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NEST SITE SELECTION BY MOUNTAIN PLOVERS (*CHARADRIUS MONTANUS*) IN A SHRUB-STEPPE HABITAT

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ABSTRACT.—Habitat use by Mountain Plovers was studied in Duchesne County, Utah, from 1996 to 1998. This area is a shrub-steppe habitat and is different from the shortgrass prairie where current Mountain Plover breeding densities are greatest. Mountain Plovers prefer areas of short, sparse vegetation. Habitat surveys quantified vegetation and open space composition at nest and randomly selected sites. Data gathered in 1998 showed significant differences between nest and random sites in maximum vegetation height ($P = 0.0021$) and percentage total rock cover ($P = 0.0027$). As percentage rock cover also reflects open space, these results are consistent with general habitat characteristics preferred by the Mountain Plover. White-tailed prairie dogs were present significantly more often near the 5 nest sites located in 1998 than the 20 random sites. Insects collected from the same nest areas and random points reflected food items known to be in the Mountain Plover diet, but there were no significant differences in diversity of insects between nest and random sites.

Key words: Mountain Plover, Charadrius montanus, *breeding habitat, Uinta Basin.*

The Mountain Plover (*Charadrius montanus*), a species native to grasslands, typically breeds in open, flat shortgrass prairie. Historically, shortgrass prairies were composed of treeless bottoms and uplands vegetated by blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*). Bison (*Bison bison*), pronghorn (*Antilocapra americana*), and prairie dogs (*Cynomys* sp.) evolved as the primary herbivores on this landscape. Because native grasslands have been altered by the removal of primary native grazers and by agricultural use of the Great Plains, there is less suitable breeding habitat available, as tall vegetation hinders the ability of this bird to detect predators (Knopf 1996). As a result of such alterations, native species are declining in number, and exotic species diversity and density are increasing (Knopf 1994). Because of long-term declines, the Mountain Plover was listed as a candidate species under the U.S. Endangered Species Act on 3 May 1993 and is currently under consideration for a threatened designation.

Breeding Mountain Plovers occur geographically from Montana south to New Mexico (Knopf 1996). Studies of breeding populations in Colorado and Montana found Mountain Plovers selecting nest sites in areas of low herbaceous vegetation and sparse shrub cover (Knopf and Miller 1994). On the Pawnee National Grassland, Colorado, Mountain Plovers prefer to nest in areas where mean grass height is <8 cm in April when breeding sites are being selected (Graul 1975). In California during winter Mountain Plovers strongly select alkaline flats, recently burned fields, and grasslands which have been heavily grazed. Flat, cultivated lands are also used for foraging and roosting (Knopf and Rupert 1995). Knopf and Miller (1994) suggested that Mountain Plovers are a species of disturbed prairie or semidesert, rather than strictly restricted to typical shortgrass prairie. In 1993 surveys confirmed a Mountain Plover population, of unknown size, breeding in Utah on the Myton Bench, Duchesne County, Uinta Basin (Day 1994). Prior to 1992 there were 12 documented historical sightings of Mountain Plovers in Utah, and 6 were in the Uinta Basin (Audubon Field Notes 1966, Waller 1967, White et al. 1983, S. Madsen, BLM, personal communication). Observed population numbers have always been small but fairly consistent from 1993 to 1998 (UDWR 1997).

Habitat characteristics in the Uinta Basin are notably different from typically standard shortgrass prairie breeding areas. In Utah vegetation is sparse; sagebrush communities are

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dominated by *Artemisia* spp. with a component of grasses including Sandberg bluegrass (*Poa secunda*), Indian ricegrass (*Sorghastrum nutans)*, and needle-and-thread (*Stipa comata;* Goodrich and Neese 1986). White-tailed prairie dogs are resident, thinly spread rather than in dense clustered towns, and are known to be an ecological "keystone" species in creating suitable habitat for other species, including the Mountain Plover (Gilbert 1980, Terborgh 1986). Prairie dogs graze on vegetation, and their mounds, being relatively bare, provide open space. Because of their habitat requirements, Mountain Plovers are strongly associated with active black-tailed prairie dog towns in Montana in their breeding, nesting, and feeding areas (Knowles et al. 1982, Olson 1985). Where Mountain Plovers breed in Utah, oil and gas development contributes to the amount of surface disturbance and bare ground. These habitat modifications may have some benefits, and Mountain Plovers are known to raise broods near excessive local disturbance (Knopf and Miller 1994).

The diet of the Mountain Plover throughout its breeding range consists mainly of ground-dwelling and winged invertebrates perched on the ground; foraging is opportunistic (Knopf 1996).

It is of interest that a small Mountain Plover population is able to breed in Utah. There are no data to indicate whether the Myton Bench population is a relic; thus, it is important to know which habitat characteristics the Mountain Plover prefers when selecting a nest site in this atypical region. Information is also needed to understand the impacts of intensive oil development and associated vegetative changes on this population. The objectives of this study were to quantify habitat parameters at Mountain Plover nest sites in the Uinta Basin and measure available food resources at these sites.

STUDY AREA

Surveys were done from Castle Peak and Wells Draws east to the border of Pariette Wetlands Wildlife Habitat Management Area, approximately 20 km southwest of Myton, Duchesne County, Utah. The study area generally encompasses T8S to T9S, and R16E to R18E. These areas have a highly variable, broken topography ranging from approximately 1500 m to 1920 m elevation. Climate and habitats of the Uinta Basin represented within the study area are typical of the shrub-steppe habitat type found in the Great Basin (Goodrich and Neese 1986). Vegetative complexes range from essentially bare sand and/or gravel to low-growing black sagebrush (*A. nova*). Greasewood (*Sarcobatus vermiculatus*), shadscale (*Atriplex confertifolia*), and occasional big sagebrush (*A. tridentata*) stands are sporadically present throughout the area.

METHODS

Mountain Plover surveys have been conducted in the study area since 1993 (UDWR 1995). Vegetation surveys were completed at all known nest sites from 1993 to 1998 (n = 11) and at 20 randomly selected sites. Random points were selected by choosing 20 sections from the total study area and fixing the sample point as close to the center of the section as possible. At each site we measured a 10-m-radius macroplot and sampled ten 1-m^2 quadrats within the macroplot. We then estimated percentage of each of the following: total vegetative cover, shrub, forb, grass, total rock cover, large rock (>7 cm), medium rock (2–7 cm), and small rock (<2 cm). We also counted the number of species noted as shrubs, forbs, grasses and grasslikes. Measurements were taken of maximum and average vegetation heights. Presence or absence of white-tailed prairie dogs was noted. Distance from nearest prairie dog mound, roadway, and well pad was recorded at each nest site. Slope and aspect at each nest site were also recorded.

In 1998 potential prey availability was sampled. We collected insects from nest areas and random sites before and during Mountain Plover nesting time and then again after hatching. Collection areas were approximately circular, extending about 0.2 km in radius from each nest or at randomly selected points. Forty minutes was spent at each collection site, and anything visible to the surveyors was caught with sweep net or forceps. All insects collected were classified to the level of family by Richard W. Baumann, Monte L. Bean Life Science Museum, Brigham Young University.

Using discriminant analysis, stepwise discriminant analysis, and Wilcoxon 2-sample tests, we compared 14 habitat characteristics at nest and random sites. The diversity of

insects collected at nest and random sites was estimated with the Shannon function (Pielou 1977) and then compared with Wilcoxon rank sums tests. A pooled *t* test for small samples was used to compare Utah nest sites with nest sites in Montana and Wyoming.

RESULTS AND DISCUSSION

The breeding area in Duchesne County, Utah, varied from typical shortgrass prairie Mountain Plover nesting habitat in a major way, primarily in general terrain composition, which is a highly variable, broken topography (UDWR 1994). Of 11 known nest sites in Utah (1993–1998), only 3 were located on flat, open ground. All others were situated on the top or at the base of slopes, or very near large rocky outcroppings. Five nest sites found in 1998 were located an average of 68.6 m from surface disturbance, usually roads (Table 1). Elsewhere, Mountain Plovers usually nest on a flat area on the top of a hill or in a valley (Graul 1975). In Montana black-tailed prairie dog towns used by Mountain Plovers were level with slopes rarely >12% (Knowles et al. 1982). In Colorado and Wyoming nests were almost exclusively found on slopes of <5% and 2%, respectively (Graul 1975, Parrish et al. 1993). All nest sites in Utah were on a slope ≤10% (Table 1). The Prairie Falcon (*Falco mexicanus*) is a common aerial predator in Colorado (F.L. Knopf personal communication) that flies low to surprise prey by coming over ridges at fast speeds. Mountain Plovers often turn their heads sideways to scan the sky for raptors and prefer open, flat habitat (Knopf 1996, Graul 1975). We saw few aerial predators, other than Golden Eagles (*Aquila chrysaetos*), in the Myton Bench study area. Only a single Prairie Falcon was seen. Therefore, we suspect that occasional large visual barriers are not as great a hindrance to the Mountain Plover in Utah as in other parts of the breeding range.

Regardless of degree of slope, the prairie dog plays an important role for Mountain Plovers as 4 of 5 nest sites in Utah in 1998 were located an average of 8.5 m from a white-tailed prairie dog mound (Table 1). Of these, some were abandoned mounds and others had prairie dogs present. No prairie dog activity was noted at the 5th nest. Stepwise discriminant analysis of all habitat parameters measured in Utah ranked presence of white-tailed prairie dogs 2nd in importance in classifying a site as nest or random ($F = 8.121$, $P = 0.0081$). When compared to adjacent areas, black-tailed prairie dog towns in Montana had a greater amount of bare ground and total plant cover was less; horizontal visibility on black-tailed prairie dog towns was significantly greater than at adjacent areas (Knowles et al. 1982). Activities of black-tailed prairie dogs increase the number of perennial and annual plant species within their towns (Bonham and Lerwick 1976). Mountain Plovers select this habitat for nesting as well as all other activities throughout the breeding season (Olson and Edge 1985). White-tailed prairie dog mounds in Utah are virtually devoid of vegetation. Mountain Plovers were often noted atop these mounds, which likely provide vantage points for predator watch. In other areas Mountain Plovers and other species of plover have a tendency to nest near conspicuous objects, such as old cow manure piles (Graul 1975). However, aside from white-tailed prairie dog mounds, nests in Utah were not observed to be in close proximity to particular objects.

Comparison of habitat surveys from 11 nest sites and 20 randomly selected sites showed that differences exist between locations selected

TABLE 1. Relationship of Mountain Plover nest sites found in 1998 on the Myton Bench to white-tailed prairie dog mounds and oil development, and slope and aspect descriptors.

	Nest					
	1	2	3	4	5	$\bar{x}$
Distance to nearest prairie dog mound (m)	>100	3	15	12	4	8.5
Distance to nearest road or oil well pad (m)	3	41	20	182	97	68.6
Slope (%)	0	10	0	9	0	3.8
Aspect	none	south	none	north	none	—

TABLE 2. Wilcoxon 2-sample tests of habitat parameters measured at Mountain Plover nest sites and randomly selected sites in 1998. Significant differences (P) were determined at the $\alpha = 0.05$ level and are indicated by an asterisk (*). Presence or absence of prairie dogs is categorical data (1 = yes, 0 = no).

	Nest sites (n = 11)		Random sites (n = 20)		
Variable	$\bar{x}$ (range)	s	$\bar{x}$ (range)	s	P
% total vegetation cover	29.6 (1–75)	11.8	34.9 (0–90)	15.8	0.1541
% shrub cover	54.9 (0–100)	30.2	45.9 (0–100)	29.8	0.1427
% forb cover	13.6 (0–95)	23.5	8.9 (0–100)	13.9	0.8202
% grass cover	31.4 (0–100)	25.3	44.1 (0–100)	28.9	0.0793
Maximum vegetation height (cm)	23.1 (3–60)	10.6	31.1 (0–137)	14.5	0.0021*
Average vegetation height (cm)	11.5 (3–35)	5.3	14.2 (0–137)	11.9	0.2226
% total rock cover	61.6 (15–99)	17.3	36.8 (0–90)	23.5	0.0027*
Presence of prairie dogs	0.6 (0–1)	0.5	0.3 (0–1)	0.4	0.1111

by Mountain Plovers and the larger surrounding area (Table 2). The 14 habitat parameters we measured separated 100% of nest sites from randomly selected sites (Fig. 1). Stepwise discriminant analysis indicated that, in addition to prairie dog presence, percentage total rock cover ($F = 14.555$, $P = 0.0007$) and number of species of forb ($F = 2.413$, $P = 0.1319$) were the most important habitat variables in predicting whether a plot was from a nest or random site. Mean percentage total rock cover at nest sites was 61.6%, which was significantly higher than randomly selected sites (36.8%, $P = 0.0027$). Although stepwise discriminant analysis did not show maximum vegetation height as a principal factor in determining the type of site, a Wilcoxon 2-sample test demonstrated that maximum vegetation height was significantly shorter at nest sites than at random sites ($P = 0.0021$; Table 2). After young left the area in July, maximum plant height at nest sites was measured at 23.1 cm, and average vegetation height was 11.5 cm. Mean vegetation height at nest sites in Montana measured at a similar time during the season was only 4.35 cm (Olson and Edge 1985), and in Wyoming <10 cm (Parrish et al. 1993). Graul (1975) recorded the mean height of blue gramma–buffalo grass in Colorado at <8 cm in April. Although vegetation is slightly taller in Utah, percentage total plant cover is similar to other breeding areas. For example, Utah mean plant cover at nest sites was 29.6%, cover in Montana was 38.7% (Olson and Edge 1985), and in Wyoming 26.4% (Parrish et al. 1993). We assumed that component groups (shrubs, grasses, cacti), which make up percentage total cover, were independent, and we found no significant differences when sites in Utah were tested against sites in Montana ($P = 1.6797$) and Wyoming ($P = 1.711$). Mean percentage grass cover in Colorado was even higher at 68% (Knopf and Miller 1994). Conversely, Utah had a high percentage of open space between plants (about 70%), and Knopf (1994) suggested that Mountain Plovers have a minimum requirement of 30% bare ground.

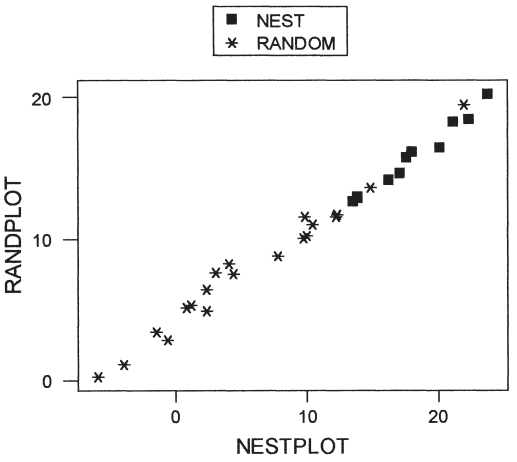

Fig. 1. Discriminant analysis of 1998 nest (n = 11) and random (n = 20) sites. Each point is plotted by its score as a nest category (x-axis) and as a random category (y-axis). All nest points were correctly classified as nests; 75% of random points were correctly classified as random.

Mountain Plovers did not select bare areas for actual nest sites in Montana (Olson and Edge 1985), but rather preferred the increased visibility created by open spaces near nest sites for foraging and other activities.

Habitat data were collected each field season after young left the vicinity of the nest. Results from the 3 seasons differ in the number of sample nest points and, during 1996, location of random points. There was also overall variance between years in annual vegetation growth. To account for these differing sets of data, years were examined separately and then together (Table 3). Because in every year some nest sites were locations used by Mountain Plovers in previous years and some were current season sites only, we performed separate tests for each year with and without old nest sites. Results from the current year's nest sites only must be regarded cautiously as the sample size is small. Significant differences occur between years of data collection in percentage total vegetation cover, maximum and average plant height, and number of forb species present. Such variation likely correlates with each year's precipitation, though rainfall data were not recorded. Of 6 contrasts between nest and random sites, 4 showed percentage rock cover significantly higher at nest sites than random sites. Three contrasts showed maximum vegetation height at nest sites significantly lower than random sites. As rock cover is interpreted to represent open space, these results are consistent with other studies that describe Mountain Plover habitat as having short vegetation with a bare ground component of at least 30% (Knopf and Miller 1994). Despite differences between the Uinta Basin and shortgrass prairie habitats, the combination of these ecological components in Utah is compatible with Mountain Plover needs, and the small population maintains a rather consistent number of individuals. We do not have data, however, to indicate whether this small population is a separate deme or draws individuals from elsewhere to maintain its numbers.

Insect collections taken from both nest and random sites were similar. Twelve orders were represented, with Hymenoptera (31.0%) and Orthoptera (23.0%) collected most often (Fig. 2). The average number of insects collected at nest sites was 16.6 ($s = 6.53$), and at random sites 17.5 ($s = 6.19$). There was no significant difference in diversity of insects between nest and random sites collected early in the breeding season ($P = 0.4384$), or those collected late ($P = 0.1864$). Mountain Plover diet consists mainly of arthropods. Baldwin (1971, as cited in Knopf 1996) found ground-dwelling beetles to account for 60% of the diet by mass, with grasshoppers and crickets 24.5% and ants 6.6%. These groups were represented in the Myton Bench collections. In Montana ground-dwelling beetles were found in significantly greater numbers on black-tailed prairie dog towns than off towns (Olson 1985). Although coleopterans and orthopterans constituted >85% of the summer diet of Mountain Plovers in Colorado, they showed much more flexibility in selecting food items than expected during winter. A comparison of diets of Mountain Plovers from 3 different sites in California showed diversity in frequency of different arthropod orders taken across sites. Collectively, coleopterans were still important (25.9%), while hymenopterans were 2nd most common at 24.9% (Knopf 1998). In this study collecting was opportunistic, and consequently all invertebrates potentially available to the Mountain Plover as a food source may not be represented. However, any bias that may exist in this method would be the same for both nest and random sites. Insect availability on and off prairie dog towns in Montana was very similar, but Olson's (1985) findings suggested prey vulnerability was greater on dog towns because of short, sparse vegetation. Mountain Plover foraging consists of short runs and then brief stops to survey the ground for insects (Knopf 1996). The open space and short vegetation of the shrub-steppe habitat in the Uinta Basin is likely favorable to this foraging behavior.

The Mountain Plover breeding site in Utah is unique compared with other breeding areas because of its shrub-steppe habitat structure. As the breeding range of Mountain Plovers shrinks with increased development of native shortgrass prairies, perhaps this species is being pushed to adopt alternative habitats. The Uinta Basin is home to a combination of floral and faunal species that provide ecological elements comparable to other areas in which the Mountain Plover is known to breed, but further study is needed to understand the relationship of members of this population to other breeding groups, as well as the full extent of Mountain Plover breeding populations in Utah.

TABLE 3. Comparisons of habitat parameters using Wilcoxon 2-sample tests. Data were analyzed for each year's current nest sites, and also with all known nest sites at the time of data collection. Randomly selected points ($n = 20$) in 1996 were different from points sampled in 1997 and 1998. Data between years were also examined. *P*-values indicating a significant difference at the $\alpha = 0.05$ level are reported.

Variable	1996 v. 1997 v. 1998	All years nest v. all years random	1996 nest ($n = 3$) v. 1996 random	1998 nest ($n = 5$) v. 1998 random	1998 nest ($n = 11$) v. 1998 random	1997 nest ($n = 6$) v. 1997 random	1996 nest ($n = 6$) v. 1996 random
% total vegetation cover	0.0001					0.0381	
% shrub							
% forb							
% grass		0.0269					
Maximum vegetation height (cm)	0.0001	0.0142		0.0022	0.0021		
Average vegetation height (cm)	0.0001			0.0381		0.0514	
Number of shrub species							
Number of forb species	0.0023						
Number of grass species							
Presence of prairie dogs		0.0391		0.0275			
% total rock cover		0.0001		0.0381	0.0027	0.0136	
% small		0.0082			0.0389		
% medium		0.0011		0.0351	0.0286		0.0137
% large		0.0158			0.0404		

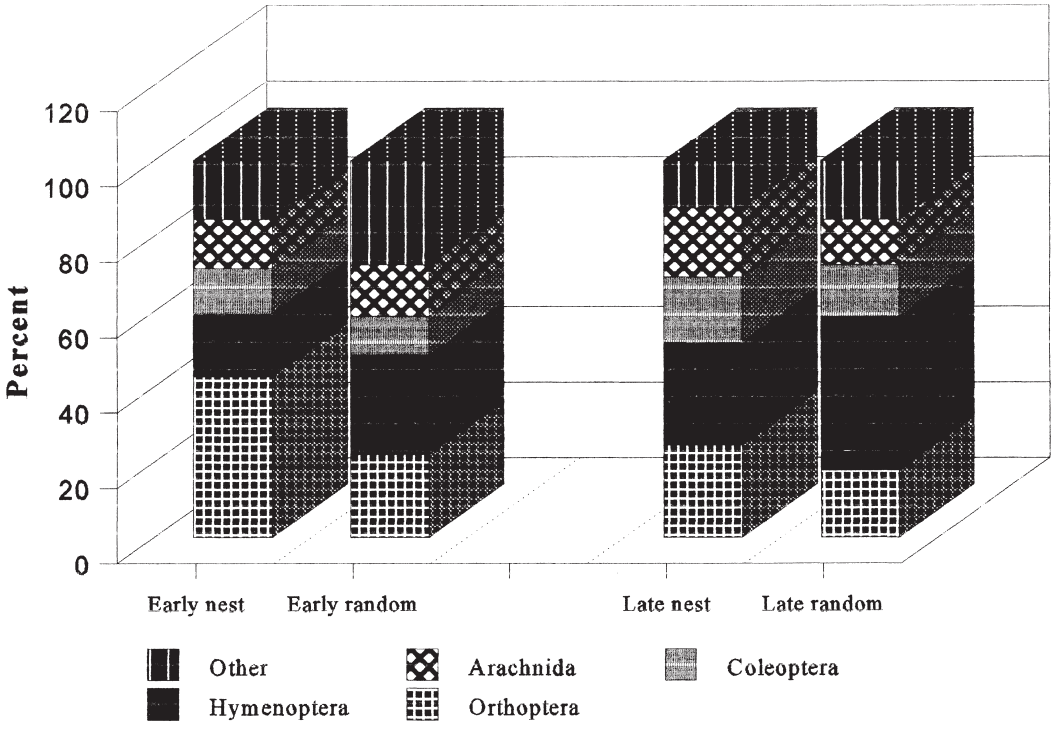

Fig. 2. Insect collections from Mountain Plover nest sites and randomly selected sites taken before nesting (early) and after young left the site (late). The 4 major orders collected are represented.

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