FINAL REPORT

SECTION 6

ENDANGERED SPECIES ACT

FEDERAL AID PROJECT E-26

MOUNTAIN PLOVER BREEDING ACTIVITY ON CULTIVATED FIELDS

APRIL 1, 1993 - MARCH 31, 1995

FINAL REPORT

STATE: Oklahoma Project Number E-26

PROJECT TYPE: Research

PROJECT TITLE: Mountain Plover Breeding Activity on Cultivated Fields

SEGMENT DATES: 1 April 1993-31 March 1995

STUDY TITLE: Mountain Plover Breeding Activity on Cultivated Fields

I. Objective

Quantify breeding activities and nesting success of mountain plover (*Charadrius montanus*) in agricultural settings in the Oklahoma Panhandle, southeastern Colorado, and southwestern Kansas.

II. Abstract

In 1993 and 1994 we studied mountain plovers (*Charadrius montanus*), a Category 2 species, on cultivated fields during the breeding and premigratory flocking periods. The study area was southeastern Colorado, southwestern Kansas, and the western end (primarily Cimarron County) of the Oklahoma Panhandle. A total of 1,616 mountain plovers was found on a total of 310 cultivated fields; these fields were most often used for growing wheat or milo, although they were often bare when we observed them. A total of 47 nests on cultivated fields was found, of which at least 30 (24.7% of 121 eggs) chicks hatched from 15 (34.1%) nests, and at least 14 (11.6% of 121 eggs) young fledged from 8 (17.0% of 47 nests) broods. Minimum fledging success rate was 0.30 young/nest. In premigratory flocks, 273 adults and 71 young (3.8/1 ratio) were counted, yielding 0.52 fledglings for every 2 adult mountain plovers. We determined the outcome of 44 nests: 15 (34.1%) were successful (hatching at least 1 chick), and 29 (65.9%) failed. Causes of failure were: plowing up, 21 (47.7%); weather, 7 (15.9%); and predation, 1 (2.3%). We selected 71 study fields for long-term study,

visiting them at least 5 times. Study fields were observed during an average period of 82.9 days, and mountain plovers were observed on them an average of 40.7 (49.1%) days. Clearly, significant numbers of mountain plovers made a major investment in cultivated fields as breeding habitat. During the height of the breeding season (15 April through 14 July), the maximum length of time that study fields were left undisturbed (no plowing) averaged 55.6 days, more than sufficient time for mountain plover breeding activity to extend from courtship through egg hatching.

In the mountain plover study area, the following information on long-billed curlews (Numenius americanus) on 36 cultivated fields also was recorded: 108 adults, 2 nests, 9 precocial young in 3 broods, and 1 fledged young in 1 additional brood.

III. Procedures

Ten Soil Conservation Service soil survey books (OK, 2; CO,4; KS, 5) were examined to identify potential nesting areas of mountain plovers on cultivated fields during the 1993 and 1994 breeding seasons. The study was conducted in southeastern Colorado, southwestern Kansas, and the western end of the Oklahoma Panhandle, primarily Cimarron County. We were in the field a total of 82 days: 43 days in 1993 from 6 April through 18 August and 39 days in 1994 from 19 April through 31 July. Searches were concentrated during morning and evening when mountain plovers were easiest to locate because of their increased activity. We divided observations of mountain plovers into two primary "seasons": the breeding season from 6 April through 14 July, and the premigratory flocking season from 15 July through 18 August.

In late May, 71 fields (35 in 1993 and 36 in 1994) were randomly selected as study fields from a total pool of 123 qualifying fields (52 in 1993 and 71 in 1994). To qualify for selection, a field had to have had $\geq$1 mountain plovers engaged in breeding behavior/activity between 15 April through 20 May. The intent was to exclude fields with mountain plovers that might have exhibited breeding behavior early, before they had actually selected a specific breeding site. Five of the study fields (7.0%) were studied in both 1993 and 1994. Each study field selected was visited at least 5 times during the breeding and premigratory flocking seasons. On each visit to a study field, we gathered data on mountain plover breeding activity, field size, most recent crop type, estimated last plowing date, etc.

Certain analyses relevant to breeding were based on the period from 15 April through 14 July, which we considered the period of most intense plover breeding. The height of the breeding season was further divided into an "early" breeding period from 15 April through 20 May. The reasons for dividing the breeding period in this way were to (1) establish a baseline from which to determine if plovers remained on a field, even if it was plowed, from the early breeding period to the latter part of the breeding season, and (2) determine renesting attempts if they remained. Also, we wanted to quantify how researcher efforts on study fields affected results over time by comparing the results from study fields, where data were gathered over the entire breeding season, to the results from qualifying fields that were not selected as study fields, where data were gathered early in the breeding season only.

We used criteria developed by Shackford (1991; unpubl. data) between 1986-92 to identify fields likely to attract mountain plovers; i.e., those fields having (1) fine loamy soils, (2) large size (>30 ha), (3) sparse vegetation/stubble cover (typically turned-under wheat), (4) flat topography, and (5) uniform, flat plowing. In addition to the 123 fields qualifying for study fields, we also observed plovers in other fields. For plover observations in every field, plus any subsequent visits at these fields, we recorded the same data as that recorded in study fields.

Three techniques were used to identify breeding activity: (1) watching for plovers while slowly driving perimeters of cultivated fields; (2) scan surveys of suitable fields with a 10x binocular or a 15x spotting scope; and (3) listening for plover calls and occasionally playing taped mountain plover calls to elicit responses. All nests located in the 71 study fields were monitored until they hatched, were destroyed, or were abandoned. When nests were found off study fields, they also were monitored.

We estimated the number of precocial chicks and fledged young resulting from all cultivated field (i.e., study fields, qualifying fields, etc.; n=47) nests to calculate minimum hatching and fledging rates. Fledging rate also was quantified by comparing the number of adults and fledged young after 14 July, when premigratory flocking began. Mountain plovers were classified as adults or fledged young by their plumage when possible. Because adults usually could be classified at a slightly greater distance than fledged young, we excluded any adults observed beyond the limit at which we could verify fledged young to exclude a bias (because the birds were in flocks, this distance was usually easy to determine).

A "study site" was defined as a study field (or fields) and all other cultivated fields with mountain plovers that touched the study field(s) either directly or indirectly (i.e., through another non-study field with plovers). Observed breeding activity was summarized in descending order of probability that ≥1 mountain plovers had a breeding territory (or territories) on a particular field/site (i.e., nest > precocial young > copulation > scrape building, etc.).

Long-billed curlews were recorded on mountain plover study fields and other nearby areas when they were encountered. We did not specifically search for long-billed curlews.

IV. Results and Discussion

Frequencies of various nesting/breeding activities observed prior to 21 May (early nesting period) and during the entire observation period (6 April through 18 August) on both study fields and study sites are summarized in Table 1. On the 71 study fields, we confirmed 15 fields that had ≥1 nest (9 in 1993 and 6 in 1994) prior to 21 May. By 18 August the number rose to 23 study fields with ≥1 nest and 8 additional study fields with ≥1 broods of precocial chicks, or a total number of 31 study fields with confirmed nestings (18 in 1993 and 13 in 1994). Sixteen study sites were confirmed to have ≥1 nest (10 in 1993 and 6 in 1994) before 21 May. By 18 August, the number rose to 29 study sites with ≥1 nest (17 in 1993 and 12 in 1994) and 18 additional study sites with ≥1 brood of precocial young (8 in 1993 and 10 in 1994), for a total of 47 study sites with confirmed nestings (25 in 1993 and 22 in 1994) (Table 1). Nests, chicks, and/or fledged young, representing a minimum of 47 nestings, were found on 71 fields (0.66 nest/study field). A minimum of 10 nestings were found on the remaining 52 qualifying fields that were not selected as study fields (for information on how we determined qualifying fields, see Procedures, page 3). The implication was that other nestings on cultivated fields went unnoticed because we did not have time to search for them.

Study fields were checked for an average period of 82.9 days (range 72-114); plovers were observed on them an average of 40.7 days (range 1-97), or 49.1% of the total observation period. The incubation period for mountain plovers is 29 days. Because (1) the average length of time that mountain plovers used study fields was 40.7 days and (2) nesting was confirmed on 43.7% of the study fields and 66.1% of the study sites, it was apparent that mountain plover use of cultivated fields did not represent a quick, meaningless foray away from native prairie habitat. Their use represented a significant investment

in cultivated fields as breeding and nesting territories. Furthermore, we observed that mountain plovers, in virtually every case, appeared to be totally dependent upon the cultivated fields at or near a site, and not dependent upon any native prairie that might be in the area. Although breeding activity on cultivated fields was the focus of our study (and therefore the activity we most often recorded), the most common behavior observed was feeding: the bird's primary behavior on cultivated fields was nearly always its quick runs and stops as it searched for food, and often we saw plovers pick up and eat insects as they worked a cultivated field. Furthermore, for strong flyers, the birds were surprisingly sedentary, usually staying on a single field. During the heat of the day shade appeared to be very important for both adults and young; sometimes they would leave a particularly bare field for the shade of vegetation in a nearby field or at roadside. We even had the opportunity to observe some birds closely on fields that were adjacent to native prairie; almost without fail, these birds chose cultivated fields over native prairie, provided there was sufficient shade on the cultivated fields. Infrequently, when a field was plowed very cleanly, the plovers would move to adjacent native prairie, but we believe more for shade than food.

A total of 31 nests was found on 23 study fields, but 16 more nests were found, and monitored, on an additional 14 fields (range of nests/field = 1-4). Forty-four of the 47 nests had a total 121 eggs ($\bar{x}$ = 2.8 eggs/nest) when found. The remaining 3 nests were discovered just after they were plowed up; although broken egg shells were seen at each of them, the number of eggs could not be accurately determined. At least 30 (24.7% of 121 eggs) chicks hatched from 15 (34.1%) of the 47 nests. At least 14 (11.6% of 121 eggs) young fledged from 8 (17.0% of 47 nests) broods. Minimum fledging success rate was only 0.30 young/nest. In contrast, 273 adults and 71 young (3.8/1 ratio) were counted in premigratory flocks, yielding 0.52 fledglings for every 2 adult mountain plovers (an additional 645 mountain plovers in premigratory flocks were too distant to classify by age).

Neither estimate of fledging success rate was free of bias. Undetected chick/fledgling movement might have lowered the first estimate, and the fact that 2 male and 1 female mountain plovers can produce 2 nests among them (Graul 1973) could have lowered the second estimate. Additionally, we occasionally observed nesting mountain plovers in tall (=35 cm) vegetation. One nest remained active until the fast-growing wheat was at least 38 cm high. Finding some mountain plovers on fields with tall vegetation, usually by serendipity, suggested that tall vegetation, such as that found in milo stubble and growing

wheat fields, concealed other mountain plovers on study fields, which could have resulted in an underestimation of the number of mountain plovers, nests, and young on our study fields. It also might explain, at least in part, total enumeration of 23.6% more mountain plovers during the premigratory flocking period (n=989) than during the breeding period (764).

Nesting success or failure could be evaluated for 44 of the 47 nests located. Evaluation was based on nest outcomes that were either known or strongly suspected by the correlation of minimum number of days for hatching and known or estimated plowing dates, the presence of shell fragments, etc. (One excellent way to estimate the last plowing date was to use vegetation growth, or lack thereof, as an index.) Fifteen (34.1%) nests (n=44) were successful (hatching $\geq$1 chick), but 29 (65.9%) failed; causes of failure were plowing-up, 21 (47.7%); weather, 7 (15.9%); and predation, 1 (2.3%). Plowing-up of nests was the most common cause of nest failure, and plowing and weather together accounted for all but 1 of the losses.

Two storms occurred during the 1994 breeding season: a snowstorm on 5 May and a hailstorm early in June, with hailstones 13-20 mm in diameter. We confirmed the loss of 2 study nests from this hailstorm. Also, we suspected that the hailstorm killed or drove off adult mountain plovers on at least 2 study fields, because the fields were devoid of birds thereafter. Such weather, plus occasional heavy downpours, can contribute to nest failures.

On the positive side, the predation rate appeared to be quite low (2.3%) on cultivated fields. This is particularly interesting when compared with recent plover research on the Pawnee National Grassland in northeastern Colorado where the predation rate was approximately 50% (F. Knopf, Nat. Biol. Serv., pers. commun.). Thus, nest failure from all causes on cultivated fields was only about 16% higher than losses on native prairie from predation alone. Furthermore, landowner attitudes toward the plover appeared positive. We extensively discussed plover nesting on cultivated fields with approximately 12 landowners, lessees, and hired help. When we pointed out that farming may be creating new, and perhaps much-needed, breeding habitat for the species, and that the species' ultimate fate could depend on cultivated land, farmers were both intrigued and sympathetic. Two farmers went even further: 1 (and his son) located several nests for us as he was plowing, being able to avoid plowing up 2 of them, and the other farmer allowed us to spray paint around 3 nests so he could identify their location and plow around them.

Table 2 shows the results of this survey by state and county, including the number of mountain plovers found, total number of fields with mountain plovers, their total acreage, and their average acreage. We located a total of 310 cultivated fields and observed a total of 1,616 mountain plovers. This total (1,616) was the sum of adults seen in the breeding period for both years (758), plus adults and fledged young seen in the premigratory flocking period both years (989), less 131 "duplicates" seen on the same fields during both periods of the same year. Some of this total (1,616) may represent birds counted twice because the same bird (a) moved to a different field in the same year or (b) was counted separately in both years. On the other hand, we took the lowest possible number of birds on each field for the entire season as our recorded total; in taking the lowest possible total, undoubtedly additional birds were seen that were not recorded in the final tally. It was likely that additional birds went unnoticed. Furthermore, we believe that adding the number of plovers seen during both years gave the most accurate picture for the following reasons: (a) few birds were found on exactly the same fields in both years, perhaps due partly to the fact that crop and plowing regimens usually varied in alternate years, (b) new areas were explored the second year that were not covered in the first year, and (c) perhaps most importantly, the number of birds in an area appeared to vary as much as 2-3 times between years, and it was unlikely that these wide fluctuations in population were primarily the result of birds coming in from our other study areas, where populations did not decrease proportionately. Thus, whether we actually saw more or less than 1,500 birds is debatable, but we believe this figure to be a minimum estimate of the total number of individual birds that used, at least to some extent, cultivated fields in the study area. Leachman and Osmundson (1990), in a literature review of the Mountain Plover, concluded that four different sources suggested recent declines of the species ranging from 50 to 89% in distribution and/or population size; thus, the population of this Category 2 species appears to be decreasing rather rapidly. The total number of mountain plovers that we located (approximately 1,500) were on only a small part of the cultivated fields within the species' total range; thus the total number of birds breeding on cultivated fields might be much higher. Furthermore, Leachman and Osmundson (1990), using mountain plover density provided by Fritz Knopf (Service, in litt. 1986), estimated the total number of birds on the Pawnee National Grassland at 4,580; most authorities consider these grasslands to be the stronghold of the species. Our figure of 1,500 birds on cultivated fields represents a third of that number--birds that have not previously been counted as part of the breeding population.

The total acreage where mountain plovers were found in Cimarron County, Oklahoma, was 11,336 acres (11,768 acres minus 432 acres of fields sampled in both 1993 and 1994) (Table 2). The total number of acres of all cultivated fields in the county was estimated at 387,701 acres in 1992 (U. S. Department of Commerce 1992); thus, the cultivated land on which we found mountain plovers was only 2.9% of the total acreage of plowed fields in the county.

During the 1993 and 1994 breeding seasons, we located mountain plovers on cultivated fields in 6 new counties: Baca, Cheyenne, Kiowa and Prowers counties in Colorado and Grant and Stanton counties in Kansas. A field in Grant County, Kansas, with 5 mountain plovers (Table 2) was the easternmost record to date of plovers on cultivated land. Prior to this study, Shackford (1991) found mountain plovers nesting or engaged in breeding behavior on cultivated fields in Cimarron County in Oklahoma in 1986 and in 1992 (Shackford, unpubl. data) in the following counties: Washington and Weld (CO), Greeley, Hamilton and Morton (KS), Kimball (NE), and Laramie (WY). Wershler (1989) reported a mountain plover nest on a cultivated field in Alberta, Canada, in 1988.

Field size averaged 147.0 acres (Table 2). Present or previous vegetation types on those fields where it could be determined (n=208) were: wheat (n=132, 63.4%); milo (38, 18.3%); weeds (24, 11.5%); corn (12, 5.8%); barley (1, 0.5%); and sunflower (1, 0.5%). On the 71 study fields during the height of the breeding season (15 April through 14 July), the average interval between 2 plowings on a field, when multiple plowings occurred (n=52), was 33.9 days. More importantly, however, the maximum length of time the 71 study fields were left undisturbed (no plowing) averaged 55.8 days, with all field types undisturbed, on average, $\geq$48.0 days (Table 3). Because incubation for mountain plovers is 29 days, this left, on average, almost a month (26.8 days) of undisturbed time for courtship, nest building, and egg laying. Courtship and nest building can be as brief as 11 days; Graul (1973) reported that 2 females began second clutches 11 and 13 days after completion of the first clutches in a multi-clutch system. Although Graul (1975) reported egg laying intervals as long as 4.5 days, most of the intervals that he was able to determine were between 1.4 and 2.0 days. Thus, courtship through egg hatching apparently can occur in 46-50 days, about 10 days less than the 55.8 days of undisturbed time averaged on our study fields. However, precocial young also are vulnerable to plowing. The maximum number of days fields of growing wheat and milo stubble were left undisturbed averaged 89.8 and 72.0 days, respectively (Table 3), and nest and fledgling success of

mountain plovers on those fields could be high. Wheat was the primary crop in all study areas, usually >>50% of the cultivated fields that produced a crop that year.

During the heat of the day (ca. 1100-1700 hrs), mountain plovers usually sought shade beneath vegetation. Within large relatively bare fields, plovers could often be located during mid-day by carefully checking shaded areas under sparse vegetation. This greatly decreased the search area and increased search effectiveness at a time of day when birds were usually hard to find.

A total of 108 adult long-billed curlews was located on 36 cultivated fields. Two curlew nests were found on cultivated fields; both fields were mountain plover study fields that were bare of vegetation (Shackford 1994). In addition, 3 precocial broods (4, 4, and 1 chicks) and an additional brood with 1 fledged young also were found on cultivated fields. The 36 fields with curlews were distributed, by county, as follows: 28 in Cimarron (OK), 6 in Kiowa (CO), 1 in Hamilton (KS), and 1 in Morton (KS). Field type was recorded for 34 of the 36 cultivated fields. The most commonly used field types were bare fields (23) and wheat fields (8). Wheat fields were seldom disturbed during the breeding season (Table 3); thus, curlews nesting there could have relatively high nesting success. The long-billed curlew was downlisted from Category 2 to Category 3C in November 1991. Long-billed curlews fledged from nests in wheat fields might contribute significantly to their overall population, because curlews were seen there frequently (Shackford 1994), and wheat was the primary crop type in the study area. However, nests in maturing wheat fields would be particularly difficult to find because of the tall vegetation, and to our knowledge none have been discovered there.

Warren D. Harden and Melynda Hickman (ODWC), both of Norman, Oklahoma, made significant contributions to the data presented herein.

V. Recommendations

Until 1986 (Shackford 1991), researchers believed that virtually all mountain plovers nested on native prairie. With the recent discovery of extensive nesting on cultivated fields, it is likely that large numbers of this Category 2 species may have been overlooked (and therefore not counted) on cultivated fields in the past. If this is the case, it is likely that the mountain plover is not as habitat limited as once believed. Thus, these "new" populations ultimately may result in significantly increased population estimates and/or important revisions

in our understanding as to where the species is concentrated. We believe that further research is clearly warranted. Research on the relationship between mountain plovers and cultivated land would be particularly productive in the following areas: (1) geographic limits, (2) field type limits, (3) relative abundance and nesting success on cultivated vs. native prairie habitats (preferably where both habitats exist in close proximity) to evaluate if cultivated land is a population "sink," and (4) habitat selection where cultivated fields are adjacent to native prairie and what aspects, specifically, attract the plover to the preferred habitat. With support from the National Biological Service, we plan to further explore the geographic limits of mountain plover nesting on cultivated fields during the 1995 breeding season.

As the mountain plover is reviewed for endangered species status, we believe a thorough assessment of the species status on cultivated land is necessary. Results indicated that cultivated land was important to the mountain plovers in our study area, even though our study area covered only a part of the available (cultivated) habitat within the species' range. If cultivated fields are determined to be a population "sink" for the species, we suggest contacting farmers to encourage them to use easily implemented, wildlife-sensitive, farming practices. One such idea is to plow/harvest fields from the center of the field outward (Mooney 1995); this increases the probability that chicks (of mountain plovers, pheasants, quail, etc.) will escape outward to surrounding fields. The traditional way of plowing, from the outer edge inward, can herd chicks toward the center of the field where they are plowed under in the last passes of the plow or, surviving that, are exposed to predators in the freshly plowed field that now has no cover. Should it become necessary, biologists might contact farmers to avert the plowing under of known nests. One nest during our study successfully hatched chicks after a farmer purposely plowed around it and left the nest in a circle of unplowed ground only 0.5 m across.

Also, we believe that further scientific exploration on the relationship between long-billed curlews and cultivated fields, especially wheat fields, is warranted.

VI. Significant Departures

Twenty-five soil samples were collected in 1993 and analyzed for particle size by attempting to pulverize the many small clods in each sample to their "real" particle makeup and then passing each sample through a series of sieves. Results as reported in the 1994 Annual Performance Report suggested that soil samples near nests (n=22) contained more silt/clay (43.4%) and less sand

(55.2%) than 3 samples from cultivated fields where mountain plovers did not nest (silt/clay, 19.5%; sand 79.9%). However, we cannot conclude that these differences are statistically meaningful because of: (1) the small sample size from unused fields and (2) problems associated with the only method available to us to analyze the 1993 samples. Soil scientists from Oklahoma State University advised us after we had analyzed our 1993 samples that the heretofore widely used approach of passing soil through a series of sieves (the method mutually agreed on to be used in this study because of its cost-effectiveness) is no longer believed to provide defendable results because samples are rarely reduce to individual particles. This is most problematic for fine-textured soils with small clods, like ours. Dependable chemical methods exist but they are costly (ca. $25/sample) and were not budgeted for in this project. As a result, we have not analyzed the 1994 samples (22 from nest areas) to avoid providing misleading results. Samples from both 1993 and 1994 will be analyzed with the proper approach in fall 1995 with base support from the Oklahoma Cooperative Fish and Wildlife Research Unit to provide: (1) a statistical comparison of the 2 methods and (2) reliable data on the particle/size characteristics of plover nest sites on cultivated fields. Results will be delivered to the Oklahoma Department of Wildlife Conservation after analyses are completed.

Although originally proposed, we have not delivered 7.5-minute topographic maps of nest locations because: (1) 14 maps from 3 states would be required to record all nests; (2) field layout, size, and location in most areas is likely dynamic and will change in time; and (3) based on our observations over 2 years, individual mountain plovers likely relocate to various field in a general area depending on prevailing agricultural practices (e.g., an area cultivated in 1994 but unplanted in several subsequent years will likely not be used). We submit that at this point in management of the mountain plover, the fact that a sizeable number of them nested on cultivated fields over a multi-state area is important but their precise year-to-year locations are of limited value. Our current work (summer 1995) with support from the National Biological Service indicates that mountain plovers also use cultivated fields in Nebraska, Wyoming, and Montana, and we have located the species on cultivated fields in several more counties in eastern and central Colorado.

VII. Literature Cited

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VII. Prepared by: John S Shackford

J. S. Shackford and D. M. Leslie, Jr

Oklahoma Cooperative Fish and Wildlife

Research Unit, Stillwater, OK

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Approved: Oklahoma Department of Wildlife

Conservation

By: Harold Namminga

Harold Namminga, Federal Aid Coordinator

Oklahoma Department of Wildlife

Conservation

Date: 18 July 1995

Table 1. Mountain plover breeding activity on 71 cultivated fields in Oklahoma, Colorado, and Kansas in 1993 and 1994. Data presented by study fields and study sites (see text for definition).

Breeding/ Breeding Activity[1]	Study fields, prior to: 22 May (%)	Study fields, prior to: 18 August (%)	Study sites, prior to: 22 May (%)	Study sites, prior to: 18 August (%)
Total Confirmed	15 (21.1%)	31 (43.7%)	16 (22.5%)	47 (66.1%)
Nest	15 (21.1%)	23 (32.4%)	16 (22.5%)	29 (40.9%)
Precocial young	0 (0.0%)	8 (11.3%)	0 (0.0%)	18 (25.4%)
Total Probable	56 (78.9%)	40 (56.3%)	55 (77.5%)	24 (33.8%)
Feeding Hurriedly[2]	1 (1.4%)	1 (1.4%)	1 (1.4%)	0 (0.0%)
Copulation	1 (1.4%)	0 (0.0%)	1 (1.4%)	0 (0.0%)
Scrape display/building	9 (12.7%)	6 (8.5%)	9 (12.7%)	6 (8.5%)
"Pick-toss" nest/scrape matter	1 (1.4%)	3 (4.2%)	2 (2.8%)	2 (2.8%)
Male courting female	1 (1.4%)	1 (1.4%)	4 (5.6%)	0 (0.0%)
Courtship flights[3]	19 (26.8%)	15 (21.1%)	24 (33.8%)	11 (15.5%)
Courtship calls	19 (26.8%)	13 (18.3%)	12 (16.9%)	5 (7.0%)
Adults in breeding season[4]	5 (7.0%)	1 (1.4%)	2 (2.8%)	0 (0.0%)
TOTALS	71 (100.0%)[5]	71 (100.0%)	71 (100.0%)	71 (100.0%)

Table 1. (cont.)

1-See text for explanation of the order of breeding behavior/activity and definition of "study site."

2-Feeding plovers usually average about a 3-second pause between short "runs" (usually about 4-8 steps); feeding birds which averaged about 1 second between runs were confirmed several times to be incubating adults off the nest; they apparently fed swiftly so as to return quickly to incubation.

3-Simultaneous calls usually heard, assuming distance was not too great.

4-Two or more plovers (but not necessarily both sexes) during breeding season and in apparently good cultivated field breeding habitat.

5-All columns do not round off precisely to 100.0%.

Table 2. Numbers of mountain plovers and cultivated fields with total acreage and average field size in Oklahoma, Colorado, and Kansas in 1993 and 1994.

State County	# of plovers[1]	# of fields[2]	Total # acres[2]	Average field size (acres)
Oklahoma-Cimarron	536[3]	87	11,768.0	135.3
Colorado	890	181	29,326.0	162.0
Baca	3	2	240.0	120.0
Cheyenne	5	2	360.0	180.0
Kiowa	879	175	28,546.0	163.1
Prowers	3	2	220.0	110.0
Kansas	190	42	6,230.0	148.3
Grant	5	1	160.0	160.0
Greeley	2	3	320.0	106.7
Hamilton	88	21	3,696.0	176.0
Morton	90	16	1,734.0	115.6
Stanton	5	2	320.0	160.0
TOTAL	1616[4]	310	47,324.0	152.7

1-Includes adults seen during breeding period (6 April-14 July), as well as adults and fledged young during premigratory flocking period; any mountain plovers seen early in the season and believed to be in migration were not included.

Table 2. (cont.)

2-A small percentage of these fields and acres (<5%) were used in both years; however, because field size, crop, plowing regimen, and number of plovers could vary between years, these few "duplicates" have been considered here as separate fields. This simplifies certain aspects of the table (such as calculation of average field size) without significantly altering results.

3-Shackford, in a 1986 Cimarron County study of 5 rare species including the mountain plover, offered an estimate of only 67-133 plovers in the county; the higher number here reflects better censusing of plovers on cultivated fields in 1993 and 1994 rather than an actual increase in the number of birds.

4-See plover population comments on page 12-13.

Table 3. Study field utilization and plowing[1] analyses during mountain plover breeding season[2] in 1993 and 1994.

		Summer Fallow[3]				Crop		
	TOTAL	Bare Field[4]	Wheat Mulch[5]	Milo Stub	Wheat Stub	Milo	Wheat	Corn
Study field use (%)	71 (100.0)	43 (60.6)	3[6] (4.2)	2 (2.8)	1 (1.4)	15 (21.1)	4 (4.2)	3 (5.6)
Max.# days fields undisturbed on ave.[7]; range	55.8 (n=71) 29-91	53.5 (n=43) 29-91	55.0 (n=3) 36-72	72.0 (n=2) 53-91	48.0 (n=1) 48-48	52.5 (n=15) 31-71	89.8 (n=4) 86-91	51.3 (n=3) 35-61
Ave.# days between plowings	33.9 (n=52)	33.6 (n=35)	26.0 (n=1)	NA	NA	36.5 (n=13)	NA	29.3 (n=3)
Ave.# plowings/ season	1.6 (n=113)	1.7 (n=74)	1.3 (n=4)	0.5 (n=1)	1.0 (n=1)	1.8 (n=27)	0.3 (n=1)	1.7 (n=5)

Table 3. (cont.)

Expected rate of plowing	low to high	low to high	low	low	low	medium	very low	high
Type of plowing	all types	haro[6] fert	haro fert	haro fert	haro fert	haro plnt fert cult	hvst	haro plnt fert cult

1-Includes all mechanical operations (see footnote 7 below) for the 91-day plover breeding season (15 April through 14 July).

2-All statistics are for the plover breeding season only.

3-No harvestable crop produced.

4-Includes some fields with considerable weedy vegetation, at least part of the season.

5-Wheat, planted as a crop, which is turned under when crop fails.

6-Although sample sizes of certain field types were low, plowing schedules for individual field types were often quite rigid (planting of milo, for example, usually occurred on or about 15 June on study fields); thus, results from considerably larger sample sizes might be quite similar in most cases.

Table 3. (cont.)

7-The "Max.# days fields undisturbed on ave." row is the averaged maximum for all fields of that type; this is neither the average number of days that fields of a particular type were left undisturbed nor the maximum number of days a field within a particular field type was left undisturbed (this can be found in the range row).

8-Plowing code: cult-cultivate, fert-fertilize, haro-harrow (plow, usually using a agricultural implement which has spikes or discs, so as to level, break up clods, root up weeds, etc.), hvst-harvest, plnt-plant.

APPENDIX 1

SENSITIVE DATA: LEGAL LOCATION OF MOUNTAIN PLOVER AND LONG-BILLED CURLEW NESTS

MOUNTAIN PLOVER RECORDS: OKLAHOMA

Nest#	State-Co.	Date found	Legal Part of sec.	Sec.	Tshp	Rnge	#Nst	#Egg^
1.	OK-Cimarron	5/7/93	sel/4swl/4x	35	5	7	1	2
2.	OK-Cimarron	6/5/93	wl/2swl/4	10	4	6	1	3
3.	OK-Cimarron	4/22/94	sel/4	8	4	7	1	3
4.	OK-Cimarron	5/11/94	sel/4	2	4	6	1	3
5.	OK-Cimarron	5/11/94	nl/4	15	4	6	1	3
6.	OK-Cimarron	5/21/94	sel/4	3	4	6	1	+
7.	OK-Cimarron	6/1/94	el/2*	10	4	6	1	+
8.	OK-Cimarron	6/1/94	el/2*	10	4	6	1	+
9.	OK-Cimarron	6/13/94	swl/4	21	4	6	1	3
10	OK-Cimarron	7/6/94	el/2*	10	4	6	1	3
Subtotal							10	20

(Relevant 7.5-minute topographic maps for OK: Keyes SW-#s 2,4 5,6,7,8,9,10; Keyes West-#s 1,3)

MOUNTAIN PLOVER RECORDS: COLORADO

1.	CO-Kiowa	5/11/93	cl/2el/2	14	17	42	1	2
2.	CO-Kiowa	5/12/93	wl/2nel/4*	11	17	50	1	3
3.	CO-Kiowa	5/12/93	swl/4	31	18	49	1	3
4.	CO-Kiowa	5/13/93	nl/2sel/4	1	19	45	1	3
5.	CO-Kiowa	5/13/93	sl/4*	12	18	45	1	3
6.	CO-Kiowa	5/13/93	sl/4*	12	18	45	1	2
7.	CO-Kiowa	5/13/93	nwl/4	16	18	42	1	3
8.	CO-Kiowa	5/13/93	sl/2nwl/4	18	18	44	1	1
9.	CO-Kiowa	5/13/93	sl/2swl/4*	19	18	44	1	2
10	CO-Kiowa	6/2/93	sl/2sel/4	6	18	49	1	3
11.	CO-Kiowa	6/2/93	sl/2swl/4	26	17	50	1	3
12.	CO-Kiowa	6/2/93	nel/4	35	17	50	1	3
13.	CO-Kiowa	6/12/93	nl/2swl/4	13	18	50	1	3
14.	CO-Kiowa	6/12/93	in nwl/4	16	18	49	1	3
15.	CO-Kiowa	6/12/93	swl/4	21	18	49	1	3
16.	CO-Kiowa	6/16/93	wl/2nel/4*	11	17	50	1	2
17.	CO-Kiowa	7/1/93	sl/2swl/4*	19	18	44	1	3
18.	CO-Kiowa	4/24/94	nl/2sel/4*	19	18	43	1	1
19.	CO-Kiowa	4/25/94	s3/5sl/2	36	18	49	1	3

MOUNTAIN PLOVER RECORDS: COLORADO (cont.)

Nest#	State-Co.	Date found	Legal Pt.ofSec.	Sec.	Tshp	Rnge	#Nst	#Egg^
20.	CO-Kiowa	5/16/94	sel/4*	35	18	49	1	3
21.	CO-Kiowa	5/17/94	in el/2	1	19	49	1	3
22.	CO-Kiowa	5/17/94	nwl/4	6	19	48	1	3
23.	CO-Kiowa	5/18/94	sl/2sel/4	13	18	45	1	3
24.	CO-Kiowa	5/18/94	sl/2nel/4	13	19	45	1	3
25.	CO-Kiowa	5/18/94	nl/2sel/4*	19	18	43	1	3
26.	CO-Kiowa	5/18/94	nl/2sel/4*	19	18	43	1	3
27.	CO-Kiowa	5/18/94	nl/2sel/4*	19	18	43	1	3
28.	CO-Kiowa	6/15/94	nl/2	1	18	49	1	3
29.	CO-Kiowa	6/15/94	sel/4*	35	18	49	1	3
Subtotal							29	79

(Relevant 7.5-minute topographic maps for CO: Arsenic Lake SW-#s 2,10,11,12,16; Brandon-#s 4,8,9,17,23,24; Cheyenne Wells 3 SW-# 5,6; Cheyenne Wells 4 SE-# 1; Dunlap Ranch-# 28; Eads-#s 19,20,21,22,29; Hawkins-#s 3,13,14,15; Sheridan Lake-#s 18, 25,26,27; Stuart-# 7;)

MOUNTAIN PLOVER RECORDS: KANSAS

1.	KS-Hamilton	5/14/93	sl/4	16	21	42	1	3
2.	KS-Hamilton	6/1/93	nl/2nel/4	1	22	42	1	3
3.	KS-Hamilton	5/19/94	sl/2*	1	22	42	1	3
4.	KS-Hamilton	5/19/94	sl/2*	1	22	42	1	3
5.	KS-Morton	5/20/94	nel/4*	24	32	42	1	3
6.	KS-Morton	6/13/94	nel/4*	24	32	42	1	3
7.	KS-Morton	6/13/94	sl/2sel/4	36	31	42	1	2
8.	KS-Stanton	6/15/93	nel/4	35	28	39	1	2
Subtotal							8	22

(Relevant 7.5-minute topographic maps for KS: Big Bow-# 8; Richfield-#'s 5,6,7; Tribune 3 NW-#'s 1,2,3,4)

TOTAL RECORDS FOR MOUNTAIN PLOVER IN OK, CO, AND KS 47 121

APPENDIX 1 (cont.)

LONG-BILLED CURLEW RECORDS: OKLAHOMA

Nest#	State-Co.	Date found	Legal Pt.ofSec.	Sec.	Tshp	Rnge	#Nst	#Egg^
1.	OK-Cimarron	5/27/93	s1/2	2	3	7	1	3
2.	OK-Cimarron	6/13/94	n1/2s1/2	31	4	6	1	4

(Relevant 7.5-minute topographic maps for OK: Keyes SW-# 2; Keyes W-# 1)

TOTAL RECORDS FOR LONG-BILLED CURLEW							2	7

^-some clutches with <3 eggs may have been counted before egg-laying was complete.
+=nest found just after being plowd up; although eggshells were seen, the exact number of eggs could not be reliably determined.
x-this reads "the se1/4 of the sw1/4 of the section."
*-multiple nests found on this field during one or both field seasons.