Nebraska Environmental Trust Fund

Final Project Report Narrative: 05-182-3

Prairie Partners Grassland Bird Research, Outreach, and Conservation

Introduction

Nebraska Prairie Partners (NPP) is a cooperative project of Rocky Mountain Bird Observatory and the Nebraska Game and Parks Commission. Through this project, both entities achieve their common goal of conserving native grassland birds and their habitats by gathering biological information and encouraging landowner involvement in shortgrass prairie habitat stewardship in western Nebraska. For this grant, we sought assistance from the Trust for educational program delivery, outreach literature development, and construction, and implementation of simple conservation tools.

We have accumulated information on several bird species of conservation concern and established a landowner contact database of over 350 individuals. Our work had triggered a number of questions that we found answers for, including local and regional population trends and habitat preferences of grassland birds, more accurate estimates of Burrowing Owl and Mountain Plover productivity, local and landscape features affecting habitat use by at-risk species, and more extensive searches for Burrowing Owl and Ferruginous Hawk nesting areas in under surveyed portions of the panhandle. The following is an in detail synopsis on how all of the questions were addressed, as well as how the various projects were implemented in the field, and what lies in the future as a result of this work.

Section-based Surveys for Grassland Bird Species

The purpose of Section-based surveys is a targeted "umbrella-type" approach to monitoring multiple species of grassland birds with one large and quantitatively defensible monitoring criteria. The benefit of these surveys would be the acquisition of large quantities of data on multiple grassland bird species population trends over a relatively short period of time, and to have it be rather inexpensive. Therefore, when negative population trends are observed for a species, more directed research could be focused on a single species as opposed to continual monitoring of a whole suite of bird species.

Section Surveys were conducted in 2005-2007 on native shortgrass prairie with n ~ 400/year and dryland agriculture with n ~ 50/year in the eighteen western counties of Nebraska. The sample unit for surveying grassland birds was the section (approximately 259 ha), and the 44 dryland agriculture sections are hereafter collectively referred to as "cropland". The number of sections to survey was determined mainly by funding constraints and expected species composition for the two habitat types (based on earlier prairie Section Surveys in Nebraska and preliminary cropland surveys in Colorado). Funding allowed for the hiring of two technicians, and 450 was the estimated total number of sections that they could complete. The majority of the sections were placed in native habitats due to greater species richness in this habitat. A lower number of samples were allocated to cropland habitats because of lower species richness, while maintaining a large enough sample to obtain an adequate number of detections for density analyses.

The Section Survey design is simple to implement logistically because the majority of land in the Great Plains is divided and mapped by section, and country roads tend to be built along the edges of sections. Data collection by section is also conducive to management, since most land holdings correspond to section boundaries. Candidate sections for surveys were identified in ArcView GIS using digital maps of land-use/land-cover, multi-resolution land characteristics, native vegetation, and public land surveys acquired from the United States Geological Survey and the Conservation and Survey Division of the University of Nebraska. Sections were considered candidates for surveys if they contained 243 – 283 Ha of native shortgrass prairie, shortgrass/mixed-grass mosaic, or shrubs. This size range allowed for odd-shaped sections to be included and those that contained lakes, buttes, or other small anomalies inside. Surveyed sections were randomly selected from these candidates using programming in Quattro Pro and Excel.

Since Section Surveys are road-based, any random section without a road on its perimeter could not be used. In addition, after ground-truthing, some random sections contained large areas (> 16 ha) of cultivation, CRP (ungrazed, usually non-native, Conservation Reserve Program fields), or forests. In these cases, the closest suitable candidate section was used as an alternate. The number of sections surveyed in each county was roughly proportional to the amount of shortgrass prairie that was present and its accessibility (counties with higher road density generally allowed for greater proportions of candidate sections to be surveyed). In 2001, 180 sections were surveyed in five counties. These same sections were surveyed in 2002, as well as 45 additional sections in three new counties. In 2003, 451 randomly selected sections were surveyed, including 135 from previous years (410 native shortgrass prairie sections and 41 cropland sections). In 2004, 450 sections were surveyed.

In 2005, 447 sections were surveyed in 18 counties including: Banner, Box Butte, Chase, Cherry, Cheyenne, Dawes, Deuel, Dundy, Garden, Hayes, Keith, Kimball, Lincoln, Morrill, Perkins, Scotts Bluff, Sheridan, and Sioux. Both 2006 and 2007 section numbers were comparable in number and proportion to those during the 2005 field season. Sections were surveyed from 15 May through 3 July 2004, to encompass the main period of breeding activity in grassland birds. The start date was determined by the widespread arrival and courtship displays of late-breeding species like Lark Buntings. Surveys were terminated when birds started congregating in post-breeding flocks and the frequency of courtship displays was notably reduced.

Each section was surveyed using three roadside point counts, with five minutes of observation time at each point. Point locations were at tenths of a mile, between 0.1 and 0.9 miles, along a section line, and were determined using random-number tables. The minimum distance between points was 0.2 miles (320m) to maximize independence of observations. The geographic coordinates for each point were determined using a Garmin Etrex (GPS) unit.

Surveys were conducted from sunrise to 1000 MST when bird activity, and thus detectability, was highest. Weather conditions were recorded and surveys were postponed during heavy rains, dense fog and/or winds > 29 km/hour. All birds seen or heard within the survey section (180 degree field of view from the observer) during the five-minute period were recorded, along with their distance from the observer (measured using a Bushnell Yardage Pro 500 Rangefinder) and the habitat they were using at first sighting (including ground, shrub, fence, road, tree, homestead, stock tank, or flying). A major deviation from section survey between the 2005 and 2006-07 field seasons was the inclusion of repeat sampling to estimate species-specific detectability in 2006-07.

A departure in the bird data collection protocol from previous years was that starting in 2004, we now treat all dependent detections of individual birds as part of a ‘cluster’ together with the first independently observed bird, rather than as separate independent observations of those individuals. This means that if the detection of an individual bird is dependent upon the previous detection of another individual, the resulting observation is recorded as one independent detection with a cluster size of C, where C is the original individual detected plus the sum of any additional individuals detected as a result of the first individual revealing its presence.

For example, a bird sings, and is thus detected independently. The observer then looks over to that bird, and as a result, detects a second individual. The resulting observation is recorded as one detection with a cluster of two birds. This practice ensures that we adhere more strictly to the assumption inherent in random sampling that all observations are independent of each other. Local vegetation conditions at each point were quantified by estimating the percent cover of grass in two height categories thought to be important to prairie birds (> and < 15cm) in the section and the ditch, the percent cover of all shrubs, and the dominant shrub species.

Section Survey data were entered into an Access database and densities were estimated using Program Distance 5.0 software. No flyover detections were used in the DISTANCE analysis (except for swallows, raptors and common night hawk). In 2004 and 2005 Density estimates were obtained using cluster analysis. We evaluated the fit of detection models using uniform, half-normal and hazard-rate key functions with cosine, simple polynomial, and hermite polynomial parameter adjustments. Assumptions for density analyses using Distance are: 1) all birds at distance = 0 are detected; 2) distances to birds close to points are measured accurately; and 3) birds do not move in response to the observer’s presence. For our analyses, densities were calculated only for those species that had a minimum of 20 observations, or had a coefficient of variation less than 50%, indicating robust data. Species distribution and relative abundance data were assessed using maps created in Arc Map for both 2005 and 2007, respectively (Appendix A and B). These data were incorporated into a larger shortgrass prairie bird database maintained by RMBO, and were submitted to the Nebraska Natural Heritage Program.

Table 1. Observation totals for all bird species detected during section-based surveys in the Nebraska portion of Bird Conservation Region 18 in the years 2005-2007. Bold species are Tier I species, and italicized species are Tier II listed in the Nebraska Natural Legacy Plan.

Species	2005 Counts	2006 Counts	2007 Counts*
American Avocet	*1*	*0*	*0*
American Crow	11	6	9
American Goldfinch	21	10	0
American Kestrel	40	19	5
American Robin	50	54	7
American White Pelican	*0*	*13*	*0*
Baltimore Oriole	6	3	0
Bank Swallow	25	24	11
Barn Swallow	98	158	30
Belted Kingfisher	0	1	0
Black-billed Magpie	3	6	2
Black-capped Chickadee	0	3	0
Black-headed Grosbeak	0	2	0
Blue Grosbeak	23	11	3
Blue Jay	1	2	0
Blue-winged Teal	1	0	0
Bobolink	15	13	1
Brewer's Blackbird	*29*	*39*	*12*
Brewer's Sparrow	**6**	**7**	**1**
Broad-tailed Hummingbird	2	1	2
Brown Thrasher	10	12	0
Brown-headed Cowbird	230	150	36
Bullock's Oriole	35	20	3
Burrowing Owl	**31**	**46**	**9**
Cassin's Kingbird	*11*	*2*	*3*
Cassin's Sparrow	51	299	5
Canada Goose	0	5	1
Chestnut-collared Longspur	*158*	*313*	*14*
Chimney Swift	4	0	0
Chipping Sparrow	0	5	6
Clay-colored Sparrow	0	2	0
Cliff Swallow	115	482	45
Common Grackle	196	330	35
Common Nighthawk	35	76	12
Common Raven	0	2	0
Cooper's Hawk	*1*	*0*	*0*
Dickcissel	64	49	1

Downy Woodpecker	0	0	1
Eastern Bluebird	0	0	1
Eastern Kingbird	78	94	12
Eared Grebe	0	2	0
Eurasian-collared Dove	0	0	0
European Starling	71	83	29
Ferruginous Hawk	**2**	**4**	**0**
Field Sparrow	1	4	1
Gadwall	2	0	0
Golden Eagle	*3*	*0*	*0*
Grasshopper Sparrow	633	770	39
Great Blue Heron	1	0	5
Great Horned Owl	1	0	2
Greater Prairie-Chicken	**8**	**2**	**0**
Green-winged Teal	1	0	0
Horned Lark	2216	2914	158
Horned Grebe	0	9	0
House Finch	5	1	0
House Sparrow	28	8	9
House Wren	7	7	0
Indigo Bunting	0	3	0
Killdeer	62	61	10
Lark Bunting	736	1241	90
Lark Sparrow	432	423	41
Lazuli Bunting	0	0	1
Lesser Yellowlegs	1	0	0
Loggerhead Shrike	40	23	8
Long-billed Curlew	**34**	**70**	**13**
Mallard	19	5	0
McCown's Longspur	**41**	**130**	**12**
Mountain Bluebird	*2*	*4*	*4*
Mourning Dove	963	1036	97
Mountain Plover	**0**	**0**	**1**
Northern Bobwhite	*7*	*1*	*1*
Northern Flicker	3	5	1
Northern Harrier	*8*	*7*	*0*
Northern Mockingbird	20	8	2
Northern Pintail	3	0	0
Northern Rough-winged Swallow	24	59	7
Orchard Oriole	44	18	10

Peregrine Falcon	*1*	*0*	*0*
Prairie Falcon	*1*	*6*	*0*
Red-headed Woodpecker	9	7	5
Red-tailed Hawk	24	28	3
Ring-billed Gull	0	1	0
Red-winged Blackbird	199	209	27
Ring-necked Pheasant	83	134	10
Rock Pigeon	12	4	42
Rock Wren	29	35	3
Sage Thrasher	*1*	*11*	*1*
Say's Phoebe	23	55	4
Scaled Quail	0	1	0
Scissor-tailed Flycatcher	*0*	*1*	*0*
Short-eared Owl	**0**	**1**	**0**
Song Sparrow	0	5	0
Spotted Towhee	1	3	0
Swainson's Hawk	*17*	*18*	*9*
Tree Swallow	1	15	4
Turkey Vulture	14	17	7
Upland Sandpiper	39	75	7
Vesper Sparrow	19	27	9
Violet-green Swallow	3	0	0
Warbling Vireo	1	0	0
Western Bluebird	0	1	0
Western Kingbird	241	378	49
Western Meadowlark	2194	3283	136
Western Wood-Pewee	3	1	0
Wild Turkey	2	16	0
Willet	*5*	*0*	*0*
Wilson's Phalarope	1	0	0
Wood Duck	3	0	0
Yellow-headed Blackbird	0	7	0
Yellow Warbler	3	3	1

Data presented in Table 1. demonstrate and almost universal decrease in bird number across years for all bird species, but the degree to which it is a defensible result is still not supported. While the section survey method was deemed applicable for those species that were readily abundant in sections and had an associated high degree of detectability (very few species), the major flaw that arose with this sampling method was that we obtained decent estimates of abundance, but the majority of species had an enormous degree of detection uncertainty with them that it is virtually impossible to support any apparent negative trend in the raw count data. Also, because of this poor association with detectability, it was difficult to support any sort of habitat association for any of the bird species. These results suggest that for the bulk of species, and most importantly the lower abundance species, it is important to consider species-specific monitoring as opposed to the “umbrella” monitoring approach of the section surveys. Bird detectability is just too low for most species to be able to accurately assess trends over any amount of time.

<u>Burrowing Owls</u>

Between 2001-2007 NPP conducted Burrowing Owl surveys, and in the seasons 2005-2007 we conducted a major study that involved habitat modeling and productivity analyses. The Burrowing Owl (*Athene cunicularia*) is a small diurnal owl typically found in grasslands and rangelands (Figure 1). Burrowing Owls have been listed as threatened or endangered at the local, national and international scales due to population declines. In the U.S. and also in Nebraska, these declines are related to the association between the Burrowing Owls and Prairie Dogs; Burrowing Owls often use Prairie Dog burrows as nesting sites. A combination of the effects of habitat destruction from agricultural production, sylvatic plague and eradication programs have reduced Prairie Dog populations by about 90-98% of their former range. In Nebraska, the more significant populations of breeding Burrowing Owls are found in the state’s panhandle.

Figure 1. An adult Burrowing Owl perched on the edge of a prairie dog burrow in eastern Morrill County during the 2007 field season.

Specifically, the objectives of our Burrowing Owl research in the panhandle were to: (1) estimate parameters that describe the pattern of association between habitat characteristics, land-use and relative abundance, (2) estimate species detectability with the intention of improving surveys and estimates of relative abundance, (3) and to estimate the spatial structure of species counts and use that information to develop species distribution maps. All of these objectives would help us to determine what aspects of Burrowing Owl ecology and habitat preferences are important for maintaining a strong, viable population in the panhandle.

Our study was conducted in the Nebraska panhandle, where more than 90% of the land in this region is privately owned and is used primarily for agricultural production. Agricultural practices are mainly in the form of dryland and irrigated agriculture as well as cattle ranching. Crop production is mainly in the form of small grains (wheat and millet) on dryland fields and corn, soy beans and sugar beets on the irrigated sites. This part of the state also overlaps the Shortgrass Bird Conservation Region (BCR 18).

Burrowing Owl surveys encompassed a large area that included all 10 Nebraska panhandle counties: Banner, Box Butte, Cheyenne, Dawes, Deuel, Kimball, Morrill, Scotts Bluff, Sheridan, and Sioux. We conducted burrowing owl surveys mainly at prairie dog colonies, but we also monitored some small burrow complexes of other mammals. At each burrow complex we chose a location that afforded the best view of the colony. For larger colonies we used multiple points that offered non-overlapping views of colony. We revisited each point 2-4 times during the survey period. We surveyed for owls at known burrow complexes. During each visit we conducted two three-minute surveys; one prior to territorial or alarm call playback and one post playback. We conducted these surveys between sunrise and 1000 or between 1700 and sunset. Surveys began in late June and ran until late July.

We conducted all of our analyses using the statistical computing language R, and adopted a Hierarchical Bayesian approach because it allowed us deal with multi-level processes in an efficient manner, and also afforded us the opportunity to include prior information in certain parts of the model. To begin we treated counts as a binomial process:

$$y_{ij} = Binomial(N_i, p)$$

where y_{ij} are the counts at site i and visit j, N_i is some unobserved site abundance and p is the detection rate. Notice that including N in the binomial model is the same as saying that there is some true number of individuals at a site, but that one can only observe some proportion of that true number. N can be estimated as:

$$N_i \sim Poisson(\lambda_i)$$

where λ_i is the site specific Poisson mean (i.e. average relative abundance).

$$p(y_{ij} \mid N_i, p) = \prod_{i=1}^{I}\left(\left(\prod_{j=1}^{J} Bin(y_{ij}; N_i, p)\right) Pois(N_i; \lambda_i)\right)$$

For this model, one can assume that estimated mean abundance (λ) represents the corrected average number of individuals in each sampling unit. This requires a further assumption that the population is closed. In our application, however, we assume that we may have violated this assumption and so we regard λ as a corrected relative abundance estimate.

We can easily model the nuisance parameter p as a function of covariates using a logistic model:

$$\log_e\left(\frac{p}{\mathbf{1}-p}\right)=\beta_{\mathbf{0}}+\beta_i x_i$$

where β_0 is the intercept of a linear model and $\beta_i x_i$ is a collection of model parameters β_i and x_i covariate data. We can then model the site specific mean using an overdispersed log linear model:

$$\text{u}(s) = \log_e(\lambda(s)) = \mu(s) + z(s) + \varepsilon(s)$$

where $\mu(s)=\sum\beta_{\mathbf{0}}+\beta_i x_i$ the sum of a set spatially indexed covariates, $z(s)$ is a spatial random effect, which is represented as a correlated error term, and $\varepsilon(s)$ is an error term representing uncorrelated error. This model structure allowed us to include the effects of spatial autocorrelation in terms of the site means. This term was modeled as:

$$z \sim MVN(\mathbf{0},\sigma_z^{\mathbf{2}}K)$$

where $\sigma_z^{\mathbf{2}}$ is the spatial variance and K is a correlation function that specifies how correlated the error terms are. In our model $K=e^{-|d-d|/\theta}$ and θ represents the degree of spatial dependence (so-called range parameter in geostatistics). The uncorrelated error term represents the small scale variation in the data and was included to help account for potential overdispersion in the observations. Here, we include uncorrelated error as a term sampled from a normal distribution with mean zero and variance $\sigma_\varepsilon^{\mathbf{2}}$:

$$\varepsilon \sim Normal(\mathbf{0},\sigma_\varepsilon^{\mathbf{2}})$$

In our model, both $\sigma_z^{\mathbf{2}}$ and $\sigma_\varepsilon^{\mathbf{2}}$ were parameterized as $\tau_z=\mathbf{1}/\sigma_z^{\mathbf{2}}$ and $\tau_\varepsilon=\mathbf{1}/\sigma_\varepsilon^{\mathbf{2}}$, also known as Bayesian precision parameters.

Briefly, our algorithm is a Metropolized Gibbs sampler since it combined both Gibbs sampling when the full conditional distribution was available and employed Metropolis-Hastings (M-H) when the full conditional was not available, as when updating based on the integrated likelihood (cite).

Our algorithm worked as follows:

1. We began with updating the vector of u(s) conditional on the other model parameters using M-H.
2. Then $z(s)$ was sampled from a full conditional multivariate normal distribution.
3. Following draws of $z(s)$ we updated θ via M-H.
4. We then drew the vector β for the log linear model on abundance from a low-dimensional full conditional multivariate normal.
5. Next, we updated both precision parameters as draws from Gamma full conditionals.

6. Finally, we updated β for the logistic model and N using M-H.

To reduce serial autocorrelation we hierarchically centered our covariates and hierarchically centered the model. We fit multiple candidate models for each species using the method outlined above. For each model we also estimated the posterior probability for each model assuming a uniform prior where M was the number of models:

$$\text{p(Model}_\text{i}) = (1/\text{M}) * p(y_{ij} \mid \text{Model}_\text{i}) / \sum_{j=1}^{J} (1/\text{M}) * p(y_{ij} \mid \text{Model}_\text{j})$$

We then used the median of each posterior model probability to average model parameters and predictions. We used this same modeling framework for the Mountain Plover patch surveys that follow in a later portion of this report.

For owls we analyzed count data for the observed number of adults and juveniles separately. For the 2005 counts we built two base abundance models. Our first model assumed that average abundance was constant across sites. Our second model included the number of active burrows occupied by Prairie Dogs (Burrow) within a town. We included this because it appeared that more owls were seen on larger more active burrow complexes. In 2006 and 2007 we added two additional parameters to the second model: the shortest linear distance of the center of the patch from the road (Distance) and burrow area (Area). We considered these distance parameter because larger Prairie Dog colonies appeared to be located farther from the road. We considered the area parameter as a refinement of our assumption about the association between colony size and owl abundance. For the final two years, we also added a fourth base model that contained dummy variables for the presence or absence of certain agricultural practices near the colony. These landuse practices included dryland agriculture (Dryland), irrigated agriculture (Irrigated), rangeland (Range) and an intercept term representing “other” landuse practices (i.e. corn fields, residential or paved areas). We built four additional models that included pairwise comparisons of the above models.

For owl detectability, we considered two base models. The first model contained an effect of the call played between counts (Call). We considered this model for the same reasons as in the plover analysis. Our second base model contained the effects of Call, a dummy variable for the time of day when the count was conducted (Time + Time^2) and the effect of the ordinal day in the breeding season (Day + Day^2). We did not consider the effect of observers because the large number of observers in this survey (n=7) posed numerical problems to our algorithm. We combined our abundance and detection models for a total of 4 models in 2005 and 8 models in 2006 and 2007

For both the owl and plover analyses we assumed uninformative uniform priors on abundance parameters. For owls we assumed a uniform prior with a lower bound of 0 meters, but with an upper bound of 100,000 meters. We assumed uninformative inverse gamma priors [IG(1, 10)] on our precision parameters in both analyses. For 2005, we assumed uninformative normal priors on the detection parameters [N(0,10)] in both analyses. In our model detectability influences our ability to accurately estimate relative abundance. Thus, we used the Bayesian structure of our model to update and improve our detection estimates between years. We used estimates from the 2005 as priors in

2006 analyses and in 2007 we used priors from the 2006 analyses. Similarly, we used uninformative uniform priors on model probabilities in 2005, but used the posteriors as priors to inform model probabilities in 2006, and used 2006 posteriors to inform 2007 model probabilities. However, for the burrowing owl analysis there were fewer models for 2005 than in 2006 and 2007. As a result, we used uninformative priors in both 2005 and 2006, but did use informative model priors in 2007.

We ran each model for 110,000 iterations, using three chains per model. We used the first 10,000 iterations as a burn-in period. Our inferences were drawn from summaries of the chains based on the last 100,000 iterations, but to further reduce serial autocorrelation we thinned the chains using every100th iteration. Because of the long periods of time needed to run each chain we adopted a parallel processing approach. We used the Prairiefire processing bank at the University of Nebraska-Lincoln Computer Science Department to run large batches of single chains. For example, consider a set of eight models each containing three chains. We would submit this model set to the processing bank as a series of 24 jobs to run simultaneously. In this case, we could cut our processing time down considerably. We used the R package *coda* to reconstruct the chains and build posterior summaries for each model.

Following the fitting and selection of our models, we made spatial predictions of abundance. Our plover prediction grid was made using the center coordinates of 1720 agricultural sections within the survey area. Because of the large spatial extent of the owl surveys, we used an arbitrary prediction grid of 3692 two square mile cells. Again, predictions were made using the center coordinates of each cell. For both species, we made spatial predictions by drawing samples from the full conditional predictive distribution as the other model parameters were updated in the MCMC algorithm.

Our 2005 data arose from a survey composed of 181 sites; 96 of the sites were visited once, 63 were visited twice, 18 were visited three times and four were visited four times. Based on the maximum counts at each site we estimated an average relative abundance of 1.67 adults/site and 1.93 juveniles/site. Our 2006 data came from a survey of 298 sites, but because of missing covariate values we analyzed counts from 281 sites; 196 of the sites were visited once, 5 were visited twice and 97 were visited three times. Based on the counts from each site we estimated an average relative abundance of 2.64 adults/site and 3.82 juveniles/site. In 2007 we used data from 290 sites, but because of missing values, we only analyzed 246 sites; 37 of those sites were visited once and 209 were visited twice. Based on the maximum counts we estimated a relative average abundance of 1.73 adults/site and 1.97 juveniles/site.

Our best model for the 2005 owl survey suggested that variation in both adult and juvenile owl relative abundance contained a weak effect of the number of active burrows in a prairie dog colony. Assuming an average colony size of 72.19 we estimated relative abundance for adult owls to be 1.09 (95% CI: 0.93 – 1.29) and 0.96 (95% CI: 0.77 - 1.17) for juveniles. For 2006 and 2007 our best model included the effect of landuse. Model predictions for adult owls in both years suggest that relative abundance was highest in sites surrounded by rangeland or by some combination of dryland agricultural fields and rangeland. Sites surrounded by irrigated agricultural fields appear to have lower relative abundance, except when paired with the effect of rangeland or a combined with both rangeland and dryland effects. We found a similar effect for juvenile relative abundance in response to landuse.

The best detection model for both adults and juveniles was the multiparameter model in all years. Our average detectability estimates for adults were similar in 2005 and 2006, but decreased somewhat in 2007. Our estimates for juvenile detectability show a slight increase from 2005 to 2006 followed by a decrease in 2007. The effect of playing calls varied considerably for adults. In 2005, the model predicted detection rate before the call was 0.60 (95% CI: 0.54 – 0.66) and 0.18 (95% CI: 0.15 – 0.22) after the call. In 2006 this effect was 0.58 (95% CI: 0.55 – 0.61) before and 0.57 (95% CI: 0.54 – 0.60) after. In 2007 the call effect was 0.45 (95% CI: 0.42 – 0.48) before and 0.47 (95% CI: 0.43 – 0.50) after. For juveniles, our detectability estimate in 2005 was 0.37 (95% CI: 0.31 – 0.43) before the call and 0.07 (95% CI: 0.05 – 0.09) after the call. In 2006, we estimate this rate to be 0.52 (95% CI: 0.49 – 0.55) before the call and 0.55 (95% CI: 0.52 – 0.59) after the call. In 2007 we estimated detectability to 0.38 (95% CI: 0.35 – 0.41) before the call and 0.43 (95% CI: 0.40 – 0.47) after.

The effect of the time of day on detectability varied over the three years for both adults and juveniles. In 2005, this effect showed a somewhat non-linear decrease for adults, but with considerable uncertainty. In 2006, we estimated a largely linear effect of time with only a very slight increase in detectability. The effect of time looked slightly non-linear again in 2007, but with a very slight decrease in detectability early in the morning or later in the evening. For juvenile owls, our predictions for the effect of time showed an increase in detectability early in the morning and later in the evening in 2005, but this effect weakened a bit in 2006 and by 2007 we estimated the effect of time to be a somewhat negative linear decrease in detection rate.

We predicted the effect of ordinal day on adult detectability in 2005 to be a largely linear increase as the season wore on, whereas in 2006 we estimated this effect as a negative decline in detection rate over time; we estimated a similar, but weaker, effect in 2007. For juveniles, we predicted detectability to be extremely low in the first days of the survey, but found an increase midway through the season, followed by a decline. In 2006 and 2007, we estimated a similar effect, but detectability leveled off after the midpoint of the survey, with the overall effect being weaker in 2007.

Adult relative abundance estimates were correlated over longer distances in 2005 and 2006 compared with 2007. As well, the amount of spatial variation in these abundance predictions was higher in 2005 and 2006. The amount of small-scale uncorrelated variation increased slightly in 2006 and 2007. Using these parameters, we made spatial predictions in 2005 that showed most of the adult owl abundance was concentrated in the eastern part of the panhandle with some smaller patches of high abundance in the west. In 2006, we predicted regions of very high abundance in the northeast corner and southeast corner of the panhandle. The predicted spatial surface for 2007 was comparatively flat with most of the high abundance areas concentrated in the center of the panhandle or in southeast corner. The error in these predictions was generally lower near observation points, but the magnitude of these errors was considerably smaller in 2007 compared with 2005 and 2006. Summing over these predictions yielded the following relative abundance predictions: in 2005 we estimated 4,612 (95% CI: 133.89 – 517,776.60) adults, in 2006 we estimated 10,368 (95% CI: 183.67 – 2,723,995), and in 2007 we estimated 4,351 (95% CI: 339.45 – 56,765.16) adults.

Juvenile relative abundance estimates were also correlated over fairly large distances in the first two years of the study, but over much smaller distances in the last year. Similarly, spatial variation was higher in the first two years than the final year, but the uncorrelated variation was higher in the last two years compared to the first year. The resultant maps showed a similar patchy distribution of abundance. The highest regions of abundance in 2005 we located in the southern part of the panhandle, while the areas with the lowest abundance were mainly in the central and northwestern parts of the panhandle. In 2006, we predicted more areas of higher abundance, followed by an apparent flattening of the prediction surface in 2007. We found a similar pattern in the distribution of prediction errors as in the adult owl analysis. Summing over the predictions we estimated 8,736 (95% CI: 76.30 – 12,995,197.00) juveniles in 2005, 10,712 (95% CI: 47.33 – 42,373,095) in 2006, and 3,447 (95% CI: 124.70 – 96,683.90) in 2007.

With a State Wildlife Grant awarded to the NPP for the 2008-2009 fiscal year, we will also be doing a metapopulation viability analysis using the occupancy data collected during the 2001-2007 field seasons, largely funded through Nebraska Environmental Trust grants. This analysis will allow NPP to determine strongholds of Burrowing Owls in the panhandle, and coupled with the results of our habitat modeling the best way to manage for this threatened bird species across western Nebraska. The results of the habitat modeling work will hopefully be submitted to Conservation Biology by the end of 2008, and when published a reprint will be sent to the Nebraska Environmental Trust,

<u>Ferruginous Hawk</u>

The NPP conducted research and nest monitoring for Ferruginous Hawks in the panhandle during the 2005 through 2008 field seasons. While the scope of the research and monitoring varied between years, between locating new nests in 2005 and estimating sampling detectability in 2007, considerable knowledge was gained above our preliminary surveys for this species in the 2001 through 2004 time frame. Ferruginous Hawk occupancy surveys were primarily conducted with a small aircraft (Figure 2) flying in the early morning when the light was best, but several nests were routinely checked on foot because the nests did not fall into a logical flight path. Aerial surveys were utilized because it allowed us to get the most information on nest occupancy for the amount of time and money it required to check a suitable number of nests, and landowner permission to access some lands where nests were known was not always possible. An additional benefit of conducting aerial surveys was that we were also able to collect information on Golden Eagle nest occupancy, another tier-listed raptor in the panhandle, and perform similar analyses as the Ferruginous Hawk without needing additional funds.

Figure 2. Nebraska Prairie Partner Project Assistant, Larry Snyder, and a pilot with Sidney Aviation prepare to board a plan prior to an aerial raptor survey over the Kimball Grasslands Biologically Unique Landscape during the 2007 field season.

Prior to the 2005 field season, NPP had done some preliminary Ferruginous Hawk surveys in the panhandle, but the focus of the 2005 field season was to survey previously unsurveyed areas to locate new nests and best approximate the distribution of Ferruginous Hawks in the panhandle. While we only recorded a total of 12 active nests during the 2005 field season, we did identify a lot of area where Ferruginous Hawk occupancy is limited at best, specifically southern Sioux County. In the 2006 field season the goal of NPP was to check every nest in the database, and to collect a number of different local and regional habitat variables that could be used to identify key habitat requirements for successful nesting of this species.

The goal in 2007 was similar to that of 2006, but we also wanted to determine the effectiveness of sampling raptor nests with an aerial survey, and while flights in previous years were usually done in late May so that chicks could be counted, we conducted two rounds of flights in 2007. One flight was conducted in early May and one in early June to see if our nest occupancy states varied between surveys, so that past data could be corrected for if imperfect detectability was a pronounced problem. We thought this might be an issue since in late May trees are beginning to leaf out and if the adults were not present at the nest we might call some nests unoccupied that actually were occupied.

We also conducted a total of four exploratory flights (two in northern panhandle, two in southern panhandle) to further understand their distribution throughout the panhandle.

The focus of the surveys in 2008 were very minimalistic, in that we only wanted to survey nests that had a known occupancy in both 2006 and 2007 so that we could identify any landscape or habitat features important to the dynamic nature of nest turnover. We had two good years of occupancy data in 2006 and 2007 that we could identify nests that went locally extinct between years, and adding a second year of this analysis would help us to eliminate some of the between year variability that might be present. In all of the aforementioned years we simultaneously collected data on Golden Eagles and will have results from them in the future, but we also collected data and locations for any new nests that we located during these flights or other surveys.

The most important result of the 2005 field season was that we really identified the major nesting sites for both Ferruginous Hawks and Golden Eagles, with Ferruginous Hawks being focused in the Niobrara River Valley and Kimball Grasslands areas and Golden Eagles being most present in the Wildcat Hills. There are some exceptions to these statements, but for the most part that is where these two species are really concentrated, and the results in subsequent years with other exploratory flights support these statements. Limited data on local habitat conditions was collected during the 2005 field season and nest numbers themselves were very low, so no habitat association analysis was performed for the 2005 survey year.

During the 2006 field season we conducted a total of four flights and recorded occupancy data for a total of 107 Ferruginous Hawk nests, with a total of 21 (19%) being given the status of occupied. Again, the majority of active nests were primarily located in the Niobrara River Valley and Kimball Grasslands portions of the panhandle. In 2006, a total of 26 Ferruginous Hawk chicks were counted in the checked nests, though a portion of the nests were too obscured by branches or the adult was sitting on the nest and prohibited a chick count. Habitat associations results from the 2006 nest occupancy surveys were conducted with the statistical program R, and used a logistic regression model to correlate nest occupancy with a suite of habitat predictor variables that included distance from road, area of surrounding contiguous rangeland, nesting substrate, distance from agricultural fields, and distance from nearest residence. Results of this analysis are presented in Table 2.

In the model that was the best fit for the data collected, a significant positive correlation of nest occupancy was found with larger contiguous areas of native rangeland around the nesting area. This is in agreement with the known ecology of this bird, which suggests that its population has declined because of continued fragmentation of its native habitat and its aversion to human disturbance. We also found a positive correlation of active nests being more common in trees (Table 2, Figure 3), which is interesting to note, since this bird would have evolved in a shortgrass prairie environment where trees would have been limited. This apparent change in nesting substrate preference reflects the adaptive potential of this bird to changing landscapes, which will be important in the future when lands may become even more fragmented and the face of the landscape will be changing dynamic ways (e.g. – wind turbines, etc.).

Table 2. Hypothesized models, degrees of freedom, AIC scores, delta AIC scores, and model weights for Ferruginous Hawk nest occupancy during the 2006 field season. Lower AIC scores reflect a better model fit, and models below null model have limited significance on explaining the variation in the data.

Model	k	AIC	d.AIC	w.AIC
Rangeland Area (+) ~ Substrate (trees)	3	84.39	0	0.260
Residence (+) ~ Substrate (trees)	3	84.42	0.029	0.256
Rangeland Area (+) ~ Substrate (trees) ~ Residence (+)	4	86.20	1.805	0.106
Rangeland Area (+) ~ Substrate (trees) ~ Crop (neutral)	4	86.24	1.843	0.104
Rangeland Area (+) ~ Substrate (trees) ~ Road (neutral)	4	86.39	1.999	0.096
Null Model	1	86.47	2.081	0.092
Rangeland Area (+)	2	87.42	3.031	0.057
Global Model (All Variables)	6	89.52	5.130	0.020
Residence (+) ~ Road (neutral) ~ Crop (neutral)	4	91.02	6.633	0.009

In the two separate rounds of flights in 2007, we located and recorded data on a total of 136 Ferruginous Hawk nests, where we found a total of 35 (25%) of them to be active in that field season. Similar habitat relationships were found as the 2006 survey results with a significant correlation with large blocks of unfragmented rangeland. In total we counted 69 chicks during the 2007 aerial surveys (Figure 4), which was a significant increase proportionally over the 2006 field season. The reason for this increase is not known, but had more to do than just having a greater number of active nests from which to count chicks from.

Figure 3. An active Ferruginous Hawk nest in a tree on the Kimball Grasslands area of the southwest panhandle during 2007 field season.

Figure 4. Two Ferruginous Hawk chicks in a tree nest on the Kimball Grasslands Biologically Unique Landscape in 2007. Chick counts were made at nests whenever possible to determine relative productivity of Ferruginous Hawks in the panhandle.

A major goal of the repeat survey in the 2007 field season was to determine how effective our aerial survey was at actually determining the actual occupancy of a nest in a given year. By replicating our surveys we actually discovered that our aerial surveys are remarkably good at determining actual occupancy, since only 1 nest of the 136 had a different occupancy status on the second visit, going from occupied to unoccupied. Even variation in occupancy in this direction is not problematic since the nest could have failed or experienced other difficulty in the time period between sampling. It would have been much more problematic if we found nests inactive the first flight (when adults should've been incubating nests) and then active during the second flight, but we had no instances where this occurred.

During the 2007 field season we also conducted four exploratory aerial surveys in areas not covered during 2005 flights, and located over twenty new nest locations for Ferruginous Hawks extending in far east Morrill County along the North Platte River breaks. One of these flights was done predominantly throughout the Wildcat Hills, and while no Ferruginous Hawk nests were located we did located over 15 new Golden Eagle nests. We will be conducting a Golden Eagle analysis similar to the Ferruginous Hawk analysis in the future, but currently we report that in 2006 there were 13 (32%) active nests amongst the 40 surveyed, and in 2007 there were 17 actives nests (28%) of 59 total surveyed. Chick counts for Golden Eagles were minimal as many chicks had fledged by the time we conducted some of the flights.

During the 2008 field season NPP conducted aerial surveys only on nests that had previously been occupied since 2001, and looked to get a second year of data to compliment the 2006 to 2007 local nest extinction and colonization data for a state-transition model analysis that would treat nest occupancy as a dynamic year-to year ecological process. The funding for this project is being funded through a State Wildlife Grant through the Nebraska Game and Parks Commission, but results will be sent to the Nebraska Environmental Trust when completed, as the flights were conducted with Trust dollars. Overall, in 2008 NPP surveyed a total of 55 Ferruginous Hawk nests and found 27 (49%) of them to be active, whereas a total of 37 Golden Eagle nests were surveyed and 11 (29%) were active. The increased occupancy percent is a reflection of surveying fewer nests (and ones that had a previous occupancy record), but the total number of active nests was down and was a reflection of a group of nests in Morrill County that are historically active but did not get surveyed in the 2008 field season.

Results of all these Ferruginous Hawk nesting surveys have provided NPP researchers with a good idea of the habitat requirements for successful nesting by Ferruginous Hawks, as well as a good approximation of the range in the panhandle, including where they were earlier in the decade and no longer found nesting. NPP has taken the next step in Ferruginous Hawk conservation by focusing their efforts in these recently vacated areas by constructing nesting platforms (funded through new Nebraska Environmental Trust grant) and installing them in these areas. Areas will be prioritized based on past colonization and in areas with unfragmented rangeland that has little human disturbance, and will be installed in the fall of 2008 so that they will be available for nesting in 2009. These nesting platforms will provide a tree-like nesting structure, but without providing any dispersal corridors like tree rows that bring non-native predators into the shortgrass prairie. We will also work with landowners so that they will be responsible for monitoring nesting activity from year to year, so that NPP can continue to track the population of this threatened bird in western Nebraska.

Mountain Plover

NPP has been working to various degrees with Mountain Plover since 2002, including a large scale survey of all Nebraska's shortgrass prairie in the 2003 field season to delineate the extent of their range. During this survey no plover were encountered outside Kimball, southern Banner, and southwest Cheyenne Counties (Figure5), and in years after this survey all of the work NPP conducted on Mountain Plover habitat associations was done across this limited area. During the 2005 through 2007 field seasons NPP recorded dates when Mountain Plover were first observed on the study area, and used estimated hatch dates based on egg floatation to determine when nesting was initiated and how long it continued across the study area (Figure 6). While the first observations of Mountain Plover had some variation between years, it was fairly routine to have them showing up between the middle of March and early April during all study years. In terms of nesting chronology, NPP found that nests were always initiated in late

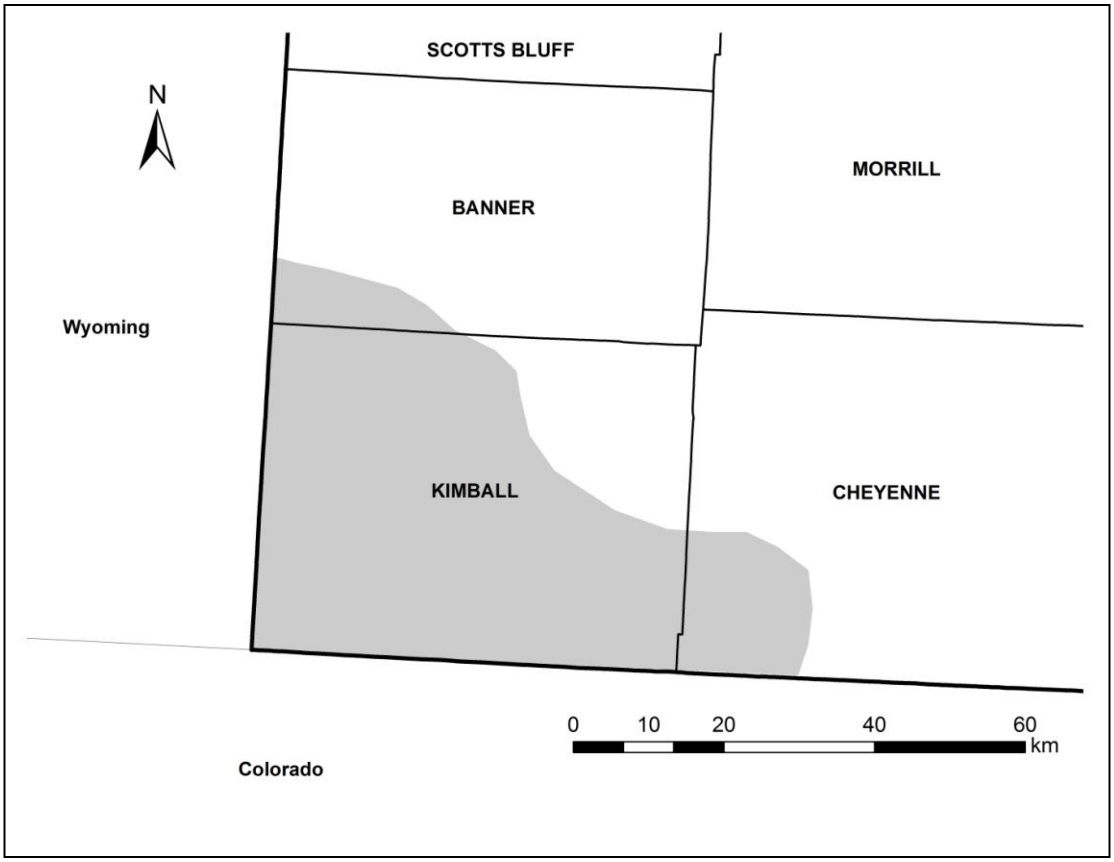

Figure 5. Rough distribution of breeding Mountain Plover (shaded area) observed in the southwest panhandle of Nebraska during the 2002 through 2008 field seasons.

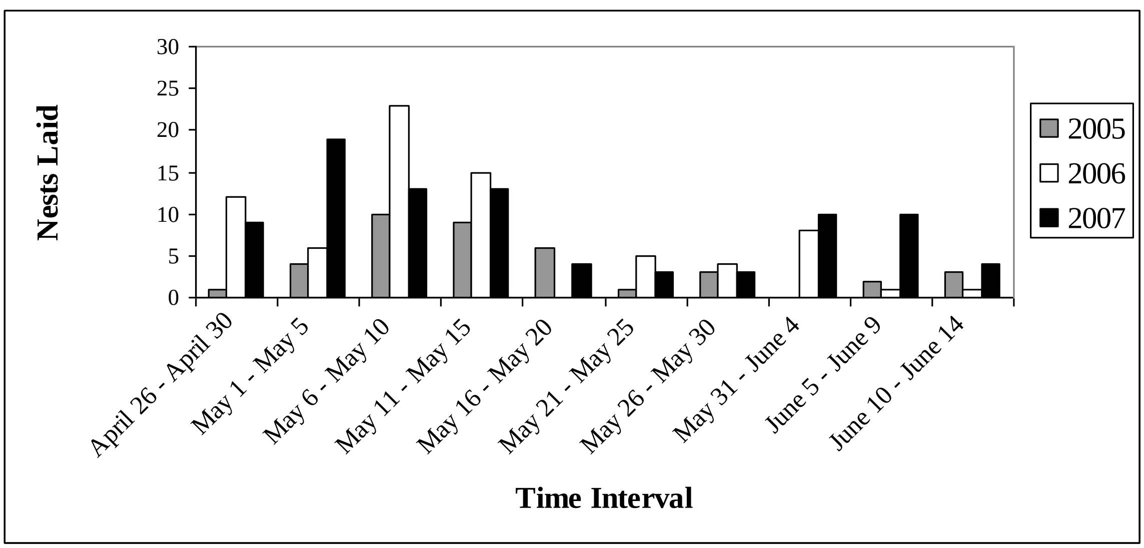

Figure 6. Estimated date that Mountain Plover nests were laid based on a 29 day incubation period from the midpoint between nest checks for nests located in Nebraska during nest marking for the 2005-2007 field seasons.

April of all study years with a second surge of nesters occurring in late May, and nest incubation carried into July over all study years. For a more detailed breakdown of this study see Appendix C which contains a manuscript accepted by the Nebraska Bird Review with results from this portion of NPP's Mountain Plover research.

NPP also worked in conjunction with the University of Nebraska – Lincoln with State Wildlife Grants to perform patch surveys for Mountain Plover during the 2005-2007 breeding seasons so that habitat preferences and spatial scaling of this species could be discerned. Mountain Plover has been listed as threatened species both at the state and national level due to apparent population declines, and with the reasons for the declines being unclear, some conjecture has been postulated about habitat destruction (Figure 7) and the destruction of nests by agricultural practices. Once believed to be largely absent, the population of breeding plovers in Nebraska has garnered recent attention from the work that NPP initiated during the 2002 field season.

Figure 7. Mountain Plover incubating a nest a fallow millet stubble field that will be tilled under within the next day.

The NPP conducted patch surveys took place across the Kimball Grasslands Biologically Unique Landscape in the southwestern panhandle (Figure 5), including portions of Kimball, Cheyenne, and Banner Counties. We identified sections likely to contain Mountain Plovers based on their known ecology, and randomly selected a subset of those sections. Within each section we placed a 4 ha patch (200m x 200m) in the part of the section that looked like it had the best nesting habitat. To estimate detectability, we visited each patch three times in 2005, four times in 2006 and three times in 2007. During each visit we conducted two three-minute surveys; one prior to territorial or alarm call playback and one post playback. We conducted these surveys between sunrise and 1000 or between 1700 and sunset. Surveys began in early April and were completed by the end of June.

For the 2005 plover counts we built four base abundance models. Our first model assumed that average abundance was constant across sites. Our second model contained an effect of the shortest linear distance of the center of the patch from the road (Distance). We considered this as test of whether plovers were selecting or avoiding sites that might experience more disturbances or are more exposed to nest predators. Our third base model included a dummy variable (Use) for the types of landuse within each patch (0=dryland or irrigated agriculture, 1=rangeland). We considered these effects because we wanted to test whether plovers prefer habitat patches that are regarded as more similar to native grasslands (rangeland) or they prefer highly disturbed agricultural fields. Our final model simply combined the effects of distance from road and landuse. In 2006 and 2007 we added additional variables to our landuse model: one was a dummy variable for the presence of rocky soil in the patch (Rocks; 0=present, 1=absent) and the other was a similar variable for the presence of vegetation in the patch (Vegetation). We considered these effects because plovers have been found to select sites that contain rocky soil and have at least 30% bare ground

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For the plover detectability models we considered two base models. The first model contained an effect of the call played between counts (Call). We considered this because our raw data showed that counts were different before and after the call was played. Our second base model contained the effects of Call, the observer at the time of the count (Observer), the time of when the count was conducted (Time + $Time^2$) and the effect of the ordinal day in the breeding season when the count was conducted (Day + Day^2). We considered this model as a whole because we wanted to keep the number of potential models small when combined with our abundance models. We also found it unlikely, based on our data and prior expectations from the work of other researchers, that detection probability would be constant between observers and through time. For example, we noticed from field observations that counts early in the season seemed to have fewer plovers. Likewise, counts made earlier in the day tended to be higher than counts made later in the day. When we combined our abundance and detection models we had a total of 8 models.

The 2005 data arose from a survey composed of 104 sites with 103 sites visited 3 times and 1 site visited twice. The 2006 data were composed of 111 sites that were each visited 4 times. The 2007 data were composed of 129 sites that were each visited 3 times. Based on the maximum counts for each site we estimated 0.17 birds/patch in 2005, 0.23 birds/patch in 2006, and 0.67 birds/patch in 2007.

In 2005, the best model describing variation in plover relative abundance assumed that abundance was constant across sites, where there was no selection or habitat preference per se. There was some support for the models where abundance varied according to landuse and distance from road, but our model averaged predictions showed that relative abundance was similar across sites. Our model averaged relative abundance estimate was 0.96 plovers/site (95% CI: 0.87 – 1.05). Similarly, in 2006, the best model assumed relative abundance was constant, but there was much more support for this model. Using the top model, we estimated average relative abundance to be 0.95 plovers/site (95% CI: 0.78 – 109). We found the same result for the 2007 counts with even more evidence that the constant abundance model was supported by the data. Again, using the top model, we estimated that average relative abundance was 0.99 plover/site (95% CI: 0.89 – 1.10).

In all years, the best model describing variation in the probability of detecting mountain plovers was the full model. Our estimates of average plover detectability showed an increase over the three years of this study, and in all years we found a positive effect of whether a call was played before the count as well as an observer effect. In 2005, the detection estimates for the first observer were 0.01 (95% CI: 0.005 – 0.02) before a call was played and 0.03 (95% CI: 0.02 – 0.05) after the call. Our detection estimates for the second observer were 0.02 (95% CI: 0.01 – 0.04) before the call and 0.08 (95% CI: 0.05 – 0.11) after the call. In 2006, the effect of the first observer was 0.02 (95% CI: 0.01 – 0.03) before the call and 0.08 (95% CI: 0.04 – 0.11) after the call. Our estimates for the second observer were 0.02 (95% CI: 0.01 – 0.05) before and 0.08 (95% CI: 0.05 – 0.13) after the call. In 2007, the effect of the first observer was 0.06 (95% CI: 0.04 – 0.09) before the call and 0.21 (95% CI: 0.15 – 0.28) after the call. Our estimate for the second observer was 0.07 (95% CI: 0.05 – 0.10) before the call and 0.23 (95% CI: 0.17 – 0.30) after the call.

The effect of the time of day when the count was conducted varied considerably between years. The predicted effect of time suggested that in 2005, time was mainly a linear effect, whereas in 2006 and 2007 time had a much more non-linear effect with detectability being highest early or late in the day. In 2005 the effect of ordinal day in the breeding season showed a negative linear effect as the season progressed. In 2006, this effect was fairly weak, but still negative, and similarly in 2007, this effect was weak, but was more non-linear than in the previous two years.

In all three years the estimates of autocorrelation in abundance among sites, as measured by the range parameter (Theta), were similar. Thus, our estimate of Theta suggests that average relative abundance is correlated to about 5700 meters. The variation in relative abundance was higher within a patch compared to between patches in 2005 and 2006, but this pattern was reversed in 2007. Using these parameters, we made spatially explicit predictions (i.e. maps) of relative abundance within the survey area. The resulting map for 2005 and 2006 showed spatial distributions with low variability , but spatial variability increased in the predictions in 2007. The predictions for the highest relative abundance of plovers were in the western portion of the survey area in 2005, but the orientation of the highest predictions changed from a north-south distribution in 2005 to an east-west distribution in 2006 and 2007. These high abundance areas were located in southern portion of the study area. Because our relative abundance predictions are corrected we could estimate total relative abundance by summing all of our spatial predictions. For 2005 this estimate was 1686 plover (95% CI: 464.25 – 6054.76); in 2006 it was 1661 plover (95% CI: 474.89 – 5700.78); and in 2007 it was 1581 plover (95% CI: 326.39 – 7513.85).

The Nebraska Natural Legacy Plan also lists accidental tillage of nests as a major conservation concern for Mountain Plover, and in 2004 the NPP began implementation of a "nest marking" program with the local landowners across the Kimball Grasslands Biologically Unique Landscape. The program involved educating landowners about Mountain Plover conservation issues, and then securing permission from them to access their lands to locate Mountain Plover nests. Once this was done, NPP personnel used ATV's to drive parallel transects down fallowed or crop stubble fields to flush birds of their nests in the late morning to early evenings of late April through the end of June (Figure 8). Once a bird was flushed off the nest technicians backed off of the area and waited for the bird to return so that an exact nest location could be determined. Once the nest was located a GPS location was taken, eggs were floated, and blaze orange painted wooden lathe were placed on the four sides surrounding the nest so landowners could visualize the nest area and miss it with their tillage operations for a $100/nest incentive payment (Figure 9). Landowners were also provided with a map of approximate nest locations on their lands, so they had a good idea of where to look for nests.

Figure 8. Nebraska Prairie Partners personnel conducting Mountain Plover nest marking in an organic millet stubble field south of Kimball, Nebraska in May 2006.

Figure 9. Adult Mountain Plover incubating a marked nest in a millet stubble field that had recently been tilled, but thanks to the nest marking program this nest was saved and hatched three young.

After Mountain Plover nests were located and marked in the agricultural fields, nest fates were monitored twice a week as a means of evaluating the effectiveness of the program, and to better understand the ecology and habitat processes that impact Mountain Plover nest survival. Nest fates were recorded as successful, predated, abandoned, sterile, cultivated, or destroyed by hail, and the repeat monitoring allowed us to perform a daily nest survival estimate using a logistic exposure framework within the statistical program R. This sort of analysis is required of nesting studies, as there are too many other biases that can impact apparent nest survival estimates. An “successful” nest fate was awarded to nests that either had chicks still in the nests or those of which contained egg shell fragments from when the chicks broke out of the eggs, because mountain plover are a precocial species and the chicks leave the nesting area very shortly after they hatch, which eliminates most opportunities to observe chicks in the nest. A whole suite of covariates were also collected and used in the analysis, including nest age, ordinal day of season, precipitation between nest checks, and distance from road.

While the climatic conditions varied between years, all nests from 2005 to 2007 when nest monitoring was performed were lumped together to improve sample size. We determined our overall nest survival estimate to be 79%, which is almost two-fold larger than any other nest survival estimate reported for this species across its entire range. The only substantial effect of any covariate that we observed on our data was a negative effect with nest age. This result is different than that observed for most other studies, but is likely attributed to increased predation in the later stages of incubation, because birds were observed at nests and acting more demonstrative during this time period, and could very easily attract more predation pressure in the immediate nesting area. Predation events were relatively sparse during this study, and the types of predators observed were snakes, swift fox, coyotes, and ground squirrels. Very few nests were abandoned, sterile, destroyed by weather, or were accidentally cultivated, but in the 2007 field season we wanted to determine what impact tillage would have on Mountain Plover nests if we did not mark them for landowners.

During the 2007 field season we purchased 200 quail eggs from the Sutton Research Institute, and painted them to reflect the color of Mountain Plover eggs. Quail eggs were also roughly the same size as Mountain Plover eggs, making them a suitable surrogate for this study. Our “dummy” nests composed of three quail eggs were placed in random locations in fields that had just been nest marked, so that NPP personnel had GPS locations of the nests, but they were not marked and landowners had no knowledge that any such nests were in their fields. Dummy nests were monitored twice a week at the same time as the real Mountain Plover nests, and the nest fate, number of eggs, and tillage operation were recorded so that we could look at the impact that various tillage operations have on nest survival in agricultural fields.

Impacts of various tillage operations varied to a great degree (Table 3), where rigorous mechanical operations like sweeping and disking were much more detrimental to nests than operations like no till (chemical fallow) where the only possibility of nest loss is being run over by the tire. In recent years with spiking gas prices, a good majority of farmers have been using chemical fallow which is good for Mountain Plover as long as there are no harmful side effects of the chemical on the eggs, and because nest loss seemed minimal in 2007 we adapted our nest marking program and excluded chemical fallowed fields from being surveyed in 2008. This allowed us to focus more time and effort on the organic and mechanically tilled fields where nest loss would be expected to be higher (Appendix D).

Table 3. Fates of dummy nests and overall egg survival percentages (excluding predated nests) in response to various agricultural tillage operations during the 2007 field season.

Nest Fate	**Sweeping**	**Disking**	**Chiseling**	**No Till**	**Planting**	**Total**
Successful	1	1	1	3	0	6
Partial Success	6	3	1	0	2	12
Cultivated	10	20	3	1	0	34
Total	17	24	5	4	2	52
% Lost to Tillage	58.8%	83.3%	60%	25%	0%	65.4%
# Surviving Eggs	10	7	4	9	2	32
# Eggs Exposed	46	70	12	12	6	146
% Egg Survival	21.8%	10%	33.3%	75%	33.3%	21.9%

Our Mountain Plover nest marking program has grown substantially in every year of its existence, with significantly more landowners involved and acres enrolled than in the beginning of the program (Table 4). Also, in each year that the program has been going on their have been an increasing number of nests located by landowners in addition to those found by the NPP nest marking program (Table 4). Overall, the number of nests we have found in any given year has grown significantly over time (Figure 10), and in recent years is more attributable to a larger local population of plover than it is to an increase in the number of acres surveyed. Some conservative population size estimates from our nesting densities on marked fields extrapolated to the rest of the county indicate a regional population somewhere in the vicinity of 400-600 breeding individuals, which is significantly more than was first thought when NPP began its research and monitoring for this bird species. In the future NPP is hoping to make this a landowner lead initiative, where landowners will be transitioned and trained to locate the nests and report them to a volunteer coordinator, and the incentive payments will be slowly decreased until it is a volunteer program. Future funding will help with this venture, but during the 2009 field season NPP will be conducting nest marking in full effort, and we will be conducting a landowner workshop in September 2009 to educate landowners on tillage operations and land management options they use to help restore/maintain suitable Mountain Plover habitat for years to come..

Table 4. Number of landowners and acres enrolled in the Mountain Plover nest marking program for respective years, including the total number of acres that nest marking was conducted on and landowner reported nests in the southwestern panhandle of Nebraska.

Year	**Landowners**	**Acres Enrolled**	**Acres Surveyed**	**Nests Marked**	**Landowner Located Nests**
2002	5	NA	NA	4	1
2003	16	NA	NA	8	1
2004	16	12,000	8,240	20	1
2005	19	25,570	19,600	49	7
2006	63	89,000	35,890	86	13
2007	68	123,900	23,575	111	19

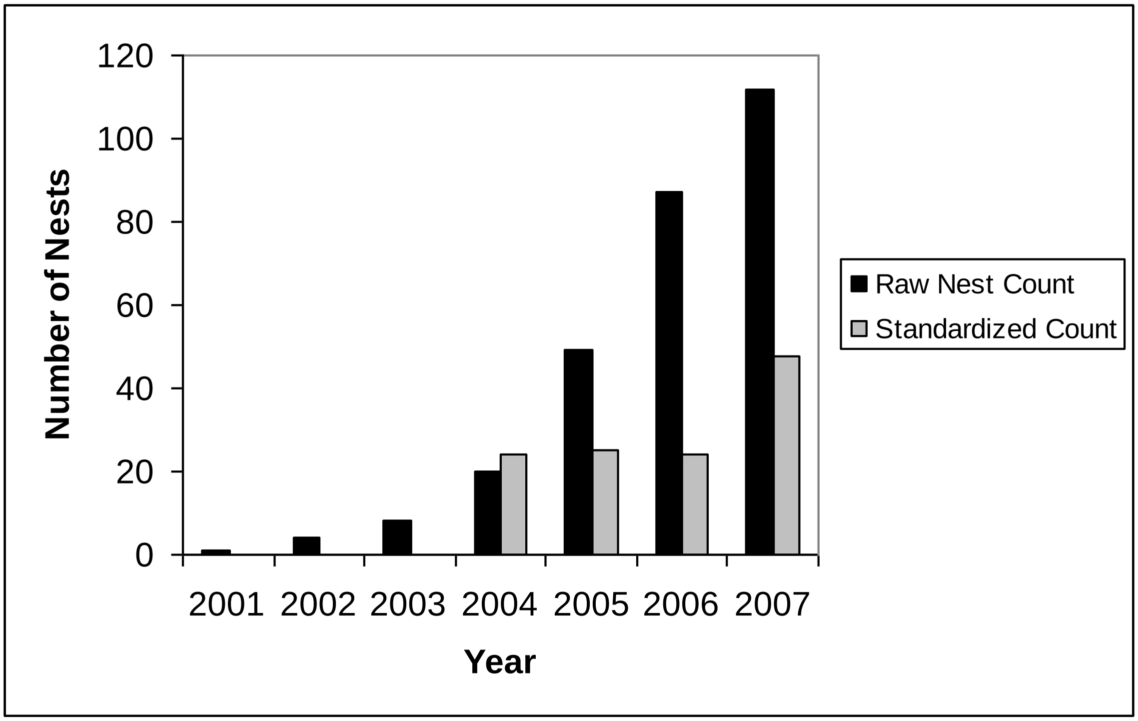

Figure 10. Total number of Mountain Plover nests located during nest marking in each year (black), and raw count data for years 2004-2007 standardized by number of acres surveyed (grey). Standardized data was calculated with the following equation for display on this figure: (number of nests located / number of acres surveyed) * 10,000).

As part of NPP's new grant with the Nebraska Environmental Trust, we will also be working to get some habitat improvement projects on the ground, specifically taking agricultural land out of production and reseeding it back to more native conditions. Currently, one of those projects is underway through the groundwork we laid during this current grant cycle. An additional benefit of the work NPP did with Mountain Plover during the duration of this grant, was collect data on the nesting ecology and habitat preferences of both McCown's and Chestnut-collared Longspurs and prepare a manuscript that is ready to be submitted to the Prairie Naturalist (Appendix E). We found that McCown's Longspurs actually will breed in agricultural fields where they can be destroyed by tillage operations, but the extent to which these fields may be acting as sinks could not be quantified with the current observations, but may be a need in the future as McCown's Longspur is a Tier I listed species of concern in Nebraska. We also found areas where both longspur species were breeding together, and describe to composition of those habitats so that habitat projects can mimic those conditions on future projects.

Through the work with Mountain Plover that the Nebraska Environmental Trust funded with this grant, we were able to learn a great deal of information about Mountain Plover ecology, habitat preferences, and the overall conservation status that Mountain Plover should receive within Nebraska. Our manuscripts will help provide NPP with scientific credibility, and this research will also lead to the inclusion of larger scale projects in the future with other state and federal agencies to conserve this native species.

Project Colony Watch

Project Colony Watch is a program developed by the Rocky Mountain Bird Observatory to actively involve members of the public interested in bird conservation in bird monitoring activities, and subsequently reducing travel budgets while still obtaining important data for analyzing population trends of colonial nesting birds. A major objective of this grant was to establish an annual Project Colony Watch reporting program for Burrowing Owls in the panhandle of Nebraska, and to a lesser extent reporting the activity of Ferruginous Hawk nests across the same area. The NPP has monitored both of these species in the panhandle since 2001, hence a great deal of the known nesting locations for these bird species have been determined and monitored for multiple years by NPP personnel. The belief of this was objective is that NPP is still interested in monitoring these species populations, but continued annual monitoring is both time consuming, labor intensive, and expensive, and greatly limits our time and financial abilities to work with other species of conservation concern. Therefore, having conservation-minded members of the public obtain this information with our oversight was the obvious solution to this problem.

Burrowing Owls

During the years 2001-2007 the NPP would roughly monitor over 300 prairie dog towns a year to record adult and juvenile Burrowing Owl numbers throughout the panhandle. In both the 2006 and 2007 field seasons the NPP utilized a total of four different volunteers to assist us with collecting data, and these individuals still reported their limited observations (32 sites) to us during the 2008 field season. The Wildcat Audubon Society also reports Burrowing Owl numbers on prairie dog towns that they routinely monitor, but we had a great deal of difficulty getting landowners enrolled in the Burrowing Owl Project Colony Watch program for a variety of reasons.

Specifically, there was a major conflict of interest for landowners who had limited interest in monitoring a prairie dog town. While landowner attitudes were very positive with regards to Burrowing Owls, they were equally negative in regards to prairie dogs. Landowners perceive prairie dogs as vermin and as a threat to their livelihood, and these connotations in respect to prairie dogs were difficult to overcome. A second reason why the Burrowing Owl Colony Watch program was unsuccessful was significant increasing gasoline prices in both the summers of 2007 and 2008, and is sure to be an important point to consider for this sort of program in the future across the panhandle. Rising gas prices have a definite negative impact on volunteer involvement in these programs, especially in western Nebraska where a lot of travel time may be required between survey locations. In fact, three of our four volunteers said gas prices limited the extent of their involvement during the 2008 field season. The NPP still expect that some rather limited data will be obtained in years to come, but to the extent of that data being in enough quantity to substantiate any population trends will be extremely limited at best.

Ferruginous Hawks

We began getting landowners to monitor Ferruginous Hawk nests beginning in the 2006 field season, and while the Project Colony Watch program for this species is a lot more effective than that for Burrowing Owls, there are some elements that are still difficult. A small minority of landowners are still hesitant to trust us with any data with respect to threatened species on their land, but is a much smaller group of landowners compared with the Burrowing Owls. A second problem with getting public involvement is that for a species like Ferruginous Hawks, the bulk of the people involved have to be landowners, since monitoring the nests usually requires gaining access to private lands since these hawks do not routinely nest in proximity of roads.

Project Colony Watch for Ferruginous Hawks is much more optimistic in western Nebraska though, in large part because they do not have the extreme negative connotation that Burrowing Owls have and the landowners are often in proximity of nests and can check them routinely. As part of our new Nebraska Environmental Trust grant we are going to be installing several Ferruginous Hawk nesting platforms on private lands in the panhandle, and a landowner requirement for these platforms on their property will be annual reporting of Ferruginous Hawk nesting activity.

Outreach and Education

Over this time period NPP complemented its species/habitat research and monitoring efforts with various avenues of outreach and education, which allowed us to share our findings with local producers, agency personnel, and other concerned individuals who help manage the land in western Nebraska. This bridge that was built with these individuals allowed us to assist with the creation and continued preservation of optimal habitats on private lands for a variety of threatened grassland birds, which is of grave importance in western Nebraska where over 95% of land is privately owned and zoned for agriculture.

Our most personal means of landowner outreach activity was one-on-one visits at the landowners personal residence, especially with those who had a vested interest in our work, because these are the people who manage the land we are interested in maintaining or improving. For this particular grant we were supposed to conduct at least 30 ranch visits/inventories, and between our Mountain Plover nest conservation programs, hawk and eagle nest monitoring, ranch bird inventories, and wildlife escape ladder outreach we met and worked with 308 landowners, totaling over 100 ranches visited. We highly recommend this sort of landowner outreach in the future, as we were able to convey our information to a large number of local land managers, and was flexible enough to accommodate their busy and on-the-go schedules. Overall, in addition to the number of landowners we educated about grassland bird habitat and conservation, their continued involvement in opportunities like hawk nest monitoring speaks to the connection and groundwork that has been laid with the landowners in these communities.

The NPP routinely attended regional science meetings, public gatherings, local fairs, and other associated venues where we would often give public presentations and poster displays with respect to bird conservation, attend and lead birding days, send out annual newsletters to our landowner database, lead educational trainings about bird conservation, hosted a bird banding station, and gave other school presentations about bird conservation and habitat improvement. These activities also generated a great deal of positive publicity and name recognition for NPP, which in some instances allowed us to meet other people interested in bird conservation, and in some cases enroll their lands in habitat improvement projects to benefit grassland birds. Through this grant we were supposed to provide 40 opportunities to have the public hear about the NPP and its bird conservation associations, and since the spring of 2005 we provided the public with over 50 opportunities and actually reached over 4,900 people during the duration of this grant.

While this sort of venue was successful at reaching large volumes of people, it was less successful at getting landowners to enroll their lands into habitat projects than the one-on-one visits, because the presentations were directed at a wider array of people and were therefore not as focused as when speaking to one person directly about their concerns, and how you might be able to work with them with their problems. The most positive result of these public presentation was that it really spread the word on NPP throughout the panhandle and even wider parts of Nebraska when we spoke and had booths at the Prairie Bird Symposium and Rivers and Wildlife Celebration in Kearney.

In conjunction with a Nebraska Environmental Trust grant entitled the Nebraska Shortgrass Prairie Partnership awarded to the Rocky Mountain Bird Observatory in 2004, the NPP also delivered results and bird conservation discussions through a variety of Nebraska Environmental Trust sponsored workshops, ranging from landowner focused workshops to those directed towards urban residents (Figure 11). The following workshops were delivered during this time period in fulfillment of this grant: Urban Workshop in Chadron, Nebraska, the Pine Ridge Symposium at Chadron State College, a Prescribed Burn Workshop at Cedar Canyon State Recreation Area, a landowner workshop in Carter Canyon west of Gering, Nebraska, an Urban Workshop at Sullivan Hills Lutheran Church Camp north of Lodgpole, Nebraska, the Wildcat Hills Biologically Unique Landscape Workshop in Scottsbluff, Nebraska, and a Playa/Wetland Conservation Workshop for landowners in Perkins County, Nebraska. Through these workshops we reached a total of 339 members of the public interested in learning about bird conservation issues.

Figure 11. Participants at the Urban Resident workshop near Lodgepole, Nebraska enjoy some birding during the hay wagon ride portion of the workshop, where concerned public were given the opportunity to do some birding and learn more about bird conservation.

Overall, these workshops were very successful outreach tools in promoting bird conservation in western Nebraska, and lead to habitat improvement projects in multiple cases. While some workshops were more successful than others, both landowner and urban resident attendance was sufficient to plant the seed of bird conservation in the panhandle, and routinely reported on the workshop evaluation forms that our workshops were beneficial in increasing their awareness about bird habitat requirements, bird ecology, and an overall appreciation of birds. We consider our workshops a very successful outreach activity, and under our current Nebraska Environmental Trust grant we are putting on a Mountain Plover Habitat Conservation workshop in Kimball, Nebraska and a Pine Ridge Biodiversity Workshop in Chadron, Nebraska to educate landowners and other interested parties on the results of NPP research and monitoring within these two critical habitats of western Nebraska. With continued funding in the future, workshops will continue to be a staple of NPP outreach in the panhandle of Nebraska.

The NPP also use a variety of pamphlets and brochures to supplement their outreach activities, and often distribute these materials through all the avenues aforementioned in this section. In total during this grant interval, the NPP met its requirements by distributing 3,177 Pocket Guides to Prairie Birds, 530 Sharing Your Land with Shortgrass Prairie Birds/Wildlife manuals, 24 Integrating Bird Conservation into Range Management manuals, 153 Stewardship Resource Guides, 60 Interactive Bird CD-ROMs, and 15 Shortgrass Activity Books. This outreach material is wide-ranging in both content and use, but with this variety the NPP was able to cater to its target audience and ensure that bird and habitat conservation were the focus of our outreach. These outreach supplements are extremely useful for both one-on-one ranch visits and for distribution at workshops, and provide the opportunity for interested parties to take a closer look at a later time period. We feel these outreach supplements were very useful in promoting both bird conservation and the NPP, and again anticipate using them for outreach purposes in years to come in western Nebraska.

Conservation

Stock Tank Ladders

With the advent of this Nebraska Environmental Trust grant, the NPP began constructing and installing wildlife escape ladders in stock tanks throughout the panhandle of Nebraska, and subsequently began monitoring avian drowning in these stock tanks to test the effectiveness of the ladders at preventing drowning mortality. The wildlife escape ladders are made of expanded metal and are bent to form a pyramid shape along the edge of the stock tank with a small flap that is bent down outside the tank (Figure 12), and should have an average lifetime expectancy of five to six years. The wildlife escape ladder provides birds and other wildlife with a grasping area from which they can pull themselves from the tank, and in the 2006 field season NPP wanted to quantify the impact that stock tank drowning may have on bird populations and to identify what stock tank attributes (if any) were responsible for increased drowning risk.

Figure 12. Nebraska Prairie Partner Project Assistant, Larry Snyder, installing a wildlife escape ladder in a stock tank on a habitat project near Kimball, Nebraska.in April 2008.

During the 2006 field season wildlife escape ladders were systematically based in every other stock tank that was visited for installation, and a suite of different covariates were collected for each tank that included tank size, distance between tank edge and waterline when full, other escape devices, and tank depth. Landowners were given datasheets and instructions on how to complete them so that they could record bird drowning during stock tank checks during the summer. In October NPP collected all of the data from the various landowners throughout the panhandle and entered the data into a spreadsheet. The statistical program R was used to perform a logistic regression analysis (0=no drowning observed, 1=drowning observed) on the data, and the variance in effort of searching between landowners was adjusted for by including sampling effort as a categorical variable in all models developed.

Three very substantive results were observed in the modeling of the bird drowning data. First, and most important, is that tanks with wildlife escape ladders had significantly fewer drowning events than tanks without ladders or with other floatation devices (Table 5). To the best of NPP's knowledge, this is the only quantitative analysis to demonstrate this very positive result. Secondly, we observed that the presence of other floatation devices (e.g. – wooden fence posts, etc.) actually had a negative impact on bird drowning (Table 5), and which has been a focus of our landowner outreach ever since because mistakenly landowners have often placed these devices in the stock tanks to prevent drowning, but inadvertently were promoting bird drowning. Thirdly, it was found that the distance between the tank edge and water line was the predominant variable responsible for increased bird drowning events (Table 5). The logic is that when the tank water level is near the edge, birds do not have to lean as far over to drink water, and therefore do not end up falling into the tank where they drown because they can not escape anywhere

Table 5. Hypothesized models, AIC scores, delta AIC scores, and model weights for bird drownings in stock tanks during the 2006 field season. Lower AIC scores correlate to a better model fit, and anything below the null model has limited significance.

Model	k	AIC	d.AIC	w.AIC
Effort + Ladder + Tankwater	4	52.305	0	0.232
Effort + Tankwater	3	52.893	0.588	0.173
Effort + Ladder	3	53.378	1.073	0.136
Effort + Other + Tankwater	4	53.603	1.298	0.121
Null	1	53.98	1.675	0.1
Effort + Other	3	54.105	1.8	0.094
Effort + Ladder + Other + Tankwater	5	54.277	1.972	0.086
Effort + Ladder + Other	4	55.079	2.774	0.058

Overall, we found that on average one bird drowned per tank without an escape ladder installed in it per year, and with our very conservative estimate of 8,000 stock tanks in the panhandle (assumed one tank per square mile and used NRCS data to estimate amounts of rangeland in panhandle) we would be looking to say that 8,000-10,000 birds die annually (40,000-60,000 over the lifetime of a ladder) in the panhandle alone because of stock tank drowning. The majority of birds that were reported to have drowned in the stock tanks were Western Meadowlarks which have been showing negative population trends, but other species of conservation concern that were reported included Ferruginous Hawks, a Tier I listed species in the Nebraska Natural Legacy Plan.

Given these results and the fact that states like Wyoming now require ladders to be placed in tanks on all Landowner Incentive Program projects, a large undertaking was taken using both Nebraska Environmental Trust and Nebraska Game and Parks Commission funds to build a surplus of stock tank ladders for installation in the panhandle. In January of 2008, NPP hosted two consecutive ladder build days at the North Platte NRD building in Scottsbluff (Figure 13), and cut a total of 481 ladders that were bent in early April at the Kimball High School Ag Building by NPP personnel and volunteers. A great deal of these ladders are still not installed yet, but when all of these ladders are installed by spring 2009, there will be a total of over 1,000 wildlife escape ladders installed in panhandle stocks tanks because of NPP. The effect that these ladders will have on bird conservation in western Nebraska will be significant and was only possible through funds by the Nebraska Environmental Trust.

Figure 13. NPP personnel using acetylene torches to cut bulk expanded metal in the shape of wildlife escape ladders that would later be bent prior to installation in tanks.

<u>*FEHA nest cribs*</u>

Since beginning nest activity monitoring on Ferruginous Hawks in 2001, the NPP have always looked at ways to enhance and conserve habitat for this threatened bird species in western Nebraska. Nest cribs were identified as a potential way through which tree root health and structural integrity could be maintained from cattle trampling and rubbing on trees with Ferruginous Hawk nests, thereby minimizing the chances that those particular trees would degrade and fall down over a number of years (Figure 14). Our monitoring efforts located a number of trees with active Ferruginous Hawk nests, but a second challenge with installing these nest cribs was securing landowner permission. For the most part landowners were very cooperative, and were more than willing to help conserve birds that they didn't perceive as a threat to their livelihood.

Figure 14. Nest crib installed around a frequently occupied Ferruginous Hawk tree nest in Sheridan County. The tree branch blew down in a storm during the 2007 field season, but have since colonized a neighboring tree.

The objective for this portion of the grant was for NPP to install nest cribs around five trees that warranted them for the benefit of Ferruginous Hawks, and during the granting period we installed a total of four nest cribs distributed widely in the panhandle. Two of the cribs are still in operation, but one was removed because the landowner put sheep (instead of cattle) in the pasture, and one sheep was found with its head caught in the nest crib. We didn't perceive sheep to pose as great a threat as cattle to tree structural integrity, and for fear of the landowner losing livestock we removed the nest crib from the tree, but that particular nest was active in every year and still appears to be suitable. The fourth crib was placed around a tree nest in northeast Sheridan County, and is still present around the tree, but a windstorm during the 2007 field season caused the branch with the nest to be blown off, and the hawks have subsequently colonized a neighboring tree that we moved and installed the nest crib around.

We consider the nest cribs to be a beneficial conservation measure for Ferruginous Hawks when a number of conservation hazards are present, especially with our research and monitoring efforts indicating that more and more Ferruginous Hawks are nesting in trees throughout the panhandle. The nest cribs are not perfect as the one tree whose branch blew down indicates, but in combination with the Nebraska

Environmental Trust sponsored nesting platforms that the NPP will be installing this fall in historical habitat throughout the panhandle, the NPP have taken two beneficial steps towards ensuring long term sustainability of Ferruginous Hawks in western Nebraska.

Working Groups

During the course of this grant, the NPP also became involved with some working groups involved in bird conservation issues. These working groups are aimed at optimizing bird research and monitoring, and ensuring that funds put forth towards habitat improvement projects are best utilized. Specifically, the NPP Coordinator is now involved with the Science and Research Working Group with the Nebraska Partnership for All-Bird Conservation, and was also invited to participate in a structured decision making workshop concerning Mountain Plover conservation at the National Conservation Training Center in Shepherdstown, West Virginia. The NPP is also actively involved in the Nebraska Natural Heritage Program, reporting all sightings of Tier I and II species for the heritage database for inclusion in the identification of biodiversity hot spots in western Nebraska that conservation measures can be directed towards at later dates.

Appendix A. Density and distribution maps for species encountered during 2005 section surveys in western Nebraska.

Appendix B. Density and distribution maps for species encountered during 2007 section surveys in western Nebraska.

Appendix C. Submitted and accepted manuscript sent to the Nebraska Bird Review concerning Mountain Plover Breeding Distribution, Migration Chronology during the 2006 and 2007 field seasons.

Appendix D. Manuscript getting ready to be submitted to Conservation Biology concerning the nest marking program, daily nest survival of Mountain Plover nests in agricultural fields, and the quantitative impact nest marking has on the local population.

Appendix E. Manuscript that is being submitted to the Prairie Naturalist in reference to McCown's and Chestnut-collared Longspurs nesting across the Kimball Grasslands Biologically Unique Landscape during the 2007 field season.