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Project Title: *Factors Influencing Rangewide Survival of Mountain Plover* (Charadrius montanus) *Chicks*

Project Investigators: *Victoria J. Dreitz (Colorado Division of Wildlife), Stephen J. Dinsmore (Iowa State University), and Kathryn P. Huyvaert (Colorado State University)*

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Introduction

The Mountain Plover (*Charadrius montanus*) is an upland precocial shorebird that breeds throughout the prairie ecosystems of the North American Great Plains. Steep, constant declines in population size have been reported for Mountain Plovers across their range since 1966. Factors driving population declines appear to be acting on fecundity and subsequent reproductive output of the species (Miller and Knopf 1993, Knopf and Wunder 2006). The nesting ecology of Mountain Plovers has been well-studied across the species' breeding range including areas in Colorado (Graul 1975, Knopf and Wunder 2006, Dreitz and Knopf 2007) and Montana (Knowles et al. 1982, Knowles and Knowles 1984, Dinsmore et al. 2002). Information on Mountain Plover life history post-hatching is very limited, however. Demographic information, including estimates of vital rates for birds transitioning through the post-hatching stage (i.e., the period from hatching to fledging), are lacking. From a conservation perspective, information on the post-hatching stage is imperative because population dynamics often show great sensitivity to survival of young (Anders *et al*. 1997; Colwell *et al*. 2007).

A stage-specific matrix model based on data obtained in Colorado and Montana suggested that understanding ways to increase chick survival should be a priority for conservation efforts that are restricted to breeding grounds to increase population viability of Mountain Plovers (Dinsmore et al. 2010). Multiple factors may influence the survival of young birds. Young individuals lack experience with selective pressures such as predation, foraging efficiency, parasites, migration patterns, and extremes in environmental conditions which are correlated with habitat quality. Further, these selective pressures differ spatially and temporally across the species' range. The distribution of individuals among habitats reflects their ability to discriminate between habitat types and to assess habitat quality. Thus, the landscape configuration and the proximity of resources provided by different habitat types of the North American Great Plains may be critical to the reproductive output of Mountain Plovers.

The objectives of this study were to: (1) investigate natural and anthropogenic factors influencing Mountain Plover chick survival across the species' range; (2) identify landscape characteristics across the species' breeding range that are positively correlated with the highest levels of chick survival; and (3) provide information to further develop conservation, restoration, and management efforts for Mountain Plovers on public and private lands. Specifically, we planned to examine to what degree various factors (e.g., habitat types, predation, parasites, starvation) impact chick survival. In spring 2009, we completed a pilot study in Colorado and Montana to determine appropriate field methods for this study including methods to obtain adequate samples for laboratory analyses. Below, we describe our progress and provide descriptive statistics for the 2010 field work conducted in Colorado and Montana separately and the progress of our laboratory analyses. The 2010 field season in both Colorado and Montana experienced a prolonged season, ending in mid August

versus mid- to late-July. Our main hypothesis for this occurrence is a colder and wetter spring than the past 5-10 years in our study areas; however, we have not yet closely examined weather data given time constraints posed by the prolonged field season.

Project Activities

This field research study is the first to be conducted at a rangewide-scale on Mountain Plovers focusing in two different breeding areas, eastern Colorado and Montana. We investigated cause-specific mortality of Mountain Plover chicks given recent information suggesting that this vital rate highly influences population growth. While conservation efforts for the Mountain Plover will change through time as threats change and as we obtain information on its ecology, understanding the factors causing mortality of chicks/broods at a rangewide-scale now will provide insight into the role geography and concomitant variation in the landscape plays on the reproductive output of Mountain Plovers.

Field Methods. This field study was conducted by monitoring radio-transmittered Mountain Plover chicks from 1 d post-hatch to ≥30 d post-hatch.

We identified ~1d old plover chicks by monitoring nests. We used egg flotation (Westerskov 1950) to age eggs and to estimate days until hatching, and we also monitored radio-marked adults to determine whether eggs had hatched (see below). After hatching and when chicks were completely dry, chicks were captured by hand to receive a radio transmitter. Chicks were weighed and examined for ectoparasites and a small blood sample (<50 µL) was obtained by jugular or brachial venipuncture at this initial and subsequent captures (~16 d old, see below). Once the transmitter was deployed, chicks were monitored at ≤24 hr intervals, depending on weather conditions. We recorded information including status (live/dead), number of chicks in brood, habitat type, UTM coordinates, time of day, and observer for each location datum collected.

Average mass of Mountain Plover chicks at hatch is 7-11 g (Graul 1975, Miller and Knopf 1993). A 0.35 g transmitter was placed on <1 d to ~16 d old chicks. The 0.35 g transmitter falls within the suggested guidelines of transmitters not exceeding 5% of body mass for small birds (<50 g; Caccamise and Hedin 1985, Gaunt et al. 1999). Battery life of the 0.35 g transmitters was ~20 d. To monitor radio transmittered plover chicks to fledging age, ≥30 d, we recaptured chicks at ≤16 d and replaced the 0.35 g radio transmitter with a 0.65 g radio transmitter. Data on body mass of Mountain Plover chicks is limited, but suggests 16 d old chicks are >20 g (Dreitz unpubl. data).

Various transmitter attachment methods (e.g., glue, sutures) have been tested on surrogate species, including Killdeer (*Charadrius vociferus*). A leg harness technique modified from one described by Rappole and Tipton (1991) has minimal to no impact on chicks of surrogate species from 1-42 d post-hatch (Dreitz, unpubl. data). The leg harness technique we used in this study consists of a 100% polyurethane clear, flat elastic material (Stretchrite®) cut to ~1.5mm in width. The material is assembled in a figure-8 design with two leg loops that expand to accommodate chick growth; the transmitter sits in the middle of the chick's back (Dreitz, unpubl. data). These transmitter attachments were assembled in advance so transmitter placement takes <15 sec.

Colorado

Study Area. In Colorado the study area was located exclusively on privately owned lands in Lincoln County. Private landowners have collaborated on previous studies on Mountain Plovers in Colorado (Dreitz and Knopf 2007, Dreitz unpubl. data) allowing continued access to >3000 km^2 of habitat. In eastern Colorado, Mountain Plovers primarily use the following habitats for breeding activity: grasslands occupied by black-tailed prairie dogs (*Cynomys ludovicianus*, hereafter simply 'prairie dog'); native grassland without prairie dogs; and agricultural fields, predominantly dryland agriculture.

Results. We placed 0.35 g radio transmitters on 93 1-5 day old Mountain Plover chicks on 3 different habitat types in eastern Colorado: 36 chicks that hatched on prairie dog, 28 chicks that hatched on native grassland, and 24 chicks that hatched on agricultural fields. A total of 30 radio-transmittered chicks survived to 16 d: 11 chicks were located on prairie dog at time of transmitter replacement, 9 chicks on native grassland, and 10 chicks on agricultural fields. We confirmed fledging (survival to ≥30 d) of 9 radio-transmittered chicks: 1 chick was primarily located on prairie dog, 3 chicks were primarily located on native grassland, and 5 chicks were primarily located on agricultural fields. Additionally, we confirmed fledging in 8 chicks without radio transmitters (some chicks within a brood did not receive a radio transmitter): 2 chicks primarily located on prairie dog, 2 chicks primarily located on native grassland, and 4 chicks primarily located on agricultural fields.

We classified chick mortality as one of the following: avian predation, mammalian predation, unknown predation, weather-induced (e.g., hail or rain), or unknown mortality cause. We determined avian predation based on evidence such as finding the transmitter near avian plucking post, nest site, or in avian pellets. We identified mammalian predation when we found transmitters that were in mammalian dens, cached, scat was found near the transmitter or carcass, and/or other physical signs (e.g., teeth marks) were present on the carcass or transmitter. We defined an unknown predation when the transmitter was found with or without remnants of a chick or the transmittered chick was not with the adult but its sibling(s) were still present. Mortalities were classified as weather-induced when the whole carcass of a chick was found with the transmitter and known extreme weather events (e.g., hail) had occurred 24 hrs prior. These chicks were collected and evaluated by necropsy to confirm a weather-induced mortality event. Mortalities were defined as unknown when there was not enough evidence to suggest one of the other 4 mortality categories but remains of the chick were found.

We confirmed mortalities of 38 radio-transmittered chicks. Most mortalities (n = 13, 34%) occurred due to avian predation, mainly by Burrowing Owls (*Athene cunicularia*) and prior to chicks reaching 16 d. Mammalian predation was confirmed for 8 of the 38 known mortalities. The mammalian predators occurred more often on older chicks, > 16 d, and included Swift Fox (*Vulpes velox*) and American Badger (*Taxidea taxus*). Unknown predation occurred on 3 of the radio-transmittered chicks. Weather is suspected in the deaths of 5 radio-transmittered chicks; necropsy results are still pending to confirm this conclusion. Unknown mortality occurred in 9 radio-transmittered chicks. There were sufficient remains in 5 of the 9 unknown mortalities in which necropsy and other laboratory analyses are pending.

Avian predation was confirmed more often on prairie dog habitat (n=7) than grassland (n=4) or agricultural fields (n=1), while mammalian predation was confirmed more often on grassland (n=7) than prairie dog (n=0) and agricultural fields (n=1). Weather-induced mortality occurred most often on agricultural fields (n=4) than prairie dog (n=0) or grassland (n=1). Agricultural fields also had the most unknown mortalities (n=5) compared to grassland (n=3) or prairie dog (n=1). These preliminary results suggest that the causes of Mountain Plover chick mortality do differ among habitats in Colorado.

We confirmed survival to fledging for 10% (9 radio-transmittered chicks out of 93 initially radio-transmittered). This result excludes two chicks who were brood mates that reached our fledging criteria of ≥30 d old which were found died at 32 d old on an agricultural field. Remains of these two individuals were collected; necropsy and laboratory analyses are pending. In addition, we confirmed fledging of 8 chicks that did not have a radio transmitter but at least one of their brood mates did have a radio transmitter. We were unable to determine survival or mortality in 45% of the radio transmittered chicks (44 of 93 initially radio-transmittered chicks) due to sampling procedures (e.g., inability to access property), equipment malfunction (e.g., premature failure of radio transmitter battery life), potential predator taking remains out of study area, and other potential issues.

Montana – Iowa State University, subcontract agreement finalized 07/06/2009

Study Area. The Montana study area was located in southern Phillips County in north-central Montana. Approximately 2250 km^2 of the Montana study area is in public ownership with the Bureau of Land Management (Malta Field Office) and US Fish and Wildlife Service, Charles M. Russell National Wildlife Refuge. In this study area, Mountain Plovers preferentially use sites associated with black-tailed prairie dog colonies for breeding (Knowles et al. 1982; Knowles and Knowles 1984; Dinsmore et al. 2002, 2003).

Results. The 2010 field season was extremely wet in the study area, hampering our ability to locate nests and monitor chicks. A localized 6" rainfall on 19 May destroyed many nests, delayed the peak hatch to mid-June, and probably resulted in fewer re-nesting attempts.

We placed a total of 39 radio transmitters on chicks. Only 6 chicks survived to 16 d old with 1 chick confirmed to fledge (≥30 d), and 1 chick was still alive when monitoring was ceased in early August.

A total of 19 mortalities were documented. Avian predation was confirmed in 4 mortalities; 1 chick by Burrowing Owl and 3 by unknown avian predators. No mammalian predation was observed in Montana. Weather-induced mortality was the main cause of mortality in Montana with 13 chicks dying from exposure to heavy rainfall in June. Eighteen birds died of unknown causes; in most cases the radio signal simply disappeared and we suspect these birds were depredated by Black-billed Magpies (*Pica hudsonia*) and carried off the colony. A total of 2 chicks probably died as a result of handling effects but additional laboratory analyses (necropsy) are being conducted to confirm our speculation.

Laboratory Analyses –Colorado State University, subcontract agreement finalized 06/11/2009

Preliminary molecular analyses of a subset of blood samples collected from chicks suggest that a small number of chicks were exposed to blood parasites. We examined 28 samples from chicks aged 16-32 days collected in eastern Colorado using a PCR protocol and primers directed at a portion of the cytochrome B gene. These primers are thought to target solely the blood parasite genera *Plasmodium* (species from this genera cause avian malaria) and *Haemoproteus* (Beadell et al. 2004) but anecdotal work in our lab suggests that other parasites may also be detected. Three of the 28 (10.7%) samples appeared 'positive' for blood parasite DNA using this technique. Follow-up with additional primer sets and DNA sequencing is needed to confirm this finding and, if definitively positive, to determine which genus/genera the parasites belong to. During microscopic analysis of blood smears collected from a small subset of the birds represented in the 28 samples (n= 6), we found very little evidence of parasitism. Typically, PCR analyses reveal higher prevalence than microscopy (Fallon et al. 2003) but, taken together, these two sources of preliminary data suggest that the degree of blood parasitism in Mountain Plover chicks from eastern Colorado is relatively low.

We received blood smears collected from seven Mountain Plovers chicks at the Montana site in 2010. No evidence of blood parasitism was documented using microscopy on these samples, either. We are working on a protocol to optimize extraction of DNA from blood harvested from a blood smear which could then be followed up with PCR analyses to support this initial finding. Additionally, we plan to evaluate blood parasite loads in samples collected from adult mountain plovers from eastern Colorado to better understand the degree of parasitism in the population as a whole. Such a study would better inform the risk Mountain Plover chicks face in terms of disease caused by blood parasites.

Project Summary

We confirmed survival to fledging for 10 (9 chicks in Colorado, 1 chick in Montana) out of 132 radio-transmittered Mountain Plover chicks (93 chicks in Colorado, 39 chicks in Montana). On prairie dog habitat in both study areas, avian predation was the main cause of mortality, with Burrowing Owls the main confirmed avian predator, especially on younger chicks, those <16 d. This result may be an

artifact of a higher density of Burrowing Owls compared to other avian predators in the study or the ease of locating transmitters near Burrowing Owl nest sites or roosting areas compared to those of other avian predators. However, our data are the first to provide information that Burrowing Owls do prey on Mountain Plover chicks.

The preliminary results of this field study suggest that the causes of Mountain Plover chick mortality do differ among habitats but may be consistent within particular habitat types across the species' range. Conservation and management efforts will be difficult and controversial given that the main avian and mammalian predators on Mountain Plover chicks, a species of conservation concern, are other species of conservation concern, Burrowing Owl and Swift Fox. Additional years of study are warranted to confirm or refute this one year finding. We caution any interpretation or manipulation of these data beyond that contained in this report. The information in this report is preliminary and subject to further evaluation including more in-depth laboratory and statistical analyses.

Future Project Activities

The Mountain Plover is a unique migratory species in that it prefers areas of relatively high levels of disturbance (e.g., intensive grazing by domestic or native herbivores or fire). From a conservation perspective, understanding how different habitats impact survival of young shorebirds may be critical because population dynamics often show the greatest sensitivity to survival of young (Anders et al. 1997, Colwell et al. 2007). Conducting this study across the plover's breeding range will add to developing conservation and management strategies at the local, regional, and continental scale for the mountain plover.

Future activities of this project include: (1) submission of project summary to peer-reviewed journal(s) and development of more general informational publications for public outreach and education, (2) evaluate and restructure current conservation and management efforts for public land managers and private landowners, and (3) continue outreach and education efforts with private landowners to participate in the continuation of research studies, particularly in Colorado, by fostering an awareness of and appreciation for the biological diversity associated with prairie ecosystems in which the Mountain Plover resides.

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