Landbird species composition and relative abundance during migration along the Middle Rio Grande

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Abstract.-In this paper, we report species composition and relative abundances of stopover migrants during spring and fall migration along the middle Rio Grande in 1994. We recorded 157 landbird species using mist-netting and survey methods at two sites on the Rio Grande, the Bosque del Apache and the Rio Grande Nature Center. A total of 6,509 birds was captured during spring and fall migrations at these sites. Of 157 species, 47% were neotropical long-distance migrants, 50% were short-distance migrants, and the remaining 3% were residents or border migrants. Comparisons of relative abundance from our 1994 field research to similar findings from studies conducted in 1981-83 and 1987-90 demonstrated that populations of many species have remained relatively stable over approximately 6 and 12 year periods, while some species have become more common or rare. Research recommendations focusing on bird use of stopover habitats during migration along the Rio Grande are provided.

INTRODUCTION

Narrow belts of riparian vegetation along ephemeral, intermittent, and perennial streams and rivers are most visible in shrubsteppe, grassland, and desert regions of the western United States where they comprise less than 1% of the landscape (Ohmart 1994). Yet, riparian habitats in arid and semiarid environments are unique reservoirs for biological diversity, including diversity of migratory animals. North and south travel along major waterways is characteristic of migratory birds that nest in North America. River corridors may be more important to migrating birds in desert regions of North America than in humid, more heavily vegetated areas (Wauer 1977). During spring and fall migration, riparian habitats can attract more than ten times the number of migratory birds compared to surrounding upland sites (Stevens et al. 1977; Hehnke and Stone 1979; Hink and Ohmart 1984). The riparian habitats along the Rio Grande are potential stopover sites for migratory landbirds that use the great Plains-Rocky Mountain "flight route" (Ligon 1961; Lincoln 1979). The availability of food, water, cover, and suitable north-south routing along this major aridland river may influence survival and guide migration of landbirds (Ligon 1961; Stevens et al. 1977; Wauer 1977; Finch 1991).

Human use of water for irrigation and consumption, and human use of land for agriculture, urban development, livestock grazing, and recreation have greatly altered riparian habitats in the Southwest (Tellman et al. 1993; Ohmart 1994; Finch et al. 1995). In Arizona and New Mexico, 90% of native

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riparian ecosystems are estimated to have been eliminated, and 83% of remaining riparian areas managed by the U.S. Bureau of Land Management are reported to be in unsatisfactory condition (Almand and Krohn 1979). Noss et al. (1995) lists riparian woodlands in California, Arizona and New Mexico as "endangered ecosystems". How changes in riparian habitats along the Rio Grande have affected long-term or short-term migration patterns, population numbers, and survival of migratory landbirds are unclear. Effective conservation strategies for neotropical and short-distance migratory landbirds cannot be established without basic information about the importance of riparian corridors as stopover habitat during migration.

In spring 1994, we initiated a study to investigate use of riparian habitats along the middle Rio Grande by neotropical and short-distance landbird migrants during fall and spring migration. Here, we report species composition and relative abundance of stopover migratory landbirds at two sites along the middle Rio Grande. We examined changes in relative abundance of landbird migrants by comparing our results with relative abundance data from previous studies. Based on this information, we provided recommendations for new research that will supply a sound basis for conserving migratory landbirds and riparian habitats along the middle Rio Grande.

METHODS

Study site

This study was conducted at two sites in the Middle Rio Grande Valley of New Mexico: Rio Grande Nature Center (RGNC, N 35°07' and W 106°41'), Bernalillo County, NM, and Bosque del Apache National Wildlife Refuge (BNWR, N33°48' and W106°52'), Socorro County, NM. The data were collected in spring from April 4 to June 15, and in fall from August 1 to November 13, 1994.

RGNC, a 270 acre stretch of bosque along the Rio Grande, lies within the city limits of Albuquerque. Rio Grande cottonwood (*Populus fremontii var. wislizeni*) with a Russian olive (*Elaeagnus angustifolia*) understory, and clumps of willow (*Salix spp.*) and saltcedar (*Tamarix chinensis*) form the major habitats. These are surrounded by agricultural lands and residential housing. The availability of suitable habitat at RGNC site is restricted in area and diversity because of urban development and human activities in the Albuquerque area. The 57,191 acre BNWR, located about 90 miles south of Albuquerque, was established in 1939 as a refuge and breeding grounds for migratory waterfowl and other wildlife. We identified five major habitat types at BNWR: cottonwood-willow, screwbean mesquite (*Prosopis pubescens*), saltcedar, agriculture land, and willow strips along the irrigation waterways. This floodplain vegetation is wider in area and less exposed to disturbance from human use than that at RCNC.

Survey counts

In spring 1994, we established six transects in the three dominant vegetation types at RGNC: cottonwood, mixed vegetation, and agriculture fields. At BNWR, we installed eight transects in the four dominant habitat types: cottonwood, saltcedar, screwbean mesquite, and agriculture fields. Two willow transects along the irrigation waterways were added at BNWR during the fall field season. All transects were at least 400 m apart. Each transect was 1 km long, and point count stations were located at 200 m intervals (6 stations/transect). It should be noted that although the transects were located based on dominant vegetation types, almost all transects contained various amounts of other vegetation. The transects were not standardized in orientation or linearity because of the patchy availability of the vegetation types.

Bird surveys were started about one half hour after sunrise and completed before 12:00 (MST). One transect in each habitat type was surveyed daily at BNWR and RGNC. To reduce bias due to variation in survey time, the order of visitation to habitat types was rotated. Birds seen or heard as transects were walked were recorded. Bird behavior and weather information were also noted. Observations were separated according to perpendicular distance from the transect: $\leq$ 25 m or $>$ 25 m. All birds detected during surveys were used for this study.

Mist-netting operation

Migrants were captured (and recaptured) using nylon mist-nets (12 x 2.6 m with 30 mm or 36 mm

mesh). Twenty mist-nets were used at each site. Unless rain, high winds, or temperature dictated a change, mist-nets were opened 15 minutes before sunrise and operated approximately 6 hours each banding day.

Species, subspecies, age, and sex were identified by consulting Pyle et al. (1987), US Fish & Wildlife Service Bird Banding Manual (1984), and various field guides. Body mass of each captured individual was weighed to the nearest 0.1 g using a digital electronic balance (ACCULAB V-333). Morphological characteristics including unflattened wing chord, tarsus length, tail length, and molt condition were measured on each bird. Additional information such as feather length, wing span, and wing area were also collected for some species to assist in species identification and to meet other research goals. The amount of skull ossification was examined in fall to identify age. Each individual was banded with a National Biological Service aluminum leg band. Birds were released immediately after this process.

Classification of migration type and relative abundance

We evaluated species composition and relative abundance in relation to the migration distance of each species. Migratory distance was classified based on the Partners in Flight list (1992): (A) long-distance migrants (or neotropical migrants, species breeding in North America and wintering primarily south of the United States); (B) short-distance migrants (species breeding and wintering extensively in North America); (C) species breeding primarily south of the U.S. /Mexican border but having populations that extend into the southwestern U.S.; and (D) permanent residents, species inhabiting sites year-round.

Hink and Ohmart (1984) conducted a three-year study of riparian habitats and associated terrestrial vertebrate communities of the Middle Rio Grande Valley from 1981 to 1983. The study provided the first available comprehensive data on landbird species composition and relative abundance in the middle Rio Grande. As a follow-up to Hink and Ohmart, and to assess bird population changes, Hoffman (1990) conducted avian surveys in the Middle Rio Grande Valley State Park from 1987 to 1990. To compare relative abundance data from our project with data from these two studies, we adopted relative abundance categories used by Hink and Ohmart (1984) and Hoffman (1990): abundant (very high density), common to fairly common (high to moderate density), uncommon (low density), and rare (very low density). Thus, abundant species can be readily observed during their migration, common to fairly common species should be seen fairly easily by most observers during migration, uncommon species may be seen with diligent searching, and rare species are much less predictable (some of these species are casual or accidental to the Middle Rio Grande). Similar classification systems for relative abundance of southwestern birds are used by other ornithologists (e.g., Hubbard 1978; Rosenberg et al. 1991).

RESULTS

Species composition

For the two sites combined, 157 species were recorded during mist-netting operation (108 species) and daily survey (43 additional species). Seventy-four species (47%) belonged to type A, Neotropical or long-distance migrants; 78 species (50%) were type B or short-distance migrants that breed and winter extensively in North America; 2 species (1%) were type C, Mexico/U.S. border species; and the remaining 3 species (2%) were residents or migrants not defined by the Partners in Flight list (Table 1, Fig. 1).

For the two sites combined, a total of 6,509 landbirds of 102 species were captured by mist-netting during spring and fall migrations (Table 1). During the 1994 spring migration, we banded 436 individuals of 50 species at RGNC and 421 individuals of 53 species at BNWR. During fall migration, 4,269 individuals of 77 species were captured at RGNC and 1,383 individuals of 55 species were banded at BNWR. The seasonal difference in numbers of birds captured was unusually large in some species. For example, a total of 877 Wilson's Warblers were captured during fall migration at the two study sites, while only 34 individuals of this species were captured during spring migration. An extreme example was Chipping Sparrow; while only 3 birds were captured during spring migration, 950 birds were captured during fall migration.

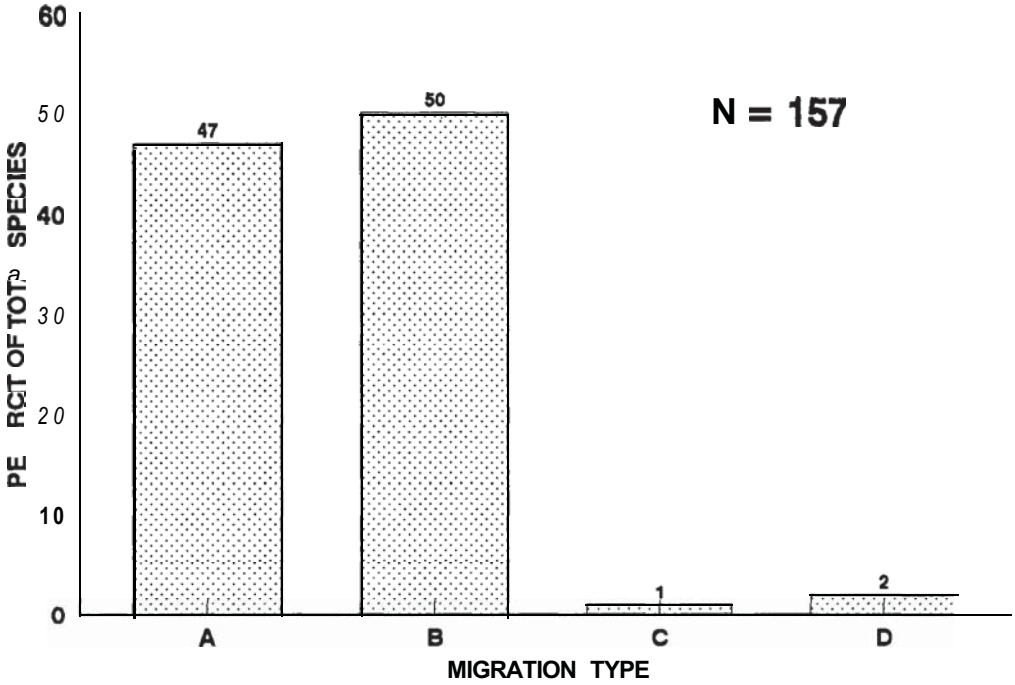

Figure I-Migratory status of landbirds (N=157 species) detected along the middle Rio Grande during spring and fall migrations, 1994. A = neotropical migrants, B = short-distance migrants, C = species breeding along U.S./Mexico border, and D = permanent residents.

Table I-Migratory distances (MD) and relative abundances of landbirds recorded in the middle Rio Grande Valley during studies by Yong and Finch (YF; this study), Hoffman (HF; 1990), and Hink and Ohmart (HK; 1984), and total number of mist-netting captures (N) at Bosque del Apache and Rio Grande Nature Center during spring and fall migrations, 1994.'

Common name	Scientific name[2]	MD	YF	HF	HK	N[3]
Cathartidae						
Turkey Vulture	*Cathartes aura*	*B*	**C**	*U*	*U*	
Accipitridae						
Osprey	*Pandion haliaetus*	*B*	*R*	*R*	*R*	
Northern Harrier	*Circus cyaneus*	*B*	*U*	*R*	*c*	
Sharp-shinned Hawk	*Accipiter striatus*	*B*	*U*	*U*	*U*	*3*
Cooper's Hawk	*Accipiter cooperii*	*B*	*C*	*U*	*C*	*1*
Northern Goshawk	*Accipiter gentilis*	*B*	*n*	*R*	*U*	
Red-tailed Hawk	*Buteo jamaicensis*	*B*	*C*	*U*	*c*	
Swainson's Hawk	*Buteo swainsoni*	*A*	*C*	*n*	*C*	
Ferruginous Hawk	*Buteo regalis*	*B*	*R*	*n*	*U*	
Falconidae						
American Kestrel	*Falco sparverius*	*B*	*C*	*U*	*C*	*2*
Phasianidae						
Scaled Quail	*Callipepla squamata*	*B*	*U*	*n*	*R*	
Gambel's Quail	*Callipepla gambelii*	*B*	*C*	*C*	*C*	
Ring-necked Pheasant	*Phasianus colchicus*	*B*	*C*	*U*	*C*	

(Cont'd.)

Table 1. Continued

Common name	Scientific name[2]	MD	YF	HF	HK	N[3]
Wild Turkey	*Meleagris gallopavo*	D	U	n	n	
Columbidae						
Rock Dove	*Columba livia*	B	C	U	C	
Mourning Dove	*Zenaida macroura*	B	A	R	A	4
Cuculidae						
Yellow-billed Cuckoo	*Coccyzus americanus*	A	U	R	U	6
Greater Roadrunner	*Geococcyx californianus*	B	C	C	C	
Strigidae						
Western Screech-owl	*Otus kennecotti*	B	U	n	U	
Great Horned Owl	*Bubo virginianus*	B	C	U	C	
Caprimulgidae						
Common Nighthawk	*Chordeiles minor*	A	U	R	C	
Trochilidae						
Black-chinned Hummingbird	*Archilochus alexandri*	A	A	A	A	
Broad-tailed Hummingbird	*Selasphorus platycercus*	A	C	U	C	
Rufous Hummingbird	*Selasphorus rufus*	A	C	U	C	
Calliope Hummingbird	*Stellula calliope*	A	R	n	C	
Alcedinidae						
Belted Kingfisher	*Ceryle alcyon*	B	C	U	C	3
Picidae						
Downy Woodpecker	*Picoides pubescens*	B	C	U	C	12
Hairy Woodpecker	*Picoides villosus*	B	R	R	R	4
Red-napped Sapsucker	*Sphyrapicus nuchalis*	B	U	n	U	1
Lewis' Woodpecker	*Melanerpes lewis*	B	U	n	U	
Northern Flicker	*Colaptes auratus*	B	C	C	C	16
Tyrannidae						
Olive-sided Flycatcher	*Contopus borealis*	A	U	R	C	4
Western Wood-Pewee	*Contopus sordidulus*	A	C	U	C	46
Willow Flycatcher	*Empidonax trail/ii*	A	U	R	C	22
Least Flycatcher	*Empidonax minimus*	A	R	n	R	1
Hammond's Flycatcher	*Empidonax hammondii*	A	R	n	R	6
Dusky Flycatcher	*Empidonax oberholseri*	A	C	n	C	92
Gray Flycatcher	*Empidonax wrightii*	A	U	n	U	27
Cordilleran Flycatcher	*Empidonax difficilis*	A	U	n	R	20
Black Phoebe	*Sayornis nigricans*	B	C	R	C	17
Say's Phoebe	*Sayornis saya*	B	C	R	C	4
Ash-throated Flycatcher	*Myiarchus cinerascens*	A	C	U	C	10
Brown-crested Flycatcher	*Myiarchus tyrannulus*	B	R	n	n	4
Western Kingbird	*Tyrannus verticalis*	A	C	R	C	6
Cassin's Kingbird	*Tyrannus vociferans*	A	R	n	R	
Alaudidae						
Horned Lark	*Eremophila alpestris*	B	U	R	U	
Hirundinidae						
Purple Martin	*Progne subis*	A	R	n	R	
Cliff Swallow	*Hirundo pyrrhonota*	A	U	U	C	
Barn Swallow	*Hirundo rustica*	A	A	C	C	
Tree Swallow	*Tachycineta bicolor*	B	U	U	U	
Violet-green Swallow	*Tachycineta thalassina*	A	C	C	C	1
Bank Swallow	*Riparia riparia*	A	U	R	U	

(Cont'd.)

Table 1. Continued

Common name	Scientific name[2]	MD	YF	HF	HK	N[3]
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	A	C	U	C	9
Corvidae						
Blue Jay	*Cyanocitta cristata*	D	R	R	R	
Scrub Jay	*Aphelocoma coerulescens*	B	C	U	C	7
Common Raven	*Corvus corax*	B	U	R	C	
Chihuahuan Raven	*Corvus cryptoleucus*	B	R	n	R	
American Crow	*Corvus brachyrhynchos*	B	C	A	C	
Pinyon Jay	*Gymnorhinus cyanocephalus*	B	U	n	C	
Paridae						
Mountain Chickadee	*Parus gambelli*	B	U	U	R	6
Black-capped Chickadee	*Parus atricapillus*	B	C	C	U	11
Remizidae						
Verdin	*Auriparus flaviceps*	B	U	n	U	1
Aegithalidae						
Common Bushtit	*Psaltriparus minimus*	B	U	n	U	6
Sittidae						
Red-breasted Nuthatch	*Sitta canadensis*	B	R	R	R	3
White-breasted Nuthatch	*Sitta carolinensis*	B	C	U	U	12
Pygmy Nuthatch	*Sitta pygmaea*	B	R	n	R	
Certhiidae						
Brown Creeper	*Certhia americana*	B	R	U	R	
Troglodytidae						
Rock Wren	*Salpinctes obsoletus*	B	U	n	R	
Bewick's Wren	*Thryomanes bewickii*	B	C	U	C	47
House Wren	*Troglodytes aedon*	A	U	U	C	26
Marsh Wren	*Cistothorus palustris*	B	R	R	C	1
Muscicapidae						
Sylviinae						
Ruby-crowned Kinglet	*Regulus calendula*	B	C	U	C	190
Blue-gray Gnatcatcher	*Polioptila caerulea*	A	U	U	U	1
Turdinae						
Swainson's Thrush	*Catharus ustulatus*	A	R	R	R	2
Hermit Thrush	*Catharus guttatus*	B	C	U	C	74
American Robin	*Turdus migratorius*	B	A	A	C	62
Townsend's Solitaire	*Myadestes to wnsendi*	B	U	R	R	
Western Bluebird	*Sialia mexicana*	B	R	R	R	
Mountain Bluebird	*Sialia currucoides*	B	U	n	U	
Mimidae						
Gray Catbird	*Dumetella carolinensis*	A	R	R	C	2
Northern Mockingbird	*Mimus polyglottos*	B	U	R	C	1
Sage Thrasher	*Oreoscoptes montanus*	B	R	n	R	1
Crissal Thrasher	*Toxostoma dorsale*	B	R	n	U	
Motacillidae						
Water Pipit	*Anthus spinoletta*	B	U	R	U	
Bombycillidae						
Cedar Waxwing	*Bombycilla cedrorum*	B	C	U	C	

(Cont'd.)

Table 1. Continued

Common name	Scientific name[2]	MD	YF	HF	HK	N[3]
Ptilogonatidae						
Phainopepla	*Phainopepla nitens*	A	R	n	R	
Laniidae						
Loggerhead Shrike	*Lanius ludovicianus*	B	U	n	U	
Sturnidae						
European Starling	*Sturnus vulgaris*	B	A	A	C	2
Vireonidae						
Solitary Vireo	*Vireo solitarius*	A	C	R	U	12
Warbling Vireo	*Vireo gilvus*	A	C	C	C	28
Red-eyed Vireo	*Vireo olivaceous*	A	R	R	R	1
Yellow-throated Vireo	*Vireo flavifrons*	A	R	n	R	
Emberizidae						
Parulinae						
Orange-crowned Warbler	*Vermivora celata*	A	C	R	C	193
Nashville Warbler	*Vermivora ruficapilla*	A	R	n	R	1
Virginia Warbler	*Vermivora virginiae*	A	C	n	C	67
Lucy's Warbler	*Vermivora luciae*	C	R	n	R	4
Yellow Warbler	*Dendroica petechia*	A	C	R	C	97
Magnolia Warbler	*Dendroica magnolia*	A	R	n	R	1
Blackpoll Warbler	*Dendroica striata*	A	R	n	R	
Grace's Warbler	*Dendroica graciae*	A	R	n	R	
Yellow-rumped Warbler	*Dendroica coronata*	B	A	C	A	539
Black-throated Gray Warbler	*Dendroica nigrescens*	A	R	R	U	1
Townsend's Warbler	*Dendroica townsendi*	A	U	n	R	4
Palm Warbler	*Dendroica palmarum*	A	R	n	R	1
Black-and-white Warbler	*Mniotilta varia*	A	R	n	R	1
Northern Waterthrush	*Seiurus noveboracensis*	A	U	n	U	11
Ovenbird	*Seiurus aurocapillus*	A	R	n	R	
Kentucky Warbler	*Oporornis formosus*	A	R	n	R	1
Mourning Warbler	*Oporornis Philadelphia*	A	R	n	n	1
MacGillivray's Warbler	*Oporornis tolmiei*	A	C	n	C	210
Common Yellowthroat	*Geothlypis trichas*	A	C	U	C	44
Wilson's Warbler	*Wilsonia pusilla*	A	A	C	A	911
Yellow-breasted Chat	*Icteria virens*	A	U	U	C	8
Thraupinae						
Summer Tanager	*Piranga rubra*	A	C	R	C	23
Western Tanager	*Piranga ludoviciana*	A	C	C	C	67
Cardinalinae						
Pyrrhuloxia	*Cardinalis sinuatus*	D	R	R	n	1
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	A	R	n	R	1
Black-headed Grosbeak	*Pheucticus melanocephalus*	A	A	A	A	111
Blue Grosbeak	*Guiraca caerulea*	A	A	C	A	121
Lazuli Bunting	*Passerina amoena*	A	C	R	C	104
Indigo Bunting	*Passerina cyanea*	A	R	R	C	2
Painted Bunting	*Passerina ciris*	A	R	n	n	1
Dicksissel	*Spiza americana*	A	R	n	R	1
Emberizinae						
Green-tailed Towhee	*Pipilo chlorurus*	A	C	R	C	47
Rufous-sided Towhee	*Pipilo erythrophthalmus*	B	C	U	C	50
Brown Towhee	*Pipilo fuscus*	B	R	n	U	

(Cont'd.)

Table 1. Continued

Common name	Scientific name[2]	MD	YF	HF	HK	N[3]
Cassin's Sparrow	*Aimophila cassinii*	B	R	n	n	1
Chipping Sparrow	*Spizella passerina*	A	A	R	C	953
Clay-colored Sparrow	*Spizella pallida*	A	U	n	R	70
Brewer's Sparrow	*Spizella breweri*	A	C	n	C	149
Vesper Sparrow	*Pooecetes gramineus*	B	C	n	U	144
Lark Sparrow	*Chondestes grammacus*	A	C	n	C	167
Lark Bunting	*Calamospiza melanocorys*	A	R	n	R	6
Savannah Sparrow	*Passerculus sandwichensis*	B	C	n	C	118
Grasshopper Sparrow	*Ammodramus savannarum*	A	R	n	n	3
Song Sparrow	*Melospiza melodia*	B	C	A	C	135
Lincoln's Sparrow	*Melospiza lincolnii*	A	C	R	U	101
White-throated Sparrow	*Zonotrichia albicollis*	B	U	R	U	6
Golden-crowned Sparrow	*Zonotrichia atricapilla*	B	R	n	n	1
White-crowned Sparrow	*Zonotrichia leucophrys*	B	A	A	A	450
Dark-eyed Junco	*Junco hyemalis*	B	A	A	A	283
Icterinae						
Bobolink	*Dolichonyx oryzivorus*	A	R	n	R	
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	A	U	R	C	
Red-winged Blackbird	*Agelaius phoeniceus*	A	U	R	C	72
Western Meadowlark	*Sturnella neglecta*	B	A	C	A	2
Brewer's Blackbird	*Euphagus cyanocephalus*	B	U	U	C	
Common Grackle	*Quiscalus quisculus*	B	U	n	U	
Great-tailed Grackle	*Quiscalus mexicanus*	B	C	C	U	5
Brown-headed Cowbird	*Molothrus ater*	B	C	A	C	10
Orchard Oriole	*Icterus spurius*	A	R	n	R	2
Northern Oriole	*Icterus galbula*	A	C	U	U	35
Fringillidae						
House Finch	*Carpodacus mexicanus*	B	A	C	C	203
Pine Siskin	*Carduelis pinus*	B	C	C	C	15
Lesser Goldfinch	*Carduelis psaltria*	B	C	C	U	38
American Goldfinch	*Carduelis tristis*	B	C	U	C	97
Evening Grosbeak	*Coccothraustes vespertinus*	B	U	U	R	
Ploceidae						
House Sparrow	*Passer domesticus*	B	A	C	C	
Total						6,509

[1] *MD = migratory distance (A = neotropical migrants, B = short-distance migrants, C = species breeding along U.S./Mexico border, and D = permanent residents; from list by Partners in Flight (1992). Columns YF, HF, and HK are relative abundances (R = rare, U = uncommon, C = common, A = abundant, n = not observed during given study).*

[2] *Common and scientific names are based on the A.O.U. Check-list of North American Birds (1983).*

[3] *N = number of mist-netting captures at combined sites in spring and fall, 1994. Species detected during transect surveys rather than with mist-nets were left blank.*

Comparing combined spring and fall data between the two sites, more species and more individuals were captured at the RGNC site (4,705 individuals of 87 species) than at the BNWR site (1,804 individuals of 71 species). In general, more individuals of any given species were captured at RGNC. However, more individuals of the following species were caught at BNWR: Lucy's Warbler, Pyrrhuloxia, Summer Tanager, Verdin, Yellow-billed Cuckoo, Ruby-crowned Kinglet, Rufous-side Towhee, Yellow-breasted Chat, Western Wood-Pewee and Common Yellowthroat.

Some species that breed mostly in the eastern United State and are rare or otherwise unusual in the Middle Rio Grande Valley were captured in low numbers. These included Black-and-white Warbler, Dickcissel, Gray Catbird, Kentucky Warbler, Magnolia Warbler, Mourning Warbler, Nashville Warbler, Swainson*s Thrush, Painted Bunting, Orchard Oriole, Red-eyed Vireo, Rose-breasted Grosbeak, and White-throated Sparrow. Brown-crested Flycatcher, a species not previously reported in the Middle Rio Grande Valley, was captured at BNWR during both spring and fall migration seasons. Western Palm Warbler, a regular migrant along the Pacific Coast but rare in the interior Southwest, was captured at RGNC during spring migration. One Golden-crowned Sparrow, another regular Pacific Coast species that is rare in the Middle Rio Grande Valley was captured in fall at the RGNC. We captured several species such as Kentucky Warbler, Mourning Warbler, Swainson's Thrush, and Red-eyed Vireo that were not on the BNWR bird checklist. Others such as Magnolia Warbler, Palm Warbler, and Cassin's Sparrow were not on the RGNC bird checklist.

Two species of concern, Yellow-billed Cuckoo and Willow Flycatcher, were captured at banding stations. Four Yellow-billed Cuckoo were captured at BNWR in spring and two at BNWR in fall. A total of 22 Willow Flycatchers was captured at the two sites. Eight of these were captured during spring migration and 14 during fall migration. About 30% of these Willow Flycatchers were identified as the endangered Southwestern race (*Empidonax traillii extimus*) based on morphology measurements and body color (see Aldrich 1951; Unitt 1987; Hubbard 1987; Browning 1993 for identification criteria). Mean (±SD) capture dates for Willow Flycatchers in spring were May 15(±5) at BNWR and Mav 30(±11) at RGNC. In fall, mean capture dates were August 27(±14) at RGNC and September 5(±7) at BNWR.

Relative abundance

Of the 157 species detected, 14 (10%) were classified as abundant, 56 (36%) were common, 39 (25%) were uncommon, and 47 (30%) were rare (Table 1, Fig. 2). Of the 74 long-distance migratory species, 6 (8%) (Black-chinned Hummingbird, Barn Swallow, Wilson's Warbler, Black-headed Grosbeak, Blue Grosbeak, and Chipping Sparrow) were abundant; 39 (53%) were common to uncommon, and 29 species (39%) were rare. Among the 78 short distance migrants, 9 species (12%) were abundant, 55 species (71%) were common to uncommon, and 14 species (18%) were rare. While long-distance migratory species had more rare species, short-distance migratory species had more common and uncommon species (log-likelihood G = 8.69, df = 3, $P < 0.05$).

The most commonly-captured species at RGNC were Chipping Sparrow (882 birds), Yellow-rumped Warbler (492), and Wilson's Warbler (484). These three species accounted for 39% of the total captures at the site. At BNWR, the most commonly-captured species, Wilson's Warbler (427), White-crowned Sparrow (159), and Ruby-crowned Kinglet (140), accounted for 40% of the total captures at the site. When captures from the two sites were combined, the most commonly-captured species were Chipping Sparrow (953 captures), Wilson's Warbler (911), Yellow-rumped Warbler (539), and White-crowned Sparrow (450). These four species made up 44% of total captures. Nineteen additional species comprised another 38% of the common captures. Arranged in decreasing abundance, these were Dark-eyed Junco (283), MacGillivray's Warbler (210), House Finch (203), Orange-crowned Warbler (193), Ruby-crowned Kinglet (190), Lark Sparrow (167), Brewer's Sparrow (149), Vesper Sparrow (144), Song Sparrow (135), Blue Grosbeak (121), Savannah Sparrow (118), Black-headed Grosbeak (111), Lazuli Bunting (104), Lincoln's Sparrow (101), American Goldfinch (97), Yellow Warbler (97), and Dusky Flycatcher (92).

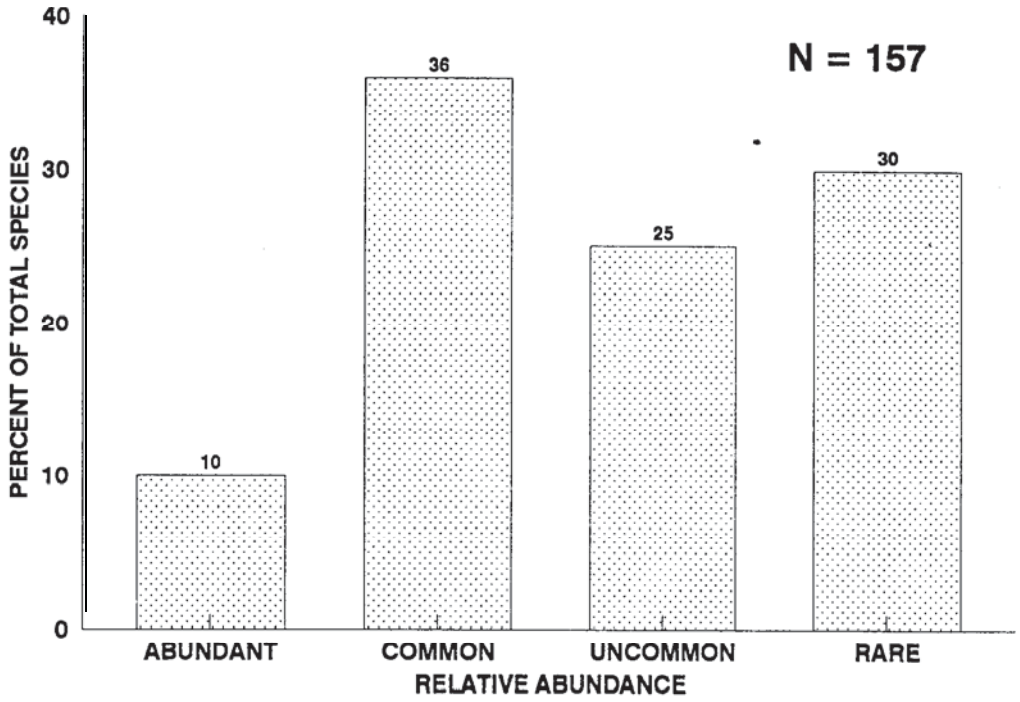

Figure P-Relative abundance of landbirds (N=157 species) recorded in middle Rio Grande riparian habitats during spring and fall migrations, 1994.

Comparisons of relative abundance

We detected more species in migration along the Rio Grande during our 1994 spring and fall field seasons than were reported by Hink and Ohmart (1984) during their comprehensive three-year study. Relative abundances from our study corresponded significantly with abundance data from studies by both Hink and Ohmart (1984) (Log likelihood G = 173.67, df = 12, $P < 0.001$) and Hoffman (1990) (Log likelihood G = 126.88, df = 12, $P < 0.001$). The similarity of our abundance data with Hink/Ohmart's was greater than that with Hoffman's data. Hoffman, whose sampling localities were fewer than ours and were restricted to the Albuquerque area, reported only 98 of the 157 landbird species we observed. We detected seven additional species - Wild Turkey, Brown-crested Flycatcher, Grasshopper Sparrow, Golden-crowned Sparrow, Cassin's Sparrow, Painted Bunting, and Mourning Warbler - that were not recorded by either Hink and Ohmart or Hoffman. All these species were classified as rare and were only detected during our mist-netting operation with the exception of Wild Turkey which we observed during daily surveys and classified as uncommon. Of the seven new species, Painted Bunting and Mourning Warbler breed mostly in the East; Golden-crowned Sparrow breeds mostly along the Pacific Coast; and Brown-crested Flycatcher and Cassin's Sparrow have relatively restricted breeding distributions, mostly in the Southwest. Pyrrhuloxia, another rare species along the middle Rio Grande, was not detected during 1981-83 by Hink and Ohmart, but it was recorded by Hoffman and ourselves.

Relative abundances of Calliope Hummingbird, Olive-sided Flycatcher, Brewer's Sparrow, Indigo Bunting, Yellow-breasted Chat, Gray Catbird, and Marsh Wren were lower in 1994 (our study) than in the 80's (Hink and Ohmart 1984; Hoffman 1990). In contrast, relative abundances of Cordilleran Flycatcher, European Starling, Great-tailed Grackle, Chipping Sparrow, Black-capped Chickadee, Mountain Chickadee, and House Sparrow were higher in 1994 than in the previous decade.

DISCUSSION

Species composition and relative abundance

This study documents volume, relative abundance, and composition of migratory species in the middle Rio Grande Valley. We recorded seven additional species that Hink and Ohmart (1984) did not observe during their comprehensive study. The migrants detected during our study included summer residents such as Black-headed Grosbeak, Blue Grosbeak, Black-chinned Hummingbird, and Cordilleran Flycatcher that breed in the area and are present during late spring and summer; winter residents such as White-crowned Sparrow, Dark-eyed Junco, and Yellow-rumped Warbler that are present for varying lengths of time between September and April; and transient species such as most of the warblers and flycatchers that use the middle Rio Grande riparian habitats as stopover sites during spring and fall migration.

Not only were New Mexico breeding birds detected during their spring and fall migrations, but numerous species breeding in other western states and even several eastern species were also detected during this study. During fall migration, a large portion of Rio Grande migrants are young, hatching-year birds (Yong and Finch unpublished) thought to be especially vulnerable to navigational mistakes, starvation, and predation on their first journey south to the wintering grounds. We argue that disturbance (e.g., burning, bridges, recreation, urbanization, and grazing) and changes in habitat structure and plant species composition in the Rio Grande bosque will increase the probability that migration of some species will be altered or disrupted, and that such changes will affect not only local New Mexico birds but also populations from a much wider geographic region.

We suspect that the higher volume of migrants at the Rio Grande Nature Center site compared to the Bosque del Apache site is due to constriction of suitable Rio Grande habitat within the town of Albuquerque. Urban encroachment around the RGNC may cause migrants to be concentrated into a narrow and limited habitat corridor along the river itself. Likewise, Hink and Ohmart (1984) found that a mature cottonwood-Russian olive site with little human use had significantly lower total bird density than a similar habitat near downtown Albuquerque. Hink and Ohmart suggested that direct human activity may have influenced avian habitat use in this situation.

Causes of differences in species composition patterns between BNWR and RGNC are unclear, but may be related to the north or south distributional limits of a species; differences in habitat structure, quality, and quantity at each site; variation of migration routes among species; or weather conditions at stopover time. For example, in the middle Rio Grande valley, the BNWR probably represents the northern distributional limits of Pyrrhuloxia and Verdin. No individuals of these two species were detected during intensive surveys at RGNC. The Yellow-billed Cuckoo, a sensitive species because of its population declines in parts of the West (Breeding Bird Survey, see Peterjohn et al. 1995), was captured only at BNWR. The weekend banding program at RGNC operated by Rio Grande Bird Research Inc. since 1979 has not captured any Yellow-billed Cuckoos since 1990. This species generally nests in lowland deciduous woodlands, willow and alder thickets, second-growth woodlands, deserted farmlands, and orchards (Johnsgard 1986). We speculate that habitat conditions are more suitable at BNWR for this large, wary species than at RGNC owing to reduced habitat disturbance and recreation by humans.

Although relative abundance data from studies by Hink and Ohmart, Hoffman, and ourselves are qualitative, somewhat subjective, and associated with variations in time, location, efforts, and techniques, nevertheless, the high similarities in species composition and abundance levels between our study and the other two studies suggest that (1) the different investigators were relatively consistent in assigning species abundance levels, (2) relative abundances of many landbird species along the middle Rio Grande have remained relatively stable based on the general abundance levels we assigned, and (3) observed differences among studies in relative abundances of certain species may indicate temporal changes in some populations from 1981-83 (Hink and Ohmart 1984) and 1987-90 (Hoffman 1990) to 1994 (our study).

Brown-crested Flycatcher, a species that was not recorded during the previous two studies was captured during spring and fall migration at

BNWR. BBS data demonstrate that populations of Brown-crested Flycatcher significantly increased 6.7% per year on average from 1980 to 1994 in the West. Throughout the United States, Wild Turkey populations showed a significant yearly increase of 10.5% from 1980 to 1994 (BBS). The Rio Grande race *(M. g. intermedia)* of the Wild Turkey was reintroduced to the BNWR in 1974, and its population has since become well-established in the middle Rio Grande Valley (Peggy Mitchusson, BNWR Wildlife Biologist, personal communication).

In contrast, some species showed consistent population declines based on changes in relative abundance and BBS trends. For example, Hink and Ohmart classified Olive-sided Flycatcher as a common species in the middle Rio Grande, but Hoffman classified it as rare, and we classified it as uncommon. Because the population trend for Olive-sided Flycatcher (based on 320 BBS routes distributed nationwide) shows a declining rate of -3.7% per year from 1980 to 1994, the changes in flycatcher relative abundance between study periods may reflect real decreases along the middle Rio Grande.

Discrepancies in relative abundances between studies were noticed for several uncommon and rare species such as Indigo Bunting, Gray Catbird, and Yellow-breasted Chat. Species that were detected during this study but not by Hink and Ohmart or Hoffman were generally identified as rare or accidental species. Disparities in detection rates could result from use of different counting techniques by the three studies. Very rare species are often only detected during mist-netting operations, a technique we used but Hink/Ohmart and Hoffman did not use. This probably explains why we recorded more species in total during one sampling year than did either of the other two studies over multiple-year periods.

Southwestern Willow Flycatcher is state-listed as endangered in New Mexico, Arizona, and California, and was federally listed as Endangered in 1995 (US Fish and Wildlife Service 1995). Southwestern Willow Flycatcher is a riparian obligate species that nests in cottonwood-willow and similar habitats. This subspecies historically bred south of the Santa Ynez river in southern California, east across Arizona, the extreme southeastern corner of Nevada, southern Utah, possibly southwestern Colorado, throughout New Mexico, and into western Texas (Unitt 1987; Browning 1993). The population decline of this subspecies is apparently due to progressive loss of suitable riparian habitats, especially shrub willow and backwater ponds that supply nesting habitat for the birds, and brood parasitism by the Brown-headed Cowbird (Tibbitts et al. 1994; USFWS 1995). In 1987, Hubbard speculated that only about 100 pairs of Southwestern Willow Flycatchers were left in New Mexico, although recent surveys organized by New Mexico Game and Fish Department report twice that number (Sartor Williams III, personal communication). Earlier and current studies and conservation policies for Southwestern Willow Flycatcher focus primarily on its breeding biology. Given that the species is migratory, using riparian habitats while traveling in spring and fall, we suggest that the persistence of this subspecies could also depend on survival success during annual migration.

Conservation of riparian habitat and migratory landbirds

The population status of neotropical and short-distance migratory landbirds in North America has been the subject of considerable interest, as evidence suggests that many of them are declining and that these declines have accelerated in recent years (Droege and Sauer 1989; Robbins et al. 1989; Teborgh 1989; Askins et al. 1990; Finch 1991). Longterm banding data from Rio Grande Nature Center, New Mexico, suggest that some migratory landbird species that use the Rio Grande corridor such as Western Tanager, Solitary Vireo, Western Wood-Pewee, and Brown Creeper have declined during the last ten years (Wang and Finch unpublished). Riparian habitats provide resources for more species of breeding birds than surrounding uplands (Knopf 1988). The most productive cottonwood stands can have as many as 1,000 pairs or more breeding birds per 100 acres (Carothers et al. 1974). Some avian species that inhabit riparian habitats, such as Willow Flycatcher and Bell's Vireo, are specific in their habitat requirements. Consequently, as riparian habitats decrease in area and/or suitability, so may the abundances of these habitat-specific species (Yong and Finch 1995). Loss of riparian habitats in the Southwest could potentially affect 78 (47%) of approximately 166

avian species that breed in riparian habitats of the region (Johnson et al. 1977).

The conservation of migratory species is complicated by the very life history characteristic that permits these birds to exploit seasonal environments, namely migration (Morse 1980; Terborgh 1989; Finch 1991; Moore and Simons 1992). Declines in populations of neotropical and short-distance migratory species have been attributed to events associated with both breeding and overwintering areas. The rapid rate of deforestation in tropical areas, for example, has been implicated in population declines of many forest-dwelling landbird migrants (Lovejoy 1983; Rappole et al. 1983; Robbins et al. 1989a). Other data point to the importance of changes in suitability of breeding habitats (Whitcomb 1977; Hutto 1988). For example, forest-interior migrants are reported to be especially "area sensitive" (Robbins 1980; Robbins et al. 1989b), which explains, in part at least, why fragmentation of forested breeding habitat has been implicated in loss of migratory birds (Lynch and Whigham 1984; Wilcove 1988).

The persistence of migrant populations depends on the bird's ability to find favorable conditions for survival throughout the annual cycle (Morse 1980). Consequently, problems associated with the en *route* ecology of migrants must factor into anv analysis of population dynamics (Moore and Simons 1992). When migrants stopover, they must adjust their foraging behavior to unfamiliar habitats, resolve conflicting demands of predator avoidance and food acquisition, compete with other migrants and resident birds for limiting resources, respond to unpredictable and sometimes unfavorable weather, and correct for orientation errors (Moore and Simons 1992). These problems are magnified when migrants cross inhospitable environments, such as deserts, and arrive at stopover sites with depleted energy stores, As stopover habitat is transformed, degraded or disappears, the likelihood of solving such problems decreases, the cost of migration increases, and successful migration may therefore be jeopardized (Moore et al. 1993; Moore et al. 1995). Consequently, riparian corridors may provide suitable habitat at an especially critical time for migrating birds.

Research programs are urgently needed to monitor changes in bird populations and habitats during different seasons (Martin and Finch 1995) along the Rio Grande. Traditionally, most research and management pertaining to landbird conservation have focused on the breeding period. The data presented in this study suggest that the migration period is also important for birds. To account for the habitat needs of migrating birds in management and restoration plans, spring and fall use of riparian corridors by landbird migrants should be evaluated. We recommend that studies be designed to characterize the *en route* habitat use by migrants, including daily and seasonal patterns of avian species richness and abundance among habitats.

To effectively conserve migratory landbirds that travel through the Southwest, natural resource managers require basic information on the importance of riparian corridors as stopover habitat. Unfortunately, the composition and extent of floodplain riparian vegetation along the middle Rio Grande has been altered more than any other vegetation type in New Mexico by human-induced hydrological and ecological changes during the last two centuries (Bullard and Wells 1992; Dick-Peddie 1993). Although the Rio Grande riparian habitat appears continuous, in actuality it is interrupted by human residential areas, presence of exotic woody plants, powerlines, bridges, roads, dams and diversion structures, and protected parks and wildlife refuges interspersed with nonprotected stretches used bv livestock and agriculture (Finch et al. 1995). Different types of riparian habitat mav varv in suitability for use by migrating landbirds. Moreover, alteration of particular riparian habitats may reduce or enhance suitability as a stopover area. Migrants need suitable habitat during all periods of their annual cycle, and significant loss or deterioration of habitats that alters patterns of use during any time period could lead to population changes. Thus, responses of landbird migrants to variation in riparian habitats, including human-induced alteration caused by urban encroachment, burning, conversion, draining, and flooding, should be assessed.

In conclusion, we encourage new research to address:

- Whether, how, and why migrants select different riparian habitats;
- How habitat variation affects stopover biology, including foraging behavior, stopover length, and rate of fat (re)deposition; and

- How responses to different habitat types or to habitat changes vary among species.

Further understanding of migrant habitat use of exotic woody plants and seral stages of plant communities is needed to determine what habitats resource managers should manipulate or restore to benefit migrants. Research on migrant use of riparian landscapes is needed to estimate suitable quantities and configurations of habitat types, structural classes, and seral stages to meet the differing needs of multiple species. Inducing regeneration of floodplain vegetation by excluding livestock, planting native species, and introducing flooding will help to mitigate deterioration of riparian habitats and maintain migratory bird populations year-round in this riverine system (Farley et al. 1994). Given the rapid changes in habitat structure and composition of the Rio Grande bosque at the local level (Mount et al. 1996), we recommend that research and conservation be implemented simultaneously and quickly.

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