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VERTEBRATES AND VEGETATION ON A SURFACE-MINED AREA IN SOUTHERN ILLINOIS

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ABSTRACT

Abundance and diversity of vertebrates, especially small mammals and birds, and terrestrial vegetation were measured on surface-mined lands in the Bankston Fork watershed, Williamson and Saline counties, Illinois. Habitats examined, on sites mined 5-34 years earlier, included reed marsh, fescue grassland, old field, woodland edge, pine woodland, black locust woodland, and other deciduous woodland. Tree density and basal area were greatest in pine woodland (1,156 trees and 26 basal m^2 per ha). Small mammals were most abundant in grass plantings (23 captures per 100 trap-nights), primarily because of high deer mouse *(Peromyscus maniculatus)* and prairie vole *(Microtus ochrogaster)* populations. However, the white-footed mouse *(P. leucopus)* was the most widely distributed mammal. Diversity values (H′) for small mammal communities in herbaceous plant dominated and edge habitats were about twice the values obtained for woodlands. Breeding bird diversity in edge habitat was generally greater than in other habitats; pine plantation supported relatively high wintering bird populations. Fence lizards *(Sceloporus undulatus)* and six-lined racerunners *(Cnemidophorus sexlineatus)* were locally abundant, as were aquatic amphibians and reptiles. Grass plantings on the most recently reclaimed areas contained less biotic diversity than did older mined lands or adjacent unmined lands. Habitat diversity and edge contributed to observed small mammal and bird diversity and are recommended for development in reclamation planning.

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INTRODUCTION

Surface mining of coal is viewed as having a major impact on the traditional use of lands in Illinois as well as the Midwest. Generally a consequence of such drastic disturbance of land is the opportunity to examine aspects of reestablishment of fauna and flora both as a result of natural processes and those generated by man through reclamation efforts. A setting for such research was the 13,344-ha Bankston Fork watershed, located in Williamson and Saline counties, Illinois, of which over 25% was disturbed by mining during 1936-1976. Because surface mining is expected to continue, the environmental consequences are of major importance as we develop plans for reclamation and particularly attempt to establish baseline data. Even though surface mining for coal began in the United States over 100 years ago (Klimstra and Jewell 1973), significant studies of vertebrate populations and their habitat on mined lands are limited (Czapowskyj 1976, Nawrot et al. 1982). In addition, due to much variability in planting and grading practices, or lack thereof, particularly on pre-law lands, each large surface-mined area possesses its own characteristic wildlife habitat attributes and is therefore deserving of study. This study in 1975-76 attempted to determine species composition, abundance, and diversity of elements of vertebrate fauna and vascular flora on surface-mined lands in the Bankston Fork watershed.

STUDY AREA

The study area consisted of 3,457 ha surface mined in the Bankston Fork watershed in Williamson and Saline counties, Illinois (T9S, R4E, Sec. 13-16, 20-29, 33-36; T9S, R5E, Sec. 19-30). Based on 1970-71 aerial photographs, approximately 62% of the surface-mined land consisted of spoil banks (ungraded spoils) and 38% was graded to a rolling or level topography. Spoil banks were 50% wooded, 7% old field stage, and 43% fescue (*Festuca arundinacea*) dominated grass-legume plantings. Graded areas were 37% wooded, 30% old field, and 33% fescue dominated plantings. Fescue plantings were confined primarily to lands mined after 1962, when the first regulations requiring significant reclamation in Illinois became effective. Other cover types represented primarily pre-law lands (mined before 1962).

Twenty-two sites representing seven general habitat types were examined. These habitat types included reed marsh (1 site, 16 years after mining), fescue grassland (1 graded and 2 spoil bank sites, 5-14 years old), old field (2 graded sites, 25 and 30 years old), woodland edge (3 graded and 1 partially graded site, 19-32 years old), pine woodland (2 spoil bank and 2 graded sites, 19-34 years old), black locust (*Robinia pseudoacacia*) woodland (1 partially graded and 1 spoil bank site, 25 and 34 years old, respectively), and other deciduous woodland (3 spoil bank and 3 graded sites, 16-32 years old). The two spoil bank sites in fescue grassland were "strike-off" areas, i.e., the crests of spoils had been leveled. As allowed under then applicable Illinois law, topsoil had been replaced on none of the sites studied.

METHODS AND MATERIALS

A 152.4-m line transect was established as a sampling baseline at each of 22 sites examined. Sampling occurred February 1975 through January 1976.

Six vegetation sampling points, each serving as the center of a circular plot, were established at 30.5-m intervals along each transect. At each point, density and basal area of trees (woody plants greater than 6.4 cm DBH) were recorded per 0.04-ha circular plot, density of shrubs (woody plants 2.5-6.4 cm DBH) was recorded per 0.004-ha circular plot, and areal ground cover was estimated (Braun-Blanquet 1932:32) per 0.0004-ha plot for each species in the herbaceous layer. The herbaceous layer was sampled twice, June and September. Unlike graded sites, spoil banks possessed enough topographic variation to influence vegetation development; sampling and data analysis were therefore more involved. Tree sampling plots on spoils were centered on ridges; to alleviate overrepresentation of ridgetop stands, all trees were classified in regard to topographic position (ridge, slope, or valley). Density and basal area per hectare were then calculated separately within each of these strata. Values obtained were then multiplied by a weighting factor equivalent to the proportion of site area actually occuped by that stratum. Weighted density and basal area values per stratum were then summed to produce total density and basal area. Shrubs were sampled with six points on each ridge-centered transect and six in adjacent valleys. Herbaceous layer vegetation was sampled at six points on ridges, three on slopes, and three in valleys along each transect at spoil bank sites.

Twenty trapping stations at 7.6 m intervals on each transect were used to assess small mammal abundance. One standard Victor mouse trap and two Museum Special snap traps were set per station. Bait was rolled oats and peanut butter; Sevin was added during spring and summer to reduce loss to insects. Traps were operated for two consecutive nights during four sampling periods: February-March, June, August, and late November. Approximately 12 pitfall traps (1.4 kg cans half full of water and buried with tops at ground level) were employed September through mid-November in fescue grassland, old field or edge habitats, and woodlands.

A modified version of the Forbes Cross strip-census (Forbes 1907 *in* Graber and Graber 1963) was used to assess bird populations. Modifications included one observer instead of two and a three-fold reduction in the distance in front of the observer over which birds were counted. Along each wooded transect the sampling unit was a 152.4 x 30.5-m belt; in open areas dimensions were 152.4 x 45.7 m. During a census the observer counted all birds 30.5 m or less to the front while maintaining a walking pace of approximately 30 minutes per km. With few exceptions, birds flying over 3 m above the vegetation canopy (or greater than 12 m above the ground surface when no canopy was present) were not included. Censuses were made between sunrise and 1100 hours; at the 22 sites the transect was covered five times during each of four periods: February-March 1975 and January 1976; April-June 1975; July-September 1975; and October-December 1975.

Species richness (S) of trees, small mammals, and birds was measured as number of species per unit area. Species diversity (H′) was calculated according to the equation $H' = -\Sigma p_i \log p_i$ (Shannon and Weaver 1949), where p_i = the proportion of total individuals or some other importance value represented by species i in the sample.

Noteworthy vertebrate specimens were deposited in the collection of the Cooperative Wildlife Research Laboratory, Southern Illinois University.

RESULTS

Vegetation

The common reed (*Phragmites australis*) formed dense stands and was the dominant species in reed marsh. Tall fescue dominated fescue grassland; alfalfa (*Medicago sativa*) and sweet clover (*Melilotus* spp.) were common. Brome grass (*Bromus* spp.), broom sedge (*Andropogon virginicus*), yellow sweet clover (*Melilotus officinalis*), Korean lespedeza (*Lespedeza stipulacea*), dwarf sumac (*Rhus copallina*), and trumpet creeper (*Campsis radicans*) each accounted for more than 5% ground cover in old field. In woodland edge, brome grass, brambles (*Rubus* spp.), yellow sweet clover, poison ivy (*Toxicodendron radicans*), and Japanese honeysuckle (*Lonicera japonica*) were common in the herbaceous layer; sandbar willow (*Salix interior*), black locust, and dwarf sumac were common shrubs. Common trees in woodland edge were the same as those in adjacent woodlands.

Tree densities and basal areas were greatest in pine and black locust plantations (Table 1). Shortleaf (*Pinus echinata*) and loblolly pines (*P. taeda*) were dominant species in pine woodland. Black locust dominated locust woodland. On the partially graded locust site, living and dead black locust accounted for 66% and 19% of total tree density, respectively. On the spoil bank locust site, living and dead black locust accounted for 30% and 28% of total tree density, respectively. High locust mortality, attributable primarily to locust borer (*Megacyllene robiniae*),was associated with high tree diversity (Table 1). This diversity resulted from favorable conditions for invading species such as wild black cherry (*Prunus serotina*), American elm (*Ulmus americana*), box elder (*Acer negundo*), river birch (*Betula nigra*), and sycamore (*Platanus occidentalis*). Vegetative ground cover was moderately developed in locust woodland and was largely brome grass, blackberry (*Rubus allegheniensis*), poison ivy, dwarf sumac, and Japanese honeysuckle. In contrast, herbaceous and shrub cover in pine woodland was sparse.

Other deciduous woodlands included three planted sites of sweet gum (*Liquidambar styraciflua*), cottonwood (*Populus deltoides*), and sycamore/sweet gum, and three natural stands dominated by sycamore, cottonwood, and willows (*Salix nigra* and *S. interior*). Highest tree density occurred at the willow dominated pond edge (Table 1), while lowest density occurred in the cottonwood plantation (272 trees/ha). Greatest basal area was in the gum plantation (16.6 m^2/ha), and least basal area occurred in the sycamore-gum plantation (7.3 m^2/ha). The pond edge contained greatest shrub density (Table 1), and the volunteer cottonwood stand contained least (75 shrubs/ha).

Mammals

The white-footed mouse (*Peromyscus leucopus*) accounted for 42% of 1,498 animals trapped and was the most widely distributed species (Table 2). Mean trapping success for total small mammals increased from 3.3 captures per 100 trap-nights in winter to 7.2 in spring and from 6.8 in summer to 11.3 during fall. Reed marsh, fescue grassland, woodland edge, and old field exhibited relatively high small mammal species diversity, while later successional stages reflected low diversity.

Fescue grassland exhibited greater numbers of small mammals than other areas studied (Table 2); deer mice (*Peromyscus maniculatus*) and prairie voles (*Microtus *ochrogaster*) predominated and accounted for 49% and 38% of captures, respectively. Although snap-trapping of the least shrew (*Cryptotis parva*) yielded less than 2% of total captures, it was probably common as evidenced by a capture rate of 4.9 per 100 pitfall trap-nights.

The negative effect of grazing on small mammal populations was demonstrated after cattle were introduced late September 1975 on the graded fescue site. Prior to this introduction, the graded site produced a higher trapping success in every season than all others, including fescue strike-off sites. In comparison, the strike-off site subjected to grazing prior to and throughout the study continually demonstrated lower populations than either ungrazed site. From August to late November, captures per 100 trap-nights on the fescue dominated sites increased from 31.7 to 61.7 on the ungrazed strike-off site, from 10.0 to 35.0 on the grazed strike-off site, but decreased from 37.7 to 10.0 on the graded site. This last decline was 2 months after initiation of grazing. However, capture rate increased for the least shrew on the graded site; it was never caught in snap traps until after grazing, when it comprised 42% of total captures.

Old field on surface-mined land demonstrated high small mammal populations; prairie voles, white-footed mice, and deer mice predominated (Table 2). The distribution of *Peromyscus* depended on type of old field; at one site, relatively mesic and dominated by brome grass, *P. maniculatus* accounted for 83% of *Peromyscus* captured. In contrast, at the other, relatively xeric, old field site dominated by broom sedge, trumpet creeper, and drawf sumac, *P. leucopus* accounted for 89% of *Peromyscus* captures.

Birds

Of 125 species of birds observed, 81 were potential breeding species (Kleen and Bush 1971); the most numerous are noted in Table 3. Relatively high bird densities were present in reed marshes, where red-winged blackbirds (*Agelaius phoeniceus*) accounted for 60% of individuals observed during spring and summer. Densities were high in woodland edge, which exhibited greatest breeding bird diversity among habitats examined (Table 3). Fescue sites reflected low densities, exhibiting characteristic grassland avifauna. Dickcissels (*Spiza americana*) and grasshopper sparrows (*Ammodramus savannarum*) were abundant during spring and early summer at the graded fescue site.

During fall-winter bird numbers were lower than in spring-summer for all habitats except pine woodland, where winter abundance was associated primarily with cover provided when such shelter was lacking elsewhere. The high winter abundance included several conifer-loving winter residents such as the golden-crowned kinglet (*Regulus satrapa*) and red-breasted nuthatch (*Sitta canadensis*), which represented 35% and 21%, respectively, of the individuals observed October-March. Bird species diversity was also high in pine plantations during winter.

Based on pooled data collected during 20 runs per transect over a 1-year period, annual avifaunal diversity was generally low in old fields and fescue pastures, but high in wooded habitats. Fescue grassland and old field averaged 12.3 ± 1.2 (1 S.E.) and 12.5 ± 0.5 (1 S.E.) species per 20 transect runs, while wooded habitats ranged from 18.5 to 24.5 species per 20 runs.

Other Vertebrates

A complete account of large mammals and birds, reptiles, amphibians, and fishes is beyond the scope of this paper, and can be reviewed elsewhere (Urbanek 1976). However, the following findings are noteworthy. Fence lizards (*Sceloporus undulatus*) and six-lined racerunners (*Cnemidophorus sexlineatus*) were locally abundant in patches of rocky, xeric habitat throughout the study area. Fowler's toads (*Bufo woodhousei*), cricket frogs (*Acris crepitans*), chorus frogs (*Pseudacris triseriata*), and spring peepers (*Hyla crucifer*) were common to abundant. Diversity of fishes was greater in creeks and lake edges than in ponds. Number of fish species captured per two seine sweeps was 6.5 ± 1.56 (1 S.E.) for creeks, 5.8 ± 1.02 for lake edge, and 1.0 ± 0.71 for ponds. Large numbers of larval anurans and salamanders were, however, frequent in the pond habitat and were associated with small or no fish populations.

DISCUSSION

Each of the seven major habitat types examined can be viewed as a potential reclamation alternative. Each has been shown to possess certain value for wildlife.

The reed marsh supported such uncommonly found small mammal species as the southern log lemming *(Synaptomys cooperi)* and rice rat *(Oryzomys palustris)*. A specimen of the latter, taken on 15 August 1975, confirmed the presence of this species in the Saline River Valley, where it had not been previously reported (Klimstra and Scott 1956, Klimstra and Roseberry 1969, Natural Land Institute 1981:66). Other wetlands, occurring on the mined area but not examined, probably also provided habitat for these species, as well as for numerous birds, reptiles, and amphibians.

Fescue grassland represented the most recent form of surface mine reclamation and is an example of the expansive, low diversity, low edge, agricultural reclamation that over the past two decades has come to dominate in the United States. These plantings have been shown to be good habitat for some small mammals, but poor for all but a few species of birds. Primary beneficiaries of this reclamation type are deer mice and voles *(Microtus* spp.). Deer mice have been shown to prefer new areas with some sparse cover at the ground surface, while *Microtus*, which use runways, prefer dense cover at ground level (McGowan 1980). The suitability of newly mined lands with little or no woody cover for deer mice has been well documented (Verts 1957, Kirkland 1976, Sly 1976, Hansen and Warnock 1978, McGowan 1980). The ubiquitous white-footed mouse, however, predominates on older sites with at least some woody vegetation (Verts 1957, Jones 1967, Bookhout et al. 1968, Sly 1976, Hansen and Warnock 1978). These findings concur with the differential use of the two old field sites by these two species of *Peromyscus*. In regard to birds, Whitmore and Hall (1978) and Wray et al. (1978) have shown that prairie species dominate grass plantings created by recent reclamation in West Virginia. Grasshopper sparrows tend to be the most common breeding species, provided the vegetation does not become too dense and some bare ground is available (Whitmore 1979). In our study, grasshopper sparrows and dickcissels were found only on the graded fescue site. Apparent absence on the strike-off sites indicates the species need for a flat to rolling topography.

When diversity and abundance of small mammals and birds are considered, woodland edges were the most productive habitats. Karr (1968) found breeding bird diversity was positively correlated with foliage-height diversity on a surface-mined area in east central Illinois. Chapman et al. (1978) noted heterogeneity of vegetative cover types was related to high bird populations on Virginia contour mines. Curtis et al. (1978) reported multilayered vegetation structure accelerated bird succession on contour mines in eastern Tennessee. Edge effect and well developed vertical stratification of the vegetation are probable reasons for high bird diversity in the woodland edge sites we examined. In regard to mammals, 69% of the uncommonly captured pine voles (*Pitymys pinetorum*) and all three individuals of the southeastern shrew (*Sorex longirostris*), captured at a Williamson Country site, were taken in woodland edge. Because it is difficult to capture, this shrew species is probably more common than trapping results indicate (George 1977). Southeastern shrews have also been taken on mined lands in southern Indiana (Jones 1967).

Woodland interiors were generally low in small mammal abundance and diversity and low to moderate in breeding bird diversity. Most birds present were forest edge rather than forest interior species, a result shared with Brewer (1958), who studied birds on surface mines in Perry County, Illinois. Age of sites, interspersion of different habitat types, and lack of the mature woodlands interior woodland species inhabit, contributed to the observed species composition.

Vegetation development was satisfactory on sites examined; although some unreclaimed gob and slurry deposits were present, these accounted for only a small proportion of the total area. Tree growth and survival were generally good, similar to results found by Kolar and Ashby (1978) in state-wide surveys of reclaimed lands in Illinois and Indiana. The significant mortality of black locust in their and our studies had a beneficial effect by opening the area to colonization by invading species. Ashby and Kolar (1977) found other tree species planted with black locust or in decadent stands grew better than where black locust was not planted.

Several aspects of habitat on the surface-mined area occurred in localized patches or wetlands not intensively studied; many reptiles and amphibians were associated with these areas. An example of habitat suitability pertains to the six-lined racerunner, which was very common on mined lands we studied but was previously unrecorded in Williamson County (Smith 1961, Klimstra and Hutchison 1965).

Terpening et al. (1975) provided data for a 3,289-ha unmined area immediately north of the surface-mined area studied. Comparisons indicated greater small mammal abundance on the mined area of our study, due to high rodent populations in fescue grassland. Small mammal diversity did not differ between mined land, on which 12 species were trapped, and unmined land, where 11 species were captured. Squirrels (*Sciurus* spp.) were more common on unmined land, where there were more mast bearing and denning trees. Bird diversity appeared greater on unmined land, possibly because of the presence of wooded fencerows and different types of woodlands. Open country forms such as wintering northern harriers (*Circus cyaneus*) appeared more common on mined lands.

This study demonstrated that a surface-mined area containing a variety of habitats can support a diverse array of wildlife. Because different reclamation regimes produce different habitats, the variety of wildlife can be increased by diversifying the reclamation within a given mined area. Creation of several cover types results in additional edge, a valuable addition to wildlife habitat in this study. Even though certain habitats, such as woodlands, may be limited in fauna, their edges may provide excellent habitat. Flexibility in choice of cover establishment and development of wetlands need incorporation into reclamation planning.

Current reclamation usually produces large, homogeneous grass or grass-legume plantings that cannot produce the diversity characteristic of mined or unmined lands containing many habitat types. The value of pre-law lands as wildlife habitat has been demonstrated (Yeager 1942; Riley 1954, 1960; Myers and Klimstra 1963; previously cited studies). In contrast, current practices are more limited.

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Table 1. Tree and shrub characteristics in selected habitats on surface-mined land in the Bankston Fork watershed, 1975.

	Woodland Edge	Pine Woodland	Locust Woodland	Other Woodland		
				Misc.[a]	Sweet Gum	Pond Edge
Trees:						
Number/ha	230.7	1,156.3	1,044.0	476.4	474.2	960.8
	±51.4[b]	±261.2	±103.9	±101.6		
Basal Area (m^2/ha)	5.3	25.8	20.1	9.6	16.6	14.0
	±1.9	±5.8	±1.8	±1.2		
S (0.24 ha)	8.5	7.5	13.0	7.0[c]		
	±1.56	±1.19	±0.00	±1.29		
H′ (0.24 ha)[d]	2.01	1.14	2.30	1.44[c]		
	±0.11	±0.39	±0.53	±0.44		
Shrubs:						
Number/ha	757.2	231.5	463.3	586.6	123.5	1,604.9
	±70.1	±77.4	±421.4	±287.9		

[a]Deciduous woodland, excluding locust plantations, sweet gum plantations, and wooded pond edge.
[b]One standard error of the mean.
[c]Includes sweet gum plantation and pond edge.
[d]Importance value used = relative density + relative basal area.

Table 2. Small mammal captures per 100 trap-nights, species richness (S), and species diversity (H′) in selected habitats on surface-mined land in the Bankston Fork watershed, 1975. Nomenclature according to Hoffmeister and Mohr (1957).

Species	Reed Marsh	Fescue Grassland	Old Field	Woodland Edge	Pine Woodland	Locust Woodland	Other Woodland
Sorex longirostris	-	-	-	*[a]	-	-	-
Cryptotis parva	-	0.4	*	-	-	-	-
Blarina brevicauda	0.4	0.1	0.2	0.4	0.4	0.1	0.1
Tamias striatus	-	-	-	-	-	0.1	-
Peromyscus maniculatus	-	11.0	1.6	0.4	-	-	0.2
Peromyscus leucopus	4.0	1.6	3.1	5.1	2.1	2.5	2.8
Oryzomys palustris	0.2	-	-	-	-	-	-
Synaptomys cooperi	0.6	*	-	-	-	-	-
Microtus ochrogaster	0.2	8.6	5.3	0.9	0.1	-	0.1
Pitymys pinetorum	-	-	-	0.6	0.1	-	0.1
Mus musculus	0.2	1.0	-	0.1	-	-	-
Zapus hudsonius	-	-	*	*	-	0.1	-
Total Captures/100 TN	5.6	22.7	10.2	7.4	2.6	2.8	3.4
		±4.5[b]	±1.0	±1.0	±0.6	±0.3	±0.6
S (480 TN)	6.0	4.0	3.5	4.8	2.3	2.5	2.7
		±0.58	±0.50	±0.25	±0.48	±0.50	±0.33
H′ (480 TN)	1.52	1.45	1.27	1.38	0.60	0.59	0.78
		±0.08	±0.25	±0.23	±0.26	±0.23	±0.14

[a]Species captured in pitfall traps but not in snap traps.
[b]One standard error of the mean.

Table 3. Abundance of important breeding bird species (number of individuals observed per ha), total abundance (all breeding species), species richness (S), and species diversity (H') during late April-June in selected habitats on surface-mined land in the Bankston Fork watershed, 1975. Nomenclature according to American Ornithologists' Union, Committee on Classification and Nomenclature (1982).

Species	Reed Marsh	Fescue Grassland	Old Field	Woodland Edge	Pine Woodland	Locust Woodland	Other Woodland
Colinus virginianus	*[a]	0.1	0.9	0.1	*	0.4	0.1
Zenaida macroura	*	0.3	*	0.4	0.2	*	0.1
Picoides pubescens	-	*	*	0.6	0.1	0.2	0.3
Stelgidopteryx serripennis	1.3	0.6	-	*	-	-	0.1
Cyanocitta cristata	-	*	*	0.2	0.5	0.4	0.6
Parus carolinensis	0.4	-	0.1	1.5	1.1	1.1	0.3
Thryothorus ludovicianus	*	*	0.1	0.6	0.2	*	0.2
Polioptila caerulea	-	*	-	0.6	0.2	0.2	0.1
Dumetella carolinensis	*	-	-	0.3	*	*	0.1
Toxostoma rufum	-	0.1	-	0.3	-	-	0.1
Vireo griseus	*	-	-	*	0.2	*	0.2
Dendroica discolor	-	*	1.0	*	-	-	*
Icteria virens	-	-	*	0.6	*	*	0.1
Cardinalis cardinalis	0.9	*	0.1	2.4	1.6	1.9	1.1
Passerina cyanea	0.4	0.6	*	2.6	1.1	0.6	1.1
Spiza americana	-	1.6	-	-	-	-	-
Pipilo erythrophthalmus	*	*	0.1	1.3	1.1	1.1	0.5

Spizella pusilla	*	0.3	2.2	1.1	0.4	-	0.4
Ammodramus savannarum	-	1.1	-	-	-	-	-
Melospiza melodia	1.7	*	0.1	*	0.8	-	-
Agelaius phoeniceus	9.9	2.7	0.1	0.3	-	-	*
Sturnella magna	-	0.2	0.4	-	-	-	-
Quiscalus quiscula	*	*	-	0.4	*	*	0.3
Molothrus ater	1.3	0.1	0.3	2.8	0.9	0.9	1.5
Carduelis tristis	-	*	0.3	0.2	0.1	0.4	0.2
Total Abundance (number/ha)	17.2	8.4	6.2	17.3	9.3	8.6	8.5
		± 3.3[b]	± 0.1	± 2.2	± 3.8	± 3.0	± 1.4
S (5 transect runs)[c]	9.0	7.3	7.0	11.8	8.8	8.5	8.7
		± 0.88	± 1.00	± 0.95	± 1.89	± 2.50	± 1.23
H′ (5 transect runs)	2.18	2.31	2.34	3.15	2.81	2.77	2.80
		± 0.30	± 0.22	± 0.14	± 0.28	± 0.48	± 0.24

[a]Species observed in indicated habitat but not during a late April-June census.
[b]One standard error of the mean.
[c]Each transect run covered 0.70 ha in fescue pasture and old field and 0.46 ha in each other habitat.