OCCURRENCE OF BREEDING MOUNTAIN PLOVERS (*Charadrius montanus*) IN THE WYOMING BASINS ECOREGION

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September 1999

INTRODUCTION / BACKGROUND

The mountain plover (*Charadrius montanus*) is endemic to the shortgrass prairie and adjacent shrub-steppe in western North America, where it breeds in flat, dry, and sparsely-vegetated sites (Knopf 1996). The population began to decline early in the century (Cooke 1915, Abbott 1940, Laun 1957), and has continued declining up to the present (Graul and Webster 1976, Knopf 1994, Knopf 1996). Several factors may be responsible; the most significant causes are probably extensive plowing and alteration of native grazing and fire regimes in the shortgrass prairie (Knopf 1994, Knopf 1996). Plowing directly destroys nests and hatchlings and, along with altered disturbance regimes, reduces habitat quality by producing tall and dense vegetation. These factors have eliminated mountain plovers from most of the eastern portion of their historic breeding range (Graul and Webster 1976), and have likely converted much of the shortgrass prairie from a population source to a population sink.

On 16 February 1999, the U.S. Fish and Wildlife Service proposed listing the mountain plover as Threatened under the U. S. Endangered Species Act (U. S. Fish and Wildlife Service 1999), making the species a management priority for land and wildlife managers. Conservation of mountain plovers in the shortgrass prairie is complicated by the large proportion of privately-owned land in the region. However, much of the shrub-steppe portion of their breeding range is under the jurisdiction of the USDI Bureau of Land Management, providing an opportunity to coordinate recovery efforts over a fairly large area. Furthermore, this region is not subject to nearly as much plowing as the shortgrass prairie. The most pervasive human land use in shrub-steppe systems is open-range livestock grazing, which is not only compatible with mountain plover reproduction, but can actually increase habitat quality (Kantrud and Kologiski 1982, Knopf 1996).

In order to integrate mountain plover conservation with other land uses, natural resource managers need to know the potential for mountain plover occurrence both locally and regionally. The objective of this study was to model mountain plover occurrence over a large area of shrub-steppe, using habitat attributes that are available in digital form.

STUDY AREA

This project was conducted in the Jack Morrow Hills, an approximately 2.8 X 10^5 ha region of southwestern Wyoming, east of the town of Farson and south of South Pass City (Fig.

1a). The area includes portions of the Green River, Sweetwater River, and Great Divide Basin watersheds, and encompasses the site where John Kirk Townsend collected the first mountain plover known to science in 1832 (Knopf 1996). The study area lies completely within the Wyoming Basins ecoregion (Fig. 1b), a shrub-dominated semi-desert whose current boundaries were modified from Bailey (1995) by The Nature Conservancy (1997).

Elevation in the study area ranges from 2020 - 2640m; topography is variable, ranging from broad flats to steep ridges and buttes. Coarse, rocky soils alternate with stabilized sand (Munn and Arneson 1998). Annual precipitation ranges from 203 - 305mm, the majority of which falls in April and May (Martner 1986). Land cover is dominated by Wyoming big sagebrush (*Artemesia tridentata* var. *wyomingensis*) and desert shrub assemblages (e.g. *Atriplex confertifolia, Sarcobatus vermiculatus*), with frequent patches of bare soil, rock outcrop, and vegetated and unvegetated sand dunes (Merrill et al. 1996). Small patches of aspen (*Populus tremuloides*) and juniper (*Juniperus scopulorum, J. osteosperma*) occur infrequently near seeps and springs. Over 90% of the study area is under the jurisdiction of the USDI Bureau of Land Management.

METHODS

Field Surveys

Mountain plover survey routes were established along roads in three portions of the study area (Fig. 1a). Cumulative length of all survey routes was 191 km. Vegetation and topography along these routes was representative of the entire study area. Five mountain plover surveys were conducted on each route from 18 May - 30 June 1999. Each survey was performed from a vehicle traveling 30 - 40 km/ hr between 06:00 and 19:00 hrs in favorable weather, and involved two experienced observers searching for birds by eye and binocular. The same two observers performed all surveys.

Mountain plovers are most often reported in flat and sparsely vegetated sites (e.g., Graul 1975, Parrish 1988). Because observers are most likely to see birds in such sites, there is a strong possibility of observation bias when surveying across several vegetation types and topographies. In order to minimize this bias, we noted the position and behavior of each bird when it was first seen. We statistically modeled only those observations where birds were initially observed on the road surface, road margin, or in flight along the survey routes. Because the visibility of birds in these situations was not a function of vegetation or topography, we assumed that the relative frequency of these observations was an unbiased estimate of the relative frequency of occurrence of mountain plovers in the terrain immediately adjacent to the road or beneath a flying bird.

Habitat Measurement

Each mountain plover observation was located to the nearest 16m using vehicle odometer and 1:24,000 scale topographic maps, and entered into a digital point theme using the ArcView (version 3.1; Environmental Systems Research Institute, Redlands, California) geographic information system. We termed these points "present-points" to reflect the confirmed presence of mountain plovers. We then measured topographical slope and vegetation type at each present-point by overlaying the point on (1) a raster map of topographical slope, and (2) a polygon map of land cover types. The former map identifies the percent slope ([rise / run] *100) within each 30m X 30m section of Wyoming, and was derived from a digital elevation model originally based on satellite imagery (W. Reiners and K. Driese, University of Wyoming, Laramie, Wyoming).

The land cover map is described in detail in Merrill et al. (1996). Briefly, it delineates polygons of unique primary and secondary land cover types (Table 1), and estimates the percent coverage of each type, based on satellite imagery and computer classification. For some polygons, the percent coverage of primary and secondary types does not sum to 100, and an "other" (tertiary) cover type is also identified. We calculated an index of cover suitability at each present-point by first scoring the cover types 1-5 according to their suitability as mountain plover breeding habitat (Table 1). These scores were based primarily on the typical height and density of vegetation in each cover type, although substrate mobility and soil moisture were also considered for some types (e.g., active dunes, grass dominated riparian). Scores were assigned following a review of published studies of mountain plover habitat use (e.g., Wallis and Wershler 1981, Olson and Edge 1985, Parrish 1988) and consultation with experts on Wyoming vegetation (W. Fertig and G. Jones, Wyoming Natural Diversity Database / University of Wyoming, personal communications). The cover suitability index at each present-point was calculated as:

Cover suitability index = (Primary cover type score * [% coverage of primary type / 100]) +
(Secondary cover type score * [% coverage of secondary type / 100]) +
(Tertiary cover type score * [% coverage of tertiary type / 100]) (1)

The third term was not necessary for some observations because the percent cover of the primary and secondary types summed to 100.

Using similar methodology, we measured topographical slope and cover suitability index at each of 60 points along the survey routes at which mountain plovers were not observed ("absent-points"). This set of points was developed by generating a point every 1000m along each segment of the survey routes (191 points total), then eliminating points that fell within 1000m of plover observations. We then selected 60 of the remaining points; selection was random within the restraint that the number of points selected on a given route segment was proportional to the proportional length of that segment. This ensured that absent-points were distributed evenly across the survey routes.

Model Building and Validation

We used logistic regression within the program Minitab (version 11; Minitab Inc., State College, Pennsylvania) to model the relationship between mountain plover occurrence and habitat structure. Logistic regression is a statistically robust modeling technique (Press and Wilson 1978) that defines the probability of the "true" (or in this case, "present") condition of a binary response variable as a function of independent variables (Hosmer and Lemeshow 1989). The model data set consisted of all present-points and all 60 randomly chosen absent-points. We used mountain plover presence or absence as the dependent variable, and cover suitability index and percent slope as independent variables. Three separate models were constructed; two using each of the independent variables separately, and one using both independent variables simultaneously.

The accuracy of the latter model was estimated by its ability to predict mountain plover presence and absence for points (1) in the modeling data set, and (2) in a validation data set. Points in the validation data set were independent of those in the model data set. The validation data set consisted of 455 points distributed throughout the Wyoming portion of the Wyoming Basins ecoregion. Sixty-five of these were confirmed observations of mountain plovers that were made during the breeding season and mapped to within 16m of their actual location, as documented in the Biological and Conservation Database at the Wyoming Natural Diversity Database (University of Wyoming, Laramie, Wyoming). The remaining 390 points were located randomly, and thus represented available rather than unoccupied habitat. Because the intensity and distribution of mountain plover survey effort is unknown for the entire validation region, we could not generate absent-points to include in the validation data set. All points in the validation data set were separated by at least 1000m. Note that the ratio of the number of present-points to the number of available-points in the validation data set (65/ 390 = 0.17) is the same as the ratio of the number of present-points to the number of absent points in the model data set (10 / 60 = 0.17).

In order to estimate the classification success of the multiple logistic regression model, it was necessary to select a cutoff probability such that a predicted probability greater than the cutoff indicated presence, and a predicted probability less than the cutoff indicated absence. Following Fielding and Haworth (1995), we defined the cutoff probability as the mid-point between the mean probabilities for the present- and absent-points.

RESULTS

We recorded 23 observations of mountain plovers during the surveys (Appendix A, B). Observations roughly formed 2 clusters; one on Bush Rim (including its western extension), and the other on the divide between Bush Creek and Bear Creek about 13 km west of Bush Rim. Although we observed no nests or hatchlings, we saw vigorous broken-wing displays from adults on both the first and last surveys of the project, suggesting that birds were in breeding condition during the entire survey period and that nests were in the vicinity. Observations of other species of conservation concern are listed in Appendix C.

Eleven of the 23 observations were of walking or motionless birds >20m from the road edge in flat and open patches. Because of the observation bias inherent in such patches, these points were not included in the model data set. Of the remaining 12 observations, 7 were of single birds and 5 involved 2 or more individuals.

Two of the 12 unbiased mountain plover observations were within 1000m of similar observations. In order to minimize spatial auto-correlation in the regression models, we removed one randomly chosen observation from each pair. Therefore, the final model data set consisted of 10 present-points and 60 absent-points, all separated by at least 1000m from each other. Because mean inter-nest distance has been estimated at <200m (Graul 1973) and brood rearing areas are <91 ha in size (Knopf and Rupert 1996), a spacing of 1000m maximizes the chance that each present-point represents a separate bird.

The logistic relationship between probability of mountain plover presence and percent slope was strongly negative, with a near-zero probability at percent slope >8% (Fig. 2a). The null hypothesis that all slopes in the model were zero was rejected (G = 6.764, df = 1, P = 0.009), and the model had good fit to the data (deviance chi-square = 20.524, df = 33, P = 0.956). The relationship between probability of mountain plover presence and cover suitability index was positive, with probability increasing sharply at suitability indices >3.3 (Fig. 2b). This model was only weakly significant (G = 1.877, df = 1, P = 0.171), and goodness-of-fit was rather low (deviance chi-square = 13.901, df = 6, P = 0.031). Note that the model data set contained a relatively small range (2.30 – 4.10) of cover suitability indices.

Multiple logistic regression of probability of mountain plover presence on percent slope and cover suitability index yielded a significant (G = 8.799, df = 2, P = 0.012) model with good fit (deviance chi-square = 37.527, df = 56, P = 0.973). Percent slope was a strong predictor (Z = -2.25, P = 0.024), whereas cover suitability index was weaker (Z = 1.42, P = 0.156). The multiple logistic regression equation was:

$$\ln (Y / 1-Y) = -7.824 + 2.241(\text{cover suitability index}) - 0.5661(\text{percent slope}) \qquad (2)$$

where Y = probability of mountain plover presence.

This model successfully classified 8 (80%) of the present-points and 43 (72%) of the absent-points in the modeling data set. Overall classification success for the modeling data set was 73%. The model also predicted presence at 39 (60%) of the present-points in the validation data set, and predicted absence at 356 (91%) of the available-points in the in the validation data set, for an overall validation success of 87%. Because of this relatively high success rate, we extrapolated the model across the entire validation region (Fig. 3) as well as the study area (Fig. 4).

DISCUSSION

Habitat Selection and Distribution

Percent slope was a strong predictor of mountain plover presence when used either as a sole predictor (Fig. 2a) or in combination with cover suitability index (Equation 2). In contrast, cover suitability index was a weak predictor in both single- and double-variable models. However, the model data set encompassed a relatively small range of values for the cover suitability index (Fig. 2b). It is likely that cover suitability index would be a stronger predictor of mountain plover presence if extreme values were included in the model data set, because presence and absence are more predictable in very suitable and very unsuitable habitats, respectively. This is suggested by the relatively high classification success (87%) of the multiple logistic regression model when applied to the validation data set, which includes the full range of cover suitability indices.

The multiple logistic regression model was clearly better at predicting mountain plover absence in available habitat (91% success) than predicting presence at sites of known mountain plover occurrence (60% success). There are likely other habitat factors to which birds are responding when selecting breeding areas, and the inclusion of such variables in the model may significantly improve its classification success. For example, the amount of soil moisture or bare ground in the vicinity of a nest may be important (Knopf and Miller 1994). However, because statewide maps of soil moisture and bare ground coverage may be prohibitively difficult or expensive to develop, these variables may need to be applied on a site-by-site basis. Also, note that the vegetation map used in this study was based on a minimum mapping unit of 100 ha (Merrill et al. 1996), and there is likely much variation in vegetation type and coverage within this scale. A model of mountain plover occurrence using finer-scale vegetation information may be more successful predicting presence.

Additionally, mountain plovers may be using non-habitat factors to select breeding sites. Mountain plovers tend to nest in clusters in seemingly homogenous habitat (Graul 1973, Knopf 1996), suggesting that close proximity to conspecifics stimulates nesting. The clustering of mountain plover sightings in this study (Appendix A) is consistent with this observation. Also, Graul (1973, 1975) noted that adults often nested in previous year's nest sites, and chicks often returned to their hatching sites to nest. Strong site fidelity may cause some birds to return to environments that have undergone substantial vegetative succession since they were first selected as high-quality sites; birds behaving in this manner would essentially be responding to past, rather than current, site conditions. This behavior would weaken models such as ours that relate bird positions to current vegetative structure.

The preference for flat and sparsely-vegetated sites in this study area is completely consistent with results of mountain plover studies conducted elsewhere (e.g., Graul 1975, Parrish 1988, Knopf and Miller 1994). Because such areas are relatively rare, small, and well-bounded in the Wyoming Basins ecoregion (Fig. 3, 4), land and wildlife managers should be able to quickly and efficiently survey high-probability habitat. Maintaining and enhancing habitat quality across most of the region should also be relatively easy due to the high proportion of land under Federal jurisdiction. This contrasts with the situation in the shortgrass prairie, where flat and sparsely-vegetated areas are larger, more diffuse, and typically under private ownership.

It is likely that patches of high-quality mountain plover habitat are more stable in size and position in the Wyoming Basins ecoregion than in shortgrass prairie. In shortgrass prairie, low and sparse vegetation is largely due to fire and intense grazing. The spatio-temporal distribution of these processes is highly variable, and vegetation can recover from such disturbances on a relatively short time scale. Thus, the distribution of high-quality habitat probably rapidly shifted across the prairie during historical times. Today, the alteration of native fire and grazing regimes and the expansion of plowing agriculture has greatly changed this situation. In contrast, patches of low and sparse vegetation in the Wyoming Basins ecoregion are largely the result of poor soil quality, low precipitation, and wind scour (especially during winter). At any one site, these factors are relatively consistent over time, leading to persistent bare patches. Thus, the distribution of high-quality habitat was probably more stable historically and, because the area is currently dominated by grazing rather than plowing agriculture, may be much the same now as in pre-settlement times.

Associations with Other Species

Mountain plover preference for flat and bare areas may ultimately be an adaptation to nest predators (but see Sordahl 1991). Predators take a significant proportion of mountain plover eggs (Graul 1975, Miller and Knopf 1993, Knopf and Rupert 1996) and chicks (Miller and Knopf 1993, Knopf and Rupert 1996), suggesting strong pressure to develop aniti-predator behaviors. Flat areas devoid of vegetation afford maximum sight distance to nesting or foraging birds. Mountain plovers observed during this study were constantly alert, and rapidly and repeatedly lifted their heads to scan the surroundings. The two landforms (rims, and flats far from superior topographic features) on which mountain plovers were observed suggest that the ability to see approaching aerial predators was especially important. Low-flying ambush raptors such as prairie falcons (*Falco mexicanus*), short-eared owls (*Asio flammeus*), and northern harriers (*Circus cyaneus*) would necessarily silhouette themselves against the sky when approaching such landforms. Note that all 3 of these species were observed on the study area, with the latter being the most commonly seen raptor.

Also, because patches of high-quality habitat may be primarily controlled by abiotic factors in the Wyoming Basins ecoregion, the association between mountain plovers and prairie dogs may be weaker here than in the shortgrass prairie. In shortgrass prairie, mountain plovers clearly prefer black-tailed prairie dog (*Cynomys ludovicianus*) colonies to areas without prairie dogs (Tyler 1968, Campbell and Clark 1981, Knowles et al. 1982, Knowles and Knowles 1984, Olson and Edge 1985, Olson-Edge and Edge 1987). Black-tailed prairie dogs form large and dense colonies that exert tremendous grazing pressure on surrounding areas, maintaining low and sparse vegetation. In contrast, the prairie dog occurring in the Wyoming Basins ecoregion (white-tailed prairie dog; *C. leucurus*) forms more diffuse colonies in areas with more shrub cover and topographical variation. Although mountain plovers do nest on white-tailed prairie dog colonies (Campbell and Clark 1981), studies comparing the density or frequency of occurrence between sites on and off white-tailed prairie dog colonies have not been performed.

Model Limitations and Application

As with all predictive models, the model produced in this project is best viewed as a hypothesis; it is perhaps more elaborate and quantitative than some hypotheses concerning mountain plover habitat use, but it is a hypothesis nonetheless. Although the model was generally successful at predicting mountain plover occurrence over a large portion of Wyoming, there is a non-trivial amount of error associated with its predictions. This is especially true in the prediction of mountain plover presence (60% success) at any given site. Therefore, the most appropriate use of the model developed in this study is probably to identify areas in which managers responsible for mountain plover conservation should focus future survey efforts.

Mountain plover conservation will be best served by confirming the presence of breeding birds through such surveys, then basing management decisions on areas of known occupation.

ACKNOWLEDGEMENTS

This project was supported by BLM Cooperative Agreement No. K910-A97-0011. We thank L. Keith, P. Polzer, E. Axtmann, K. Driese, Dr. W. Reiners, W. Fertig, and Dr. G. Jones for their assistance and helpful advice.

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TABLES

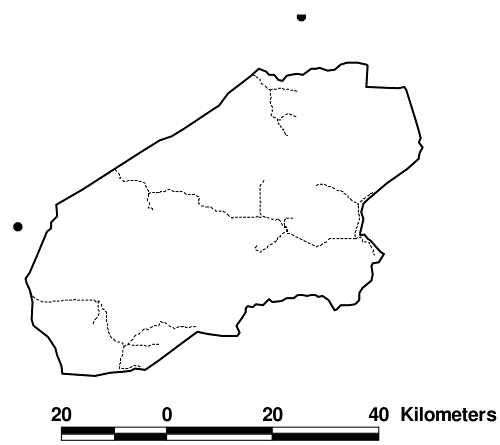
Table 1. Habitat suitability scores for mountain plovers for land cover types identified by the Wyoming Gap Analysis Project (Merrill et al. 1996). Scores were derived from a literature review and discussions with experts on Wyoming vegetation types, and were based primarily on the height and density of vegetation within cover types. 1= least suitable; 5 = most suitable.

Land cover type	Habitat suitability score
All forested types	1
Open water	1
Permanent snow	1
Subalpine meadow	2
Shrub dominated riparian	2
Meadow tundra	2
Alpine exposed rock/ soil	2
Human settlements	2
Surface mining operations	2
Grass dominated wetland	2
Grass dominated riparian	2
Mesic upland shrub	2
Xeric upland shrub	2
Basin big sagebrush	2
Irrigated crops	3
Bitterbrush shrub steppe	3
Mountain big sagebrush	3
Wyoming big sagebrush	3
Desert shrub	3
Greasewood fans and flats	3
Vegetated dunes	3
Active sand dunes	3
Black sagebrush steppe	4
Saltbush fans and flats	4
Dry-land crops	4
Unvegetated playa	4
Basin exposed soil	5
Great Basin foothills grassland	5
Mixed grass prairie	5
Short grass prairie	5

FIGURES

Figure 1. (a) The Jack Morrow Hills study area, southwestern Wyoming. Mountain plover survey routes are shown as dotted lines. (b) Regional context of the study area. I = Green River watershed; II = Sweetwater River watershed; III = Great Divide Basin watershed. The large, light gray polygon is the Wyoming portion of the Wyoming Basins ecoregion; the smaller, dark gray polygon is the Jack Morrow Hills study area.

a



b

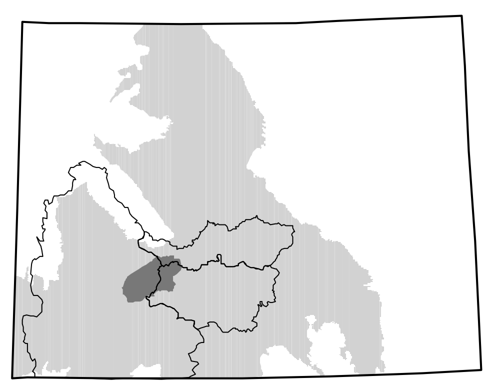
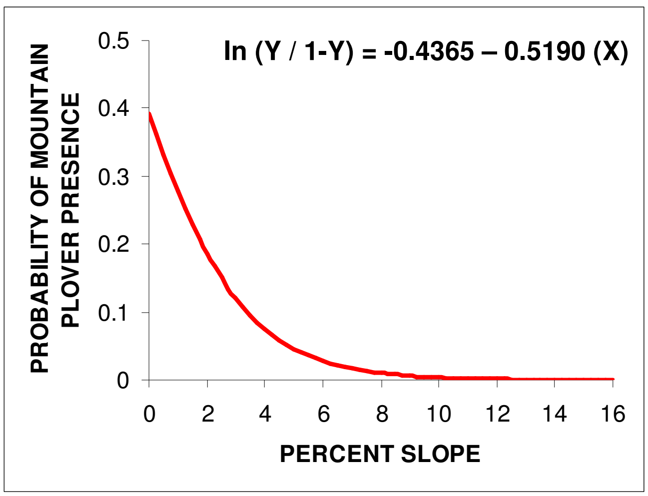


Figure 2. Logistic relationship between probability of mountain plover presence and (a) percent slope, and (b) cover type suitability index. Percent slope was calculated as ([rise / run] * 100), and was derived from a digital elevation model with 30m resolution. Cover type suitability index (Equation 1 in text) was based primarily on the height and density of vegetation within land cover types identified by the Wyoming Gap Analysis Project (Merrill et al. 1996). Solid line segments indicate the ranges of data from which the models were derived; dotted segments are extrapolations beyond these ranges. Y = probability of mountain plover presence.



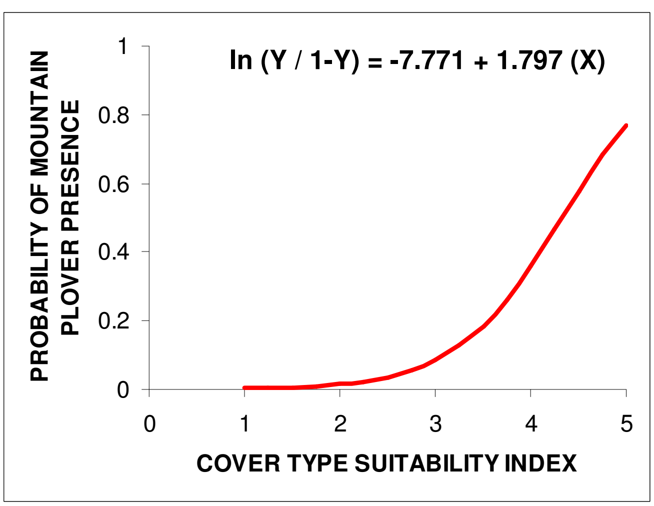


Figure 3. Probability of mountain plover occurrence during the breeding season in the Wyoming portion of the Wyoming Basins ecoregion. Map is based on a multiple logistic regression model using percent slope and cover type suitability index to predict mountain plover occurrence (Equation 2 in text). Five gray shades are shown; the lightest represents 0 - 20% predicted probability of occurrence, the darkest represents 80 - 100% probability. Cross-hatched polygons cover areas for which topographical data was not available.

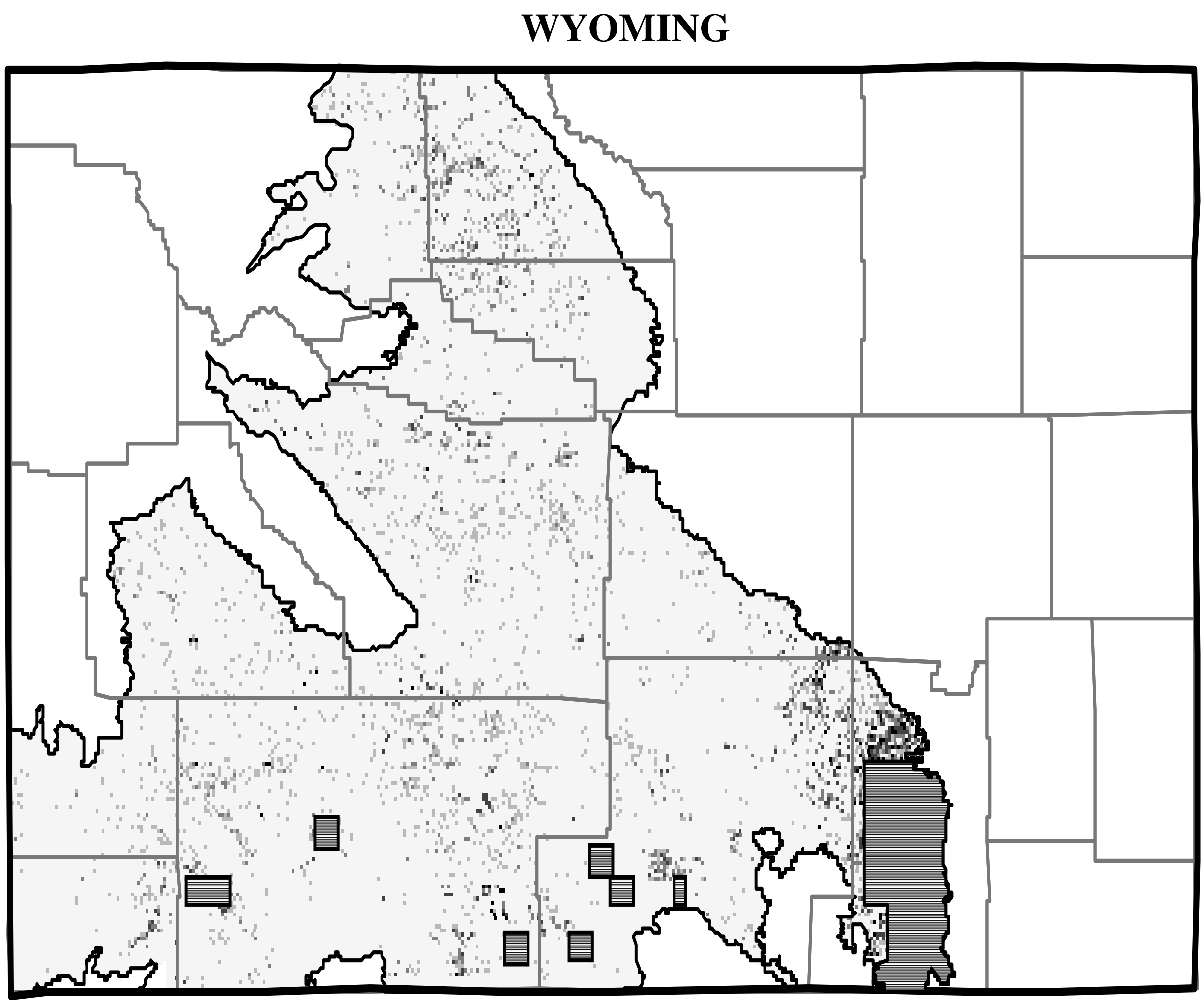
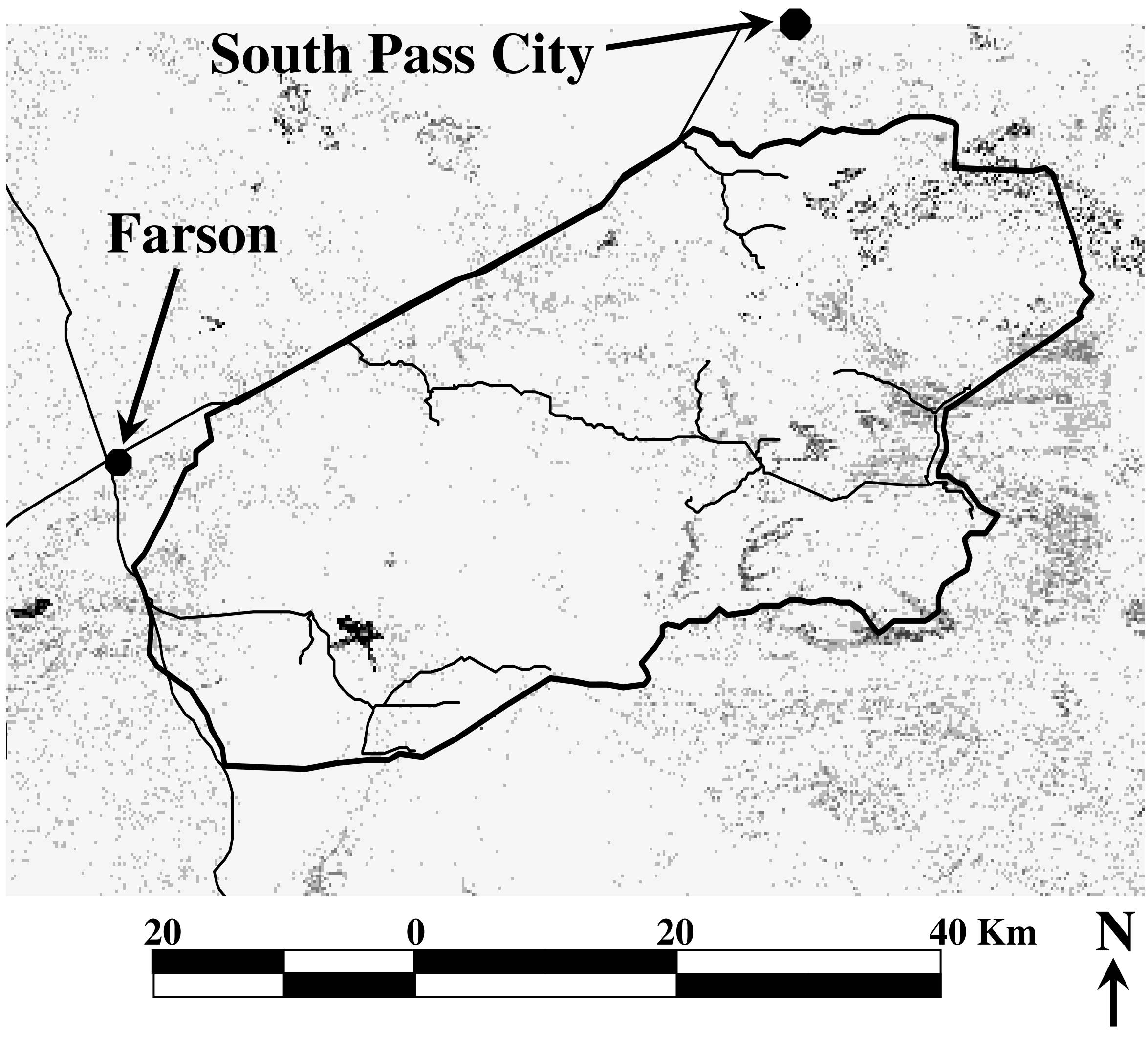


Figure 4. Probability of mountain plover occurrence during the breeding season in the Jack Morrow Hills study area, southwestern Wyoming. Map is based on a multiple logistic regression model using percent slope and cover type suitability index to predict mountain plover occurrence (Equation 2 in text). Five gray shades are shown; the lightest represents 0 - 20% probability, the darkest represents 80 - 100% probability. Bold black line is the study area boundary; fine black lines are roads, including the mountain plover survey routes within the study area.



APPENDICES

Appendix A. Mountain plover observations in the vicinity of the Jack Morrow Hills, Wyoming. Background is USGS 1:100,000 scale topographic maps; red line is study area boundary. Blue circles = observations made during 1999 surveys and included in the model data set. Green triangles = observations made during 1999 surveys but not included in the model data set due to observation bias. Red squares = breeding season observations of mountain plovers from previous years as documented in the Biological and Conservation Database at the Wyoming Natural Diversity Database, University of Wyoming.

Appendix B. Mountain plovers and mountain plover habitat observed on the Jack Morrow Hills, Wyoming, May – June 1999.

Mountain plover on western extension of Bush Rim; 18 May 1999.

Appendix B. (continued).

Mountain plover on western extension of Bush Rim; 18 May 1999.

Appendix B. (continued)

Pair of mountain plovers on Bush Rim, 10 June 1999.

Appendix B. (continued)

Mountain plover on Bush Rim; 27 May 1999.

Appendix B. (continued)

Mountain plover on the northern extension of Bush Rim; 27 May 1999.

Appendix B. (continued)

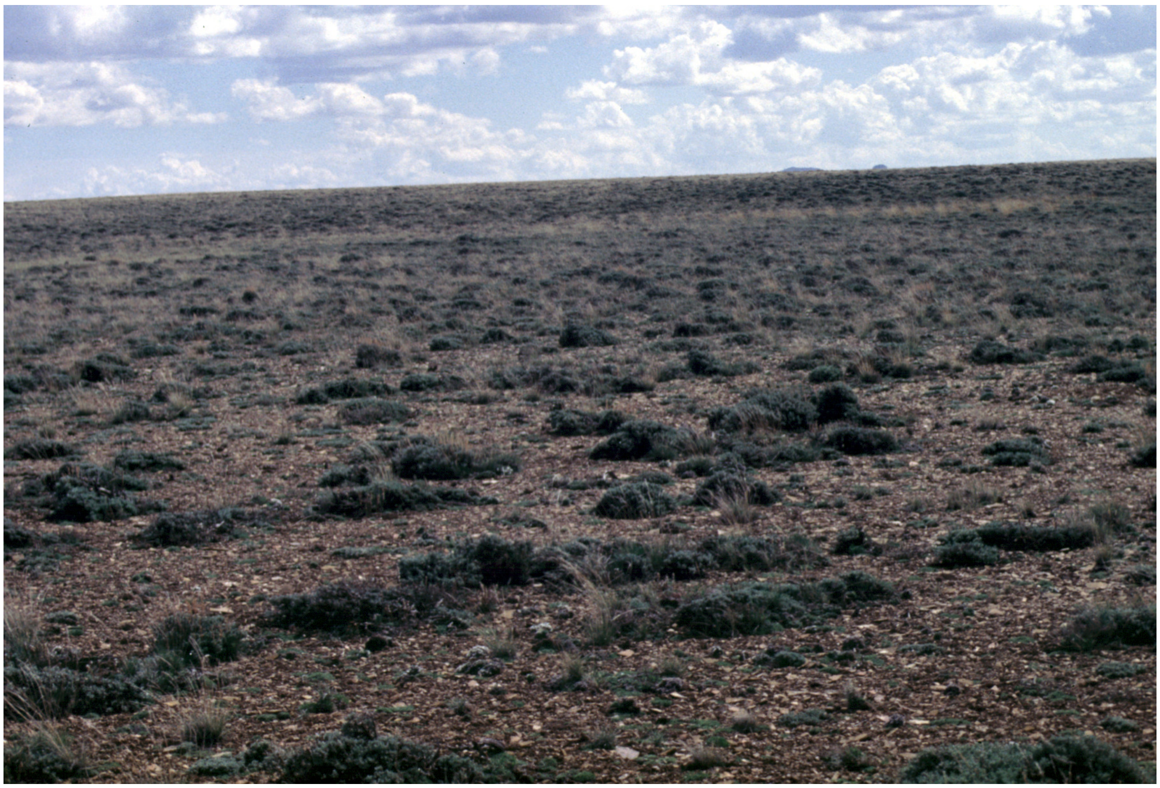
Typical habitat in which mountain plovers occur, western extension of Bush Rim.

Appendix B. (continued)

Typical habitat in which mountain plovers occur; Bush Rim.

Appendix B. (continued)

Typical habitat in which mountain plovers occur; Bush Rim.



Appendix C. Species of conservation concern (other than mountain plover) observed on the Jack Morrow Hills, Wyoming, May – June 1999.

Common name	Species	Location(s)
White-tailed prairie dog	*Cynomys leucurus*	Towns observed in several areas; especially dense in flats south and east of Oregon Buttes.
Sage grouse	*Centrocercus urophasianus*	Birds observed in several areas; several large groups, and females with broods, on Bush Rim. Active lek with 22 males observed 19 May at T24N R101W S1 NE1/4.
Loggerhead shrike	*Lanius ludovicianus*	Singles and pairs observed throughout the study area.
Ferruginous hawk	*Buteo regalis*	Single adult observed at T25N R102W S23 NW1/4.
Prairie falcon	*Falco mexicanus*	One bird observed on Bush Rim at T24N R102W S5 NE1/4.
Golden eagle	*Aquila chrysaetos*	Two immature birds observed at T25N R102W S16 SE1/4; one adult soaring in vicinity of Boar's Tusk.
Burrowing owl	*Athene cunicularia*	One pair repeatedly observed at T23N R105W S7 SW1/4.
Short-eared owl	*Asio flammeus*	One bird observed on 2 occasions on Bush Rim in vicinity of T24N R102W S5.

Appendix D. Five ArcView (version 3.1; Environmental Systems Research Institute, Redlands, California) themes (.shp files) used to display the results of an occurrence model for mountain plovers in the Wyoming Basins ecoregion. Map projection for all files is decimal degrees.

routes.shp -- (Line / arc theme). Road-based survey routes used for field surveys of mountain plovers in the Jack Morrow Hills, southwestern Wyoming. Routes were digitized on-screen from USGS 1:100,000 scale maps.

areapoly.shp --(Polygon theme). Jack Morrow Hills study area, southwestern Wyoming. Boundary digitized on-screen from USGS 1:100,000 scale maps.

wycnty.shp -- (Polygon theme). Wyoming counties. Theme acquired from the Spatial Data Visualization Center, University of Wyoming, Laramie, Wyoming.

ecoreg.shp -- (Polygon theme). The Wyoming portion of the Wyoming Basins ecoregion. Theme derived by clipping a theme of the Wyoming Basins ecoregion (acquired from The Nature Conservancy - Western Conservation Science Office, Boulder, Colorado) with wycnty.shp.

merged grids -- (Grid theme). Probability of mountain plover occurrence in the Wyoming portion of the Wyoming Basins ecoregion. Pixel values = probability of occurrence; pixel size = 30m X 30m. Probability derived from a multiple logistic regression model using percent slope and cover type suitability index as predictors (Equation 2 in text).