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Small Mammal Populations on Ohio Strip-Mined Lands Reclaimed with Herbaceous Vegetation Under Old and New Reclamation Laws[1]

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ABSTRACT. During the summers of 1978 and 1979, indices to small mammal populations were obtained in east-central Ohio on lands strip-mined for coal. The study sites were on lands reclaimed with herbaceous vegetation before or after enactment of the 1972 Ohio reclamation laws that required topsoiling before seeding. In the two years, 26,489 snap-trap-nights and 564 pitfall-trap-nights were recorded, and 3,403 mammals of eight species were captured. The post-1972 sites, seeded with a grass-legume mixture, a common practice, had the greatest numbers, with *Microtus pennsylvanicus* accounting for 86% of all captures. The pre-1972 site had the lowest total numbers, with *Blarina brevicauda* accounting for 62% of all captures. The capture of primarily a single mammalian species on the post-1972 reclaimed areas probably resulted from lack of vegetational diversity and absence of a litter layer. Mining companies commonly mow reclaimed sites 1-3 times annually. As long as this practice continues, the plant and animal communities likely will remain simple. However, small mammal numbers were significantly increased by practices instituted after the 1972 reclamation laws.

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INTRODUCTION

In Ohio, lands that were surface-mined for coal from 1947 to 1972 were not subject to stringent reclamation laws, and post-mining practices varied widely. Plantings in early years consisted mostly of trees. In 1972, newly enacted Ohio strip-mine reclamation laws required retopsoiling of mined sites before planting, and since that time emphasis has been on plantings of grass-legume mixtures.

Several workers have investigated Ohio strip-mined lands as wildlife habitat (Riley 1954, Bookhout et al. 1968, Lindsay 1974, DeCapita and Bookhout 1975), with the general conclusion that the areas will support wildlife in moderately high numbers. Studies of small mammals have not been made on lands reclaimed under the new Ohio strip-mining laws. We investigated whether the new reclamation practices had any significant effects on the small mammal populations of reclaimed lands.

DESCRIPTION OF STUDY AREAS

Three study areas, one mined and reclaimed before passage of the 1972 Ohio strip-mining laws, and two mined and reclaimed after the 1972 laws but of different ages, were selected in Harrison County, Ohio. Trapping was conducted in 32-ha study plots in each study area.

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Harrison County lies in the unglaciated east-central section of Ohio within the Appalachian Plateau. This area is characterized by steep slopes and long, sinuous ridges. Harrison County is one of the most heavily strip-mined counties in Ohio; about 20% of the county is affected by strip-mining (Ohio Division of Reclamation, unpubl. rep.). The presence of limestone causes the spoilbanks in Harrison County to be calcareous; the pH ranges from 6.4 to 7.9 (Limstrom 1950). Because of this calcareous overburden, restoration of the vegetation is generally successful, and erosion is not a major problem.

THE 1975 MINED AREA. This area was mined and reclaimed in 1975. The topsoil was replaced and the area was seeded with a mixture of yellow sweet clover (*Melilotus officinalis*), red clover (*Trifolium pratense*), orchard grass (*Dactylis glomerata*), and tall fescue (*Festuca arundinacea*). The area was planted with oats (*Avena sativa*) the year the topsoil was replaced to give an immediate cover to retard erosion, but oats were not present the following year. This type of reclamation is typical of current practices in the region. The four perennial plants were the dominant species in 1978, and provided a dense cover of about 94% (Urbanek 1982). Crown vetch (*Coronilla varia*), a volunteer, was also present in patches, especially on slopes. In 1979 yellow sweet clover was absent, and crown vetch covered about 25% of the area, up from 10% in 1978. This area had a plant diversity of 3.6 species/0.5 m^2, and a total plant biomass of 506 g/0.5 m^2, of which grasses made up about one-half (Urbanek 1982).

THE 1977 MINED AREA. This area was both mined and reclaimed in 1977 by the same procedures used on the 1975 area. The same mixture of four plant species was planted, along with oats the first year. The same four species were the dominant plants in 1978, but yellow sweet clover was not present in 1979. Little crown vetch was present, and no spreading of this species was noticed in 1979. Ground cover was similar to the 1975 area (>95%) as was plant species diversity (3.9 species/0.5 m^2). However, total plant biomass was lower (443 g/0.5 m^2); grasses made up about two-thirds of this (Urbanek 1982).

THE 1966-68 MINED AREA. This area, mined before the 1972 laws, was reclaimed in 1966-68. No topsoil was replaced, but the ground was graded, and crown vetch was planted as ground cover. This was the dominant plant during the study, forming a dense ground cover of nearly 100%. Patches of quack grass (*Agropyron repens*) were scattered throughout the area. Total plant biomass was high (553 g/0.5 m^2), but was made up almost entirely of vetch, and only 6.5% of the total was grasses (Urbanek 1982). Plant species diversity was the lowest of the three study areas, 1.6 species/0.5 m^2 (Urbanek 1982). This area was representative of reclamation practices in the east-central region of Ohio under the old Ohio strip-mining laws.

Although the percentage of ground cover was high and similar on all of the sites, and total plant biomass was similar, the structure of the vegetation was different. The 1966-68 area, presumably because of its age and the nature of crown vetch which has a tremendous yearly growth and dieback, had a dense litter layer, approximately 400 g/0.5 m^2 (Urbanek 1982). This was significantly greater than the litter layers in the post-1972 mined sites, both of which had approximately 250 g/0.5 m^2 (Urbanek 1982). Biomass of grasses was equal on the post-1972 sites, but the 1966-68 area had only 12-15% as much (Urbanek 1982).

METHODS AND MATERIALS

Each study area was trapped for four consecutive nights in June, July, and August 1978 and May, June, July, and August 1979. The areas were trapped sequentially. Trap lines in each area were established with 160 stations, each station 10 m apart with two snap traps per station. The traps were set in the evening and checked within two hours after sunrise the next morning to prevent deterioration of the digestive tracts that were to be examined later (McGowan 1980). A total of 26,489 snap-trap-nights were recorded.

Bait was a mixture of peanut butter, oats or cornmeal, animal fat, and Sevin, an insecticide. The Sevin was added to the bait beginning in July 1978 on all areas and was successful in reducing bait loss to insects.

In 1979, 12 pitfall traps were placed in each area during each trapping period to monitor *Sorex*, which is known to be more easily taken in pitfall traps than in snap traps (MacLeod and Lethiecq 1963). Each trap consisted of a coffee can 125-mm in diameter and 160-mm deep, half-filled with water and set into the ground with its top edge flush with the ground surface. Traps were covered during the day and were moved to new locations at the start of each trapping session. A total of 564 pitfall-trap-nights were recorded.

RESULTS

A total of 3,403 mammals were caught in the two years (Table 1). Of these, 97.9% were of three species: *Microtus pennsylvanicus* (74.0%), *Peromyscus maniculatus* (12.5%), and *Blarina brevicauda* (11.4%). Numbers of mammals captured per unit effort were highest in the 1977 area (16.65 captures/100 Trap Nights, TN) and the 1975 area (15.78/100 TN), and were not significantly different from each other (Newman-Keuls test, $q = 0.14$, NS, Zar 1974). Total captures were significantly lower in the 1966-68 area (6.15/100 TN; Newman-Keuls test, $q = 4.23$, $P < 0.001$). In the 1977, 1975,

TABLE 1

Mammals captured in snap traps, Harrison County, Ohio, June-August 1978 and May-August 1979.

	1977 area	1975 area	1966-68 area
Species	Number of mammals (No./100 TN)	Number of mammals (No./100 TN)	Number of mammals (No./100 TN)
Blarina brevicauda	1 (0.01)	47 (0.53)	340 (3.80)
Sorex cinereus	———	2 (0.02)	35 (0.39)
Microtus pennsylvanicus	1175 (13.71)	1268 (14.24)	79 (0.88)
Peromyscus species[a]	248 (2.89)	86 (0.97)	91 (1.01)
Zapus hudsonius	3 (0.03)	2 (0.02)	4 (0.04)
Napaeozapus insignis	———	1 (0.01)	———
Mus musculus	———	2 (0.02)	1 (0.01)
Totals	1427 (16.65)	1408 (15.78)	550 (6.15)

[a]Of a random subsample of 162 mice measured for specific identification, one captured on the 1966-68 area was *P. leucopus*, four were not definitely assignable to either species, and the remainder were *P. maniculatus*.

and 1966-68 areas, four, seven, and seven species were captured, respectively. However, species taken regularly (totalling over 10 individuals captured) numbered two in the 1977 area, three in the 1975 area, and four in the 1966-68 area.

The only two abundant mammals in the 1977 area were *M. pennsylvanicus* (N = 1175, 13.71/100 TN) and *P. maniculatus* (N = 248, 2.89/100 TN). One individual of *B. brevicauda* and three individuals of *Zapus hudsonius* were caught in 1978. In 1979, only *Microtus* and *Peromyscus* were captured in snap traps; four individuals of *Microtus* (2.22/100 TN) were caught in pitfall traps. The numbers of *Microtus* captured were not significantly different in the two years (12.61/100 TN, 1978; 14.57/100 TN, 1979; $t = 0.245$, $P > 0.50$); however, *Peromyscus* numbers dropped significantly from 1978 to 1979 (6.35/100 TN, 1978; 0.17/100 TN, 1979; $t = 4.697$, $P < 0.05$). Fewer mammals were captured in 1979 than in 1978. This probably resulted from the decline in the numbers of *P. maniculatus,* which had comprised almost one-third of the animals caught in 1978.

Microtus was the most frequently caught mammal in the 1975 area (N = 1268, 14.24/100 TN), followed by *Peromyscus* (N = 86, 0.97/100 TN). As in the 1977 area, *Microtus* numbers were not significantly different in the two years (14.30/100 TN, 1978; 14.20/100 TN, 1979; $t = 0.263$, NS); however, *Peromyscus* numbers decreased significantly in 1979 (1.78/100 TN, 1978; 0.35/100 TN, 1979; $t = 3.254$, $P < 0.05$). In 1978, eight individuals of *Blarina* were caught in the 1975 area, all in August, and accounted for 1.3% of all captures. In 1979, 39 individuals of *Blarina* were caught, accounting for 5.3% of all animals caught in June, July, and August; in 1979 *Blarina* was the second most frequently caught mammal. Two individuals of *Sorex cinereus,* two of *Z. hudsonius,* and one of *Napaeozapus insignis* were trapped in 1978, but none were caught in 1979. One individual of *Mus musculus* was captured each year; six individuals (2 *Sorex,* 3 *Microtus,* and 1 *Peromyscus*) were caught in pitfall traps (3.13/100 TN).

The most frequently caught mammals in the 1966-68 area were *Blarina* (N = 340, 3.80/100 TN), *Peromyscus* (N = 91, 1.01/100 TN), *Microtus* (N = 79, 0.88 /100 TN), and *Sorex* (N = 35, 0.39/100 TN). Three individuals of *Z. hudsonius* were captured in 1978 and one in 1979. One individual of *M. musculus* was caught in 1978 and none in 1979. Capture rates were significantly higher than in the post-1972 mined areas for *Blarina* (Non-parametric Multiple Comparison test, $q = 3.61$, $P < 0.025$; Zar 1974) and *Sorex* (Non-parametric Multiple Comparison test, $q = 3.98$, $P < 0.005$), and significantly lower for *Microtus* (Non-parametric Multiple Comparison test, $q = 5.96$, $P < 0.001$). Total *Peromyscus* numbers were not significantly different in the three areas (Kruskal-Wallis test, $H = 0.241$, NS; Zar 1974). Eight individuals (4 *Sorex* and 4 *Zapus*) were caught in pitfall traps (4.44/100 TN).

DISCUSSION

Previous studies of small mammals on Ohio strip-mined lands reclaimed before the 1972 laws showed that *P. leucopus* and *B. brevicauda* were the most abundant species, and that *Microtus* was much less numerous (Bookhout et al. 1968, DeCapita and Bookhout 1975). The 1966-68 area was similar in that *Peromyscus* and *Blarina* were the most numerous forms. However, the 1966-68 area differed substantially in capture rates. *Blarina* numbers were higher and *Peromyscus* numbers much lower than in the previous studies. In addition, whereas *P. leucopus* was the predominant species captured in the older studies, we caught almost entirely *P. maniculatus.* In Ohio, these two species are not easily separable, and a multi-character identification, requiring extensive measurements, is needed for accurate separation (Birch 1977). Because of the number of animals caught and the need to get the animals frozen as quickly as possible, these measurements were not taken when the animals were caught, but only after they were thawed for digestive tract removal. Thus, all *Peromyscus* captured were not identified to species. Of the 162 individuals measured in a random subsample from all areas and months trapped, only one mouse, caught in the 1966-68 area, was identified as *P. leucopus.* Four others could not be definitely assigned to either species. For this reason, all *Peromyscus* were considered to be *P. maniculatus.* Differences in reclamation practices are most likely responsible for the differences in species occurrence. Many researchers have noted that *P. leucopus* prefers trees, whereas *P. maniculatus* prefers more open grassy areas (Wetzel 1958, Kaufman and Fleharty 1974, Birch 1977, Hansen and Warnock 1978). Previous studies were done in areas where trees were planted and predominated, resulting in more trees and bare ground than in this study.

The post-1972 mined areas differed from the 1966-68 area in the structure of the small mammal community. An insectivore was the predominant species in the 1966-68 area, whereas a grazing rodent was predominant in the post-1972 lands. In addition, the total number of small mammals caught was two to three times greater in the post-1972 lands than in the pre-1972 area. *M. pennsylvanicus* was the most abundant small mammal in the post-1972 areas. This differs not only from the 1966-68 area, but also from previous studies (Bookhout et al. 1968, DeCapita and Bookhout 1975). The presence of *Microtus* was probably a result of the presence of grasses, a major food item for this species and a primary determinant of its distribution (Bailey 1924, Zimmerman 1965, M'Closkey and Fieldwick 1975). Tolin (1975) found that in Harrison County, *Microtus* was the most abundant small mammal in mined areas with calcareous overburden on which grasses predominated. Urbanek (1976), working in Illinois on strip-mined lands reclaimed for fescue pasture, also found *Microtus* in large numbers, although the numbers were lower than in our study. The 1966-68 area, and the sites of the previous Ohio strip-mine studies (Bookhout et al. 1968, DeCapita and Bookhout 1975), had little grass and few voles. The crown vetch also might have played a role in depressing *Microtus* populations. Several studies have indicated that crown vetch contains a substance that is poisonous to non-ruminants, and that it could poison juvenile *Microtus* (Shenk et al. 1974, 1976). Crown vetch provides good cover and substrate for runways, and consequently provides a good refuge for *Microtus.* However, unless the

voles have access to areas of grass, the population might not be maintained. The scattered patches of quack grass might have provided sufficient food to maintain the small population of *Microtus* seen.

The large numbers of *M. pennsylvanicus* in the lands reclaimed under the 1972 laws were probably the result of low vegetational diversity and the presence of a simple understory. With increasing plant diversity and litter biomass, over time the number of small mammals species would probably increase. However, mining companies in Ohio commonly mow reclaimed sites 1-3 times per year to harvest mulch for use on newly reclaimed sites or for cattle feed. The litter biomass increased on the 1977 site from 150 g/0.5 m^2 in 1978 to 250 g/0.5 m^2 in 1979 (Urbanek 1982), as would be expected with succession. However, in 1979, the 1977 area litter biomass only equaled that of the older 1975 site, which showed no increase in the two years. This indicates that with the removal of the mulch, the litter layer on these sites will not increase. As long as this practice continues, the plant community will probably remain simple, and mammalian diversity will remain low. State and federal laws require that strip-mined land be reclaimed and returned to a state of productivity at least as great as that before strip-mining occurred. In terms of small mammal numbers, the lands reclaimed under the new laws are much more productive, although they produce large numbers of essentially one species. This small mammal population could support a larger population of predators, such as hawks (Accipitrinae), owls (Strigidae and Tytonidae), foxes (*Vulpes vulpes, Urocyon cinereoargenteus*), and weasels (*Mustela* sp.). In this way the new laws may have increased the value of reclaimed lands for wildlife.

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