Avian community composition and habitat importance in the Rio Grande corridor of New Mexico

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Abstract.-We investigated avian species richness and abundance within vegetation communities of the Rio Grande Corridor of New Mexico during spring, summer, and fall 1992 and 1993. A subset of 64 transects, for which all bird and vegetation variables were available, representing 16 composite vegetation community types were subjected to canonical correlation analysis to investigate relative habitat importance. Generally, the higher ranking community types had cottonwood and other native woody species as dominants and the lower ranking communities were those types that are highly manipulated and/or monotypic-such as mowed river edge, pecan orchards, and relatively pure stands of saltcedar. Bird occurrence and distribution in the Rio Grande Corridor is not so neatly related to composition of native vegetation as is sometimes characterized. Exotic plant species such as saltcedar and Russian olive, are utilized to varying degrees by the existing avian community. Ranking of avian use by habitat types may help direct restoration efforts towards situations where more significant gains in avian use can be made.

INTRODUCTION

Concerns about declines in many neotropical migrant (NTM) bird species (Robbins et al. 1989, Finch 1991, and Finch and Stagel 1992) have heightened the interest in conservation, monitoring, and research concerning these species and their habitats. It is important to the management of the Rio Grande Corridor to understand and monitor fauna1 use patterns in the changing mosaic of existing habitats. In New Mexico, these habitats include (1) natural riparian habitats dominated by native Fremont cottonwood (*Populus fremontii* var. *wislizenii*) and/or willow (*Salix* spp.) with differing degrees of exotic saltcedar (*Tamarix chinensis)* and/or Russian olive (*Elaeagnus angustifolia*) encroachment, (2) monotypic stands of exotic saltcedar or Russian olive, (3) marshes primarily dominated by cattail (*Typha* spp.) and hardstem bulrush (*Scirpus acuta*), (4) mowed river edge areas dominated by grasses such as alkali sacaton (*Sporobolus airoides*), (5) active agricultural areas such as pecan (*Carya illinoensis*) orchards and row crops, and (6) manipulated riparian areas associated with agricultural irrigation channels generally dominated by wolfberry (*Lycium* spp.) and fourwing saltbush (*Atriplex cunescens).*

The Rio Grande Valley of New Mexico has undergone a large scale conversion from bosque (riparian woodlands) dominated by Fremont cottonwood and/or native willows to either exotic saltcedar and/or Russian olive dominated stands Wan Cleave 1935, Freehling 1982, Howe and Knopf 1991, Crawford et al. 1993, Ellis 1994) or

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agricultural "habitats" (Crawford et al. 1993). Additionally, the historic Rio Grande watercourse has been extensively dammed and channelized for flood control and to manage agricultural and urban water needs. This alteration has effectively eliminated the seasonal scouring floods needed to promote regeneration of native vegetation (Minckley and Brown 1982, Howe and Knopf 1991). Crawford et al. (1993) thoroughly reviewed and summarized the historic channel and habitat changes that have led to the existing conditions in the Middle Rio Grande of New Mexico. However, in the Rio Grande Valley south of Caballo Reservoir, native riparian vegetation communities have been almost entirely replaced by an intensively managed agricultural environment. Bordering the channelized river is a levee system within which vegetation is strictly controlled. Few remnant patches of riparian vegetation remain.

The importance of natural riparian habitat to the associated avian communities in the southwestern United States has become recognized only in the last two decades (Smith 1975, Johnson and McCormick 1978, DeGraff 1980; Schmitt 1976; Johnson and Jones 1977; Hundertmark 1978; Warner and Hendrix 1984). Breeding birds of southwestern riparian habitats have been categorized according to their dependence upon riparian vegetation (Hubbard 1971, Hubbard and Hayward 1973, Schmitt 1976, Hundertmark 1978). Although these areas comprise a small portion of the landscape, they are recognized as concentrations of high biotic diversity with unique assemblages of flora and fauna. Studies have found that more than 60% of vertebrates found in these systems of the southwest are obligate to them (Ohmart and Anderson 1982). Hubbard (1977) reported 16-17% of the breeding avifauna of North America were found in the Gila and San Juan river valleys of New Mexico with roughly 25% of these species restricted to the riparian habitat. Riparian habitat also provides important resources for birds during spring and fall migration. Stevens et al. (1977) found ten times greater bird density in riparian habitats as opposed to adjacent upland habitats.

A great deal of concern has been raised over the reduction, fragmentation, and degradation of native riparian vegetative communities and the subsequent effects on fauna1 diversity and abundance. In some situations, bird density is increased by the presence of agricultural land adjacent to riparian habitat providing a major food source to certain species (Carothers et al. 1974, Conine et al. 1978, Anderson et al. 1984). Extreme alteration of a riparian system, however, can have negative effects on the native avian community. Species of birds are expected to decline and, perhaps, eventually abandon riparian systems where replacement of native vegetation occurs (Raitt and Delesantro 1980, Hunter et. al. 1987). Conine et al. (1978) found that 21 "riparian species" did not use agricultural habitats in the lower Colorado River Valley. Klebenow and Oakleaf (1984) observed a decrease in species number and species densities in the avian community historically inhabiting a riparian system in Nevada as a result of severe reduction and alteration of native vegetation.

Large scale research projects in the Southwest have investigated avian use of riparian habitat on the lower Colorado River in California and Arizona (Anderson et al. 1977a), lower Rio Grande in Texas (Engel-Wilson and Ohmart 1978), middle Rio Grande in New Mexico (Hink and Ohmart 1984), and Pecos River in New Mexico and Texas (Hunter et al. 1988). Research by Engel-Wilson and Ohmart (1978) on the Rio Grande near Presidio, Texas, differed in most of the vegetative types studied and the fact that cottonwood/willow habitat types were uncommon in their study area. The Middle Rio Grande Biological Survey (MRGBS) conducted by Hink and Ohmart (1984) for the U.S. Army Corps of Engineers was an intensive survey of floral and fauna1 conditions in the middle Rio Grande Valley of New Mexico from Española, Rio Arriba County, to San Acacia, Socorro County, New Mexico, with a core study area from Bernalillo, Sandoval County, to the town of Bosque, Valencia County. Results from the MRGBS have been the primary management reference for federal agencies when addressing biological effects in the bosque of the Rio Grande in New Mexico.

Hink and Ohmart (1984) found 277 species of birds, 239 of which were considered to be in their normal range. This represented approximately 60% of the birds known to occur in New Mexico. Approximately 85 to 95 of these species were suspected to breed in the middle Rio Grande of New Mexico. Species richness values for the MRGBS ranged from a low of 7 to a high of 55 species for selected vegetation Community/Structure (C/S) types per season. Species richness for cottonwood C/S types ranged from 30 to 50 species. Densities estimated by Hink and Ohmart (1984) ranged from 300 to 500 birds/100 acres (40 ha) for cottonwood C/S types and reached highs of up to 1000 birds/ 100 acres (40 ha) during migration for certain C/S types. Other studies of avian use of riparian habitats (including restored sites) in the Rio Grande Valley of New Mexico have been completed (King 1976; Jojola 1977; Cole 1978; Hundertmark 1978; Raitt and Delasantro 1980; Freehling 1982; Hoffman 1990; Ellis 1994; Farley et al. 1994a,b) however, most were limited in geographic area and none represented more than nine vegetation types.

As native cottonwood dominated habitat patches are lost to attrition or through fires and the area occupied by riparian habitats is reduced, large scale habitat restoration efforts will be crucial to maintain any native habitat diversity.. Farley et al. (1994a,b) assessed avian use of different age sites revegetated with native plant species relative to mature woodlands in the Middle Rio Grande Valley. Results showed that revegetated sites were important to NTM species. Avian communities at older sites were most similar to those present in mature woodland.

We investigated the hypothesis that Rio Grande vegetation types represent a gradient of relative importance to NTM birds that can be estimated from correlations of species presence and abundance with vegetation structural features. Objectives involved sampling bird presence and relative abundance among representative vegetation tracts, and performing multivariate analysis of bird detection among vegetation community types. To be useful in conservation decision-making, data were collected and analyzed for all bird species in the corridor; NTM bird occurrence was evaluated in context with the entire assemblage of birds species associated with the corridor when NTM species were present.

STUDY AREA AND METHODS

The study area followed the flood plain of the Rio Grande in New Mexico with the northern boundary 2 to 3 km north of Velarde, Rio Arriba County, at the south end of the Canon del Rio Grande. The southern boundary was located near Mesquite, Doña Ana County, New Mexico. This portion of the Rio Grande was approximately 480 km long with the flood plain varying in width. The study area was divided into five strata approximately representing the surrounding biotic communities described by Brown and Lowe (1980). Biotic communities which the study area passed through include; Great Basin Grassland, Great Basin Conifer Woodland, Plains and Great Basin Grassland, Semidesert Grassland, and Chihuahuan Desertscrub. Stratification of the study area along these boundaries was considered necessary because biotic communities contain different vegetation influences and avian assemblages, thus potentially contributing different species to riparian areas transecting those biotic communities.

Habitat C/S types were determined following Hink and Ohmart (1984) who derived their classification based on Brown et al. (1979) and information from W.A. Dick-Peddie (unpublished report to New Mexico Natural Heritage Program, 1981). A community type is a distinct assemblage of plant species with species ranked as to dominance and codominance within canopy layers. Species composing 50% or more of a canopy layer were considered dominant. Species composing 25 to 50% of a canopy layer were considered codominant. Six basic structure types were determined by ocularly ranking the dominant and codominant overstory, midstory, and understory vegetation species. Structure types I and II both represent mature stands with well developed upper canopies generally of cottonwood. Types I and II were distinguished by the degree of development of the middle and lower vegetation layers. Type I had well developed structure from the ground up while type II was lacking significant middle and lower canopies. Types III and IV were intermediate in size with the two differing in development of the mid and lower canopy layers. Type III had a well developed lower canopy layer while type IV did not. Structure types V and VI were small in size class with little to no middle canopy layer. Type V was typically characterized by a dense lower canopy layer while type VI had all the vegetation in the lower canopy layer but it was sparse. This process defined an individual C/S type description for each transect.

Avian surveys were conducted during breeding (summer) and migration (spring and fall) periods from 1 June 1992 through 30 September 1993; the winter period from mid-October to mid-April was not sampled. Avian surveys essentially followed transect techniques developed by Emlen (1971) with modifications as described by Anderson et al. (1977b) and used by Hink and Ohmart (1984) to facilitate comparability. Data on individual birds detected (audibly and/or visually) included side of the transect where detected and lateral distance from transect line.

Primary bird sampling was conducted on 72,500 m long variable distance transects representing 49 different vegetation C/S types for which vegetation structure was measured in summer 1993. This sampling provided data for analyzing bird richness, relative abundance, and biomass relative to 17 vegetation structure variables. Incidental species observations within the study area were recorded for use in historical comparisons with avian assemblages derived from ornithological literature review.

Analyses included data from 64 transects for which there were data for all variables. These 64 transects represented 49 different C/S types comprising 16 composite types based on community composition and dominance similarities. These multivariate procedures did not allow use of records that lacked data for 1 or more variables.

Variables concerning bird detection and vegetation structure were subjected to canonical correlation analysis (CCA) to evaluate multivariate interrelationships among the variables and for ordination of transects representing different C/S types. CCA is a process that operates on 2 related sets of variables and develops linear combinations of the 2 respective variable sets such that correlation is maximized between the resultant linear combinations. There are as many canonical variates as the number of variables in the smaller set of original variables. The CCA process as applied to these data sets was described in greater detail by Cooley and Lohnes (1971), Smith (1981), and Jongman et al. (1987). CCA was used initially to compute 3 canonical variates derived from the 3 bird detection variables relative to 17 vegetation structure variables. Calculations were performed on standardized variable values to eliminate influences of different magnitudes of scale in the original variables. Redundancy analysis (Cooley and Lohnes 1971) was then performed to examine the degree of relationship of original variables in each set to their respective canonical variate and to the canonical variates calculated for the opposite set. CCA was performed on all avian species and NTM bird species seperately.

Significant canonical variates and canonical scores for vegetation C/S types of individual transects were examined for pattern. Comparable variates that were interpretable relative to composite vegetation community types were used further to select rankings of composite communities. The signed cross-product (cross-products of two negative scores were treated as negatives) was calculated from the bird and vegetation scores for each transect. These cross-products were averaged within composite community types and the signed magnitude of the mean value was used to order the communities relative to anticipated importance to groups of birds.

RESULTS

Field work during both years detected 259 bird species of which 162 species were observed on transects in study tracts. For all bird species observed during our sampling, 147 were NTM species as defined by the Partners in Flight program (Gautheraux 1992). Species richness values varied from 12 to 49 species among the primary transects. There were 30 of the 72 transects (41.7%) that had $\geq$ 35 bird species in composite over all surveys in all seasons. These 30 transects were broadly distributed among vegetation community types, but Russian olive and saltcedar were at least codominant species in 53% of these richest sites and were the dominant species at 20% of the richest sites. Fewer species were detected at monotypic stands of salt cedar. Young stands of cottonwood-willow had low bird richness values but were important recruitment for future riparian woodlands and were important to bird species that prefer early successional stages. Relative avian abundance values varied from 15 to 260 individuals during the breeding season and from 30 to 350 individuals for all seasons combined. The most frequently detected species were black-chinned hummingbird (*Archilochus alexandri*), blue grosbeak (*Guiraca caerulea*), and mourning dove (*Zenaida macroura*), but detections were too few to reliably estimate species densities among transects.

We performed canonical correlation analysis of three bird variables and 17 vegetation structure variables for a subset of 64 primary transects (those having complete bird and vegetation data) representing 49 C/S types and 16 composite vegetation community types. Analyses were applied separately to (1) all bird species and (2) NTM species, for the breeding season and all seasons combined. For all species combined, there were two significant canonical variates each for all seasons and summer only. In each case, the first variate accounted for 65-70% of the variance and related bird biomass inversely to number and size of trees and directly to ground vegetation structure. The second variate for all species accounted for 48-53% of variation and related bird richness and abundance directly to number, size, and species count of small and large trees. For NTM species, there was one significant canonical variate (56-57% of variation accounted) each for all seasons combined and for summer only. Both variates related bird richness and abundance to ground herbaceous structure, tree number, and tree size; however, the summer only variate differed from all seasons in that bird richness and abundance were inversely correlated and presence of large trees had greater influence on bird importance scores in summer (Table 1).

DISCUSSION

There was no single vegetation variable or multivariate construct that definitively placed each transect or C/S category above or below any other site. Ordering of composite vegetation community type importance based on signed cross-products of canonical scores for the 64 transects produced similar rankings for all species and NTM species across seasons and all species in summer, but ranking differed for NTM in summer only (Table 1). Generally, higher ranking composite community types had cottonwood and other native woody species as dominants. Lower ranking communities were those types that are highly manipulated (mowed river edge, pecan orchards) or had extensive composition of salt cedar or other exotic woody species. Some more simply structured vegetation types (i.e., salt cedar-willow-cottonwood) had low bird value in composite but represented sites important to sensitive species and are important as early stages of what should progress into well-developed riparian woodland.

Our analyses provide "point-in-time" relative values of communities evaluated, but should not be interpreted as categorical values applicable to specific sites over a long term. This research also provides a landscape view of ranked vegetation community importance to birds in the Rio Grande Corridor that should be assessed by resource managers for compatibility with priorities for maintaining other elements of nature.

Table 1. Relative ranked importance (1 = highest) for 16 composite community/structure types (based on mean signed cross products of comparable canonical variate scores among transects) for all bird species (ALL) combined and for Neotropical migrant (NTM) bird species during the summer sampling season and for all seasons combined within the Rio Grande Corridor, New Mexico, 1992-1993.

Relative rank[a] community (species)[b,c]	All seasons ALL	All seasons NTM	Summer ALL	Summer NTM
SC	14	16	13	8
C/RO	10	11	8	11
C/(RO-SC)	9	7	10	10
C/(Exotic-WI)	11	9	12	5
(ME-SC)	8	8	11	6
C/(RO-J)	12	13	7	2
C/(NO-etc.)		4	1	3
C/(ME-etc.)	2	5	3	9
(SC-WI-C)	15	14	15	13
RO	5	3	4	14
C	7	10	5	4
C/SC	3	6	2	1
C/(WI-etc.)	4	2	9	12
MARSH	6	1	6	16
MOWED RIVER EDGE	16	15	16	15
PECAN	13	12	14	7

[a] *Rank is based on score cross-products (average among transects within composite categories) for the respective species richness and abundance dominated canonical variates for all species (CV2) and NTM species (CV1). Negative signs were given to cross-products for which one or both canonical scores were negative.*

[b] *C=cottonwood, J=juniper, ME=mesquite, NO=New Mexico olive, RO=Russian olive, SC=saltcedar, SE=Siberian elm, WI=willow*

[c] *Composite C/S types: C/(RO-SC) includes C/RO-SC and C/SC-RO; C/(Exotic-WI) includes C/WI-RO, C/SC- WI, C/WI-SC, C/WI-SE, and C/WI-RO, SC; (ME-SC) includes ME-SC and SC-ME; C/(RO-J) includes C/J and C/RO-J; C/(NO-etc.) includes C/RO-NO, C/NO- WI, and C/NO-SE; C/(ME-etc.) includes C/ME, C/ME-RO, C/ME-SC; (SC- WI-C) includes SC- WI-C, SC- WI, WI-C, and C-WI; C/(WI-etc.) includes C/ WI, C/WI-Marsh, and C/WI-Restored*

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