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USE OF CULTIVATED FIELDS BY BREEDING MOUNTAIN PLOVERS IN COLORADO

FRITZ L. KNOPF AND JEFFERY R. RUPERT

Abstract. Populations of breeding Mountain Plovers (*Charadrius montanus*) in North America declined an average of 3.7 percent per year from 1966 through 1993, resulting in a 63 percent total decline during that period. This decline led to listing the species as a Candidate Species under the federal Endangered Species Act. Mountain Plovers have been observed nesting on cultivated fields, but nest loss may be high on these sites. During the 1994 breeding season we surveyed Mountain Plover use of contiguous cultivated and native-prairie sites in Weld County, Colorado. Birds used both sites equally in April. The cultivated field was planted in early May, which probably destroyed nests and resulted in plovers reinitiating courtship and renesting. No resurgence of courtship was observed on native prairie during the same period. Observations of Mountain Plovers with radio transmitters during the 1994 breeding seasons revealed that some of the birds that lost nests or chicks on native prairie moved to the recently cultivated field to forage. Two of three Mountain Plovers that hatched eggs within 2 kilometers of the cultivated field moved chicks onto that field until the chicks fledged. We conclude that cultivated fields provide acceptable, and locally valuable, feeding habitat for Mountain Plovers. Because Mountain Plovers have also been reported to nest on plowed ground from Nebraska to Oklahoma, however, and because 31.9 percent of native habitats in the southwestern Great Plains have been cultivated, we also conclude that mechanical working of fields during the nest and early chick phases may contribute to the 3.7 percent annual rate of decline of this species. Four management options are suggested to improve Mountain Plover recruitment on and near cultivated lands.

EL USO DE CAMPOS CULTIVADOS EN COLORADO POR PARTE DE LOS CHORLITOS LLANEROS EN REPRODUCCIÓN

Sinopsis. Las poblaciones en reproducción de Chorlitos Llaneros (*Charadrius montanus*) en América del Norte disminuyeron en un promedio de 3,7 por ciento por año desde 1966 hasta fines de 1993, lo que se tradujo en una disminución total de un 63 por ciento durante aquel período. Esta disminución produjo la clasificación de la especie como Especie Candidata estipulada en la ley federal Endangered Species Act. Se han observado Chorlitos Llaneros haciendo sus nidos en campos cultivados, pero la pérdida de nidos puede ser alta en estos sitios. Durante la estación de reproducción en 1994 censamos el uso por parte del Chorlito Llanero de dos clases de sitios llaneros contiguos, cultivados y nativos, en el Condado de Weld, Colorado. En abril las aves usaron ambos sitios con la misma frecuencia. Se sembró el campo cultivado a principios de mayo, lo cual probablemente destruyó los nidos e indujo a los chorlitos a reiniciar el cortejo y a hacer los nidos nuevamente. No se observó ningún resurgimiento de cortejo en la llanura nativa durante el mismo período. Las observaciones de Chorlitos Llaneros con radiotransmisores durante las estaciones de reproducción de 1994 revelaron que algunas de las aves que perdieron sus nidos o sus pollos en la llanura nativa se mudaron al campo recién cultivado para forrajear. Dos de tres Chorlitos Llaneros que criaron pollos dentro de 2 kilómetros del campo cultivado trasladaron sus pollos allí hasta que volaron. Concluimos que los campos cultivados proveen un hábitat alimenticio aceptable y localmente valioso para los Chorlitos Llaneros. Sin embargo, dado que la información da cuenta de que los Chorlitos Llaneros hacen sus nidos en terreno arado desde Nebraska a Oklahoma, y como un 31,9 por ciento de los hábitats nativos en el suroeste de la Gran Llanura han sido cultivados, concluimos asimismo que la labranza mecánica de los campos durante las fases del nido y de los pollos nuevos puede explicar en gran medida la tasa anual de disminución de 3,7 por ciento en esta especie. Se sugieren cuatro opciones para mejorar el restablecimiento del Chorlito Llanero en terrenos cultivados y cerca de los mismos.

Key Words: *Charadrius montanus*; Colorado; Mountain Plover.

The Great Plains grasslands are the most endangered ecosystem in North America (Samson and Knopf 1994). As a group, grassland birds have shown the most universal and most severe declines of all native bird species, including neotropical migrants (Knopf 1994). Breeding populations of Mountain Plovers (*Charadrius montanus*) declined 63 percent from 1966 to 1993, despite what appeared to be normal rates of productivity in native habitats (Miller and Knopf 1993) and high adult survival (Knopf and Rupert 1995). Because of this decline, the U.S. Fish and Wildlife Service has listed the species as a Candidate Species for Threatened or Endangered status under the federal Endangered Species Act.

Mountain Plovers nest across the western Great Plains and eastern Colorado Plateau region, with a core breeding area in Weld County, Colorado (Graul and Webster 1976). The species nests in areas of shortgrass prairie historically grazed by native herbivores and currently managed as rangeland for domestic herbivores or as dryland (non-irrigated) farms.

The breeding biology of Mountain Plovers is best known from studies at the Pawnee National Grassland in northcentral Colorado. Nests are usually located in areas of native shortgrass prairie dominated by blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloë dactyloides*; Graul 1975) with the area around nests being 30% or more bare ground (Knopf and Miller 1994). Chicks leave the nest shortly after hatching and often move more than 1 km from the nest site (Knopf and Rupert 1996). Chicks raised on these grasslands generally use disturbed sites (e.g., areas that have suffered locally severe overgrazing, roadsides), especially where some forbs have invaded (Graul 1975).

Breeding Mountain Plovers forage, and occasionally nest, on cultivated fields near native shortgrass-prairie landscapes. Since the early 1990s, nesting on such fields has been relatively common in areas along the eastern boundary of the shortgrass-prairie region, from Texas to Wyoming (Shackford 1991; J. Shackford, pers. comm.). During our ongoing studies of Mountain Plovers in Colorado, we conducted a periodic survey of plover use of a cultivated field contiguous to native-prairie habitat on the Pawnee National Grassland. In this paper we document relative use of native versus cultivated sites; describe habitats used for nesting and brood-rearing on native prairie; and document movements of birds that indicate that this species readily uses cultivated fields during the nesting and brood-rearing periods of the reproductive cycle.

METHODS

We studied Mountain Plovers on the Pawnee National Grassland, a 780-km^2 shortgrass prairie in Weld County, Colorado, during the 1992–1994 breeding seasons. Graul (1973) summarized the physiography, vegetation, and climate of this region.

In 1993 many cultivated fields within 2 km of our study area were left fallow during the April–July breeding season. In 1994 one field contiguous to the study area was left fallow. We implemented a 20-point survey of Mountain Plovers along the fenceline separating the native prairie and cultivated field, with survey points 0.15 km apart. In 1994 we conducted 19 replications, from 20 April through 13 June. All surveys were conducted at sunrise. From each survey point we counted the number of adult Mountain Plovers we saw and/or heard on each side of the survey line. We were confident that the birds were equally visible on both sides of the survey line. Trends in the use of the two sites were compared using univariate repeated-measures analyses of variance and paired t-tests.

In 1994 we captured 26 adult birds at nests on the Pawnee National Grassland and fitted them with radio transmitters before their eggs hatched. Birds were captured with a leg snare or swing-door box trap (Knopf and Rupert 1996). We relocated each adult almost daily from the time its chicks hatched until the adult left the study area. Because the landowner denied us access to the adjacent cultivated field, we did not conduct any nest searches there, nor did we capture and fit adults with transmitters on that land.

We determined the relative coverage of grass versus bare ground around nests and brood-rearing sites (at distances of 10, 25, and 50 m in each of the cardinal directions) for 11 adult Mountain Plovers that fledged chicks in 1993 or 1994 on the Pawnee National Grassland. Twelve 0.5-m^2 plots were photographed at each nest and brood-rearing site after Knopf and Miller 1994, except that in our study we took photographs in all four cardinal directions. A clear dot-grid was placed over each photograph to determine the percentages of area in grass or bare ground. We also recorded frequencies of cow manure piles and prickly pear cactus (*Opuntia* spp.).

RESULTS

Population Surveys

Mountain Plovers were easily detected from distances up to 150 m away. Individuals occasionally could be seen from two adjacent survey points, in which case they were recorded only for the first point. Plovers moved freely back and forth between the cultivated field and native prairie. We frequently watched individual birds walk from one side of the fenceline to the other during a survey. Repeated-measures analysis of variance revealed no difference in the number of Mountain Plovers detected on native and cultivated sites throughout the survey season (20 April–13 June; $F = 1.35$, $df = 16$, $P = 0.16$).

The number of Mountain Plovers using native-prairie ($\bar{X} = 12.5 \pm 4.24$) and cultivated ($\bar{X} = 12.5 \pm 4.12$) sites ($t < 0.01$, $P > 0.99$) and the pattern of use ($F = 0.79$, $df = 6$, $P = 0.58$) were similar in the first 7 of the 19 surveys we conducted (Fig. 1). The number of birds peaked on the third survey but then declined markedly through the seventh survey. Between 3 and 6 May the cultivated field was chemically treated for weeds and planted. In the eighth survey, Mountain Plover detections on native prairie remained low, whereas detections on the cultivated field peaked sharply (Fig. 1). Birds at this time were seen only foraging on native prairie but were seen mostly advertising territories and courting on the cultivated field (see Knopf 1996b for review of behaviors).

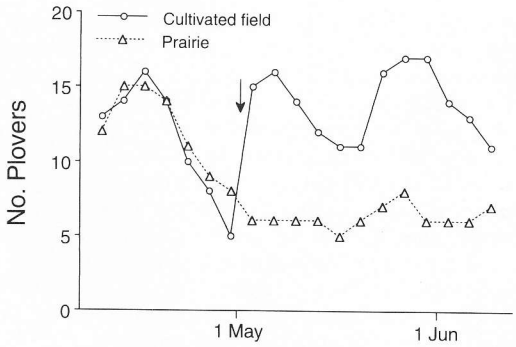

FIGURE 1. Number of adult Mountain Plovers detected on paired plots at a native-prairie and cultivated-field interface in Weld County, Colorado, in 1994. Plotted values are 3-point running means; statistics presented in text were calculated on raw data. The arrow indicates the date when the cultivated field was planted.

In the remaining 11 surveys, numbers of Mountain Plovers detected on native prairie remained relatively constant (Fig. 1). Numbers on the cultivated field peaked for a third time in the fifteenth survey, 36 d into the survey period (May 25); no courtship behaviors were seen at this time. The number of plovers detected was greater ($t = 5.47$, $df = 6$, $P = 0.002$) on cultivated ($\bar{X} = 13.9 \pm 4.30$) than on native-prairie ($\bar{X} = 6.1 \pm 1.95$) sites in the last seven surveys, when all courtship behavior had ended on the cultivated field.

Movements to Cultivated Fields

After losing a nest or chicks, adult Mountain Plovers sometimes stayed in the study vicinity. After losing chicks to predators in mid-July 1994, 2 of 17 adults with transmitters moved to forage on recently cultivated fields. These individuals remained on the cultivated fields 3–5 d as part of a loose flock that varied from 35 to 55 individuals.

We often saw Mountain Plovers with small chicks on cultivated fields near our study site. In 1994 we monitored the movements of three adults with transmitters that had nested on the Pawnee National Grassland within 2 km of a cultivated field. Two of those adults moved their chicks to a cultivated field within 2 d of hatching, and these families stayed on the field until the chicks fledged.

Brood Habitats on Native-Prairie Grasslands

In the Pawnee National Grassland, habitats used for brood-rearing contained more bare ground and less grass cover than did habitats surrounding nests (Table 1). Occurrences of forbs ($F = 1.80$, $P = 0.18$), prickly pear ($F = 0.01$, $P = 0.94$), and cow manure ($F = 0.14$, $P = 0.71$) were similar between nest and brood-rearing habitats.

Many Mountain Plovers nesting in the Pawnee National Grassland moved broods to the vicinity of cattle-watering tanks, which were generally devoid of vegetation for more than 20 m around the tank. To determine if birds were simply attracted to bare ground or if the presence of cattle enhanced the attractiveness of a site, we surveyed for Mountain Plovers at 56 stock tanks and compared plover presence to cattle use. Mountain Plovers occurred at 11 of 28 stock tanks with cattle but were absent at the 28 stock tanks where cattle were absent ($\chi^2 = 29.29$, $df = 3$, $P > 0.0001$). This survey indicated that Mountain Plovers are strongly attracted either to cattle or, as with cultivated fields, to recent site disturbance.

DISCUSSION

Use of Cultivated Fields

The first peak in Mountain Plover numbers was similar between the cultivated field and native prairie. Detectability of birds began to drop in both areas as individuals began incubating eggs. Birds were confirmed nesting at this time, and six nests were found on the native-prairie side of the survey line. The cultivated field was private land, and although we were not granted permission to survey for nests, we used reproductive behaviors to track breeding phenology and were confident that birds were also nesting on the cultivated field.

A second peak in Mountain Plover numbers on the cultivated field occurred immediately af-

TABLE 1. Mean (± se) percent cover of grass versus bare ground in Mountain Plover nest habitat and brood-rearing habitat, Weld County, Colorado, 1993–1994

Plot	Grass			Bare ground		
	$\bar{X}$	Z/F	P	$\bar{X}$	Z/F	P
Nest habitat	87 ± 1.6	2.4	0.001	9 ± 1.0	2.6	0.002
Brood habitat	84 ± 1.4			15 ± 1.3		

Note: Comparisons are for 11 adults that successfully raised chicks to fledging. All data are from native-prairie habitats only.

ter the field was sprayed for weeds and then planted to millet (*Setaria*). The machinery working the field probably destroyed most nests, as adults immediately began courting again. Numbers of birds detected again dropped rapidly, as clutches presumably were completed and birds began incubating.

Mountain Plover numbers on the cultivated field peaked a third time in late May, but no courtship behaviors were observed at this time. Instead, this third peak was associated with the hatching of the original nests on the Pawnee National Grassland and the movement of broods to the cultivated field to forage. One adult with a transmitter moved from the grassland to the cultivated field and remained there until its two chicks fledged.

Numbers of Mountain Plovers using the cultivated field began to decline steadily in early June (Fig. 1). This decline was likely a response to the rapidly growing millet crop which made the site less acceptable as plover habitat. Mountain Plovers require very short vegetation, which facilitates predator detection (Graul 1975). At this time, plovers with broods moved back to the Pawnee National Grassland. The fate of most nests on the cultivated field was uncertain; however, a single nest we observed daily was abandoned when the millet reached a height of about 20 cm.

Adult Mountain Plovers nesting in Pawnee National Grassland that lost all their eggs or chicks to predation sometimes moved to cultivated fields to forage, where loose flocks of 50–100 birds were common. These flocks also included some adults that had moved their chicks to the cultivated fields (Knopf and Rupert 1996). Generally, however, flocks stayed at a specific field only for a few days after it had been cultivated or planted and then moved again; this pattern is seen regularly among wintering flocks of Mountain Plovers in California (Knopf and Rupert 1995). In our study, adults with chicks either stayed on the same cultivated field until the chicks could fly or moved back to native prairie when the cropland vegetation became too tall.

Mountain Plovers as Bare-ground Associates

Mountain Plovers have evolved, as have other shortgrass-prairie birds, in an intensively grazed ecosystem dominated by bison (*Bison bison*), prairie dogs (*Cynomys* spp.), and pronghorn (*Antilocapra americana*; Knopf 1996a). In taller, mixed-grass prairies, Mountain Plovers are associated primarily with the intensive grazing found in prairie-dog towns (Knowles et al. 1982, Olson-Edge and Edge 1987). On the Pawnee National Grassland, Mountain Plovers select both nest and brood-rearing sites that have more bare ground than do surrounding areas. We do not think, however, that Mountain Plovers choose to nest specifically in areas of approximately 30% bare ground or to raise chicks in areas of approximately 15% bare ground. Rather, these percentages represent the average maximum bare ground currently available to birds on the Pawnee National Grassland.

Mountain Plovers regularly use cultivated fields on migration and in winter, as well as in the breeding season (Grinnell and Miller 1944, Laymon et al. 1986, Knopf and Rupert 1995). Knopf and Miller (1994) first concluded that Mountain Plovers are associated with bare ground, based on data collected at the nest site. Prior to that time, this species had been described as a prairie associate of blue grama and buffalo grass landscapes. During three breeding seasons (1992–1994) in Colorado, however, we found no nests in buffalo grass (N = 147). This grass reproduces asexually by sending out stolons and has a tendency to mat, thus precluding a bare-ground component for situating nests.

Breeding Mountain Plovers in Colorado use cultivated lands where range-management practices strive to protect soils and provide relatively uniform landscapes of grass cover. Most grazing prescriptions on public lands use some variation of the allotment approach to regulate stocking densities and herbage removal, thus favoring homogenous grass cover across broad landscapes (Knopf 1996c). Standardized grazing of allotments precludes areas of excessive grass/soil disturbances characteristic of native ungulate and rodent herbivores—disturbances to which Mountain Plovers have evolved. Using allotments contrasts with grazing by bison; this native grazer preferentially forages on black-tailed prairie dog (*Cynomys ludovicianus*) towns (Krueger 1986), thus maximizing grazing pressure at some sites while leaving others only lightly grazed. These intensively grazed sites provide specific habitats used by other grassland birds (Knopf 1996a).

Managing for Mountain Plovers on or Near Plowed Ground

Mountain Plovers in Colorado appear to be equally attracted to cultivated fields and grazed native prairie. Most cultivated fields, however, are usually planted to a late-season crop or are recultivated every 4–6 wk to control weeds. These activities certainly destroy some nests and chicks, which use crypsis to avoid detection (Sordahl 1991). Mountain Plovers have been documented nesting on plowed fields in Texas, Oklahoma, Kansas, Colorado, Nebraska, New

TABLE 2. RELATIVE EXTENT OF CROPLAND VERSUS NATIVE RANGELAND IN THE PRIMARY BREEDING RANGE OF MOUNTAIN PLOVERS IN THE SHORTGRASS-PRAIRIE REGION OF THE SOUTHWESTERN GREAT PLAINS

	Cropland (ha)	Rangeland (ha)	Cropland (%)
Colorado	2,760,763	6,225,134	30.7
Kansas	329,387	93,150	78.0
Nebraska	112,351	59,454	65.4
New Mexico	344,291	631,695	35.3
Oklahoma	128,223	262,845	32.8
Texas	514,310	823,527	38.4
Wyoming	167,873	1,215,203	12.1
Totals	4,357,198	9,311,008	31.9

Note: Data are from the Natural Resource Inventory, U.S. Department of Agriculture, 1994.

Mexico, and Wyoming (J. Shackford, pers. comm.). Because more than 30% of native habitats used by Mountain Plovers have been converted to cropland in this region (Table 2), we hypothesize that reduced productivity as a result of tillage may explain part of the 3.7% annual rate of decline of this species continentally from 1966 to 1993. It seems likely that cultivated fields represent regional reproductive "sinks" for nesting Mountain Plovers (Pulliam 1988).

In view of the fact that agricultural practices may play a large role in the decline of Mountain Plovers, we offer four management options to reduce nest and chick losses on cultivated fields.

1. Encourage farmers to prepare and plant fields used by Mountain Plovers in a short window of time in May and June. Fields are currently prepared weeks or even months in advance of planting.

2. If weed control is necessary during the period 1 May–15 July, encourage chemical rather than physical treatments on fields used by Mountain Plovers.

3. Mandate seeding of native grasses only and allow grazing of lands registered in the Conservation Reserve Program (CRP). Current practices often result in tame (introduced) cool-season grasses being planted on the western plains and preclude grazing in an ecosystem that evolved with intensive grazing pressure. Grazing on CRP lands will increase the amount of habitat suitable for grassland species and will also provide additional economic incentives to enroll in the CRP.

4. Management of publicly owned (or private) grazing allotments adjacent to cultivated fields could be changed to make them more attractive to Mountain Plovers during the period when the birds select nest sites. Highly intensive, long-term grazing of contiguous native grasslands should enhance nesting habitat. In addition, Mountain Plovers tend to select grasslands that are occupied by cattle or other herbivores. Cattle generally are not moved onto the Pawnee National Grassland until late May, depending on growth of the warm-season grasses. Moving cattle onto pastures in early May should further enhance the attractiveness of native-prairie sites over cultivated lands. Mountain Plovers are also attracted to recently burned grasslands (Knopf and Rupert 1995). Winter or early spring burning could be used to make native rangelands more attractive than cultivated lands for breeding Mountain Plovers.

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