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INTRODUCTION

The Mountain Plover (*Charadrius montanus*) is a loosely colonial (Graul 1975) upland shorebird that breeds across the xeric tablelands of the western Great Plains and shortgrass prairie ecoregion of North America (Knopf and Wunder 2006). This is a species of conservation concern throughout its range because of apparent range-wide population declines (Knopf and Wunder 2006). The U.S. Shorebird Conservation Plan (USSCP) recently classified the species as globally highly-imperiled (Brown et al. 2001; USSCP 2004). Reasons for the decline of Mountain Plovers are not fully understood. Habitat destruction and the tendency of the species to nest in agricultural fields, where nests may be susceptible to destruction from agricultural practices, have been identified as possible causes (Shackford et al. 1999, Dreitz 2005, Knopf and Wunder 2006).

Bruner et al. (1904) described the species as "not uncommon in extreme western Nebraska" at the turn of the 20th Century and noted the species had been observed in Cheyenne, Dawes, and Sioux Counties. Observed declines in Mountain Plover abundance in Nebraska over the following decades were likely the result of actual population declines and a lack of systematic surveys for the species (i.e., detectability). As late as the new millennium, Sharpe et al. (2001) described the species as a rare, regular breeder limited to southwestern Kimball County. Sharpe et al. (2001) also suggested that the earliest spring migrants in Nebraska arrived in early April, and that most migrants left by the middle or end of July.

However, the conclusions of Sharpe et al. (2001) regarding the status of Mountain Plovers in Nebraska were largely based on inconsistent and opportunistic observations of nesting Mountain Plovers on stony, overgrazed rangeland.

Additional information was gleaned from the results of Shackford et al. (1999) who found plovers on agricultural fields (e.g., winter wheat) in southwestern Kimball County. Mountain Plovers are cryptically colored, oftentimes remain motionless when approached by perceived threats, and occupy a range within Nebraska that is largely privately owned. These three factors have made locating plovers difficult, and have compounded our poor comprehensive understanding of Mountain Plover's abundance across its distribution in Nebraska. Despite this, the species is state-listed as threatened under the Nebraska Nongame and Endangered Species Conservation Act and is classified as a Tier I, at-risk species according to the Nebraska Natural Legacy Project (Schneider et al. 2005).

In 2002 the Nebraska Prairie Partners (NPP), a cooperative partnership between the Rocky Mountain Bird Observatory (RMBO) and Nebraska Game and Parks Commission (NGPC), initiated a project to identify the extent of the breeding distribution and population size of Mountain Plover in Nebraska. The NPP made a concerted effort to gain access to private lands in the southwestern panhandle before initiating systematic research and monitoring activities focused on Mountain Plover ecology. Specific monitoring activities included road-side surveys, early spring visual checks in areas where plover were found in previous years, and monitoring nests in agricultural fields (nest marking) throughout May and June of most years. In addition, surveys of randomly selected 200x200 meter patches (patch surveys) were conducted in late April and May of the 2004-2007 field seasons.

The purpose of this paper is to provide an updated, descriptive assessment of Mountain Plover in Nebraska. We base our conclusions on six years (2002-2007) of Mountain Plover monitoring data in the southwestern panhandle of Nebraska. We reviewed data collected from our monitoring activities to reassess the status of Mountain Plover in Nebraska including 1) estimated arrival dates of spring migrants and departure dates of fall migrants, 2) nesting chronology and time intervals of peak nesting activity, and 3) a general distribution of breeding Mountain Plovers in the southwest panhandle.

METHODS

Study Area

The majority of surveys outlined in this manuscript took place across the Kimball Grasslands Biologically Unique Landscape (BUL) in the southwestern panhandle (Schneider 2005), including portions of Kimball, Cheyenne, and Banner Counties. Surveys were also conducted in the 17 westernmost counties of Nebraska during the 2004 field season. The Kimball Grassland BUL is characterized by xeric tablelands on both sides of the Lodgepole Creek drainage. On the tablelands the predominant composition of the land is native rangeland and dryland wheat/millet farming (pers. obs.). Both intensively grazed rangeland and dryland wheat farming provide Mountain Plovers with essential breeding habitat, specifically flat, disturbed areas with greater than 30% bare ground (Knopf and Miller 1994). The Kimball Grasslands BUL adjoins Wyoming to the west and lies adjacent to the northern boundary of the Pawnee National Grassland in Weld County, Colorado, once considered a major stronghold for Mountain Plover before recently observed population declines (Knopf and Rupert 1996).

Migration Chronology

Preliminary surveys detected Mountain Plovers across the study area in early spring. These surveys were usually limited to southern Kimball County, and were conducted in early April during the 2002-2005 field seasons. In 2006 and 2007 these surveys were initiated on 3 April and 20 March, respectively, in order to better approximate the first day Mountain Plovers arrive in Nebraska. These surveys were also conducted opportunistically at similar areas in late August and early September in 2006 and 2007 to document the last day that Mountain Plovers were observed across the study area before fall migration.

Nesting Ecology

The Mountain Plover nest marking program was developed in 2003 by Fritz Knopf in cooperation with RMBO and the Colorado Division of Wildlife, to locate and protect Mountain Plover nests from accidental tillage on privately-owned agricultural fields. NPP implemented the program in Nebraska from late April through the end of June in all field seasons beginning in 2004. Working in conjunction with local producers, nests were located in agricultural fields by driving parallel transects with ATVs in fallow and stubble strips till adult birds were flushed off a nest, at which point technicians backed off the area and waited for the adult to return before determining the exact location of the nest. Once located, the nest was marked with orange-painted wooden lathe, and an incentive payment was offered to landowners for each nest they avoided with tillage operations.

When we located a nest, we floated the eggs to estimate nest age according to Dinsmore et al. (2002). We subsequently revisited nests twice a week to determine their fate (e.g. – successful, predated, abandoned, etc.). We assumed a 29-day incubation period (Knopf and Wunder 2006) to estimate when nests were initiated, and in the event a nest succeeded between revisits, we used the midpoint between revisits and the average 29-day incubation period (Knopf and Wunder 2006) to estimate the laying date. While nest marking was concluded at the end of June, nest checks during the 2005 through 2007 field seasons were continued as long as needed to assign a fate to all marked nests. After estimating nest initiation dates for nests monitored during the 2005-2007 field seasons, we grouped the three years together by interval and tested for the existence of two distinct sets of nest initiation dates by comparing a 2 component normal mixture distribution with a single normal distribution, and carrying out a likelihood ratio test with 3 degrees of freedom to account for the additional 3 parameters needed for a 2 component mixture distribution.

Mountain Plovers were sometimes observed incubating eggs and exhibiting several different agonistic behaviors (see Graul 1973 or Knopf and Wunder 2006 for descriptions) during patch surveys, suggesting that nesting occurred in close proximity, and provided further information on the nesting habits across this study area. In order to explore potential patterns between Mountain Plover nesting chronology (e.g., cold weather delaying nest initiation) and local climatic conditions, we accessed the High Plains Climate Research Center database (University of Nebraska-Lincoln, Lincoln, Nebraska) and obtained temperature and precipitation data for April through July during the 2006 and 2007 field seasons from a weather station in Kimball County, Nebraska.

Breeding Distribution

Roadside transect surveys and the patch surveys began in mid-April of all years, and continued through the end of May or first week in June. In 2003, we conducted roadside surveys to determine Mountain Plover occupancy throughout the 17 counties of extreme western Nebraska; Sioux, Dawes, Sheridan, Box Butte, Scotts Bluff, Banner, Morrill, Kimball, Cheyenne, Deuel, Garden, Keith, Perkins, Chase, Dundy, Hayes, and Lincoln Counties. Patch surveys were conducted during the 2004-2007 field seasons at areas where plovers were encountered during the 2003 surveys. While patch surveys had an underlying experimental design and were therefore more informative (e.g., as opposed to solely documenting presence/absence), they were also more labor intensive and were therefore only conducted on the reduced range where plover were encountered during the 2003 roadside transects, specifically in Banner, Kimball, and Cheyenne Counties. Patch surveys were conducted to determine breeding Mountain Plover habitat associations and to estimate the relative abundance of plovers in Nebraska, and while not specifically designed to address the objectives in this paper, they provided sightings important in estimating the distribution of plover in Nebraska.

RESULTS AND DISCUSSION

Migration Chronology

The earliest observations of Mountain Plovers in Kimball County were 2 adults on 5 April 2002, 4 adults on 18 March 2003, 5 adults on 8 April 2004, 4 adults on 3 April of 2006, and multiple groups of three plovers on 24 March 2007. Because some of these dates are the first day of the season that we attempted to locate plover (2004 and 2006), and are probably later than when plover truly arrived, evidence presented here suggests that Mountain Plover likely begin migrating into Nebraska as early as the middle to end of March. Our latest observations of Mountain Plover in Nebraska for the 2002, 2003, and 2004 field seasons were 1 August (10 fledglings), 15 August (1 adult), and 16 July (5 adult, 4 fledglings), respectively. However, increased survey effort in the fall of 2006 and 2007 resulted in the observation of a flock of 28 plovers (mostly juveniles) on land adjacent to an area with relatively high nest densities on 31 August 2006. Additionally, on 3 September 2007 we observed 78 Mountain Plover (both adults and juveniles) on the adjoining land to the south of where the 2006 group was observed. Both the 2006 and 2007 observations suggest migration dates that are much later than previously believed.

Nesting Ecology

While few Mountain Plover nests had ever been located in Nebraska (see Sharpe et al. 2001 for a listing of all events), our monitoring efforts yielded a total of 278 nests (272 on agricultural fields and 6 on native rangelands) over the duration of this study. The majority of Mountain Plover nests in Nebraska were initiated during the first two weeks of May. Using these nests, we were able to back estimate the onset of Mountain Plovers nesting to late April of all years. This estimate is interesting because we rarely located nests during nest marking in late April. We believe this pattern is likely because plovers were not displaying behavioral cues that would suggest the presence of a nest.

We estimated the earliest nests were initiated on 26 April 2006 and 28 April 2007, based on hatching dates and a 29-day incubation period. These dates are nearly a month later than earliest arrivals were detected on the study area. While the earliest date of arrival of spring migrants in 2006 is not known, a colder April in 2007 (avg. low = -1.83 °C) compared to 2006 (avg. low = -0.21 °C) could be responsible for the observed delay between plover arrival and nest initiation. However, our results could be an artifact of some other events not addressed in this study. The first two weeks of May coincided with the onset of warmer weather in both 2006 (avg. low = 1.29 °C) and 2007 (avg. low = 5.18 °C). This was also the period when plovers began to display behavioral cues associated with nesting, a requirement for identifying exact nesting locations.

We based our observed plover nesting chronology on data from the 2005-2007 field seasons, and the histogram of our estimated initiation dates suggested a skewed, bimodal distribution for all three field seasons (Figure 1). After grouping the three field seasons together we found statistical support for a bimodal distribution, where the two component model was a better approximation to the data ($\chi^2 = 50.5$, $df=3$, $p < 1e^{-11}$). Approximately 70% of the nests are assigned to the first component with an average initiation date of 6 May (Ordinal Day = 126, $\sigma^2=25.6$), and the other 30% of nests are in the second component with an average initiation date of 1 June (Ordinal Day = 152, $\sigma^2=37.7$) (Figure 2).

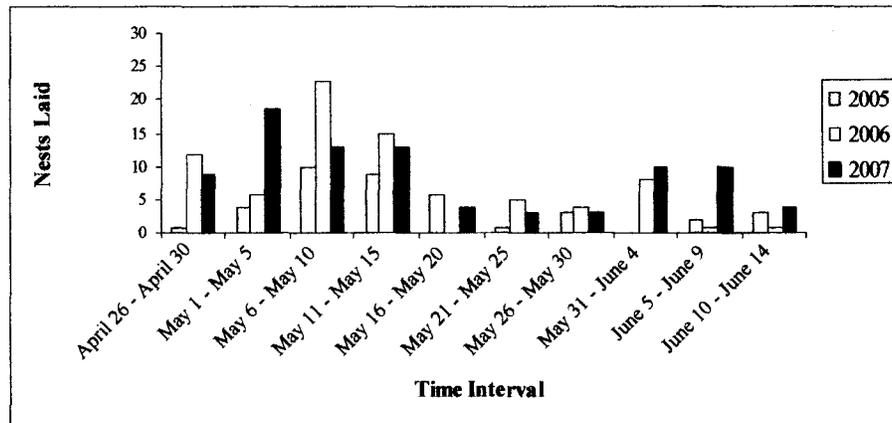


Figure 1. Estimated date that Mountain Plover eggs were laid based on a 29-day incubation period. For nests hatched between revisits, 29-day incubation is applied from the middle of relevant nest visits. Nests were located in Kimball County, Nebraska during nest marking for the 2005-2007 field seasons.

This result suggests that the largest numbers of nests were initiated in early May, with another pulse of nest initiation in late May and early June. One explanation for this observed pattern was that the initial peak represents first nesting attempts, while the second peak represents second nesting attempts by resident plovers (or inexperienced first time breeders) who lost their first nests (Knopf and Wunder 2006). Another explanation is that the second peak is nests initiated by non-

resident plovers dispersing into Nebraska following nest failures elsewhere (Knopf and Rupert 1996). While it is possible that the smaller grouping of nests initiated in early June are first nesting attempts, it seems more probable that these are second nests being laid in response to previous nest failures in mid-May.

We observed Mountain Plovers incubating eggs into the middle of July, which is when it was previously believed that plovers were migrating south (Sharpe et al. 2001). While the possibility exists that the birds observed in late August and early September of 2006 and 2007 were migrants from areas farther north, the contents of a number of our marked nests in Nebraska during the 2006 and 2007 field seasons did not hatch until mid-July. This information coupled with the 34-36 day chick-fledgling period (Knopf and Wunder 2006), suggest that the groups observed in late August and September could have been locally-reared juveniles that had not yet migrated.

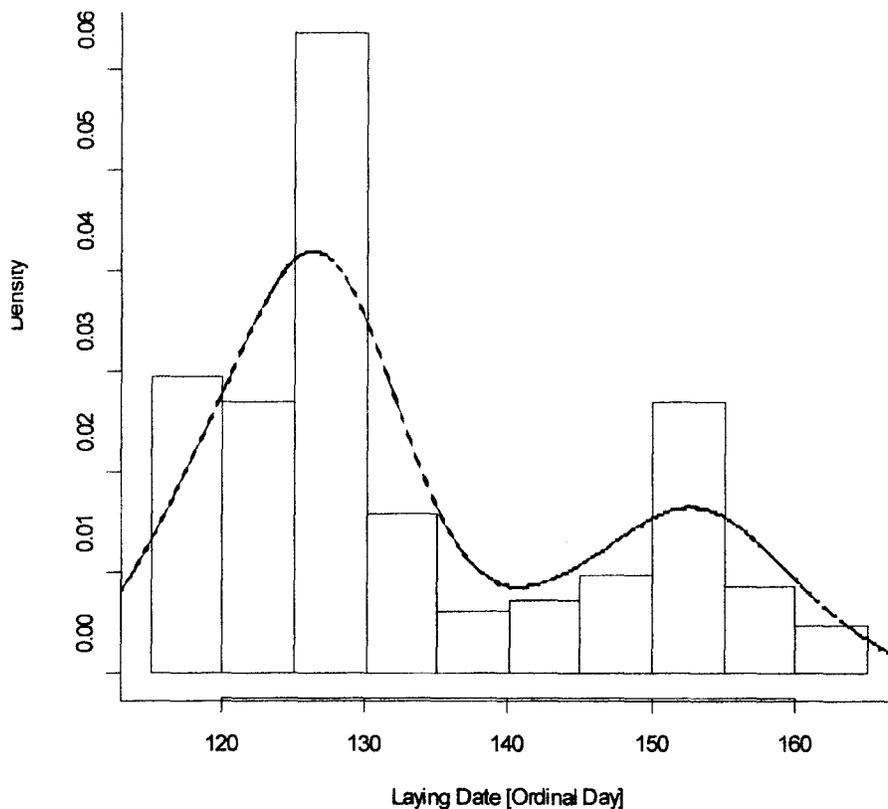


Figure 2. Frequency histogram of nest initiation date for Mountain Plovers in Nebraska. The solid curve is a kernel density estimate using a Gaussian kernel.

Breeding Distribution

Mountain Plovers were observed in Banner, Cheyenne, and Kimball Counties during patch surveys. Approximately 83% of our occupied survey patches were located south of I-80 in Kimball County. Plover nests were also located in the three aforementioned counties, but most nesting by plovers was concentrated in southern Kimball County. The NPP has received landowner reports of Mountain Plovers in agricultural fields in both Deuel and Scotts Bluff Counties, but these sightings have not been verified and, if true, are likely attributable to extralimital individuals or migrants. Based on our data, we estimate the current distribution of plovers in Nebraska (Figure 3) to include the southwestern portion of Cheyenne County (southwest of Sidney and south of I-80), all of Kimball County except the area north of I-80 and east of Highway 71, and the very southern portion of Banner County (west of Highway 71). While Mountain Plovers were located across this entire range, we found multiple core nesting areas (all within Kimball County) where breeding densities were much higher.

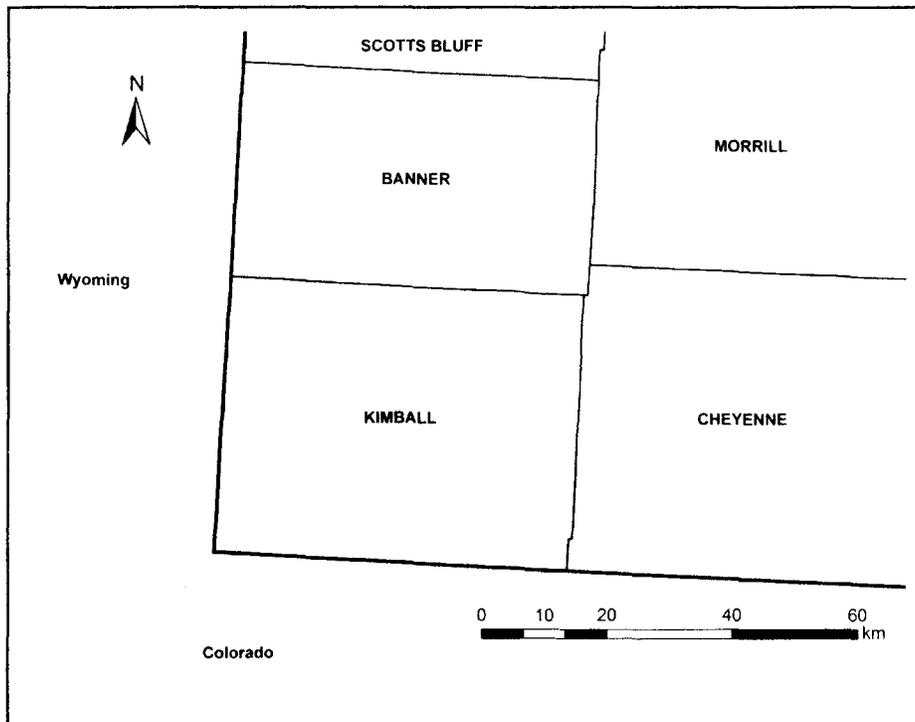


Figure 3. Rough distribution of breeding Mountain Plover (shaded area) observed in the southwest panhandle of Nebraska during the 2002 through 2007 field seasons.

CONCLUSIONS

In 2007, we conducted our nest marking program on 23,575 acres of agricultural fields, and located a total of 111 Mountain Plover nests. If we assume that ~70% of our total nests are nests belonged to original (not renesting) nesting birds (Figure 2), we would deduce a minimum number of approximately 40 breeding pairs (80 breeding adults) of Mountain Plovers in the 2007 field season. This number does not depend on whether or not the perceived renesting attempts (Figure 2) are made by resident or non-resident birds in response to original nest failure, and also does not take into account the number of non-breeding birds on the study area, or detection probabilities associated with the nest marking method. Therefore, the actual number of Mountain Plovers across this landscape is almost certainly greater than our minimum number (~80), and with 106,450 acres of suitable dryland wheat/millet available across the landscape in 2007 (NPP, unpublished data) the number might range up to 180 breeding pairs (360 breeding adults).

Compared with historically documented sightings, our results indicate that Mountain Plovers are more numerous in Nebraska than previously believed. Our results suggest a spring migration chronology similar to that suggested in Colorado (Graul 1975), with Mountain Plover arriving in Nebraska in mid- to late March, which is earlier than previously documented in Nebraska (Sharpe et al. 2001). Our data also suggest that juveniles may reside within the state as late as early September, which is significantly longer than previously documented (Sharpe et al. 2001). If true, this suggests that Mountain Plovers are present on the breeding grounds in Nebraska for approximately 5 months in any given year. Our assessment of Mountain Plovers in Nebraska, using the same terminology of Sharpe et al. (2001), suggests that their status should be revised from a rare, regular breeder to a fairly common, regular breeder with a localized distribution within the state.

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