

CHANGES IN RIPARIAN VEGETATION AND SUBSEQUENT CHANGES IN AVIFAUNA IN A  
CATTLE-EXCLUDED PORTION OF LOWER BONITA CREEK, GRAHAM COUNTY, ARIZONA

A REPORT ON BASELINE DATA FOR VEGETATION AND BREEDING BIRDS

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## SUMMARY

Bonita Creek, like many waterways in the Southwest, is an important riparian corridor that has been degraded within the last century. Bonita Creek has among the highest number of breeding bird species found in southwestern riparian systems, however, individual numbers are relatively low. The floods of 1978 and 1983 removed many of the trees which formed the canopy. The lack of successful regeneration in Bonita Creek indicated that drastic measures were needed for the riparian vegetation, and the creek itself, to be rejuvenated.

Cattle were excluded from 3 km of Bonita Creek beginning in 1984. Baseline data were collected on vegetation and breeding birds in 1985 and 1986 to assess future changes which may occur within the enclosure. This report summarizes the baseline findings and discusses them in light of past work completed on vegetation and birds in Bonita Creek.

Bonita Creek should improve tremendously in terms of wildlife use, erosion control, and water quality given extensive successful regeneration of broadleaf tree species and overall stabilization of the watershed.

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INTRODUCTION

Interest in riparian systems and the processes affecting them has intensified since the mid-1970s. Among the most important issues concerning the management of riparian areas is realizing the potential for regeneration of native riparian vegetation. Cattle grazing has been repeatedly implicated as causing the failure of riparian vegetation to successfully regenerate in many areas after perturbations (e.g., flooding). Many heavily grazed riparian areas have been slow to regenerate, however, no controlled study or management regime has been implemented to determine the actual effects of cattle grazing independent of other possible factors (Rucks 1984).

The exclusion of cattle from some riparian areas has now become part of a progressive local management planning process developed by the U.S. Bureau of Land Management, Safford District, Arizona. Approximately 3 km of lower Bonita Creek were fenced in 1984 to allow for regeneration in the absence of cattle. Bonita Creek was flooded in 1978-1979 and in 1983 when much of the mature riparian vegetation was removed. Subsequent regeneration of broadleaf riparian trees was very limited during the period from 1980 to 1984, with most seedlings failing to exceed 1 m. The enclosure was justified in an attempt to (1) stabilize stream banks, (2) maintain water quality, (3) improve wildlife habitat, (4) determine effects of excluding cattle on riparian plant communities, and (5) determine how long it takes for riparian habitat to recover from severe, prolonged disturbance.

This report provides baseline data and interpretation on the condition of riparian plant and bird communities along lower Bonita Creek. Data were collected both inside and adjacent to the cattle enclosure in 1985 and 1986, so as to assess current conditions and possible future changes along Bonita Creek. Also, comparisons between this report and the previous works of Minckley and Clark (1981), Clark (1984), and Rucks (1984) are discussed in light of present and future riparian management.

#### STUDY AREA

The study area was along lower Bonita Creek, 37 km northeast of Safford, Arizona, from 975 to 1128 m in elevation. Seven transects, each 762 m in length, were established consecutively from the Gila River confluence north approximately 6 km to collect vegetation and bird data (Table 1). The vegetation sampled on Bonita Creek was of the Mixed Broadleaf Series of the Southwestern Riparian Deciduous Forest Type (Brown et al. 1980). Mixed Broadleaf habitats have a large diversity of dominant plant species. Honey mesquite (Prosopis glandulosa) forms the midstory canopy along the entire surveyed stretch of the creek and was the numerically dominant species. The dominant broadleaf species were Fremont cottonwood (Populus fremontii), Goodding willow (Salix gooddingii), and Arizona sycamore (Platanus wrightii). Other riparian broadleaf species included Bonpland willow (Salix bonplandiana), netleaf hackberry (Celtis reticulata), Arizona walnut (Juglans major), and velvet ash (Fraxinus velutina). All of these broadleaf trees formed the canopy layer. The understory consisted primarily of seepwillow (Baccharis salicifolia), burro brush (Hymenoclea monogyra), and regenerating riparian broadleaf seedlings. Groundcover, when present, consisted primarily of Bermuda grass (Cynodon dactylon) and various other herbaceous perennials and annuals. Minckley and Clark (1981), Clark (1984), and Rucks (1984) described the vegetation of Bonita Creek in more detail.

Natural regeneration of cottonwood, willow, sycamore, and seepwillow was evident throughout lower Bonita Creek each spring but was most prevalent within 8 km of the confluence. Between 1979 and 1983 however, regenerating trees were trampled or repeatedly clipped by the licensed 270 head of cattle and no seedling reached pole size before the 1983 flood. The construction of the cattle enclosure in 1984 was an attempt to determine if regenerating trees could grow to adult size in the absence of cattle.

The cattle enclosure was located from approximately 1.5 km to 5 km from the confluence with the Gila River. Cattle grazing was evident outside the enclosure throughout 1985 with approximately 120 head present on the entire allotment. In 1986, cattle numbers were down to about 60 head and none were observed in the creek bottom until late July. Occasionally, a few cows found their way into the enclosure but they were removed as quickly as possible.

#### METHODS

Vegetation density and vertical and horizontal diversity were sampled along each transect using the board technique MacArthur and MacArthur (1961). Foliage density was measured at intervals of 50 m along transects (lateral distance from transect to where foliage covers at least half of a 21 x 29 cm board) at vertical heights of 0.15 m, 0.6 m, and every subsequent 1.5 m to the top of the canopy. Foliage height diversity (FHD) and horizontal patchiness (at each vertical layer) values were calculated from the above data as described by Anderson et al. (1983).

Tree and shrub counts were conducted to determine plant species composition. Trees and shrubs were determined by species and by two height classes (> and <3 m). When shrubs and patches of young trees occurred in dense clumps they were counted by measuring foliage diameter and foliage

height of each clump; based on this volume measurement these patches were converted to counts of individuals. Thus, calculating the minimum number of shrubs in an area was possible by estimating the percent ground cover in each 15 m by 30 m strip of dense shrub cover. Total number of trees and shrubs for each species within a 15 m strip on each side of each transect were recorded. Tree and shrub counts were converted into number per ha for each species.

Each transect was censused using the Emlen variable-distance method (Emlen 1971, Anderson et al. 1977) for birds nine times from 15 May to 15 August during 1985 and 1986. Each transect covered approximately 14 ha and bird densities were converted into number per 40 ha. Transects generally were placed along the median of the creek bottom and crossed heterogeneous stands of riparian strands, broadleaf old growth, honey mesquite, and open areas. The patchiness within transects was at times extensive and was reflected in the vegetation data.

Transects were divided by two criteria. (1) Inside or outside of the enclosure and (2) at the lowermost or uppermost reaches of the surveyed area (Table 1). The four categories for data analysis, therefore, were: (1) lowermost-outside (BC-3), (2) lowermost-inside (BC-4 and 5), (3) uppermost-inside (BC-6 and 7), and (4) uppermost-outside (BC-8 and 9). The latter category was surveyed during 1986 only. Vegetation data are presented by transect only while bird data are presented both by transect and by transect category. This design allows for future comparison between inside and outside the enclosure and possible effects due to slight increases in elevation.

Bird species were grouped by foraging height categories in vegetation. These groups were: (1) ground, (2) understory (<1 m), (3) mid-foliage (1 m to 4.5 m), and (4) canopy (>4.5 m). Other miscellaneous groups were defined as: (5) aerial foragers, (6) granivores, (7) cowbirds (Yolothrus spp.)-European

Starlings (*Sturnus vulgaris*), and (8) raptors. The first four groups are based upon quantified work by Rosenberg et al. (1982), Clark (1984), and personal observations. Foraging heights for most species also reflected typical height of nesting. Differences among transects and transect categories in bird group use were important to assess possible future changes in vegetation structure.

## RESULTS

### Vegetation

There was substantial variation in vegetation structure among the seven transects established on lower Bonita Creek (Table 2). Structurally, transects outside the enclosure were high in foliage density in the canopy (BC-3) or in the understory (BC-8, 9). Inside the enclosure, each transect was structurally different from each other with differing combinations of well-developed understory and canopy. The midstory layer was the least developed on all the transects and was also the least variable of the vertical layers in foliage density and horizontal patchiness among transects (Table 2).

Tree species composition changed among transects along the elevational gradient, especially with riparian broadleaf trees (Table 3). Fremont cottonwood, Goodding willow, and Arizona sycamore were numerically dominant among the broadleaf species on the three lowermost transects (BC-3, 4, and 5; 65-93%). On the four uppermost transects (BC-6, 7, 8, and 9), cumulative numbers of Fremont cottonwood, Goodding willow, and Arizona sycamore were equal to or lower (37-48%) than cumulative numbers of Arizona walnut, netleaf hackberry, velvet ash, and Bonpland willow. This supports the split between uppermost and lowermost transects. Regeneration of riparian broadleaf trees and seepwillow was evident throughout the surveyed area but was concentrated at the uppermost end outside the enclosure (BC-8, 9) and at the lowermost end

inside the enclosure (BC-5). Burro brush, tree tobacco (Nicotiana glauca), graythorn (Ziziphus obtusifolia), and spiny hackberry (Celtis pallida) were also frequently present in the understory. Honey mesquite was relatively equally distributed among all transects and formed the dominant plant in the midstory layer.

### Birds

A total of 62 species were recorded during the summers of 1985 and 1986 in lower Bonita Creek, compared with 46 species recorded during Clark's (1984) study of broadleaf habitats throughout the Gila River complex (Table 4). Clark (1984) omitted an additional four species (Black-chinned Hummingbird, Archilochus alexandri); Costa's Hummingbird, Calypte costae; Vermilion Flycatcher, Pyrocephalus rubinus; and Yellow warbler, Dendroica petechia) from his tables which were undoubtedly present during his study. Thirty-eight species were recorded with measurable densities during the present study with most, if not all, considered to be breeding species. The range of species richness among transects, between years, did not differ substantially (Table 5). With years combined, the range in species richness was 35 to 46 among transects. The range for species with measurable densities, with years combined, was 34 to 39. A total of 64 summering species were recorded for Bonita Creek when both Clark's (1984) and the present study were considered together.

The average number of individuals on lower Bonita Creek was 452 per 40 ha compared with 244 per ha during Clark's (1984) study (Table 4). Clark (1984) did not consider Gambel's Quail (Callipepla gambelii) numbers, but also many common species during his study were recorded in much lower densities than during the present study. Clark's (1984) results are a composite of a number of broadleaf habitats including Bonita Creek, so densities may not be directly



comparable to the present data. Total individual numbers during the present study were consistently greatest on the uppermost-inside transects (BC-6, 7; Table 5). The other transects were very similar to each other in total individual numbers.

Among bird groups, large differences were not found among transect categories for bark foragers, ground foragers, understory foragers, midstory foragers, aerial foragers, cowbirds/starlings, and raptors (Table 6). Numbers of canopy foragers were substantially greater on the lowermost-outside (BC-3) and the uppermost-inside (BC-6, 7) categories than in the other two categories. Numbers of granivores were substantially greater on the uppermost-inside (BC-6, 7) category.

Generally, relative numbers within bird groups followed closely with the vegetation characteristics of each transect category. The midstory layer was the least variable of the vegetation layers in foliage density and patchiness and this was reflected in the birds primarily using this layer. The canopy was most well developed on the lowermost-outside (BC-3) and the uppermost-inside (BC-6, 7) transect categories, and canopy birds were closely aligned with this vegetation structure. Understory foragers, however, were slightly more numerous inside the enclosure (BC-4, 5, 6, and 7) but there was no apparent association with foliage density in the understory. Higher granivore numbers in the uppermost-inside (BC-6, 7) category were partly influenced by the presence of several mature fig trees (Ficus cariatd) on one of the transects (BC-6, see Clark 1984).

#### DISCUSSION

Minckley and Clark (1981) completed their work on Bonita Creek in 1978 and described vegetation characteristics before the extensive winter flooding of 1978-1979. Rucks (1984) completed a detailed analysis on the condition of

riparian vegetation in 1980 after one flooding event but prior to the larger 1983 flood. Data from the present study in 1985 and 1986 records a decline in mature trees and an increase in young age classes with decreasing cattle numbers and cattle exclusion.

Bonita Creek had a better-developed canopy before the floods than after. There was little net difference in the number of honey mesquite during the flood stages and, therefore, little shift in the absolute status of the midstory (riparian scrub layer in Rucks 1984). However, the relative status of this layer was enhanced after the flood. Mature mesquite was susceptible to flooding, however, recruitment after the flood was fast and extensive. Successful regeneration of mature broadleaf species was not extensive either before or immediately after the 1978-1979 flood probably due to high livestock numbers. Any young trees present after 1979 were undoubtedly removed in the 1983 flood.

Flooding is a natural force that destroys mature riparian stands. However, flooding also provides for extensive new seedbeds for these same riparian species. Initial germination appeared to be extensive every year after the 1978-1979 flood, however, very few regenerated broadleaf trees survived to even the seedling size class (Rucks 1984). Trees germinating after the 1983 flood survived due to total cattle exclusion or the relatively low livestock numbers in the entire allotment in 1986.

Grazing has occurred on Bonita Creek for over 100 years. Grazing pressure, especially since 1972, on Bonita Creek was apparently severe enough to affect the regeneration of even the least palatable ash and walnut seedlings. The grazing allotments on Bonita Creek changed hands in 1972 and corresponded with a downward trend in successful reproduction of all riparian broadleaf plants (Rucks 1984). Of the five creek and river systems studied by

Rucks (1984), only one had extensive successful regeneration after the 1978-1979 flood and it was also the only system excluded from cattle (Aravaipa Creek since 1973). This finding prompted the enclosure now on Bonita Creek.

During the present study, cattle numbers were dramatically dropped by the allottee in 1985 and again in 1986. In association with the drop in cattle numbers, some regeneration outside the enclosure exceeded seedling size, but by August almost all riparian broadleaf seedlings were browsed when the remaining cattle concentrated in the creek bottom. Continued reduction in cattle numbers will probably cloud interpretations of regeneration inside the enclosure compared with that outside the enclosure. However, regeneration inside the enclosure has at least a one year lead on that outside the enclosure. More detailed data on the present condition of vegetation for the entire Bonita Creek patterned after Rucks (1984) are now being analyzed (S. Gerszewski in prep.).

From the baseline data provided in this report, it may be possible to provide predictions for future changes in bird numbers resulting from changes in vegetation characteristics. If tree regeneration is more successful inside the enclosure then ground, understory, and midstory foragers should increase substantially more inside the enclosure than outside the enclosure. These differences may be more pronounced with midstory foragers as the baseline data indicated little difference in either vegetation or birds in this group among transect categories at present. Data collected far in the future may be better able to determine changes in bark and canopy foragers with vegetation changes.

I have used bird groups based on foraging heights to characterize bird species associations with vegetation characteristics. Several studies indicate that bird species are most closely associated with particular tree

species than to any measure of foliage density (Balda 1969, Holmes and Robinson 1981, Clark 1984, Rice et al. 1984). Clark (1984) found that insectivorous birds on Bonita Creek seemed to separate by preferences for mesquite or broadleaf tree species and then divided among the various vertical layers within each plant species. For the purposes of the present study, however, it was easier to use foraging heights rather than tree species preferences to demonstrate broad associations. Future changes in tree species diversity on Bonita Creek will also alter the relative importance of each vertical vegetation layer. Fine-tuning habitat selection criteria would be of interest but would require more intensive data collection efforts.

Bonita Creek supports among the highest number of breeding bird species found anywhere in the United States. Riparian systems in the Southwest generally support high numbers of species, especially when mature broadleaf tree species are predominant in the system. Total species richness in Bonita Creek is enhanced by species foraging extensively along the creek bottom which are more typical of desert upland habitats. Despite high species richness, however, individual numbers per species and total individual numbers are relatively low for Bonita Creek compared with other mature mixed broadleaf and cottonwood-willow habitats with similar species richness (Carothers et al. 1974, Hunter 1987). The present condition of Bonita Creek, with large barren patches, is associated with these low individual numbers. Bird numbers should increase appropriately as these barren patches develop with regenerating vegetation. If past management practices are reinstated with high cattle numbers, then individual bird numbers will undoubtedly drop with the eventual loss of some uncommon bird species.

Three state-listed threatened (Zone-tailed Hawk [Buteo albonotatus], Common Black-Hawk [Buteogallus anthracinus], and Northern Beardless Tyrannulet

[Camptostoma imberbe]) and two proposed federal threatened (Yellow-billed Cuckoo [Coccyzus americanus] and Bell's Vireo [Vireo bellii]) species occur in Bonita Creek. All five of these species are obligated to healthy riparian habitat and have suffered dramatic declines elsewhere in the Southwest (Hunter et al. in press). The continued existence of these and other riparian bird species is dependent upon sound management practices in riparian systems and adjacent watersheds.

The ecology of riparian systems, with all the processes involved in successful regeneration of such systems, is still poorly understood. This report provides necessary baseline data in assessing the usefulness of exclosures in teasing out one factor, that of grazing pressure, from other factors that also may be involved in affecting regeneration success. Future management of riparian systems needs to be based on such studies to justify management procedures which otherwise may be too controversial to be easily accepted.

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Appendix I. Raw breeding data used in this report. Densities are presented per year for each transect. Birds are placed in groups. Densities are number per 40 ha. + = present without measurable density.

Bird group/species	Transect and years											
	BC-3		BC-4		BC-5		BC-6		BC-7		BC-8	BC-9
	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1986	1986
<b>Bark foragers</b>												
Gila woodpecker	20	19	25	22	16	6	31	9	26	13	11	22
Ladder-backed woodpecker	10	9	7	6	10	4	14	5	6	14	12	16
<b>Ground foragers</b>												
Rock wren	1	3	3	0	6	0	2	1	4	0	3	0
Canyon wren	9	20	13	10	19	16	8	22	16	22	17	28
Crissal Thrasher	0	0	0	0	0	1	0	0	2	0	0	0
Abert's Towhee	0	1	6	6	1	4	0	0	2	2	0	1
Brown Towhee	0	1	0	4	0	+	0	1	0	0	7	2
Black-throated Sparrow	1	2	3	0	8	6	0	1	2	2	5	6
<b>Understory foragers</b>												
Black Phoebe	14	13	22	18	31	15	9	19	30	26	24	31
vermilion Flycatcher	21	15	4	6	14	6	1	8	7	13	7	2
Bewick's Wren	3	12	9	13	13	8	27	23	7	23	4	16
Bell's Vireo	10	17	34	41	28	21	27	16	16	14	26	15
yellow-breasted chat	8	14	22	18	6	7	17	20	11	10	10	2



Appendix I. cont.

Bird group/species	Transect and years											
	BC-3		BC-4		BC-5		BC-6		BC-7		BC-8	BC-9
	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1986	1986
<b>Midstory foragers</b>												
Ash-throated Flycatcher	3	0	2	2	0	7	0	4	0	0	4	4
Verdin	38	51	27	50	25	48	35	48	30	47	34	30
Cactus Wren	0	6	2	1	3	2	1	2	1	1	2	1
Northern Mockingbird	0	0	1	0	0	0	0	0	0	0	0	0
Hutton's Vireo	0	0	0	0	0	0	0	4	0	2	0	0
Lucy's warbler	23	7	14	13	21	9	23	15	3	9	15	7
Northern Cardinal	21	13	8	12	9	13	27	11	23	25	12	8
Blue Grosbeak	5	6	5	5	7	8	17	7	5	3	14	6
<b>Canopy foragers</b>												
Yellow-billed Cuckoo	1	3	3	1	5	0	5	4	6	4	1	2
Brown-crested Flycatcher	18	20	18	9	10	14	29	23	31	13	25	21
Western Kingbird	21	19	3	6	15	3	11	6	8	3	2	11
Cassin's Kingbird	25	22	4	2	6	11	8	15	22	33	4	18
Northern Beardless Tyrannulet	0	0	0	0	0	0	0	3	+	1	0	0
Bridled Titmouse	0	4	0	1	0	0	5	1	2	13	10	10
Phainopepla	0	0	1	0	1	0	0	0	0	0	0	0
Yellow warbler	35	22	2	1	8	3	21	26	29	21	3	15
Northern Oriole	16	12	9	10	6	4	19	12	17	3	3	10
Hooded Oriole	16	11	6	4	16	13	37	23	5	15	17	14

Appendix I. cont.

Bird group/species	Transect and years											
	BC-3		BC-4		BC-5		BC-6		BC-7		BC-8	BC-9
	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1986	1986
Summer Tanager	12	17	10	19	11	9	30	22	25	26	18	9
Lesser Goldfinch	6	5	4	7	7	15	12	21	8	11	2	10
Aerial foragers												
Violet-green swallow	+	+	+	+	+	+	+	+	+	+	+	+
Lesser Nighthawk	+	0	0	0	2	+	0	2	0	0	0	0
Black-chinned Hummingbird	6	14	10	10	14	12	6	8	6	2	23	6
Costa's Hummingbird	0	6	0	0	0	2	0	0	2	0	8	0
Granivores												
Gambel's Quail	27	36	22	8	43	12	139	27	54	22	56	23
wild Turkey	0	0	0	0	0	0	0	0	+	0	0	0
Mourning Dove	11	18	22	11	18	10	33	9	22	12	16	10
white-winged Dove	10	4	9	8	4	3	43	43	17	17	3	1
Lark Sparrow	0	1	0	2	0	5	0	0	0	0	0	5
House Finch	15	7	21	3	18	16	62	16	7	13	2	10
House Sparrow	2	0	0	0	0	0	0	0	0	0	0	0
Cowbirds/starlings												
European Starling	5	0	0	0	6	0	8	0	6	0	0	0
Brown-headed Cowbird	21	14	68	15	50	38	25	13	27	14	40	19
Bronzed Cowbird	1	0	0	0	4	0	0	0	0	0	0	0

Appendix I. cont.

Bird group/species	Transect and years											
	BC-3		BC-4		BC-5		BC-6		BC-7		BC-8	BC-9
	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1986	1986
<b>Raptors</b>												
Turkey Vulture	0	1	0	0	0	0	0	0	0	0	0	0
Cooper's Hawk	0	0	0	+	0	0	+	0	0	0	0	0
Red-tailed Hawk	+	0	0	0	+	1	0	1	+	+	0	+
Zone-tailed Hawk	0	0	0	0	0	0	+	0	+	1	0	0
Common Black-Hawk	2	1	1	1	0	0	1	1	0	0	0	1
American Kestrel	0	1	0	0	+	0	0	0	0	0	0	0
Great Horned Owl	1	1	+	+	1	+	0	0	+	0	0	0
Common Barn-Owl	0	0	0	0	0	1	0	0	0	0	0	0

Table 1. Characteristics of transect categories and transects used on lower Bonita Creek, Graham County, Arizona, during 1985 and 1986.

Category	Transect name	Meters		Hectares censused	Location	Elevation (m)
		Length	Width			
Lowermost- outside	BC-03	762	183	14	T6S R28E Sec. 21 NE	975
Lowermost- inside	BC-04	762	183	14	T6S R28E Sec. 21 NE	975
	BC-05	762	183	14	T6S R28E Sec. 16 SW	1012
Uppermost- inside	BC-06	762	183	14	T6S R28E Sec. 16 NW	1049
	BC-07	762	183	14	T6S R28E Sec. 9 SW	1067
Uppermost- outside	BC-08	762	183	14	T6S R28E Sec. 8 NE	1097
	BC-09	762	183	14	T6S R28E Sec. 5 SE	1128

Table 2. Vertical and horizontal vegetation characteristics for mixed broadleaf transects along Bonita Creek. Transect abbreviations are as in Table 1. FHD = foliage height diversity.

Category/ transect	Foliage density ( $\frac{m^2}{m^2}$ ) at each vertical layer (m)				FHD	Horizontal patchiness (% variation) in each vertical layer (m)			
	0.6	0.6-4.6	4.6+	Total		0.6	0.6-4.6	4.6+	Total
<b>Lowermost- outside/</b>									
BC-3	0.391	0.437	0.853	1.681	1.660	0.105	0.099	0.205	0.409
<b>Lowermost- inside/</b>									
BC-4	0.223	0.251	0.318	0.792	1.181	0.008	0.022	0.072	0.102
BC-5	0.622	0.267	0.319	1.208	1.297	0.153	0.038	0.071	0.262
<b>Uppermost- inside/</b>									
BC-6	0.338	0.346	0.513	1.217	1.251	0.033	0.082	0.194	0.309
BC-7	0.246	0.233	0.517	0.996	1.705	0.017	0.023	1.120	0.160
<b>Uppermost- outside/</b>									
BC-8	0.525	0.211	0.135	0.871	1.104	0.069	0.009	0.012	0.090
BC-9	0.575	0.280	0.233	1.088	1.259	0.133	0.019	0.024	0.176
Mean	<b>0.420±</b> 0.158	<b>0.289±</b> 0.078	<b>0.413±</b> 0.238	<b>1.122±</b> 0.294	<b>1.351±</b> 0.235	<b>0.074±</b> 0.058	<b>0.042±</b> 0.035	<b>0.100±</b> 0.077	<b>0.215±</b> 0.117
Range	0.316	0.136	0.476	0.588	0.470	0.116	0.070	0.154	0.234

Table 3. Tree and shrub count for lower Bonita Creek. Number per ha for each transect.

Species	Height (m)	BC-3	BC-4	BC-5	BC-6	BC-7	BC-8	BC-9
<u>Salt cedar (Tamarix chinensis)</u>	<3				2			
<u>Jojoba (Simmondsia chinensis)</u>			3		2	1		
<u>Creosote (Larrea tridentata)</u>		2	13	4	6	3	9	
<u>Graythorn (Ziziphus obtusifolia)</u>		5	10	4	26	8	12	19
<u>Netleaf hackberry (Ceitis reticulata)</u>	>3 <3	1	6	4	2	4	1 1	5
<u>Spiny hackberry (C. pallida)</u>		23	21	6	20	4	15	18
<u>Prickly pear (Opuntia spp.)</u>					1			
<u>Cholla (Opuntia spp.)</u>							1	
<u>Barrel cactus (Ferocactus spp.)</u>			1					
<u>Velvet ash (Fraxinus velutina)</u>	>3 <3			2		2	1	6 7
<u>Tree tobacco (Picotiana glauca)</u>		39	38	60	55	15	43	15
<u>Wolfberry (Lycium spp.)</u>		2	11	4	1	1		
<u>Catclaw acacia (Acacia greggii)</u>	>3 <3	6	1		1	1	1 3	3
<u>Honey mesquite (Prosopis glandulosa)</u>	>3 <3	89 14	82 39	72 9	95 29	37 13	64 25	36 15
<u>Blue palo verde (Cercidium floridum)</u>	>3		1	1	2	2	1	
<u>Arizona sycamore (Platanus wrightii)</u>	>3 <3	10	3 1	3 2	6	5	4 2	26 27

Table 3. cont.

Species	Height (m)	BC-3 BC-4 BC-5 BC-6 BC-7 BC-8 BC-9						
		BC-3	BC-4	BC-5	BC-6	BC-7	BC-8	BC-9
Desert mistletoe ( <u>Phoradendron californicum</u> )		8	8	2			7	1
Burro brush ( <u>Hymenoclea monogyra</u> )		59	92	76	131	87	230	69
Seepwillow ( <u>Baccharis salicifolia</u> )		69	69	128	57	86	77	152
Desert broom (a. <u>sarothroides</u> )				1		6	8	2
Goodding willow ( <u>Salix gooddingii</u> )	>3	6	4	1		1	3	3
	<3		3	1			6	23
Bonpland willow ( <u>bonplandiana</u> )	>3	1	1		1	4		6
	<3	1	1	1			30	119
Coyote willow ( <u>S. exigua</u> )							2	1
Fremont cottonwood ( <u>Populus fremontii</u> )	>3	10	1	2	3	6		
	<3		2	21			25	24
Arizona walnut ( <u>Juglans major</u> )	>3			1	5	3		3
	<3							1
Fig ( <u>Ficus carliata</u> )	>3				2			
Box elder ( <u>Acer Degundo</u> )	>3							1
Proportion of Fremont cottonwood, Goodding willow, and Arizona sycamore among broadleaf species		93	65	79	47	48	47	37

Table 4. Bird species found on Bonita Creek during 1977-1978 (Clark 1984) and 1985-1986 (present study). Densities are compared between the studies. Densities from Clark (1984) are for mixed broadleaf habitats on the Gila River complex as a whole. Densities are number per 40 ha. + = species recorded without measurable densities. ? = species not listed by Clark (1984) but were probably present on lower Bonita Creek during his study.

Species	Group	Average densities	
		Clark (1977-1978)	Hunter (1985-1986)
Great Blue Heron** ( <u>Ardea herodias</u> )			
Common Merganser** ( <u>Mergus merganser</u> )			
Killdeer** ( <u>Charadrius vociferus</u> )			
Turkey Vulture ( <u>Cathartes aura</u> )	Raptor	0	
Cooper's Hawk ( <u>Accipiter cooperii</u> )	Raptor		
Red-tailed Hawk ( <u>Buteo jamaicensis</u> ) +	Raptor		
Zone-tailed Hawk ( <u>Buteo albonotatus</u> ) +	Raptor		
Common Black-Hawk ( <u>Buteogallus anthracinus</u> )	Raptor	2	1
American Kestrel ( <u>Falco sparverius</u> )	Raptor		
Gambel's Quail*** ( <u>Callipepla gambelii</u> )	Granivore		39
Wild Turkey ( <u>Meleagris gallopavo</u> )	Granivore		
Mourning Dove ( <u>Zenaida macroura</u> )	Granivore	108	16
White-winged Dove ( <u>Zenaida asiatica</u> )	Granivore	8	12
Yellow-billed Cuckoo <sup>-</sup> ( <u>Coccyzue americanus</u> )	Canopy		3
Common Barn-Owl ( <u>Tyto alba</u> )	Raptor		
Great Horned Owl ( <u>Bubo virginianus</u> )	Raptor		
Western screech-Owl ( <u>Otus kennicotti</u> )	Raptor		
Whiskered screech-Owl ( <u>Otus trichopsis</u> )	Raptor		
Elf Owl ( <u>Nicrathene whitneyi</u> )	Raptor		4
Lesser Nighthawk ( <u>Chordeiles acutipennis</u> )	Aerial	0	



Table 4. cont.

Species	Group	Average densities	
		Clark (1977-1978)	Hunter (1985-1986)
Black-chinned Hummingbird ( <i>Archilochus alexandri</i> )	Aerial		10
Costa's Hummingbird ( <i>Calypte costae</i> )	Aerial		2
Gila Woodpecker ( <i>Melanerpes uropygialis</i> )	Bark	6	18
Northern Flicker ( <i>Colaptes auratus</i> )	Ground	1	0
Ladder-backed Woodpecker ( <i>Picoides scalaris</i> )	Bark	2	10
Western Kingbird ( <i>Tyrannus verticalis</i> )	Canopy	9	9
Cassin's Kingbird ( <i>Tyrannus vociferans</i> )	Canopy	3	14
Brown-crested Flycatcher ( <i>Myiarchus tyrannulus</i> )	Canopy	4	20
Ash-throated Flycatcher ( <i>Myiarchus cinerascens</i> )	Midstory	4	3
Black Phoebe ( <i>Sayornis nigricans</i> )	Understory	4	22
Say's Phoebe ( <i>Sayornis saya</i> )	Understory	0	
Vermilion Flycatcher ( <i>Pyrocephalus rubinus</i> )	Understory		8
Northern Beardless Tyrannulet <sup>†</sup> ( <i>Camptostoma imberbe</i> )	Canopy	0	
Violet-green Swallow** ( <i>Tachycineta thalassina</i> )	Aerial		
Common Raven ( <i>Corvus corax</i> )		1	0
Bridled Titmouse ( <i>Parus wollweberi</i> )	Canopy	2	5
Verdin ( <i>Auriparus flaviceps</i> )	Midstory	13	38
Bewick's Wren ( <i>Thryomanes bewickii</i> )	Understory	6	13
Canyon Wren ( <i>Catherpes mexicanus</i> )	Ground	9	17
Rock Wren ( <i>Salpinctes obsoletus</i> )	Ground	2	2
Cactus Wren ( <i>Campylorhynchus brunneicapillus</i> )	Midstory	0	2
Northern Mockingbird ( <i>Mimus polyglottos</i> )	Midstory	1	
Curve-billed Thrasher ( <i>Toxostoma curvirostre</i> )	Ground	1	0
Crissal Thrasher ( <i>Toxostoma crissale</i> )	Ground	0	

Table 4. cont.

Species	Group	Average densities	
		Clark (1977-1978)	Hunter (1985-1986)
<u>Phainopepla (Phainopepla nitens)</u>	Canopy	0	
<u>European Starling (Sturnus vulgaris)</u>	C/S*	0	2
<u>Bell's Vireo (Vireo bellii)</u>	Understory	6	22
<u>Hutton's Vireo (Vireo huttoni)</u>	Midstory	0	
<u>Lucy's warbler (Vermivora luciae)</u>	Midstory	11	13
<u>Yellow warbler (Dendroica petechia)</u>	Canopy		15
<u>Yellow-breasted Chat (Icteria virens)</u>	Understory	6	12
<u>Northern Cardinal (Cardinalis cardinalis)</u>	Midstory	3	14
<u>Blue Grosbeak (Guiraca caerulea)</u>	Midstory	4	8
<u>Brown Towhee (Pipilo fuscus)</u>	Ground	1	2
<u>Abert's Towhee (Pipilo aberti)</u>	Ground	0	2
<u>Lark Sparrow (Chondestes grammacus)</u>	Granivore	0	1
<u>Black-throated sparrow (Amphispiza bilineata)</u>	Ground	1	3
<u>Brown-headed Cowbird (Molothrus ater)</u>	C/S	4	29
<u>Bronzed Cowbird (Molothrus aeneus)</u>	C/S	0	
<u>Northern Oriole (Icterus galbula)</u>	Canopy	3	10
<u>Hooded Oriole (Icterus cucullatus)</u>	Canopy	3	15
<u>Summer Tanager (Piranga rubra)</u>	Canopy	5	17
<u>Lesser Goldfinch (Carduelis psaltria)</u>	Canopy	0	9
<u>House Finch (Carpodacus mexicanus)</u>	Granivore	10	14
<u>House Sparrow (Passer domesticus)</u>		0	

Table 4. cont.

Species	Group	Average densities	
		Clark (1977-1978)	Hunter (1985-1986)
Number of species		46	62
Species with measurable densities		32	38
Numbers of individuals		244	452

\*C/S = cowbirds and starlings.

\*\*Densities not estimated from transect readings.

\*\*\*Densities not estimated by Clark (1984).

ˆ State threatened status.

ˆ Federal proposed threatened status.

Table 5. Bird species richness and number of individuals among transects at Bonita Creek. Densities are birds per 40 ha.

Year	Avifaunal characteristic	Transects and transect categories						
		Lowermost- outside		Lowermost- inside		Uppermost- inside		Uppermost- outside
		BC-3	BC-4	BC-5	BC-6	BC-7	BC-8	BC-9
1985	Species richness	38	37	39	35	42		
	Species with measurable density	35	35	36	31	36	---	
	Total individuals	438	420	462	734	486	---	
1986	Species richness	41	37	40	39	36	35	38
	Species with measurable density	39	34	35	38	34	34	36
	Total individuals	449	345	354	492	450	440	395
Years combined								
	Species richness	46	41	46	42	43	35	38
	Species with measurable density	37	35	39	36	38	34	36
	Total individuals	448	390	415	645	473	440	395

Table 6. Species richness and individual numbers for bird groups occurring on Bonita Creek. Data is with years (1985-1986) combined. Group definitions are described in text. Spp. rich. = species richness; individ. = individuals.

Species group	Transect category							
	Lowermost- outside		Lowermost- inside		Uppermost- inside		Uppermost- outside	
	Spp. rich.	Individ.	Spp. rich.	Individ.	Spp. rich.	Individ.	Spp. rich.	Individ.
Bark								
foragers	2	30	2	25	2	30	2	31
Ground								
foragers	5	15	6	29	5	22	4	34
Understory								
foragers	5	67	6	86	6	83	6	72
Mid story								
foragers	6	88	7	75	7	87	6	66
Canopy								
foragers	10	145	11	71	11	161	10	93
Aerial								
foragers	4	13	4	13	3	7	3	19
Granivores	6	66	2	60	5	134	5	63
Cowbirds/ starlings	3	21	3	46	2	24	1	30
Raptors	5	3	4	2	4	1	2	1

Appendix I. Raw breeding data used in this report. Densities are presented per year for each transect. Birds are placed in groups. Densities are number per 40 ha. + = present without measurable density.

Bird group/species	Transect and years											
	BC-3		BC-4		BC-5		BC-6		BC-7		BC-8	BC-9
	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1986	1986
<b>Bark foragers</b>												
Gila woodpecker	20	19	25	22	16	6	31	9	26	13	11	22
Ladder-backed woodpecker	10	9	7	6	10	4	14	5	6	14	12	16
<b>Ground foragers</b>												
Rock wren	1	3	3	0	6	0	2	1	4	0	3	0
Canyon wren	9	20	13	10	19	16	8	22	16	22	17	28
<b>Crissal Thrasher</b>	0	0	0	0	0	1	0	0	2	0	0	0
Abert's Towhee	0	1	6	6	1	4	0	0	2	2	0	1
Brown Towhee	0	1	0	4	0	+	0	1	0	0	7	2
Black-throated Sparrow	1	2	3	0	8	6	0	1	2	2	5	6
<b>Understory foragers</b>												
Black Phoebe	14	13	22	18	31	15	9	19	30	26	24	31
Vermilion Flycatcher	21	15	4	6	14	6	1	8	7	13	7	2
<b>Bewick's wren</b>	3	12	9	13	13	8	27	23	7	23	4	16
Bell's Vireo	10	17	34	41	28	21	27	16	16	14	26	15
Yellow-breasted Chat	8	14	22	18	6	7	17	20	11	10	10	2

Appendix I. cont.

Bird group/species	Transect and years											
	BC-3		BC-4		BC-5		BC-6		BC-7		BC-8	BC-9
	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1986	1986
Midstory foragers												
Ash-throated Flycatcher	3	0	2	2	0	7	0	4	0	0	4	4
Verdin	38	51	27	50	25	48	35	48	30	47	34	30
Cactus Wren	0	6	2	1	3	2	1	2	1	1	2	1
Northern Mockingbird	0	0	1	0	0	0	0	0	0	0	0	0
Hutton's Vireo	0	0	0	0	0	0	0	4	0	2	0	0
Lucy's warbler	23	7	14	13	21	9	23	15	3	9	15	7
Northern Cardinal	21	13	8	12	9	13	27	11	23	25	12	8
Blue Grosbeak	5	6	5	5	7	8	17	7	5	3	14	6
Canopy foragers												
Yellow-billed Cuckoo	1	3	3	1	5	0	5	4	6	4	1	2
Brown-crested Flycatcher	18	20	18	9	10	14	29	23	31	13	25	21
Western Kingbird	21	19	3	6	15	3	11	6	8	3	2	11
Cassin's Kingbird	25	22	4	2	6	11	8	15	22	33	4	18
Northern Beardless Tyrannulet	0	0	0	0	0	0	0	3	+	1	0	0
Bridled Titmouse	0	4	0	1	0	0	5	1	2	13	10	10
Phainopepla	0	0	1	0	1	0	0	0	0	0	0	0
Yellow Warbler	35	22	2	1	8	3	21	26	29	21	3	15
Northern Oriole	16	12	9	10	6	4	19	12	17	3	3	10
Hooded Oriole	16	11	6	4	16	13	37	23	5	<b>15</b>	17	14

Appendix I. cont.

Bird group/species	Transect and years											
	BC-3		BC-4		BC-5		BC-6		BC-7		BC-8	BC-9
	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1986	1986
Summer Tanager	12	17	10	19	11	9	30	22	25	26	18	9
Lesser Goldfinch	6	5	4	7	7	15	12	21	8	11	2	10
<b>Aerial foragers</b>												
Violet-green Swallow	+	+	+	+	+	+	+	+	+	+	+	+
Lesser Nighthawk	+	0	0	0	2	+	0	2	0	0	0	0
Black-chinned Hummingbird	6	14	10	10	14	12	6	8	6	2	23	6
Costa's Hummingbird	0	6	0	0	0	2	0	0	2	0	8	0
<b>Granivores</b>												
Gambel's Quail	27	36	22	8	43	12	139	27	54	22	56	23
wild Turkey	0	0	0	0	0	0	0	0	+	0	0	0
Mourning Dove	11	18	22	11	18	10	33	9	22	12	16	10
White-winged Dove	10	4	9	8	4	3	43	43	17	17	3	1
Lark Sparrow	0	1	0	2	0	5	0	0	0	0	0	5
House Finch	15	7	21	3	18	16	62	16	7	13	2	10
House Sparrow	2	0	0	0	0	0	0	0	0	0	0	0
<b>Cowbirds/starlings</b>												
European Starling	5	0	0	0	6	0	8	0	6	0	0	0
Brown-headed Cowbird	21	14	68	15	50	38	25	13	27	14	40	19
Bronzed Cowbird	1	0	0	0	4	0	0	0	0	0	0	0



Appendix I. cont.

Bird group/species	Transect and years											
	BC-3		BC-4		BC-5		BC-6		BC-7		BC-8	BC-9
	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1986	1986
Raptors												
Turkey Vulture	0	1	0	0	0	0	0	0	0	0	0	0
Cooper's Hawk	0	0	0	+	0	0	+	0	0	0	0	0
Red-tailed Hawk	+	0	0	0	+	1	0	1	+	+	0	+
Zone-tailed Hawk	0	0	0	0	0	0	+	0	+	1	0	0
Common Black-Hawk	2	1	1	1	0	0	1	1	0	0	0	1
American Kestrel	0	1	0	0	+	0	0	0	0	0	0	0
Great Horned Owl	1	1	+	+	1	+	0	0	+	0	0	0
Common Barn-Owl	0	0	0	0	0	1	0	0	0	0	0	0