

Sparrow migration along a river corridor in desert grassland

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Abstract.—We analyzed trends of sparrows and towhees captured in fall at the Rio Grande Nature Center, Albuquerque, New Mexico from 1985 to 1994. Species were grouped into three breeding-habitat classes: grassland and shrubsteppe, riparian and deciduous vegetation, and upland forests, woodlands, and edges. Spearman's rank correlations were used to determine whether population trends were similar within and among species groups. We found that steep fluctuations in captures of many species masked population increases or decreases over time. Eight of nineteen (42%) correlations of pairs of species were significant within habitat groups. This indicated that some species populations fluctuated in similar ways, suggesting that shared factors on the breeding grounds may have influenced numbers captured in migration.

INTRODUCTION

The scarcity of water, food, and shelter in combination with the dry heat of semi-arid and arid grasslands and deserts in the western United States can pose formidable barriers to travel by animals adapted to living in moister, more vegetated environments. Many migratory songbirds use river corridors as flyways through arid grasslands because rivers supply suitable species-specific resources that may be lacking in the surrounding landscape (Finch et al. 1995). In this paper, we examined migration patterns of selected emberizid species using the Rio Grande in central New Mexico. The Rio Grande is an important flyway and wintering grounds for migratory geese and sandhill cranes (*Grus canadensis*), but less is known about its value to migrating songbirds (Yong and Finch 1996; Finch and Yong in press). In particular, our paper documents use of a western riparian corridor by sparrow species that breed in short-grass prairie and shrubsteppe of the Great Plains and interior West.

From Cochiti Dam to Elephant Butte, New Mexico, the floodplain vegetation of the Rio Grande is composed of deciduous riparian forest surrounded by desert grassland and shrubland (Finch et al. 1995; Whitney 1996). Although the riparian forest, locally referred to as the "bosque," has changed greatly since European settlement, it continues to be identified as one of the most important reservoirs for biological diversity in New Mexico (Finch and Yong in press). State and international conservation programs have recently been mobilized to protect the bosque's biological resources from threats such as water development, urban growth, exotic woody plant invasion, livestock grazing, arson, and recreational overuse (Whitney 1996). In this paper, we describe breeding and wintering distributions and fall capture trends of 12 migratory emberizid species (sparrows and towhees) along the middle Rio Grande over a ten-year period. Breeding habitats occupied by these migratory sparrows ranged from prairie grasslands and sagebrush to shrub thickets, deciduous riparian woods, and forest clearings and edges. We arranged species based on general similarities in use of breeding habitats and searched for patterns of population changes associated with specific species groups. We focused on

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emberizid species that breed in grasslands in particular because many of these species are reported to have declining populations (Finch 1991, Askins 1993, DeSante and George 1994, Herkert 1995).

METHODS

The Rio Grande Nature Center (RGNC) is located along the middle Rio Grande, Bernalillo County, New Mexico (35°07'N, 106°41'W). Rio Grande Bird Research, Inc., established a long-term banding station at RGNC and has mist-netted landbirds during fall migration since 1979. We used data collected from 1985 to 1994 because the netting effort was less constant during the first six years of the banding study. The study area was established in riparian habitat, and the sampling sites included woods, two human-made ponds, and agricultural fields. The banding location was excluded from public access, and habitat disturbance or modification during the study was not evident (Cox 1994).

Twenty mist nests (12m x 2.6m with 30 mm or 36 mm mesh) were used to capture and recapture landbirds from early August through mid-November each year. Nets remained at the same locations through the study period and were operated by volunteers during weekends in fall. Nets were opened about 15 minutes before local sunrise, were checked every 20-30 minutes, and remained up for approximately six hours each banding day. Nets were closed during rain, snowfall, and other excessive weather conditions (i.e., temperature > 38°C or winds > 40 km/h). Species, age, and sex identification were based on the North American Bird Banding Manual (U.S. Fish and Wildlife Service and Canadian Wildlife Service, 1984), Identification Guide to North American Passerines (Pyle et al. 1987) and various field guides. Each bird was banded with a U.S. Fish and Wildlife Service aluminum leg band (see Yong et al. 1995).

We treated yearly weekend mist-netting efforts as temporally stratified repeated samples. We recognized that daily capture totals of each species could be affected by factors such as weather conditions and species-specific seasonal migration patterns but considered these factors to be of stochastic influence on the annual totals and

population trends through the ten-year period. We adjusted the net hour variation among years by calculating yearly indices for each species by dividing the total number of captured individuals by the total number of net hours of a given year, and then multiplying the resulting numbers by 100. This produced a yearly estimate of birds/100 net hours of banding operation.

To evaluate patterns of migration within a taxonomic group, we focused on emberizids because (1) species diversity was high enough to detect patterns within this taxon, if patterns existed, (2) species differed in habitat use enough to detect trend differences between groups, if there were differences, and (3) several of the emberizid species caught in this study occupied western grasslands during the breeding season, and therefore, they were deemed appropriate subjects for addressing the grassland theme of this proceedings.

To examine population trends of emberizids captured at RGNC, we performed Spearman's rank correlation with year as one variable and birds captured/100 net-hours of each species as the second variable. We applied Spearman's rank correlation because captures were not normally distributed through time for some species (Zar 1984). Only common species with total capture numbers > 80 were used for population trend analyses. We defined trends as significant at $P < 0.1$. We chose this alpha level to reduce Type II error and increase chances of detecting population declines of migratory birds. If population problems can be detected early due to initial warnings from trend data, the species has a greater chance of population recovery through close monitoring and prompt conservation actions.

We also evaluated population trend data obtained from the Breeding Bird Survey (BBS), a large-scale program for monitoring numbers of North American birds coordinated by the National Biological Service (NBS) (U.S. Fish and Wildlife Service prior to NBS separation) and the Canadian Wildlife Service since 1966. BBS is a roadside survey, primarily encompassing the continental United States and southern Canada. The survey is conducted once a year during the peak of the breeding season. Each survey route is 39.4 km long with 50 stops at 0.8 km intervals along secondary roads. Observers start 0.5 hr before local sunrise

and at each stop count all birds detected within 0.4 km radius during a 3 min period (see Robbins et al. 1986).

We retrieved Breeding Bird Survey trend data for New Mexico, western United States, and continental United States from the NBS's database through the INTERNET. These trends were estimated using the route-regression method (Geissler and Sauer 1990). Regional trends were estimated as a weighted average of trends on individual routes. Route trends were estimated using the estimating equations estimator (Link and Sauer 1994) which calculates a multiplicative trend. Observer effects were incorporated into the model to prevent bias associated with increases in observer quality over time (Sauer et al. 1994).

To graphically illustrate possible patterns within and among groups of species, we grouped ten-year trends based on species use of breeding habitats: (1) prairies and grassland/shrubsteppe, (2) coniferous and mixed forests, clearings, and edges, and (3) deciduous woods, riparian thickets, and wet meadows. We treated Chipping Sparrow individually because its high abundance dwarfed the

trends of other emberizid species. To determine whether species with significant trend similarities clustered together, Spearman's rank correlation coefficients and alpha levels were arranged into a species-by-species display matrix.

RESULTS AND DISCUSSION

Twelve sparrow species with total samples greater than 80 captures from 1985 to 1994 were compared. Chipping Sparrow, White-crowned Sparrow, and Dark-eyed Junco were the most commonly-captured sparrow species, with Chipping Sparrow about four times more abundant than the White-crowned Sparrow or junco (table 1). Chipping Sparrows were more abundant than most other passerine species as well (Finch et al. 1995; Yong et al. 1995). Half of the 12 emberizid species bred primarily in Canada and the United States and wintered in Mexico and South America (fig. 1) and half had temperate breeding and wintering ranges that extensively overlapped (fig. 2). Green-tailed Towhees, and Brewer's, Lincoln's, and

Table 1. Breeding habitat and population trends of common migratory sparrows captured at Rio Grande Nature Center, Albuquerque, NM.

Common name	Scientific Name	Acronym ¹	BH ²	N	BT	NM	WE	US
Green-tailed Towhee	<i>Pipilo chlorurus</i>	GTTO	F	141	+		+	+
Rufous-sided Towhee	<i>Pipilo erythrophthalmus</i>	RSTO	R	126	-	+	+	+
Chipping Sparrow	<i>Spizella passerina</i>	CHSP	F	4221	+	-	-	+
Clay-colored Sparrow	<i>Spizella pallida</i>	CCSP	G	86	+		-	+
Brewer's Sparrow	<i>Spizella breweri</i>	BRSP	G	202	-		+	+
Vesper Sparrow	<i>Pooecetes gramineus</i>	VESP	G	110	+	-	+	-
Lark Sparrow	<i>Chondestes grammacus</i>	LASP	G	426	+	-	-	-
Savannah Sparrow	<i>Passerculus sandwichensis</i>	SAVS	G	109	-		+	-
Song Sparrow	<i>Melospiza melodia</i>	SOSP	R	261	+		+	+
Lincoln's Sparrow	<i>Melospiza lincolnii</i>	LISP	R	284	+		+	+
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	WCSP	R	1089	+		+	-
Dark-eyed Junco	<i>Junco hyemalis</i>	DEJU	F	915	-		+	+

¹ Common names and scientific names are based on the A.O.U. Check-list of North American Birds (1983). Acronyms are from USFWS (1984).

² BH = major breeding habitats (F = coniferous and mixed forests and woodlands, G = prairie grassland and shrubsteppe, R = riparian thickets and deciduous woods). N = the number of birds captured at Rio Grande Nature Center from 1985 to 1994. BT = population trends (Spearman's rank correlation) from banding data. NM, WE, and US = population trends from BBS data from 1980 to 1994 in New Mexico, western United States, and entire United States, respectively.

* $P < 0.1$ for BT, and $P < 0.05$ for NM, WE, and US.

White-crowned Sparrows were primarily western breeders in the United States, although Lincoln's and White-crowned Sparrows spread further north and east into Canada and northwest into Alaska during breeding. Clay-colored Sparrow was the only captured sparrow species whose breeding range (northern Great Plains, northern Midwest, and central Canada) was markedly disjunct from its wintering grounds south of the United States/Mexico border. Other species tended to be more continental in distribution, with Savannah Sparrow, Song Sparrow, Dark-eyed Junco, and Chipping Sparrow breeding into Alaska and much of Canada, and Rufous-sided Towhee, Lark Sparrow,

and Vesper Sparrow breeding widely east and west within the United States.

Based on RGNC data from 1985 to 1994, only Clay-colored Sparrow, Lark Sparrow, and White-crowned Sparrow exhibited significant trends (table 1). The positive trend for Clay-colored Sparrow was consistent with BBS trends for the continental United States over the same period of time. White-crowned Sparrow and Lark Sparrow showed positive trends in our study also, but BBS data did not show any matching trends at broader levels. BBS trends for other species varied with respect to significance and direction of trends between the western United States and the conti-

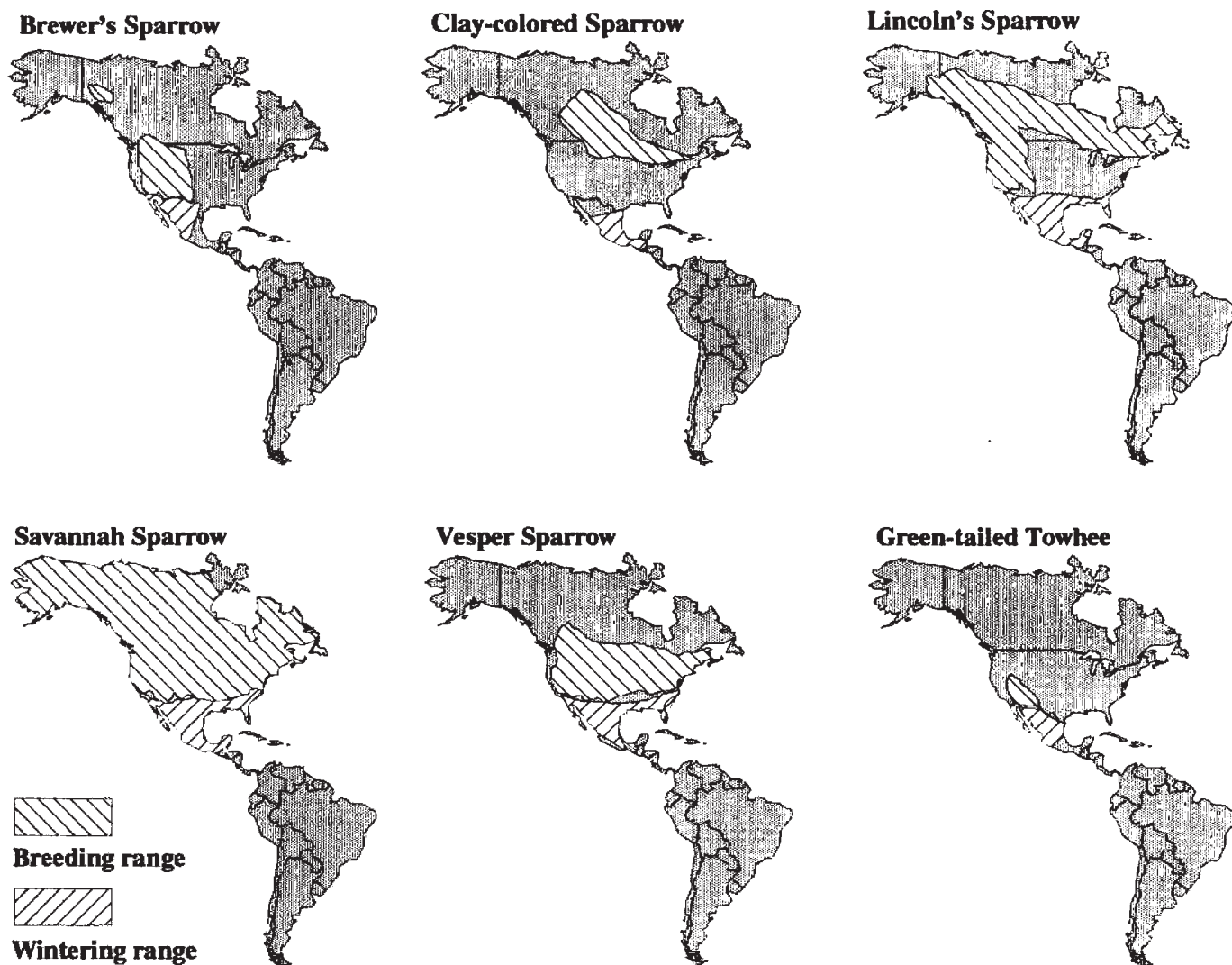


Figure 1. Distributions of six emberizid species commonly captured along the middle Rio Grande in fall that breed primarily in the United States and Canada and winter south of the U.S./Mexico border. Species names for each acronym are given in Table 1.

nental United States, except for Brewer's Sparrow and Dark-eyed Junco that showed significant declines at both levels. Except for four species that exhibited nonsignificant trends, BBS samples in New Mexico were generally insufficient for analysis. Patterns of population increases and decreases of species grouped by breeding habitat use or migratory distance were not evident based on RGNC or BBS data.

To further evaluate variation in numbers of RGNC-caught sparrows over the ten-year period, we classified species into habitat groups and graphed birds captured/100 net hours for multiple species/habitat. We defined Clay-colored,

Brewer's, Lark, Savannah, and Vesper's Sparrows as species that breed in prairie and shrubsteppe habitats; Rufous-sided Towhees, and Lincoln's, Song, and White-crowned Sparrows as species that breed in deciduous woods, riparian shrub, and wet meadow thickets; and Green-tailed Towhee, Dark-eyed Junco, and Chipping Sparrow as species that breed in coniferous and mixed forests and woodlands, especially along edges and clearings. Chipping Sparrow was graphed separately because its high abundance dwarfed numbers of other species, masking intraspecific variation. Patterns of population fluctuation among species were evident within and among habitat groups (fig. 3). Sharp

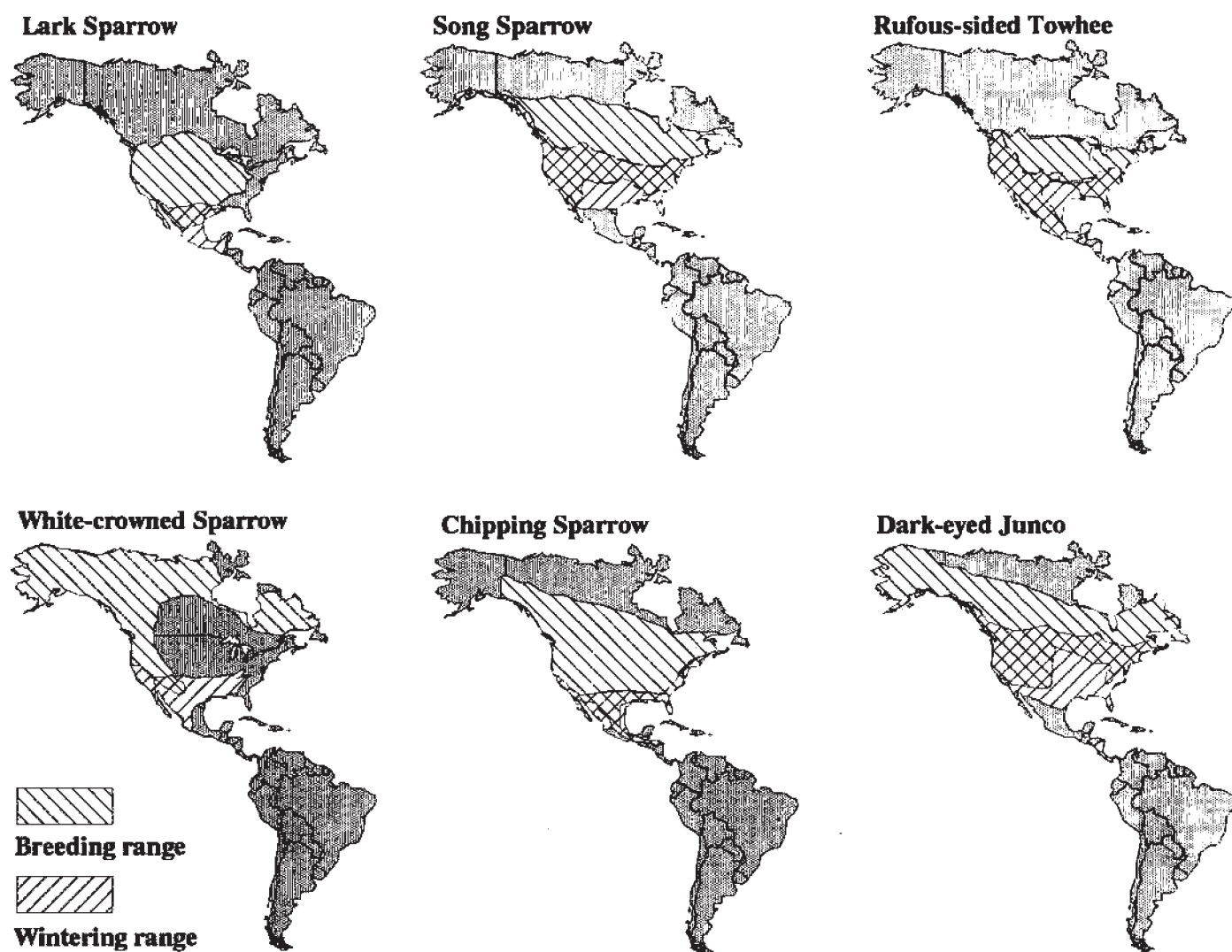


Figure 2. Distributions of six emberizid species commonly captured along the middle Rio Grande in fall that breed and winter primarily within the United States and Canada. Species names for each acronym are given in Table 1.

peaks and troughs in captures of many species canceled out increases and decreases over time, explaining why so few species trends were significant in our earlier trend analyses.

Thirteen (20% of 66) correlations of population trends in species pairs were significant, of which 8 of 19 (42%) were within habitat groups. All were positive suggesting that species tracked similar environmental conditions or resources and responded in a similar way when environments changed, rather than to avoid other sparrow species because of competition. Steep fluctuations, with a peak in 1989-90, a decline in 1991 and another peak in 1992, were conspicuous in the

three most common species, Chipping Sparrow, White-crowned Sparrow, Dark-eyed Junco, as well as in the most abundant grassland species, Lark Sparrow (fig. 3). Correlations of these four species were significantly positive for most pairs (table 2). The lack of a significant correlation between Chipping Sparrow and Dark-eyed Junco, however, is noteworthy because both species tend to use similar habitats and were initially grouped as such. Strong similarities in population trends among species that use a broad variety of habitats may be related to increased power to detect fluctuations owing to increased sample size; climate fluctuations such as periodic drought and precipitation

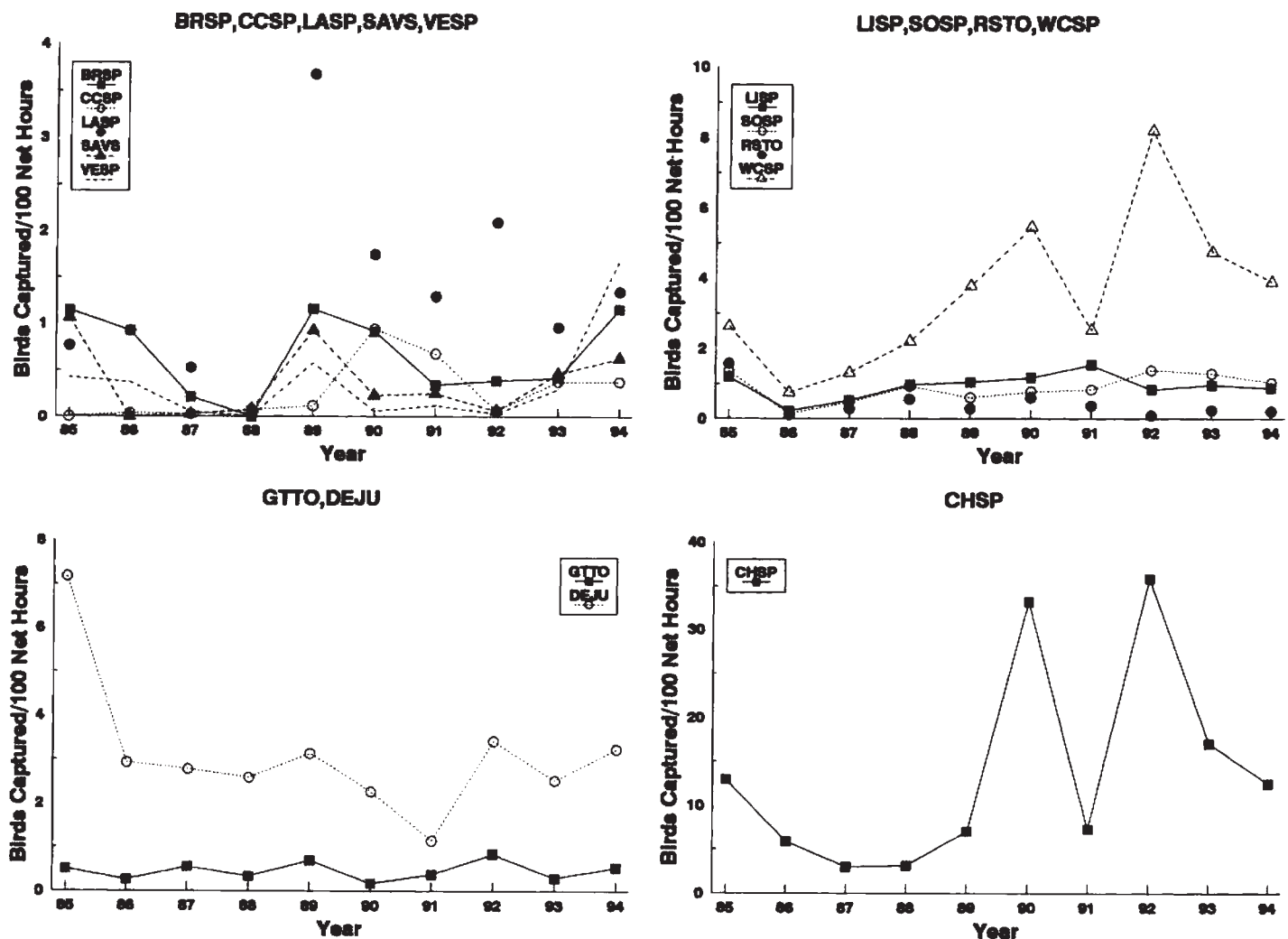


Figure 3. Numerical trends (captures/100 net hours) of 12 emberizid species caught from 1985 to 1994 at the Rio Grande Nature Center, Albuquerque, New Mexico. Species names for each acronym are given in Table 1. Species were grouped based on their breeding habitat use: grassland and shrubsteppe habitats (BRSP, CCSP, LASP, SAVS, VESP); deciduous and riparian habitats (LISP, SOSP, RSTO, WCSP); and coniferous and mixed forests and edges (GTTO, DEJU, CHSP). CHSP was graphed separately because of its high capture rates.

that cross vegetational boundaries; and changes in food supply related to climate.

Similarities in fluctuations within the grassland group included apparent declines by 1988 of all five species, peaks in 1989-90, declines by three species in 1992, and increases of all species by 1994. By arranging grassland species based on significant correlations (50% of 10 matches) among pairs, we confirmed that grassland species with similar trends clustered together (table 2), suggesting that similar factors caused populations of these species to covary over time. Factors that may induce species with sympatric distributions to vary in similar ways include changes in: weather and climate, food supply, availability of suitable habitat, predator densities, cowbird densities, pesticides, and disease rates. During a five-year study in Wisconsin and Michigan, Blake et al. (1989) also find that abundances of common species mostly varied in a parallel manner, indicating that they were influenced by the same or similar elements. They also found that annual variation in abundances of long-distance migrants was correlated with periodic drought. During a time of moderate to extreme drought (1986-1988), populations of more than 60% of the species, the majority being neotropical migrants, declined. They proposed that long-distance migrants may have been more

affected by drought than other species because they nested in June when effects of drought were most severe. Grassland sparrows in our study may be more susceptible to drought than riparian and forest sparrows because water is more limited in grasslands to begin with, such that a severe drought can decimate seed and insect food supplies. The declining trends of grassland species that we detected between 1985 and 1988 may have been caused by the same or similar drought conditions observed by Blake et al. (1989) during the same period.

While less obvious, numbers of riparian sparrows also significantly covaried in two pairs of species (Lincoln's Sparrow x Rufous-sided Towhee, and White-crowned Sparrow x Song Sparrow) over time (table 2). Capture rates of all four riparian species declined in 1986 and stabilized afterward except for WCSP (fig. 3). Numbers of Green-tailed Towhee and Dark-eyed Junco were also correlated, exhibiting a spatially isolated response in relation to other species pairs in table 1. Interestingly, DeSante and Geupel (1987) also reported a precipitous drop in captures in 1986 for many coastal breeding bird species in central California. This was related to significant reproductive failure associated with high rainfall during the breeding season. In general, reduced or increased productivity on

Table 2. Relationships between population trends of 12 sparrow species captured along the middle Rio Grande. Numbers represent Spearman's rank correlation coefficients (*r*), and symbols represent species pairs having significantly similar trends.¹ See table 1 for species names associated with each acronym.

Name	DEJU	GTTO	RSTO	LISP	SOSP	WCSP	CHSP	LASP	SAVS	BRSP	VESP
GTTO	0.61*										
RSTO	-0.26	-0.31									
LISP	-0.28	-0.15	0.81**								
SOSP	0.38	0.27	-0.01	0.25							
WCSP	0.12	0.16	-0.10	0.21	0.64*						
CHSP	0.14	-0.03	-0.07	0.26	0.69*	0.90***					
LASP	0.12	0.31	-0.27	0.15	0.12	0.71*	0.59*				
SAVS	0.25	0.18	0.45	0.67*	0.43	0.36	0.31	0.67*			
BRSP	0.50	0.10	-0.05	0.09	-0.02	0.25	0.26	0.54*	0.60*		
VESP	0.37	0.07	-0.06	0.12	0.25	0.02	0.05	0.32	0.65*	0.90**	
CCSP	0.50	0.10	-0.06	0.09	-0.02	0.25	0.26	0.51	0.21	0.04	0.06

¹ Analyses were based on birds captured/100 net-hours from 1985-1994. * $P \leq 0.10$; ** $P \leq 0.01$; *** $P \leq 0.001$.

the breeding grounds in any year should be reflected in capture trends of migrating hatching-year birds in fall. Therefore, reduced nesting success and low recruitment of young may explain the plunge in capture rates we observed for migrating riparian sparrows and the junco in fall 1986 and migrating grassland sparrows in 1987-88.

CONCLUSION

The middle Rio Grande valley supplies stopover habitat in fall for a variety of emberizid species that breed in prairie and shrubsteppe, riparian habitats, and deciduous and coniferous forests further north (Finch et al. 1995). Similar fluctuations in groups of species were detected using fall banding data, suggesting that populations of different species were similarly affected by factors common to either their breeding or wintering grounds. Given that fall trends reflect the numerical contributions of hatching-year birds, we deem it more likely that shared factors on the breeding grounds rather than on the wintering grounds were influential in determining capture numbers and species covariation in fall. While excessive rainfall or extreme drought could lead to the observed population fluctuations of some species in this study, other factors such as changes in available habitat structure and quantity, and effects of natural disturbances such as insect outbreaks, fire, and other climatic events are also important in interpreting population dynamics of migratory sparrows (Rotenberry et al. 1989). Avian population responses are dependent on species, habitat, and geography. To fully understand population trends of migratory birds, these variables need to be accounted for.

We did not detect consistent increasing or decreasing trends in groups of emberizid species. This is in contrast to studies that indicate populations of more species of North American grassland sparrows are declining than increasing in portions of their range (Askins 1993; Peterjohn et al. 1995). Our banding station is further west than the midwestern prairie states where species such as grasshopper sparrows (*Ammodramus savannarum*), dickcissels (*Spiza americana*), Henslow's sparrow, (*Ammodramus henslowii*), Brewer's sparrow, Clay-colored Sparrow, and Lark Sparrow are reported to have declined

over 1-3 decades (e.g., Central U.S. BBS, Peterjohn et al. 1995) and therefore, we may not have sampled migratory populations that nested in areas where apparent problems have been identified.

Riparian habitats are important to many more species than those that breed in them, including transients such as grassland and upland forest sparrows. Alteration and loss of riparian habitats throughout the Southwest (Rea 1983; Rosenberg et al. 1991; Ohmart 1994; Noss et al. 1995) may have potential to negatively affect migratory species that breed and winter elsewhere, by reducing the amount of suitable habitat they can stop at to find food and replenish fat stores (Finch and Yong in press). We recommend that greater efforts be focused on monitoring and conserving riparian habitats to ensure successful songbird migration. Unfortunately, information on what stopover habitats are important to transients is generally lacking in the western United States, so more research is also needed.

We also emphasize that songbird migration along interior western rivers cannot be fully interpreted without understanding the inseparable relationship of rivers to their arid and semi-arid surroundings. Likewise, to fully appreciate, sustain, and restore the physical and biotic resources and diversity of western grassland ecosystems, scientists, land managers, and conservationists must acknowledge and provide for the rivers and streams running through them.

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