

Summer Avian Community Composition of Tamarix Habitats in Three Southwestern Desert Riparian Systems¹

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Abstract.--Data from three southwestern river systems were used to assess avian response to salt cedar (Tamarix chinensis). Species were grouped by breeding biology and groups responded differently in their occurrence in salt cedar among the valleys. Biogeographical and climatic factors may explain these differences.

INTRODUCTION

Rapid expansion of exotic salt cedar (Tamarix chinensis) in the arid Southwest has stimulated research on its life history and its effect on fauna and flora of native riparian habitats (Horton 1964, 1977). Serious concern has developed regarding stability of bird communities occurring in affected riparian systems. Loss of native riparian vegetation and subsequent spread of salt cedar generally has been shown to have negative effects on the population sizes of many riparian bird species (Carothers 1977, Cohan et al. 1978).

Reports on the status of bird populations in riparian vegetation along the lower Colorado River indicate lower species richness and total density of birds in salt cedar compared with most native riparian habitats (Anderson and Ohmart 1984a). At least eight bird species on the lower Colorado River were considered common at the turn of the century (Grinnell 1914) but are now approaching extirpation largely because they remain restricted to dwindling native habitat and do not occur in salt cedar habitats (Hunter 1984). Many of these same species, however, are found in stable numbers in salt cedar habitats along the Rio Grande and the Pecos River (Engel-Wilson and Ohmart 1978, Hildebrandt and Ohmart 1982, Hunter et al. in review). These two river valleys form the eastern boundary of the arid Southwest, while the lower

Colorado River is the last major riparian system on the western boundary.

Data from each of the three river systems were analyzed to assess avian response to salt cedar relative to remaining stands of native habitat on the eastern and western boundaries of the arid Southwest. We are concerned here primarily with bird species of which there is documented evidence of serious declines in population size along the lower Colorado River. We limit our comparisons of habitat use to the summer season (May-July), since many of the species suffering serious declines are breeders on the lower Colorado River. In light of the evidence that some of these declining species use salt cedar in river valleys other than the lower Colorado River, we search for general trends in breeding biology, residency status, and general use of native habitats for all breeding species found in at least two of the three valleys we have studied. We propose that biogeographical and associated climatic factors may be responsible for these trends.

METHODS

Description of Vegetation and Study Areas

The lower Colorado River study area extends from Davis Dam on the Arizona-Nevada border to the U.S.-Mexico boundary. Before the middle 1800s, the lower Colorado River was dominated by stands of cottonwoods (Populus fremontii) and willow (Salix gooddingii), with intermittent stands of honey mesquite (Prosopis glandulosa). Screwbean mesquite (P. pubescens) was largely restricted to old backwater areas. Clearing and burning of the native vegetation and water management practices created a void, that was filled by screwbean mesquite and the exotic salt cedar in the early to mid-1900s (Ohmart et al. 1977). Salt cedar is now the numerically dominant riparian tree species along the lower Colorado River covering, in pure stands, 15,688 ha. There remain some large stands of honey mesquite, but these are declining rapidly.

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ly. Pure cottonwood stands, estimated to encompass 2,000 ha in the 1600s, now cover less than 100 ha (Anderson and Ohmart 1984b).

The lower Rio Grande study area extends from Fort Quitman to Presidio, Texas. As on the lower Colorado River, the lower Rio Grande was naturally dominated by cottonwood, willow, and honey mesquite until clearing for agriculture removed almost all of this native vegetation (Engel-Wilson and Ohmart 1978). Presently, only 12 ha of mature cottonwood-willow habitat remain intact. Salt cedar is the dominant phreatophyte on the lower Rio Grande comprising, in a monoculture state, at least 64% (5,600 ha) of the total vegetation (Engel-Wilson and Ohmart 1978).

The middle Pecos River study area extends from Fort Sumner, New Mexico to Pecos, Texas. Historical accounts dating back to the 1600s indicate that the middle Pecos River valley was devoid of mature riparian vegetation except for isolated cottonwood bosques near Roswell and Fort Sumner, New Mexico (Hildebrandt and Ohmart 1982). Honey mesquite is found throughout the valley, but highly structured stands only occur in the southern third of the study area. Presently, salt cedar is the principal riparian tree along the Pecos River, encompassing 22,800 ha in New Mexico, and 87,200 ha in Texas (Pecos River Basin Water Salvage Project 1979).

Data Collection

Bird censusing was conducted in all major riparian plant communities following a modified Ealen (1971) variable-distance line transect technique (Anderson and Ohmart 1984). Each of the transects (100 along the Colorado River, 21 along the Rio Grande, and 30 along the Pecos River) was censused three times monthly. Densities were calculated for the summer season (nine censuses for each transect) and expressed as birds/40 ha. Transects were classified into plant community-structure types. Plant communities were identified by the dominant tree species and included cottonwood-willow, honey mesquite, screwbean mesquite (lower Colorado River only), and salt cedar. Structure types were defined by the proportion of total foliage density at each of three vertical layers.

All data were collected by personnel trained by the lower Colorado River field laboratory, which allowed for direct comparison of data among valleys. Data are for four summers from the lower Colorado River (1977-80), one summer from the Rio Grande (1977), and one summer from the Pecos River (1980). Details concerning these and other field techniques employed are presented in Anderson and Ohmart (1984a).

Analysis

Bird species were grouped into three main categories based on their peak breeding period. These groups were (1) migratory midsummer breeders, (2) migratory spring and early-summer breeders, and (3) resident spring and early-summer breeders. These criteria were judged by our field

observations and supported by life-history data (Bent 1964, Phillips et al. 1964, Anderson and Ohmart 1984a).

Two lines of analysis were followed after classifying birds into the above categories. The first was to determine the proportion of bird density per unit area in each major plant community among the three river valleys. This was found by equally weighting, by area, each plant community and calculating the percentage of birds that would be found from density estimates. These proportions do not reflect the distribution of individuals among the present distribution of plant communities, but rather they refer to the relative importance of each plant community to bird abundance in each river valley. This allows for direct comparison of the relative importance of salt cedar to bird species in each river valley in relation to available native habitats.

The above approach does not take into account differences in structure type for each community in each river valley. Since there were differences in the amount and kind of structure types found in each valley, a second line of analysis was needed. Due to limitations in space, we present only data for the salt cedar habitats found in each valley. We combined salt cedar transects to stress the average height of the canopy layer in terms of >4.5 m, 0.6-4.5 m, and 0.0-0.6 m. The Rio Grande lacks salt cedar with the peak canopy layer <0.6 m; whereas the Pecos River lacks salt cedar with a canopy height >4.5 m. However, all river valleys have salt cedar with canopy heights between 0.6 and 4.5 m (this is the most often encountered type of salt cedar along other southwestern riparian systems).

Bird densities per month were transformed by taking $\log_{10} n + 1$ of the density and averaged from transects for salt cedar with 0.0-0.6 m, 0.6-4.5 m, and >4.5 m peak canopy heights both within and among river systems. Duncan's Multiple Range test for variable log of abundance (Zar 1974) was applied to arrange and separate or group salt cedar habitats with an $\alpha=0.05$ for each bird species. In this way, we could determine the relative importance of average canopy height of salt cedar stands as well as differences among river valleys in the actual densities of birds in salt cedar.

RESULTS

Use of Salt Cedar Within Valleys

Seven species occurring in at least two of the studied valleys were determined to be midsummer migratory breeders. All of these species arrive in large numbers no earlier than April with the latest species to arrive, the Yellow-billed Cuckoo (*Coccyzus americanus*), appearing by early June. All of these species are open-cup nesters, and all leave the breeding areas by September. Six of the seven midsummer migratory breeders are found on the Colorado River and five show a clear preference for the cottonwood-willow community on this river system (table 1). Two species, the Western

Table 1.--Proportion of bird populations in plant community types on the lower Colorado River, middle Pecos River, and lower Rio Grande, scaled within valleys. A clear preference for a community is indicated by underlining. A species absence from a river valley is indicated by a dash. CW = Cottonwood-willow; SC = salt cedar; HM = honey mesquite, SM = screwbean mesquite.

Breeding category/species	Time of residency	Proportion of population per unit area									
		Colorado				Pecos			Rio Grande		
		CW	SC	HM	SM	CW	SC	HM	CW	SC	HM
MIDSUMMER MIGRATORY											
Yellow-billed Cuckoo	Jun-Aug	<u>68</u>	2	20	10	53	45	2	54	9	37
Western Kingbird (<u>Tyrannus verticalis</u>)	Apr-Sep	<u>60</u>	27	6	7	<u>67</u>	18	15	34	0	<u>66</u>
Bell Vireo (<u>Vireo bellii</u>)	Apr-Sep	<u>67</u>	0	33	0	--	--	--	15	37	48
Yellow-breasted Chat (<u>Icteria virens</u>)	May-Aug	<u>84</u>	8	2	6	42	58	0	51	35	14
Summer Tanager (<u>Piranga rubra</u>)	May-Sep	<u>98</u>	2	0	0	<u>87</u>	13	0	28	39	33
Blue Grosbeak (<u>Guiraca caerulea</u>)	May-Sep	42	30	4	24	41	55	4	43	23	34
Painted Bunting (<u>Passerina ciris</u>)	May-Sep	--	--	--	--	0	<u>82</u>	18	47	28	25
SPRING AND EARLY SUMMER MIGRATORY											
Ash-throated Flycatcher (<u>Myiarchus cinerascens</u>)	Mar-Oct	21	13	35	31	<u>72</u>	11	17	10	44	46
Lucy Warbler (<u>Vermivora luciae</u>)	Mar-Jul	15	27	33	25	--	--	--	11	49	40
Brown-headed Cowbird (<u>Molothrus ater</u>)	Mar-Jul	33	26	14	27	22	<u>65</u>	13	<u>55</u>	28	17
Northern Oriole (<u>Icterus galbula</u>)	Mar-Jul	47	12	22	19	<u>71</u>	26	3	40	20	40
SPRING AND EARLY SUMMER RESIDENTS											
Greater Roadrunner (<u>Geococcyx californianus</u>)	Permanent	17	26	30	27	8	<u>75</u>	17	16	12	<u>72</u>
Ladder-backed Woodpecker (<u>Picoides scalaris</u>)	Permanent	47	7	20	26	<u>80</u>	13	7	46	31	23
Verdin (<u>Auriparus flaviceps</u>)	Permanent	23	14	31	32	0	0	<u>100</u>	4	9	<u>87</u>
Cactus Wren (<u>Campylorhynchus brunneicapillus</u>)	Permanent	26	6	<u>58</u>	10	0	0	<u>100</u>	0	0	<u>100</u>
Black-tailed Gnatcatcher (<u>Polioptila melanura</u>)	Permanent	10	16	39	35	--	--	--	0	5	<u>95</u>
Northern Mockingbird (<u>Mimus polyglottos</u>)	Permanent	<u>52</u>	13	22	13	56	34	10	20	16	<u>64</u>
Crissal Thrasher (<u>Toxostoma crissale</u>)	Permanent	19	18	<u>44</u>	19	7	<u>64</u>	29	0	13	<u>87</u>
Pyrrhuloxia (<u>Cardinalis sinuatus</u>)	Permanent	--	--	--	--	0	18	<u>82</u>	0	0	<u>100</u>

Kingbird and Blue Grosbeak occur in the salt cedar community to some extent, but the other species are largely absent from salt cedar. In contrast, these same species on the Rio Grande and Pecos River occur in greater proportions in salt cedar compared with native plant communities, with the exception of the Western Kingbird. Only two of six species show clear preferences for cottonwood-willow on the Pecos River. The migratory midsummer breeding species are not as restricted to the cottonwood-willow community on the Pecos River and Rio Grande as they are on the Colorado River.

Four species were classified as migratory spring and early summer breeders. These species arrive by late March and all but the Ash-throated Flycatcher leave the breeding areas by July. The Brown-headed Cowbird is a nest parasite and does not build its own nest. The other three species have protective nests placed in tree cavities or constructed to conceal the eggs. No clear preference patterns exist in any plant community for any river valley in this category (table 1). The salt cedar community is not avoided in any of the river valleys by any of these species.

Eight species were classified as resident spring and early summer breeders. At least four species begin breeding activities by mid-February. Many of these species produce multiple broods with the last young fledging by July. Five of the eight species build open-cup nests, two build covered nests, and one uses cavities for nesting. Seven of eight species are restricted to the honey mesquite community on the Rio Grande, with only the Ladder-backed Woodpecker showing higher proportional occurrence in the cottonwood-willow community (table 1). The Ladder-backed Woodpecker is the only species in this category to occur consistently in higher proportions in the cottonwood-willow community in each river valley. This probably relates to easier excavation of cavities in cottonwoods and willows, compared with honey mesquite and salt cedar. The Greater Roadrunner and Crissal Thrasher show very high proportional use of salt cedar on the Pecos River in contrast to their use of this plant community on the Rio Grande and Colorado River. The Verdin, Cactus Wren, and Black-tailed Gnatcatcher show stronger restriction to honey mesquite on the Rio Grande and/or Pecos River, on the Southwest's eastern riparian systems, than they do on the Colorado River, which represents the most western riparian system.

Use of Salt Cedar Among Valleys

Proportion of bird densities per unit area in each plant community reported above does not take into account differences in structure types found on each river system. Below we present results and trends found in bird occurrence in salt cedar in relation to the average canopy height layer in each river valley.

We report first on the average canopy layer between 0.6-4.5 m since it was found in each river valley. Four migratory midsummer breeding insectivores have significantly higher densities in salt cedar on the Rio Grande with an additional three

species on the Pecos River at this canopy height ($P < 0.05$, table 2). Two species in this breeding category, Blue Grosbeak and Western Kingbird, occurred in as high or higher density on the Colorado River than found on the Pecos River and the Rio Grande, respectively. Three of four migratory spring and early-summer breeders were found to have significantly higher densities on the Colorado River; only the Brown-headed Cowbird was not found to differ in density among the three river valleys. Four of seven resident spring and early-summer breeders occurring on the lower Colorado River were found in significantly higher densities there. Greater Roadrunner and Ladder-backed Woodpecker densities were high on the Colorado but were not different from the Pecos River and Rio Grande, respectively. For both the second and third breeding categories, only Northern Mockingbird occurred in significantly lower densities on the Colorado River than found in the other two river systems. In summary, five of six species of migratory mid-summer breeders have significantly lower densities on the Colorado River when compared with the Rio Grande and/or Pecos River; whereas, nine of 11 spring and early-summer breeding species occurring on the Colorado River were found in significantly lower densities on the Rio Grande and/or Pecos River.

In salt cedar with average canopy heights >4.5 m, four of seven migratory midsummer breeding species have significantly higher densities on the Rio Grande than on the Colorado River. Two species, Western Kingbird and Blue Grosbeak, have significantly higher densities on the Colorado River. Only one of 11 spring and early-summer breeders (including both migratory and resident) on the Colorado River was found in significantly lower densities than on the Rio Grande.

Salt cedar with average canopy height 0.0-0.6 m has three of five migratory midsummer breeders, mutually occurring on both the Pecos and Colorado rivers, with significantly higher densities on the Pecos River. All migratory midsummer breeders have lower densities on the Colorado River. The Northern Mockingbird was, as at the other two canopy heights, the only spring and early-summer breeder to be found in significantly lower densities on the Colorado River.

DISCUSSION

Comparing Salt Cedar Use Among Valleys

No species was found to use salt cedar among valleys consistently, in relation to structure type or in use of native plant communities. The Ladder-backed Woodpecker, Blue Grosbeak, and Brown-headed Cowbird were species in which reasonable predictions could be made on use of salt cedar in all river systems from knowledge of only one river system. Therefore, applying data from one river system for use of salt cedar will lead to serious errors in management on other river systems for most riparian bird species.

Data on Bell Vireos can be used as a possible source for such errors. The Bell Vireo on the

Table 2.--Relative use of salt cedar at three levels of canopy height by birds on the lower Colorado River (CR), lower Rio Grande (RG), and middle Pecos River (PR). Bird densities transformed to $\log_{10}n+1/40$ ha. Significant values are derived from Duncan's Multiple Range Test for variable logs of abundance (Ott 1977), $\alpha = 0.05$. A species absence from a river valley is indicated by a dash.

Breeding category/ species	Bird density in canopy layer height levels						
	0.6-4.5 m			≥ 4.5 m		0.0-0.6 m	
	CR	RG	PR	CR	RG	CR	PR
MIDSUMMER MIGRATORY							
Yellow-billed Cuckoo	0.000	0.301	0.975 ^a	0.000	0.301 ^a	0.000	0.418 ^a
Western Kingbird	0.560	0.000	0.877 ^a	0.861 ^a	0.000	0.360	1.133 ^a
Bell Vireo	0.000	1.148 ^a	-	0.000	0.736 ^a	0.000	-
Yellow-breasted Chat	0.634	1.860 ^a	0.911 ^b	0.301	1.743 ^a	0.000	0.000
Summer Tanager	0.000	1.108 ^a	0.301	0.810	1.450 ^a	0.000	0.259
Blue Grosbeak	1.260 ^a	1.048	1.377 ^a	1.026 ^a	0.715	0.901	1.085
Painted Bunting	-	1.233 ^a	0.783	-	1.038	-	0.000
SPRING AND EARLY SUMMER MIGRATORY							
Ash-throated Flycatcher	0.810 ^a	0.602	0.360	0.885 ^a	0.259	0.699 ^a	0.418
Lucy Warbler	1.457 ^a	0.983	-	1.967 ^a	0.703	1.002	-
Northern Oriole	1.203 ^a	0.301	0.641 ^b	1.012 ^a	0.301	0.661	0.761
Brown-headed Cowbird	1.513	1.437	1.373	1.363	1.397	1.227	1.170
SPRING AND EARLY SUMMER RESIDENT							
Greater Roadrunner	0.634 ^a	0.100	0.774 ^a	0.502 ^a	0.100	0.519	0.735
Ladder-backed Woodpecker	0.634 ^a	0.593 ^a	0.301	0.593 ^a	0.201	0.360	0.201
Verdin	0.950 ^a	0.534 ^b	0.000	1.171 ^a	0.000	0.952 ^a	0.000
Cactus Wren	0.492 ^a	0.000	0.000	0.301 ^a	0.000	0.418 ^a	0.000
Black-tailed Gnatcatcher	0.816 ^a	0.359	-	0.725 ^a	0.000	0.842	-
Crissal Thrasher	0.752 ^a	0.233 ^b	0.579 ^b	0.560 ^a	0.100	0.678	0.667
Northern Mockingbird	0.201	0.560 ^b	1.533 ^a	0.201	0.761 ^a	0.301	1.390 ^a
Pyrrhuloxia	-	0.301	0.259	-	0.159	-	0.301

^aDenotes significantly higher abundance compared with same canopy height level in other river valleys.

^bAbundance significantly lower than ^a but significantly higher than the remaining river valley.

lower Colorado River is nearly extirpated as a breeding species; although, at the turn of the century it was listed by Grinnell (1914) as among the most characteristic birds in the willow-cottonwood association. This species fails to use pure salt cedar stands on the lower Colorado River but still occurs and breeds rarely in salt cedar mixed with honey mesquite as well as remaining cottonwood-willow stands. On the Rio Grande, this species occurs in high densities and uses pure salt cedar. Therefore, it has remained common in this river valley. In addition, Bell Vireos are spreading in the Grand Canyon coincidental to the spread of salt cedar along the Colorado River

(Brown et al. 1983); however, salt cedar in this area forms a narrow band adjacent to the mesquite belt which is similar to salt cedar-honey mesquite mix habitats where we find Bell Vireos on the lower portion of the river. If we wanted to manage for Bell Vireos on the lower Colorado River based on Rio Grande or Grand Canyon data, we would show that salt cedar is acceptable to this species and might recommend that salt cedar not be cleared, in fact, we might encourage its proliferation. Given the present Bell Vireo density in pure salt cedar habitats on the lower Colorado River (0/40 ha), this would be a serious mistake. The same can be said for Summer Tanagers based on Rio

de data and Yellow-billed Cuckoos from Pecos
er data. All three of these species are in
ous danger of extirpation from the lower
Grado River.

Colorado River data alone would indicate that
majority of birds do not use salt cedar in
proportions compared with native plant com-
munities. Thus, we might recommend that clearing
cedar from other river valleys would not seri-
ly impact riparian bird populations. However,
many species on the Rio Grande and Pecos
there would be serious impacts if native
communities were not restored where salt
cedar was to be cleared. The important point here
that each river valley should be surveyed for
range of riparian habitats available and how
bird species responds to each habitat; rely-
on data from geographically distant river sys-
or even different portions of the same river
them are unacceptable options.

Biogeographical Considerations

Few patterns in bird occurrence in salt cedar
st if the three river systems are considered
arately. Two patterns that do exist are (1)
atory midsummer breeding species are largely
stricted to cottonwood-willow and avoid salt
ar on the Colorado River and (2) resident
ing and early-summer residents are restricted
oney mesquite and avoid salt cedar on the Rio
nde. Since the Pecos River is a major tribu-
y to the Rio Grande and these rivers together
the easternmost riparian zones in the arid
thwest, we contrast data from these two rivers
data from the lower Colorado River. Several
ditional patterns emerge representing the entire
d Southwest by comparing eastern and western
ndaries.

Species that are migratory midsummer breeders
the lower Colorado River may be associated with
ure broadleaf riparian forests because they
not tolerate lower-statured salt cedar or other
riparian habitats (i.e., honey mesquite and open
ands of cottonwood-willow) that do not provide a
tilayered foliage cover to protect these
pecies (and/or their eggs and young) from thermal
tress. In fact, all bird species that occur
ensively in salt cedar on the lower Colorado
er during summer (beside doves; see Walsberg
Voss-Roberts 1983) begin nesting early in the
ar (March through June) and/or have covered
ats. Elevational gradient lowers from east to
t, and in the arid Southwest average summer
peratures become higher so that the lower Colo-
o River represents the extreme summer environ-
nt.

Migratory and resident spring and early-summer
eeding species show a trend of declining use of
cedar from west to east. Many of these
pecies occur in salt cedar and other plant com-
munities on the lower Colorado River but become
re and restricted to honey mesquite on the Rio
Grande and Pecos River. These species are primar-
ly Sonoran and Chihuahuan desert species. Cold
inters in western Texas and eastern New Mexico

may not allow the permanent resident species to
spread into alternative riparian habitats such as
salt cedar and survive to breed the next year. As
one proceeds from west to east winters become more
severe, but where winters are less severe (as on
the Colorado River) and, at least during some
years, when food resources remain high, individ-
uals forced into "suboptimal" habitats may survive
to breed the next year (Anderson et al. 1982).

These data suggest that environmental
extremes, such as seasonal temperature, may be
important in a species' ability to use all avail-
able habitats. We are observing groups of species
with similar habitat preferences and with similar
breeding biology becoming restricted in the same
way in their use of habitats. The response to
salt cedar may be linked to the abilities of these
species to cope with extreme physiological condi-
tions and not only to the presence or absence of
interspecific competition for limited nesting
space or food resources (Carothers et al. 1974).
Data on relative insulation properties of salt
cedar, insect biomass, and relative bird use of
salt cedar along an east-west gradient are needed
to help clarify these points. The Gila River, in
Arizona, presently is under study to investigate
further the trends presented here.

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