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Non-Game Bird habitat Associated With Haul Roads and Surface Mining for Bentonite Clay

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NON-GAME BIRD HABITAT ASSOCIATED WITH
HAUL ROADS AND SURFACE MINING FOR
BENTONITE CLAY

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Advisor

Thesis Advisor

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NON-GAME BIRD HABITAT ASSOCIATED WITH HAUL ROADS AND SURFACE MINING FOR BENTONITE CLAY

Abstract

Tim A. Schaid

A 2 year study was conducted to investigate possible differences in density and diversity of birds in relation to distance from mining haul roads and various aged mine spoils. Winter bird surveys and breeding bird counts were conducted during 1977 and 1978. Bird density and diversity were estimated and compared between the following habitat areas: old spoils (mined $\geq$20 years ago, unreclaimed), new spoils (mined $\leq$20 years ago, reclaimed) and unmined areas. Within unmined areas density and diversity of birds 100m, 300m, 500m, and 900m from a mining haul road were compared to detect differences in density and diversity with distance from the haul road. Density of common bird species within mined and unmined areas was compared. Forward stepwise multiple regression was used to identify groups of physical and/or vegetation variables that accounted for variation in bird density and diversity indices. Management suggestions for reclamation of strip mined areas are given.

Horned larks (*Eremophila alpestres*) was the only species observed during the 1977 winter survey within the old spoils, new spoils and unmined areas. Highest horned lark density occurred in new spoils. Horned larks, common redpolls (*Acanthis flammea*) and snow buntings (*Plectrophenax nivalis*) were observed during the 1978 winter survey.

All 3 species were observed in new spoils and snow buntings were the most abundent. Horned larks and common redpolls were observed in old spoils with common redpolls most abundent. Snow buntings and horned larks were observed in unmined areas. Snow buntings were the most common species in unmined areas.

Breeding bird counts indicated that the highest bird diversity occurred on reclaimed mine spoils both years. The highest bird density occurred on reclaimed areas in 1977. Bird densities in unmined areas and reclaimed spoils were similar in 1978. The lowest bird density and diversity consistently occurred in the old unreclaimed mine spoils. Vesper sparrows (Pooecetes graminius) were the most common bird species in unmined areas but were less numerous in reclaimed areas because of the absence of shrub cover.

Orthogonal T-tests were used to test for differences in bird density and diversity at 100m, 300m, 500m, and 900m intervals from a mining haul road. Differences in bird diversity were not significant at the 10% level except in 1978 between the 900m interval and the pooled 100m, 300m, and 500m intervals. Bird density increased with distance from the haul road in 1978 but not in 1977. Horned larks and brewer's sparrows (Spizella breweri) showed significant ($p \leq .10$) increases in density with distance from the haul road.

Reclamation of stripmined land resulted in bird densities similar to bird densities in unmined areas. Diversity in reclaimed areas was higher than in unmined areas. Vesper and brewer's sparrows were uncommon on reclaimed land because of the absence of shrubs. Birds did not appear to be affected by presence of mining haul roads with the exception of horned larks and brewer's sparrows.

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INTRODUCTION

Our country faces the dilemma of increased mining of fuel and mineral resources while preserving and restoring our environment. An important facet of planning mining operations is re-establishment of wildlife habitat. To be effective, restoration of wildlife habitat should be based upon definitive plant ecology-environmental studies (Copeland 1973). Strip mining for bentonite clay is occurring and is projected to continue in western South Dakota and eastern Wyoming and southeastern Montana. Numerous miles of haul roads exist and many more are being constructed. Although aesthetic damage resulting from strip mining is often obvious (Detwyler 1967) little quantitative information exists on the impacts of mining on fish and wildlife populations, specifically the avifauna (Karr 1968, Copeland and Packer 1972, Terrel and French 1975, Yahner et al. 1975, Whitmore and Hall 1978). Haul roads are used by heavy vehicles to carry mined material from the field to the processing plant. Little is known about the effect of mining haul roads on wildlife populations. Mining roads in Idaho damaged winter feeding ranges of mountain goats (Copeland 1973). No studies were found dealing with effects of mining haul roads on avian populations within the Northern Great Plains.

The objectives of this study were: (1) to determine species of non-game birds nesting and wintering on various aged bentonite spoils; (2) to compare density and diversity of nesting and wintering birds on areas with haul roads and various-aged spoils to areas with no mining; (3) to evaluate variables associated with spoils and haul roads that contribute to differences in density and diversity of birds; and (4) to develop guidelines for mine spoils and haul roads in relation to avian density and diversity.

STUDY AREA

Numerous bentonite mine pits and spoils extend from Belle Fourche, S.D., in a northwesterly direction through Wyoming toward Alzada, Montana. The study area, between and parallel to U.S. highway 212 and the Belle Fourche River, extends northwest from Belle Fourche, S.D. to Colony, Wyoming. A haul road extends the length of the study area.

Soils are classified as a Grummit-shale land association with slopes gentle to moderately steep (Johnson 1976). Steeper slopes are found in drainage ways and eroded areas along the Belle Fourche River. Soils are acidic with low to moderate fertility (Johnson 1976). Belle Fourche is 966m above sea level.

Climate is continental with cold winters and hot summers. Average annual precipitation is 39cm and snowfall averages 53cm per year. Wind, usually from the northwest, averages 18k per hour. Average annual maximum temperature is 14C; average annual minimum temperature is 0C (Johnson 1976). Only 16cm of precipitation occurred from April-July, 1977, 2.95cm below normal (Climatological Data 1977). Growing conditions improved in 1978 with 29cm of precipitation from April-July, 2.15cm above normal (Climatological Data 1978).

The study area was in the mixed grass prairie association (Johnson and Nichols 1970), with mining and ranching (cattle and sheep) the major land uses. Prevalent grasses in the study area were western wheatgrass (*Agropyron smithii*), prairie junegrass (*Koelaria cristata*), buffalo grass (*Buchloe dactyloides*) and blue gramma (*Bouteloua gracilis*). Introduced species such as bluegrass (*Poa* spp.) and brome grass (*Bromus* spp.) were widespread throughout the study area. Prevalent forbs were wild onion (*Allium* sp.), sunflowers (*Helianthus* sp.), curlycup gumweed (*Grindelia squarrosa*), yellow sweetclover (*Melilotus officinalis*) and western yarrow (*Achillea millefolium*). The principle shrub was big sagebrush (*Artemesia tridentata*). Less common shrubs were saltbrush (*Atriplex* sp.), rubber rabbitbrush (*Chrysothamnus nauseosus*), and broom snakeweed (*Gutierrezia sarothrae*). Cottonwood (*Populus* sp.) and ponderosa pine (*Pinus ponderosa*) were common along the Belle Fourche River. Burr Oak (*Quercus macrocarpa*) occurred on Snomo soils (Johnson 1976) and drainage ways. Sedges (*Carex* spp.) and cattails (*Typha* spp.) were common in ponds and wet areas.

METHODS AND MATERIALS

Selection of Study Plots

Aerial photos were used to locate haul roads and stratify the study area according to plant communities and mining sites. Land owners and mining personnel assisted in identifying age of the mine spoils.

Mining sites and haul roads were not considered to be random within the study area and study plots were not selected randomly. The study area was divided into three habitat categories; unmined, old spoils and new spoils. Each category was located by the same mining haul road to equalize traffic levels. All categories were restricted to grass-sagebrush habitat since mining occurred there most often. Categories were divided into as many study plots of equal size (200m x 200m) as space allowed. All study plots were parallel and 300m from the mining haul road except in the unmined category. Unmined plots were located 100m, 300m and 500m from the mining haul road. Plots 900m from the haul road were added in 1978.

Study Plots

Unmined areas were defined for the purpose of this study as land on which mining had not occurred. Fourteen plots were located at each interval from the haul road. Thirty unmined plots were located in Crook County Wy. near Colony (T56N R61E Sec. 10,15). Twelve unmined plots were located in Butte County, S.D. (T9N R2E Sec. 30). Fourteen plots 900m from the haul road were in Butte County, S.D. (T9N R1E

Sec. 14,24,30).

Oil spoils were land on which strip mining for bentonite clay occurred 20 or more years ago and were not revegetated. Bare ground, steep slopes, mine pits and spoil piles were common. Twenty old spoil plots were located in Butte County, S.D. (T9N R1E Sec. 14,15,23).

New spoils were defined as land on which mining for bentonite clay was completed 3 to 20 years ago and reclamation procedures completed. Spoil banks were rounded and a mixture of wheatgrass and green needlegrass (Stipa viridula) planted. Sixteen new spoil plots were located in Crook County, Wy. (T56N R61E Sec. 25,26,36).

Vegetation Measurements

Vegetation was measured using a series of randomly located .04ha circles as described by James and Shugart (1970). Five .04ha circles, each with 20 sample points, were used for each plot (100pts/plot). Sample points were located along 2 perpendicular north-south and east-west axes (10pts/axis). Sample points were located, with every other step, by a mark on the observers shoe. The observer walked each axis from the center to the outside of the circle.

A steel rod (1m x 6.3mm) sharpened to a point and marked into 10cm divisions (Weins 1969) replaced the ocular tube described by James and Shugart (1970). The rod was lowered vertically into the vegetation at each sample point. Points where vegetation contacted the rod were measured and recorded. Percent frequency of ground cover and plant species occurrence was calculated using vegetation touching the rod at the highest point.

$$\%\ \text{frequency of occurrence} = \frac{\#\ \text{of hits}}{\#\ \text{of possible hits}} \times 100$$

Average height of vegetation was calculated using height measurements of all plants encountered. Plant species diversity was calculated using the Shannon-Weaver formula (Shannon and Weaver 1963).

Visual obstruction readings (VOR) were recorded using the Robel Pole (Robel et al. 1970). The pole was placed at the center of each .04ha circle and readings were made from the north, south, east and west. A mean VOR was calculated for each plot based on 20 readings.

Presence of water was recorded as mean surface area (m^2). Surface area was visually estimated in 1977 and an open-sight alidade plane table (Lind 1974) were used in 1978.

Winter Bird Survey

A transect method (Emlen 1971) was used to survey birds during the first week of January 1977 and 1978. Transects were walked throughout daylight hours except when the wind was greater than 25 Km per hour.

Temporary plots, 400m x 200m and perpendicular to the haul road, were used in 1977 within unmined areas, old spoils and new spoils. Two transects were located in unmined areas, 3 in old spoils and 4 in new spoils. Birds were counted 4 times on each transect.

Permanent plots parallel and 300m from the haul road were used for the 1978 winter survey. Twenty old spoil transects and 16 new spoil transects were walked 6 times; 14 unmined area transects were walked 4 times.

Breeding Bird Counts

The Emlen (1971) transect method was used to estimate bird densities from 24 May-17 July 1977 and 1978 on permanent plots. Most counts were repeated 12 times in 1977 and 16 times in 1978. Variation in replication of transects occurred both years. Because of this variation estimates were standardized by expressing densities as birds per 4 ha (plot size). Densities on tables were expressed as birds per 40 ha.

Counts were made in the morning between 06:00-09:00. Bird counts were not made when wind was more than 25 km per hour, or on rainy days. Total counts for each habitat category were used to estimate red-winged blackbirds, yellowheaded blackbirds, killdeers, upland sandpipers and water birds (scientific names of birds in appendix). These birds were concentrated around wet areas and/or were so conspicuous that a total count provided the best estimate of their numbers.

Diversity estimates were used to evaluate the variety of birds present within each habitat category. Diversity was calculated using the Shannon-Weaver formula (Shannon and Weaver 1963) as modified by Poole (1974).

Evaluation of Mining Influences on Avifauna

Influences of strip mining were determined by evaluating the following: (1) number of bird species present in unmined areas, old spoils and new spoils; (2) population density and bird species diversity of unmined areas, old spoils and new spoils; (3) differences in density of common species found in unmined areas, old spoils and new spoils. Common species are birds which occurred on 50% of the plots within a habitat category.

Evaluation of Mining Haul Road Influences

Influences of mining haul roadsswere determined by evaluating the following: (1) number of bird species present on unmined plots 100m, 300m, 500m, and 900m from the haul road; (2) bird species diversity and population density of birds on unmined plots 100m, 300m, 500m, and 900m from the haul road; and (3) differences in average density of common bird species at increasing intervals from the haul road. Orthogonal T-tests were used to test for significant statistical differences ($p \leq .10$) in density and diversity of birds.

Multiple Regression Analysis

Multiple stepwise forward regression analysis (Nie et al. 1975) was used to determine correlations between independent variables (Table 1) of 3 habitat categories (300m unmined areas, old spoils, new spoils) and the following dependent variables measured during the breeding season: standardized population density, bird species diversity and average density of common bird species ($\geq$50% frequency of occurrence). A set of independet variables was then selected by the program which explained the most variation in the dependent variable.

Percent frequency of common plants ($\geq$50% frequency of occurrence) was used as an independent variable in regression analysis of bird density and bird diversity. Common plants were used in multiple regression analysis of common bird species if the bird being analyzed occurred in conjunction with the plant on at least 50% of the plots. The 50% frequency of occurrence level was chosen to help avoid inadvertent correlations with infrequently occurring plants.

Multiple regression in the unmined category was performed only with plots 300m from the haul road to facilitate comparisons with old and new spoils which were also 300m from the haul road.

Table 1. Independent variables used in multiple stepwise forward regression analysis.

Variable
Mean surface area of water (m^2)
Ground cover % [1]
Unvegetated area %
Persistent litter cover % (capable of lasting more than 1 year)
Nonpersistent litter cover % (lasting one year or less)
Litter cover % (persistent + nonpersistent)
Forb cover %
Shrub cover %
Warm season grass %
Cool season grass %
Grass cover % (warm season + cool season)
Average height of vegitation (cm)
Visual obstruction reading (index)
Plant species diversity
Japanese brome % (*Bromus japonicus*)
Downy brome % (*Bromus tectorum*)
Buffalo grass % (*Buchloe dactyloides*)
Prairie sandreed % (*Calamovilfa longifolia*)
Rubber rabbitbrush % (*Chrysothamnus nauseosus*)
Foxtail barley % (*Hordeum jubatum*)
Prairie junegrass % (*Koeleria cristata*)

Table 1. continued

Variable
Bluegrass % (*Poa* spp.)
Blue gramma % (*Bouteloua gracilis*)
Green bristlegrass % (*Setaria* spp.)
Green needlegrass % (*Stipa viridula*)
American vetch % (*Vicia americana*)
Big sagebrush % (*Artemisia tridentata*)
Saltbush % (*Atriplex* spp.)
Agropyron spp. %
Cattails % (*Typha* spp.)
Carex spp. %
Kochia spp. %
Yellow sweetclover % (*Melilotus* spp.)
Moss-lichen %
Prickly pear % (*Opuntia* spp.)
Spiny indianwheat % (*Plantago spinulosa*)

$$\% = \frac{\text{hits}}{\text{100pts}} \times 100$$

Coefficients of determination and regression coefficients were calculated (Nie et al. 1975). Regression coefficients should be interpreted with caution because of intercorrelations between variables. Conclusions about importance of independent variables to a dependent variable were made based on the first 2 or 3 variables to enter the regression equation. When only part of the variables significant at a given level are used, the significance level given is that for the entire group of variables. The entire equation must be used if the equation is used for predicting bird density and diversity.

RESULTS AND DISCUSSION

Winter Survey

Statistical analysis was not performed on winter surveys because of an inadequate number of observations. Horned lark was the only species observed in 1977 within the old spoils, new spoils and unmined categories. The highest horned lark density (Table 2) occurred in new spoils where flocks of over 100 birds were observed.

Three species of birds were observed during the 1978 winter survey. Horned larks and common redpolls were observed in old spoils with common redpoll most abundant (Table 2). Horned larks, snow buntings and common redpolls were observed in new spoils and snow buntings were the most prevalent species. Snow buntings and horned larks were observed in unmined areas. Snow bunting was the most common species (Table 2).

Summer Survey

Vegetation measurements: Ground coverage in old spoils was 14% both years while unvegetated area ranged between 79% in 1977 and 81% in 1978 (Table 3). Field observations indicated that ground cover was predominantly located between mine spoils and in areas where topsoil was undisturbed by mining. Sagebrush was only found in undisturbed areas and accounted for 66% (1977) of the total shrub cover.

Forbs and grasses were the most common ground cover in old spoils. Grasses were found on undisturbed areas and rarely disturbed soil (within recent years some areas have been revegetated with crested wheatgrass (*Agropyron cristatum*)). Barnyardgrass (*Enchinochloa crusgalli*) was observed on mined areas where other grasses were not

Table 2. Density of birds and frequency of plots on which birds occurred during winter surveys, 1977 and 1978.

Species	Old Spoils			New Spoils			Unmined		
	$\bar{Y}$[1]	SD[2]	F[3]	$\bar{Y}$	SD	F	$\bar{Y}$	SD	F
					1977				
Horned Lark	15	17	3/3	33	22	4/4	18	25	1/2
					1978				
Horned Lark	1	3	2/20	.2	1	1/16	2	8	1/14
Common Redpoll	18	5	3/20	.2	1	1/16	--	--	--
Snow Bunting	--	--	--	28	11	1/16	13	13	1/14

1 mean bird density/40ha

2 standard deviation

3 frequency = $\frac{\text{plots on which bird occurred}}{\text{total plots}}$

Table 3. Selected mean habitat values measured in June and July on 20 transects in old spoils, 1977-78.

Variable	1977		1978	
	$\bar{Y}$[1]	SD[2]	$\bar{Y}$	SD
Size of water (m^2)	3602	3984	1792	4341
% Ground cover	14	12	14	10
% Unvegetated area	79	19	81	11
% Persistent litter cover	tr[3]	1	tr	tr
% Nonpersistent litter	5	5	3	2
% Litter cover (persistent + nonpersistent)	6	6	3	2
% Forb cover	3	3	8	6
% Shrub cover	3	5	2	3
% Cool season grass	4	6	4	6
% Warm season grass	2	4	1	3
% Grass cover (cool + warm season)	7	10	5	7
Visual obstruction reading	0	0	tr	tr
Plant species diversity	.5	.3	.6	.4

Table 3. cont.

Variable	1977		1978	
	$\bar{Y}$	SD	$\bar{Y}$	SD
Average height of vegetation (cm)	10	7	8	3
% Agropyron spp.	2	3	2	2
% *Artemisia tridentata*	2	4	1	2
% Kochia sp.	2	2	4	5
% *Atriplex* spp.	tr	1	1	2

1 mean

2 standard deviation

3 0<tr<.5

growing. Coolseason grasses made up 84% of the grass cover. Agropyron spp. was the most common grass accounting for 30% of the total grass cover. Forbs, especially Kochia sp., grew throughout the old spoils when remnants of topsoil were present. Many pits with water existed within the old spoil area. Some were devoid of vegetation while others contained cattails and sedges. Forb cover increased in 1978 (Table 3). A reduction in standard deviation of most vegetation measurements indicated less variability in the distribution of vegetation in 1978.

Birds: Twenty-one species of birds were observed in old spoils in 1977 and 20 in 1978 (Table 4). Species diversity was 13 both years. Average bird density increased from 35 to 52 birds/40ha in 1978. Killdeers, horned larks, mourning doves and red-winged blackbirds showed the greatest increases in 1978.

The most common birds observed in old spoils were vesper sparrows, red-winged blackbirds, western meadowlarks, mourning doves and killdeers. Vesper sparrows were observed exclusively in sagebrush areas. Meadowlarks were observed in sage-grassland areas but often used exposed mine spoils and boulders for singing perches. Red-winged blackbirds nested in stands of cattails. Mourning doves nested in sagebrush and on the side of nearly bare mine spoils. Mallards and American wigeons were the most common species of waterfowl (Table 4). Waterfowl were observed on bodies of water surrounded by cattails and sedges.

Increases in bird density in 1978 were related to improved water

Table 4. Bird density and frequency of plots on which birds occurred within old spoils during the 1977 and 1978 breeding season.

Common bird species	1977			1978		
	$\bar{Y}$[1]	SD[2]	F[3]	Y	SD	F
Eared Grebe	--	--	--	.01	.04	1/20
Mallard	.11	.28	5/20	.03	.06	5/20
Pintail	.03	.13	1/20	--	--	--
Gadwall	.02	.07	1/20	--	--	--
American Wigeon	.12	.32	3/20	.02	.05	4/20
American Shoveler	--	--	--	.02	.05	3/20
Blue-winged Teal	.04	.20	1/20	.02	.06	2/20
American Kestrel	.02	.06	2/20	.01	.02	1/20
Killdeer	.38	.18	20/20	.79	.47	20/20
American Coot	--	--	--	.02	.07	1/20
Spotted Sandpiper	.02	.09	1/20	.01	.02	1/20
Wilson's Phalarope	.02	.07	1/20	--	--	--

Table 4. cont.

Common bird species	1977			1978		
	$\bar{Y}$	SD	F*	$\bar{Y}$	SD	F
Mourning Dove	.36	.67	8/20	1.50	5.84	11/20
Common Nighthawk	.08	.19	3/20	.08	.25	2/20
American Kingfisher	.01	.05	1/20	--	--	--
Common Flicker	.02	.11	1/20	.02	.09	1/20
Horned Lark	.15	.26	7/20	.36	.35	15/20
Rough-winged Swallow	.02	.11	1/20	--	--	--
Mountain Blue Bird	--	--	--	.04	.18	1/20
Western Meadowlark	.42	.40	14/20	.24	.18	1/20
Yellow-headed Blackbird	.02	.07	1/20	.02	.07	1/20
Red-winged Blackbird	.32	.26	17/20	1.01	1.15	18/20
Brewer's Blackbird	.48	.79	8/20	.21	.44	6/20
Lark Bunting	.04	.09	4/20	.04	.16	1/20
Vesper Sparrow	.52	.64	11/20	.42	.69	14/20

Table 4. cont.

Common bird species	1977			1978		
	$\bar{Y}$	SD	F	$\bar{Y}$	SD	F
Average Bird Density	35.00	19.00		52.00	71.00	
Bird Diversity	13.00	4.30		13.00	3.50	
Total Species	21			20		

1 mean density/40ha

2 standard deviation

3 frequency = $\frac{\text{plots on which bird occurred}}{\text{total plots}}$

conditions and less variability of vegetation in areas with ground cover. It appeared to field observers that vegetation in moist areas was more abundant and taller in 1978 than 1977. Large flocks of mourning doves observed in 1978 but not in 1977 contributed to the increased bird density in 1978. The flocks ($\geq$50) were on 1 transect relatively untouched by mining with a sage-grassland ground cover.

Regression: Height of vegetation and surface area of water accounted for 63% ($p \leq .05$) of the variation in bird density in 1977 (Table 5). Height of vegetation had a positive influence. Regression analysis in 1978 (Table 5) indicated that grass cover and visual obstruction readings accounted for 56% ($p \leq .10$) of the variation in bird density. The importance of water and grass cover was supported by field observations. Mourning doves, meadowlarks and vesper sparrows were common in grass-sagebrush areas. Red-winged blackbirds and waterfowl were observed on or near water impoundments.

Variation in bird diversity was not explained at the 10% significance level in 1977. Plant species diversity and average height of vegetation accounted for 45% ($p \leq .05$) of the variation in bird diversity in 1978 (Table 5). Height of vegetation had a negative influence.

Significant ($p \leq .10$) variation in density of killdeers, horned larks and western meadowlarks was not explained in 1977 or 1978. Average height of vegetation and plant species diversity were both important to red-winged blackbirds in 1977 (Table 6) explaining 49% of the variation ($p \leq .01$). Field observations indicated that red-winged

Table 5. Results of forward stepwise multiple regression analysis of bird density and diversity associated with old spoils during the breeding season (N=20).

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
	Bird Density 1977		
Average height of vegetation (cm)	0.293	0.457	
Surface area of water (m^2)	-0.000[1]	0.630	$p \leq .05$
Y intercept	1.301		
	Bird Density 1978		
% grass cover	0.438	0.429	
Visual obstruction reading	13.589	0.555	$p \leq .10$
Y intercept	1.071		
	Bird Diversity 1978		
Plant species diversity	0.850	0.134	
Average height of vegetation (cm)	-0.088	0.453	$p \leq .05$
% litter cover	0.010	0.487	

Table 5. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)
% Grass cover	0.136	0.520
% Shrub cover	0.160	0.561
% *Atriplex* spp.	-0.044	0.585
% Forb cover	0.131	0.591
% Ground cover	-0.140	0.720 $p \leq .10$
Y intercept	1.491	

1 actual value = -0.0003

blackbirds were attracted to moist areas supporting cattails and sedges. No variation was explained at the 10% significance level in 1978.

The most important variable to vesper sparrows was big sagebrush. Multiple regression in 1977 with or without plant species (Table 6) as independent variables indicated the importance of big sagebrush. With plant species included big sagebrush accounted for 57% ($p \leq .05$) of the variation in vesper sparrow density. Sagebrush accounted for 66% of the total shrub cover in 1977 and 50% in 1978. During the 1978 breeding season, sagebrush accounted for 85% ($p \leq .05$) of the variation in vesper sparrow density (Table 7).

Mourning doves were common in grass-sagebrush areas but also were observed on the side of mine spoils with little vegetation. Grass cover and visual obstruction readings explained 51% ($p \leq .10$) of the variation in mourning dove density in 1978 (Table 7). Both had positive regression coefficients.

New Spoils

Habitat measurements: New spoils had 34% ground cover in 1977 and 42% in 1978 (Table 8). Forb cover was 13% both years with *Kochia* sp. and sweetclover the most common forbs. Grass cover increased from 31% in 1977 to 34% in 1978. Coolseason grasses made up 86% of the total grass cover in 1977 and 97% in 1978. *Agropyron* spp. was the most common grass and accounted for 38% of the grass cover in 1977 and 29% in 1978. No shrub species existed within new spoils. Average height of vegetation and plant species diversity remained the same both years.

Birds: Twenty-four species of birds were observed on new spoil plots

Table 6. Results of forward stepwise multiple regression analysis of common bird species associated with old spoils during the 1977 breeding season (N=20).

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
	Red-winged Blackbird		
Average height of vegetation (cm)	0.023	0.198	
Plant species diversity	-0.742	0.494	$p \leq .01$
% Shrub cover	0.020	0.591	$p \leq .10$
Y intercept	0.397		
	Vesper Sparrow		
% Big Sagebrush	0.096	0.568	
Plant species diversity	0.949	0.693	$p \leq .05$
Y intercept	-0.179		
	Vesper Sparrow (without plant species)		
% shrub cover	0.323	0.455	

Table 6. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)
Plant species diversity	0.610	0.541
% Nonpersistent litter cover	-0.047	0.569
% Unvegetated area	-0.039	0.627
% Ground cover	0.467	0.638
% Warm season grasses	0.572	0.650
Average height of vegetation (cm)	0.220	0.673
Surface area of water (m^2)	-0.000[1]	0.733
% Forb cover	0.412	0.745
% Cool season grass	0.418	0.827 $p \leq .10$
Y intercept	2.938	

1 actual value = 0.0001

Table 7. Results of forward stepwise multiple regression analysis of common bird species associated with old spoils during the 1978 breeding season (N=20).

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
	Mourning Dove		
% Grass cover	0.325	0.379	
Visual obstruction reading	11.320	0.510	$p \leq .10$
Y intercept	-1.690		
	Vesper Sparrow		
% Big sagebrush	0.269	0.852	
% *Atriplex* spp.	-0.067	0.873	
% *Poa* spp.	0.087	0.884	
% *Agropyron* spp.	-0.093	0.927	$p \leq .05$
Y intercept	0.278		

(Table 9). Bird diversity increased from 15 to 18 in 1978 indicating the 24 species were represented by a more equal proportion of birds in 1978. The birds observed most often in new spoils were killdeers, mourning doves, horned larks, western meadowlarks and red-winged blackbirds. Bird density increased from 60 to 86 birds/40ha in 1978. Killdeers, mourning doves and red-winged blackbirds accounted for most of the increase. Mallards and blue-winged teal were the most common waterfowl.

Regression: In 1977, litter cover, forb cover, warm season grasses and height of vegetation accounted for 63% ($p \leq .10$) of the variation in bird density (Table 10). Results of multiple regression in 1978 (Table 10) showed that visual obstruction readings, *Kochia* sp. and litter cover accounted for 44% of the variation in bird density ($p \leq .01$). In the field, meadowlarks and mourning doves were numerous in densely vegetated areas while horned larks were usually observed in sparsely vegetated areas. Similar observations are documented in Bent (1964) and Bent (1965).

Multiple regression using bird diversity as an independent variable failed to explain variation at the 10% significance level in 1977 or 1978. I feel that the presence of water and the associated vegetation, especially cattails is important to bird diversity. Without such areas red-winged blackbirds, yellow-headed blackbirds and waterfowl would be reduced or eliminated.

Japanese brome explained 68% ($p \leq .05$) of the variation in kill-

Table 8. Selected mean habitat values measured in June and July on 16 transects in new spoils, 1977-78.

Variable	1977		1978	
	$\bar{Y}$[1]	SD[2]	$\bar{Y}$	SD
Surface area of water (m^2)	6016	8775	1042	1880
% Ground cover	34	16	42	24
% Unvegetated area	47	18	49	24
% Persistent litter	1	1	0	0
% Nonpersistent litter	13	7	3	2
% Litter cover (persistent + nonpersistent)	14	6	3	2
% Forb cover	13	8	13	9
% Shrub cover	0	0	0	0
% Cool season grass	18	11	33	19
% Warm season grass	3	4	2	3
% Grass cover (cool + warm season)	21	10	34	22
Visual obstruction reading	tr[3]	tr	tr	tr

Table 8. cont.

Variable	1977		1978	
	$\bar{Y}$	SD	$\bar{Y}$	SD
Plant species diversity	.7	.2	.7	.2
Average height of vegetation (cm)	14	6	14	4
% *Agropyron* spp.	8	8	10	9
% *Melilotus officinalis*	7	6	6	6

1 mean

2 standard deviation

3 0<tr<.5

Table 9. Bird density and frequency of plots on which birds occurred within new spoils during the 1977 and 1978 breeding season.

Common bird species	1977			1978		
	$\bar{Y}^1$	SD[2]	F[3]	$\bar{Y}$	SD	F
Mallard	.23	.51	6/16	.11	.24	5/16
Pintail	.02	.05	1/16	.01	.02	1/16
Gadwall	.06	.09	5/16	.01	.02	1/16
American Wigeon	.08	.15	4/16	.04	.09	3/16
American Shoveler	.01	.05	1/16	.01	.05	1/16
Blue-winged Teal	.11	.22	4/16	.15	.34	5/16
American Kestrel	--	--	--	.01	.05	1/16
Great Blue Heron	.02	.05	1/16	--	--	--
Killdeer	.29	.16	15/16	1.14	.71	16/16
American Coot	.01	.02	1/16	--	--	--
Upland Sandpiper	--	--	--	.10	.24	4/16
Spotted Sandpiper	.02	.04	4/16	.19	.37	6/16

Table 9. cont.

Common bird species	1977			1978		
	$\bar{Y}$	SD	F	$\bar{Y}$	SD	F
Wilson's Phalarope	.04	.08	5/16	.06	.07	7/16
Mourning Dove	.68	.95	12/16	.83	.63	14/16
Common Nighthawk	--	--	--	.08	.30	1/16
American Kingfisher	.01	.02	1/16	--	--	--
Common Flicker	.01	.05	1/16	.06	.14	3/16
Horned Lark	1.39	1.67	15/16	1.36	.96	15/16
Rough-winged Swallow	.01	.02	2/16	--	--	--
American Robin	.03	.09	2/16	.02	.08	1/16
Western Meadowlark	1.26	.59	16/16	1.32	.66	16/16
Yellow-headed Blackbird	.03	.07	3/16	.02	.10	1/16
Red-winged Blackbird	.23	.19	15/16	1.64	2.26	16/16
Brewer's Blackbird	.34	.74	5/16	.81	.76	12/16
Cowbird	.11	.27	4/16	--	--	--

Table 9. cont.

Common bird species	1977			1978		
	$\bar{Y}$	SD	F	$\bar{Y}$	SD	F
Grasshopper Sparrow	--	--	--	.05	.14	2/16
Lark Bunting	--	--	--	.05	.14	2/16
Vesper Sparrow	.47	.00	8/16	.28	.25	11/16
Lark Sparrow	.06	.25	1/16	--	--	--
Brewer's Sparrow	--	--	--	.01	.05	1/16
Average Bird Density	60.00	39.00		86.00	33.00	
Bird Diversity	15.00	3.70		18.00	2.40	
Total Species	24			24		

1 mean density/40ha

2 standard deviation

3 frequency = $\frac{\text{number of plots on which bird occurred}}{\text{total plots}}$

Table 10. Results of forward stepwise multiple regression analysis of bird density associated with new spoils during the breeding season (N=16).

Independent variable	Regression coefficient	Coefficient of determination (R^2)
	Bird Density 1977	
% Litter cover	-0.335	0.218
% Forb cover	-0.811	0.415
% Warm season grass	0.728	0.538
Average height of vegetation (cm)	-0.389	0.631
% *Agropyron* spp.	-0.652	0.701
Surface area of water (m^2)	0.000[1]	0.718
% Yellow sweetclover	0.683	0.753
% Japanese brome	-1.216	0.791
% Cool season grass	0.561	0.810
% Buffalo grass	-0.305	0.931 $p \leq .10$
Y intercept	17.448	

Table 10. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)
	Bird Density 1978	
Visual obstruction reading	19.357	0.267
% *Kochia* sp.	1.209	0.352
% Litter cover	0.744	0.439
Plant species diversity	29.500	0.548
% Ground cover	-2.580	0.580
% Cool season grass	1.786	0.660
Average height of vegetation (cm)	0.107	0.714
% Warm season grass	1.839	0.764
% Yellow sweetclover	0.836	0.836
% Unvegetated area	-0.231	0.880
% Japanese brome	0.703	0.971
% *Agropyron* spp.	0.306	0.994 $p \leq .01$

Table 10. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)
Surface area of water (m^2)	-0.000[2]	1.000 $p \le .05$
Y intercept	19.751	

1 actual value = 0.0001

2 actual value = -0.0002

deer density in 1977 (Table 11). Surface area of water, height of vegetation and ground cover accounted for 66% ($p \leq .05$) of the variation of killdeer density in 1978 (Table 12). Killdeers in the field were usually observed on sparsely vegetated areas with both forbs and grasses. Similar observations are reported in Bent (1962). Vegetation measurements did not explain variation in mourning dove density at the 10% level in 1977. Visual obstruction readings and foxtail barley explained 46% ($p \leq .10$) of the variation in 1978 (Table 12), visual obstruction reading entered the equation first. Foxtail barley entered the equation with a negative regression coefficient indicating a negative influence on mourning doves. This influence was not obvious in the field. Mourning doves were not observed in foxtail barley but were observed on banks of ponds with foxtail barley nearby.

No variation in horned lark density was explained at the 10% significance level. Horned larks were common on sparsely vegetated areas within new spoils. Forty-five percent of variation in horned lark density was explained ($p \leq .10$) when plant species were eliminated from the regression (Table 11). Forb cover entered first with a negative coefficient. Field observations agree with results that horned larks selected lightly vegetated areas. Meadowlarks were observed in grassy areas. Multiple regression analysis supported field observations. Warm season grasses explained 32% ($p \leq .01$) of the variation in meadowlark density in 1977 (Table 11). Green needlegrass, _Setaria_ spp., _Agropyron_ spp. and warm season grasses explained 73% ($p \leq .01$) of

Table 11. Results of forward stepwise multiple regression analysis of common bird species associated with new spoils during the 1977 breeding season (N=16).

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
Killdeer			
% Japanese brome	-0.045	0.682	
% Forb cover	0.017	0.766	
% *Agropyron* spp.	-0.009	0.792	
% Cool season grass	0.024	0.842	
% Ground cover	-0.021	0.917	$p \leq .05$
% Unvegetated area	-0.004	0.950	$p \leq .10$
Y intercept	0.731		
Horned Lark (without plant species)			
% Forb cover	-0.11	0.290	
% Litter cover	-0.102	0.446	$p \leq .10$
Y intercept	4.246		

Table 11. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
	Western Meadowlark		
% Warm season grass	0.191	0.317	
% Foxtail barley	-0.021	0.648	$p \leq .01$
Plant species diversity	-5.761	0.723	
Average height of vegetation (cm)	0.009	0.787	
% Japanese brome	0.028	0.817	
% Unvegetated area	0.008	0.846	
Surface area of water (m^2)	-0.000[1]	0.857	
% Yellow sweetclover	-0.490	0.869	
% Ground cover	0.019	0.878	
% *Agropyron* spp.	-0.055	0.904	
% *Kochia* sp.	-0.311	0.923	
% Forb cover	0.409	0.972	$p \leq .05$

Table 11. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)
Y intercept	3.567	
	Red-winged Blackbird	
Surface area of water (m^2)	0.000[2]	0.601
% Japanese brome	-0.002	0.684
% Litter cover	-0.001	0.706
% *Kochia* sp.	0.025	0.736
% *Agropyron* spp.	0.007	0.804 $p \leq .10$
Y intercept	0.164	
	Vesper Sparrow	
% Green needlegrass	0.092	0.399
% Foxtail barley	-0.788	0.456
% *Kochia* sp.	0.271	0.490
% Japanese brome	0.091	0.539

Table 11. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)
% litter cover	-0.093	0.579
% Unvegetated area	-0.042	0.664
Plant species diversity	-0.852	0.728
% *Agropyron* spp.	-0.319	0.793
Surface area of water (m^2)	-0.000[3]	0.837
% Warm season grass	0.055	0.954 $p \leq .01$
% Cool season grass	0.318	0.966
% Buffalo grass	-0.095	0.999 $p \leq .05$
Y intercept	3.073	

1 actual value = -0.000003

2 actual value = 0.00002

3 actual value = -0.00008

Table 12. Results of forward stepwise multiple regression analysis of common bird species associated with new spoils during the 1978 breeding season (N=16).

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
	Killdeer		
Surface area of water (m^2)	0.000[1]	0.451	
Average height of vegetation (cm)	0.115	0.557	
% Ground cover	-0.155	0.661	
% Cool season grass	0.110	0.728	
% *Kochia* sp.	-0.339	0.801	
% Foxtail barley	0.161	0.849	
% Forb cover	0.109	0.890	
Plant species diversity	1.647	0.937	$p \leq .05$
% *Agropyron* spp.	0.041	0.973	$p \leq .10$
Y intercept	-0.771		

Table 12. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)
	Mourning Dove	
Visual obstruction reading	-1.060	0.312
% Foxtail barley	-0.083	0.457 $p \leq .10$
Y intercept	1.466	
	Western Meadowlark	
% Green needlegrass	0.218	0.327
% *Setaria* spp.	0.497	0.515
% *Agropyron* spp.	-0.093	0.586
% Warm season grass	0.274	0.728 $p \leq .01$
Surface area of water (m^2)	0.000[2]	0.755
% Litter cover	0.232	0.822
Visual obstruction reading	1.176	0.854
% Forb cover	-0.041	0.906

Table 12. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
Plant species diversity	-3.207	0.922	
% *Kochia* sp.	0.152	0.968	$p \leq .05$
% Downy brome	0.035	0.974	
Average height of vegetation (cm)	-0.030	0.988	$p \leq .10$
Y intercept	2.564		
	Brewer's Blackbird		
Average height of vegetation (cm)	-0.020	0.292	
% Forb cover	-0.052	0.436	
% Unvegetated area	-0.039	0.677	
% Warm season grass	-0.137	0.884	$p \leq .001$
% Foxtail barley	-0.043	0.966	
% Green needlegrass	0.037	0.974	
% Japanese brome	-0.026	0.980	

Table 12. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)
Plant species diversity	-0.538	0.988
% Litter cover	0.037	0.994
Visual obstruction reading	-0.271	0.998 $p \leq .05$
Y intercept	4.342	

1 actual value = 0.0001

2 actual value = 0.0001

variation in meadowlark density in 1978 (Table 12). Importance of of grasses and negative regression coefficients for plant species diversity indicated that meadowlarks did not require a diverse plant composition.

Red-winged blackbirds nested in moist areas supporting cattail growth. Regression analysis in 1977 (Table 11) supported this observation indicating that surface area of water accounted for 60% ($p \leq .10$) of the variation in red-winged blackbird density. No variation in red-winged blackbird density was accounted for at the 10% significance level in 1978. I speculate that increased numbers and variation of red-winged blackbirds in 1978 resulted in less significant variation being accounted for by the regression equation. As in old spoils, red-winged blackbirds were attracted to the dense, upright and protective cover provided by cattails. Albers (1978) also reported this association.

Vesper sparrows were observed on 50% of the plots in new spoils but not in large numbers. It was believed that they were visitors from unmined areas adjacent to new spoils. Unmined areas were observed to have a large population of vesper sparrows. Vesper sparrows in new spoils were observed in grassy areas. Green needlegrass explained 40% ($0 \leq .01$) of the variation in density of vesper sparrows in 1977 (Table 11).

Unmined

<u>Vegetation measurements:</u> Unmined areas contained 5% shrub cover consisting predominantly of big sagebrush (Table 13). Grass cover

Table 13. Selected mean habitat values measured in June and July on 14 unmined transects 300m from a mining haul road, 1977-78.

Variable	1977		1978	
	$\bar{Y}$[1]	SD[2]	$\bar{Y}$	SD
Surface area of water (m^2)	446	889	1396	3056
% Ground cover	32	8	47	19
% Unvegetated area	49	9	45	19
% Persistent litter cover	3	2	1	1
% Nonpersistent litter	15	8	7	4
% Litter cover (persistent + nonpersistent)	18	8	8	4
% Forb cover	3	2	16	10
% Shrub cover	6	5	5	4
% Cool season grass	13	8	30	15
% Warm season grass	10	5	8	7
% Grass cover (cool + warm season)	23	9	37	18
Visual obstruction reading	tr[3]	tr	1	tr

Table 13. cont.

Variable	1977		1978	
	$\bar{Y}$	SD	$\bar{Y}$	SD
Plant species diversity	.8	.2	.9	.4
Average height of vegetation (cm)	8	4	15	4
% *Artemisia tridentata*	6	5	4	4
% *Agropyron* spp.	7	5	11	7
% Blue gramma	3	4	4	5

1 mean

2 standard deviation

3 0<tr<.5

increased from 23% in 1977 to 37% in 1978 and ground cover increased from 32% to 47%. Vegetation measurements showed increases in forb cover, grass cover and height of vegetation in 1978. Stock ponds and dikes provided the only water in unmined areas and contained cattails, sedges and occasionally willows.

Birds: The vesper sparrow was the most common species in unmined areas both years and the meadowlark was second both years (Table 14). Fifteen species of birds were observed on unmined plots in 1977 and 19 were observed in 1978. Average bird density increased from 37 birds/40ha in 1977 to 82 birds/40ha in 1978. Bird diversity increased from 13 to 15 (Table 14). Increased density and diversity of birds in 1978 was attributed to better vegetative cover. Vesper sparrows, red-winged blackbirds and mourning doves showed the greatest increase.

Regression: Sixty-two percent of the variation in bird density was explained by surface area of water ($p \leq .05$) in 1977 (Table 15). Surface area of water, height of vegetation, prairie junegrass and ground cover accounted for 94% of the variation in bird density ($p \leq .10$). Ground cover had a low negative influence on bird density relative to other variables in the equation. In 1978 unvegetated area entered the regression equation first with a positive regression coefficient. It appears that although ground cover was important, bare or sparsely vegetated areas were an advantage for nesting, dusting, and obtaining grit. Ground cover entered ninth with the largest positive regression coefficient.

Eighty-four percent ($p \leq .05$) of bird diversity was explained by

Table 14. Bird density and frequency of plots on which birds occurred within unmined 300m during the 1977 and 1978 breeding season.

Common bird species	1977			1978		
	$\bar{Y}$[1]	SD[2]	F[3]	$\bar{Y}$	SD	F
Mallard	.50	.94	4/14	.20	.80	1/14
American Wigeon	--	--	--	.20	.36	1/14
Blue-winged Teal	--	--	--	1.40	.42	3/14
Killdeer	2.00	.94	12/14	3.40	3.10	11/14
Upland Sandpiper	--	--	--	.60	.93	6/14
Wilson's Phalarope	--	--	--	.60	1.60	2/14
Mourning Dove	2.90	6.50	4/14	8.10	8.70	12/14
Common Nighthawk	.30	1.10	1/14	.30	1.10	1/14
Common Flicker	.10	.36	2/14	.30	1.10	1/14
Horned Lark	3.40	4.40	9/14	7.40	8.30	11/14
Barn Swallow	.10	.54	1/14	--	--	--
Sage Thrasher	.10	.54	1/14	--	--	--

Table 14. cont.

Common bird species	1977			1978		
	$\bar{Y}$[1]	SD[2]	F[3]	$\bar{Y}$	SD	F
American Robin	.40	1.60	1/14	--	--	--
Mountain Blue Bird	--	--	--	.80	2.90	1/14
Common Yellowthroat	--	--	--	.40	1.10	2/14
Western Meadowlark	7.70	3.70	14/14	1.10	5.90	13/14
Red-winged Blackbird	2.30	3.10	8/14	8.70	12.00	7/14
Brewer's Blackbird	.70	2.20	2/14	.10	.27	1/14
Common Grackle	.20	.80	1/14	--	--	--
Grasshopper Sparrow	--	--	--	.40	.93	2/14
Lark Bunting	--	--	--	2.20	8.30	1/14
Vesper Sparrow	13.00	11.00	14/14	30.00	17.00	14/14
Brewer's Sparrow	.20	.43	3/14	3.6	4.00	8/14
Average Bird Density	37.00	18.00		82.00	33.00	
Bird Diversity	13.00	2.40		15.00	2.70	

Table 14. cont.

Common bird species	1977			1978		
	$\bar{Y}$	SD	F	$\bar{Y}$	SD	F
Total Species	15			19		

1 mean density/40ha

2 standard deviation

3 frequency = $\frac{\text{number of plots on which bird occurred}}{\text{total plots}}$

Table 15. Results of forward stepwise multiple regression analysis of bird density and diversity associated with unmined areas during the 1977 breeding season (N=14).

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
	Bird Density		
Surface area of water (m^2)	0.001	0.622	
Average height of vegetation (cm)	0.202	0.806	$p \leq .05$
% Prairie junegrass	0.306	0.878	
% Ground cover	-0.056	0.942	$p \leq .10$
Y intercept	2.991		
	Bird Diversity		
% Big sagebrush	0.038	0.383	
% *Poa* spp.	-0.133	0.843	$p \leq .05$
Y intercept	1.179		

sagebrush and bluegrass (*Poa* spp.) in 1977 (Table 15). Sagebrush had a positive regression coefficient while bluegrass entered with a negative coefficient. Karr (1968) and Karr and Roth (1971) found that addition of shrub cover to a grass habitat increased diversity of birds. In 1978, surface area of water accounted for 60% ($p \leq .10$) of the variation in bird diversity (Table 16). Water entered with a negative regression coefficient. This is explained by the fact that large numbers of red-winged blackbirds were attracted to water areas in 1978. Pielou (1967) reported that a large number of one species relative to other species on a plot would have a negative effect on diversity for that plot. However, water areas had a positive effect on unmined areas as a whole by attracting species which would be absent or uncommon if water were not present.

Height of vegetation and warm season grass were important for explaining variation in killdeer density (63% $p \leq .01$) in 1977 (Table 17). Visual obstruction readings and unvegetated areas accounted for 48% ($p \leq .05$) of killdeer density in 1978. Unvegetated areas had a positive regression coefficient both years. Killdeers were observed on areas unvegetated or sparsely vegetated with forbs and grasses in unmined as well as in other habitat categories. Bent (1962) reported that kill-deers were found in a variety of habitats but are usually associated with bare ground or sparsely vegetated areas.

Grasses and shrubs were important to mourning doves. Regression analysis in 1978 indicated that prairie junegrass explained 55% ($p \leq .01$) of the variation in mourning dove density (Table 18). Prairie june-grass and litter cover together explained 82% ($p \leq .01$) of the variation in

Table 16. Results of forward stepwise multiple regression analysis of bird density and diversity associated with unmined areas during the 1978 breeding season (N=14).

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
	Bird Density		
% Unvegetated area	0.922	0.279	
% *Poa* spp.	-0.338	0.490	
% Blue gramma	0.550	0.553	
% Shrub cover	-0.301	0.674	$p \leq .05$
% *Agropyron* spp.	-0.095	0.721	
% Warm season grass	-0.394	0.747	
% Litter cover	0.628	0.784	
% Forb cover	-0.376	0.819	
% Ground cover	1.251	0.870	
Surface area of water (m^2)	0.001	0.949	$p \leq .10$
Y intercept	-87.150		

Table 16. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)
	Bird Diversity	
Surface area of water (m^2)	-0.000[1]	0.602
% Litter cover	0.060	0.776
Plant species diversity	0.961	0.889
% Forb cover	0.006	0.923
% Japanese brome	-0.001	0.947
Average height of vegetation (cm)	0.001	0.961
% Big sagebrush	-0.019	0.976
Visual obstruction reading	-0.033	0.987
% Cool season grass	-0.008	0.990
% Ground cover	0.032	0.993
% Unvegetated area	0.027	0.999 $p \leq .10$
Y intercept	-2.217	

Table 16. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)

1 actual value = -0.00003

Table 17. Results of forward stepwise multiple regression analysis of common bird species associated with unmined areas during the 1977 breeding season (N=14)

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
	Killdeer		
Average height of vegetation (cm)	0.007	0.376	
% Warm season grass	-0.011	0.628	$p \leq .01$
% Forb cover	0.029	0.698	
% Prairie junegrass	0.037	0.755	
Plant species diversity	0.161	0.802	
% Unvegetated area	0.005	0.849	
Surface area of water (m^2)	-0.000[1]	0.908	
% Big sagebrush	-0.027	0.930	
% Shrub cover	0.019	0.978	$p \leq .05$
% *Carex* spp.	0.015	0.987	
% Persistent litter cover	-0.006	0.998	$p \leq .10$

	Regression coefficient	Coefficient of determination (R^2)	
	-0.186		
% Warm season grass	-0.122	0.333	
% Prairie junegrass	0.565		
% Blue gramma	-0.108	0.764	
% *Poa* spp.	0.187	0.870	
% Forb cover	-0.245	0.955	$p \leq .001$
Surface area of water (m^2)	0.000[2]	0.978	
% *Agropyron* spp.	0.007	0.987	$p \leq .01$
% Shrub cover	-0.169	0.991	
% Cool season grass	-0.172	0.993	
% Ground cover	0.167	0.997	
% Nonpersistent litter cover	0.006	1.000	$p \leq .05$

Table 17. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
Y intercept	-0.042		
	Western Meadowlark		
Surface area of water (m^2)	-0.000[3]	0.340	
Plant species diversity	-0.970	0.612	
Average height of vegetation (cm)	0.009	0.691	
% Buffalo grass	0.090	0.762	
% Nonpersistent litter cover	0.024	0.878	$p \leq .01$
% Cool season grass	0.008	0.934	
% *Agropyron* spp.	-0.047	0.958	
% Prairie junegrass	-0.036	0.976	
% Persistent litter cover	0.028	0.989	$p \leq .05$
% Warm season grass	-0.016	0.994	
% Unvegetated area	-0.010	0.999	$p \leq .10$

Table 17. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
Y intercept	1.875		
Red-winged Blackbird (without plant species)			
% Ground cover	0.749	0.387	
Surface area of water (m^2)	-0.000[4]	0.559	
% Warm season grass	-0.725	0.663	
Average height of vegetation (cm)	0.049	0.699	
% Shrub cover	-0.723	0.772	
% Persistent litter cover	-0.022	0.813	
% Forb cover	-0.691	0.826	
% Cool season grass	-0.720	0.923	$p \le .05$
Plant species diversity	-0.759	0.949	
% Nonpersistent litter cover	0.033	0.954	
% Unvegetated area	0.030	0.993	$p < .10$

Table 17. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
Y intercept	-2.456		
Vesper Sparrow			
Surface area of water (m^2)	0.001	0.790	
% Forb cover	-0.525	0.854	
% Persistent litter cover	0.135	0.894	
% Shrub cover	-0.590	0.947	$p \leq .001$
% Warm season grass	-0.386	0.972	
% Cool season grass	-0.436	0.978	
% Ground cover	0.433	0.992	
% Big sagebrush	0.143	0.998	$p \leq .01$
% *Carex* spp.	0.041	0.999	$p \leq .05$
% *Agropyron* spp.	0.007	1.000	$p \leq .10$
Y intercept	0.334		

Table 17. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)

1 actual value = 0.00005

2 actual value = 0.00002

3 actual value = 0.0002

4 actual value = 0.00005

mourning dove density. Mourning doves used prairie junegrass and bluegrass in nest building. Nests were also built in sagebrush which had a positive regression coefficient.

Observations of horned larks in the field did not suggest a relationship with any plant species. As in old spoils and new spoils horned larks were often observed in sparsely vegetated areas. Forb cover in 1978 accounted for 43% ($p \leq .05$) of the variation in horned lark density and had a negative regression coefficient (Table 18). Warm season grass entered the 1977 regression equation first explaining 33% ($p \leq .01$) of the variation in horned lark density, and had a negative regression coefficient (Table 17). Ground cover had the largest positive regression coefficient in 1977. Bent (1964) reported that horned larks are found in a variety of habitats but are usually associated with bare ground or sparsely vegetated areas. McAtee (1905) concluded that horned larks selected lightly vegetated areas.

Meadowlarks were common in grassy-sagebrush areas. A meadowlark and grass-sagebrush association was reported by Cameron (1907) and Kendeigh (1941). Regressions supported this observation since most variables entering the regression equation both years were related to grass-cover (Table 17,18). Bluegrass and Japanese brome explained 62% ($p \leq .01$) of the variation in 1978, and had positive regression coefficients. Surface area of water entered first in 1977 explaining 33% ($p \leq .01$) of the variation in meadowlark density. Water had a negative influence relative to other variables in the equation.

Table 18. Results of forward stepwise multiple regression analysis of common bird species associated with unmined areas during the 1978 breeding season (N=14).

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
	Killdeer		
Visual obstruction reading	0.207	0.290	
% Unvegetated area	0.015	0.483	$p \leq .05$
Plant species diversity	1.844	0.553	
% Japanese brome	-0.021	0.640	
% Cool season grass	0.021	0.683	
% Blue gramma	0.045	0.722	
% Warm season grass	-0.294	0.784	
% Big sagebrush	-0.182	0.867	
% Shrub cover	0.156	0.937	$p \leq .10$
Y intercept	-2.454		

Table 18. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
	Mourning Dove		
% Prairie junegrass	0.153	0.553	
% Litter cover	0.039	0.820	
% Blue gramma	-0.008	0.937	
% Big sagebrush	0.158	0.951	
% *Agropyron* spp.	0.024	0.958	
Visual obstruction reading	1.373	0.966	
% American vetch	-0.196	0.970	
% Buffalo grass	0.206	0.976	
% Unvegetated area	0.047	0.985	
% Prickly pear	0.700	0.999	$p \leq .01$
% Japanese brome	-0.009	1.000	$p \leq .10$
Y intercept	-3.950		

Table 18. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)
	Horned Lark	
% Forb cover	-0.117	0.426
Surface area of water (m^2)	-0.000[1]	0.642
Plant species diversity	-1.371	0.740
% Litter cover	-0.068	0.766
% Warm season grass	-0.054	0.788
% Ground cover	0.028	0.848 $p \leq .10$
Y intercept	3.646	
	Western Meadowlark	
% *Poa* spp.	0.147	0.337
% Japanese brome	0.230	0.619 $p \leq .01$
% Moss-lichen	0.092	0.718
% Warm season grass	-0.095	0.775

Table 18. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
% Blue gramma	0.202	0.812	
Surface area of water (m^2)	0.000[2]	0.823	
% *Agropyron* spp.	-0.148	0.830	
% Yellow sweetclover	0.398	0.851	
Plant species diversity	2.642	0.866	
Average height of vegetation (cm)	-0.200	0.892	
% Litter cover	0.107	0.997	$p \leq .05$
Y intercept	-0.854		
Red-winged Blackbird			
% Forb cover	0.063	0.540	
% Prairie junegrass	0.214	0.801	$p \leq .001$
% Big sagebrush	-0.527	0.893	
% *Poa* spp.	-0.111	0.931	

Table 18. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
Visual obstruction reading	1.116	0.962	
% Shrub cover	0.402	0.983	$p \leq .01$
% Warm season grass	-0.027	0.991	
% Litter cover	-0.043	0.997	$p \leq .05$
% Moss-lichen	-0.036	0.999	$p \leq .10$
Y intercept	0.268		
Vesper Sparrow			
% Prairie junegrass	0.302	0.704	
% Forb cover	-0.397	0.873	
% Japanese brome	-0.010	0.886	
Average height of vegetation (cm)	0.360	0.901	
% Blue gramma	-0.071	0.909	
% Unvegetated area	0.271	0.922	

Table 18. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)	
% *Agropyron* spp.	0.122	0.930	
% *Poa* spp.	-0.286	0.935	
% Ground cover	0.432	0.976	$p \leq .01$
% Cool season grass	-0.103	0.985	
Visual obstruction reading	1.555	0.999	$p \leq .05$
Y intercept	-26.817		
Brewer's Sparrow			
% Blue gramma	0.087	0.232	
% *Agropyron* spp.	-0.131	0.348	
% Forb cover	0.072	0.618	
% Litter cover	-0.078	0.730	
Visual obstruction reading	0.853	0.808	$p \leq .05$
% Warm season grass	0.026	0.854	

Table 18. cont.

Independent variable	Regression coefficient	Coefficient of determination (R^2)
% Big sagebrush	-0.266	0.893
% Shrub cover	0.226	0.938
Surface area of water (m^2)	0.000[3]	0.975
% *Poa* spp.	-0.026	0.993 $p \leq .10$
Y intercept	0.432	

1 actual value = 0.0001

2 actual value = 0.0003

Vesper sparrows were associated with grass-sagebrush areas in the field. Males used sagebrush as singing perches. In 1978 (Table 18) junegrass entered the regression first accounting for 70% ($p \leq .01$) of the variation in vesper sparrow density. Vesper sparrows were observed perched on sagebrush eating junegrass seeds from plants protruding through the bush. Surface area of water explained 80% ($p \leq .01$) of the variation in 1977 (Table 17). Bent (1964) reported that vesper sparrows benefited from a sparse distribution of sagebrush within a grass habitat. Appleton (1911) concluded vesper sparrows did not require sagebrush cover but a sparse mixture of sagebrush with other vegetation.

Brewer's sparrows were rarely observed in 1977, but were common in 1978. They appeared to be attracted to dense patches of sagebrush within a grass habitat. Data do not support this observation; however, regression analysis indicated that shrub cover had the largest positive regression coefficient when all variables were in the equation (Table 18). Bent (1964) documents a relationship between brewer's sparrows and the presence of sagebrush.

The 1977 regression equation without plant species (Table 17) accounted for the most variation in red-winged blackbird density. Ground cover and surface area of water explained 56% ($p \leq .05$) of the variation in red-winged blackbird density. Forb cover in 1978 explained 54% ($p \leq .01$) of the variation. Red-winged blackbirds were common in areas with cattails, especially around ponds, ditches and drainage areas where little vegetation except cattails and sedges existed. Bent (1965) and Albers (1978) reported tall vegetation restricting visibility was attractive to red-winged blackbirds.

Difference Between Habitats

In unmined areas and new spoils 30% to 40% of the total area was covered with vegetation compared to 14% in old spoils. New spoils and unmined areas had ponds with cattails and sedges on their banks. Drainage areas within unmined areas had cattails growing in them.

Unmined areas had the advantage of shrub cover (big sagebrush) but only 3 ponds were over $50m^2$ in size. New spoils had no shrubs but did have forb and grass cover with 6 ponds at least $50m^2$ in size. Ponds with cattails attracted red-winged blackbirds, waterfowl and shorebirds. Ponds were numerous in old spoils, but were typically small with steep unvegetated banks and muddy water. These ponds attracted few birds. New spoils had the largest bird density in 1977 (Table 19). Density in unmined and old spoil areas was similar. In 1978 new spoils and unmined areas were similar (Table 20). Old spoils had the lowest bird density both years.

From 1977 to 1978 bird diversity remained constant in old spoils but increased in unmined areas and new spoils (Table 19,20). Bird diversity both years was higher in new spoils ($p \leq .01$) than all other areas. Allaire (1978) reported a higher bird diversity on reclaimed mined areas. Old spoils and unmined areas had similar bird diversity in 1977. I speculate that low density and diversity on unmined areas during 1977 resulted from heavy grazing and low precipitation levels. The addition of shrubs to new spoils would increase density and diversity of birds by attracting vesper and brewer's sparrows.

Karr and Roth (1971) reported that the addition of shrubs to a grassland would increase diversity. Patches of sagebrush within new spoils would increase horizontal diversity of vegetation which is a predictor of bird diversity (Roth 1976).

Old and new spoils had the largest killdeer densities (Table 21, 22). The largest density for killdeer occurred in new spoils during 1978.

Densities of mourning doves in mined and unmined areas during both years were not different at the 10% level (Table 21,22). Most of the mourning doves observed in old spoils were observed on two plots.

Horned lark density remained constant in new spoils from 1977 to 1978 but increased in old spoils and unmined areas. Old spoils had the lowest horned lark densities both years (Table 21,22).

Density of meadowlarks was higher ($p \leq .01$) within new spoils than pooled unmined and old spoil areas during 1977 and 1978 (Table 21,22). Unmined areas had the second highest meadowlark density ($p \leq .05$) both years and old spoils the lowest. In 1978, meadowlark density within unmined areas was similar to meadowlark density within new spoils (degrees of freedom did not allow the difference to be tested statistically).

Red-winged blackbirds were about equal in number within old and new spoils in 1977. Unmined areas had the lowest red-winged blackbird numbers ($p \leq .01$). In 1978 red-winged blackbird densities were considerably higher than in 1977 (Table 21,22). No difference in red-winged blackbird density was detectable at the 10% level between habitats

Table 19. Orthogonal T-test for differences in bird density and diversity between habitat categories during 1977 breeding season.

Habitat		Bird Density			Bird Diversity		
	N[1]	$\bar{Y}$[2]	SD[3]	S[4]	$\bar{Y}$	SD	S
Pooled unmined	42	36	15	.69	12	3	.40
Old spoils	20	35	19		13	4	
Pooled unmined and old spoils	62	36	16	.03	12	3	.006
New spoils	16	60	39		15	4	

1 number observations (transects)

2 mean density/40ha

3 standard deviation

4 significance level

Table 20. Orthogonal T-test for differences in bird density and diversity between habitat categories during the 1978 breeding season.

Habitat		Bird Density			Bird Diversity		
	N[1]	$\bar{Y}$[2]	SD[3]	S[4]	$\bar{Y}$	SD	S
Pooled unmined	56	90	36	.03	15	3	.07
Old spoils	20	52	71		13	4	
Pooled unmined and old spoils	76	80	50	.60	14	3	.001
New spoils	16	86	33		18	2	

1 number observations (transects)

2 mean density/40ha

3 standard deviation

4 significance level

in 1978. The increase in red-winged blackbird numbers in 1978 was contributed to by the presence of wet areas throughout the breeding season.

The importance of sagebrush was indicated by higher numbers of vesper and brewer's sparrows in unmined areas compared to mined areas. Sagebrush provided cover and song perches for sparrows, meadowlarks and mourning doves. Highest vesper sparrow and brewer's sparrow (Table 21, 22) densities occurred in unmined areas in 1977 and 1978 ($p \leq .01$). Old spoils had the second highest sparrow density both years. Elimination of shrub cover (sagebrush) was the likely reason for low sparrow densities in mined areas. Corhart (1954), Schroeder and Sturges (1975) reported a reduction in vesper and brewer's sparrows following sagebrush control. Vesper sparrows observed in new spoils were believed to be visitors from nearby unmined sage-grassland habitat.

Distance From Haul Road

No difference in average bird density was detected between 100m, 300m, and 500m transects in 1977 (Table 23). In 1978 bird density increased with distance from the haul road (Table 24).

Although bird diversity was higher in 1978 than 1977, no difference was observed between 100m, 300m, and 500m plots either year (Table 23, 24). Nine hundred meter plots in 1978 had a higher ($p \leq .07$) bird diversity than other distance intervals because of large population of brewer's sparrows and horned larks.

No difference ($p \leq .10$) in density were observed between plots at various distance intervals from the haul road for killdeers, meadow-

Table 21. Orthogonal T-test for differences in density of common birds between habitat categories during the 1977 breeding season.

Habitat	N[1]	$\bar{Y}$[2]	SD[3]	S[4]	$\bar{Y}$	SD	S
		Killdeer			Mourning Dove		
Pooled unmined	42	1	1	.001	2	5	.43
Old spoils	20	4	2		4	8	
Pooled unmined and old spoils	62	2	2	.04	3	6	.11
New spoils	16	3	2		7	9	
		Horned Lark			Meadowlark		
Pooled unmined	42	4	5	.02	7	3	.02
Old spoils	20	2	3		4	4	
Pooled unmined and old spoils	62	3	4	.02	6	4	.001
New spoils	16	14	17		13	6	

Table 21. cont.

Habitat	N[1]	$\bar{Y}$[2]	SD[3]	S[4]	$\bar{Y}$	SD	S
		Red-winged Blackbird			Vesper Sparrow		
Pooled unmined	42	1	2	.008	14	9	.001
Old spoils	20	3	3		5	6	
Pooled unmined and old spoils	62	2	3	.49	11	9	.02
New spoils	16	2	2		5	10	

1 number observation (transects)

2 mean density/40ha

3 standard deviation

4 significance level

Table 22. Orthogonal T-test for differences in density of common birds between habitat categories during the 1978 breeding season.

Habitat	N[1]	$\bar{Y}$[2]	SD[3]	S[4]	$\bar{Y}$	SD	S
		Killdeer			Mourning Dove		
Pooled unmined	56	4	4	.001	7	9	.52
Old spoils	20	8	5		15	58	
Pooled unmined and old spoils	76	5	5	.002	9	31	.89
New spoils	16	11	8		8	6	
		Horned Lark			Meadowlark		
Pooled unmined	56	13	14	.001	11	6	.001
Old spoils	20	4	3		2	3	
Pooled unmined and old spoils	76	11	13	.41	9	6	.01
New spoils	16	14	10		13	7	

Table 22. cont.

Habitat	N[1]	$\bar{Y}$[2]	SD[3]	S[4]	$\bar{Y}$	SD	S
		Red-winged Blackbird			Vesper Sparrow		
Pooled unmined	56	8	17	.60	25	14	.001
Old spoils	20	10	11		4	7	
Pooled unmined and old spoils	76	9	16	.21	19	15	.001
New spoils	16	16	23		3	3	
		Brewer's Sparrow					
Pooled unmined	56	12	18	.004			
Old spoils	20	0	0				
Pooled unmined and old spoils	76	9	16	.001			
New spoils	16	0	1				

1 number observations (transects)

2 mean density/40ha

3 standard deviation

4 significance level

larks and vesper sparrows (Table 25,26). Red-winged blackbirds nested along the haul road when water and cattails were present.

In 1977 no significant differences in mourning dove densities were detected between the 100m, 300m and 500m distance intervals (Table 25). Although in 1978 no significant differences were observed in mourning dove density, the density calculated for 500m was almost one half the density for 100m. The situation was reversed in 1977 suggesting no avoidance of the haul road by mourning doves (Table 25,26).

Larger densities of horned larks and brewer's sparrows were observed at increased distances from the mining haul road. The pattern was the same for horned larks in 1977 and 1978 except the difference between 100m and 300m plots was not significant at the 10% level in 1977. Brewer's sparrows were not tested in 1977 because of the low sample size. Since only 2 species (Brewer's sparrow and horned lark) showed significant ($p \leq .10$) increase in density with distance from the haul road, it is unlikely that the bird population within the study area was negatively effected by the presence of haul roads. Brewer's sparrows were only tested for one year and horned lark density on the 100m and 300m plots were not significantly different in 1977. Supporting this conclusion, Brewer (1958) reported that killdeers nested on roads used by mining trucks. Whitmore and Hall (1978) reported horned larks nested on median strips of super-highways. Michael (1975) and Ferris (1979) concluded that birds were not disturbed next to highways in West Virginia and Maine.

Table 23. Orthogonal T-test for differences in bird density and diversity between distance intervals from the haul road during the 1977 breeding season.

Distance from haul road		Bird Density			Bird Diversity		
	N[1]	$\bar{Y}$[2]	SD[3]	S[4]	$\bar{Y}$	SD	S
100m	14	33	14	.52	12	3	.28
300m	14	37	18		13	2	
Pooled 100m and 300m	28	35	16	.42	12	3	.89
500m	14	39	13		12	3	

1 number of observations (transects)

2 mean density/40ha

3 standard deviation

4 significance level

Table 24. Orthogonal T-test for differences in bird density and diversity between distance intervals from the haul road during the 1978 breeding season.

Distance from haul road		Bird Density			Bird Diversity		
	N[1]	$\bar{Y}$[2]	SD[3]	S[4]	$\bar{Y}$	SD	S
100m	14	62	29	.10	14	4	.44
300m	14	82	33		15	3	
Pooled 100m and 300m	28	72	32	.05	14	4	.95
500m	14	92	25		14	2	
Pooled 100m, 300m and 500m	42	79	31	.001	14	3	.07
900m	14	124	28		16	2	

1 number observations (transects)

2 mean density/40ha

3 standard deviation

4 significance level

Table 25. Orthogonal T-test for differences in density of common birds between distance intervals from the haul road during the 1977 breeding season.

Distance from haul road	N[1]	$\bar{Y}$[2]	SD[3]	S[3]	$\bar{Y}$	SD	S
		Killdeer			Mourning Dove		
100m	14	1	1	.73	0	1	.14
300m	14	2	1		3	7	
Pooled 100m and 300m	28	2	1	.47	2	5	.21
500m	14	1	2		4	6	
		Horned Lark			Meadowlark		
100m	14	2	3	.23	6	4	.36
300m	14	3	4		8	4	
Pooled 100m and 300m	28	3	4	.02	7	4	.20
500m	14	6	5		6	3	

Table 25. cont.

Distance from haul road	N[1]	$\bar{Y}$[2]	SD[3]	S[3]	$\bar{Y}$	SD	S
		Red-winged Blackbird			Vesper Sparrow		
100m	14	1	2	.13	12	8	.70
300m	14	2	3		13	11	
Pooled 100m and 300m	28	2	3	.56	13	9	.28
500m	14	1	2		17	8	

1 number observations (transects)

2 mean density/40ha

3 standard deviation

4 significance level

Table 26. Orthogonal T-test for differences in density of common birds between distance intervals from the haul road during the 1978 breeding season.

Distance from haul road	N[1]	$\bar{Y}$[2]	SD[3]	S[4]	$\bar{Y}$	SD	S
			Killdeer			Mourning Dove	
100m	14	3	3	.76	8	14	.99
300m	14	3	3		8	9	
Pooled 100m and 300m	28	3	3	.20	8	12	.14
500m	14	5	5		4	5	
Pooled 100m, 300m, and 500m	42	4	4	.50	7	10	.60
900m	14	3	4		6	6	
			Horned Lark			Meadowlark	
100m	14	3	3	.10	10	5	.79
300m	14	7	8		11	6	
Pooled 100m and 300m	28	5	7	.02	10	6	.72
500m	14	16	15		11	6	

Table 26. cont.

Distance from haul road	N[1]	$\bar{Y}$[2]	SD[3]	S[4]	$\bar{Y}$	SD	S
Pooled 100m, 300m and 500m	42	9	11	.001	11	5	.24
900m	14	26	15		13	6	
		Red-winged Blackbird			Vesper Sparrow		
100m	14	6	11	.57	20	12	.11
300m	14	9	12		30	17	
Pooled 100m and 300m	28	8	11	.69	25	15	.63
500m	14	11	27		27	12	
Pooled 100m, 300m and 500m	42	9	18	.88	26	14	.26
900m	14	8	16		21	12	
		Brewer's Sparrow					
100m	14	1	2	.07			
300m	14	4	4				

Table 26. cont.

Distance from haul road	N[1]	$\bar{Y}$[2]	SD[3]	S[4]	$\bar{Y}$	SD	S
Pooled 100m and 300m	28	3	3	.07			
500m	14	9	12				
Pooled 100m, 300m and 500m	42	5	8	.001			
900m	14	35	21				

1 number observations (transects)

2 mean density/40ha

3 standard deviation

4 significance level

SUMMARY AND CONCLUSIONS

Winter surveys were conducted to determine bird species on new spoils, old spoils and unmined areas. Horned larks were the only birds observed in all catagories during 1977 winter with the largest numbers observed in new spoils. During the winter of 1978, horned larks and common redpolls were observed in old spoil areas with common redpolls most common. Horned larks, snow buntings and common redpolls were observed in new spoils and buntings were the most common. Snow buntings and horned larks were observed in unmined areas with snow buntings the most common species.

Density and diversity of birds was estimated during the breeding season for new spoils, old spoils and unmined areas, 1977 and 1978. Density and diversity of birds was also calculated at various distances from a mining haul road. New spoils had the highest bird density in 1977. The highest density in 1978 occurred on unmined plots 900m from from the haul road. Densities of birds in unmined areas and new spoils were similar in 1978. Bird diversity was highest in new spoils both years. Diversity of birds increased during 1978 in new spoils and unmined areas but did not in old spoils. Old spoils had the lowest density and diversity of birds both years. The species of birds found on all 3 areas were similar except that vesper sparrows and brewer's sparrows were less numerous or absent on reclaimed areas. Elimination of shrub cover (sagebrush) was the likely reason for low sparrow densities in mined areas. The addition of shrubs to new spoils would increase density and diversity by attracting other birds such as vesper and brewer's sparrows.

The following differences in density of individual birds were observed between habitats: Killdeer densities were higher in new spoils, mourning doves had comparable densities in all 3 areas, meadowlarks and horned lark densities were higher in new spoils, red-winged blackbirds were more numerous in new spoils, vesper and brewer's sparrows had greater densities in unmined areas.

Killdeer and horned larks were usually observed on sparsely vegetated areas within all habitat types.

The greatest densities of meadowlarks were observed in grass-forb and grass-sagebrush areas. Variables entering meadowlark regression equations were groundcover related.

Areas with cattails and sedges supported the largest numbers of red-winged blackbirds. Tall vegetation was important.

In all 3 habitats highest densities of mourning doves were found in areas with grass and shrub cover. Litter cover and prairie junegrass accounted for 82% of mourning dove density in unmined areas. Sagebrush had a positive correlation to mourning dove density in unmined areas. The larger amounts of ground cover in new spoils and unmined areas accounted for the higher mourning dove densities in these areas.

Vesper sparrows were attracted to grass-sagebrush areas. Sagebrush accounted for most of the variation in vesper sparrow density in old spoils. However, vesper sparrows do not require dense sagebrush cover but a sparse mixture of sagebrush with other vegetation. Small patches of sagebrush attracted vesper sparrows in old spoils. A grassy-sagebrush mixture existed in unmined areas which supported the largest vesper sparrow density. Sagebrush was the most common shrub in unmined areas but in 1978 prairie junegrass explained 70% of the variation in vesper sparrow density.

Density and diversity of birds in old spoils depended on the presence of vegetation. Old spoils had the least ground cover and supported the lowest density and diversity of birds. The largest numbers of birds (meadowlarks, vesper sparrows, mourning doves) were observed in the more vegetated areas. Water in old spoils usually had unvegetated shorelines and attracted few bird species. Wet areas supporting cattails and sedges attracted red-winged blackbirds.

Ground cover (forbs and grasses) was important to birds in new spoils and unmined areas. A grass-sagebrush mixture was an important positive factor present in unmined areas that was not present in new spoils. Patches of sagebrush in new spoils would increase horizontal diversity of vegetation and bird diversity. Water and its associated vegetation was an important positive factor in new spoils and unmined areas, attracting waterfowl, red-winged blackbirds and shorebirds.

Average bird density increased significantly ($p\leq.10$) with distance from the haul road in 1978 but not in 1977. No significant ($p\leq.10$) differences in diversity of birds was detected at increased distances from the haul road except at the 900m interval in 1978 ($p\leq.07$). This difference was because of high horned lark and brewer's sparrow densities on 900m plots. T-tests indicated that horned lark and brewer's sparrow density increased with distance from the haul road. No change in density with distance from the haul road was significant at the 10% level for killdeers, mourning doves, meadowlarks, red-winged blackbirds and vesper sparrows. Based on field observations and T-tests, it is unlikely that the presence of haul roads affect density or diversity of birds during the breeding season. Brewer's sparrows and horned larks should be studied further before final conclusions are made.

I suggest the following management practices for reclaimed lands.

1. Shrubs should be present on reclaimed areas (left where possible during mining and/or transplanted during reclamation). Shrub cover attracts a variety of birds including vesper and brewer's sparrows.

2. Water impoundments should be preserved. Water impoundments most attractive to birds in this study had open water with vegetation along their shores and watersheds covered with grasses, forbs and shrubs (35%-40% cover).

3. Spoils and the shorelines of water impoundments should be sloped to minimize erosion and allow growth of vegetation.

4. Disturbed areas should be reseeded with a mixture of native grasses.

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APPENDIX

Scientific names of birds observed

within the study area.

TABLE`1. Scientific names[a] of 51 bird species observed within the study area.

Common Loon (Gavia immer)[c]
Western Grebe (Aechmophorus occidentalis)[d]
Eared Grebe (Podiceps caspicus)
Mallard (Anas platyrhynchos)
Pintail (Anas acuta)
Gadwall (Anas strepera)
American Wigeon (Anas americana)
American Shoveler (Anus clypeata)
Blue-winged Teal (Anas discors)
American Green-winged Teal (Anas crecca carolinensis)
Lesser Scaup (Aythya affinis)[d]
Common Merganser (Mergus merganser)[d]
American Kestrel (Falco sparverius)
Hungarian Partridge (Perdix perdix)[c]
Great Blue Heron (Ardea herodias)
American Coot (Fulica americana)
American Avocet (Recurvirostra americana)[d]
Killdeer (Charadrius vociferus)
Upland Sandpiper (Bartramia americana)
Spotted Sandpiper (Actitis macularia)
Willet (Catoptrophorus semipalmatus)[c]
Wilson's Phalarope (Steganopus tricolor)

Ring-billed Gull *(Larus delawarensis)*[c]

Mourning Dove *(Zenaidura macroura)*

Common Nighthawk *(Chordeiles minor)*

Belted Kingfisher *(Megaceryle alcyon)*

Common Flicker *(Colaptes auratus)*

Eastern Kingbird *(Tyrannus tyrannus)*

Western Kingbird *(Tyrannus verticalis)*[b]

Horned Lark *(Eremophila alpestris)*

Barn Swallow *(Hirundo rustica)*

Cliff Swallow *(Petrochelidon pyrrhonota)*[d]

Rough-winged Swallow *(Stelgidopteryx ruficollis)*

Sage Thrasher *(Oreoscoptes montanus)*

American Robin *(Turdus migratorius)*

Mountain Blue Bird *(Sialia currucoides)*

Loggerhead Shrike *(Lanius ludovicianus)*[b]

Common Yellowthroat *(Geothlypis trichas)*

Western Meadowlark *(Sturnella neglecta)*

Yellow-headed Blackbird *(Xanthocephalus xanthocephalus)*

Red-winged Blackbird *(Agelaius phoenicius)*

Brewer's Blackbird *(Euphagus cyanocephalus)*

Common Grackle *(Quiscalus quiscula)*

Brown-headed Cowbird *(Molothrus ater)*

Common Redpoll *(Acanthis flammea)*

Grasshopper Sparrow *(Ammodramus savannarum)*

Lark Bunting *(Calamospiza melanocorys)*

Vesper Sparrow *(Pooecetes graminius)*

Lark Sparrow *(Chondestes grammacus)*

Brewer's Sparrow *(Spizella breweri)*

Snow Bunting *(Plectrophenax nivalis)*

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[a]A.O.U. Check-list of North American Birds (Fifth ed., 1957; 32nd Suppl. Suppl., Auk 90:411; 33rd Suppl., Auk 93:875).

[b]Bird was observed within unmined areas but not on transects.

[c]Bird was observed within new spoils but not on transects.

[d]Bird was observed within old spoils but not on transects.