DISTRIBUTION AND HABITAT ASSOCIATIONS OF THE MEXICAN PLATEAU WINTER GRASSLAND BIRD COMMUNITY

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ABSTRACT

In February 1998, as part of an ongoing study of the Mexican Plateau grassland bird community, we conducted widespread surveys of grassland birds in the states of Chihuahua and Durango, México. We completed 454 area search plots identifying 64 species and 8,768 individual birds. The main questions on which we focused this winter centered on distribution of species north to south and effect of grass species composition on the wintering bird community. We also continued to fine-tune vegetation data collection in conjunction with area searches. Of the 18 species and categories (*Ammodramus* sp., sparrow sp., and no birds) we tested, nine showed northerly or southerly distributions ($p<0.05$). The category entitled "no birds" (no birds recorded on particular area search plots) was significantly more likely to occur towards the south. For most species, observed distributions matched those north-south distributions predicted from analysis of winter ranges published in the available literature (e.g. Howell and Webb 1995). However, there were a few discrepancies. Proportion of common grass genera on plots did not seem to have a large effect on the wintering grassland bird community; rather, measures of "grassiness" and presence of other vegetation structure (shrubs, cacti, and trees) seemed to be more important. Therefore, we recommend resumption and continuation of the collection of vegetation structure data (as in years prior to 1998) with less emphasis on species composition. Future work will focus on surveys of land owners and relating their management practices to winter bird community composition.

INTRODUCTION

As a group, native prairie grassland birds have the largest proportion of declining species demonstrating the steepest population declines of any behavioral or ecological bird guild in North America (Knopf 1994). According to the Breeding Bird Survey, of the prairie-dependent birds showing statistically significant trends over a thirty-year period (1966-1996) at least 80% are declining. Knopf (1994) reported that causes of grassland bird population declines are difficult to determine. He concluded that the lack of understanding of grassland birds' winter ecology precludes optimistic projections, especially for those species experiencing widespread declines, since the cause is likely to be from events occurring on the winter grounds. Such steep and widespread declines, however, warrant investigations on both breeding and wintering grounds. The numbers and magnitudes of the declines are so great that these species and their principal habitat should receive greater conservation attention.

Many of these species, including the majority of shortgrass and mid-grass prairie birds, winter in vast numbers in the semi-desert grasslands of the Mexican Plateau (Howell and Webb 1995). The distribution and natural history of birds in this area are among the least known in both the United States and Mexico (Phillips 1977). In addition to the species mentioned above, the list of declining and/or little-known grassland species that winter on the Mexican Plateau includes: Northern Harrier, Long-billed Curlew, Burrowing Owl, Short-eared Owl, Cassin's Sparrow, Brewer's Sparrow, Lark Bunting, Baird's Sparrow, Sprague's Pipit, McCown's Longspur, and Chestnut-collared Longspur (Sauer *et al.* 1996, Howell and Webb 1995).

In February 1998, as part of an ongoing study of the Mexican Plateau grassland bird community, we performed widespread surveys of grassland birds in the states of Chihuahua and

Durango, México. While conducting inventories, we noted vegetation composition to describe species gross habitat associations, especially among grass types. Furthermore, we allocated transects broadly along a north-to-south transect to test the distribution of birds' ranges along this transect. Species of particular concern for this study were Mountain Plover, Sprague's Pipit, Cassin's Sparrow, Baird's Sparrow, Grasshopper Sparrow, Lark Bunting, and McCown's Longspur. Past results have been reported in Carter et al. (1997) and Leukering and Bradley (1997). Based on past work in which we analyzed vegetation structure of grasslands (including grass height and number of grass hits on Robel/Wiens poles), we were interested in investigating what effect, if any, grass species composition had on bird community structure. Finally, since we focused on grass community structure, we were also interested in how bird communities could be defined using primarily grass composition data in combination with measurement of more gross features such as presence of cacti, shrubs, and trees.

Study Area

The Mexican Plateau is located in north-central Mexico and the southwestern U.S. Encompassing one-third of Mexico, it slopes gently upward to the south between Mexico's two primary mountain ranges, the Sierra Madre Occidental and Sierra Madre Oriental. From the international border it rises from roughly 750m until merging on the southern end with the Transvolcanic Belt at about 2000m (Howell and Webb 1995). Within this region, the grassland portion of the Plateau occurs as a mosaic between Chihuahuan desert scrub in the lowlands and dry oak and pine-oak woodlands at the higher elevations. Within the state of Chihuahua the principal habitats are desert scrub (41%), pine forest (16%), and farm/pasture lands (36%) (Flores Villela and Gerez 1994). The proportion of the latter underwent a 7% increase in the decade between 1981 and 1992 as the overall proportion of perturbed lands increased. While governmental data indicate that as recently as 1981, 24% of the state was undisturbed grassland, more recent federal assessments do not recognize any natural grasslands remaining in the state (Flores Villela and Gerez 1994).

We conducted area searches on private and communal pastures, croplands, and grassland from extreme northern Chihuahua to central Durango, but concentrated our efforts in Chihuahua. Most area searches were conducted within 25 km of state and federal highways in western and central Chihuahua from Janos to Hidalgo del Parral. We originally partitioned the area from northern Chihuahua to northern Guanajuato into 22 equal bands of latitude (approx. 0.45°) and planned to conduct 40 area searches per band. However, we found little or no grassland habitat from northern Durango to central Zacatecas, so we concentrated on the ten bands in Chihuahua and conducted approximately 50 area searches in each. We did not work in two of these ten bands, because we anticipated obtaining results from other researchers conducting similar work at the time.

METHODS

Area Search

We adapted the area search technique (Ambrose 1989) for use with wintering grassland birds. Area search in this context allows observers to flush and pursue inconspicuous species for greater identification accuracy. This facilitates detailed assessments of generally difficult-to-quantify species (Ralph *et al*. 1993). Although several researchers (*e.g.* Gutzwiller 1993, Hutto *et al.* 1986) have successfully surveyed winter birds with modified point-counts in other habitats, in grassland that approach is precluded by the inconspicuous nature of many of the species present. Completion of approximately 100 pilot area search plots in 1996, and an additional 384 in 1997, affirmed use of this technique for gathering data on the wintering grassland birds of the Mexican Plateau.

Area search plots were located in grassland habitats from bare ground to savanna, and generally within 1 km of roads. The size of each plot was set at three hectares (173m x 173m), determined as the amount of terrain that could be censused thoroughly in a 20-minute time frame. Birds flushed out of the area were pursued for identification; birds flying into the area during the census were not counted; and birds flying over the area were recorded separately and were excluded from analyses, unless evidence existed that the species was utilizing the area in some way (*e.g*., Northern Harrier actively hunting).

In the course of conducting 445 area searches, 64 species were recorded (Table 1). Of these, 22 species and categories (i.e., sparrow sp., *Ammodramus* sp.) appeared on at least 28 plots (Table 1). Of these, we selected 18 (Northern Harrier, American Kestrel, Mourning Dove, Horned Lark, Sprague's Pipit, Loggerhead Shrike, Cassin's Sparrow, Brewer's Sparrow, Vesper Sparrow, Savannah Sparrow, Baird's Sparrow, Grasshopper Sparrow, Chestnut-collared Longspur, Eastern Meadowlark, and Western Meadowlark, plus the three categories *Ammodramus* sp., sparrow sp., and plots with no birds (hereafter, NOBI)) for analysis.

Vegetation Measurements

After completing an area search, we collected vegetation measurements. Within each area search plot, we estimated ground cover to the nearest 10% for bare ground, forbs, and each genus of grass: bluestems (*Andropogon* sp.), lovegrasses *(Eragrostis* sp.), gramas *(Grama* sp.), three-awn sp. (*Aristida* sp.), "tobosa" (*Tobosa* sp*.),* "windmill grass" (*Chloris* sp.), and "other grasses." We estimated canopy cover of the shrub component to the nearest 1% for the following shrub types: *Acacia* sp*.*, *Agave* sp., Cholla (*Opuntia imbricata*), paddle-type cactus *(Opuntia* sp*.),* Mesquite (*Prosopis* sp.), and *Yucca* sp.

Through previous analyses, we have determined that most count-based assessments of rare vegetation occurrences (shrubs, large cacti, and trees) on plots were not useful in analysis but are very important in structuring bird communities. Thus we adopted the point-quarter method of determining densities of the more common of the rare vegetation types noted above: *Opuntia* sp., <1m tall shrubs, 1-2m tall shrubs, and trees (any woody plant over 2m high). For each area search plot, from the center of the plot we estimated the distance (nearest whole meter up to 250m) in each of four quadrants of the main vegetation types. For use in data analysis, we averaged the four point-quarter estimates for each type and then subtracted those values from the maximum distance of 250. This created a new variable which increases with increasing density of the vegetation item on a plot.

Of the 25 vegetation variables collected, most of which were dropped since they were highly correlated with each other (visual shrub estimate with point-quarter measurement) or had too many instances of zero. This left six variables which consistently explained most of the variance (Table 2). Since most count data of randomly occurring events (particularly vegetation hits) are not normal, we used a log transformation to normalize variables (Zar 1984).

Analysis Methods

To test the distribution of species from north to south we used t-tests on UTM northings. Normality was confirmed by plotting observed values against a normal distribution (Wilkinson *et al*. 1996). For the vegetation/bird community analysis, we used principal components analysis (PCA), which creates new variables (components) that are exact combinations of the original vegetation variables. PCA determines components so that maximal amounts of variance are explained (Wilkinson *et al.* 1996). The principal components we use are simply linear combinations of the original variables into one or more new components that are useful in summarizing differences in habitat associations among species of birds. Once components are identified, species may be replotted on the principal component factors. We chose the number of principal components to be selected based on rules of thumb that components should have eigenvalues above 1.0 and have more than three of the original variables with loadings above 0.3 (Wilkinson *et al*. 1996).

RESULTS AND DISCUSSION

Distribution of species north to south

Nine species showed distributions that were either more northerly or southerly (Table 3). By using published range maps (e.g. in Howell and Webb 1995 and National Geographic Society 1987), we made *a priori* predictions on whether a species is more northerly, southerly, or evenly distributed. Fourteen of the 18 species matched our predictions. The category NOBI was distributed more southerly, while we predicted it to be of even distribution. Species which did not match our predictions were Sprague's Pipit (predicted to be distributed more southerly but was more even), Grasshopper Sparrow (predicted to be distributed evenly but which was more northerly), and Eastern Meadowlark (predicted to be more northerly but was more southerly).

The reasons for the discrepancies vary with the species. We predicted Sprague's Pipit to be more southerly since our study area is in the northern part of its winter distribution--in fact, very near the periphery of its range. Apparently, though, we were far enough south to find an even distribution of the species. Our prediction for Western Meadowlark was based on the range maps in Howell and Webb (1995), which depict the species as absent from the southern 40% of Chihuahua but with occurrence further south beginning in northern Durango. We found the species throughout the latitude of our study area, with highest numbers in the area where Howell and Webb depicted its absence.

The more northerly distribution of Grasshopper Sparrow is difficult to explain, but it may be related to the fact that we record two subspecies, the highly migratory *perpallidus* and the purportedly resident *ammolegus*. Our study area is well within the species' wintering area, as depicted by Rising (1996), and we believe that the central Mexican range was thought to represent mostly *perpallidus* since others, by their breeding distribution, would be unlikely. However, Howell and Webb (1995) have a question mark in Chihuahua indicating uncertainty as to the breeding status of the species in an area where breeding has not been reported. Thus, if we are correct in believing that the majority of Grasshopper Sparrows we encounter are *ammolegus* (many were well seen, including two captured for banding), and if that subspecies is an undocumented but common resident in northern Chihuahua, the expected distribution of the species would be skewed towards more resident *ammolegus* in some manner (probably more northerly) from our current understanding.

Effects of grass genus composition on bird community composition

Figure 1 is from a previous report (Carter et al. 1997) and is reproduced here since it is useful in understanding the framing and testing of this year's hypothesis. By focusing on collecting mainly vegetation structure variables in 1997, and subjecting these result to a PCA analysis, we found four clusters of species associated, respectively, with grass (Savannah Sparrow, Baird's Sparrow, Grasshopper Sparrow, *Ammodramus* spp., sparrow sp., and Western Meadowlark), shrub (Loggerhead Shrike, Cassin's Sparrow, Brewer's Sparrow, Vesper Sparrow, and Black-throated Sparrow), bare ground (Horned Lark), and forbs (Sprague's Pipit), with one species, Chestnut-collared Longspur, an apparent grassland generalist. These results stimulated us to ask how important genus of grass is in structuring the wintering bird community.

We tested the importance of grass genera by subjecting the percent cover of five common genera of grasses, bare ground, and forbs to the same PCA analysis (Fig. 2). Viewing the plots, we believe Figure 2 is a possibly misleading representation of how the bird community responds relative to grass genera. We believe that either the grass genera data are very noisy (plots dominated by one grass genus are rare), or that species are not necessarily sorting themselves by variables related to grass genera, but rather by correlates of grass genera that we did not measure (such as horizontal cover or grass density).

The first explanation seems plausible since even when plots appear to be "dominated" by one species of grass there is much variation in plot composition due to factors such as topography and disturbance. A moderately common grass genus was *Aristida* with a coefficient of variation (C.V. = std. dev./mean) among plots of 1.93. Among common species the C.V. for *Aristida* spp. rises: Horned Lark = 3.02, Vesper Sparrow = 2.02, Savannah Sparrow = 3.17, Chestnut-collared Longspur = 2.15. We interpret this amount of variance to be high and reflective of the highly variable nature of percent cover of grass genera within plots. Possibly a better approach would be to use bird-centered data, where the percent cover of genera is estimated at locations of a species and at paired random plots.

The second explanation also seems likely. For example, there is a cluster of species in the *Andropogon* positive space consisting of Sprague's Pipit, Cassin's Sparrow, and Western Meadowlark (Fig. 2). We believe this space also includes a shrubby component because of the presence of Cassin's Sparrow, but we excluded shrub variables to examine how species respond to just grass genera. Without a variable relating the shrub component, we are at a loss to explain the species grouping. Similarly, the forb space consists of Brewer's Sparrow, Vesper Sparrow, and Grasshopper Sparrow. Brewer's is typically found in more shrubby areas, with Grasshopper Sparrow in more grassy areas; Vesper Sparrow may actually key on habitats with more forbs. We believe this is a very confusing picture of the bird community and is largely a result of forcing an analysis with just grass genera data. However, Horned Lark in all analyses tends to fall in the bare ground portion of a PCA plot. Chestnut-collared Longspur tends to fall in the center of the space as a generalist.

Effects of grass and structure on bird community composition

By lumping all grass genera into a “grassiness” variable, which is a sum of the cover estimates for each genera, and adding structure types (shrubs, cacti, and trees) to the plots, we believe we are presented with a much clearer picture (Fig. 3). These results show a strong forb and grass space with an opposing bare space, with structure components further defining grass/forb v. bare. Before reaching Figure 3, we went through the intermediate step of adding structure types to the grass genera data. These PCA plots (not presented in the interest of saving space) were as confusing as Figure 1 and we were at a loss to explain them. We conclude that percent cover of grass genera (alone or with structure type added) are not useful in describing where species of the wintering bird community may be found, either because plots are highly variable or too many important habitat correlates must be left out to do the test. However, an analysis based on a variable reflecting “grassiness” in combination with bare, forb and shrub/tree cover does seem to be useful. In Figure 3, it is interesting to note that most bird species fall in the upper half of the space defined by more grass and forbs.

The center of the PCA plot hosts apparent generalists (Western Meadowlark and Vesper Sparrow). Three species (Northern Harrier, American Kestrel, and Sprague's Pipit) seem to be moderate generalists but are located toward the more forb/grass area of the PCA plot. This seems to fit the two raptors which are grassland generalists. As with last year's report (Carter et al. 1997), Sprague's Pipit continues to evade explanation, but we are comfortable saying it prefers more grass though not as much as the two *Ammodramus* species. Species which do not fall in this upper half are either habitat generalists which need a shrubby habitat component (Loggerhead Shrike), or are habitat generalists which avoid shrubs (Savannah Sparrow and Chestnut-collared Longspur). The longspur seems correctly positioned, since in our experience it avoids areas of shrubby vegetation structure. However, we see Savannah Sparrow as a species that does not avoid areas of some structure, even preferring to perch on shrubs and fences upon being flushed from grass. Perhaps our oversight of not recording the presence of fence has caused this result.

The area of the plot defined by cactus hosts few species and contains area search plots on which no birds were seen. We believe that these areas are often heavily grazed with few grasses remaining. Located in this area are Loggerhead Shrike and Mourning Dove. Loggerhead Shrike is a sit-and-wait predator that visually locates prey on the ground. Thus, it prefers areas of less cover, since potential prey items (e.g., beetles and mice) are more readily seen there. This species' leaning to the shrubs/trees area of the plot indicates its requirements for high perches from which to scan for prey. Mourning Dove is often found in very open areas (often being found on the ground in areas of bare dirt), but requires perch sites and escape cover. Perhaps its position on the PCA plot is a compromise between the two structure components (cactus and shrubs) and bare ground. Only one species, Horned Lark, occupied the area of the PCA plot defined by bare ground.

The PCA space defined by more shrubs and trees with grass includes Cassin's Sparrow, Brewer's Sparrow, and Eastern Meadowlark--an eclectic combination of species. Cassin's Sparrow has a strong affinity for structure and grass (T. Leukering pers. obs.), though in our data the latter is overridden by the former. It is most often found in areas with shrub cover (which is highly correlated in our data with cholla cactus and yucca) and at least clumps of dense grass, though it occasionally uses fences as the structure component (T. Leukering pers. obs.). Virtually all individuals that we have detected in three years of working in northern Mexico have been flushed from dense grass, but most of those flushed dropped into or next to the bases of shrubs (usually "spiny"ones--cactus or yucca). This species' requirement for escape cover seems to override its foraging-habitat preferences, thus it is not found in areas of dense grass lacking a shrub component. Brewer's Sparrow is usually found in areas of tall structure, but it forages for weed and grass seeds on the ground across the range from bare ground to fairly grassy areas, thus the shrubby aspect to its habitat selection dominates its position on the PCA plot. Eastern Meadowlark is decidedly a graminophile, in our experience being found in grassier areas than is the similar Western Meadowlark. We are unsure of the causes of the former's apparent selection of shrubby areas, unless it is due to some grassy correlate of those areas or it in fact spends much time perching in shrubs and trees, which we have not noticed.

The two *Ammodramus* species both fall in the more grassy upper portion of the PCA plot, with Baird's in the quadrant defined by more grass and Grasshopper Sparrow in areas with more forbs. The undifferentiated category *Ammodramus* sp. is even higher into the more grassy area, which repeats findings of previous analyses (Carter et al. 1997; Fig. 1). This location is a function of the fact that individuals of the genus are more likely to remain unidentified when in heavy cover, thus seen poorly. Both Grasshopper and Baird's Sparrows would have been located in a more grassy area of the PCA plot had all individuals of the genus been identified to species.

We believe that the category of sparrow sp. (SPSP) consists mostly of individual sparrows that we did not see well enough to even separate Savannah Sparrow from either of the two *Ammodramus* species. This is confirmed by the location of SPSP within the polygon formed by *Ammodramus* sp., Baird's Sparrow, Grasshopper Sparrow, and Savannah Sparrow. Furthermore, if all presumptive Savannah Sparrows were identified to species, then the Savannah Sparrow location would move more towards the sparrow sp. location, a location with which we are more comfortable.

Management Implications and Further Study

We wonder how useful the data presented here are on determining how far north and south different species may be wintering. Certainly it can be tested as we have shown and may be useful in defining where relatively more individuals of a species can be found at a point in time. What is troubling is that species may be moving in response to weekly, annual, and inter-annual weather conditions and possibly other unknown factors. There is no doubt that species respond to annual rainfall and probably to rainfall of the previous year (hence available cover), but this remains undocumented. Answering this question would require a large cooperative effort (as proposed by CBO) among many partners and probably in conjunction with LANDSAT or similar imagery. The question is particularly important to management since a land owner doing all the "right" things with his lands may still go though periods where no birds are using an area. More questions need to be framed in order to tease apart short-term weather effects, such as unusually cold weather in the north for two weeks, versus long-term climatic cycles, such as drought. This would require long-term studies in which area search plots are repeated throughout winters as well as among years. We believe it is still important to measure relative abundances, if only to help determine where we think certain species are more abundant and thus determine areas important for their conservation.

With the last two reports on our research on the Mexican Plateau it has been relatively easy to describe the habitat needs of birds that are not solely dependent upon grass. Horned Lark has repeatedly been shown to prefer areas with bare ground. Species needs in grasslands with shrubs (or other structure) are easily defined. Management for these species on the winter grounds may be as simple as maintaining shrub/cactus/tree areas within blocks of native grass habitat. What remains difficult is defining what vegetation composition/structure is used by the grass-loving birds of the Mexican Plateau (Savannah Sparrow, Grasshopper Sparrow, Baird's Sparrow, and, possibly, Western Meadowlark). To some extent, we have defined *a priori* a grassland-dependent bird community, then asked what features of the grassland further defines this community. To attack this question we have collected bird-centered data to further describe use preferences, but these data remain unanalyzed. However, we would also like to advance the idea that at our current level of knowledge, simply maintaining native grasses in large plots throughout the plateau is a worthwhile management strategy. Grazing on these landscapes is acceptable, even desirable, as long as the condition of plots over time is tracked. Conversion to agriculture, and other forms of use not dependent on maintaining grass, is highly detrimental.

These broad conclusions lead us to recommendations for future study. We don't believe we have a firm idea about what structures grassland bird communities, but we have a good understanding of broad habitat needs. Where we (and others) seem to be lacking in understanding is the Mexican system of grazing land tenure and what conditions result. Our work in the winter of 1999 will focus on direct land owner contacts including use of a survey designed to determine how land is managed and what conditions result. Dr. Jorge Nocedal (Instituto de Ecología, Durango, México, currently on sabbatical at CBO) has proposed a land owner survey study which combines information from land owner surveys with area search plots consisting of both bird and vegetation data. We believe this study will further elucidate grassland management actions that will benefit both wintering and breeding grassland birds.

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LITERATURE CITED

Ambrose, S. 1989. The Australian bird count - Have we got your number? RAOU Newsletter 80:1-2. Royal Australian Ornithologists Union, Moonee Ponds, Vic., 3039, Australia.

Carter, M.F., and T. Leukering, J.S. Bradley and C.S. Aid. 1997. Habitat associations of the Mexican plateau winter grassland bird community. Unpubl. report. Colorado Bird Observatory

Flores Villela, O., and P. Gerez. 1994. Biodiversidad y conservación en México: vertebrados, vegetación y uso del suelo. Universidad Nacional Autónoma de México, México, D.F.

Gutzwiller, K.J. 1993. Refining the use of point counts for winter studies of individual species. Wilson Bull. 105:612-627.

Howell, S.N.G., and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford Univ. Press, Oxford.

Hutto, R.L., S.M. Pletschet, and P. Hendricks. 1986. A fixed-radius point count method for nonbreeding and breeding season use. Auk 103:593-602.

Knopf, F.L. 1994. Avian assemblages on altered grasslands, p. 232-246. *In* J.R. Jehl, Jr. and N.K. Johnson [eds.], A century of avifaunal change in western North America. Studies in Avian Biology, No. 15.

Leukering, A., and J. Bradley. 1997. Some observations of birds on the Central Mexican Plateau. Western Birds 28:177-180.

National Geographic Society. 1987. Field Guide to the Birds of North America, 2nd ed. National Geographic Soc., Washington DC.

Phillips, A.R. 1977. Summary of avian resources of the Chihuahuan Desert region. *In* R.H. Wauer and D.H. Riskind [eds.], Transactions of the symposium on the biological resources of the Chihuahuan Desert region, United States and Mexico. Sul Ross State Univ. USDA Nat. Park Service Transactions and Proceedings Series, No. 3.

Ralph, D.J., G.R. Guepel, P. Pyle, T.E. Martin, and D.F. Decent. 1993. Handbook of field methods for monitoring landbirds. U.S. Forest Service Gen. Tech. Rep. PAW-144.

Rising, J.D. 1996. The Sparrows of the United States and Canada. Academic Press, San Diego.

Sauer, J.R., B.G. Peterjohn, S. Schwartz, and J.E. Hines. 1996. The North American breeding bird survey home page. Version 95.1. Patuxent Wildlife Research Center, Laurel, MD.

Wilkinson, L., G. Blank, and C. Gruber. 1996. Desktop data analysis with SYSTAT. Prentice Hall, NJ.

Zar, J.H. 1984. Biostatistical analysis, second edition. Prentice Hall, NJ.

TABLE 1. Number of plots (n) and abundance of bird species (individuals/3 ha) detected on 445 area searches conducted on the Mexican Plateau grasslands of Chihuahua and Durango, Mexico during February, 1998.

Species	n	$\bar{x}$(SE)
Double-crested Cormorant (*Phalacrocorax auritus*)	2	0.004(0.003)
Snow Goose (*Chen caerulescens*)	3	0.000(0.000)
Ross's Goose (*Chen rossii*)	1	0.000(0.000)
Mallard (*Anas platyrhynchos*)	1	0.000(0.000)
Mexican Duck (*Anas platyrhynchos diazi*)	2	0.000(0.000)
Turkey Vulture (*Cathartes aura*)	40	0.002(0.002)
White-tailed Kite (*Elanus leucurus*)	1	0.004(0.004)
Northern Harrier (*Circus cyaneus*)	40	0.097(0.019)
Sharp-shinned Hawk (*Accipiter striatus*)	1	0.002(0.002)
Harris's Hawk (*Parabuteo unicinctus*)	2	0.000(0.000)
Red-tailed Hawk (*Buteo jamaicensis*)	8	0.002(0.002)
Ferruginous Hawk (*Buteo regalis*)	2	0.000(0.000)
American Kestrel (*Falco sparverius*)	35	0.061(0.011)
Merlin (*Falco columbarius*)	2	0.004(0.003)
Scaled Quail (*Callipepla squamata*)	5	0.184(0.008)
Sandhill Crane (*Grus canadensis*)	5	0.000(0.000)
Killdeer (*Charadrius vociferans*)	1	0.000(0.000)
Long-billed Curlew (*Numenius americanus*)	3	0.036(0.034)
Mourning Dove (*Zenaida macroura*)	39	0.490(0.300)
Rock Dove (*Columba livia*)	1	0.000(0.000)
Barn Owl (*Tyto alba)*	1	0.002(0.002)
Burrowing Owl (*Speotyto cunicularia*)	6	0.013(0.005)
Short-eared Owl (*Asio flammeus*)	10	0.045(0.017)
Ladder-backed Woodpecker (*Picoides scalaris*)	3	0.007(0.004)
Say's Phoebe (*Sayornis saya*)	17	0.043(0.011)
Horned Lark (*Eremophilia alpestris*)	87	1.438(0.249)
Tree Swallow (*Tachycineta bicolor*)	7	0.013(0.011)
N. Rough-winged Swallow (*Stelgidopteryx serripennis*)	1	0.000(0.000)
Cliff Swallow (*Petrochelidon pyrrhonota)*	1	0.000(0.000)
Western Scrub-Jay (*Aphelocoma californica*)	24	0.083(0.018)
Chihuahuan Raven (*Corvus cryptoleucus*)	26	0.020(0.009)
Common Raven (*Corvus corax*)	18	0.002(0.002)
Corvus sp.	3	0.000(0.000)
Verdin (*Auriparus flaviceps*)	2	0.004(0.003)
Cactus Wren (*Campylorhynchus brunneicapillus*)	8	0.034(0.014)
Bewick's Wren (*Thryomanes bewickii*)	1	0.002(0.002)
Blue-gray Gnatcatcher (*Polioptila caerulea*)	2	0.029(0.027)
Black-tailed Gnatcatcher (*Polioptila melanura*)	2	0.007(0.005)
Northern Mockingbird (*Mimus polyglottos*)	1	0.002(0.002)

TABLE 1 (continued).

Species	n	x̄(SE)
Curve-billed Thrasher (*Toxostoma curirostre*)	5	0.013(0.006)
Crissal Thrasher (*Toxostoma crissale)*	1	0.004(0.004)
European Starling (*Sturnus vulgaris)*	2	0.000(0.000)
Sprague's Pipit (*Anthus spragueii*)	28	0.119(0.028)
Loggerhead Shrike (*Lanius ludovicianus*)	39	0.083(0.013)
Pyrrhuloxia (*Cardinalis sinuatus*)	3	0.011(0.007)
Canyon Towhee (*Pipilo fuscus*)	6	0.031(0.014)
Cassin's Sparrow (*Aimophila cassinii*)	29	0.092(0.019)
Rufous-crowned Sparrow (*Aimophila ruficeps*)	2	0.004(0.003)
Aimophila sp.	5	0.018(0.009)
Chipping Sparrow (*Spizella passerina*)	21	0.418(0.181)
Clay-colored Sparrow (*Spizella pallida*)	9	0.218(0.113)
Brewer's Sparrow (*Spizella breweri*)	40	1.157(0.405)
Spizella sp.	10	0.404(0.276)
Vesper Sparrow (*Pooecetes gramineus*)	123	1.607(0.236)
Black-throated Sparrow (*Amphispiza bilineata*)	22	0.319(0.126)
Lark Bunting (*Calamospiza melanocorys*)	3	0.013(0.010)
Savannah Sparrow (*Passerculus sandwichensis*)	112	6.353(0.998)
Baird's Sparrow (*Ammodramus bairdii*)	85	0.339(0.047)
Grasshopper Sparrow (*Ammodramus savannarum*)	48	0.204(0.043)
Ammodramus sp.	78	0.375(0.059)
Lincoln's Sparrow	1	0.002(0.002)
White-crowned Sparrow (*Zonotrichia leucophrys*)	5	0.025(0.013)
sparrow sp.	39	0.178(0.050)
Chestnut-collared Longspur (*Calcarius ornatus*)	121	3.948(0.849)
Eastern Meadowlark (*Sturnella magna*)	40	0.240(0.072)
Western Meadowlark (*Sturnella neglecta*)	55	0.290(0.064)
Sturnella sp.	17	0.034(0.009)
Brewer's Blackbird (*Euphagus cyanocephalus*)	6	0.117(0.086)
House Finch (*Carpodacus mexicanus*)	13	0.270(0.226)
Lesser Goldfinch (*Carduelis psaltria*)	3	0.045(0.033)

TABLE 2. Six vegetation variables (of 25) considered for PCA. Many similar variables were eliminated due to lake of sample size, lack of normality, and/or colinearity with a more robust variable (e.g., visual estimates of cactus cover were dropped in favor of point quarter cactus measurements). The four point-quarter measurements on a plot were averaged and the value was subtracted from 250 (the maximum distance estimated) so that larger point-quarter numbers reflect more importance to birds.

Variable Name	Definition
FORB	percent estimate of forb cover
GRASS	sum of percent grass cover of genera noted
BUSHPQ	point quarter distance (minus 250 m) to <1 m tall shrubs
SHRUBPQ	point quarter distance (minus 250 m) to 1-2 m tall shrubs
TREEPQ	point quarter distance (minus 250 m) to woody vegetation >2 m tall
CACTUSPQ	point quarter distance (minus 250 m) to cacti

TABLE 3. Distribution of species testing UTM northing for plots with a species versus plots without the species. Predicted distribution is that resulting from consulting field guides, actual is the test of UTM northings. We did not make predictions for the two non-specific categories (--).

Species	Predicted Distribution	Actual Distribution	p>t	Agreed w/ Prediction
Northern Harrier	north	north	0.004	Y
American Kestrel	even	even	0.766	Y
Mourning Dove	even	even	0.318	Y
Horned Lark	north	north	0.000	Y
Sprague's Pipit	south	even	0.837	N
Loggerhead Shrike	south	south	0.014	Y
Cassin's Sparrow	even	even	0.474	Y
Brewer's Sparrow	even	even	0.735	Y
Vesper Sparrow	even	even	0.263	Y
Black-throated Sparrow	south	south	0.019	Y
Savannah Sparrow	north	north	0.000	Y
Baird's Sparrow	south	south	0.034	Y
Grasshopper Sparrow	even	north	0.004	N
Ammodramus sp.	--	even	0.589	--
sparrow sp.	--	even	0.537	--
Chestnut-collared Longspur	north	north	0.000	Y
Eastern Meadowlark	north	south	0.057	N
Western Meadowlark	even	even	0.169	Y
no birds	even	south	0.001	N

TABLE 4. Species and means for untransformed vegetation variables used in PCA of habitat associations of wintering grassland bird species on the Mexican Plateau of Chihuahua, Mexico. Values greater than the mean for all plots are bold.

Species	Bare	Forb	Grass	Cactus P. Qtr.	Shrub P. Qtr.	Tree P. Qtr.
Northern Harrier	22.26	**17.42**	58.71	**22.05**	59.34	34.80
American Kestrel	20.37	**16.30**	60.00	**19.79**	97.15	49.57
Mourning Dove	**31.05**	13.68	50.53	**46.36**	**139.39**	**100.88**
Horned Lark	**33.13**	7.97	56.67	12.42	13.19	6.77
Sprague's Pipit	**24.81**	**14.07**	**60.74**	1.72	**105.03**	**79.49**
Loggerhead Shrike	**28.06**	10.00	**60.83**	12.47	**129.44**	**87.08**
Cassin's Sparrow	21.43	11.43	**67.14**	**24.63**	**141.73**	**66.73**
Brewer's Sparrow	20.00	**14.47**	**63.16**	**23.37**	**147.90**	**90.09**
Vesper Sparrow	23.95	**17.48**	57.48	**20.40**	**108.80**	**71.42**
Savannah Sparrow	24.29	**16.25**	55.80	8.13	49.38	29.30
Baird's Sparrow	21.07	12.14	**66.07**	**21.25**	90.15	54.18
Grasshopper Sparrow	22.71	**20.21**	56.04	10.86	58.93	42.76
Ammodramus sp.	18.46	13.59	**67.18**	9.93	71.68	51.19
sparrow sp.	23.33	**18.79**	57.88	11.32	95.47	51.75
Eastern Meadowlark	22.31	11.28	**65.38**	**33.57**	**134.26**	**77.90**
Western Meadowlark	24.42	**15.38**	58.24	16.77	**102.21**	**71.35**
Chestnut-collared Longspur	**27.26**	10.63	**60.11**	7.36	34.75	28.93
no birds	**31.06**	9.15	59.79	**38.91**	**119.09**	**61.60**
MEAN	*24.44*	*13.90*	*60.10*	*18.96*	*94.33*	*58.65*

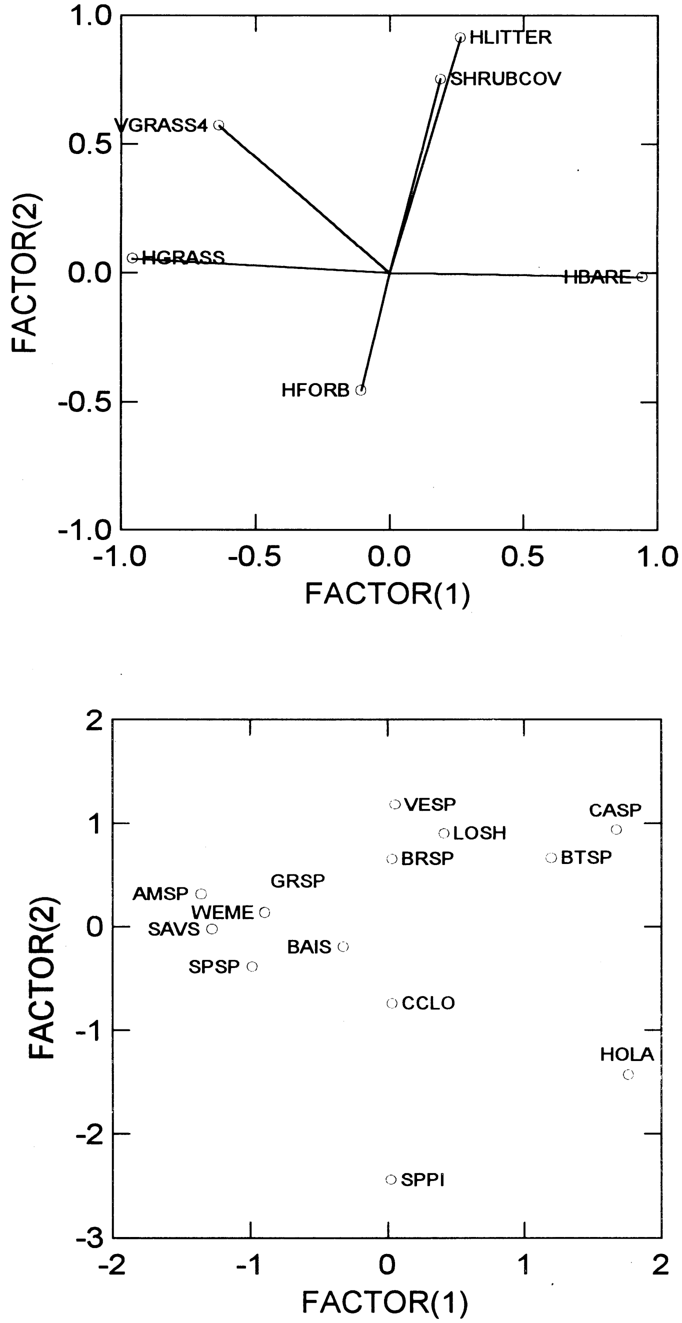

Figure 1.
Species
plotted on two principal component axes. The top illustration shows loadings of the original variables on the PCA axes. The lower illustration shows locations of species in PCA space. HOLA - Horned Lark, SPPI - Sprague's Pipit, LOSH - Loggerhead Shrike, CASP - Cassin's Sparrow, BRSP - Brewers's Sparrow, VESP - Vesper Sparrow, BTSP - Black-throated Sparrow, SAVS - Savannah Sparrow, BAIS - Baird's Sparrow, GRSP - Grasshopper Sparrow, AMSP - *Ammodramus* spp., SPSP - sparrow species, CCLO - Chestnut-collared Longspur, WEME - Western Meadowlark.

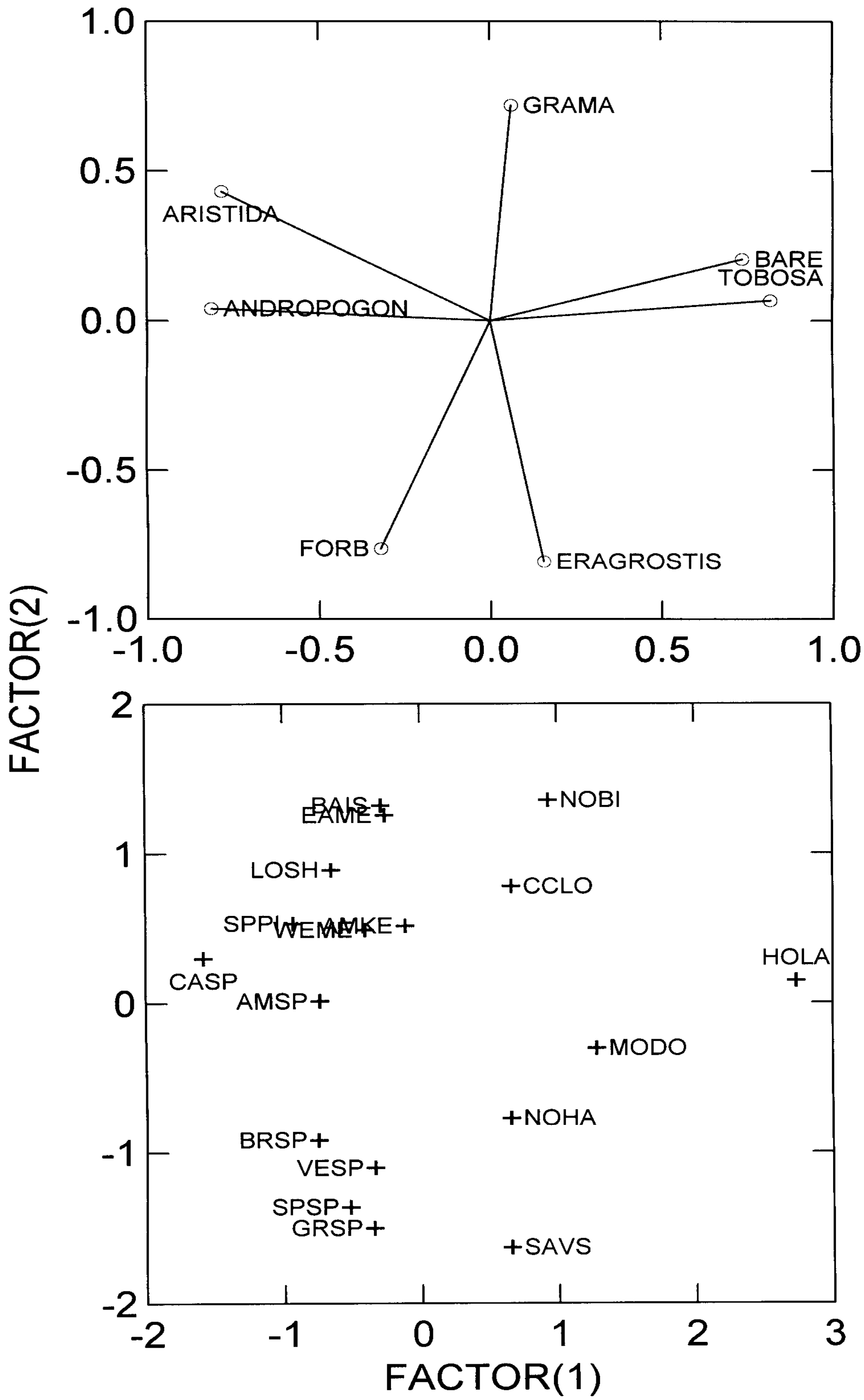

Figure 2. See Fig. 1 for an explanation. Four-letter species codes in addition to those listed in Fig 1. are: NOBI - no birds, AMKE - American Kestrel, NOHA - Northern Harrier, MODO - Mourning Dove, EAME - Eastern Meadowlark.

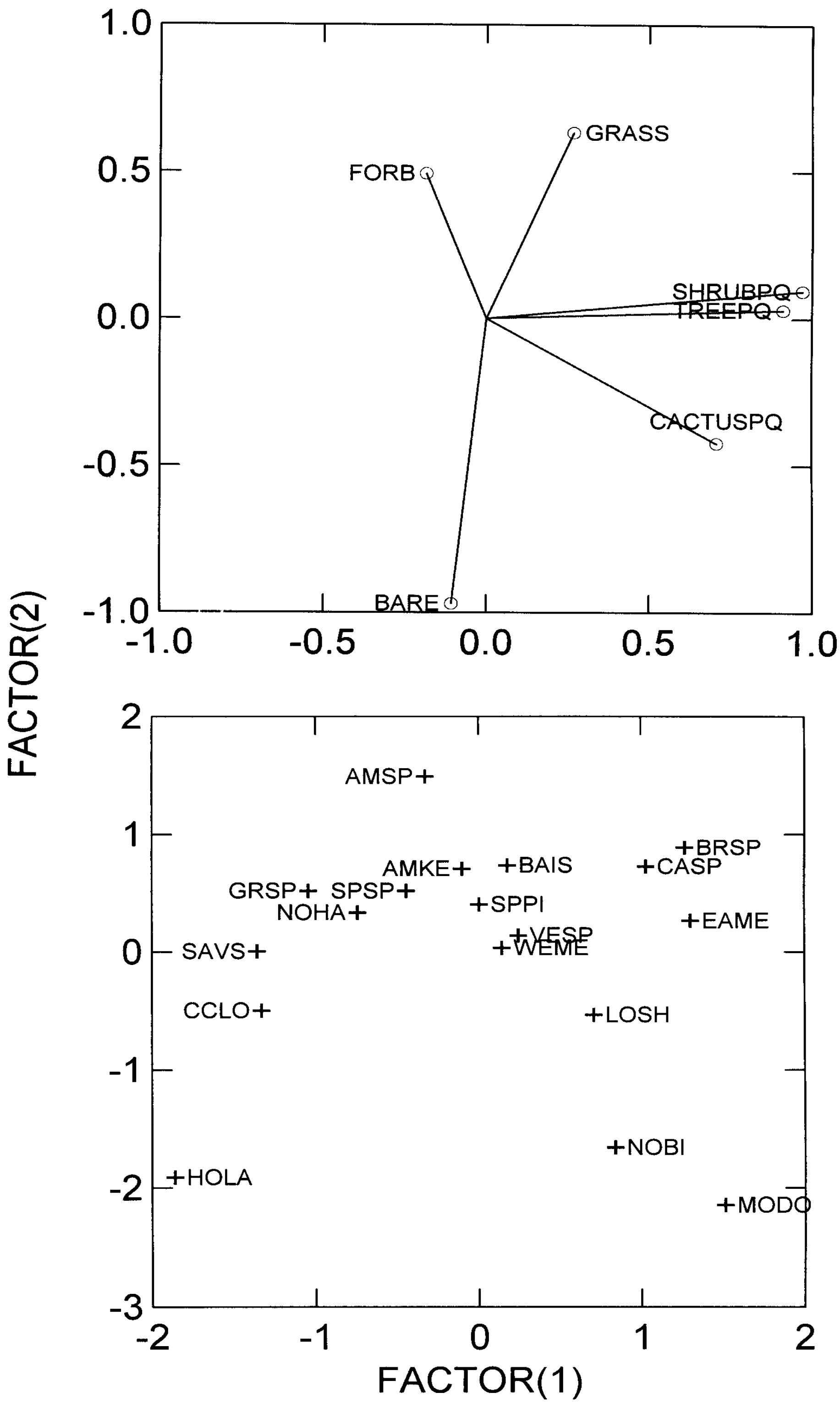

Figure 3. Species plotted on two principal component axes with the grass variable as the sum of grass genera depicted in Fig. 2. See Figs. 1 and 2 for four-letter species codes.