State of California
THE RESOURCES AGENCY
Department of Fish and Game

STATUS OF NINE BIRD SPECIES OF SPECIAL CONCERN ALONG THE COLORADO RIVER 1/

by

William C. Hunter 2/
Center for Environmental Studies
Department of Zoology
Arizona State University

ABSTRACT

The population status and distribution of nine species of birds occurring in riparian vegetation on the lower Colorado River in California were determined through field surveys and analysis of available population data, the habitat requirements of individual species and currently available habitat. All species had been listed previously by the Department as species of special concern. Five species (Gila Woodpecker, Gilded Northern Flicker, Vermilion Flycatcher, Sonoran Yellow Warbler, Summer Tanager) are in serious danger of extirpation from California and should be given Endangered status. Seven species including Gila Woodpecker, Gilded Northern Flicker, Vermilion Flycatcher, Brown-crested Flycatcher, Sonoran Yellow Warbler, Yellow-breasted Chat, and Summer Tanager are largely dependent on cottonwood-willow habitat. At least 10 species (including three species not treated here) constitute an entire bird community that potentially will be lost because of the continued reduction of the remnant mature cottonwood-willow habitat. The only practical way to retain and attract viable populations of these bird species in California is to restore cottonwood-willow habitat by revegetating suitable areas.

1/ Supported by Federal Aid in Wildlife Restoration, Project W-65-R-1 (554), Nongame Wildlife Investigations, Wildlife Management Branch Administrative Report No. 84-2 (December 1984).

2/ Under the direction of Dr. E. Lee Fitzhugh, Wildlife Extension, University of California, Davis.

RECOMMENDATIONS

1. Preserve currently existing cottonwood-willow and mesquite habitats through direct land purchase or conservation easements. The Soto Ranch is a prime example for this action.

2. Support large-scale ($\geq$20 ha, $\geq$50 acres) revegetation efforts to restore cottonwood-willow and mesquite habitat types.

3. Implement the recommendation outlined by Remsen (1978; 11) on acquiring land for revegetation with native plants and include artificial snags for cavity nesting species.

4. Initiate land stewardship and education programs to involve and assist private land owners--including farmers, ranchers and resort owners--and recreation-oriented government agencies in the maintenance and revegetation of native riparian species for wildlife.

5. List the Gila Woodpecker, Gilded Northern Flicker, Vermilion Flycatcher, Sonoran Yellow Warbler and Summer Tanager as “endangered” birds under the California Endangered Species Act.

6. List the Brown-crested Flycatcher, Yellow-breasted Chat, and Northern Cardinal as “threatened” under the California Endangered Species Act.

7. Continue monitoring the status of the Crissal Thrasher.

8. Work with the Bureau of Reclamation to investigate the effects of the 1983 flooding on critical habitat types and the bird species associated with those habitats.

9. Survey the Imperial Division (which was not surveyed in this study due to the 1983 flood) for those bird species considered in this report, plus Elf Owl, Yellow-billed Cuckoo, and Arizona Bell’s Vireo.

10. Investigate the effects of nest-hole competition by European Starlings and nest parasitism by Brown-headed Cowbirds, and determine if they are actually responsible for population declines independent of, or in addition to, the loss of habitat.

11. Further investigate the habitat relationships and reproductive success of the Summer Tanager in athel tamarisk.

INTRODUCTION

During the twentieth century, the distribution and abundance of native birds along the lower Colorado River (Figure 1) have changed extensively. Grinnell (1914) and others explored the lower Colorado River and documented the distribution and habitat relationships for many bird species. This has provided a base from which we may compare the present status of a number of bird species. Recent surveys (Cardiff 1978; Gaines 1977a, 1977b; Remsen 1978; Serena 1981a, 1981b) defined the present distribution and abundance of many bird species considered by California as being Endangered, Rare, or of special concern and which occur along the California side of the lower Colorado River. Habitat requirements and reasons for population declines for many of these species have been suggested based upon many hours of observation; however, analysis of quantitative data has been lacking.

In 1972, Dr. Robert D. Ohmart of Arizona State University, was awarded a contract from the Bureau of Reclamation to identify and map the types of vegetation present and determine the densities and diversities of wildlife associated with each type along the lower Colorado River. In 1973, Dr. Bertin W. Anderson assumed responsibility for developing and directing the project. Under the leadership of Anderson and Ohmart, this project has gathered the largest data base in the continental United States to determine avian use of native, non-native, and revegetated habitats. Only from such a large data base may habitat requirements be assessed for species considered to be rare. In 1983, the University of California, Davis, was awarded a contract by California Department of Fish and Game to cooperate with Drs. Anderson and Ohmart in defining the distribution, abundance, and habitat requirements of the Gila Woodpecker (Melanerpes uropygialis), Gilded Northern Flicker (Colaptes auratus chrysoides), Vermilion Flycatcher (Pyrocephalus rubinus), Brown-crested Flycatcher (Myiarchus tyrannulus), Crissal Thrasher (Toxostoma dorsale), Sonoran Yellow Warbler (Dendroica petechia sonorana), Yellow-breasted Chat (Icteria virens), Summer Tanager (Piranga rubra), and Northern Cardinal (Cardinalis cardinalis) along the California side of the lower Colorado River.

The species named above are considered by the California Department of Fish and Game to be Bird Species of Special Concern (Remsen 1978). This category, which provides no special state or federal protection, has been developed for species whose status is unknown or that soon may be faced with extirpation in California. The information gathered in this study was used in determining habitat requirements for each species on the Colorado River, the amount of habitat existing on the California side, and the occurrence of and use by each bird species in the habitats found in California. From this, management recommendations to perpetuate viable populations of these species are outlined.

History

Vegetation

A complete literature search on past and present biotic communities of the lower Colorado River has been submitted by Dr. Robert D. Ohmart and is presently under review by the Bureau of Reclamation. In almost every account, dating from the 1600's to the early 1900's the lower Colorado River was described as being bordered by large forests of cottonwood (Populus fremontii) and willow (Salix goodingii) with intermittent bosques (riparian forests) of honey mesquite (Prosopis glandulosa). The water flow of the river itself was very calm during the winter, but almost yearly during late spring and early summer the flows increased to a raging torrent fed by melting snow in the Rocky Mountains. These floods scoured many areas and often destroyed large tracts of cottonwood-willow forest, but they also prepared seedbeds for future plant regeneration. The annual late spring or early summer floods usually were of short duration (two weeks to a month) and resulted in what may be considered a healthy renewal of vegetation. Grinnell (1914:58-61) gave very good accounts of how the flooding affected vegetation along the Colorado:

> ...The flow of the river varies from 4,000 to 100,000 cubic feet per second. The time...of highest flood, in June, [is] at the time of melting snow among the sources of the Colorado River, in the Rocky Mountains...
>
> ...The only trees capable of thriving on the unstable portion of the flood-bottom are such as grow rapidly, willows and cottonwood...
>
> ...It is noteworthy that this aggressive work of the river is much more conspicuous on the west side of each valley than on the east side. The law of westward cutting of north-and-south flowing streams in the northern hemisphere, as brought about by the earth's rotation, is thus clearly illustrated in the Needles-to-Yuma section of the Colorado River.

The extensive mesquite bosques were situated on the second terrace above the flood channel itself. As Grinnell (1914) reported, honey mesquite is very intolerant to flooding, being more xeric in its requirements than other riparian plant species. From the accounts, screwbean mesquite (Prosopis pubescens) is thought to have expanded its distribution during the past 40 years along the lower Colorado River (Ohmart pers. comm.). Historically, screwbean mesquite was found mixed with willow and quailbrush (Atriplex lentiformis) between the first and second terraces (Grinnell 1914). Marshes primarily were found from the confluence of the Gila River south to the Gulf of California. Grinnell (1914) reported marshes as few and of small size with the reed (Phragmites australis) growing in dense patches from Picacho south. Other riparian vegetation associations described by Grinnell (1914) included arrowweed (Tesseria sericea), quailbrush, and saltbush (Atriplex canescens).

Changes in the vegetation due to logging for fuel, flooding by dams, and clearing for agriculture, began to take its toll on existing vegetation. The first dam along the river was at Laguna and was completed in 1909. Its purpose was to provide water for irrigation. Grinnell (1914) reported that all the trees within 13 km (8 miles) above the dam had been drowned by 1910 and were replaced by mud flats where arrowweed was growing. Below the dam there was a deepening of the channel and the former flood-bottan was far above flood level. Hoover Dam was completed in 1935. Its completion ended the late spring flooding. With the completion of Davis, Parker, and Imperial Dams, control of the Colorado River was complete and allowed more of the riparian resources to be used by man.

The invasion of salt cedar (Tamarix chinensis) from the Gila River occurred between 1910 and 1920, Salt cedar spread rapidly into areas where native vegetation had been logged or cleared (Horton 1977; Horton, Mourts and Kraft 1960; Ohmart, Deason and Burke 1977). Salt cedar became the dominant plant along the river by being salt, fire, and flood tolerant. Native plant species were susceptible to damage due to changes in salinity levels, fires, and flooding and were not able to regenerate at the same rate as salt cedar. The lack of late spring floods restricted much of the regeneration of native plants since cottonwood and willow produce seeds only in spring. Seeds of native vegetation need receding flood waters for germination. Salt cedar though, produces seeds through to fall and, therefore, had a better chance of germinating. By the 1940's salt cedar became the dominant plant species in many areas along the Colorado River. Also, silt beds which formed above dams were often vegetated by species associated with marshes, primarily cattail (Typha domingensis) and bulrush (Scirpus spp.) The marshes currently found in the Imperial and Topock Divisions received their foothold during the 1940's.

The Colorado River now supports few unaltered stands of vegetation. Almost all stands of mesquite, cottonwood, and willows have at least some salt cedar associated with them. The creation of reservoirs has engulfed many riparian stands (Phillips, Marshall and Monson 1964). Where one now sees agricultural fields from terrace to terrace, as in the Palo Verde Valley (approximate width, 13-16 kms; 10 miles), extensive riparian forests once stood. Ohmart et al. (1977) estimated that there were 2000 ha (5,000 acres) of cottonwood dominated stands in the 1600's, whereas today there are less than 80 ha (200 acres). Marsh vegetation has become dominant in constantly flooded areas which historically would have produced seedbeds for the regeneration of willows and cottonwoods.

Avifauna

The majority of ornithologists visited the lower Colorado River Valley before dam construction. Cooper (1869, 1870) concentrated his efforts in the vicinity of Ft. Mojave (near Needles) while Mearns (1894) worked from Ft. Yuma to the Gulf of California. Our best source of ornithological data comes from Grinnell (1914) whose party systematically observed and collected birds and mammals between Needles to Yuma. Swarth (1914), Brown (1903), and others also added details on relative bird abundance and occurrence.

Since Grinnell's time very little has been published on ornithological studies along the lower Colorado. The best source of bird data while the river valley was undergoing extensive vegetational change comes from Monson (1949, pers. field notes from 1943-1960) who served as refuge manager at Havasu and Imperial National Wildlife Refuges. Many of Monson's field notes were reported in Phillips et al. (1964). Present understanding of bird-vegetation relationships and bird occurrence in the valley is primarily due to the long-term ongoing Anderson and Ohmart studies, Additional observations by field ornithologists during the last decade (Garrett and Dunn 1981; Rosenberg et al. in prep) have greatly enriched our knowledge of bird life throughout the valley.

METHODS

General Procedures

Although this report discusses habitat use by birds on the California side of the river, the analyses are for the lower Colorado River as a whole. Therefore, data from Arizona and Nevada were used in addition to the California data for assessing habitat use by birds in the Colorado River Valley. Important vegetation types that presently occur in Arizona were included in this assessment. This is important information to include, especially if these habitats existed historically in California.

From data analyses, we defined habitats that were used by each bird species for which adequate data existed. Then we determined what characteristics within the habitats were correlated with the population density of each species. Next, we identified which California habitats had the characteristics needed for each species. Then we determined the acreage for each habitat type along the lower Colorado River in California. Most habitats were surveyed monthly for the presence and use by each bird species. Notes were taken on nesting success, length of stay, and interactions within these habitats. Also, potential and actual problems that the birds were encountering, including the presence of European Starlings (Sturnus vulgaris) and Brown-headed Cowbirds (Molothrus ater), were noted.

Data Collection

Vegetation

Data were collected in riparian vegetation by Anderson and Ohmart (Vegetation Management report in review) from Davis Dam on the Arizona-Nevada border to the Mexican-U.S. border (Figure 1). Riparian plant communities were classified into six vegetation types based on dominant tree species (Table 1). Vegetation types included cottonwood-willow, honey mesquite, screwbean mesquite, salt cedar (including athel tamarix, T. aphylla), salt cedar-honey mesquite mix, and arrowweed. These vegetation types were divided into six structural types based on the vertical distribution of the foliage, with structural type I being the tallest (Table 2, Figures 2 and 3). Remaining structural types have progressively less foliage density in the upper layers above 6 m). Among 36 possible types, 23 occurred in the valley (Anderson and Ohmart 1976, 1984); these differed from each other by the dominant vegetation present, by vertical configuration, or by both.

All stands of riparian vegetation were classified and located on the maps prepared by the Bureau of Reclamation (Anderson and Ohmart 1984). Most stands were classified by Anderson and Ohmart in 1976 with the 1983 set serving as an update on vegetational changes which occurred during the intervening years. Photographs of the river valley were used for the update and field checks on specific stands were conducted when necessary. For further details on classifying riparian vegetation and the potential use of this material to wildlife managers, see Anderson and Ohmart (1977a, 1984), Anderson, Ohmart and Rice (1983), and Meents, Anderson and Ohmart (1981).

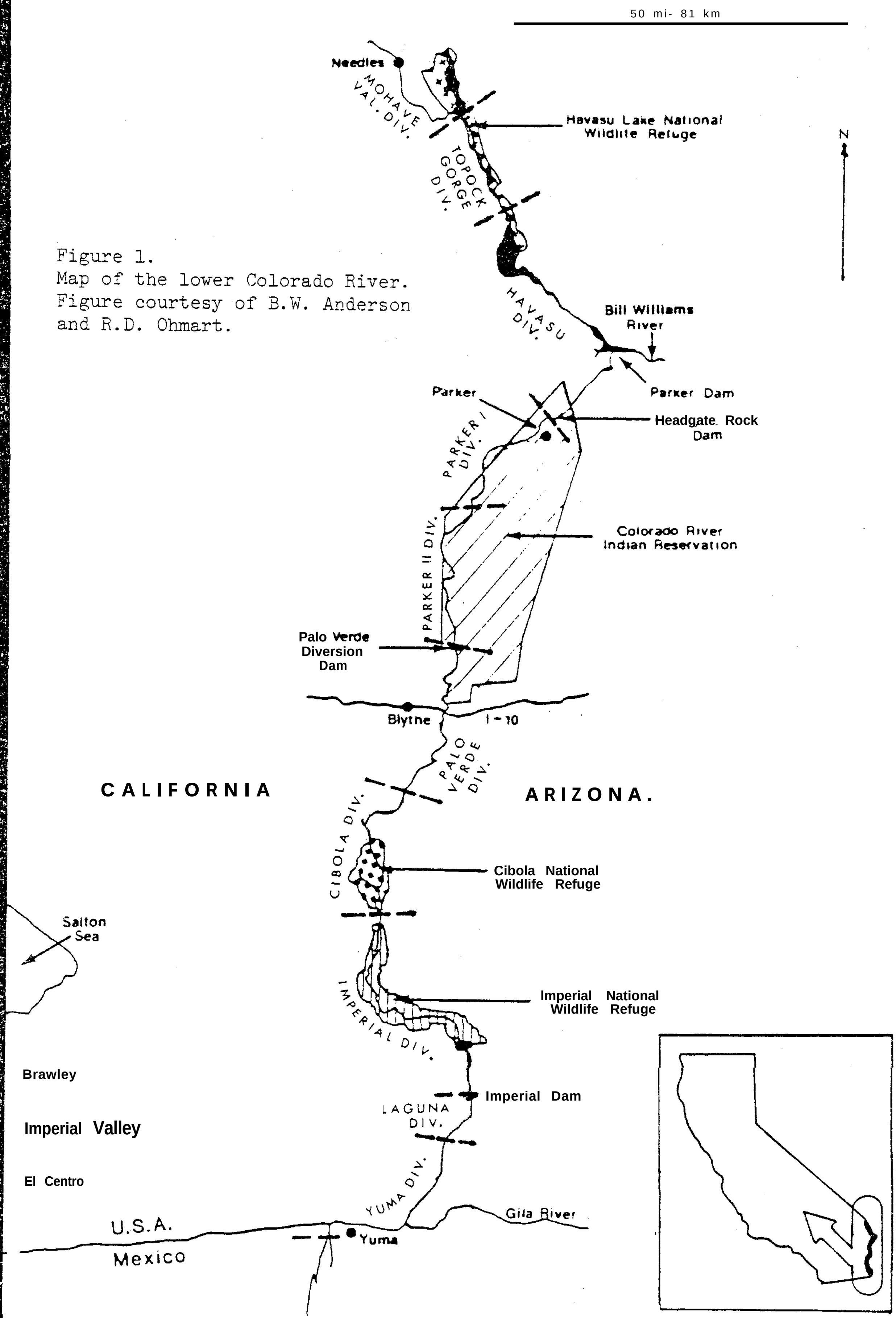

Figure 1.
Map of the lower Colorado River.
Figure courtesy of B.W. Anderson and R.D. Ohmart.

Table 1. Vegetation communities and the criteria used in classification of areas $\geq$ 10ha.

Community	Designation	Criteria
Salt cedar	SC	Stand consisting almost solely of salt cedar, primarily Tamarix chinesis.
Honey mesquite	HM	Stand consisting almost solely of honey mesquite, Prosopis glandulosa.
Arrowweed	AW	Stand consisting almost solely of arrowweed, (Tessaria sericea).
Screwbean mesquite/ salt cedar	SM	Screwbean mesquite, Prosopis pubescens mixed with salt cedar. Occasionally very few willow, Salix goodingii, or honey mesquite mixed with salt cedar.
Honey mesquite/ salt cedar	SH	Honey mesquite mixed with salt cedar.
Cottonwood-willow/ salt cedar	CW	Stands of mature cottonwood, Populus fremontii and willow; most stands are mixed with salt cedar, screwbean mesquite, and honey mesquite.

Table 2. Vegetation structure types and criteria used in classification for use in type maps for areas ≥ 10ha. Figures 2 and 3 Illustrate structure types.

Structure Type	Criteria
I	Three to four definite vertical layers of vegetation with the majority of foliage density at 6.0 m or above. Often has a high density of foliage in all layers, high foliage height (vertical) diversity, and high patchiness (horizontal) foliage diversity.
II	Primarily one vegetation vertical layer at 6.0 m or above.
III	Mostly open understory, with canopy layers from 4.5 to 6.0 m.
IV	Patches of foliage density at 0 to 0.6 m interspersed with canopy layer at 3.0 to 4.5 m.
V	Majority of foliage density at 0 to 1.5 m with most canopy trees not higher than 3.0 m.
VI	One layer of vegetation with bulk of the foliage density between 0 and 0.6 m.

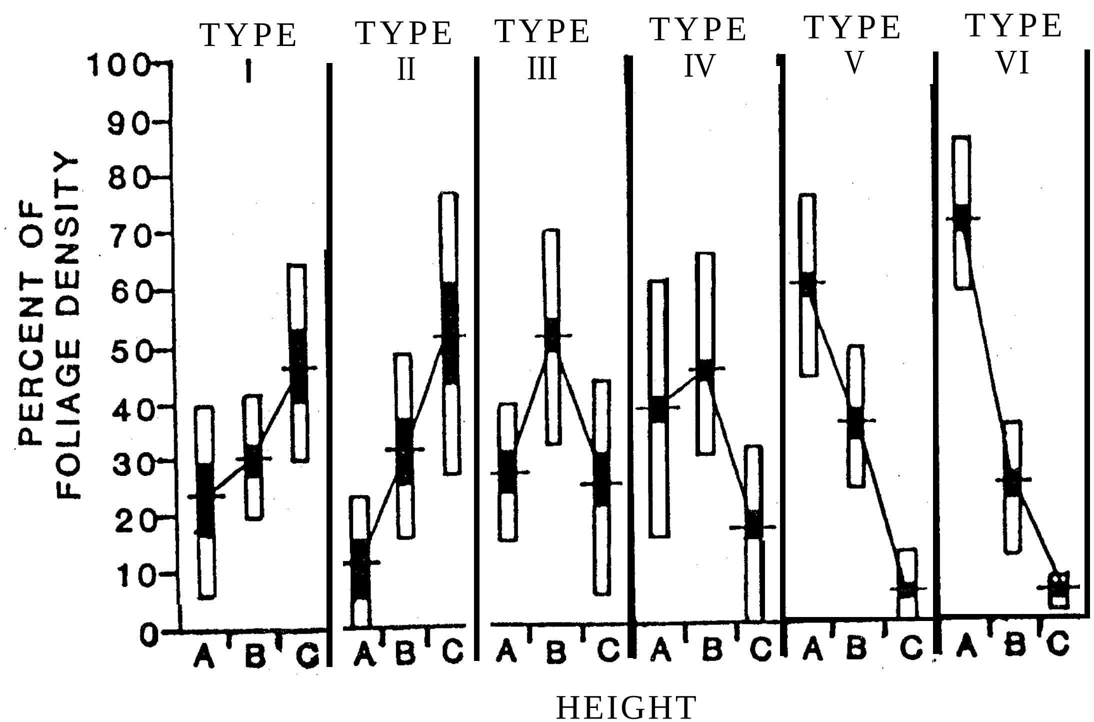

Figure 2.
Vegetation structure types. Proportion of vegetation in three vertical layers for each type. Layer A=0.0-1.5 m (0-5 ft); B= 1.51-4.5 m (5-15 ft); C=4.51+ m (15+ ft). Figure courtesy of B.W. Anderson and R.D. Ohmart.

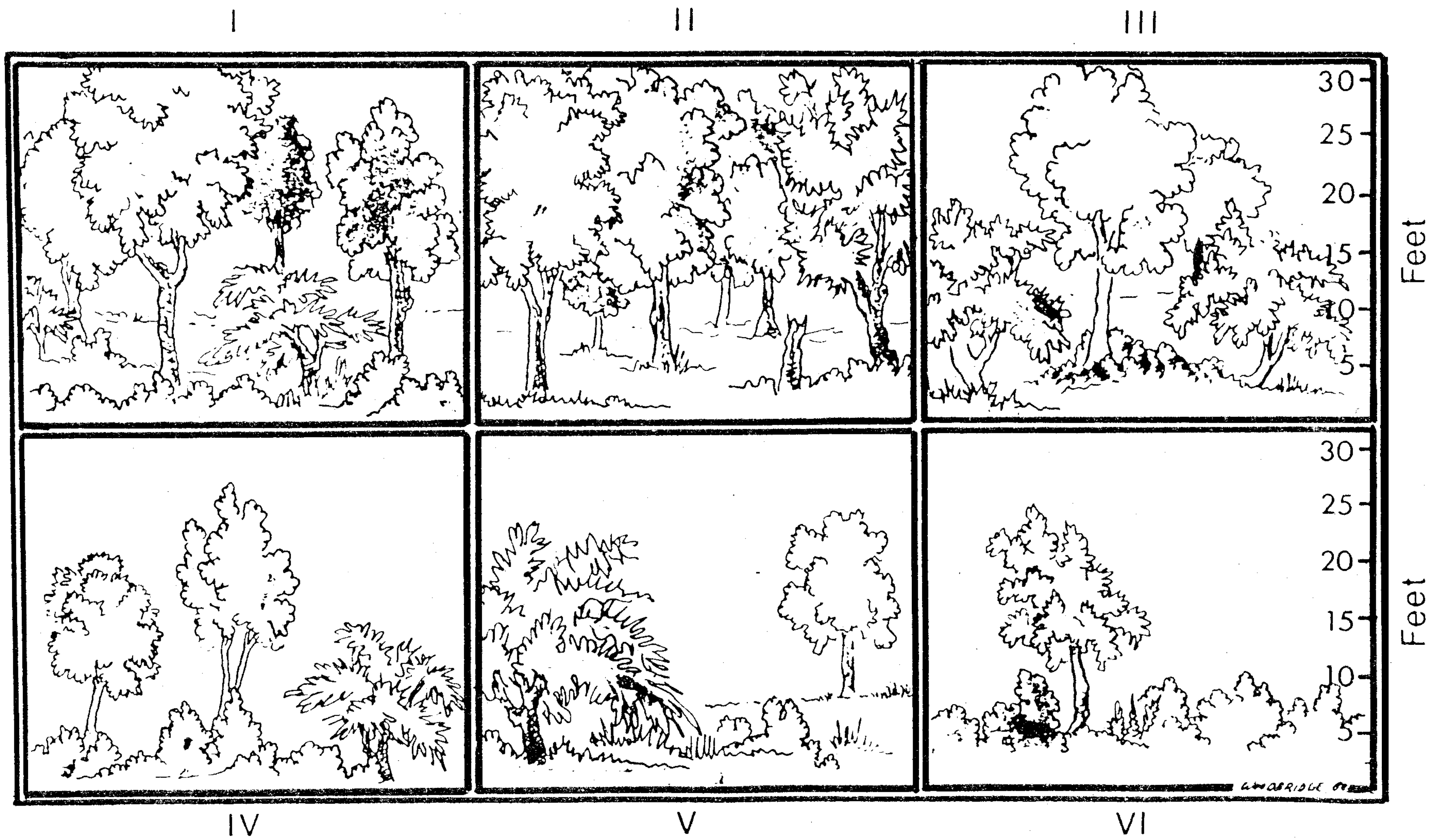

Figure 3.
Illustrative examples for the six vegetative structure types in the willow community. Figure courtesy of B.W. Anderson and R.D. Ohmart.

Birds

The Emlen variable-distance transect census method (Emlem 1971) was modified (Anderson, Engel-Wilson, Wells and Ohmart 1977; Anderson and Ohmart 1981) for estimating avian densities. Three censuses were made per month on each transect. There were from 2 to 11 transects per habitat type reflecting the amount of each habitat in the lower Colorado River valley; however, scarcer habitats tended to be over-represented. For permanent residents (i.e. Gila Woodpecker and Crissal Thrasher) data were analyzed by seasons: (1) winter (December, January, February); (2) spring (March, April); (3) summer (May, June, July); (4) late summer (August, September); and (5) fall (October, November). The seasons reflect changes in species' behavior and potential use of habitats. The remaining species were summer visitors (except Gilded Northern Flicker, Vermilion Flycatcher, and Northern Cardinal; see species accounts) and data on habitat relationships were analyzed by month, with the months varying from species to species depending on their occurrence in the valley. Data for this phase of the study were collected from December 1975 to July 1979 by Anderson and Ohmart.

Data from Anderson and Ohmart (1977b) were used to determine the densities of birds in each habitat for each season on the Colorado River. The summer season's (May, June, July) mean bird densities were used with the amount of each habitat found in California during the 1983 vegetation type mapping, to calculate the number of birds that could exist in California. Not all areas could be checked or accurately censused during 1983, so this provided information on the number of birds for each species that could occur in each of the Bureau of Reclamation Divisions. This information then was compared with field observations.

Areas identified as potential habitat for the species studied were located in California and checked about once monthly from April through July 1983. Non-riparian habitats (i.e., residential areas, private ranches, and experimentally revegetated areas) also were checked for the occurrence of these species. An estimated number of individuals, as well as any breeding activity, or other anecdotal observations, were recorded.

Analytical Methods

Vegetation

A Principle Component Analysis (PCA) was used to evaluate vegetation data (Nie et al. 1975). Sixteen vegetation variables were analyzed to determine the number of independent vegetational trends (principal components; PC's):

> patchiness (horizontal foliage diversity; Figures 4 and 5) at 1) 0.0-0.6 m (0-2 ft), 2) 0.6 m - 3.0 m (2-15 ft), 3) 3.0+ m (15+ ft), 4) total patchiness; foliage density at 5) 0.0-0.6 m (0-2 ft), 6) 0.6-3.0 m (2-15 ft), 7) 3.0+ m (15+ ft), 8) total foliage density; 9) foliage height diversity (vertical foliage diversity); 10) shrubs/ha, 11) cottonwood-willow/ha, 12) mesquite, with mistletoe (*Phoradendron californicum*)/ha, 13) honey mesquite/ha, 14) screwbean mesquite/ha, 15) salt cedar/ha; and 16) proportion of trees which were salt cedar.

Each PC included highly intercorrelated variables from the original set. A variable was included on a particular PC if it had high loading ($\geq$ 0.5 eigen-value) on that PC. Variables with high loadings were combined to define trends in the vegetation data, with the more important variables being used to verbally describe each PC. PCA's conducted separately on vegetation variables for each of four years, 1975-1978, were identical (Meents et al. 1981), and for each year almost the same percent of the total variance was explained. Thus, we combined vegetation data for all years and performed a single PCA on this larger data set, which yielded four PC's (see Results), identical in all essential features to those presented in Meents et al, (1981). For each vegetational PC, the factor scores for each of the 23 habitat types for the years 1975-1979 were used to show correlation between bird use and vegetation characteristics.

Habitat Use

For each bird species, bird density and vegetation analysis data were compared by use of non-parametric statistics (Siegel 1956, Green 1979). Non-parametric statistics are conservative and the data do not need to fit a normal curve. Each species' density in each of the 23 habitat types were ordered by ranking. These ranks were compared with rank order from every other month or season (depending on the species being a summer visitor or permanent resident respectively, including all years) by calculating Spearman's rank coefficients. Significant correlations indicate similar relative use of habitat types through time. In some cases, Spearman's rank correlations were not significant between compared months or seasons. To test whether the collective distribution of birds in habitat types was random across all months or seasons in a given year and all years for a given month or season, the Friedman's two-way analysis of variance was used. Rank distribution was tested with chi-square (x^2); a significant outcome indicated a non-random distribution of ranks among habitats. As x^2 increases, the chances that the deviation of ranks is random become increasingly remote. Areas with the smallest sum of ranks were those most used by the bird species in high densities.

Habitats which had highest use by each species were determined by adding the number of times a habitat was among the top three ranked (out of 23) for all months or seasons that each species was present. The highly ranked habitats occurring in California were located on vegetational type maps (Anderson and Ohmart 1976, 1984) and primarily constituted those areas that were checked the summer of 1983 for actual use by each species.

Vegetational factor scores for each year and for each PC also were ordered by rank, and relationships between PC's and bird densities were determined with Spearman's rank correlations. Sometimes rank correlations with individual PC's were not significant. Combinations of PC's with which bird densities were positively associated were determined by adding the standardized factor scores, ranking these values among habitats and calculating another Spearman's rank coefficient. Adding factor scores yielded interpretable results and provided statistically significant results that compared to readily observable associations if the PC's had the same sign. But, for example, PC I for riparian vegetation had positive values for cottonwood and willow habitats while PC IV had negative values for cottonwood and willow. Here, it was necessary to change the sign of the factor scores for one of these PC's before combining them to obtain a maximum correlation for bird use of cottonwocdwillow habitats. Without changing the sign, the cottonwood-willow variables would cancel each other resulting in no correlation with birds that use cottonwood-willow habitats.

Although linear relationships are dominant, curvilinear relationships between birds and vegetation also are important in our study area (Meents et al. 1981, 1983). Curvilinearity was tested for by raising factor scores for each PC to the second power. These were rank ordered and compared with rank bird densities.

Habitat breadth (HB) measurements were calculated from information theory (Shannon and Weaver 1949) for Gila Woodpecker and Crissal Thrasher. These species were the year-round residents for which adequate data were available to calculate HB by season for each year. HB describes the proportionate distributon of a species' diversity among habitat types in terms of evenness of distributon and number of habitats occupied. Maximum habitat breadth (Max HB) occurs when the total density of a species is evenly distributed among all available habitat types. In this report, HB values were used to detect broadening or narrowing of habitat use from season to season and from year to year.

Rice, Anderson and Ohmart (1980) and Anderson and Ohmart (1985) have found the data analysis procedure above to be very adequate in determining bird use of habitats on the lower Colorado River. Though the statistical techniques are complex, results readily reflect observable trends in the field.

RESULTS

Vegetation

Principal Component Analysis (PCA) for terrestrial vegetation yielded four PC's that explained 76% of the variance in vegetation data along the lower Colorado River (Table 3). PC I explained 35% of the variance and described a trend from high to low foliage density and diversity across habitat types. PC II explained 21% of the variance and described a trend from areas with many shrubs, honey mesquite trees, and trees with mistletoe to areas with many salt cedar trees. PC III described a trend from areas with much foliage density and horizontal diversity (patchiness; Figures 4 and 5) at 0-2 ft to areas with low values for these variables and explained 13% of the variance. Finally, PC IV explained 7% of the variance and described a trend from areas with many screwbean mesquite and salt cedar trees to areas with few individuals of these species but with many cottonwood and willow trees.

Summing the acreage of each terrestrial habitat in California revealed that the salt cedar community included 54% of all existing vegetation in California and SC IV was the single most abundant habitat accounting for 33% of all riparian vegetation (Table 4, Figure 6). The cottonwood-willow community comprised only 11% of the vegetation. Relatively mature native riparian habitats constituted a very small portion of the total vegetation with CW II=0.2%, CW III=0.7%, HM III=0.6%, SM II=0.4%, and SM III=2.6%. Cottonwood-willow habitats mostly occurred in the Laguna, Imperial, and Parker II Divisions. CW II was found only in the Palo Verde Division, SC I (i.e., athel-tamarisk, *T. aphylla*) only in the Yuma Division, HM III only in the Mohave Valley Division, and SM II only in the Parker II Division.

Table 3. Factor scores of 23 riparian habitat types on each of four principal components (PC). Mean factor scores for each principal component do not deviate significantly (P>0.l) from a mean of 0.0, a standard deviation of 1.0, or from a normal distribution.

	Principal Component			
Vegetation type	I	II	III	IV
Salt cedar				
I	0.29	-1.02	-1.13	-0.91
II	0.27	-0.64	-0.64	-0.51
III	-0.50	-0.46	-0.78	0.34
IV	-0.01	-1.23	0.31	0.63
V	-1.02	-0.80	0.13	0.30
VI	-0.32	-0.96	3.00	-0.21
Cottonwood-willow				
I	3.19	0.15	1.97	-0.43
II	0.32	0.29	-2.16	-1.62
III	1.62	0.05	0.12	-0.63
IV	0.59	-0.36	0.22	0.78
V	0.06	0.75	0.46	-0.27
VI	-1.06	-0.71	0.58	-1.09
Screwbean mesquite				
II	0.71	0.53	-1.41	1.41
III	0.03	0.25	-1.80	0.75
IV	0.31	0.20	0.60	1.34
V	-0.56	-0.35	-0.09	0.79
VI	-0.90	-0.80	0.13	0.30
Salt cedar-honey mesquite				
IV	-0.17	0.71	0.03	0.56
Arrowweed				
VI	-0.85	-0.05	0.63	-0.72
Honey mesquite				
III	0.87	2.04	0.13	0.75
IV	-0.14	2.19	0.55	0.49
V	-0.71	1.66	0.41	0.02
VI	-1.23	1.70	0.63	-0.72
Mean	0.03	-0.08	0.01	0.06
Standard deviation	0.98	0.94	1.11	0.98

Table courtesy of Anderson and Ohmart 1984.

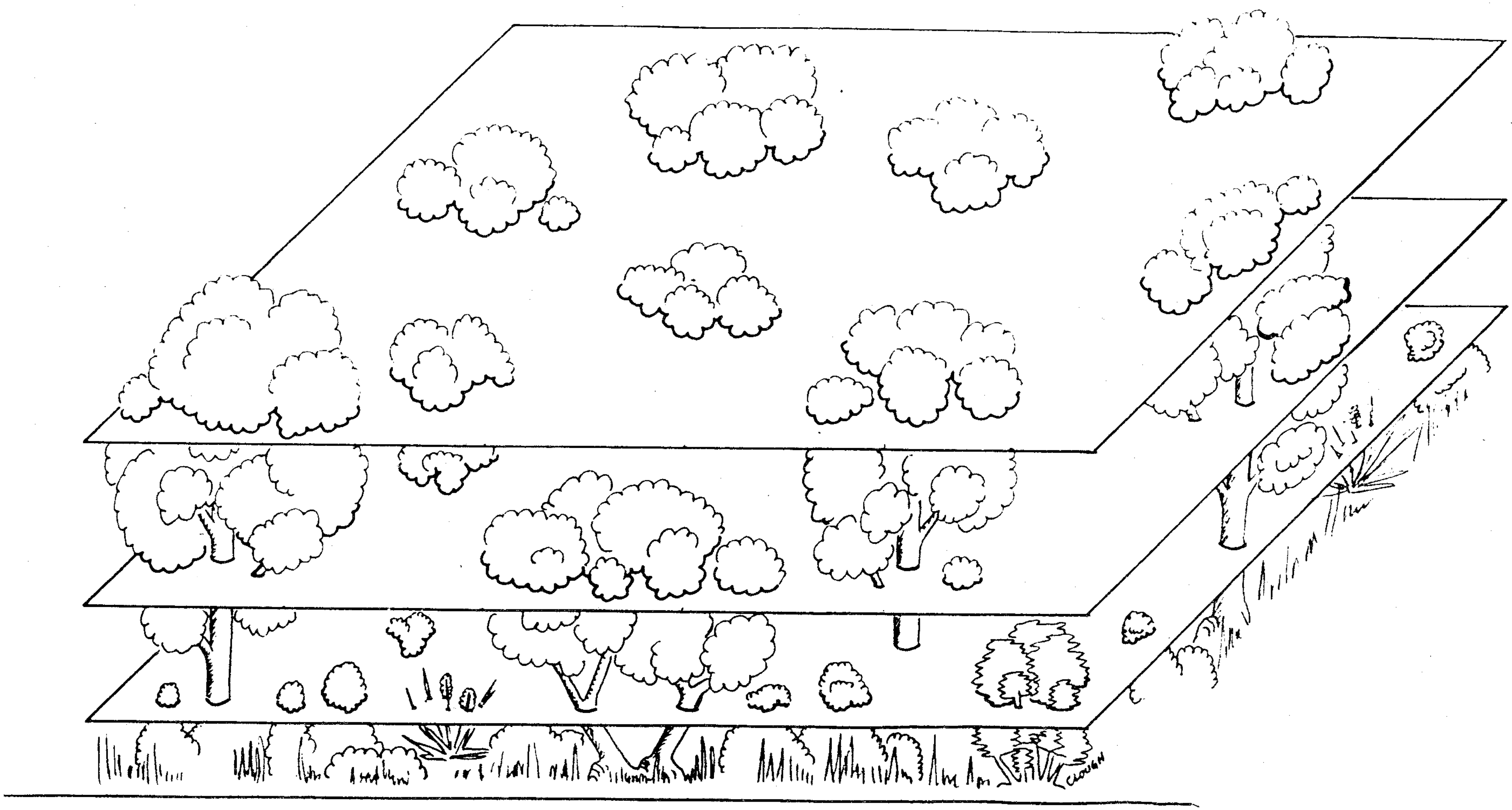

Figure 4.
Illustration of a highly patchy (horizontal foliage diversity variance) stand of vegetation. Note the amount of variation in each of the four layers combining to give a high patchiness value. Figure courtesy of B.W. Anderson and R.D. Ohmart.

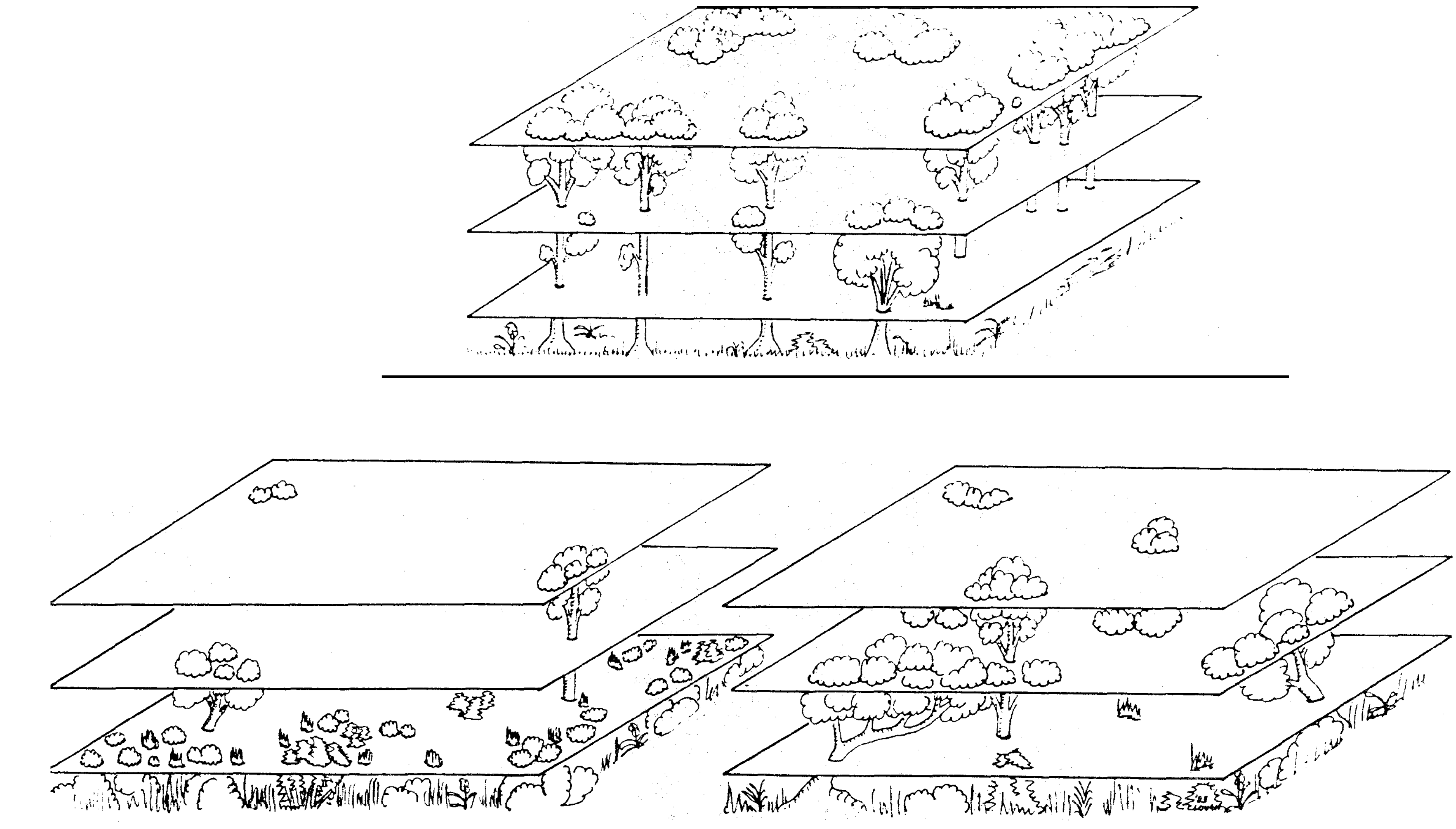

Figure 5.
Illustration of three degrees of variation in horizontal patchiness in habitats. Actual patchiness values would depend on the combination of the patches involved. Figure courtesy of B.W. Anderson and R.D. Ohmart.

Table 4. Total area for 23 riparian habitats on the lower Colorado River in California. bureau of Reclamation divisions were used as the geographical units. Communities and structure types are defined in Tables 1 and 2. Area is in acres; 1 acre = 0.4 hectares.

Community/	Structure Type	Division: Mohave Valley	Topock Gorge	Havasu	Parker I	Parker II	Palo Verde	Cibola	Imperial	Laguna	Yuma	TOTAL	PERCENT TOTAL HABITAT	PERCENT OF TOT. HAB. BY COMMUNITY TYPE
CW	I											.0	.00	10.59
	II						40.8					40.8	.17	
	III	26.7					70.5		15.5	17.9	27.8	158.4	.66	
	IV	100.0	4.9			497.0	30.6	161.6	560.4	204.5	14.4	1573.4	6.57	
		17.0				208.8	65.8		183.5	213.8	56.7	745.6	3.11	
	VI						20.0					20.0	.08	
SC	I										91.2	91.2	.38	53.79
	II											.0	.00	
	III	226.8	22.9		7.9							257.6	1.08	
	IV	858.3	61.5		208.0	1408.1	242.6	2787.5	1617.5	534.6	242.0	7960.1	33.22	
	V	227.8	6.2		117.1	1781.2		727.5		450.0	24.3	3334.1	13.92	
	VI				30.5	498.8	236.8	190.4	4.2		283.0	1243.7	5.19	
HM	III	133.9										133.9	.56	1.00
	IV				61.3	28.4			11.0			100.7	.42	
	V					5.8						5.8	.02	
	VI												.00	
SM						99.0						99.0	.41	28.91
	III	217.5			37.2	232.1				122.4	21.2	630.4	2.63	
	IV	620.0			84.2	2751.6	161.2	74.3	160.1	106.2		3957.6	16.52	
	V	231.4				130.4	97.1	35.5			178.8	673.2	2.81	
	VI	256.9			719.7	163.3		306.4			119.4	1565.7	6.54	
SH	IV	299.3	27.2	13.8	102.8			35.9	88.6			567.6	2.37	2.37
AW	VI		35.0		65.0	122.5	39.5	18.8		416.7	102.1	799.6	3.34	3.34
TOTAL		3215.6	157.7	13.8	1433.7	7927.0	1004.9	4337.9	2640.8	2066.1	1160.9	23958.4	100.00	100.00

As outlined previously, explorers and ornithologists along the lower Colorado before the 1920's commented on the expanse of cottonwood-willow forests and honey mesquite bosques. A tremendous number of acres in California (as well as in Arizona) have been converted for agricultural use. Existing riparian vegetation data indicate that mature stands of native vegetation have been virtually eliminated from California. Salt cedar has increased from introduction in the 1920's to become the numerically dominant vegetation in the 1980's.

Similarity in Use of Habitats by Birds

Bird densities were significantly correlated with habitat types (Table 5). Except for Yellow-breasted Chat, each species, during their respective stay, did not use habitats differently from year to year, month to month, or season to season in the lower Colorado River Valley. Annual, monthly, (or seasonal) variation in numbers does not influence the ranking of habitats when non-parametric statistics are used. The Crissal Thrasher had a higher tendency to use habitats similarly than one would predict by chance alone, but had a much lower percentage of significant Spearman's rank coefficents than all other species tested. All species showed a non-random use of habitats from the Fredman's two-way analysis of variance for all tests d.f.=22,$x^2 \geq 34$, $P<0.05$), indicating that there were indeed habitat preferences. The top-ranked habitats differred from species to species, but generally each species (except Crissal Thrasher) occurred in high numbers in CW I, II, III, and SM II (Table 6).

Bird Species Accounts

Gila Woodpecker

Historical Occurrence. All historical accounts showed that this species was common throughout the valley as far north as Ft. Mohave (Cooper 1869). Coues (1866) reported them as abundant. Grinnell (1914) called them common and characteristic throughout the river valley, as they were found at every station along both sides of the river. Most nested in saguaro cactus (*Carnegiea gigantea*) and in dead cottonwoods.

Habitat Use. There was a strong relationship between Gila Woodpeckers and 1) high foliage density and diversity, PC I, and 2) high foliage density and diversity coupled with high numbers of cottonwoods and willows, PC I & IV (signs reversed) (Table 7). The first factor did not exclude areas other than cottonwood-willow, the latter factor did. This implies that Gila Woodpeckers may occur in areas where cottonwoods and willows are largely absent, but in reduced densities. There was a tendency for PC I & IV (signs reversed) to become more important than PC I by itself in 1978 and 1979. This may be interpreted as higher use of areas with cottonwood-willow trees than during 1976 and 1977. The most heavily used habitats included CW I, II, III (Table 6).

Since Gila Woodpeckers are permanent residents on the Colorado River, habitat breadth (HB) measurements were taken to find any yearly or seasonal patterns of habitat use (Table 8). Habitat breadth broadened during summer, late summer and/or fall seasons and narrowed during winter and/or spring of these same years (Table 9). Gila Woodpeckers seem to be most habitat selective

Table 5. Intraspecific Spearman's rank correlation coefficients (r_s) between monthly or seasonal density distributions among habitat types, 1975-79. Significant results indicate a similar use of habitats between the seasons or months compared.

Species	Monthly (M) or (S) Seasonal	Number of correlations within each significance level				Total Spearman Rank Tests	Perce Signif icant
		$P \leq 0.05$*	$P \leq 0.02$	$P \leq 0.01$	$P \leq 0.001$		
Gila Woodpecker	S	0	0	9	75	84	100.1
Gilded Northern Flicker	M	0	0	38	133	171	100.00
Brown-crested Flycatcher	M	0	0	1	104	105	100.1
Crissal Thrasher	S	12	11	22	7	84	61.00
Yellow-breasted Chat	M	3	2	18	82	105	100.00
Summer Tanager	M	0	0	1	151	152	100.00

*r_s value for each significance level:

at $P<0.05$, $0.425 \leq r_s \leq 0.496$
$P<0.02$, $0.496 \leq r_s \leq 0.544$
$P<0.01$, $0.544 \leq r_s \leq 0.667$
$P<0.01$, $0.667 \leq r_s \leq 1.00$

Table 6. Number of times each of 23 habitat types was among the three top-ranked habitats on a monthly or seasonal basis for six bird species in the lower Colorado River Valley. Ranks of habitats were based on highest monthly or seasonal densities for each species among habitat types from 1975 to 1979. Maximum (Max) equals the total number of times that a habitat could have been ranked.

		Number of times habitat was among the three top-rated habitats					
Community	Structure Type	Gila Woodpecker (Max=18)	Gilded Northern Flicker (Max=19)	Brown-crested Flycatcher (Max=1 5)	Crissal Thrasher (Max=18)	Yellow-breasted Chat (Max=15)	Summer Tanager (Max=18)
CW	I	17	12	14	0	8	17
	II	17	17	13	0	13	12
	III	14	11	5	5	7	10
	IV	4	2	0	3	7	0
	V	0	4	0	6	9	1
	VI	1	1	0	2	0	0
SM	II	1	14	13	2	0	0
	III	0	1	0	1	0	0
	IV	0	0	0		0	0
	V	0	0	0	0	0	0
	VI	1	4	0	1	0	0
SC	I	0	0	1		1	15
	II	1	0	0	1	0	0
	III	0	0	0	4	0	0
	IV	0	0	0	0	0	0
	V	0	0	0	1	0	0
	VI	0	0	0	0	0	0
HM	III	4	3	0	7	1	0
	IV	1	0	0	11	0	0
	V	0	0	0	6	0	0
	VI	0	0	0	4	0	0
SH	IV	0	0	0	7	4	0
AW	VI	0	0	0	1	0	0

Table 7. Spearman's rank correlation coefficients (r_s) and significance levels between ranked densities of Gila Woodpeckers and ranked factor scores of riparian vegetation PC's (Table 3) for 23 habitat types. Only the significance level for the PC, power of PC, or combination of PC's that correlated the highest with bird densities for each season is shown.

Season	Year	PC	r_s	Significance	Other Significant PC Correlations
Winter	1975-76	I	.588	$P < 0.01$	I+IV (SR)
	1976-77	I	.636	$P \leq 0.01$	I+IV (SR), I^2
	1977-78	I+IV (SR)*	.620	$P \leq 0.01$	I
	1978-79	I+IV (SR)	.567	$P \leq 0.01$	I
Spring	1976	I^2	.562	$P \leq 0.01$	I, I+IV (SR)
	1978	I+IV (SR)	.596	$P \leq 0.01$	
	1979	I+IV (SR)	.624	$P \leq 0.01$	I
Summer	1976	I	.634	$P \leq 0.01$	I+IV (SR)
	1977	I	.676	$P \leq 0.001$	I+IV (SR)
	1978	I+IV (SR)	.686	$P \leq 0.001$	I
	1979	I+IV (SR)	.702	$P \leq 0.001$	I
Late Summer	1976	I	.745	$P \leq 0.001$	I+IV (SR)
	1977	I+IV (SR)	.660	$P \leq 0.01$	I
	1978	I+IV (SR)	.469	$P \leq 0.05$	I
Fall	1976	I	.744	$P \leq 0.001$	I+IV (SR)
	1977	I	.637	$P \leq 0.01$	I^2, I+IV (SR)
	1978	I+IV (SR)	.659	$P \leq 0.01$	I

*SR = refers to sign reversal on PC IV; see explanation in text under Methods in Habitat Use.

Table 8. Habitat breadth (HB) of Gila Woodpecker and Crissal Thrasher based on distribution among the various vegetation structure types for each year among all seasons from December 1975 and July 1979. Since data from 1979 was incomplete a mean (X) and standard deviation (SD) are given with 1979 data (in parenthesis and without it. Maximum habitat breadth (Max HB) for both species = 1.362.

Species	Season	Year 1976	1977	1978	1979	X (with 1979)	SD (with 1979)
Gila Woodpecker	Winter	.896	.730	.729	.825	.785 (.795)	.096 (.081)
	Spring	.811	.835	.764	.708	.803 (.780)	.036 (.056)
	Summer	.832	.786	.858	.713	.825 (.797)	.036 (.064)
	Late Summer	.955	.930	.847	--	.911	.057
	Fall	.833	.912	1.02	--	.922	.094
	X	.865	.839	.844	.749*		
	SD	.059	.084	.113	.066		
Crissal Thrasher	Winter	1.218	1.134	1.266	1.240	1.206 (1.215)	.067 (.057)
	Spring	.864	1.236	1.278	1.214	1.126 (1.148)	.228 (.191)
	Summer	1.264	1.264	1.249	1.260	1.259 (1.259)	.009 (.007)
	Late Summer	1.246	1.285	1.312	--	1.281	.033
	Fall	1.249	1.242	1.275	--	1.255	.017
	X	1.168	1.232	1.276	1.238*		
	SD	.171	.058	.023	.023		

* Late summer and fall data not collected in 1979; 1979 average is for winter, spring and summer only and are not comparable to 1976, 1977, 1978.

Table 9. Number of times habitat breadth (HB, Table 8) during winter and spring was lower than during summer, late summer, and fall within years for Gila Woodpecker and Crissal Thrasher. P = the probability that winter and/or spring HB was lower than HB of summer, late summer, and fall by binomial expansion equation.

Species	Season	Number of times winter and/ or spring H' was lower than during summer, late summer, or fall	Total Trials	P
Gila Woodpecker	Winter	7	10	P < .172 (NS)
	Spring	9	10	P < .011
	Total	16	20	P < .006
Crissal Thrasher	Winter	9	10	P < .011
	Spring	8	10	P < .055 (NS)
	Total	17	20	P < .001

during spring when they begin their breeding cycle. A broadening of habitat use during summer, late summer and fall may indicate post-breeding dispersal of young into secondary habitats (Anderson, Ohmart and Fretwell 1982). Limited breeding may occur in secondary habitats as Gila Woodpeckers are known to nest in sparse honey mesquite stands. No outstanding year-to-year trends in habitat breadth measurements could be discerned.

Field Observations. Forty-five Gila Woodpeckers were observed on the California side of the Colorado River, and 48% were using private ranches, residences, or parks. Surveys from Needles to Blythe indicate that almost all resorts with tall cottonwoods and willows (occasionally eucalyptus, athel tamarisk, and other exotics) will support one to three pairs of Gila Woodpeckers, depending on the size and number of tall trees present (Figure 7). Also, many residents provide food for the birds. Riparian vegetation (primarily exotic salt cedar) along the California side of the river supports few birds. All birds observed in riparian vegetation were found in areas with cottonwood and willow trees. One pair at the Soto Ranch, 17 km (10 miles) NNE of Needles, San Bernardino Co.; one pair near Needles; one pair at the Beal Slough revegetation site, 10 km (6 miles) SSE of Needles, San Bernardino Co., (at one time using an artificial snag); one pair near the Water Wheel Resort, 35 km (23 miles) N of Blythe, Riverside Co.; two pairs at the Clark Ranch, 21 km (15 miles) N of Blythe, Riverside Co.); one pair at Picacho State Recreation Area; and four pairs between Laguna and Imperial Dams were all that were located in riparian vegetation. Undoubtedly, there are more birds in suitable habitat in the Imperial Division, but the continued existence of this species in California may depend upon its occurrence at man-made resorts because this is where the only suitable habitat may remain. Suitable areas that should support Gila Woodpeckers but do not were all near Blythe: the 10th Ave. backwater, Goose Flats, and near McIntyre Riverside Co. Park. A seep from the All-American Canal near Laguna Dam, has had many woodpeckers in the recent past (R. Robinson pers. comm.), though on three visits I found none.

Estimated Population Size. The Gila Woodpecker population size in riparian vegetation was estimated to be 185 individuals (Table 10). Adding the number of birds found in residential areas, the actual total could be just over 200 individuals. The relatively large number of birds reported in SC IV (0.7/40 ha) accounted for about 56 of the total above, as this habitat accounted for 33% of the available habitat. It is doubtful that many of the birds found in salt cedar were breeding and were probably young dispersing from established territories during the summer. This also may be said for the rest of the salt cedar habitats as well as most of the screwbean mesquite-salt cedar habitats. Therefore, the actual breeding population may be substantially lower than 200 birds in California.

Problems. European Starlings are thought to cause displacement from nest sites of many native cavity nesting species (Remsen 1978). With the assistance of the Clark Ranch, we attempted to gather empirical data on starling pressure on Gila Woodpecker nesting. The Clark Ranch collected approximately 150 starlings in the vicinity of a Gila Woodpecker nesting territory from late April to late June. Despite the collecting, three to four pairs of starlings were present at all times in the vicinity of the Gila Woodpecker pair, while hundreds of starlings foraged in nearby fields. The Gila Woodpecker pair was forced to abandon three different nest cavities from mid-April to early June. No young were fledged by this pair. On the last

Table 10. Estimated population size of nine bird species on the lower Colorado River in California. Bureau of Reclamation divisions were used as geographical units. Estimates are based on birds per 40 ha (100 acres> for each habitat type (Table 4) that occurs in California. Birds estimated to be in each habitat were added together for each division total. The numbers represent the estimated number of individuals possible given the amount of available habitat. Bird data for each habitat are from Anderson and Ohmart (1977b).

SPECIES	Division										TOTAL
	Mohave Valley	Topock Gorge	Havasu	Parker I	Parker II	Palo Verde	Cibola	Imperial	Laguna	Yuma	
Gila Woodpecker	24.5	.6	.0	10.4	47.1	12.2	30.9	34.9	16.3	8.0	184.9
Gilded Northern Flicker	6.8	.3	.0	4.6	11.4	4.5	10.7	9.4	3.8	1.8	53.3
Vermilion Flycatcher	.5	.0	.0	.0	.0	1.2	.0	.3	.3	.5	2.8
Brown-crested Flycatcher	29.0	.4	.0	21.7	99.8	19.5	21.8	47.7	28.9	12.5	281.3
Crissal Thrasher	143.3	4.6	.7	43.2	339.6	39.2	138.8	106.2	70.7	74.3	960.6
Yellow Warbler	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Yellow-breasted Chat	42.9	.0	.2	2.3	48.2	12.3	20.0	45.9	18.1	4.7	194.6
Summer Tanager	3.1	.0	.0	.0	5.0	7.5	1.0	6.8	3.4	19.5	46.3
Northern Cardinal	.5	.0	.0	.2	.1	.0	.0	.0	.0	.0	.8

expulsion, the starlings disposed of the woodpecker eggs from the cavity. Two Gila Woodpecker nests under study at the Parker Dam residences suffered a similar fate without starling control. By 9 June, both pairs had started to renest in new cavities and by 2 July one cavity contained young while in the other, eggs were still being incubated. By 19 July, one pair had fledged at least two young; however, one young bird later was found dead. On 15 August a family of three were found in the same location while the other pair had abandoned the area.

It appears that the Gila Woodpecker is facing two very serious problems in California. The lack of suitable native habitat severely restricts viable populations outside of privately owned areas. Starlings do not appear to be a problem at most riparian habitat sites, but not all available habitat is being used since there are isolated cottonwood stands void of woodpeckers. These stands are usually less than 20 ha (50 acres) and the smaller the habitat the less likely birds will occur. Gila Woodpeckers seem to be most common at private residences, resorts, and parks where starlings definitely interfere with nesting success. Though some young are produced, possibly enough to keep the population levels stable, there is really little habitat for them to disperse to. Lack of native habitat coupled with reduced productivity due to starling interference will limit any recovery in the population for the forseeable future.

Gilded Northern Flicker

Historical Occurrence. Historical accounts rarely separated the two forms of flickers (gilded vs. red-shafted) that occur on the Colorado River, making it difficult to judge the actual abundance of the gilded form. Breeding individuals recorded included one male and two females at Ft. Mohave (Cooper 1861), one near Yuma (Bailey 1889), and some at Laguna Dam (Grinnell 1914). Swarth (1914) commented that the gilded form was found north to Ft. Mohave on the Colorado River, occurring primarily "at the few points where cactus is found, but it has been taken in different associations....". The cactus Swarth referred to was most likely saguaro. Grinnell (1914) commented on flickers being fairly common around Laguna Dam with two nesting in dead cottonwood stumps "in the drowned-out area of the river bottom". Grinnell also speculated that the species was much more common in the past given many flicker cavities found in riparian trees at Picacho and Pilot Knob. Overall, the Gilded Flicker apparently was an uncommon resident throughout the river valley, being associated primarily with saguaro cactus and secondarily with cottonwood forests.

Habitat Use. The gilded form is a permanent resident in the valley, but analyses were done monthly only from April through August to exclude the migratory red-shafted form. This monthly data showed that areas with high foliage density and diversity, PC I, usually couple with high numbers of cottonwood-willow and screwbean mesquite trees, $PC\ IV^2$, consistently had the highest ranking for Gilded Flickers (Table 11). The habitats highly used on the Colorado River by Gilded Flickers were CW I, II, III and SM II (Table 6).

Most of the habitats with high foliage density and diversity and high numbers of cottonwood-willow trees occur on the Arizona side near the confluence of Bill Williams River and Colorado River. Here, flickers are known to nest only in the nearby saguaro cactus and feed only in the cottonwood-willow habitat (Rosenberg, Ohmart and Anderson 1982). Elsewhere on the Arizona side,

Table 11 Spearman's rank correlation coefficients (r_s) and significance levels between ranked densities of Gilded Northern Flickers and ranked factor scores of riparian vegetation PC's (Table 3) for 23 habitat types. See Table 7 for details.

Month	Year	PC		Significance	Other Significant PC Correlations
April	1976	$I+IV^2$	.678	$P \leq 0.001$	I, IV^2
	1977	I	.495	$P \leq 0.05$	$I+IV^2$
	1978	I	.312	NS	
	1979	I^2	.604	$P \leq 0.01$	I, IV^2, $I+IV^2$
May	1976	$I+IV^2$	.643	$P \leq 0.01$	I, IV^2, I^2
	1977	$I+IV^2$	.639	$P \leq 0.01$	I^2, I, IV^2
	1978	$I+IV^2$	.426	$P \leq 0.05$	I^2
	1979	I	.428	$P \leq 0.05$	
June	1976	$I+IV^2$	0735	$P \leq 0.001$	IV^2, I, I^2
	1977	I	.531	$P \leq 0.02$	I+IV2
	1978	$I+IV^2$	.651	$P \leq 0.01$	I, IV^2, I^2
	1979	I	.536	$P \leq 0.02$	IV^2, $I+IV^2$
July	1976	$I+IV^2$	.598	$P \leq 0.01$	I, IV^2
	1977	I	.706	$P \leq 0.001$	$I+IV^2$
	1978	$I+IV^2$	.429	$P \leq 0.05$	
	1979	$I+IV^2$	.505	$P \leq 0.02$	I
August	1976	$I+IV^2$	.646	$P \leq 0.01$	$I+IV^2$, I
	1977	I	.549	$P \leq 0.01$	
	1978	$I+IV^2$	.558	$P \leq 0.01$	I

flickers do nest in some cottonwood-willow stands. Also, they are found occasionally in honey mesquite stands.

Field Observations. On the California side, flickers were located at only five locations. Up to four (a family group) flickers were located just north of Lost Lake Resort, 45 km (27 miles) N of Blythe, Riverside Co. This area had two large cottonwood snags with a scattering of large screwbean mesquites. At least one bird was found there throughout the summer. Up to three flickers were found near the Water Wheel Resort, where many mature screwbean mesquite and salt cedar are mixed with some scattered cottonwood snags. On 25 May a female flicker was found on Hall Island, 20 km (12 miles) NNE of Blythe, Riverside Co., among scattered large cottonwoods. One individual was heard on 9 August at Imperial Irrigation District Residence, 34 km (21 miles) S of Imperial Dam, and another was heard 21 August near the Clark Ranch. The areas listed above constituted the most reliable places to find the species in California during the last five years. The Gilded Flicker still breeds in California (undoubtedly the Lost Lake birds did) but on a much reduced scale. Additional individuals may be found in the Imperial Division.

Estimated Population Size. Approximately 53 Gilded Flickers could occur in riparian vegetation along the Colorado River on the California side (Table 10). As with the Gila Woodpecker, a relatively large proportion of individuals were from SC IV (0.3/40 ha) habitat. About 16 individuals were calculated for this habitat type and these again would probably be non-breeders. The actual number of flickers along the river appears to number no more than 40 individuals on the California side.

The Gilded Flicker reaches the northern and western limit of its geographical range at the Colorado River. With the loss of the saguaro cacti on the California side, densities in this peripheral population have declined. Even though the Gilded Flicker can use mature cottonwood-willow stands, these are now scarce (Table 4), so continued habitat loss will hasten this population's extirpation from California. Unlike the Gila Woodpecker, no flickers have been found nesting on private ranches, resorts, or parks. Starlings may interfere with nesting but they are not present in large numbers where flickers now occur.

Vermilion Flycatcher

Historical Occurrence. Mearns (1894) called the species very common from Yuma to the Gulf of California. Cooper (1861) said it was a rare summer visitor at Ft. Mojave. Swarth (1914) summarized by saying the species was an abundant resident along the wooded streams of western Arizona and along the Colorado, but only casual as far north as Ft. Mohave. Grinnell (1914, p. 154) made an interesting observation, which we may compare with the Vermilion Flycatcher's present status:

> On the California side, four miles below Potholes, the species proved to be one of the most numerous of birds present. Here the valley widens out; much land is being reclaimed for farming, and irrigation ditches supplied from the Laguna Dam conduct water throughout the region. There is much wasteland as yet, and burning has killed many of the cottonwoods. In this sort of locality the Vermilion Flycatchers were found to be far more numerous than anywhere else; it would appear that here is a native bird of the Colorado Valley which will greatly augment in numbers with the settling of the region.

Habitat Use. Data were not adequate for habitat analyses for this species.

Field Observations. Regrettably, Grinnell (1914) was wrong on his prediction for the stability of the Vermilion Flycatcher. During the 1983 summer season, only one breeding pair was found at the Parker Dam residences on 21 April. This pair fledged two young by 9 June. No other individuals were found this year. Serena (1981b) lists other spots where Vermilion Flycatchers have been found in California in the past few years and where they were absent this year. These areas included the Blythe golf course and the Clark Ranch. The Clark Ranch had an unmated female during the summer of 1982. There still remain some breeding pairs along the Bill Williams River, near Yuma, and near Willow Valley Estates (near Needles) in Arizona. During the winter, individuals, probably not all from Colorado River breeding populations, may be found in the agricultural-riparian vegetation interfaced areas (see Phillips et al. 1964).

Estimated Population Size. Three Vermilion Flycatchers were calculated to occur in California in riparian vegetation along the Colorado (Table 10). A reasonable estimate would be no more than 10, including those birds found on private residences or resorts.

Problems. Although the species does require open areas for foraging, it still requires riparian vegetation. Therefore, the tremendous loss of mature, native riparian vegetation probably has resulted in this species' demise. Brown-headed Cowbirds potentially could have been a negative factor, but the Vermilion Flycatcher has been reported to be only an occasional victim of nest parasitism (Friedmann 1963).

Brown-crested Flycatcher

Historical Occurrence. Swarth (1914) reported this species as occurring rarely as far west as the Big Sandy River in Arizona but not the Colorado. This species was considered to be a stray to the Colorado by Grinnell and Miller (1944). Monson (1949) first found the species in the valley in 1946, and on the California side in 1948. Since the 1950's the species has expanded its range where suitable habitat occurs, as far west as Morongo Valley (Banks and McCaskie 1964, Garrett and Dunn 1981).

Habitat Use. Analyses for habitat requirements have shown this species to be associated with high foliage density and diversity, PC I, and this factor coupled with high numbers of cottonwood-willow and screwbean mesquite trees, I + IV^2 (Table 12). This species is a secondary cavity nester and is dependent

Table 12. Spearman's rank correlation coefficients (rs) and significance levels between ranked densities of Brown-crested Flycatcher and ranked factor scores of riparian vegetation PC's (Table 3) 23 habitat types. See Table 7 for details.

Month	Year	PC		Significance	Other Significant PC Correlations
May	1976	$I+IV^2$	.723	$P \leq 0.001$	IV^2, I
	1977	I	.665	$P \leq 0.01$	$I+IV^2$, IV^2
	1978	I	.575	$P \leq 0.01$	$I+IV^2$
	1979	I	.637	$P \leq 0.01$	$I+IV^2$, IV^2
June	1976	$I+IV^2$	.723	$P \leq 0.001$	IV^2, I
	1977	$I+IV^2$	.618	$P \leq 0.01$	I
	1978	I	.546	$P \leq 0.01$	$I+IV^2$
	1979	I	.481	$P \leq 0.05$	IV^2
July	1976	$I+IV^2$	.719	$P \leq 0.001$	IV^2, I
	1977	I	.508	$P \leq 0.02$	IV^2, $I+IV^2$
	1978	$I+IV^2$	.526	$P \leq 0.02$	IV^2, I^2
	1979	I	.590	$P \leq 0.01$	$I+IV^2$
August	1976	$I+IV^2$	.724	$P \leq 0.001$	IV^2, I
	1977	I	.637	$P \leq 0.01$	$I+IV^2$
	1978	$I+IV^2$	.569	$P \leq 0.01$	I, I^2

upon the activities of large primary cavity nesters (Gila Woodpeckers and Gilded Flickers) and the forces of nature for cavity formation. Unlike its smaller relative, the Ash-throated Flycatcher (Myiarchus cinerascens), this species is almost totally restricted to tall (≥ 13 m or 40 ft) trees for nesting. The most heavily used habitats are CW I, II, and SM II (Table 6). Unlike the Gila Woodpecker, this species seems to use all available nesting trees and in rather high densities. At the Water Wheel Resort site, tall screwbean mesquite is the numerically dominant tree; however, a few rather tall cottonwoods are scattered throughout the site. One pair of flycatchers may be found at almost every cottonwood clump in the area for an overall density similar to that of a cottonwood-willow dominated area (such as occurs at the Bill Williams River delta). At most survey spots where Gila Woodpeckers were present, Brown-crested Flycatchers also were present but were more common.

Field Observations. At least 70 individuals were located. The earliest date that birds were found was 2 May. In California, the greatest concentrations were at the Water Wheel site (7-10 pairs) and between Laguna and Imperial Dams (about 9 pairs). As with Gila Woodpeckers, many pairs were located at resorts, residences, and parks. Also, five pairs were located at the Soto Ranch, where there are a few cottonwood snags but many tall honey mesquite snags. This species typically begins to leave the valley in early August; most are gone by the end of August. However, some linger every year into September in the cottonwood-willow habitats of the Bill Williams River delta in Arizona. The last bird recorded this year in California was on 31 August at the Water Wheel Resort site.

Estimated Population Size. The calculated number of Brown-crested Flycatchers on the California side of the Colorado was 281 individuals (Table 10). Adding birds from private residences and resorts the number could be as high as 350. High numbers of this species are found in screwbean mesquite as well as cottonwood-willow habitats. So, the high estimate (100 individuals) in the Parker II Division resulted from the relatively high amount of screwbean and cottonwood-willow habitat available. As discussed above, enough willows and/or cottonwoods are spread through screwbean habitats to support nesting sites for the species.

Problems. It is difficult to assess problems of habitat removal for a species that has expanded into the valley after much of the alteration had begun. Continued removal of tall trees would be likely to halt any further expansion, the impression being that this bird species has occupied all available areas where cavities in tall trees exist.

The starling has been listed as a potential cavity competitor for the Brown-crested Flycatcher. Starlings interfere with Gila Woodpecker nesting. However, the same does not appear to be true with Brown-crested Flycatchers on the Colorado River. Brown-crested Flycatchers begin breeding in mid-May, and seem able to defend their territories and nest cavities at that time from starlings. To what extent displaced Gila Woodpeckers must compete with Brown-crested Flycatchers for cavities is unknown.

Crissal Thrasher

Historical Occurrence. Cooper (1861) called the species common. Swarth (1914) and Grinnell (1914) also stated that the species was common in mesquite brushland.

Habitat Use. Because this species can be found in almost any riparian community and because it typically occurs in low densities, seasonal data by year did not reveal any consistent habitat preferences. However, combining each season by years revealed significant trends. The Friedman's two-way Analysis of Variance test supported this procedure ($x^2 \geq 34$, d.f.=22, $P \leq 0.05$), by showing a non-random distribution among the 23 habitats. There were habitats that supported higher densities of thrashers more times than expected by chance alone. HM III, IV, V and SM IV were these habitats (Table 6). During fall, winter, and spring, thrashers were positively associated with the number of honey mesquite trees present, PC II. The higher the honey mesquite tree count the higher thrasher densities were. However, this factor was not significant during summer and late summer(Table 13). Instead, areas with medium foliage density and diversity, PC I^2, became important during these two seasons. The negative correlation with this principle component described stands of salt cedar, screwbean mesquite, as well as honey mesquite as associated with thrasher densities. Although PC I^2 was important during late summer, thrasher densities were even more highly correlated with high numbers of both salt cedar and honey mesquite trees, PC II^2.

Habitat breadths (Table 8) revealed that the narrower values were generally during winter and/or spring, while the highest values were generally during summer, late summer or fall ($P \leq 0.001$, Table 9). The Crissal Thrasher begins its breeding cycle in early January and young are first fledged by April. As with the Gila Woodpecker, broadening habitat breadths during summer and late summer could indicate post-breeding dispersal into secondary habitats. This is reflected by the change in habitat requirements during these seasons. By the following winter, breeding seems to be mostly restricted to the established territories in the preferred habitats (Anderson et al. 1982), in this case, honey mesquite. Mild winters may allow limited breeding in secondary habitats.

Field Observations. The species was ubiqitous throughout most habitats on the California side of the Colorado River. This might be expected from the results above as post-breeding dispersers may be found anywhere.

Estimated Population Size. The Crissal Thrasher had the highest calculated population size of any species considered in this report. About 960 individuals were estimated to occur on the California side of the Colorado River during summer (Table 10). This estimate probably includes dispersing young as described above. The actual breeding population may be somewhat lower. Because the combined amount of salt cedar and screwbean mesquite vegetation constitutes a large proportion of available habitat in California and since Crissal Thrashers are associated with these habitats in summer, the higher numbers are reasonable. However, most of the prime breeding habitat, honey mesquite, exists on the Arizona side. A better indication of the Crissal Thrasher's status in California may be gained by studying the species from January through April.

Table 13. Spearman's rank correlation coefficients (r_s) and significance levels between ranked densities of Crissal Thrasher and ranked factor scores of riparian vegetation PC's (Table 3) for 23 habitat types. See Table 7 for details.

Season	Year	PC	r_s	Significance	Other Significant PC Correlations
Winter	All years	II	.410	$P \leq 0.001$	$II + II^2$
Spring	All years	II	.220	$P \leq 0.02$	
Summer	All years	I^2	-0.273	$P \leq 0.01$	
Late Summer	All years	II^2	.296	$P \leq 0.02$	12
Fall	All years	II	.254	$P \leq 0.5$	

Problems. Continued clearing of mesquite on both sides of the river may cause future declines in the population by reducing prime breeding habitat. Cowbirds do lay eggs in thrasher nests; however, recent work has indicated that thrashers largely reject cowbird eggs in the lower Colorado River area (Finch 1982).

Sonoran Yellow Warbler

Historical Occurrence. Swarth (1914) characterized the Sonoran Yellow Warbler as a common summer resident confined almost entirely to the lower Sonoran river valleys, including the Colorado River valley from Ft. Mohave to Yuma. Grinnell (1914) called this species abundant (one of the five most often encountered species along with Bell's Vireo, Yellow-breasted Chat, Summer Tanager, and Brown-headed Cowbird) and adhearing strictly to cottonwood-willow dominated habitats. Grinnell estimated no fewer than four singing males per acre of willow near Picacho. The species began to decline dramatically after 1955 and was considered extirpated from the valley by 1960 (Monson and Phillips 1981, Serena 1981a).

Habitat Use. For this study, no adequate data existed to determine use of habitats by this species.

Field Observations. The only observation of a summering Yellow Warbler was at Needles, CA from 9 June to 21 July. The individual was a singing male apparently on territory. A brief search on 9 June did not reveal a female. By 21 July the area was inaccessible due to high water; however, the male could be heard singing. Other recent evidence of local nesting, at least of summering individuals, were at Blythe in 1977, and on the Arizona side near Needles in 1977 and 1978 and near Ehrenberg in 1977 (Serena 1981b).

Estimated Population Size. This species was recorded very rarely during the breeding season on either side of the river from 1974 to 1983. No more than two singing males have been found on the California side. Although no Yellow Warblers were estimated to occur on the California side of the Colorado River during summer (Table 101, 1983 observations suggest that there are no more than two pairs in California, with a possibility of a few more in the Imperial Division.

Problems. Loss of cottonwood-willow habitats probably is the primary cause of this species' disappearance along the Colorado River. The lack of Yellow Warblers at some areas of seemingly suitable habitat, such as along the Bill Williams River in Arizona, suggest other factors may be involved, including poor conditions in wintering areas and cowbird parasitism (Remsen 1978). It is possible that the population declined to such a low level that cowbird nest parasitism caused the production of young to fall below the mortality rate. What caused this species to become so rare relatively quickly, however, remains debatable (see Discussion).

Yellow-Breasted Chat

Historical Occurrence. Grinnell (1914) considered this species to be one of the more abundant birds on the Colorado River in the cottonwood-willow association. Swarth (1914) also called it an abundant summer visitor north to Ft. Mohave.

Habitat Use. Yellow-breasted Chat densities were found to be correlated significantly with high foliage density and diversity, PC I (Table 14). Cottonwood-willow habitats demonstrated the highest correlation with this PC (Table 3) and also had the highest use by chats (Table 6). However, during 1978 and 1979, this relationship was not significant three months out of seven (Table 14). Upon inspecting the actual densities in each habitat, the numbers of chats in cottonwood-willow had remained stable, but numbers of chats in salt cedar, salt cedar-honey mesquite mix, and screwbean mesquite-salt cedar mix had increased. Most of these habitats did not score high on PC I (Table 3), thus causing the non-significant results. On the transect level, salt cedar areas that had been under study since 1974 did not have chats detected on them until 1979. Since 1979 (to the present, 1983), chats have occurred on these transects and were thought to be breeding (success unknown). Chats have always reached their highest densities in cottonwood-willow dominated habitats. Usually these areas have had a thick understory, including various plant species, where chats usually were detected during censusing. Chats may really be attracted to low level vegetation as in structural types I, IV, and V (Figure 3). A cottonwood-willow overstory still appears important in attracting high numbers of chats, but apparently is not a necessity for chat occurrence along the Colorado River. Extensive work at Cibola National Wildlife Refuge (1981-1983 Anderson, unpublished data) revealed that chats were abundant in salt cedar-honey mesquite mix areas with an arrowweed understory. This change in chat habitat use has come only recently, after many years of decline throughout Southern California (Garrett and Dunn 1981).

Field Observations. Concentrations of chats were found during surveys between Laguna and Imperial Dams (20+ pairs) in willow habitat on 1 June, between Needles and Beal Slough (16+ pairs) in willow and screwbean mesquite habitats on 9 June, at Water Wheel Resort in screwbean mesquite habitat (4-7 pairs) throughout the study, and at Picacho State Recreation Area (5+ pairs) in screwbean mesquite habitat on 15 July. Scattered singing males were found all along the river valley north to the honey mesquite stand at the Soto Ranch. Two males were found in salt cedar habitats near Palo Verde, CA and three males were found near Hall Island. Undoubtedly chats are at least fairly common in the Imperial Division which was not checked.

Estimated Population Size. The estimated population size of the Yellow-breasted Chat was about 195 individuals on the California side of the Colorado River (Table 10). Since 1978 chats have expanded into salt cedar, salt cedar-honey mesquite mix, and screwbean mesquite-salt cedar mix habitats. Our estimate may be lower than the number of chats now present. The evidence indicates that this species is increasing in the remaining habitat.

Problems. Loss of cottonwood-willow habitat has been instrumental in the decline of the Yellow-breasted Chat since Grinnell's day. Recent expansion into other habitats (salt cedar, salt cedar-honey mesquite, screwbean mesquite) is encouraging but may only be temporary. The chat also is affected by cowbird parasitism. Expansion into other habitats has come in spite of cowbird presence.

Summer Tanager

Historical Occurrence. Cooper (1861) considered the Summer Tanager as common throughout the Colorado Valley north to Ft. Mohave. Swarth (1914) rated this species as a common summer resident along the "hot river valleys of the

Table 14. Spearman's rank correlation coefficients (r_s) and significance levels between ranked densities of Yellow-breasted Chat and ranked factor scores of riparian vegetation PC's (Table 3) for 23 habitat types. See Table 7 for details.

Month	Year	PC	r_s	Significance	Other Significant PC Correlations
May	1976	I	.610	$P \leq 0.01$	I+II, IV
	1977	I	.743	$P \leq 0.001$	I+II
	1978	I	.366	NS	
	1979	I	.348	NS	
June	1976	I	.556	$P \leq 0.01$	
	1977	I	.674	$P \leq 0.001$	I+II
	1978	I	.594	$P \leq 0.01$	I+II
	1979	I	.557	$P \leq 0.01$	
July	1976	I	.549	$P \leq 0.01$	
	1977	I	.606	$P \leq 0.01$	I+II
	1978	I	.303	NS	
	1979	I	.449	$P \leq 0.05$	
August	1976	I	.427	$P \leq 0.05$	
	1977	I	.547	$P \leq 0.01$	
	1978	I	.533	$P \leq 0.02$	

Colorado and its tributaries", breeding as far north as Ft. Mohave. Grinnell (1914) considered the tanager as one of the five most characteristic species of the Colorado River cottonwood-willow association.

Habitat Use. Data for this species have revealed a distinct and unequivocal preference for habitats with high foliage density, primarily in cottonwood-willow habitats, PC I & IV (signs reversed) (Table 15). Cottonwood-willow habitats I, II, III are the most heavily used native riparian habitats. However, tanagers also have a very high affinity for SC I (athel tamarisk) (Table 6). Since large stands of athel tamarisk are used as well as cottonwood-willow stands, tanagers seem to prefer the height of trees over tree species in the lower Colorado valley. Athel tamarisk (Figure 8) is sparsely distributed in the valley with relatively large stands occurring only at Topock and Dome Valley (both sites in Arizona) and south of Winterhaven, CA. Given the amount of CW I, II, III and SC I in California, the species may be expected to be exceedingly rare (Table 4).

Field Observations. Only five tanagers were observed along the California side of the Colorado. In Arizona, up to 5 were located at the athel tamarisk stand near Topock, 3 at the athel tamarisk stand at Dome Valley, up to 10 in the Bill Williams River delta, and up to 7 at Cibola National Wildlife Refuge. Specific sites where tanagers were observed in California were 1 pair between Imperial and Laguna Dams on 1 June, 1 pair at Picacho State Recreation Area on 15 July, and 1 female 3 km N of the Clark Ranch throughout the summer. There may be more pairs to be found in the Imperial Division. The lone female near the Clark Ranch was reported to be with a male in late April by a local resident (K. McCormick pers. comm.) but the male apparently disappeared. Clark (pers. comm.) noted a lone female occasionally at her feeders, probably the same individual. Experimental revegetation sites in California, 7 km (4 mi) SSE of Palo Verde, Imperial Co., were planned by Anderson, Ohmart and Disano (1978) to maximize bird use of native vegetation primarily cottonwoods and willows). Trees were planted in 1978 but it was not until 1982 that a tanager was detected on one site where the trees had reached 30 feet in height. Tanagers should be expected to occur on these sites more consistently as the trees continue to grow (Anderson, pers. comm.). One immature male Summer Tanager was found on the revegetation site on the Arizona side on 9 June.

Estimated Population Size. The estimated population size of the Summer Tanager on the California side of the Colorado River was calculated to be about 46 individuals (Table 10). About 20 of these were calculated to occur in the Yuma Division, where a sizeable athel tamarisk stand exists, though none was located on the surveys. Probably no more than ten pairs exist on the California side of the Colorado River.

Problems. The major reason for decline of the species along the Colorado River is the loss of mature cottonwood-willow habitat. Without large ($\geq$20 ha, $\geq$50 acres) stands of tall and mature cottonwoods and willows, the species may easily become extirpated, especially on the California side. The discontinuity of the existing cottonwood-willow habitat also may have a detrimental effect on the population. The species' occurrence in athel tamarisk is biologically interesting and should be investigated further, but the SC I habitat has very low value to most other bird species in the Colorado valley (Anderson and Ohmart 1977b). Extensive flooding of the Colorado River during the summer of 1983 may result in the death of many cottonwoods and

Table 15. Spearman's rank correlation coefficients (r_s) and significance levels between ranked densities of Summer Tanager and ranked factor scores of riparian vegetation PC's (Table 3) for 23 habitat types. See Table 7 for details.

Month	Year	PC	r_s	Significance	Other Significant PC Correlations
May	1976	I+IV (SR)*	.611	$P \leq 0.01$	I
	1977	I	.695	$P \leq 0.001$	I+IV(SR)
	1978	I+IV (SR)	.778	$P \leq 0.001$	I
	1979	I+IV (SR)	.679	$P \leq 0.001$	I
June	1976	I+IV (SR), I	.643	$P \leq 0.01$	
	1977	I+IV (SR)	.718	$P \leq 0.001$	I
	1978	I+IV (SR)	.669	$P \leq 0.001$	I
	1979	I+IV (SR)	.668	$P \leq 0.001$	I
July	1976	I+IV (SR)	.573	$P \leq 0.01$	I
	1977	I+IV (SR), I	.722	$P \leq 0.001$	
	1978	I+IV (SR)	.781	$P \leq 0.001$	I
	1979	I+IV (SR)	.720	$P \leq 0.001$	I
August	1976	I+IV (SR)	.612	$P \leq 0.01$	
	1977	I+IV (SR)	.671	$P \leq 0.001$	I
	1978	I	.518	$P \leq 0.02$	I+IV(SR)
September	1976	I+IV (SR)	.645	$P < 0.01$	I
	1977	I+IV (SR)	.708	$P \leq 0.001$	I
	1978	I	.708	$P \leq 0.001$	I+IV(SR)

*SR = refers to sign reversal on PC IV, see explanation in text under Habitat Use in Methods.

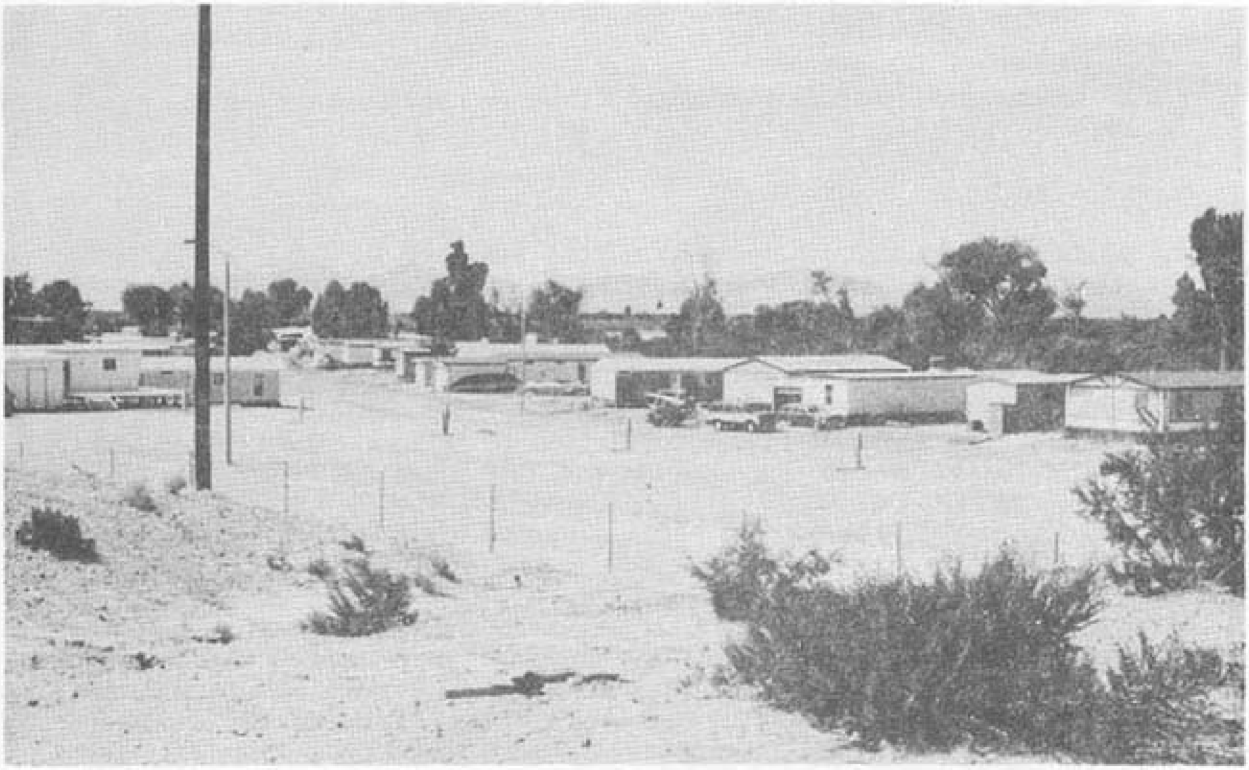

Figure 7. Resort on Colorado River north of Blythe, CA. Note some standing mature cottonwoods. Photo by author.

Figure 8. Athel tamarisk stand near Water Wheel Camp, CA. Large stands (>60 ha) of athel tamarisk on teh Arizona side of the Colorado River support Summer Tanagers. Photo by author.

willows, especially in the Imperial Division, and further reduce available habitat.

Northern Cardinal

Historical Occurrence. One record of the Northern Cardinal was reported by Swarth (1914), from the "Colorado River, Arizona", 30 November 1871. Van Rossem (1946) reported on an isolated colony near Earp, California in 1946. Monson (1949) first found the species near Parker Dam in 1943 and found them there subsequently in 1946 and 1948. Both van Rossem and Monson believe that the California birds represented a limited expansion from the isolated Big Sandy - Bill Williams rivers population in Arizona. The species was found to breed erratically near Earp during the 1960's and 1970's.

Habitat Use. Adequate data on habitat use on the lower Colorado River were not available for this species.

Field Observations. The mesquite lands where the species had been found near Earp were largely cleared by 1983 and no birds were located. However, during 1983 four cardinals were found on the California side. Two males and one female were thought to have bred 5 km (3 miles) north of the Agnes-Wilson Bridge (Guy McCaskie pers. comm.) and 1 female was found at the Soto Ranch on 20 April. Screwbean mesquite dominates the former site, and honey mesquite the latter. Cardinals are found annually at several honey mesquite stands on the Arizona side. Also, during winter, individuals are located irregularly near Lost Lake resort.

Estimated Population Size. Only one Northern Cardinal was estimated to occur on the California side (Table 10) because of sparsity of mesquite habitat on the California side and erratic occurrence of the species.

Problems. The species' occurrence on the Colorado River is erratic. Clearing mesquite brush lands probably will reduce the occurrence of this species.

DISCUSSION

Field studies indicate that five of the nine species of riparian birds examined along the Colorado River (Gila Woodpecker, Gilded Northern Flicker, Vermilion Flycatcher, Sonoran Yellow Warbler, and Summer Tanager) have incurred serious declines and are in danger of extirpation in California. Three species (Brown-crested Flycatcher, Yellow-breasted Chat and Northern Cardinal) are rare but have relatively stable populations or have never been common in the region. All eight of these species are largely dependent on native cottonwood-willow habitat or to a lesser extent on tall, pure mesquite habitat and mesquite-cottonwood-willow mix habitat (Table 16).

Other bird species occurring on the lower Colorado River include the State-listed threatened Yellow-billed Cuckoo (Coccyzus americanus), the State-listed endangered Elf Owl (Micrathene whitneyi), and Arizona Bell's Vireo (Vireo belli arizonae) which is being considered by the State for classification as endangered or threatened. These three species also are associated highly with cottonwood-willow habitats.

Table 16. PCA summary table for six bird species on the lower Colorado River. The most important PC's are listed for each species. The number of times each PC was the most highly significant correlated PC for each bird species is reported. + = PC was significant for species at least once but was never the most highly significant.

Species	Principle Component: I	I^2	II	II^2	IV	IV^2	I+II	$II+II^2$	I+IV(SR)*	$I+IV^2$	Total Tests
Gila Woodpecker	8	1							9		18
Gilded Northern Flicker	6	1				+				II	19
Brown-crested Flycatcher	8	+				+				7	15
Crissal Thrasher**		1	3	1				+			5
Yellow-breasted Chat	12				+		+				15
Summer Tanager	3								15		18

*SR = refers to sign reversal on PC IV; see explanation in text under Habitat Use in methods.

**For Crissal Thrasher each season was combined across years for PCA.

The bird species considered in this study are reported on as separate entities, but it is important to consider all of these declining or rare species as components of a single bird community. With the dramatic loss of mature, tall cottonwood-willow habitat during the twentieth century we are witnessing the loss of an entire ecological community with all its plants and animals. Only one species considered in this report, the Crissal Thrasher, is not in trouble because it uses a larger variety of habitats.

Revegetation may be the only method to reverse this trend. Revegetation can occur by itself for the benefit of wildlife or it can be included as mitigation. Revegetation done solely for the benefit of wildlife generally is considered to be too expensive except when a species' survival is at stake. We are at that stage or fast approaching it along the Colorado River for many bird species. Large-scale revegetation as mitigation is overdue. Its cost, although large when considered by itself, is small when the overall costs of a development project and the effectiveness of large-scale revegetation projects for maintaining wildlife are considered.

Habitat Trends

Vegetation Clearing

Beginning in the mid 1800's, tracts of riparian vegetation were cleared to provide fuel wood for the steam engines of river boats. Then, as settlers learned to transport river water and to control flood waters, land was cleared for agriculture. By the 1940's, with the river flow controlled by numerous dams, thousands of acres of riparian habitat were cleared for agricultural production. All bird species considered in this report rarely, if ever, use agricultural land; Crissal Thrashers may be an exception (Anderson and Ohmart 1982). Most remaining large tracts of riparian vegetation are found only on Indian lands and in national wildlife refuges. However, most of the remaining mesquite habitat on reservation lands is being converted for agricultural production (Figure 9, a-d). The respective tribal councils are trying to develop the full economic potential of their lands. Additional native habitat will be cleared for other reasons, including presently planned housing developments. Lands cleared of mature habitat and left fallow will be regenerated with salt cedar (Figure 6) and/or arrowweed (Figure 10), or rarely by Atriplex (Figure 11). Developed land, especially agricultural land, will not support populations of those species studied in this report.

River Management

Control of the Colorado River has halted the natural flooding tendencies and cyclic plant regeneration that maintain native vegetation. Instead, very little natural regeneration occurs. Old remaining stands consisting primarily of willow (Figure 12) slowly die and are replaced by salt cedar and screwbean mesquite (Figure 13). Also, channelization essentially has isolated many backwater areas from the main channel increasing the rate of xeric succession and reducing the values of these important wildlife areas. Lining channel banks with large boulders to help halt erosion has seriously reduced the area for establishment of native trees. However, revegetation with native tree species also stabilizes banks and could be used in many areas instead of or with boulders to line the river channel.

Figure 9a. Conversion from mesquite habitat to agriculture. Note new salt cedar growth 3 months after initial clearing and standing vegetation in background. Photo by author.

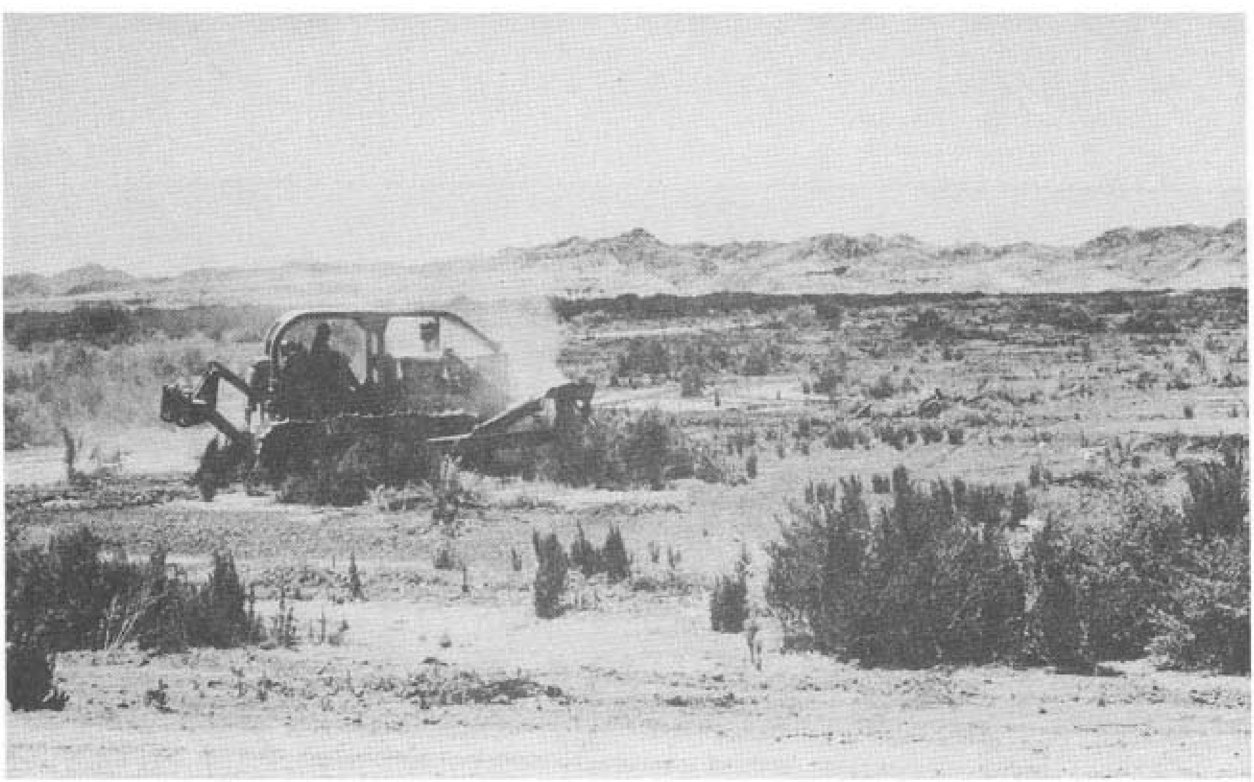

Figure 9b. Conversion from mesquite habitat to agriculture. Piles are burned and new salt cedar and arrowweed growth re-bulldozed. Photo by K. Krueper..

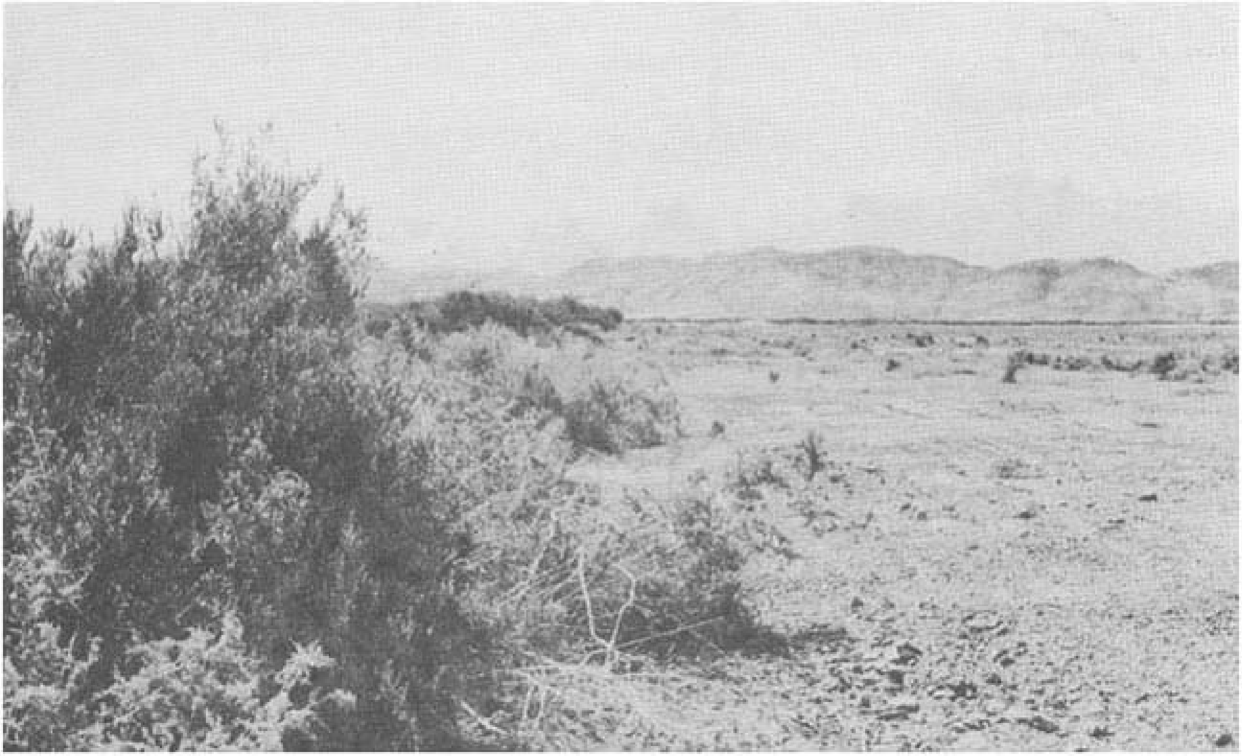

Figure 9c. Conversion from mesquite habitat to agriculture. Soil is leveled. Compare cleared area with vegetated area. Photo by author.

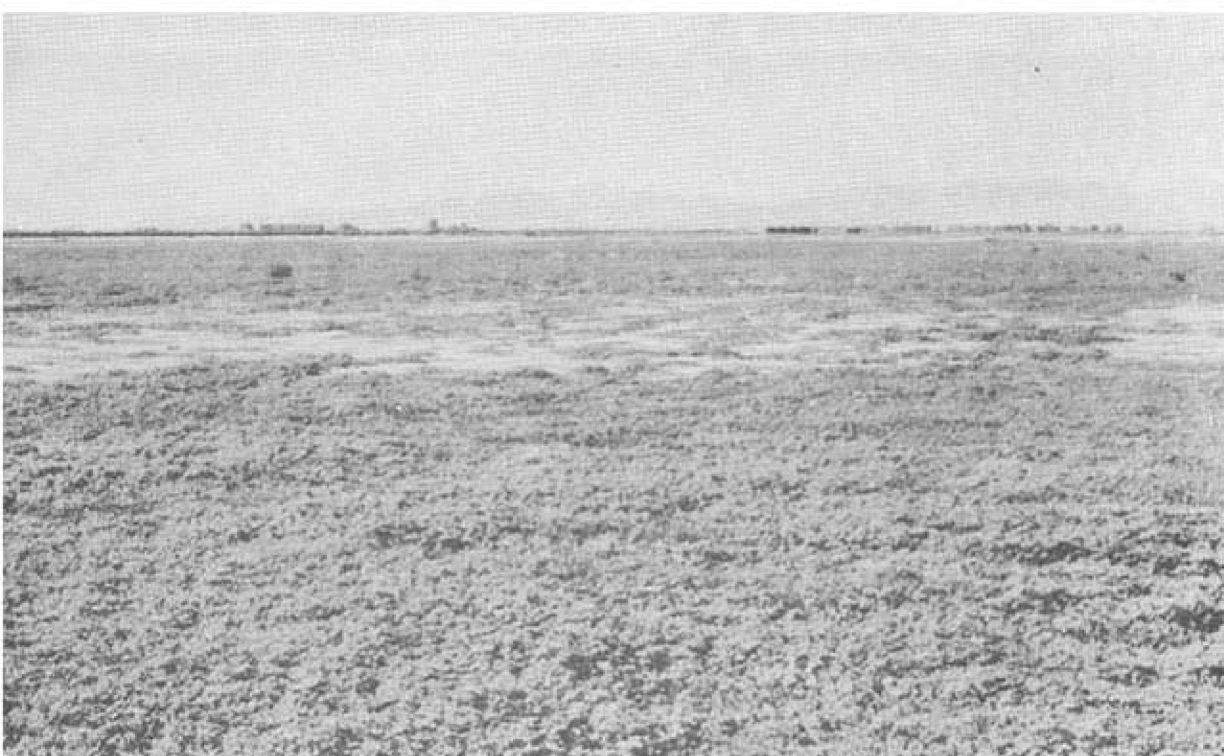

Figure 9d. Conversion from mesquite habitat to agriculture. Land is planted in this case, with alfalfa. Before the conversion to agriculture, honey mesquite was the dominant vegetation throughout this valley which extends to the base of the distant mountains. Photo by author.

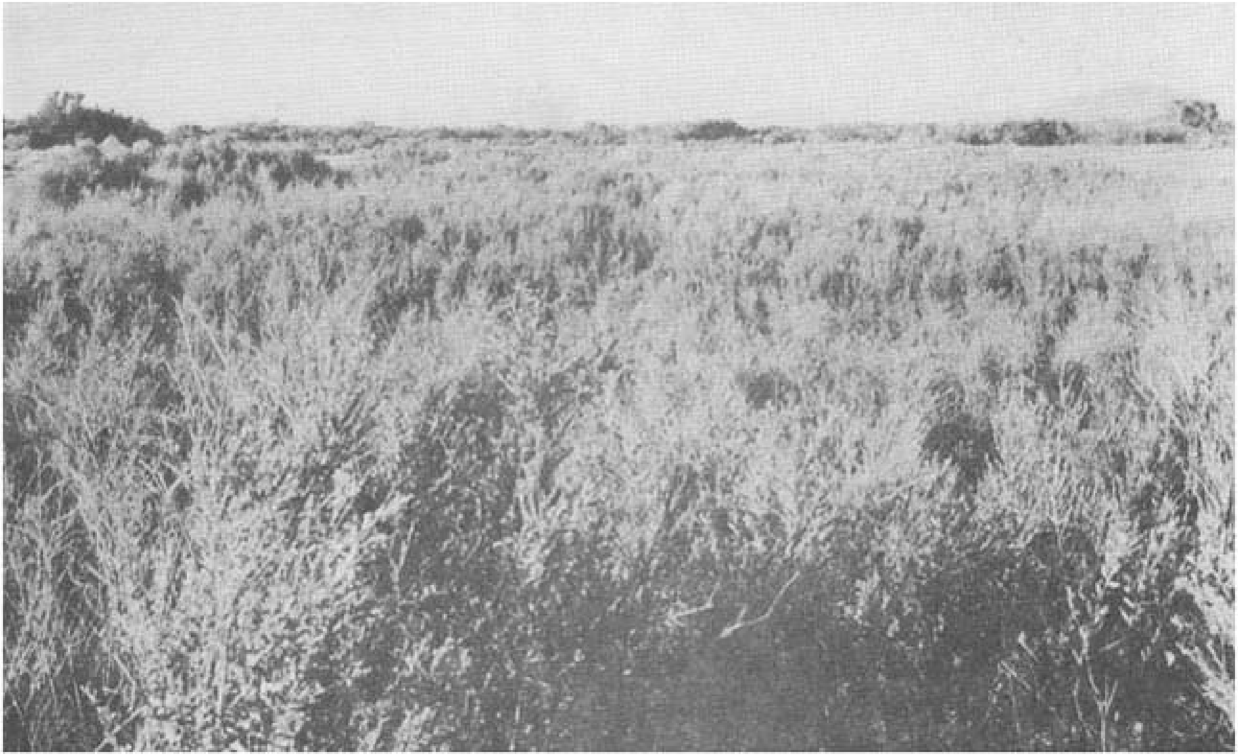

Figure 10. Arrowweed stand near Ehrenberg, AZ. Photo by author.

Figure 11. Quailbush (Atriplex lentiformis), saltbush (Atriplex carescens), coyote willow (Baccharis spp.) and inkweed (Suaeda torreyara) mixture near a honey mesquite stand. Photo by J. Jackson.

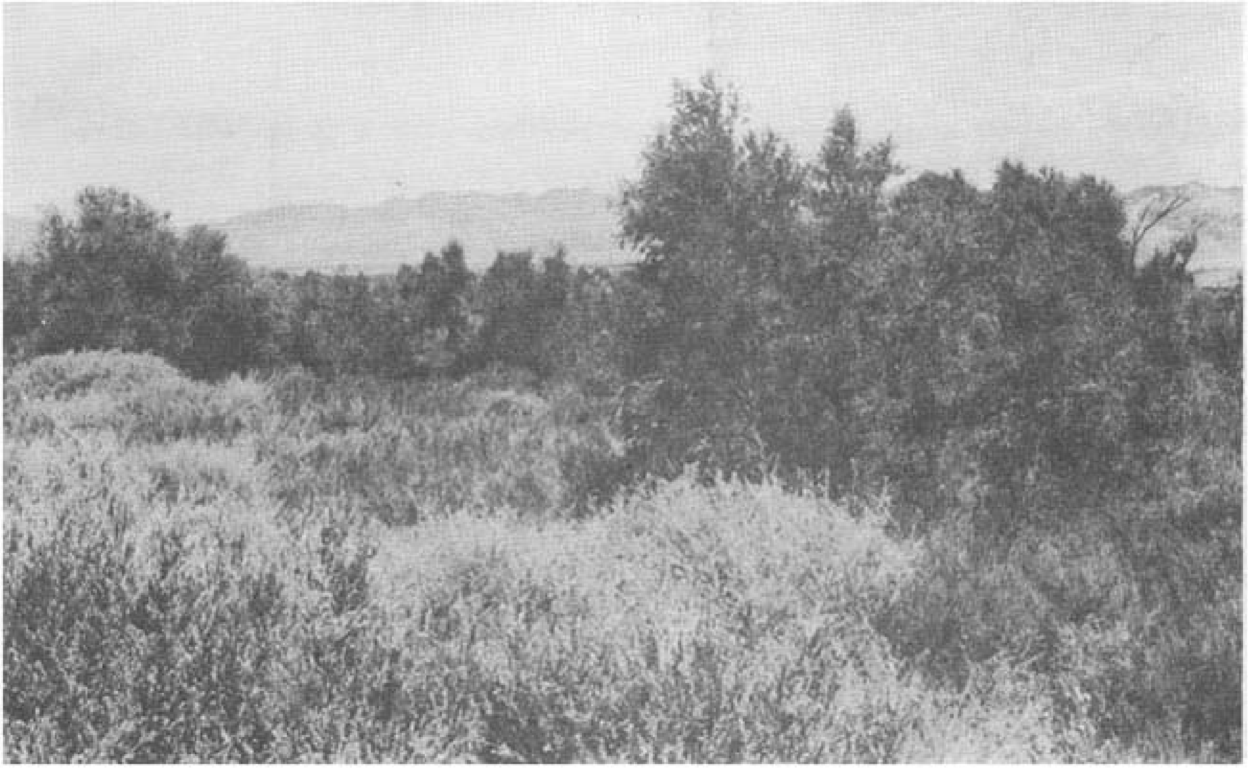

Figure 12. A decadent stand (10 ha) of willow interspersed in an arrowweed and saltbush stand. Photo by author.

Figure 13. Isolated cottonwoods and willows in salt cedar/screwbean mesquite dominated habitat along the Colorado River near Blythe, CA. This is a February picture; salt cedar and screwbean mesquite do not leaf-out until April. Photo by J. Jackson.

Flooding

Before the construction of major dams, natural flooding was an essential element in keeping the riparian systems along the Colorado healthy. However recent "controlled" flooding is different. Flooding of the Bill Williams River lasted for two years (1978-1980) with no apparent consideration for the importance of the inundated habitats. An Environmental Impact Statement was not filed for the water releases. The flood destroyed most of the mature cottonwood-willow habitat on Havasu National Wildlife Refuge (and, therefore, in the lower Colorado River; Figure 14) and also interrupted breeding of the federally endangered Yuma Clapper Rail (*Rallus longirostris yumanensis*) in adjacent marshland.

Until recently, the channelized Colorado River never flooded, but in the summer of 1983, water releases exceeded any previously controlled flows. The flooding of 1983 is likely to result in the death of most cottonwoods that were completely inundated. This tree species is intolerant of long-term flooding. Willows will probably do better, but regeneration of native trees may be limited by the timing of the flood and the potential change toward factors that favor salt cedar (Figure 15). Any mesquites inundated are likely to die within a few months. Long-term effects of the current flooding will not be completely known for several years. Immediate effects would seem to be largely negative due to a continued and accelerated loss of critical habitats needed by the bird species examined. Even though regeneration of cottonwoods and willows may occur it will be at the expense of the very few, small and isolated, healthy stands that presently persist.

Burning

Almost all stands of vegetation along the Colorado River have been subject to burning within the last fifty years (Anderson, Higgins and Ohmart 1977). Because of the accumulation of dry leaf litter, salt cedar habitats are exceptionally susceptible. Most fires result in salt cedar and arrowweed quickly regenerating, willows and mesquite occasionally regenerating, and cottonwoods, and *Atriplex* dying. When a stand is burned, all vegetation is consumed (Figure 16 a). If the stand is a mixture of native plants and salt cedar, salt cedar will be the first to regenerate and through successive fires will eventually displace the native species (Figure 16b). The value to wildlife other than doves actually increases for up to two years after salt cedar stands burn (Anderson and Ohmart unpub. data), possibly due to increased access to food items. But, as these salt cedar stands mature, wildlife values decrease dramatically.

Salt Cedar Intrusion

Each of the four previous habitat changes usually result in salt cedar replacing the native riparian vegetation. Salt cedar is fire adapted, tolerant of drought and flooding, and recovers quickly after vegetation clearing unless the roots are plowed. When fires occur the less tolerant native species have virtually no chance of reestablishing before salt cedar takes over. Cleared areas left idle invariably support salt cedar and arrowweed. Finally, most flood and land management practices along the lower Colorado favor the establishment of salt cedar. In order to reestablish cottonwoods and willows naturally, extensive changes would be necessary in the policies set forth by federal and state agencies. The only alternative, and

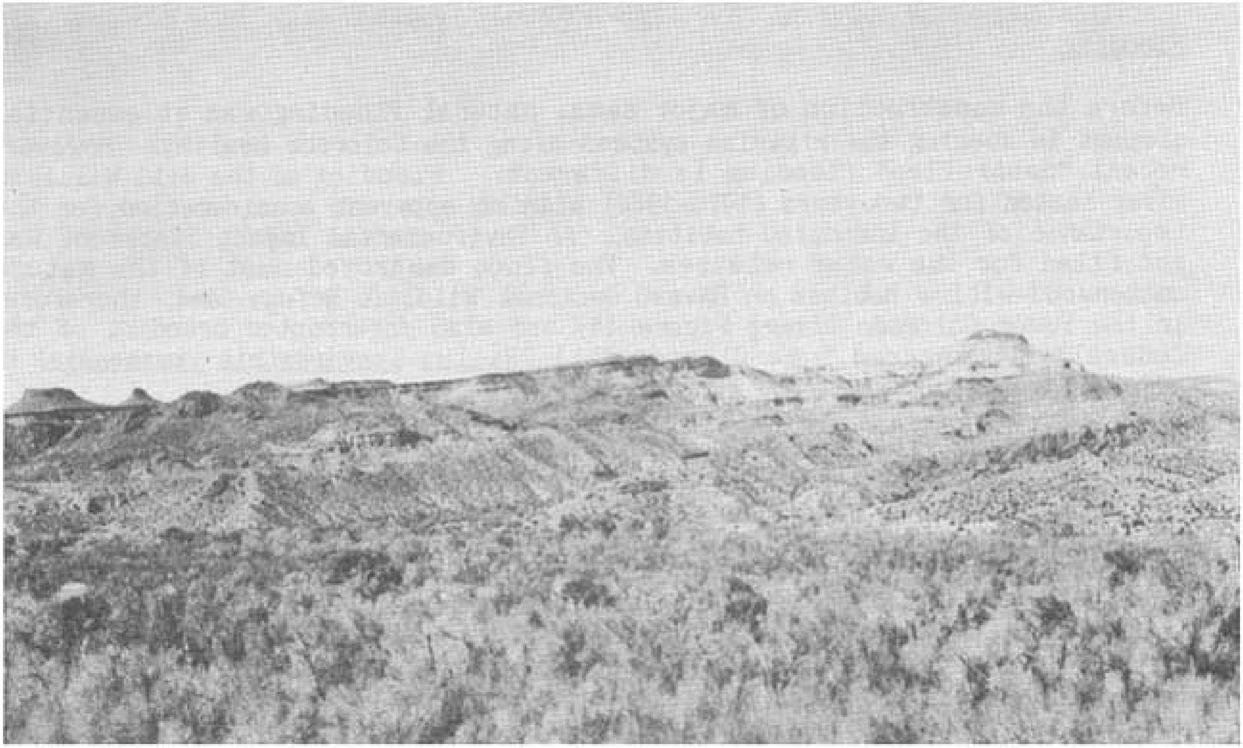

Figure 14. Cottonwood/willow habitat on Bill Williams River, AZ after extensive flooding in 1979-80. Only a few live cottonwoods remain as of 1983. Photo by J. Jackson.

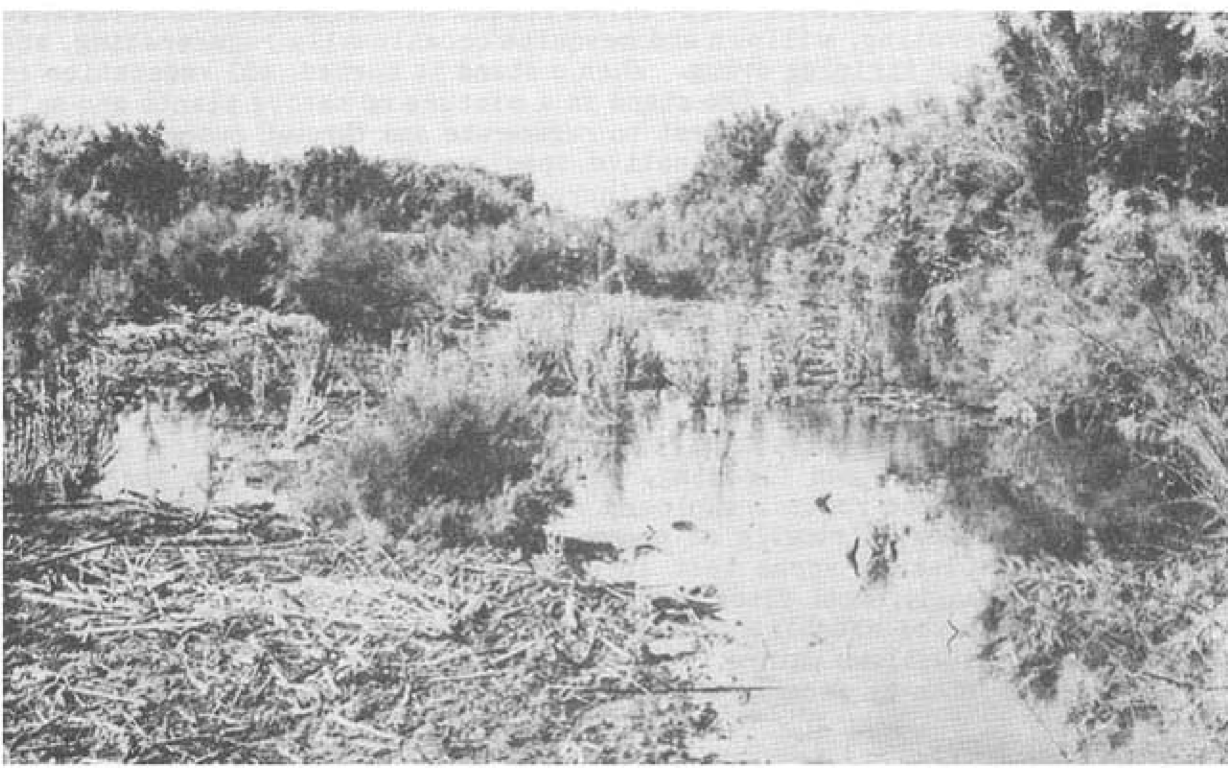

Figure 15. Flooded vegetation, mostly salt cedar and honey mesquite. Note debris piled up in open areas and renewed salt cedar growth. Photo by D. Krueper.

Figure 16a. Five months after burning salt cedar habitat. Photo by J. Jackson

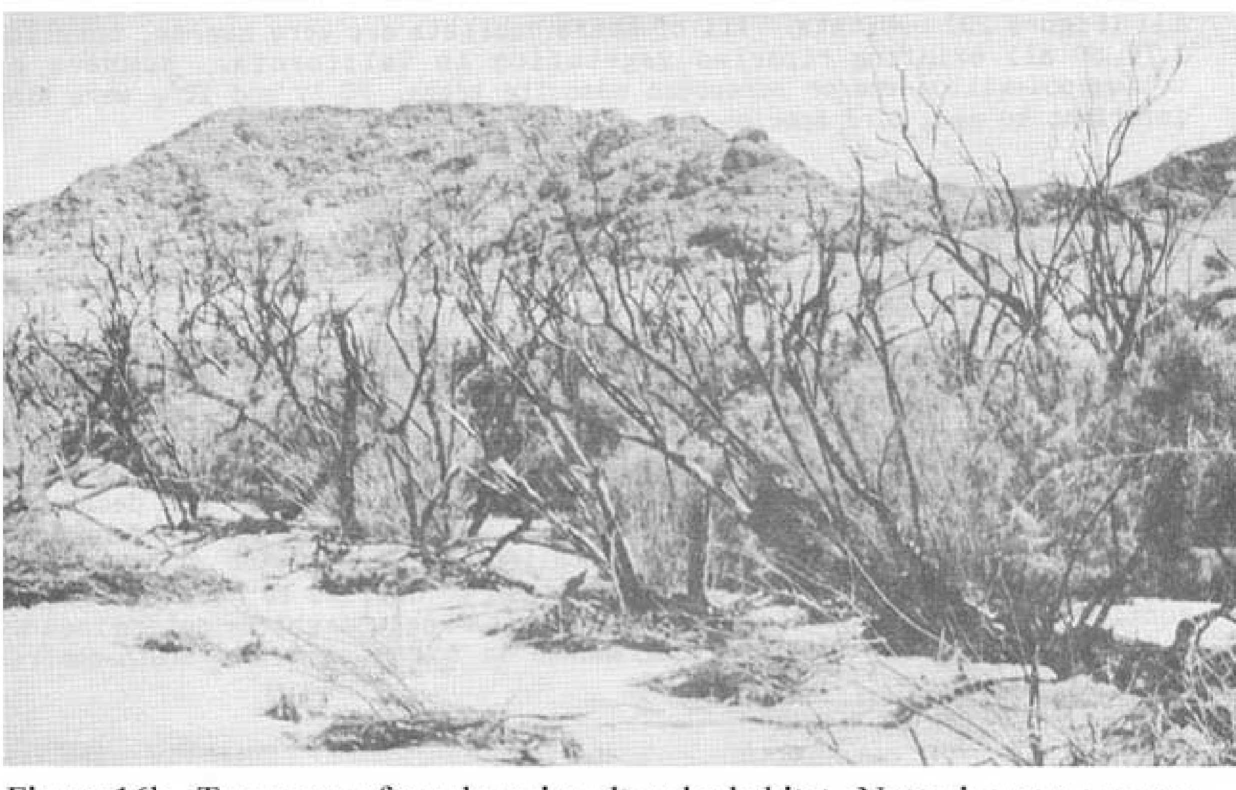

Figure 16b. Two years after a burn in salt cedar habitat. Note vigorous regeneration of salt cedar. Photo by author.

potentially the most viable option, is to reestablish native vegetation by large-scale revegetation projects.

Direct Human Interference

Many of the bird species examined here would not necessarily be disturbed by just the presence of human beings (Figure 7). Benefits may be reaped by some species by the placement of feeders and the growth of shade trees. However, the presence of domestic and feral animals, the clearing of most vegetation, and the killing of birds by indiscriminate shooting may become serious problems for the majority of birds using inhabitated areas. Also, hunting disturbance and off-road driving may have negative effects on these species.

For some species it may be too late to do anything to increase population size, even if massive revegetation projects were implemented. Many questions remain as to why these species have declined along the lower Colorado River and do not use salt cedar. It is clear, however, that cottonwood-willow forest preservation and restoration are the most important actions that can be taken to keep California populations of both migratory insectivores and cavity nesters viable.

General Trends Among the Bird Species

Declining Bird Species

All of the declining bird species, some of which are now very rare, are attracted to areas with high foliage density and diversity. Usually these areas represent mature habitats with the highest factor scores for PC I. These include CW I (Figure 17), CW III (Figure 18), SM II (Figure 19), and HM III (Figure 20) habitats. All of these habitats are very scarce, totaling 1.7% of all existing riparian vegetation in California. Numbers of cottonwood-willow and/or screwbean mesquite trees, PC IV and IV^2, were also important to many bird species.

Stable or Increasing Bird Species

The Crissal Thrasher and Northern Cardinal use habitats still somewhat common in the valley. The Crissal Thrasher commonly uses SM IV, which is the most abundant terrestrial habitat besides SC IV in California (on the Arizona side there are still large tracts of honey mesquite, all of which remain on Indian land). The status of the Northern Cardinal is one of a small population that is remaining stable at very low levels in mesquite habitat.

Unlike the Crissal Thrasher and Northern Cardinal, the Brown-crested Flycatcher uses mature habitats much like those species that are declining. However, the Brown-crested Flycatcher recently has expanded its range into the Colorado River Valley and locally into California. The species may be at its maximum population level now and may begin to decline as habitat removal continues. Why this species has expanded its range might be determined by studying the species' habitat requirements in southeastern and south-central Arizona.

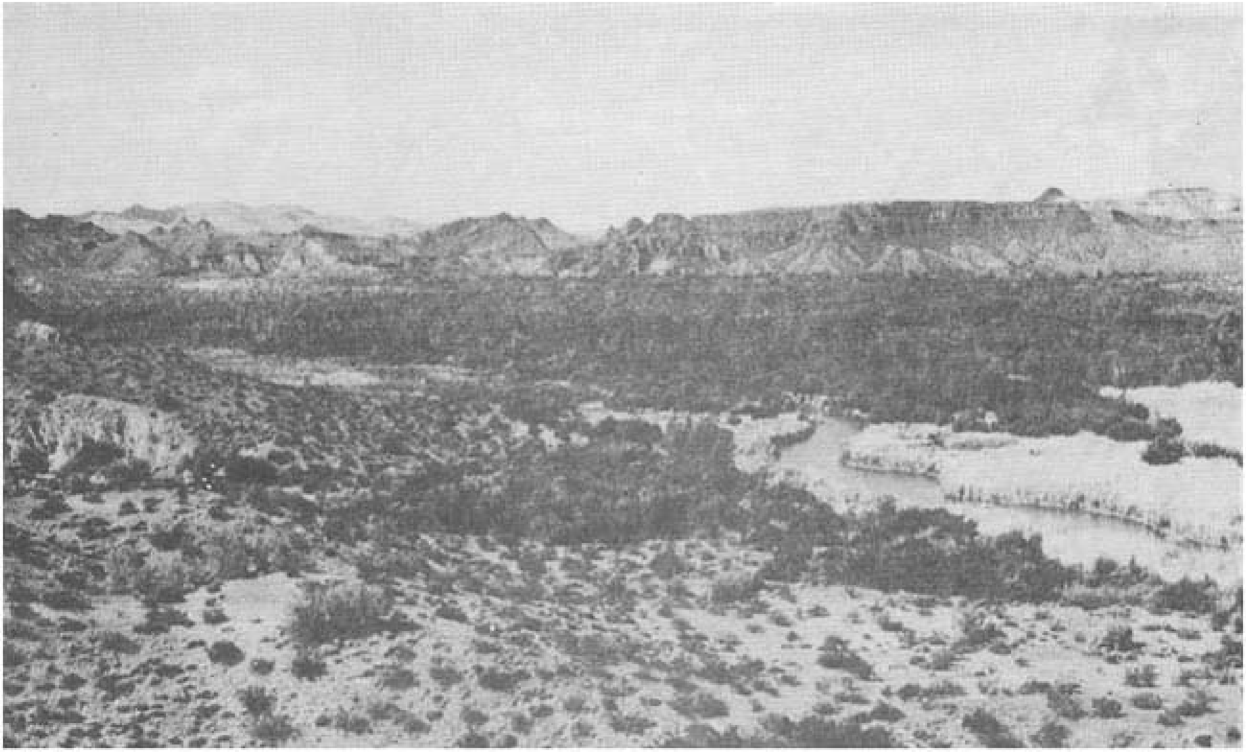

Figure 17. Cottonwood/willow habitat on the Bill Williams River near the confluence with Lake Havasu, AZ. This is the last large (about 120 ha) stand of relatively mature cottonwood/willow habitat along the lower Colorado River. Photo by D. Krueper.

Figure 18. A small (16 ha) stand of Cottonwood/willow habitat in relatively healthy condition, along a channelized portion of the Colorado Rier in Cibola National Wildlikfe Refuge, AZ. Photo by D. Drueper.

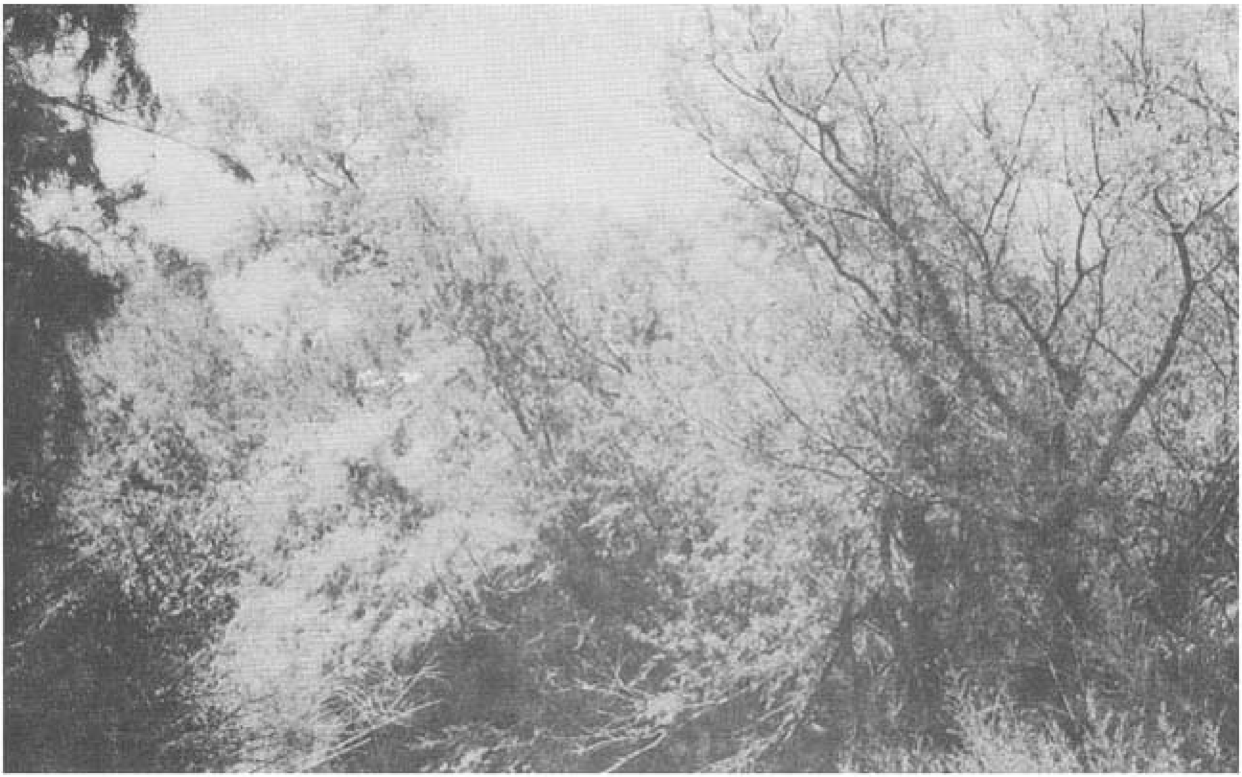

Figure 19. Screwbean mesquite/salt cedar habitat near Water Wheel Camp, CA. This tall stand of screwbean mesquite included scattered cottonwood and willow trees and was unique in California. Many of the bird species studied were found here. Photo by author.

Figure 20. Honey mesquite stand with open understory near Ehrenberg, AZ. The Soto Ranch site, north of Needles, CA is similar in sturcture. Note the closed canopy. Photo by author.

Cavity Nesters

Three of the nine species studied are dependent upon tree cavities for nesting. In addition, the Endangered Elf Owl is also a cavity nester. The Brown-crested Flycatcher population appears to be stable on the lower Colorado River. However, the Elf Owl and Gilded Northern Flicker are in imminent danger of extirpation, while the Gila Woodpecker is more numerous but in no less danger. These species are highly dependent upon large snags found in mature stands of vegetation. For Gila Woodpeckers, Gilded Flickers, and Brown-crested Flycatchers, PC IV or IV^2, were important when combined with PC I. This indicates that the number of mature cottonwood-willow and screwbean habitats (types I, II, III) were very important to these species. Since mature stands are rare and most snags have been removed by burning or clearing, these species are becoming increasingly rare. The Gila Woodpecker and Brown-crested Flycatcher have adapted to (or have been forced into) human inhabited areas where shade trees may contain nesting cavities, while the Elf Owl and Gilded Flicker have not. The owl and the flycatcher are primarily dependent on woodpeckers and flickers to excavate cavities. In order to facilitate the attraction of all these species to revegetated habitats, placement of artificial snags (fide S. Dunn and G. MacDonald, Bureau of Land Management office, Lake Havasu City, AZ) should be implemented, Anderson and Ohmart (pers. comm.) recently have girdled several of the five-year-old trees on their revegetation site to attract primary cavity nesters (and subsequently secondary ones). The presence of starlings has caused obvious disruption of Gila Woodpecker nesting, but has not necessarily disrupted Brown-crested Flycatcher nesting.

Biogeographical Considerations

The Colorado River is, to some extent, near the western edge of the geographical range of most species considered in this report. Sonoran Desert birds such as the Elf Owl, Gilded Northern Flicker and Gila Woodpecker, use the limited riparian habitats on the Colorado River. But, as one crosses into Arizona, all three of these species become common, especially in the areas dominated by saguaro cactus. All three species seem to be limited mostly by the availability of nest sites. The Northern Cardinals may be from a relict population along the Bill Williams River (van Rossem 1946) that have recently invaded California. The Crissal Thrasher reaches the absolute western edge of its range in the Imperial and Coachella Valleys. It is rarely found outside the mesquite belt along river valleys, but this species is still considered common on the Colorado River. As stated previously, the Brown-crested Flycatcher has expanded its range to its western limit on the Colorado River.

The Vermilion Flycatcher, Sonoran Yellow Warbler, Yellow-breasted Chat, and Summer Tanager also are on the western edge of their ranges. They also are obligated to cottonwood-willow habitats (the chat recently seems to be more of a facultative species) but are not limited by the presence of snags. Why have these species not expanded into salt cedar habitats? The same question can be asked about the Arizona Bell's Vireo and the Rare Yellow-billed Cuckoo, both inhabitants of riparian vegetation along the Colorado River. The question becomes more interesting when data from other southwestern river valleys indicate that many of these species do occur in salt cedar and sometimes in high densities (Engel-Wilson and Ohmart 1978, Hildebrandt and Ohmart 1982, Brown, Carothers and Johnson 1983). Could it be that these species become more habitat restricted towards the edges of their geographical distribution or in more hostile summer environments as on the lower Colorado? Recent declines of Yellow-billed Cuckoo, Bell's Vireo, and Summer Tanager populations throughout the Pacific west have continued to occur even in isolated areas where habitat has remained relatively intact (Gaines 1977b). If the majority of prime breeding habitat has been removed and severe population reductions occur during migration or on the wintering grounds, the species may not be able to recover and will decline even in remaining areas that seem suitable for the species (Serena 1981a).

Effects of Cowbirds and Starlings

Brown-headed Cowbirds have often been blamed for dramatic declines in populations of small passerines. However, only circumstantial evidence has been provided for this claim (i.e., as cowbirds increase, small passerine species decrease). Brown-headed Cowbirds have been considered an abundant bird on the Colorado River since at least Cooper's time (1869) and heavy parasitism of Yellow Warbler populations has been documented since Brown (1903). There is little question that cowbirds interfere with the nesting of small passerines (Friedmann 1963), but do they cause extirpation of local populations? Ten years of cowbird removal in Michigan where Kirtland's Warblers (Derdroica kirtlandi) breed, has resulted in no significant change in the population size (Kelly and De Capita 1982). Serena (1982) noted that where Willow Flycatchers (Empidonax trailli) were most common, cowbirds were common, and where flycatchers were absent cowbirds also were absent. Remnant populations of Arizona Bell's Vireos on the lower Colorado River often occur where cowbirds are abundant, yet singing birds (and nests) have been in the same survey spots for at least ten years (Anderson and Ohmart unpublished data) indicating that young are being produced and are keeping the population at its present level. The vireo population though, is not recolonizing into patches of unused and seemingly suitable habitat. The same trends in population decline seen in Bell's Vireos and Yellow Warblers also are seen in Yellow-billed Cuckoos, Vermilion Flycatchers and Summer Tanagers. The latter three species are not heavily parasited by cowbirds. Yellow-breasted Chats appear to be expanding despite cowbird nest parasitism. A large-scale cowbird removal program without positive evidence that an increase in small passerines will occur suggests such a program may not benefit the species in question and would certainly be expensive to maintain indefinitely.

Comments on starlings essentially echo those for cowbirds. Starling control may be ineffective without extensive tracts of habitat existing for species such as the Gila Woodpecker. At best, Gila Woodpecker populations might remain stable, producing young that have nowhere to go. Where starling pressure is greatest, some young do fledge and serve as replacements for adult mortality. Long-term starling removal programs may increase the fledging rate, but unless there is sufficient habitat similar to the areas presently being used, these young will be forced into less suitable areas. Evidence for such social regulation was presented for Gila Woodpeckers by Anderson et al. (1982).

Claims that cowbirds and starlings cause declines in other species often are interpreted as ultimate factors. Actually, increases in cowbirds and starlings and the resulting effects on other bird species are proximate factors as loss of mature habitat is the ultimate factor. Both cowbirds and starlings feed primarily in agricultural and suburban situations and should be considered agricultural-riparian edge species. As mature riparian habitat is removed, remaining stands become smaller resulting in a greater edge effect.

As edge increases, penetration by edge bird species such as cowbirds and starlings increase. Ambuel and Temple (1983) have shown in Wisconsin that the size of a stand is extremely important to the diversity of birds occurring there, even though few differences exist vegetationally between small and large stands. Edge species were much more common in smaller stands where edge habitat was proportionally greater. The same is true for habitats on the Colorado River as well as throughout California and the West. Those species needing mature cottonwood-willow habitat have decreased in remaining stands whether the species were subjected to brood parasitism or not. These areas have become more isolated and the edge effect has become greater. Conversely, increases in mature cottonwood-willow habitat will lessen the edge effect, and will provide habitat for those species requiring large stands while reducing the influence of the edge bird species.

Management Recommendations

Preservation

Purchasing existing habitats for various bird species may be an effective way to maintain viable populations. The Soto Ranch site is the most important site to consider. Here, eleven pairs of Elf Owls occur along with two pairs of Arizona Bell's Vireos, one pair of Gila Woodpeckers, five pairs of Brown-crested Flycatchers, two pairs of Yellow-breasted Chats, and possibly one pair of Yellow-billed Cuckoos; the habitat, HM III, exists nowhere else in California. The site is approximately 54 ha (135 acres) and is large enough to continue supporting these birds. Unfortunately, there are no other large tracts of mature native vegetation remaining on the California side of the Colorado River except for a few stands on Indian lands or those already under state or federal jurisdiction.

A number of areas that are privately owned or on Indian land still have good habitat potential for many of the species. The state should initiate a land stewardship program, presenting the benefits of preserving and developing riparian habitat for erosion control, recreation, as well as for preservation of rare wildlife species. The Clark Ranch could serve as a model to future land developers. Here, many cottonwoods and willows were left intact and several were planted alongside irrigation canals and alfalfa fields. This study illustrates the importance of such an area to many wildlife species. Other programs in Oregon have used incentives for landowners to restore riparian habitat (Duhnkrack 1984). Educating landowners of the benefits in restoring native riparian habitat is an important first step.

The preservation of riparian forest habitat could be included more in the multiple use concept of managing county, state and federal recreation and wildlife areas along the lower Colorado River. In addition to providing areas for public use and waterfowl and marsh habitat, these areas would provide and protect a substantial amount of native riparian forest. Planting and maintaining cottonwoods, willows, mesquite and _Atriplex_ benefits not only those species studied here, but many others and provides increased aesthetic values and shade.

Preserving existing habitats entails more than safeguarding the area. Many cottonwood-willow stands are decadent and are quickly being reduced in value by river management activities and high water (Figure 13). Methods of renovating habitats such as selectively clearing salt cedar and replanting with native plant species, can increase the wildlife value of the area immensely (Figure 21, a-b).

Mitigation

Effective mitigation should be guaranteed by the firm or agency involved in impacting an area. Agencies working on federal land are required to mitigate for significant losses of wildlife and wildlife habitat due to projects supported by the federal government. Wise use of the National Environmental Protection Act (NEPA) can benefit wildlife greatly.

The best mitigation measures involve replacement of the habitat lost with habitat with the same physical characteristics, size and species composition at a site as close as possible to the original habitat. This method for mitigation is particularly important for maintaining the amount and distribution of critically rare habitats such as the cottonwood-willow type. This method involves revegetation which often is considered expensive and inconvenient.

Mitigation also takes other forms; land-swapping usually is the easiest to be accomplished through bureaucratic channels. Assessing the trade of existing private "unaltered" habitat for an area to be altered should be carefully reviewed. Depending on the size of the project, the larger being the more important, the two areas should be at least comparable. Hopefully, the land to be acquired should be better for the bird species mentioned in this report, but if not, other alternatives should be considered. Almost all mature cottonwood-willow habitat is presently found on federal or state-owned lands along the lower Colorado River. Land-swapping, therefore is not recommended as an avenue for mitigation as this option probably will result in a net loss of habitat.

Enhancement of habitat in areas other than the one impacted is another way to mitigate. Although overall enhancement may be realized, the area impacted receives little benefit. For the species considered here, enhancement of habitat in the Central Valley of California will do nothing to help Elf Owls, Gilded Flickers, Gila Woodpeckers, Vermilion Flycatchers, Arizona Bell's Vireos, and Summer Tanagers. If a part of a geographical entity, such as the Colorado River is impacted then mitigation should occur on another part of that entity.

Revegetation

The best way to enhance an area for all species is to restore native riparian habitat by revegetation. Revegetation has been proposed for the last 15 years on the lower Colorado River as a means to mitigate for losses of habitat due to flood control management. Many mitigation projects utilizing revegetation have been planned and implemented but have ended in low success with little value to wildlife and financial loss to the agencies involved.

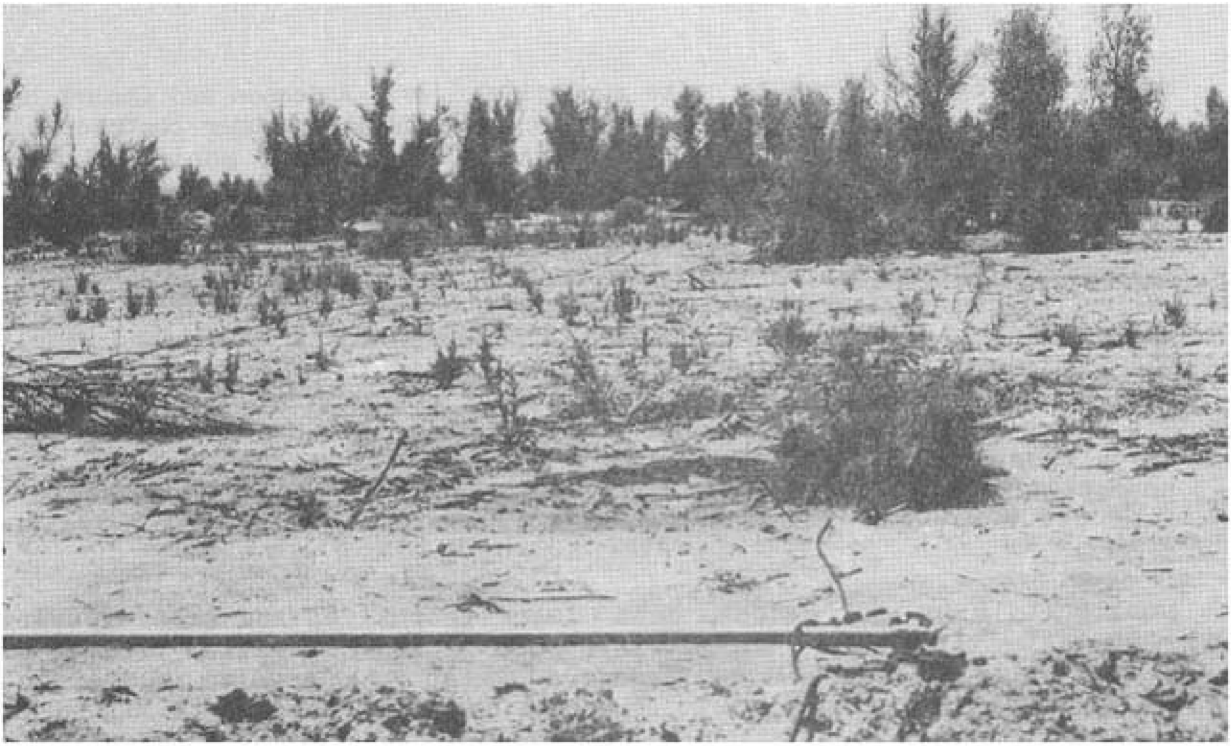

Figure 21a. Salt cedar/willow stand in 1979 after the clearing of salt cedar in a revegetation effort by Anderson, Disano and Ohmart. Photo by J. Disano.

Figure 21b. Same site in 1983, three years after the planting of quailbrush, honey mesquite, inkweed, willow and cottonwood by Anderson, Disano and Ohmart. Photo by J. Disano.

However, revegetation can be quite successful. Drs. Anderson and Ohmart have investigated large scale (≥ 20 ha, ≥50 acres) revegetation under contract with the Bureau of Reclamation, Anderson and Ohmart have monitored their revegetation efforts and in five growing seasons they changed desolate, dredge spoil sites with little vegetation and wildlife into a cottonwood-willow woodland (Figure 22 a-b). One area now supports as many as four breeding Yellow-billed Cuckoos, a species disappearing throughout California. As native riparian vegetation grew on the sites, the diversity of bird-life and the numbers of individuals increased in accordance with predicted results based on empirical data gathered during the bird censusing program. Among the species considered here, the Crissal Thrasher and Yellow-breasted Chat have become established on the sites and the Gilded Flicker, Brown-crested Flycatcher, and Summer Tanager have been detected occasionally. These revegetation efforts have not been inexpensive in either their scope or intensive labor, but they have been more successful than any other mitigation effort.

Smaller (≤10 ha, ≤25 acres), less labor intensive, and less expensive revegetation efforts also have provided some cottonwood-willow habitat for Yellow-billed Cuckoos, Summer Tanagers and the other species studied here. However, these sites do not provide enough continuous habitat to support the breeding necessary to reestablish population centers for the recovery of the Endangered Elf Owl, Rare Yellow-billed Cuckoo, Arizona Bell's Vireo, Gila Woodpecker, Gilded Northern Flicker, Vermilion Flycatcher, Sonoran Yellow Warbler and Summer Tanager. Likewise, the benefits gained on small, non-labor intensive sites have been few and have come over longer periods of time than on the Anderson and Ohmart sites. In terms of cost-benefit, large-scale sites like those of Anderson and Ohmart's are actually less expensive than the many small-scale revegetation sites. With the constant reduction of riparian vegetation and the mature condition of that habitat needed by many species, reducing the time to grow large stands (≥20 ha, ≥50 acres) of vegetation to support the species considered in this report is very important.

The recognition of mature native riparian habitats as endangered is becoming increasingly more important as the loss of these areas continues. Many of the riparian-associated bird species, whether endangered or threatened, will be extirpated as native riparian habitat disappears. Habitat preservation and restoration is imperative to prevent the loss of an entire community of bird species along the lower Colorado River.

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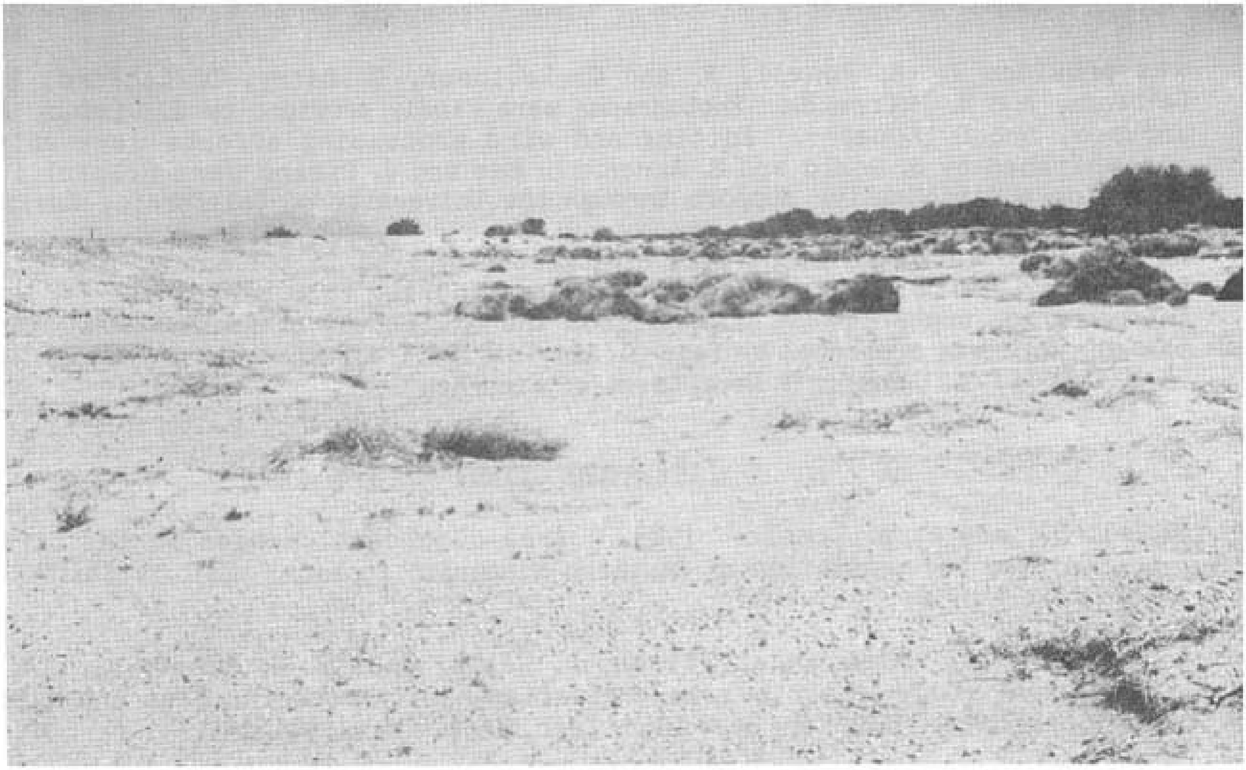

Figure 22a. Dredge spoil revegetation site planted by Anderson, Disano and Ohmart in 1978. Photo by J. Disano.

Figure 22b. Cottonwood growth on same dredge spoil, revegetation site in 1983, four years after replanting by Anderson, Disano and Ohmart. Photo by J. Disano.

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