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Influence of grazing and available moisture on breeding densities of grassland birds in the central Platte River Valley, Nebraska

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INFLUENCE OF GRAZING AND AVAILABLE MOISTURE ON BREEDING DENSITIES OF GRASSLAND BIRDS IN THE CENTRAL PLATTE RIVER VALLEY, NEBRASKA

DANIEL H. KIM,1,4 WESLEY E. NEWTON,2 GARY R. LINGLE,1,3 AND FELIPE CHAVEZ-RAMIREZ1

ABSTRACT.—We investigated the relationship between grassland breeding bird densities and both grazing and available moisture in the central Platte River Valley, Nebraska between 1980 and 1996. We also compared species richness and community similarity of breeding birds in sedge (Carex spp.) meadows and mesic grasslands. Densities of two species had a significant relationship with grazing and six of seven focal species had a significant relationship with available moisture. Bobolink (Dolichonyx oryzivorus) and Brown-headed Cowbird (Molothrus ater) densities were lower in grazed plots compared to ungrazed plots, whereas Red-winged Blackbird (Agelaius phoeniceus) densities were greater in sedge-meadow plots compared to mesic grassland plots. Bobolink, Dickcissel (Spiza americana), and Brown-headed Cowbird were negatively associated with available moisture with breeding densities peaking during the driest conditions. Our results suggest that wet conditions increase species richness for the community through addition of wetland-dependant and wetland-associated birds, but decrease densities of ground-nesting grassland birds in wet-meadow habitats, whereas dry conditions reduce species richness but increase the density of the avian assemblage. We propose that wet-meadow habitats serve as local refugia for grassland-nesting birds during local or regional droughts. Received 9 October 2007. Accepted 21 March 2008.

Grassland birds have experienced greater population declines over the past 40 years than any other avian group in North America (Askins 1993, Sauer et al. 2005). These declines in the Midwest and Great Plains have been attributed to loss of grasslands in breeding areas (Knopf 1994, Herkert 1995). Many recent studies of grassland birds have examined the effects of habitat loss and fragmentation on avian occurrence and abundance (e.g., Herkert et al. 2003). Several studies also have examined the impacts of natural ecological drivers, such as burning and grazing, but only a few studies have evaluated the dynamic wet-dry cycles associated with grasslands and their influence on avian densities or nest success (Cody 1985, George et al. 1992, Zimmerman 1992, Igl and Johnson 1999, Fuhlendorf et al. 2006).

The dominant historical ecological factors were fire and grazing in the eastern mesic tallgrass prairies (Steinauer and Collins 1996), while the historical ecological drivers in the shortgrass prairies in the western Great Plains were climate and grazing (Bragg and Steuter 1996). The mixed-grass prairie ecosystem represents the integration of the characteristics of the tallgrass and shortgrass prairies as influenced by climate and soils (Bragg and Steuter 1996). As the climate becomes more arid from the eastern tallgrass prairies to the western shortgrass plains, drought supersedes fire as the primary ecological factor.

Vegetation structure may be the most important aspect of habitat selection and suitability for grassland birds (Wiens 1969, 1973; Cody 1981; George et al. 1992; Winter et al. 2005). The forb component in mixed-grass systems, which is responsible for the majority of the structural variation, is directly affected by precipitation (Bragg and Steuter 1996). Grassland bird populations respond quickly to and are relatively tolerant of changes in vegetation structure resulting from natural (e.g., drought, wildfire) and anthropogenic disturbances (e.g., mowing, prescribed fire) (Dechant et al. 2003a, b, c; Herkert 2003). In addition, fluctuations in precipitation affect food resource availability through reductions in insect biomass during drought years (Wittenberger 1980, George et al. 1992).
Vegetation structure within the Platte River Valley of south-central Nebraska is influenced by both vegetation association and management practices. Vegetation associations in riparian wet-meadow pastures in this region vary from wetland emergent vegetation to dry-ridge grasslands based on elevation above the water table (Henszey et al. 2004). Sedge (Carex spp.) meadows and mesic tallgrass prairies are the dominant plant communities in native and restored areas within the riparian corridor and provide patches of suitable habitat for grassland birds in a mosaic of crop fields with strips of gallery forests.

We evaluated the influence of grazing and available moisture on breeding densities of grassland birds in mesic prairies and sedge meadows. We had two major objectives: (1) document differences in avian assemblages between sedge-meadow and mesic prairie plots using community metrics (richness and similarity), and (2) examine the impacts of grazing and fluctuating wet-dry cycles on the density of seven grassland bird species.

**METHODS**

*Study Area and Management.*—Research occurred on lands owned and managed by the Platte River Whooping Crane Maintenance Trust Inc. (hereafter "the Trust"). The Trust owns and manages >4,000 ha of cropland, wet-meadow grasslands, and gallery forests in Hall, Buffalo, and Phelps counties along the Platte River in central Nebraska. The study area was Mormon Island Crane Meadows in Hall County, Nebraska (40° 48' N, 98° 26' W). Wet meadows were managed using a three-pasture grazing rotation. Each pasture was grazed either in the early season (May–late Jun), mid season (late Jun–mid Aug) or late season (mid Aug–mid Oct). Rotation order changed annually (Table 1), and management included periodic prescribed burns to discourage woody plant encroachment (Currier et al. 1985). We categorized pastures as grazed only if cattle were present in the early grazing season (i.e., before or during the bird censuses).

Four permanent 16-ha plots were established on Mormon Island Crane Meadows (MICM) in Hall County, Nebraska and classified as either sedge meadow or mesic prairie following recommendations of Henszey et al. (2004). Plots 1 and 2 were classified as mesic prairie and had greater topographic relief, raising them above the water table and resulting in greater densities of goldenrod (Solidago spp.), Maximilian sunflower (Helianthus maximiliani), and yellow sweetclover (Melilotus officinalis). Plots 3 and 4 were classified as sedge meadow, were 15–60 cm closer to the water table, and included expansive seasonal wetland habitat. Plots 3 and 4 were characterized by intermittent relic channels dominated by aquatic sedge (Carex aquatilis), which formed hummocks as a result of grazing and the presence of indigo bush (Amorpha fruticosa) near sloughs and relic channels. All plots occurred within the largest contiguous tract (>1,000 ha) of wet-meadow habitat in the central Platte River Valley (Lingle 1981). Spatially, no plot was further than 2.0 km from any other plot and all plots occurred within the same landscape. The plots do not represent true replicates, but they were on different grazing schedules.

**Palmer Drought Severity Index.**—We downloaded Palmer Drought Severity Index (PDSI) data for central Nebraska (State Cli-
TABLE 2. Densities (males/10 ha) of species detected during breeding bird censuses at Mormon Island Crane Meadows in Hall County, Nebraska, 1980-1996. Densities are by plot and averaged across years. Plots 1 and 2 represent mesic mixed-grass prairie, and plots 3 and 4 represent sedge-meadow grasslands.

<table>
<thead>
<tr>
<th>Species</th>
<th>Plot 1</th>
<th>Plot 2</th>
<th>Plot 3</th>
<th>Plot 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least Bittern (Ixobrychus exilis)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.042</td>
<td>0.021</td>
</tr>
<tr>
<td>Wood Duck (Aix sponsa)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.021</td>
</tr>
<tr>
<td>Mallard (Anas platyrhynchos)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.250</td>
<td>0.417</td>
</tr>
<tr>
<td>Northern Pintail (A. acuta)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Blue-winged Teal (A. discors)</td>
<td>0.125</td>
<td>0.042</td>
<td>0.323</td>
<td>0.313</td>
</tr>
<tr>
<td>Virginia Rail (Rallus limicola)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.042</td>
</tr>
<tr>
<td>Ring-necked Pheasant (Phasianus colchicus)</td>
<td>0.042</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Northern Bobwhite (Colinus virginianus)</td>
<td>0.021</td>
<td>0.042</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Killdeer (Charadrius vociferous)</td>
<td>0.229</td>
<td>0.000</td>
<td>0.313</td>
<td>0.477</td>
</tr>
<tr>
<td>Upland Sandpiper (Bartramia longicauda)</td>
<td>1.615</td>
<td>1.500</td>
<td>1.302</td>
<td>1.208</td>
</tr>
<tr>
<td>Wilson’s Snipe (Gallinago delicata)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.063</td>
<td>0.042</td>
</tr>
<tr>
<td>Wilson’s Phalarope (Phalaropus tricolor)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.438</td>
<td>0.813</td>
</tr>
<tr>
<td>Mourning Dove (Zenaida macroura)</td>
<td>0.094</td>
<td>0.125</td>
<td>0.198</td>
<td>0.510</td>
</tr>
<tr>
<td>Sedge Wren (Cistothorus platensis)</td>
<td>0.208</td>
<td>0.000</td>
<td>0.146</td>
<td>0.271</td>
</tr>
<tr>
<td>Common Yellowthroat (Geothlypis trichas)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.063</td>
</tr>
<tr>
<td>Grasshopper Sparrow (Ammodramus savannarum)</td>
<td>1.823</td>
<td>3.208</td>
<td>0.792</td>
<td>1.052</td>
</tr>
<tr>
<td>Swamp Sparrow (Melospiza georgiana)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.083</td>
</tr>
<tr>
<td>Dickcissel (Spiza americana)</td>
<td>2.354</td>
<td>1.396</td>
<td>3.031</td>
<td>1.271</td>
</tr>
<tr>
<td>Bobolink (Dolichonyx oryzivorus)</td>
<td>5.313</td>
<td>4.938</td>
<td>5.677</td>
<td>4.969</td>
</tr>
<tr>
<td>Red-winged Blackbird (Agelaius phoeniceus)</td>
<td>1.333</td>
<td>0.167</td>
<td>7.323</td>
<td>7.208</td>
</tr>
<tr>
<td>Eastern Meadowlark (Sturnella magna)</td>
<td>0.083</td>
<td>0.167</td>
<td>0.083</td>
<td>0.021</td>
</tr>
<tr>
<td>Western Meadowlark (S. neglecta)</td>
<td>1.729</td>
<td>1.573</td>
<td>0.948</td>
<td>1.271</td>
</tr>
<tr>
<td>Yellow-headed Blackbird (Xanthocephalus xanthocephalus)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.083</td>
</tr>
<tr>
<td>Brown-headed Cowbird (Molothrus ater)</td>
<td>1.917</td>
<td>1.542</td>
<td>2.563</td>
<td>2.625</td>
</tr>
<tr>
<td>Mean species richness</td>
<td>6.8</td>
<td>6.1</td>
<td>8.1</td>
<td>10.0</td>
</tr>
<tr>
<td>Species richness</td>
<td>14</td>
<td>11</td>
<td>16</td>
<td>21</td>
</tr>
</tbody>
</table>
they were present but not counted. Eight surveys for each plot were conducted annually between 0505 and 1059 hrs CST from 23 May to 25 June from 1980 to 1990, and from 1993 to 1996 for a total of 15 years of data on plots 1–3. Plot 4 had 14 years of data, because no data were collected in that plot in 1981. Annual reports for these study sites were published in American Birds and Journal of Field Ornithology (Hay and Lingle 1982; Lingle and Haugh 1983a, b; 1991a, b; Lingle and Bedell 1989a, b; 1990a, b; Lingle et al. 1994a, b; Lingle and Bedell 1995a, b; 1996a, b).

Statistical Analyses.—We report species richness for each plot for all 15 years and averaged across years. We compared avian communities using Morisita’s (1959) Similarity Index, which ranks community similarity from 0.0 (no species overlap) to 1.0 (complete overlap). We calculated densities for each species on each plot (males/10 ha). We selected seven focal species (Upland Sandpiper, Grasshopper Sparrow, Dickcissel, Bobolink, Red-winged Blackbird, Western Meadowlark, and Brown-headed Cowbird) that were either obligate grassland nesting birds or strongly associated with grassland habitats and which occurred consistently across all four plots.

We used analysis of variance (ANOVA) to assess the effects of PDSI and grazing on the density of each bird species and overall avian diversity. We considered the design structure to be in the form of a strip-plot (Milliken and Johnson 1984). Given that PDSI is completely aliased with year (i.e., regional PDSI values are unique to each year but the same for all plots within a year), we first placed PDSI values into five categories (0–20, 21–40, 41–60, 61–80, and 81–100 percentiles). We considered these five levels of PDSI to be applied across each of the four plots simultaneously as “strips” with grazing applied randomly within each plot by PDSI combination. The results of this categorization and randomization varied (Table 1) with midpoint values of each PDSI category indicating reasonable spread and randomness of each factor level across years. We considered each of the four plots as random blocks for each PDSI by grazing level combination. Multiple occurrences of each PDSI category by grazing level combination were considered as sub-samples in time (Steel and Torrie 1980). We used PROC MIXED (SAS Institute Inc. 2004) to conduct the ANOVAs by considering three error terms and by computing Type III sums-of-squares using the most appropriate F-tests based on expected mean squares (Littell et al. 2006). We used Fisher’s protected LSD test for pairwise comparisons between means for significant main effects and interactions at \( P = 0.05 \) (Milliken and Johnson 1984). All means reported are least squares means (lsmeans) with standard errors. We performed a similar analysis for prescribed burns and PDSI, but no significant associations were found. Thus, we do not report means or statistics for burn effects.

RESULTS

Plot Similarity and Species Richness.—Species richness \( (s) \) was greater for sedge-meadow plots \( (s = 18.5) \) compared to mesic-grassland plots \( (s = 12.5) \) (Table 2). Mesic-prairie plots were more similar to each other \( (C_s = 0.83) \) than to sedge-meadow plots \( (0.72 > C_s > 0.51) \) using Morisita’s Similarity Index \( (C_s) \); however, sedge-meadow plots had the greatest similarity \( (C_s = 0.90) \).

PDSI Values.—Moisture conditions varied over the 15 years of study from mild drought \( (PDSI = -1.89) \) to extremely wet \( (PDSI = 7.94) \), flooded fields with only patches of dry ground available for nesting). Many of the bird species commonly associated with wet meadows and wetlands were detected only during extremely wet or flood conditions. For example, Virginia Rail, Wilson’s Snipe, and most waterfowl species were detected only on wet-meadow plots during relatively wet seasons \( (PDSI > 3.0) \).

Bird Densities.—ANNOVA results indicated the main effects of grazing and available moisture (i.e., PDSI), and their interaction, varied for each focal species and for all focal species combined (Table 3, Fig. 1). Data for all focal species combined indicated a significant relationship with PDSI main effect but with no grazing or interaction effects. The densities for all focal species combined, averaged across PDSI levels, were similar between ungrazed plots \( (32.1 \pm 4.00 \text{ males/10 ha}) \) and grazed plots \( (28.5 \pm 3.92 \text{ males/10 ha}) \). The densities of all focal species combined, averaged across the two grazing re-
TABLE 3. Analysis of variance assessing effects of grazing and available moisture (Palmer Drought Severity Index) on species densities.

<table>
<thead>
<tr>
<th>Species</th>
<th>Grazinga</th>
<th>PDSI</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F1,3 = 7.34</td>
<td>F4,8 = 30.52**</td>
<td>F4,8 = 0.13</td>
</tr>
<tr>
<td>Focal species</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upland Sandpiper</td>
<td>F1,3 = 9.49</td>
<td>F4,8 = 9.31**</td>
<td>F4,8 = 5.59*</td>
</tr>
<tr>
<td>Grasshopper Sparrow</td>
<td>F1,3 = 3.56</td>
<td>F4,8 = 3.81</td>
<td>F4,8 = 3.18</td>
</tr>
<tr>
<td>Dickcissel</td>
<td>F1,3 = 0.03</td>
<td>F4,8 = 68.21**</td>
<td>F4,8 = 2.15</td>
</tr>
<tr>
<td>Bobolink</td>
<td>F1,3 = 15.33*</td>
<td>F4,8 = 8.82**</td>
<td>F4,8 = 1.51</td>
</tr>
<tr>
<td>Red-winged Blackbird</td>
<td>F1,3 = 0.73</td>
<td>F4,8 = 8.88**</td>
<td>F4,8 = 0.96</td>
</tr>
<tr>
<td>Western Meadowlark</td>
<td>F1,3 = 5.77</td>
<td>F4,8 = 32.15**</td>
<td>F4,8 = 3.82</td>
</tr>
<tr>
<td>Brown-headed Cowbird</td>
<td>F1,3 = 11.62*</td>
<td>F3,5 = 13.31**</td>
<td>F3,5 = 0.63</td>
</tr>
</tbody>
</table>

a Grazed fields had cattle in the plots during spot mapping; fallow fields were not grazed during the census period.

b Significance level: * p < 0.05; ** p < 0.01.

regimes, declined with increasing PDSI from 41.9 ± 4.78 males/10 ha at the lowest level of PDSI (−0.91) to 14.0 ± 8.15 males/10 ha at the highest level of PDSI (6.96).

Bobolink and Brown-headed Cowbird densities indicated significant main effects for grazing and PDSI but no interaction between the two effects. Bobolink densities, averaged across all PDSI levels, were higher on ungrazed plots (11.5 ± 1.06 males/10 ha) than on grazed plots (5.3 ± 1.08 males/10 ha). Bobolink densities, averaged across the two grazing regimes, declined from 11.8 ± 1.15 males/10 ha at the lowest level of PDSI (−0.91) to 6.4 ± 1.50 males/10 ha at the highest level of PDSI (6.96). Brown-headed Cowbird patterns paralleled those of Bobolink. Densities were higher on ungrazed plots (4.3 ± 0.61 females/10 ha) than on grazed plots (2.6 ± 0.59 females/10 ha) and tended to decline with increasing levels of PDSI (3.9 ± 0.59 females/10 ha at PDSI 1.51 to 3.0 ± 0.99 females/10 ha at PDSI 6.96).

Upland Sandpiper had a significant grazing by PDSI interaction. Their densities on grazed plots were near constant with a mean of 2.9 ± 0.34 males/10 ha across the PDSI levels. Densities on ungrazed plots peaked at intermediate levels of PDSI (2.6 ± 0.99 males/10 ha) with low densities at both the lowest PDSI level (0.6 ± 0.58 males/10 ha) and at the highest PDSI level (0.0 ± 0.76 males/10 ha).

Dickcissel, Western Meadowlark, and Red-winged Blackbird densities varied significantly with PDSI with no indication of grazing main effects or grazing by PDSI interactions. Dickcissel densities declined with increasing PDSI levels when averaged across both grazing treatments from 5.9 ± 1.05 males/10 ha (PDSI −0.91) to 0.3 ± 1.60 males/10 ha (PDSI 6.96). Western Meadowlark densities were low (all <4.0 males/10 ha) with no significant interaction occurring between PDSI and grazing, but Western Meadowlark experienced the most erratic patterns in densities across PDSI levels. Western Meadowlark declined significantly across the PDSI levels from 2.8 ± 0.29 males/10 ha (PDSI −0.91) to 2.0 ± 0.53 males/10 ha (PDSI 6.96). Red-winged Blackbird densities varied significantly with PDSI but had no grazing effects; the species declined only slightly from 8.6 ± 3.30 males/10 ha to 5.2 ± 3.60 males/10 ha with increasing PDSI.

Grasshopper Sparrow had non-significant increases in densities under grazed treatments for the lowest PDSI level (−0.91), but had no difference between grazing treatments or across PDSI levels. Grasshopper Sparrow mean density was 2.76 ± 0.57 males/10 ha across all levels of PDSI and the two grazing treatments.

DISCUSSION

All study plots were in close proximity, but small variations in elevation (at the decimeter scale) influenced the vegetative communities (Henszey et al. 2004) and, concomitantly, avian communities. Sedge-meadow pastures had a higher water table and were more susceptible to flooding. Thus, sedge-meadow plots had greater species richness due to wetland-associated and -dependant bird species using inundated fields during wet periods (Table 1). The extent of inundation depended on both local precipitation and river flood stage; in
FIG. 1. Effects of moisture availability (Palmer Drought Severity Index or PDSI) on density of grassland birds. Open circles represent grazed plots, and closed circles represent ungrazed plots. The PDSI ranges from −2 (drier than normal, minimal standing water) to 8 (very wet, plots flooded).
some years, inundation may result from up-
stream releases from reservoirs on the Platte
River rather than local precipitation patterns.

The Bobolink’s predilection for ungrazed
pastures is supported by findings from other
studies (Bollinger 1995, Fritcher et al. 2004,
Winter et al. 2005), and likely reflects this
species’ preference for moderate to tall, dense
vegetation (Dechant et al. 2003b). The nega-
tive relationship between Bobolink densities
and PDSI suggests that nest sites may be lim-
ited during wet years or there are moisture-
related movements of Bobolink between ri-
parian and upland grasslands. Some studies
of banded Bobolink populations noted site fidelity increases with habitat quality in stable en-
vironments (Bollinger and Gavin 1989,
Fletcher et al. 2006). Grazing and climatic fluctuations might remove predictability from
riparian grasslands at our study sites, poten-
tially facilitating movements at the patch
scale.

We did not find a strong relationship be-
tween grazing and densities of Grasshopper
Sparrow, Western Meadowlark, and Upland
Sandpiper. Previous studies have reported
these three species breed in actively managed
(burned, grazed or hayed) grasslands (Dechant
et al. 1999, 2003a, d), but the low overall den-
sities for all three species limited the statistical power to detect a strong grazing-treatment ef-
fect. Upland Sandpipers typically are associ-
ated with early seral stages in grasslands, and
Western Meadowlarks display intermediate
habitat preferences with regional variation in
their responses to disturbances (e.g., associ-
ated with recent disturbance in tallgrass prai-
rie, associated with rested pastures in short-
grass prairie; Renfrew and Ribic 2001, Fritch-
er et al. 2004). The Upland Sandpiper was the
only species that had an interaction between
grazing and PDSI; however, the species had
minimal variation in densities on grazed plots
compared to ungrazed plots. Standing water
on the ungrazed plots may have reduced suit-
ability of ungrazed plots during extremely wet years for Upland Sandpipers or resulted in
their movements to upland grasslands.

Dickcissel and Red-winged Blackbird also
displayed negative relationships with PDSI.
Vegetation associations for Red-winged Blackbird appear more important than envi-
ronmental conditions during selection of
breeding habitat (Fletcher and Koford 2004).
The association with PDSI may result from
potential fluctuations in habitat suitability or
in nest-site or prey availability while Dickcis-
sels may respond to environmental conditions
at either patch or regional scales. Drought
conditions have been implicated as a prox-
imate cause of Dickcissel irruptions in some
areas (Taber 1947, Igl 1991). In addition,
Dickcissel densities during dry or average
PDSI years may be affected by interspecific
interactions with Red-winged Blackbirds. To
our knowledge, no studies have reported di-
rect behavioral dominance of Red-winged
Blackbirds over Dickcissels (Yasukawa and
Searcy 1995, Temple 2002), although both
species share similar nest-site selection (i.e.,
above ground nesters in grasslands). Dickcis-
sels in the Platte River Valley initiate nesting
2–3 weeks after Red-winged Blackbirds, and
the larger blackbird males often chase Dick-
cissel males from their territories (D. H. Kim,
unpubl. data).

Cowbird densities in our study were higher
in ungrazed plots compared to grazed plots,
which is counter to information in the litera-
ture (e.g., Kostecke et al. 2003). Possible ex-
planations include (1) regional cowbird den-
sities are near capacity (Jensen and Cully
2005), (2) the spatial proximity of grazed pas-
tures to ungrazed plots (<2 km) exert no en-
ergetic costs on female cowbirds moving
among breeding and feeding areas (Goguen
and Mathews 2001), or (3) host species’ den-
sities declined with grazing, offsetting the in-
creased foraging opportunities for cowbirds.
In our system, cowbird densities tracked Dick-
cissel and Red-winged Blackbird densities,
but especially Bobolink densities, suggesting
cowbirds may exploit the most common host
species in the study area or that these four
species share similar habitat preferences in
this region.

Available moisture may have profound ef-
fects on the avian community in sedge mead-
ows and mesic grasslands. Declining species
richness associated with drier conditions was
consistent with other grassland bird studies
(George et al. 1992, Zimmerman 1992), but
decreasing densities with higher PDSI values
suggests that sedge meadows and mesic grass-
lands may be less suitable for grassland birds
during wet conditions. The pattern of increas-
ing density associated with drought conditions in the Platte River Valley appears opposite of other reported studies (e.g., Igl and Johnson 1999). Individual species have different habitat requirements; therefore, changes in vegetation structure and amount of standing water should affect species individually. For example, Igl and Johnson (1999) found abundance of Le Conte’s Sparrow (Ammmodramus lecontei) increased with moisture availability in grasslands enrolled in the Conservation Reserve Program in the northern Great Plains. This unexpected pattern from our study could result from riparian wet-meadow grasslands acting as a refugia for species escaping drier conditions in regional upland areas. Dry conditions may cause birds to move from upland sites as vegetation structure and habitat suitability deteriorates with drought conditions. During dry years, wet-meadow habitats should remain suitable longer during the breeding season given the higher water table and greater soil moisture compared to upland sites.

Van Horne (1983) cautioned against using density as an indicator of habitat quality, especially in disturbed habitats. Additional research focusing on reproductive success over several years will be required to measure the importance of both climate and grazing on reproductive success for all seven species. For example, in Oregon, drought lowered annual reproductive success for Bobolinks (Wittenberger 1982). Dry conditions also may limit food availability for adults and young. Although some insects, such as orthopterans, may increase during dry conditions, the availability and biomass of lepidopteran larvae may decrease, restricting growth rates for young nestlings unable to efficiently process chitinous prey. In either case, birds may be able to assess the potential of food or nest-site availability based on the condition of grasslands at the beginning of the breeding season (early May in Nebraska) and to adjust their breeding densities accordingly.

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