (wooded) and the abundance of *P. maniculatus* on typically grassy ridges reflects the vegetation of these habitats. Ridges tend to be grassy due to heavy erosion and periodic desiccation that inhibits the growth of trees.

Reithrodontomys megalotis occurred both on and off the spoils usually in dense grass cover preferred by this species (Brummel, 1961; Birkenholz, 1967 and others).

DeCapita and Bookhout (1975) concluded that in spite of higher capture rates of some species on spoil areas in Ohio, spoils were inferior habitats to unmined land. This conclusion was based on the high concentration of dominance and lower species richness of mammals on spoils. The same holds for Iowa spoils, the low diversity correlating with the low quality of coal spoil habitats.

Capture rates peaked in late fall and early winter, with a secondary peak in late spring. Similar results have been reported (e.g. Beer and MacLeod, 1966; Terman, 1968). The fall-winter peak has been attributed to seasonal movements, the spring peak to the influx of animals produced by spring breeding (Blair, 1940; 1948; Beer and MacLeod, 1966).

Reproduction. On the spoils area, both Peromyscus spp. had a shorter breeding season than on the unmined area. Orr-Ewing (1950), in comparing P. leucopus populations from burned and clear-cut areas to those of natural forests, found a shorter breeding season in the less protected areas. Instances of extended winter breeding in Peromyscus spp. have been reported in habitats with good cover and food supplies and during mild winters (Linduska, 1942; Brown, 1945; Wood, 1910). Differences in breeding seasons probably reflect differences in habitat quality.

Litter sizes for P. leucopus are reported to be somewhat over four (e.g., Burt, 1940; Svihla, 1932). The litter sizes for both areas for P. leucopus were reasonably close to these figures. Reported litter sizes for P. maniculatus from the Midwest range from 3.05 to 5.2 (Svihla, 1932; Linduska, 1942; Beer, et al, 1957; Beer and MacLeod, 1966; Long, 1968). The average of both areas for P. maniculatus in this study was 3.79.

Other parameters. On Illinois coal spoils. Verts (1957) found 61% of adult P. leucopus were male, and immatures were 30% male, similar to the present results of 61.8% male adults and 39.3% males among immatures. Verts (1957) found 61% of adult P. maniculatus were male, and immatures were 56% male; present results show 53% males among adults, and negligible differences between immatures on unmined areas and Verts' (1957) data. Several studies have reported that males dominate the immature age class (Jackson, 1952; Long, 1968; Beer and MacLeod, 1966); this has been attributed to increased trap susceptibility of immature males due to social pressures (Beer, et al, 1958).

Body sizes for both species are similar to other Iowa data (Sloan, 1964). The only significant variation between the two areas was found in male P. leucopus, whose average weight was 1.7g less on the spoils than off them. The reason for this is unknown.

Conclusions

This study analyzed field data for differences in species diversity, abundance, reproduction and population parameters of small mammals on strip-mined and unmined land in southeast Iowa. The main conclusions are:

1. Strip-mining lowers small mammal species diversity and changes the relative abundance of the species. The unmined land had ten species, while the mined area had seven. Also, the mined land had a greater percentage of captures of Peromyscus spp. than did the unmined area.

2. Peromyscus spp. breeding seasons were shorter on the mined area.

3. Age ratios, incidence of pregnancy and litter sizes of Peromyscus spp. did not significantly vary between the areas. Some differences in body size and sex ratios were noted, but overall the results were equivocal and no obvious trends were found.

Table 1. Capture rate and relative abundance of small mammals on mined and unmined land.

Species	Number taken on spoils[a]	Number/100 trapnights	% relative abundance	Number taken on unmined land[b]	Number/100 trapnights	% relative abundance
Peromyscus leucopus	226	6.54	52.07	114	4.24	37.38
Peromyscus maniculatus	151	4.37	34.79	57	2.12	18.69
Microtus pennsylvanicus	18	.52	4.15	10	.37	3.28
Sorex cinereus	17	.49	3.92	22	.82	7.21
Reithrodontomys megalotis	14	.41	3.23	31	1.15	10.16
Blarina brevicauda	7	.20	1.61	4	.15	1.31
Microtus ochrogaster	1	.03	.23	17	.63	5.57
Mus musculus	0			48	1.79	15.74
Zapus hudsonius	0			1	.04	.33
Cryptotis parva	0			1	.04	.33
TOTALS	434	12.56	100.00	305	11.34	100.00

[a]3456 trapnights

[b]2690 trapnights

Table 2. Total captures per 100 trapnights by area and month.

Month	Unmined area	Spoils area	Total
August 1975	5.42	-----	5.42
September	8.08	5.94	14.02
October	4.17	13.85	18.02
November	16.67	21.00	37.67
December	25.00	23.00	48.00
January 1976	13.00	6.67	19.67
February	11.07	8.67	19.74
March	9.33	8.41	17.74
April	12.00	12.67	24.67
May	11.67	17.00	28.67
June	2.67	11.11	13.78

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