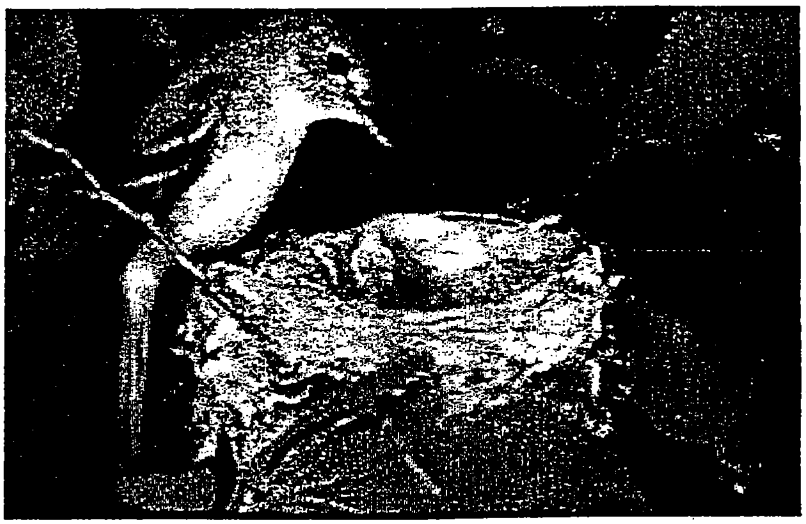
Reproductive Success of Southwestern Willow Flycatchers in the Cliff-Gila Valley, New Mexico



Summary report for the 1998 Field Season

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INTRODUCTION

The Species. — The Southwestern Willow Flycatcher *(Empidonax traillii extimus*) is a neotropical migrant passerine that ranges from southern California and Baja California eastward through Arizona, southern Utah, southern Colorado, New Mexico, and trans-Pecos Texas (Unitt 1987). This species is an obligate riparian specialist, nesting in dense vegetation associated with watercourses. In the southwest, nesting is almost always in the vicinity of surface water or saturated soils (U.S. Fish and Wildlife Service 1995).

Populations of the Southwestern Willow Flycatcher are thought to have declined significantly during this century, primarily due to extensive loss and conversion of riparian breeding habitats (Unitt 1987, U.S. Fish and Wildlife Service 1995). It has been suggested that the loss and modification of riparian habitats have been due to many factors, including water diversion and impoundment, changes in fire and flood frequency due to hydrological alterations, livestock grazing, replacement of native riparian vegetation by nonnative species, urban development, and recreational activities (Rea 1983, Kreuper 1993, U.S. Fish and Wildlife Service 1995). Additionally, a high incidence of nest parasitism by brown-headed cowbirds (*Molothrus ater*) has been reported from several sites, resulting in low reproductive success. Cowbirds lay their eggs in the nests of other species (hosts), where cowbird chicks are raised by the host parents. For small hosts, parasitized nests rarely fledge any host young (Brittingham & Temple 1983). Nest parasitism levels of more than 50% have been documented for populations at the Kern River, California (Harris 1991) and the Grand Canyon (Brown 1994). Frequently flycatchers respond to the laying of cowbird eggs in their nests by abandoning and renesting (Whitfield & Strong 1995).

In 1993, the U.S. Fish and Wildlife Service proposed to list *E. t. extimus* as an endangered species and to designate critical habitat. In February of 1995, the USFWS listed *E. t. extimus* as endangered, although no designation of critical habitat was made (U.S. Fish and Wildlife Service 1995). The subspecies has also been listed at the state level in New Mexico, Arizona, and California (Arizona Game and Fish Department 1988, New Mexico Department of Game and Fish 1988, California Department of Fish and Game 1992).

The Cliff-Gila Valley population. — Since its listing as an endangered species, numerous surveys have been conducted across the range of the flycatcher to locate extant populations and to estimate their size. Flycatchers have been found breeding at about 109 sites throughout the southwestern United States (Marshall, in review). Approximately 78% of extant sites consist of 5 or fewer territories. The entire known breeding population in 1996 was estimated at just over 500 pairs (Marshall, in review). By far the largest known breeding concentration of Southwestern Willow Flycatchers is located in the Cliff-Gila Valley, Grant County, New Mexico. This population was estimated at 184 pairs in 1997 (Parker 1997), and at 235 pairs in 1998 (P. Boucher, personal communication; Stoleson and Finch, unpublished data). These birds are located primarily on private property owned by the Pacific Western Land Company, a subsidiary of Phelps Dodge Corporation, and managed by the U-Bar Ranch. An additional 24 pairs occur on the adjacent Gila National Forest and other private holdings. Habitat preferences of flycatchers in this population differ from those reported elsewhere (Hull and Parker 1995, Skaggs 1996, Stoleson and Finch 1997), and from populations of other subspecies.

Objectives

The goals of this study are (1) to monitor nesting success and rates of cowbird parasitism to assess the reproductive health of Willow Flycatchers in the Cliff-Gila Valley; and (2) characterize and quantify the habitat preferences of this population. This report summarizes the results of the second year of the study on Willow Flycatchers, and presents preliminary analyses of habitat characterization based on data from 1997 and 1998.

Methods

Study area. — The Cliff-Gila Valley of Grant County, NM, comprises a broad floodplain of the Gila River, beginning near its confluence with Mogollon Creek and extending south-southwest toward the Burro Mountains. The study was primarily conducted from just below the US Route 180 bridge upstream to the north end of the U-Bar Ranch (approximately 5 km). In addition, flycatchers were studied in two disjunct sections of the valley: (1) the Fort West Ditch site of the Gila National Forest and adjacent holdings of The Nature Conservancy's Gila Riparian Preserve, located about 9 km upstream of the Route 180 bridge, and (2) the Gila Bird Area, a riparian restoration project comprising lands of the Gila National Forest and Pacific-Western Land Company, located some 8 km downstream of the Route 180 bridge. Most of the upper GilaValley consists of irrigated and non-irrigated pastures used for livestock grazing and hay farming. Elevations range from 1350 to 1420 m (Figure 1).

The Gila River floodplain contains numerous patches of Broadleafed Riparian Forest, with a canopy composed primarily of *Populus fremontii*, *Platanus wrightii*, *Salix gooddingi*, *Acer negundo*, and *Juglans major*. Most patches support an understory of shrubs, including *Rhus trilobata*, *Amorpha fruticosa*, *Salix* spp., *Baccharis glutinosa*, *Alnus oblongifolia*, *Elaeagnus angustifolia*; forbs, and grasses. Most habitat patches are less than 5 ha in area. The FS Fort West Ditch site and the Gila Bird Area are generally more open than patches on the U-Bar. In addition to the primary patches of riparian woodland along the Gila itself, numerous stringers of riparian vegetation extend along many of the earthen irrigation ditches. These stringers contain the same plant species as larger forest patches, but rarely exceed 10 m in width.

The study concentrated on three large riverine patches and two stringer patches on the U-Bar Ranch (see Figure 1: SE1, NW1, NE1, SW Stringer, and NW Stringer) and the FS Fort West Ditch site. Focal patches were chosen that had been occupied by Willow Flycatchers in previous years (Hull & Parker 1995). In addition, flycatchers were studied in other riparian patches as time allowed.

Spot mapping. — Territories of all breeding land birds were determined using the spot mapping method (Robbins 1970, Bibby *et al.* 1992, Ralph *et al.* 1993). In each focal patch, a grid of 100 ft squares was established and marked with flagging tape. Grids were of varying sizes and configurations depending on the size and shape of the patch. Each plot was mapped 10 - 12 times during the season, approximately every 2-3 days. Spot mapping sessions began within 15 minutes of dawn at a different random corner of the grid each time, and lasted 2 to 5 hours (Bibby *et al.*, 1992). Weather conditions, such as cloud cover, wind speed, and precipitation were recorded on each mapping day. A new map was used for each mapping session. Following mapping, observations were transferred from the daily map to master maps for each species.

From the master maps we determined the number of breeding territories of all species for each patch. We calculated estimates of the density of breeding birds (all species) for the areas that were spot-mapped, using the following caveats. First, because the territories of large and/or wide-ranging birds could potentially cover two or more patches and/or surrounding nonforested land, a territory was assigned to a particular patch only if the nest was located within the patch. Second, Mourning Doves (*Zenaida macroura*) breed in high densities in riparian habitats but forage mainly in open areas. Because including all doves found in a patch in calculations is likely to bias estimates of density, we followed Anderson *et al.* (1983) in using only 10% of the observed dove population.

Nest searches. — Nest searches were conducted on a daily basis following spot-mapping sessions. Nests were monitored every 3-5 days. Nest contents were observed using pole-mounted mirrors or videocameras, or 15X spotting scopes. Nests that were abandoned or destroyed were examined for evidence (e.g., cowbird eggs, mammal hairs) to ascertain causes of nest failure. Nest predation was assumed if nest contents disappeared before fledging of young was possible (about 12 d after hatching). Nests were considered successful if they fledged one or more flycatcher young.

Habitat Measurements. — Vegetation characteristics were sampled at nest sites and at unused points using a modified BBIRD methodology (Martin *et al.* 1997). Unused points were defined as points on the spot-mapping grid that were at least 100 ft away from the nearest Willow Flycatcher nest; we based this definition on the fact that most flycatcher territories appeared to have radii much smaller than 100 ft. Within each patch, a subset of about 50-70% of potential unused points were chosen randomly for sampling.

At each unused point and nest site, a 0.02 ha plot (radius = 8 m) was placed centered on the nest tree, or on the nearest tree to the gridpoint for unused points. Standard methodology uses 0.04 ha plots, but we used smaller plots in this study to minimize problems of nonindependence of points around nests that would result from the very small territories used by flycatchers in this area. At the center of the plot and eight other points (4 and 8 m from the center in each of the four cardinal directions), we measured canopy height using clinometers, percent canopy cover using densiometers, and estimated percent ground cover. Vertical foliage density was measured at 2, 4, 6 and 8 m in each direction from the center tree by counting hits of vegetation against a 10 m vertical pole marked in 1 m increments. Within the 0.02 ha plot, trees ($\geq$ 10 cm dbh) of all species were counted and measured (dbh). Shrubs and saplings (< 10 cm dbh) were counted and measured within a 4 m radius of the center tree. For nest sites we also recorded nest plant species, nest height, and distance and direction from the trunk.

For each sample point we calculated average ground and canopy cover and average canopy height (all = mean of 9 measurements per point); foliage density index (sum of 1 m increments touched by foliage) for understory (0-3 m in height, for a maximum score of 48 per point) and mid-canopy (3-10 m in height, for a maximum score of 112 per point); the sum of shrub/sapling (<10 cm diameter) stems and tree (≥ 10 cm diameter) stems by species and size class (<1cm, 1-5 cm, 5-7.5 cm, 7.5-10 cm, 10-30 cm, 30-50 cm, 50-70 cm, >70 cm). From these values we also calculated the total number of stems of willow and boxelder per point, an estimate of the total basal area of woody species per point, woody plant species richness (number of species of trees and shrubs per point), and plant species diversity (using the Shannon-Weaver Diversity Index). We calculated several variables to estimate the degree of habitat heterogeneity at points: patchiness (the diversity of foliage density among the four cardinal directions, using the Shannon-Weaver Diversity Index); and the coefficient of variation in measures of canopy cover, canopy height, and ground cover at each point.

Analyses. — We compared habitat values of unused points (n=40) to those at nest sites (n=152) using independent sample t-tests. Although we performed multiple statistical comparisons from the single set of data, we did not adjust our experiment-wise alpha level to minimize the risk of Type I errors because the modest sample sizes used for unused points are already prone to Type II errors, and we wanted to maximize our ability to detect trends.

To assess whether flycatchers used nest substrates randomly, we calculated an index of availability for each nest tree species to compare usage with availability. Because flycatcher nests were found in vegetation of all size classes 1 cm DBH and greater, we pooled all size classes > 1 cm DBH as potential nest substrates. A total stem count for each species was calculated from all nest sites. The relative availability of a particular plant species *x* was calculated as: total number of stems for species *x* / total number of all stems. The numbers of used versus unused stems were compared using chi-square analyses.

RESULTS

WILLOW FLYCATCHERS

Willow Flycatcher nest substrates. — We found a total of 130 willow flycatcher nests on the U-Bar ranch in 1998. An additional 35 nests were found on nearby Forest Service (FS) and Nature Conservancy (TNC) lands. In the combined data set of all 257 nests found in 1997-1998, the majority of nests (76.7%) were located in boxelder (Fig. 2). In 1998, nests were found in several

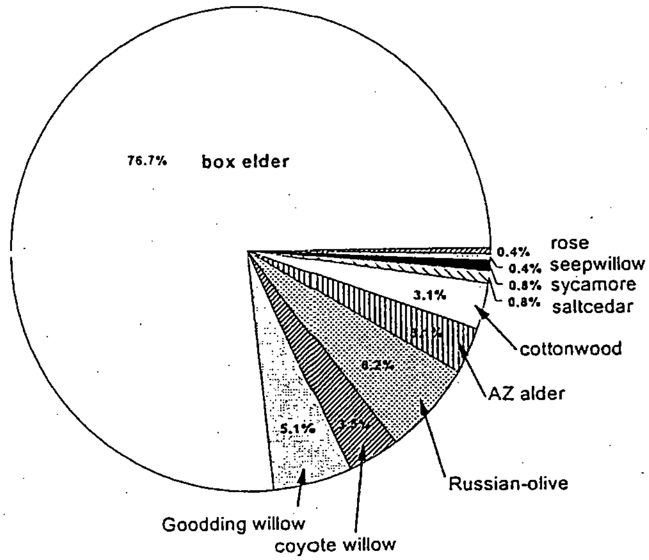

Figure 2. Nesting substrates of 257 nests of the Southwestern Willow Flycatcher in the Cliff-Gila Valley, 1997-98.

substrates not encountered previously in the Cliff-Gila Valley, including Fremont cottonwood, Arizona sycamore, seepwillow, and a nonnative climbing rose (*Rosa multiflora*). The sycamore nests represent the first recorded nests in this substrate anywhere in the Southwest (Stoleson and Finch in press). Nests in cottonwood and seepwillow were located in early successional riparian patches on FS and TNC properties. Boxelder was even more dominant (85%) as a substrate among the 213 nests found in the more mature woodlands found on the U-Bar Ranch.

Substrate use versus availability. — Plant species were not used for nesting in proportion to their availability within flycatcher territories. Boxelder and Russian olive were used significantly more than would be expected if birds chose nest trees randomly (Likelihood Ratio test G=271.8 and 5.2, P<0.001 and P=0.023, respectively). Boxelders comprised less than 35% of woody stems, yet contained more than 75% of all the nests found (Fig. 3). In contrast, willows were used less than expected by chance (G=60.6, P<0.001). The two willow species made up more than 40% of woody stems within flycatcher territories, but only 8.6% of nests were placed in either willow species. These results indicate an active preference by flycatchers for boxelder and Russian olive, and active avoidance of willow, as a nest substrate.

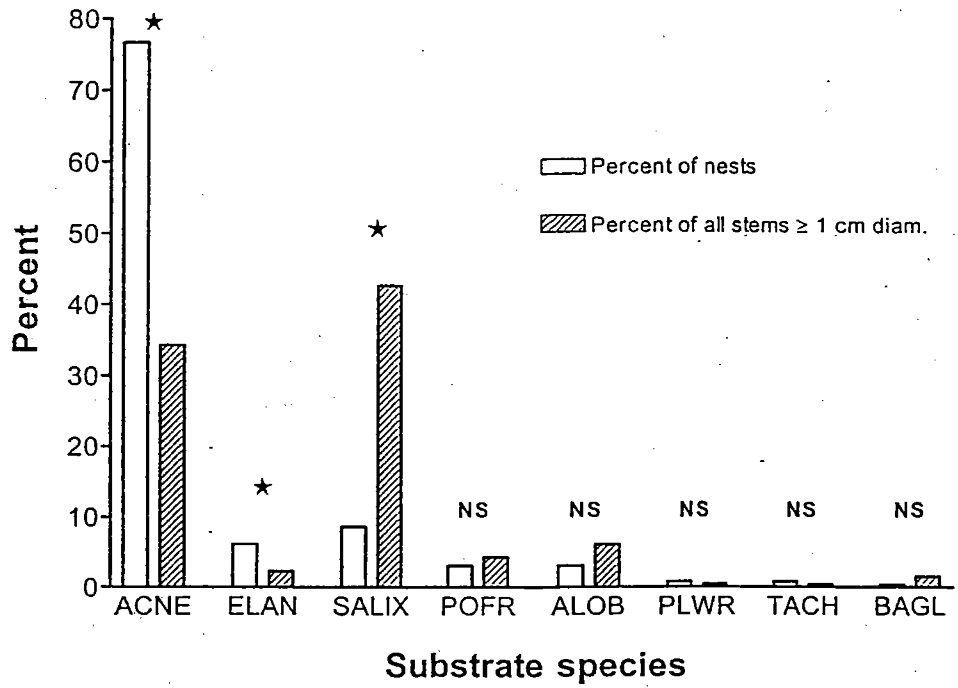

Figure 3. Use versus availability of nest substrates by Willow Flycatchers in the Cliff-Gila Valley, 1997-98. Significant ($P<0.05$) overutilization or underutilization is indicated by stars, NS = not significant. ACNE = boxelder, ELAN = Russian olive, SALIX = willow species, POFR = cottonwood, ALOB = Arizona alder, PLWR = Arizona sycamore, TACH = saltcedar, and BAGL = seepwillow.

Nest heights. — Flycatcher nests ranged from 1.2 to 18.5 m in height. The mean height of all nests found in 1997-98 was 7.4 ± 3.8 m, with a median height of 6.8 m (Fig. 4). Average nest heights varied among different nest substrates (Fig. 5). Boxelder nests were significantly higher (8.3 ± 3.7 m) than nests in all other substrates combined (4.6 ± 2.6 m; $t = -8.57$, df = 138.9, $P<0.001$). Nests also tended to be higher than average in sycamore.

Willow Flycatcher nest success. — Of 103 nests of known outcome found on the U-Bar in 1998, 45 (42.7%) successfully fledged one or more flycatcher young. The outcome of 27 nests was uncertain. Of 34 nests of known outcome found on lands other than the U-Bar Ranch, 14 (41.2%) were successful. Of the failed nests on the U-Bar, fourteen appeared to have been deserted during or immediately after building, but before any eggs were laid in them. The cause

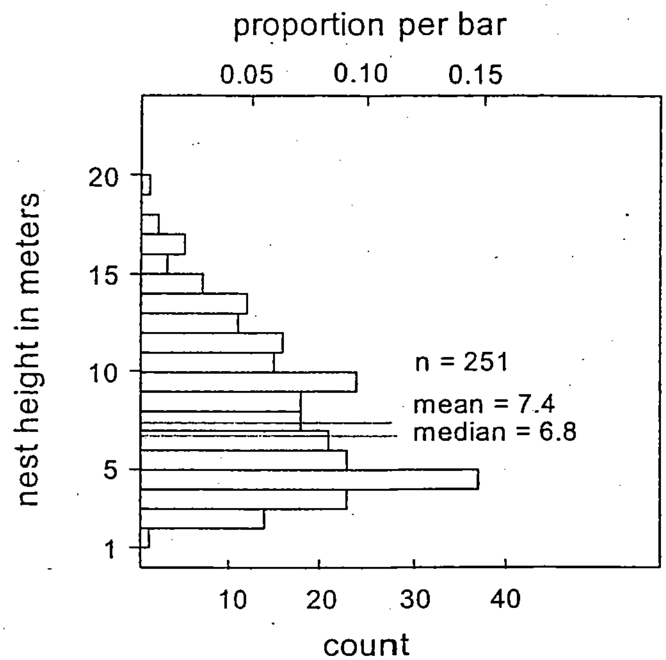

Figure 4. Distribution of heights of Willow Flycatcher nests in the Cliff-Gila Valley, 1997-98.

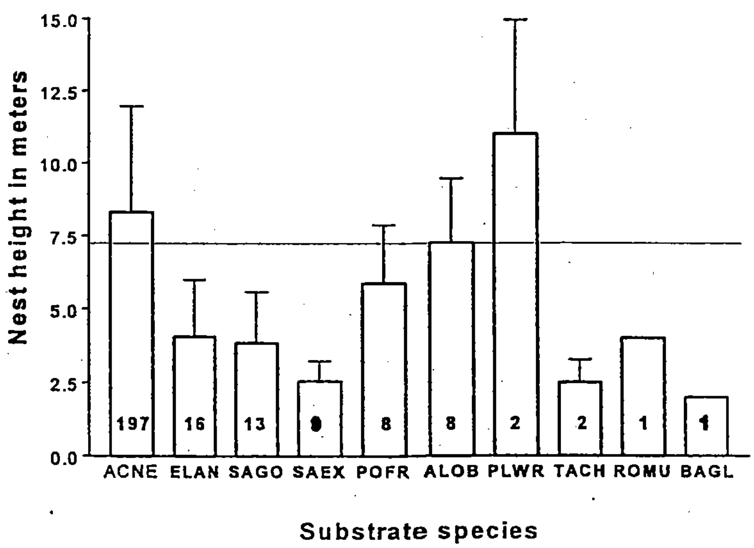

Figure 5. Heights (mean + SD) of 251 Willow Flycatcher nests in different nest substrates. Horizontal line indicates the overall mean, and numbers in bars are samples sizes. ROMU=multiflora rose, other substrate acronyms as in Figure 3.

of this high rate of desertion is unclear, but may have been related to (1) the repeated presence of humans in the vicinity of nests, (2) a high incidence of cowbirds near nests, or (3) damage from high winds. The first suggested cause is unlikely, as nests were visited at a similar rate in 1997, when only one instance of desertion was noted. The second suggestion may be possible, as a higher rate of cowbird parasitism was recorded in 1998 than in 1997 (see below). Alternatively, winds may have been responsible as we recorded numerous nests of other species being either deserted or blown out of trees entirely, including species such as the Western Wood-Pewee which is rarely parasitized by cowbirds. If deserted nests are discounted, then the nest success rate on the U-Bar was 45% in 1998.

The overall nest success rate for all nests (including those abandoned) from 1997-98 was 46.6%. The likelihood of a nest being successful varied among nest substrates (Fig. 6). Nests in Goodding's willow and Russian olive were less likely to be successful than average, while nests in boxelder, coyote willow, alder, and cottonwood were more likely to be successful than average. For the remaining plant species, sample sizes are too small to make any generalizations. The likelihood of a nest being successful showed a strong correlation with nest height: the higher the nest, the more likely it was to be successful (Fig. 7). This correlation and the fact that nests tended to be placed at different heights in different substrates may explain the differential nest success among substrates.

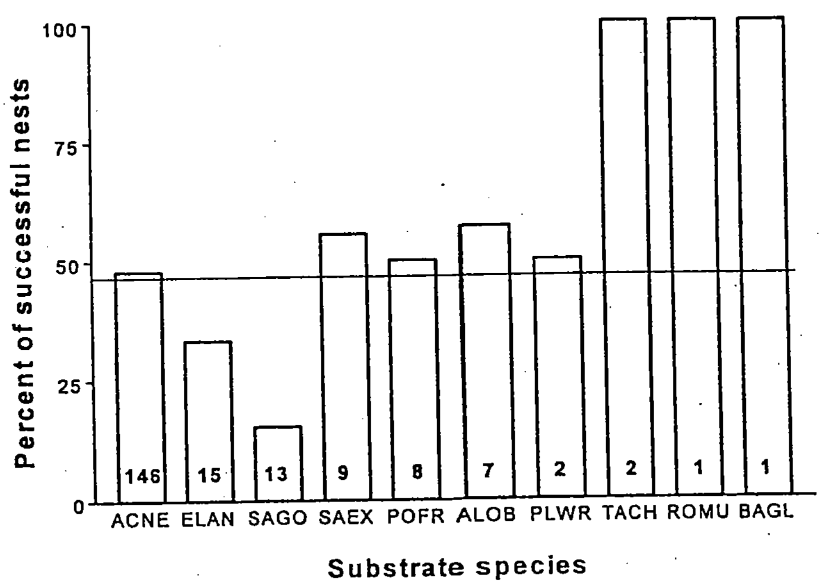

Figure 6. Nesting success as a function of nest substrate. Horizontal line indicates overall mean success rate, and substrate acronyms as in Figure 5.

A total of 74 nests of known outcome from 1997 and 1998 were located in patches that were open to cattle for at least part of the year (SW Stringer, NW Stringer, NW4, SW1, SW2, SW3, SW4, and the south end of SE1). Of these, 37 (50.0%) were successful. On the U-Bar, 88 nests of known outcome were located in patches excluded from cattle. Of these, 40 (45.5%) were successful. We found no significant effect of grazing on nesting success (G=0.33, P=0.56). Nest parasitism rates in the grazed patches (17.4%) did not differ significantly from the parasitism rate in excluded patches (21.8%; G=0.31, P=0.58). All patches at the site were within 1 km of grazed pastures for at least part of the breeding season.

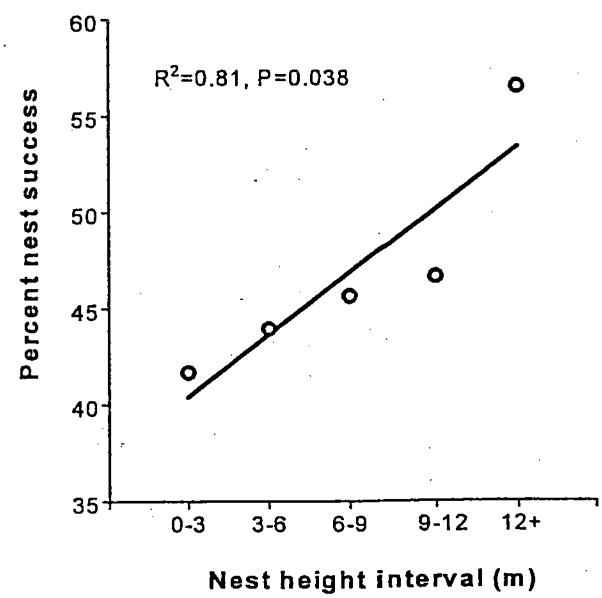

Figure 7. Correlation of nest height interval and average nesting success rate for each interval.

Causes of nest failure. — A total of 110 flycatcher nests were known to have failed during 1997-1998. Of these, the cause was not determinable for 24 (21.8%). More nests were lost to predators than to any other cause (Fig. 8). Other than one nest lost to a Great Horned Owl (*Bubo virginianus*) in 1997, we did not witness any failures due to predation, so the identity of nest predators can only be speculative. However, nests of other bird species were observed being depredated by Common Ravens (*Corvus corax*), Western Scrub-Jays (*Aphelocoma californica*), and a rock squirrel (*Spermophilus variegatus*). Desertion (defined here as nest abandonment prior to egg-laying) was the next most frequent cause of nest failure, followed by abandonment (after the onset of laying). Thirteen nests were known to have failed due to cowbird parasitism.

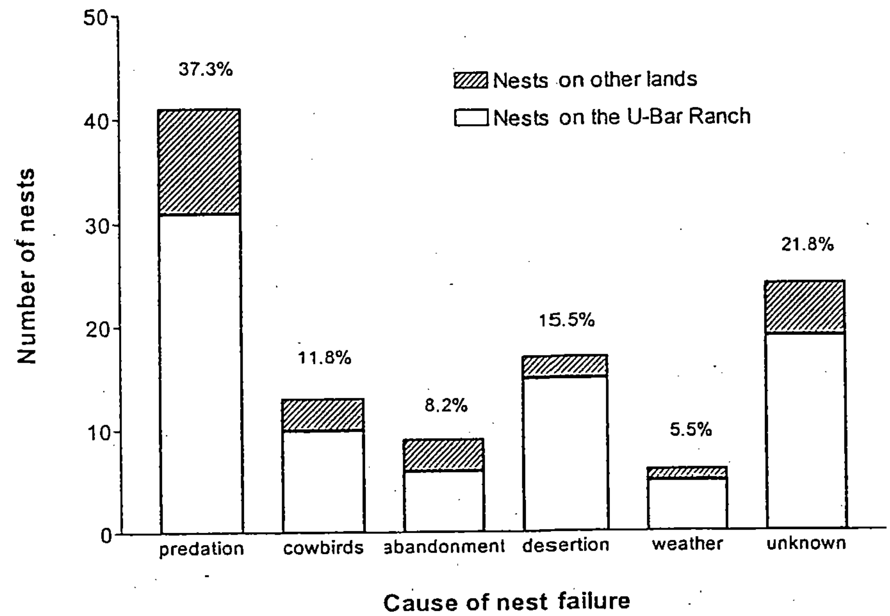

Figure 8. Causes of nest failure for 110 Willow Flycatcher nests in the Cliff-Gila Valley, 1997-98. Desertion = abandonment of nest prior to egg-laying, abandonment = after the first egg is laid.

Cowbird parasitism. — A total of 28 out of 129 nests (27.1%) of known status were parasitized by cowbirds in the Cliff-Gila Valley in 1997-1998. Observed parasitism rates were higher in 1998 than in 1997 (Fig. 9). In both years, nests on the U-Bar were somewhat less likely to be parasitized by cowbirds than nests on other lands, though this trend was not statistically significant ($G<0.95$, $P>0.25$).

The probability of a nest being parasitized by cowbirds was not significantly correlated with nest height (P=0.65), although there was a nonsignificant trend for nest parasitism to decrease with increasing nest height (Fig. 10). These data may be suspect because of the difficulties in determining whether high nests were parasitized or not.

The likelihood of a nest being parasitized varied among nest substrates. About 14% of the boxelder nests were parasitized, while nests in willow, Russian olive, and cottonwood were much more likely to be parasitized (Fig. 11). Other substrates were too infrequently used to make any generalizations.

The proportion of parasitized nests varied among the six focal patches. Surprisingly, there was a strong and almost statistically significant *negative* correlation between patch-wise parasitism rates and the estimated density of female cowbirds in a patch (Fig. 12). That is, the higher the estimated density of cowbirds within a patch, the *lower* the proportion of flycatcher nests in the patch that were parasitized.

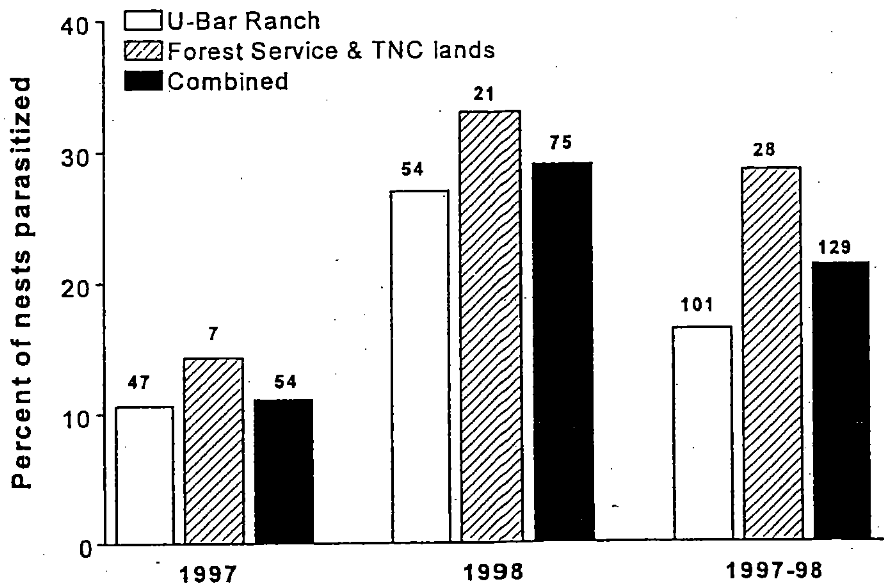

Figure 9. Rates of cowbird parasitism on Willow Flycatcher nests as a function of year and land ownership. Numbers above bars are sample sizes of all nests known to parasitized or not.

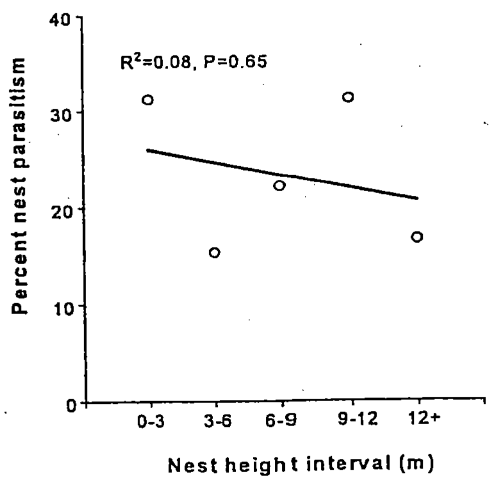

Figure 10. Correlation of nest height interval and average nest parasitism rate for each interval.

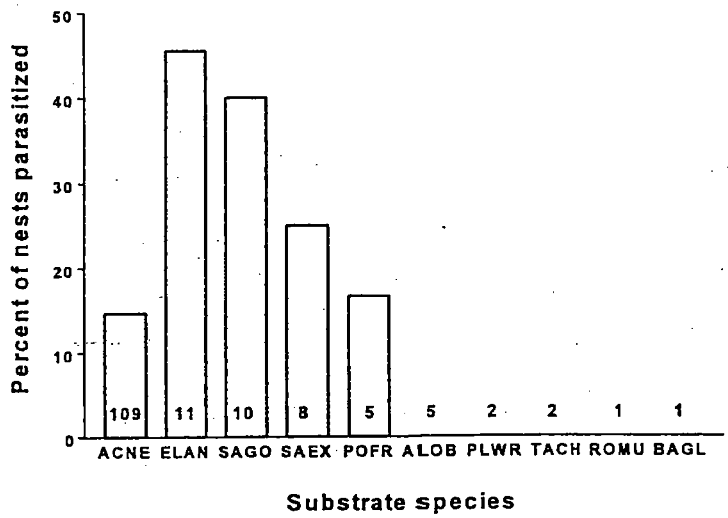

Figure 11. Average rate of nest parasitism as a function of nest substrate; acronyms as in Figure 5.

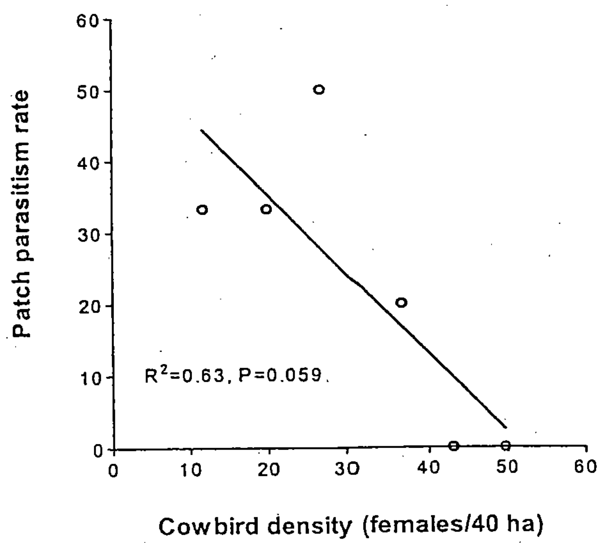

Figure 12. Correlation between average density of cowbirds per patch and patch parasitism rate.

Of the 28 flycatcher nests known to have been parasitized in 1997 and 1998, nine (32%) were abandoned immediately by the flycatchers (Fig. 13). Of those nests where cowbird eggs were accepted, most were depredated. Five nests fledged a single cowbird chick, and two fledged flycatcher young only despite having been parasitized. One nest was known to have fledged two flycatcher young in addition to a cowbird chick. The parents at this nest were seen to preferentially feed their own nestlings after the cowbird had fledged; it is unknown whether the cowbird fledgling survived. We were unable to determine the outcome of two parasitized nests in whih both cowbird and flycatcher young had hatched.

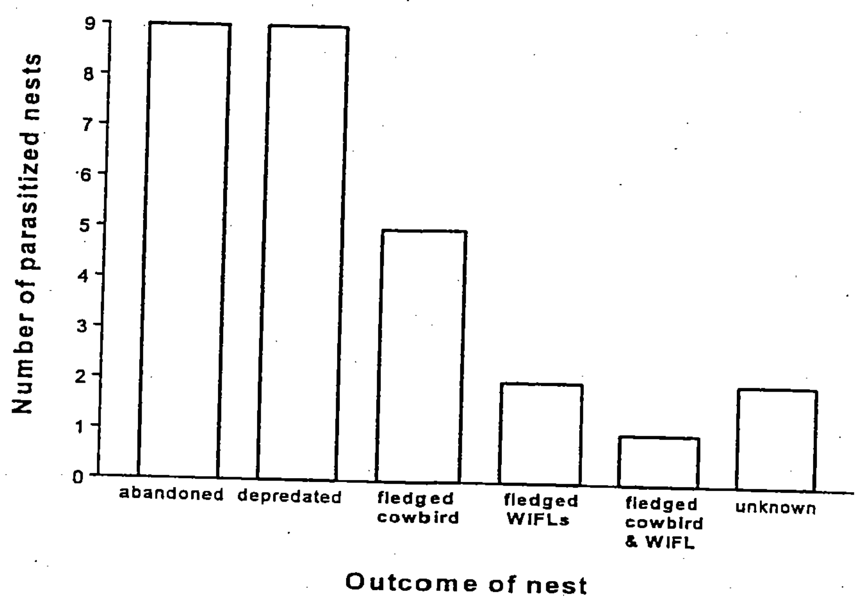

Figure 13. Fate of 28 Willow Flycatcher nests parasitized by cowbirds 1997-1998.

Willow Flycatcher nest site characteristics. — The habitat around Willow Flycatcher nests typically exhibits moderate ground cover, but high canopy cover and foliage density (Table 1). Canopy heights are moderate for the valley, averaging less than 15 m. Thus, flycatcher areas do not usually include the tall cottonwood galleries with canopies in excess of 25 m. Nor do they generally include the low, young growth of coyote willow and seepwillow. Flycatcher habitat also typically has a well-developed understory, as indicated by the high average stem count for shrubs (Table 1).

Flycatcher nesting habitat on the U-Bar Ranch, which was primarily in older, mature riparian woodland, differed significantly in some respects from nesting habitat elsewhere in the Cliff-Gila Valley. Specifically, the habitat on the U-Bar had, on average, a higher canopy, higher

Comparisons of used versus unused sites within occupied patches. — We compared habitat variables from 152 Willow Flycatcher nest sites with 40 Unused sites (defined here as gridpoints in occupied patches >100 ft from the nearest flycatcher nest). Nest sites differed significantly from unused sites in a variety of ways; these are summarized in Table 2, and Figures 14, 15 & 16. In general, in the patches where they occur, Willow Flycatchers prefer to nest in microsites that have high canopy closure, moderate canopy height, dense foliage in the subcanopy, a high density of trees but few very large trees, and many boxelders and willows (Figs. 14 & 15). Foliage density was significantly more patchy around nest sites than at unused sites (Fig. 16), suggesting that flycatchers key in to heterogeneous foliage, rather than just dense foliage *per se*. Microsite heterogeneity is also suggested by the higher variation in ground cover found at nest sites (Fig. 14). However, there was relatively little variation in canopy cover or height at nest sites (Fig. 14).

Table 2. Summary of habitat variables found to differ significantly (P<0.05) between Willow Flycatcher nest sites and unused sites (random points >100 ft. from nest sites) within occupied patches, and the direction of those differences.

Variable	value at nest sites relative to unused sites
Average ground cover (%)	lower
Coefficient of variation in % ground cover	higher
Average canopy cover (%)	higher
Coefficient of variation in % canopy cover	lower
Average canopy height	lower
Coefficient of variation in canopy height	lower
Foliage density @ 3 - 10 m	higher
Patchiness	higher
Number of tree stems	higher
Total basal area of woody stems	lower
Number of boxelder stems	higher
Number of willow stems	higher

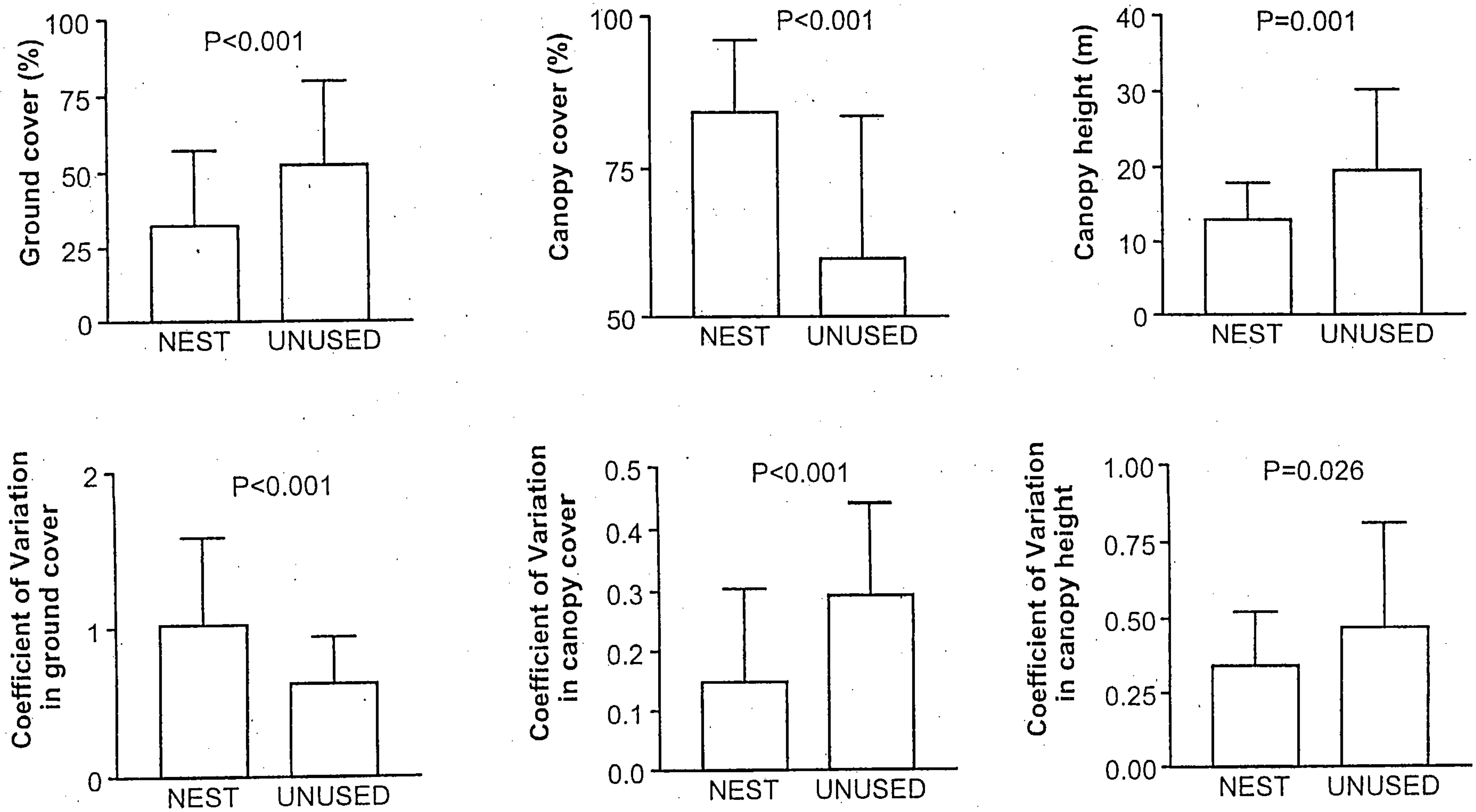

Figure 14. Comparisons of canopy cover, canopy height, and ground cover values and variation between Willow Flycatcher nest sites and unused sites. See Methods for variable definitions.

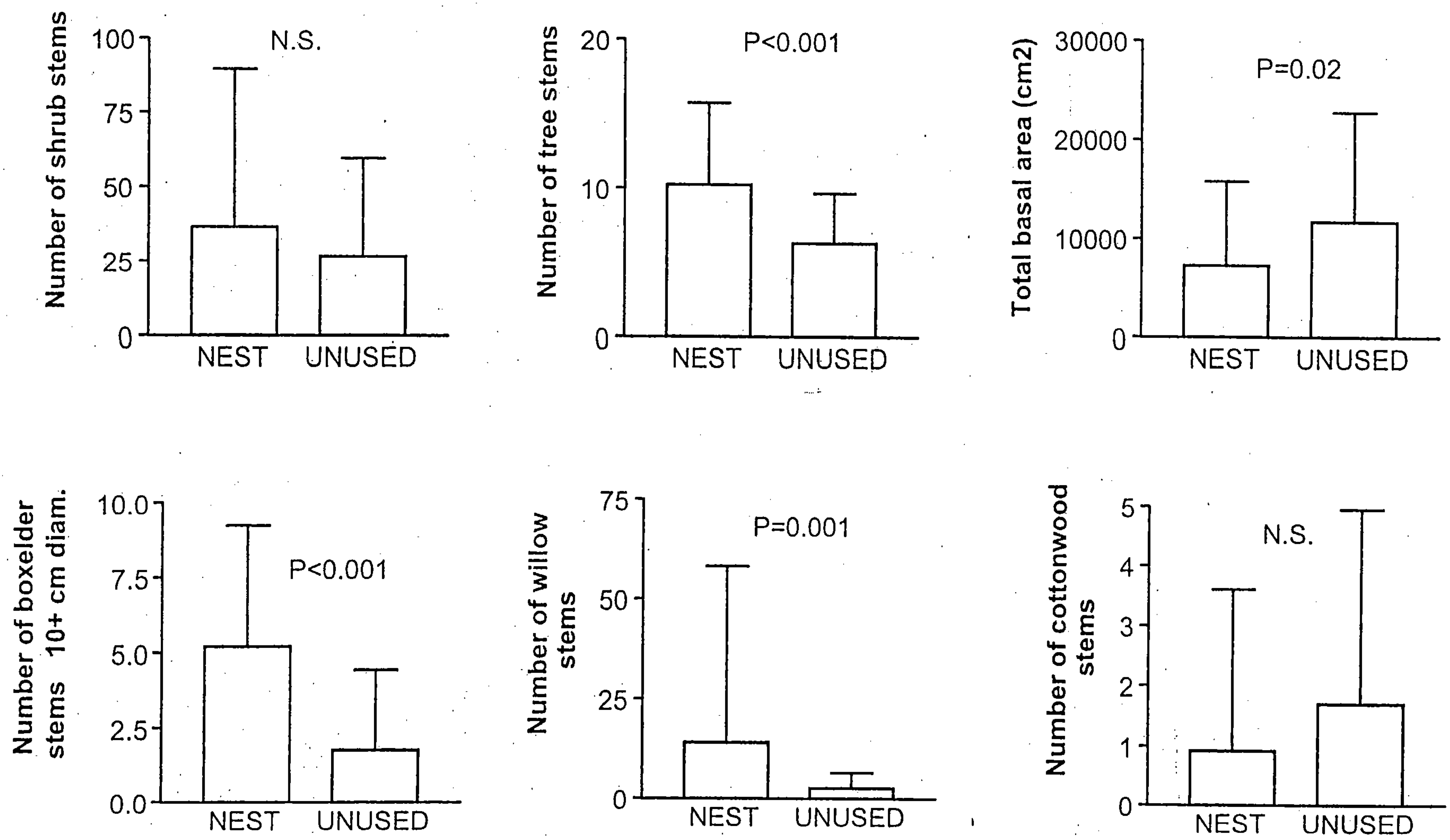

Figure 15. Comparisons of stem counts and basal area values between Willow Flycatcher nest sites and unused sites. ***See Methods*** **for variable definitions.**

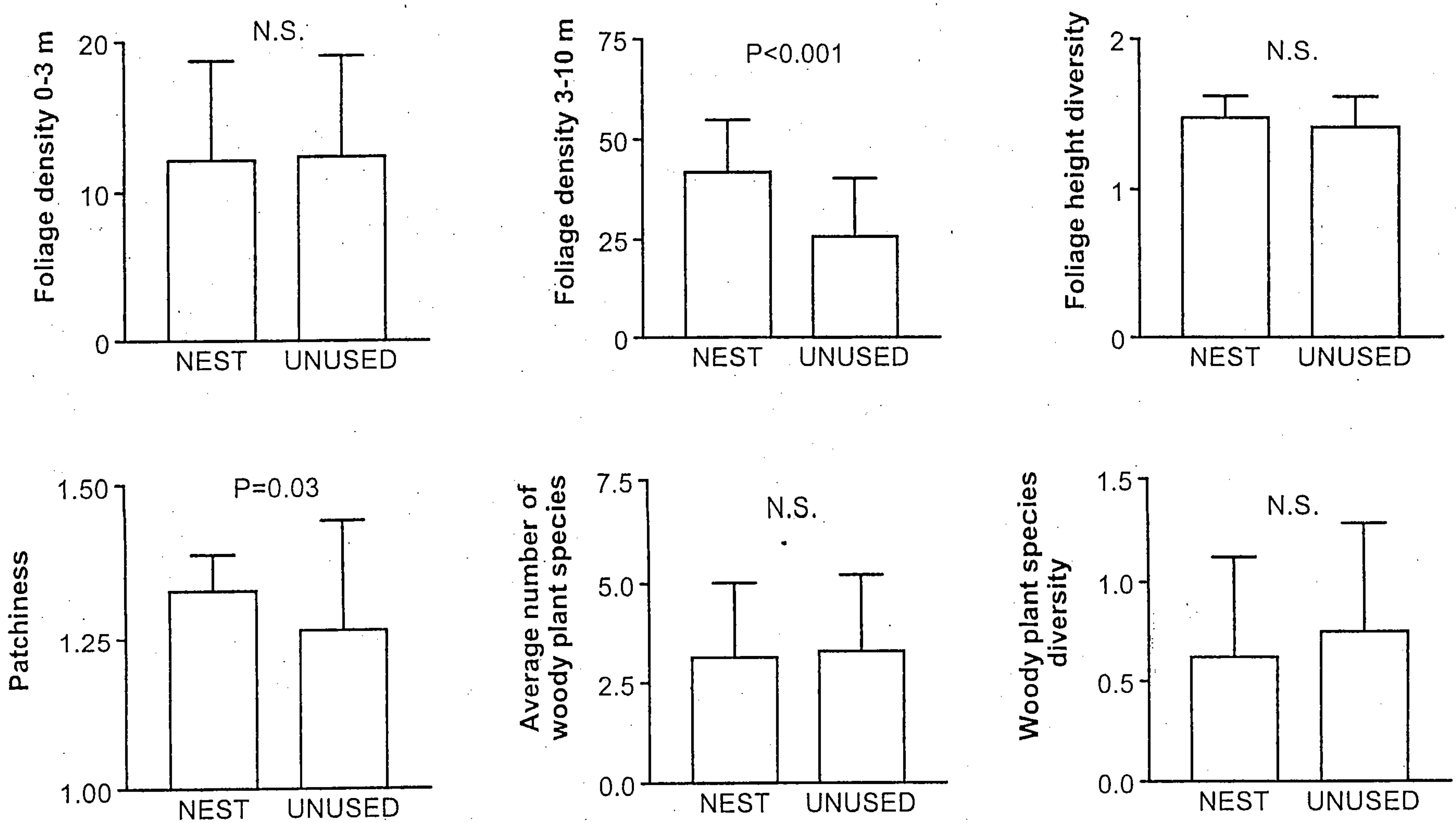

Figure 16. Comparisons of foliage density, foliage diversity, and woody plant species diversity between Willow Flycatcher nest sites and unused sites. See Methods for variable definitions.

A total of 37 adult and one fledgling flycatcher was caught, color-banded, and released. Of the adults that could be sexed, nine were males and thirteen were females. Eighteen individuals were caught more than once. One individual banded on the Fort West Ditch was later found breeding (successfully) in patch NW3, a distance of approximately 3.5 km. No other banded bird appeared to move during the course of the breeding season.

DISCUSSION

Willow Flycatcher nesting success. — As in 1997, Willow Flycatchers constituted one of the most common breeding species in the habitat patches surveyed. The observed nesting success rate (43%) was lower than that observed in 1997 (55%). This reduction in nesting success may be due to several factors, including stochastic variation in predator numbers or other factors affecting flycatcher breeding, increased rates of weather-induced nest failure, or a larger sample of nests found in suboptimal habitat due to population growth and/or increased numbers of observers. This level of nest success still compares favorably with other sites that lack cowbird control programs, as well as a number of sites (e.g., Kern River) with extensive cowbird control programs (McCarthey *et al.* 1998). It is a typical success rate for a small migratory songbird (Martin 1995). Predation was the major cause of nest failure by far (Fig. 8)

Cowbird parasitism rates were higher in 1998 (27%) than in 1997 (14.7%), although both figures are suspect because of the uncertain status of the many high nests. It is likely that the actual parasitism rate is lower than the observed rate because the probability of parasitism decreases with nest height in almost all species (Best & Stauffer 1980, Briskie *et al.* 1990). Not all flycatcher parents accepted cowbird eggs (approximately 64%). Many abandoned their nests immediately when a cowbird egg appeared. Few parasitized nests produced cowbird fledglings, as most of those where cowbird eggs were accepted were depredated.

The patch-wise parasitism rate was negatively correlated with the estimated density of female cowbirds within a patch — the more cowbirds, the less likely a Willow Flycatcher nest was to be parasitized. This reason for this counter-intuitive result is unclear. One possibility is that cowbird density may be correlated with the total number of potential host species within a patch, and that higher densities of alternate hosts serves to dilute the effect of more cowbirds on flycatchers. Further analyses are needed to verify this hypothesis.

Nesting success appeared to vary among nest substrates, perhaps because nest heights varied among substrates and nest success was correlated with nest height (Figs. 5 & 7). Parasitism rates also varied among substrates (Fig.11). Over 45% of nests in Russian olive were parasitized; these nests tended to be on patch edges. Nests in willows were also parasitized relatively frequently, and also tended to be on patch edges (Fig. 11). In contrast, nests in boxelder were parasitized only about 15% of the time (or less, as most of the highest nests of uncertain content were in boxelder).

Habitat preferences. — Our vegetation analyses suggest that Willow Flycatchers have very distinct microhabitat preferences, even within individual patches. They actively prefer boxelder and avoid willow as a nesting subtrate (Fig. 3). Willows are a favored nesting substrate in other regions (Harris 1991, McCarthey *et al.* 1998), but in few if any other areas do flycatchers have the choice of both boxelder and willow. Flycatchers may prefer boxelder in the Cliff-Gila Valley because they have higher canopy cover and denser foliage than willows.

Within occupied patches, flycatchers prefer areas with dense canopy cover, dense subcanopy foliage, moderate canopy height, large numbers of trees, boxelders, and willows. Heterogeneity in ground cover and foliage density appear to be preferred as well (Table 2).

Conservation implications. — The Cliff-Gila Valley provides critical habitat for the largest population of Southwestern Willow Flycatchers. It is noteworthy that the numbers of birds and nesting success rates tended to be higher, and cowbird parasitism rates lower, in the taller, mature riparian woodland on the U-Bar than in younger, lower vegetation elsewhere in the valley. These mature habitats appear to be associated with the earthern levees along the river that were built for flood control. Although the levees certainly hinder the natural flood regime of the Gila, they allow the growth of secondary successional species such as boxelder that are favored by flycatchers at this site. In addition, the presence of water diversion structures (ditches) appears to enhance rather than degrade the riparian habitat in the valley. In fact, three of our six focal patches (FS, SWS, NWS) were not even on the river itself, but rather on ditches. It seems likely that earthen irrigation ditches mimic the ecological functions of braided channels and backwaters, and serve to increase the extent of riparian vegetation.

The NW1 patch is severely threatened by erosion, due to cutting of the riverbank by the Gila River. The nest tree for one probable flycatcher nest discovered in 1997 (when the patch was not a focal patch) was lost due to bank erosion between 1997 and 1998. Further losses are likely unless the river course changes or the bank is stabilized.

FUTURE RESEARCH DIRECTIONS

We will continue to monitor nests of flycatchers and other riparian species to obtain better estimates of nesting success and cowbird parasitism, and to get a better handle on year to year variation in those parameters. We will continue to sample vegetation at nests and unused sites to develop sufficiently large sample sizes to (1) create a logistic regression model of habitat preferences and habitat correlates of nesting success and nest parasitism.

We will quantify habitat features in patches not occupied by flycatchers to be used in multivariate analyses of landscape-level effects on flycatcher occupancy and nesting success. Those data will be incorporated into a GIS program (Geographic Information System) to create spatially-explicit models. Landscape-level effects have been recognized as a priority research need by Arizona Partners in Flight.

We will expand our color-banding program in the coming year to increase sample sizes for estimates of survival, mate and site fidelity, and dispersal in the Cliff-Gila population. These data have also been identified as a priority research need, and the large population in the Cliff-Gila Valley provide a unique opportunity to develop robust sample sizes. By increasing banding of young birds we can document that this population is indeed a source population.

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