DISTRIBUTION, ABUNDANCE, AND HABITAT CHARACTERISTICS OF THE BUFF-BREASTED FLYCATCHER IN ARIZONA

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ABSTRACT

Geographic range and numbers of buff-breasted flycatchers (Empidonax fulvifrons) have decreased in Arizona. I conducted surveys to locate additional populations. Results suggested that some small populations have disappeared since 1980, but that other small populations have increased. I estimated reproductive success using an index based on adults' behavior. I measured vegetation in used areas, nest sites, and available areas. I used logistic regression to compare used to available areas and nest sites to used areas. Used vs. available comparisons indicated that buff-breasted flycatchers used areas dominated by pines, with a sparse oak understory. I found significant associations between buff-breasted flycatcher presence and vegetation type, structural stage, canopy cover, and forest patch width. I developed a habitat model to help manage this rare species. I recommend continued monitoring of buff-breasted flycatcher populations and creation of open pine forest with an open understory of oak. Fire may facilitate development of potential habitat.

INTRODUCTION

The buff-breasted flycatcher (Empidonax fulvifrons) is currently a rare, patchily distributed bird in the mountains of southeastern Arizona. It has declined in numbers and geographic range since the 1920s (Phillips et al. 1964). This species is on the draft list of Wildlife of Special Concern (Arizona Game and Fish Department, in prep.) According to a prioritization scheme intended to identify species most in need of conservation action and/or study (Hunter et al. 1992), the buff-breasted flycatcher in Arizona has a "concern score" of 26-28, placing it in the "very high priority" category.

The buff-breasted flycatcher has apparently never been an abundant bird in Arizona. Some turn-of-the-century ornithologists (Howard 1899, Lusk 1901, Swarth 1904, Bent 1942) referred to it as rare. Swarth (1914) stated that this bird was "nowhere very common" and "very locally distributed." More recently Phillips et al. (1964) called it a "rare summer resident, more common and widespread formerly." Bowers (1983) spent 66 days in the field in 1982 searching specifically for buff-breasted flycatchers in the Huachuca and Chiricahua mountains, and found only 36 adults in 8 locations.

There is little published scientific literature concerning the buff-breasted flycatcher. I have found only 4 accounts of the biology of this species written in the last 70 years (Brandt 1951; Bowers 1983, 1984, 1994). Its habitat has not been described quantitatively.

Concern over the buff-breasted flycatcher's decline has led the Arizona Game and Fish Department to fund an investigation, which I have conducted, into this species' current distribution, abundance, and habitat requirements. To determine locations and sizes of breeding populations of buff-breasted flycatchers in southeastern Arizona mountains, I conducted surveys. Where I found buff-breasted flycatchers, I examined their habitat characteristics on three scales: the forest patch, the territory, and the nest site. I used measurements of vegetation structure and floristics, and other habitat variables, to create a multivariate statistical model of buff-breasted flycatcher habitat.

Simple presence of a species, or even presence in high densities, is not a reliable indicator of habitat of sufficient quality to sustain a population (Van Horne 1983). Therefore I evaluated reproductive success of the buff-breasted flycatchers found, and determined the habitat variables most significantly correlated with successful reproduction.

OBJECTIVES

1. To determine the location and size of breeding populations of buff-breasted flycatchers in the mountains of southeastern Arizona.
2. To determine whether or not there is a difference between areas within a canyon used by buff-breasted flycatchers and the areas available to the birds, and the nature of that difference.
3. To determine whether there is a difference between the areas used by buff-breasted flycatchers and their nest sites, and the nature of that difference.
4. To determine if buff-breasted flycatchers are associated with particular coarse-grained vegetation attributes at a scale approximating the width of forested area in the canyon bottom usually frequented by buff-breasted flycatchers (about 100 m). By "coarse-grained" I mean characteristics that are usually applied to a large vegetated area, and are usually estimated without intensive measurement of vegetation (e.g., structural stage, vegetation type, width, canopy cover).

5. To determine the relationship between buff-breasted flycatcher occurrence and the width of the forest patch of potential habitat. By "forest patch" I mean a continuous tree-dominated area separated from other such areas by $\geq$ 100 m.
6. To determine habitat variables associated with successful reproduction in buff-breasted flycatchers.

LITERATURE REVIEW AND CONCEPTUAL DEVELOPMENT

Habitat selection. --To halt the decline of the buff-breasted flycatcher, its habitat requirements must be better understood. By habitat I mean "an area with the combination of resources (e.g., food, cover, water) and environmental conditions (e.g., temperature, precipitation, presence or absence of predators and competitors) that promotes occupancy by individuals of a given species (or population) and allows those individuals to survive and reproduce" (Morrison et al. 1992). Though below I will emphasize the importance of vegetation to the bird's habitat, I have also based much of the conceptual background of this study on resources provided directly by vegetation (e.g., nest sites, escape cover) and the relationship between vegetation and other resources (e.g., arthropod abundance, vegetation structure amenable to foraging by aerial sallies and hover-gleaning) that are important to the buff-breasted flycatcher.

Under the hierarchical habitat selection model proposed by Johnson (1980), habitat selection consists of at least three "orders." First-order selection is the selection of the geographical range of the species. Second-order selection is the selection of a home range containing all of the resources required by an individual for survival and successful reproduction (e.g., food, shelter, mates, nest sites). Third-order selection consists of selection of specific habitat components within that home range. None of these levels of habitat selection are well understood for this species.

By conducting surveys, I investigated first-order habitat selection. I did this to determine if the range of the buff-breasted flycatcher has continued to contract. This helps a manager to determine whether the factors responsible for the species' decline are still in operation, and determine specific areas where efforts to halt buff-breasted flycatcher declines might be most effective.

I investigated second-order habitat selection by the buff-breasted flycatcher to determine if the vegetation and other habitat variables within a used area are different from those available to the birds. I compared used to available areas, rather than used to unused, to avoid the uncertainty inherent in calling an area "unused". Second-order selection is of primary importance to the wildlife manager because it incorporates all of the bird's life requirements. If an animal survives and reproduces successfully, and while doing so moves throughout its home range, then it follows that the animal finds all of its requirements for survival and successful reproduction within the home range. If a researcher can identify habitat characteristics within a home range that fulfill all of the bird's life requirements and promote successful reproduction, it may be possible to create potential habitat for the species without the added cost of investigating the use and/or availability of specific resources.

I examined third-order habitat selection by evaluating the difference between nest sites and used areas. Many researchers have noted relationships between vegetation structure and/or floristics and nest site selection by forest-dwelling passerine birds (Martin and Roper 1988; Sakai and Noon 1991; Knopf and Sedgewick 1992; Kelly 1993; Norment 1993). The influence of vegetative characteristics on nest site selection may be exerted on several scales. Birds have been known to select nest sites of specific situation and orientation within the plant that supports the nest (Martin and Roper 1988; Sakai and Noon 1991). Other studies suggest additional nest site selection at the level of the patch of vegetation surrounding the nest plant (Martin and Roper 1988, Knopf and Sedgewick 1992; Kelly 1993). Several factors may affect selection of a nest site or patch characterized by particular vegetative structure or floristics. Martin and Roper (1988) and Norment (1993) found that nest placement by hermit thrushes (Catharus guttatus) within a plant and within a patch affected probability of nest predation. In both studies, nests placed in denser vegetation were less likely to be depredated. Staab (1995) and Averill (University of Arizona, unpubl. data) found that nests in denser vegetation were less likely to be parasitized by brown-headed cowbirds. Vegetation closely overhanging buff-breasted flycatcher nests may protect them from cowbird parasitism to some degree (Bowers and Dunning 1984). The microclimate conferred by characteristics of vegetation surrounding the nest affects site selection (Finch 1983). Martin and Roper (1988) found that hermit thrushes selected nest sites with a southwestern exposure more often than would be expected by chance. Sakai and Noon (1991) found that Hammond's flycatchers (Empidonax hammondii) placed their nests out of the prevailing wind more often than expected. Sakai and Noon also speculated that competition may influence selection of specific vegetation characteristics for a nest site. They observed that Hammond's flycatchers and Pacific-slope flycatchers (E. difficilis), when sympatric, appeared to use nest sites that differed in vegetation structure and floristics. The evidence that nest site selection occurred on more than one scale, and that it was affected by predation risk, microclimate, and competition suggested that high-quality nest sites may not be as abundant as has been assumed in the past (Martin and Roper 1988). I investigated nest site selection at the scale of vegetation surrounding the nest plant to determine whether management for buff-breasted flycatchers entails management for nesting habitat that is distinctly different from overall habitat.

Hutto (1985) contended that first-order selection (selection of geographic range) is based on extrinsic factors. This species' pattern of first-order habitat selection is changing. This flycatcher's range contraction may be a result of a change in extrinsic factors influencing the birds' physical ability or predisposition to breed in more northerly areas it once occupied. Conversely, the range contraction may be due to a change in local habitat features (i.e., vegetation structure) such that cues necessary for second-order selection are lacking; or, if cues for habitat selection are present and buff-breasted flycatchers inhabit the area, the vegetation structure and floristics may not provide key resources necessary for survival and reproduction, so that the population does not persist. This hypothesized change in vegetation structure and floristics may have affected any of several factors that may limit the current population of the buff-breasted flycatcher in Arizona. Several possible limiting factors, and their relationship to vegetative structure and floristics, are discussed below.

Predation. --Possible predators on adult buff-breasted flycatchers include sharp-shinned (Accipiter striatus) and Cooper's (A. cooperii) hawks. Sharp-shinned hawks are rare in the mountains of southeastern Arizona (Phillips et al. 1964), and therefore probably do not reduce buff-breasted flycatcher numbers significantly. Cooper's hawks' customary prey is considerably larger than a buff-breasted flycatcher (Johnsgard 1990). It is unlikely that a Cooper's hawk would obtain enough energy from a prey item as small as a buff-breasted flycatcher (about 8 g)(Bowers 1994) to replace the energy expended in the several attempts it would take to catch one. Cooper's hawks probably do not limit buff-breasted flycatcher numbers.

Avoidance of predation is to some degree dependent on type and amount of escape cover available to a bird. For example, Watts (1990) found that even though 88% of the song sparrows (Melospiza melodia) on his study sites were found in areas in which he had supplied supplemental woody cover, 83% of song sparrows killed by predators were killed in mowed areas with minimal cover. Furthermore, availability of escape cover may affect habitat selection in passerine birds. In a study of a community of sparrows wintering in grasslands, vesper sparrows (Poocetes gramineus) underwent a fivefold increase in relative abundance when supplementary woody cover was provided. Before provision of supplemental cover, chipping sparrows (Spizella passerina) were absent from the study site, but were present after supplementary cover was provided (Lima and Valone 1991). In a like manner, habitat selection by buff-breasted flycatchers may be affected by the availability of a particular vegetation structure, plant species or group of species that provides this valuable escape cover.

Nest predation is known to be an important decimating factor for many passerine bird species (Martin 1992). Vegetation structure and floristics at several scales surrounding the nest site are known to affect nest predation rates (Martin and Roper 1988, Kelly 1993). Some birds have been found to choose nest sites associated with reduced risk of predation (Martin and Roper 1988, Marzluff 1988). Availability of nest sites that provide adequate protection from predation may be an important factor limiting buff-breasted flycatcher abundance and distribution.

Competition. --Competition between bird species that use the same or similar resources may affect any order of habitat selection. Diamond (1975) found that competition affects the geographical range of a species. Orians (1964) found that presence of competitors in an area may affect a bird's choice of a home range. MacArthur's (1958) study demonstrated that birds may adjust their foraging patterns in the presence of competitors. Competition may exclude a bird from certain areas where it is replaced by a single competitor species or group of competitors which through diffuse competition occupy its niche. Perhaps the range expansion of a competitor or suite of competitors is causing the range contraction of the buff-breasted flycatcher.

Food availability. - With the changes in vegetation structure that Phillips et al. (1964) suggested may be responsible for the flycatcher's decline, availability of suitable insect prey may have changed. I use the term "availability" in the sense in which Wolda (1990) used it: "Insect availability is the abundance of potential prey items in microhabitats used by an insectivore when searching for food." Even if abundances of preferred prey items do not change as the vegetation structure changes, the microhabitat used by the bird may change, in the sense that the new vegetation structure is not conducive to the bird's method of foraging. Observations of Robinson and Holmes (1982) suggested that foliage-gleaning insectivores are limited in the ways that they can search for and capture prey. The buff-breasted flycatcher may be similarly constrained, such that a change in the structure of the vegetation renders previously available prey unavailable. Floristic changes may also affect prey availability in the same way. Floristics also affect the foraging movements of some passerine birds (Robinson and Holmes 1984). Because different plant species harbor different numbers and species of insects, a floristic change may affect the numbers and species of flying insects in the vicinity of the plants, and thus affect prey availability.

Brood parasitism. -- Brood parasitism by brown-headed cowbirds is known to reduce fledging success in several species of passerine birds (Mayfield 1977, Payne 1977). In the congeneric acadian flycatcher (E. virescens), cowbird parasitism is known to be extremely detrimental to host breeding success. Of the 66 nests observed by Walkingshaw (1961), 50 unparasitized nests had a successful fledging rate of 61%, while 16 parasitized nests had a fledging rate of 20%. In all six nests in which the cowbird egg hatched, the young cowbird fledged and no host young fledged. Parasitism losses to the host population can be particularly damaging if the host population is small (Mayfield 1977).

According to Phillips et al. (1964) brown-headed cowbirds occupied southeast Arizona when the area was initially investigated by ornithologists. However, the brown-headed cowbird has increased in abundance in Arizona "in recent years." The population increase of the brown-headed cowbird coincides roughly with the decrease in buff-breasted flycatcher numbers. The range expansion of the bronzed cowbird into Arizona in the early 20th century (Phillips et al 1964) also occurred at roughly the time that the buff-breasted flycatcher began to decline. Perhaps increased pressure from brood parasites in areas formerly occupied by the buff-breasted flycatcher has been a factor in the species' decline.

STUDY AREA

I conducted the study in the Chiricahua (Cochise County), Huachuca (Cochise and Santa Cruz counties), Rincon (Pima County), Santa Catalina (Pima County), Santa

Rita (Santa Cruz County), and Whetstone (Cochise County) mountains, in southeastern Arizona. These ranges were primarily north-south oriented, separated by broad flat basins of about 900-1200 m in elevation. All ranges except the Whetstones rose above 2590 m in elevation. Areas surveyed for buff-breasted flycatchers ranged from 1550-2750 m in elevation. Regionally, the climate in southeastern Arizona was semiarid, with bimodal annual precipitation. About half of the 37-63 cm of annual precipitation fell in July and August, with most of the rest falling from mid-November to mid-April. May was the driest month. At Fort Huachuca (elev 1420 m), average January temperatures were 7.9 C (average daily maximum and minimum: 14.7 and 1.2 C), and average July temperatures were 25.3 C (average daily maximum and minimum: 38.4 and 19.1 C). At higher elevations in the Huachucas average January and July temperatures were 4.4 and 18.3 C, respectively (Sellers and Hill 1974). Biotic communities were primarily Madrean montane coniferous forest and Madrean evergreen forest and woodland (Brown et al. 1979). Streambeds (containing perennial, seasonal, or intermittent water) were intermittently lined by deciduous trees such as sycamore (Platanus wrightii), ash (Fraxinus velutina), walnut (Juglans major) and willow (Salix spp.). Trees in canyon bottoms included chihuahua pine (Pinus leiophyllus), apache pine (P. englemannii), alligator juniper (Juniperus deppeanna) and oak (Quercus spp.). Higher on the canyon sides oaks, junipers, and Mexican pinion pines (P. cembroides) dominated.

METHODS

Surveys --To accomplish my first objective (determining location and size of breeding populations of buff-breasted flycatchers in southeastern Arizona mountains), I conducted surveys for buff-breasted flycatchers. Because I needed to be reasonably sure of finding enough buff-breasted flycatchers to conduct studies of second-order habitat selection, I concentrated my surveys in areas from which buff-breasted flycatchers had been reported within the last 20 years. Therefore if the species had recolonized its former range in the White Mountains (north of my study area), my surveys would not detect this recolonization. However, by surveying areas with records of buff-breasted flycatcher occupancy in the Huachuca, Chiricahua, Santa Rita, Santa Catalina, and Rincon mountains, I was in a position to detect further declines or range contractions, had they occurred. Survey sites were selected by first determining, through examination of the literature, the historic distribution of the buff-breasted flycatcher. Phillips et al. (1964) indicated that the birds once occupied several mountain ranges in the southeast corner of the state, namely the Santa Catalina, Rincon, Santa Rita, Chiricahua, and Huachuca mountains. Buff-breasted flycatchers have recently been reported from the Whetstone Mountains (T. Corman, Arizona Game and Fish Dept., pers. commun.). I surveyed all locations in these mountain ranges with published or unpublished reports of buff-breasted flycatcher occurrence, except Miller Canyon in the Huachuca Mountains. In 1995 I surveyed 11 canyons with records of buff-breasted flycatcher occurrence, and 13 canyons selected randomly from the canyons extending above 1830 m in elevation in the Santa Rita, Huachuca, and Whetstone mountains (Table 1). In 1996 I surveyed 12 canyons with records of buff-breasted flycatcher occurrence, and 15 canyons selected randomly in the Santa Catalina, Rincon and Chiricahua ranges (Table 2).

Surveys were conducted by slowly walking specified routes (usually major drainages) within potential habitat (forested or woodland areas above 1600 m elevation in mountain ranges with records of buff-breasted flycatcher occurrence), listening and looking for buff-breasted flycatchers. Approximately every 200 m (except in Carr and Sawmill canyons, Huachuca Mountains, where the distance between broadcasts was 100 m) the observer stopped and broadcast calls of the species for 30 seconds, followed by a one-minute pause to listen for a response, followed by another 30 second broadcast if no response was detected. The broadcast ceased upon response by a bird. This technique agrees with guidelines suggested by Johnson et al. (1981). I conducted surveys once in each selected canyon, during the months of May and June. Surveys began within 30 min. of sunrise and lasted up to about 4 hours. To assess responsiveness of buff-breasted flycatchers to taped calls, I conducted five trials with two observers, one of whom watched a pair of buff-breasted flycatchers while the other broadcast a buff-breasted flycatcher call 100 m distant. To assess the effectiveness of my surveys, I compared numbers of buff-breasted flycatchers detected during surveys with numbers of buff-breasted flycatchers I found occupying the survey area over 14-18 subsequent visits (when I monitored reproductive activity). To determine if a difference in number of birds detected on a survey and number detected in subsequent monitoring was due to a propensity for only one member of a breeding pair to respond to the survey broadcast, I noted the number of points at which a single buff-breasted flycatcher responded to the broadcast, and determined the proportion of these points at which I found breeding pairs during subsequent monitoring efforts. This analysis was limited to Cave Creek, Pinery, Rucker, Scotia, Sunnyside, and West Turkey Creek canyons. Carr and Sawmill canyons were excluded from this analysis because in these 2 canyons survey broadcasts were spaced at 100-m intervals, making it difficult to ascertain the location of birds. To determine trends in numbers of buff-breasted flycatchers in areas that were occupied in

1980-1983 and in 1995-1996, I examined maps depicting the areas surveyed and monitored by Bowers (1983, unpublished ms.) and recorded the number of buff-breasted flycatchers I found in those areas. I compared the maximum annual count of buff-breasted flycatchers made by Bowers in these areas with the numbers that I found in 1995 or 1996 with a paired T-test.

Habitat measurement --To accomplish my second objective (i.e., to determine whether or not there is a difference between areas within a canyon used by buff-breasted flycatchers and the areas available to the birds, and the nature of that difference), I first determined used areas. A used area was any area that was occupied by a buff-breasted flycatcher during the breeding season, regardless of behavior. I was not certain that the area I defined as an individual flycatcher's used area represented all of the area used by that individual (i.e., its home range) or the area defended against conspecifics by that individual (i.e., its territory). In 1995 I determined a used area by observing an individual flycatcher for 30 minutes, recording the bird's location every three minutes, and constructing a minimum convex polygon with these locations (Mohr 1967). I centered vegetation sampling plots on the center of the polygon, and at two points (peripheral plots) on opposite sides of the used area, 30 m from the center. The used area and peripheral plots are intended to represent habitat on the scale of the territory, though in 1995 I did not determine actual territorial boundaries. Because peripheral plots sometimes included areas that were outside the polygon, they may have included areas that were not used by the bird. Because the bird may not have used its entire territory during the 30-min observation period used to establish the used area polygon (which would result in an underestimate of the area used), and because the behavior in which the bird was engaged during that period may have caused the bird to use a subset of the vegetation and area in the territory that may not have represented the territory as a whole, I used a different technique to establish used area polygons in 1996. In 1996 I recorded 1-4 locations for a given buff-breasted flycatcher in conjunction with monitoring the bird's reproductive activity (approximately every 5 days). Observations were made at different times of day on different days. The place where the bird was first detected was recorded as the first location, and subsequent locations were recorded at 10-min intervals. Six weeks after the median start date of construction of nests that were thought to be first nesting attempts of the season, I constructed a minimum convex polygon from the set of locations. From the center of the polygon, I placed vegetation sampling plots at 0, 120, and 240 degrees, at randomly selected distances such that all vegetation sampling plots were enclosed completely within the polygon, and the plots did not overlap. Though there is still a chance (as with any minimum convex polygon technique) that the used area plots contained areas that were not actually used, the technique used in 1996 probably had less chance of including unused areas in the used area sampling plots than the technique used in 1995. The increased length of time used to establish the used area polygons, and the spread of my observations over the course of the breeding season and at different times of the day decreased the probability that my used area sampling plots represented an area biased toward the performance of a particular behavior by the bird. However, due to the impossibility of separating the effects of year and mountain range (all 1995 used area measurements were made in the Huachucas, and all 1996 used area measurements in the Chiricahuas) and my goal of creating a habitat model applicable to all potential buff-breasted flycatcher habitat in

Arizona, I lumped the data for the 2 years in some of my analyses.

On these sampling plots I sampled vegetation and other habitat variables using a method based on that proposed by Noon (1981). I sampled within a circle of 15 m radius. Trees (woody perennial plants >2 m in height and >10 cm dbh) in the circle were counted, by species and dbh class. Dbh classes (in cm) were as follows: 10-20, 20-30, 30-40, 40-50, 50-60, and >60. I estimated height and vigor, and measured dbh, of the tallest specimen of each tree species in the circle. I counted the number of shrub species in the circle. I recorded vegetative cover intersecting 29 vertical point-intercept lines. Vertical point-intercept lines were placed at 2-m intervals along 2 perpendicular lines intersecting at the center of the circle. I determined the direction of these lines by a random spin of the compass. In 1995 I recorded foliage or stems of each species of plant intercepting each vertical line in each of 6 height categories (in m): 0-1, 1-2, 2-5, 5-10, 10-20, and >20. In 1996 I combined the 2 highest categories into 1. Using a clinometer, I measured slope from the highest to the lowest point on the ground within the circle. I recorded aspect as the compass direction from the upper end to the lower end of the line used to measure slope. I recorded distance from the center of the circle to the primary riparian zone in the canyon. I recorded distance from the center of the circle to the nearest area >0.04 ha without vegetation exceeding 10 m in height. I recorded the side of the canyon on which the plot was situated. I recorded the position of the plot relative to the top and bottom of the slope on which it was situated, using 1.0 as the top of the slope, and 0.0 as the bottom of the slope. I estimated UTM coordinates of each used area using USGS 7.5' topographic maps.

I also recorded the above measurements at systematically selected points within canyons occupied by buff-breasted flycatchers, to characterize available habitat. I sampled vegetation at 30 availability plots in each occupied canyon, except Sawmill Canyon, where I sampled vegetation at 36 availability plots. In all sampled canyons except Carr, availability plots were placed by first estimating the length of the canyon from the 1830 m elevation to the top. This length was divided by 30 to space the plots evenly along the length of the canyon. I numbered the points 1-30 from the bottom of the area sampled to the top, except in Scotia Canyon where I numbered the points 1-30 from the top of the canyon to the bottom of the area sampled. To ensure that the availability plots were within a distance of the riparian area that the birds actually used, I calculated the mean and standard deviation of the distance from the riparian area to buff-breasted flycatcher nests in each canyon. In all canyons except Carr and Sawmill I placed point 1 at the mean minus one standard deviation from the riparian zone, point 2 at the mean distance from the riparian zone, point 3 at the mean plus one standard deviation from the riparian zone. I placed points 4, 5, and 6 in a similar fashion on the opposite side of the riparian zone, and continued up the canyon, alternating sides every third point. In Sawmill Canyon I placed point 1 at the mean minus one standard deviation from the riparian zone, point 2 at the mean distance from the riparian zone, point 3 at the mean distance plus one standard deviation from the riparian zone, point 4 at the mean distance from the riparian zone, and point 5 at the mean distance minus one standard deviation from the riparian zone. Points 6, 7, 8, 9, and 10 I placed in a similar fashion on the opposite side of the riparian zone. At points 3, 8, 13, 18, 23, and 28 I placed additional points (31, 32, 33, 34, 35, and 36) on the opposite side of the riparian zone, one mean plus one standard deviation from the riparian zone. In Carr Canyon I placed the availability points at the intersections of a grid of five parallel north-south lines 300 m apart and six parallel east-west lines 200 m apart. The area of the grid contains all nests found in Carr Canyon. All nests in Carr Canyon were on the east side of the riparian zone, some more than 2000 m from the riparian zone. Had I followed the same procedure in placing availability plots in Carr Canyon used in the other canyons, the plots would have been spread over an unreasonably large area, and several would have fallen outside of Carr Canyon.

To address my third objective I recorded all of the habitat measurements stated above for used vs. available areas at vegetation sampling plots centered on the nest sites. In addition, I recorded nest tree species, nest tree height, nest height, nest tree dbh, compass direction of nest from trunk, distance of nest from trunk, distance from the rim of the nest up to vegetation, distance of nest from outer edge of vegetation of the nest tree, and diameter of the supporting branch. For purposes of sampling vegetation around the nest plant, I defined the nest site as the point on the ground directly below the nest, though I recorded nest height, nest distance from trunk, nest direction from trunk, nest distance from edge of foliage, distance up to vegetation above nest, and diameter of support branch, referent to the nest's placement within the nest plant.

To address objectives 4 and 5 I re-visited 24 canyons (10 in the Huachucas and 14 in the Chiricahuas) in August 1996 that I had previously surveyed for buff-breasted flycatchers. These 24 canyons all contained some Madrean pine-oak forest or Madrean oak-pine woodland. I recorded vegetation type after Brown et al. (1979), structural stage, and estimated canopy coverage after Reynolds et al. (1992) of any forest vegetation type within a 100-m radius of 514 points at 200-m intervals along the survey routes. I estimated width perpendicular to the transect line (thus usually perpendicular to the riparian strip, which usually paralleled the transect line) of the forested vegetation within 100 m of the points. The location of these points approximates the location of the points at which buff-breasted flycatcher calls were broadcast during the surveys.

Reproductive success --To address objective 6 (determination of the degree of correlation between habitat characteristics and degree of reproductive success of buff-breasted flycatchers), I estimated reproductive success in 1995 for the buff-breasted flycatchers found in Carr, Sawmill, Scotia, and Sunnyside canyons in the Huachuca Mountains, and in 1996 in Cave Creek, Pinery, Rucker, and West Turkey Creek canyons in the Chiricahua Mountains. Following the morning surveys described above, I returned to observe buff-breasted flycatchers at locations where the species was detected. In a 30-minute observation period, I noted the number of buff-breasted flycatchers observed and the following behaviors when they occurred: presence, singing, pairing (typified by two buff-breasted flycatchers in close proximity to one another without agonistic interaction), carrying of nest material, nest construction, occupation of a nest, carrying of food, carrying of fecal sacs, and presence of at least 1 fledgling. I conducted 30-min observations once every 4-8 days for each used area established. To quantify breeding success while minimizing disturbance to the birds, I calculated an index of reproductive activity (Vickery et al. 1992). With this method, birds are assigned a rank corresponding with a degree of reproductive success, based on easily observable behaviors. Ranks are as follows:

1. occupation of a territory (implies singing or some other form of territorial defense) for

the length of time required to form a pair, build a nest, lay and incubate a clutch, and fledge young. For buff-breasted flycatchers this time period is about eight weeks (Bowers 1994).

2. pair formation (recognized by non-agonistic behavior toward a conspecific)
3. nest building, egg laying, or incubation (recognized by carrying of nest material, nest construction, distraction displays, or incubation)
4. presence of nestlings (recognized by carrying of food, carrying of fecal sacs, or begging calls)
5. fledging [recognized by observation of fledglings, or of food being carried for a longer period of time than the nestlings are known to remain in the nest. According to Bowers and Dunning (1994) young remain in the nest for 15-17 days].
6. evidence of a second nesting attempt, after successful fledging in the first attempt.
7. evidence of fledging success in first and second nesting attempts.

Because in 1995 I established a used area based on one 30-min observation period (rather than on locations of the bird on subsequent monitoring occasions), birds frequently traveled to, used, and nested in areas >50 m from the center of the used area polygon. When I discovered a nest outside a 50-m radius from the center of the used area polygon, and my observations indicated that the flycatchers at the nest were also associated with a particular used area polygon, subsequent observations were made at the nest instead of the used area polygon. In 1996, when I defined used areas by recording locations of the bird while monitoring reproductive success, there was no need to choose to observe either the nest site or the used area polygon, because my observations focused on the bird rather than the site.

I monitored activity at nests found in the course of observing buff-breasted flycatcher behavior at used areas. Ten nests were sufficiently low and free of overhanging vegetation for me to check the contents for evidence of cowbird parasitism. I attached a mirror to a telescoping pole 4.7 m long, and checked the contents of each of these 10 accessible nests. I checked only once to avoid unnecessary disturbance to the birds, and checked during the incubation or nestling periods because by that time the window of opportunity for cowbird parasitism had passed, and I could be reasonably sure that a cowbird egg would not be added to the nest after I had checked.

ANALYSES

I used logistic regression (LR) to compare used areas to availability plots and used areas to nest sites (objectives 2 and 3). As a multivariate statistical technique, LR examines the effect of several independent variables in combination. Habitat of an animal is composed of many parameters (e.g., dominant plant species, canopy cover, topography) (Hutchinson 1957). It is also thought that animals perceive characteristics of habitat in combination (James 1971). Multivariate analyses, including LR, were designed to examine the effects of many factors in combination. Multivariate statistical techniques examine the way in which a dependent variable responds to a combination of independent variables, in a manner analogous to the way in which an animal is thought to respond to a combination of habitat characteristics (Green 1971).

LR offered distinct advantages for this study over the many different multivariate statistical techniques available. Other multivariate techniques such as multiple regression and discriminant analysis operate under the assumptions that the data are samples drawn from multivariate normal populations with equal covariation. In observational studies in ecology these conditions are almost never met (Brennan et al. 1986). Because LR is a non-parametric technique, it need not have these assumptions met in order to operate. In addition, LR models employ a bivariate dependent variable (Hosmer and Lemeshow 1989). Because I used the model to differentiate areas used by buff-breasted flycatchers from available areas, my dependent variable was dichotomous. and LR was appropriate. LR is a nonlinear technique (Brennan et al 1986). Goldstein (1977) and Johnson (1981a) contended that because many ecological phenomena are non-linear, nonlinear statistical techniques may represent them more accurately.

Because LR is a non-parametric technique, it is less powerful than its parametric equivalents (i.e., it carries a greater probability of type II error). It may fail to detect a difference between used and available habitat that would have been detected with a more powerful, parametric test. (Morrison, pers. commun.). However, in comparison with discriminant function analysis, Brennan et al. (1996), Halperin et al. (1971), and Press and Wilson (1978) achieved greater group separation (between groups of independent variables associated with different values of the dependent variable) with LR.

To reduce the number of variables used in this analysis to a useful subset, I first eliminated variables that occurred in <10% of the sampling plots. I then compared the 2 groups with Mann-Whitney U-tests on each variable, and eliminated those that did not show a significant difference between the 2 groups. I then checked the remaining variables for intercorrelation. Of a correlated pair of variables ($\underline{R} > 0.8$) I eliminated the variable that showed the less significant difference in the Mann-Whitney U-test. I performed separate LR analyses for each of the 8 canyons and each of the 2 mountain ranges in which I measured buff-breasted flycatcher habitat, and for both mountain ranges combined, resulting in 12 models. Because birds are thought to select habitat hierarchically, on different "orders" (Johnson 1980), I performed separate analyses to compare used to available areas, and used areas to nest sites. Because many of the availability plots were not dominated by pine, and because it has long been known that buff-breasted flycatchers have been associated with pine or pine-oak forests, I attempted to identify variables differentiating used pine forest areas from many apparently suitable available pine forest areas by conducting another LR analysis comparing used to available areas, but restricting the analysis to sampling plots with 19-79% cover of apache and chihuahua pine (pine-dominated). This range of values of pine cover encompassed the mean $\pm$ 1SD for pine cover in used area plots.

To avoid redundancy among the variables input into the LR procedure, I conducted each analysis twice: once with a set of variables including those that were combinations of other variables (i.e., % apache and chihuahua pine cover 5-10 m, number of oak trees 20-30 cm dbh) and again with set including variables that were components of these combinations (i.e., % Pinus englemannii cover 5-10 m, number of Quercus hypoleucoides 20-30 cm dbh). I found that the two variable sets produced comparable results with regard to number of variables selected, classification rate, ^{2} significance, and goodness of fit. Models made using the combination variable sets showed higher R values, and tended to select variables that corresponded better with my field observations of buff-breasted flycatcher habitat, so results presented here were produced using the combination variable sets. I used a forward stepwise procedure for variable entry, with a criterion for entry of P <0.10, and a criterion for removal of P >0.11. I used indicator-type categorical variable contrasts.

I then listed all variables selected in any of the 12 used-vs.-available models and selected a subset that met the following criteria: variables expressed as % cover showed $\geq$5% cover and means differing by $\geq$5% between groups (or standard deviations differing by >50%), variables expressed as counts of trees or shrub species showed >10% difference in means between groups (or standard deviations differing by >50%), variables measuring tree vigor showed a between-group difference in means >20%, variables expressed as probability of presence of a shrub species showed >50% between-group differences, variables representing dbh of the tallest specimen of a tree species in the plot showed a between-group difference in mean dbh >10 cm (and occurred in >20% of the plots) and variables representing the height of the tallest specimen of a tree species in the plot showed a mean height difference >3 m (and occurred in >20% of the plots). I eliminated variables that did not meet these criteria because the statistically significant between-group differences in variables that occurred infrequently were probably not biologically significant. I entered this set of variables into another LR procedure using the pooled data from all canyons sampled. I repeated this selection and LR procedure with the 12 nest site vs. used area models, the successful nest site-vs.-unsuccessful nest site model, the successful used area-vs.-unsuccessful used area model, and the pine-dominated used area-vs.-available model, to create an overall model for each of these comparisons.

Despite between-year differences in the technique used to determine used areas, I lumped data from 1995 and 1996 to construct the overall used vs. available LR model. MANOVA analysis using the same input variables that were used to create the overall used vs. available model showed significant multivariate differences in habitat variables between mountain ranges, but significant univariate differences were few. Because the 1995 technique was used only in the Huachuca Mountains and the 1996 technique was used only in the Chiricahua Mountains, I could not separate the effect of the techniques from the effect of geographical area.

The validity of the overall used vs. available model was examined by randomly sampling approximately 75 % of the 168 used area sampling plots and the 248 available sampling plots, and running the LR procedure again. I repeated this procedure 10 times. and recorded the mean and standard deviation of correct classification rate of used areas. and the number of times each variable was selected. This validation procedure was also used for the overall used vs. available model in pine-dominated areas, and the overall nest site vs. used area model.

To address objectives 3 and 4 I tested vegetation type, forest structural stage, canopy cover category, forest width, and these 4 variables combined, for association with buff-breasted flycatcher presence at survey broadcast points using ^{2} contingency tables. I tested for these associations twice: once including all vegetation types recorded. and once including only vegetation types that included pines (Madrean pine forest, Madrean pine-oak forest, Madrean pine-juniper forest, and Madrean oak-pine woodland).

To identify habitat characteristics associated with successful reproduction (objective 6) I performed LR analyses comparing successful to unsuccessful nests, and successful to unsuccessful used areas. A nest or used area from which young were known to have fledged was considered successful. I performed multiple regressions, with stepwise variable entry, of reproductive success rank on habitat variables of used areas, using the same criteria to select regressors that I used in the initial canyon-specific LR procedures.

To address concerns that the perpendicular of the lines on which the point-intercepts were situated caused the center of the vegetation sampling plot to be oversampled relative to the outer portion of the plot, I made a truncated data set by eliminating from consideration 13 point-intercepts in each vegetation sampling plot, such that there were an equal number of point-intercepts in the outer half of the sampling plot area and the inner half of the area. I then conducted Mann-Whitney U-tests on 171 variables that met my original 3 criteria for variable selection, between the truncated set and the original data set with its entire complement of point-intercepts, to determine whether there were significant differences between the 2 sets.

RESULTS

Surveys

Buff-breasted flycatchers found in 1995-1996--In the course of the surveys, I counted 86 buff-breasted flycatchers. I detected buff-breasted flycatchers in Carr, Sawmill, Scotia, and Sunnyside canyons in the Huachuca Mountains (Table 1), Cave Creek (middle fork), Pinery, Rucker, West Turkey Creek, Saulsbury, Ward, Pine, Red Rock, Bear, and East Turkey Creek canyons in the Chiricahua Mountains, and Sycamore Canyon in the Santa Catalina Mountains (Table 2). Assuming that the buff-breasted flycatcher call broadcast during the survey was audible within 100 m on either side of the survey transect, I surveyed 939 ha in the Huachuca Mountains, 132 ha in the Santa Rita Mountains, 50.3 ha in the Whetstone Mountains, 2004 ha in the Chiricahua

Mountains, 588 ha in the Santa Catalina Mountains, and 80 ha in the Rincon Mountains. for a total of 3793 ha surveyed.

While conducting behavioral observations I found additional buff-breasted flycatchers in Carr (4 additional birds), Scotia (3 additional birds), and Sunnyside (8 additional birds) canyons in the Huachucas, and Cave Creek (2 additional birds), Pinery (6 additional birds), Rucker (2 additional birds) and West Turkey Creek (including Saulsbury and Ward canyons) (10 additional birds) in the Chiricahuas, bringing the total number of adult buff-breasted flycatchers detected in the course of the study to 121 (Table 3). In Sawmill Canyon in the Huachuca Mountains I detected 24 birds during the survey. Subsequent observations determined that there were 12 breeding pairs present, but two of those were outside the area surveyed. Some birds may have been double-counted on the survey in Sawmill Canyon.

I found few buff-breasted flycatchers in canyons from which they had not previously been reported. I found 1 pair in Sycamore Canyon in the Santa Catalina Mountains, 1 pair and an undetermined number of juveniles in Bear Canyon, Chiricahua Mountains, and 1 probable sighting in East Turkey Creek, Chiricahua Mountains. In addition, I found buff-breasted flycatchers in formerly or presently occupied canyons, but in areas of the canyon from which the birds were previously unknown and probably not looked for. I found 1 individual in Pine Canyon, Chiricahua Mountains, at the junction with the Rattlesnake Trail, far from the junction of Pine and Hoovey canyons. I found 7 buff-breasted flycatchers and a nest with nestlings in Rucker Canyon 4-5 km downstream from Rucker Lake. In Sawmill Canyon, Huachuca Mountains, on the steep hillside below Pat Scott Peak, >2 km from the nearest bird in the well-known concentration of buff-breasted flycatchers in the lower part of the canyon, I located 2 successfully breeding pairs. Locations of all buff-breasted flycatchers detected are mapped and their UTM coordinates listed in a separate document (Locations of buff-breasted flycatchers encountered in the course of field investigations, Arizona Game and Fish Department Heritage Fund Project No. I94004).

. Comparisons with previous findings on distribution and abundance --I have few records of locations where researchers or birders have looked specifically for buff-breasted flycatchers and reported their absence, so it is difficult to assess the significance of my observations of birds in areas from which they have not been previously reported. However, the negative change (previously occupied areas that I found unoccupied) that I observed was 56%, while the positive change (new buff-breasted flycatcher locations found / areas surveyed for which previous buff-breasted flycatcher occupancy had not been reported) was 12.5%. In most of the canyons surveyed and subsequently monitored for buff-breasted flycatcher reproduction by Bowers (1983, unpublished ms.) I found more birds within his study areas in my surveys and monitoring than he did. Maximum number of birds found by Bowers in any of the 4 years that he observed in a given canyon is shown in parentheses: Within Bowers' study areas, I found 17 birds in Carr Canyon (9), 20 birds in Sawmill Canyon (11), 4 birds in Scotia Canyon (6), 4 birds in Sunnyside Canyon (2), 6 birds in Cave Creek Canyon (2), 8 birds in Rucker Canyon (1), and 14 birds in West Turkey Creek Canyon (5). A paired T-test indicates that I found significantly more birds in these locations ($\underline{P} = 0.015$) Bowers did not observe in every canyon in each year of his study.

In 15 of the 25 areas with prior buff-breasted flycatcher records that I surveyed. I did not find the species (Table 4). Twelve of the canyons that I surveyed in 1995-1996 were inhabited by buff-breasted flycatchers at some time between 1980-1983 (Bowers and Dunning 1994). I found buff-breasted flycatchers in all but 5 of these canyons: East Whitetail, South Fork Cave Creek, Rose, Garden, and Rock Spring. In 2 of these 5 canyons (East Whitetail and South Fork Cave Creek canyons, Chiricahua Mountains). Bowers and Dunning found only 1 bird in 1 year. These canyons were probably not host to long-term breeding populations in 1980-1983. In Rock Spring and Garden canyons Bowers and Dunning found only 1 breeding pair of buff-breasted flycatchers (and accompanying juveniles) in 1 year in each canyon, with 2 males at the Garden Canyon site the following year. The birds found by Bowers in Garden Canyon in 1982-83 were outside the area that I surveyed, so I don't know if buff-breasted flycatchers were present there in 1995-96. At Rose Canyon Lake, Bowers found 1 bird in 1980, 2 birds in 1982, and no birds in 1983. I have 3 reliable reports of buff-breasted flycatchers in the Santa Rita Mountains in the last 15 years (J. Murray, G. Monson, pers. commun.). Though to the best of my knowledge I surveyed the immediate areas where these birds were found, I did not find buff-breasted flycatchers at any of these locations. In the Chiricahua Mountains in Pine Canyon (at the intersection with Hoovey Canyon), H. Snyder (pers. commun.) reported a singing buff-breasted flycatcher apparently holding a territory in 1994, but I did not find the species there in 1996. This area looked like particularly good potential buff-breasted flycatcher habitat.

Evaluation of survey technique --In my 5 trials of buff-breasted flycatchers' responsiveness to taped calls, the flycatchers being observed about 100 m from the broadcast responded to the broadcast 4 times. However, the birds that did not respond had responded to the previous broadcast about 5 minutes earlier, at which time they moved to the area from which the broadcast was made. The subsequent broadcast was 100 m from this point.

I found 58 buff-breasted flycatchers during surveys in canyons that were subsequently monitored for nesting activity, and 80 buff-breasted flycatchers over the entire monitoring period (14-18 visits distributed over the 3-month breeding season): a difference of 27.5% (Table 3). In Cave Creek, Pinery, Rucker, Scotia, Sunnyside, and West Turkey Creek canyons, single buff-breasted flycatchers responded to the survey broadcast at 15 points. Of the 15 points where single birds responded, I found a breeding pair during subsequent monitoring at 12 points (80%).

Reproductive Success

Used areas --I identified 56 used areas (37 in 1995 and 19 in 1996) and ranked the reproductive success of the buff-breasted flycatchers using them. Six areas received a rank of 0 (buff-breasted flycatchers observed, but not for a long enough period of time to carry out a successful nesting attempt), 5 areas received a rank of 1 (territorial buff-breasted flycatcher present long enough to carry out a successful nesting attempt, but no pairing observed), no areas received a rank of 2 (territorial pair of buff-breasted flycatchers present for a sufficient period of time to carry out a successful nesting attempt, but no evidence of nesting observed), 13 areas received a rank of 3 (evidence of nesting observed, but no evidence of nestlings observed), 7 areas received a rank of 4 (evidence of presence of nestlings observed, but no evidence of fledging), 22 areas received a rank of 5 (evidence of fledging observed, but no evidence of a subsequent nesting attempt), 1 area received a rank of 6 (evidence of successful fledging in a first nesting attempt, and evidence that the pair made a subsequent nesting attempt), and 2 areas received a rank of 7 (evidence of successful fledging in more than 1 nesting attempt) (Table 5). Of the 27 areas that received a rank $\geq$3 (indicating presence of a breeding pair) in 1995, 13 (48%) received a rank $\geq$5 (indicating successful fledging). Of the 19 areas that received a rank $\geq$3 in 1996, 12 (63%) successfully fledged young. Over both years, 25 of 46 breeding pairs (54%) successfully fledged young.

Nests.--In 1995 I found 41 buff-breasted flycatcher nests, constructed by 25 pairs. Fifteen (36%) successfully fledged young, 25 (61%) failed, and the outcome of one is unknown. Median fledging date was between 1 July and 6 July. Fifteen of the nests were subsequent nesting attempts following failure of the preceding nesting attempt, and 3 were second attempts after successfully fledging the first brood. I found 15 nests (built by 8 pairs) in Carr Canyon (0 fledging success), 16 (10 successes and one unknown) built by 11 pairs in Sawmill Canyon, 2 (1 success) built by 1 pair in Scotia Canyon, and 8 (3 successes) built by 5 pairs in Sunnyside Canyon. The first nest was found on 4 May, and the first fledglings on 22 June.

In 1996 I found 26 nests, built by 19 pairs. Twelve nests (46%) successfully fledged young, 12 nests (42%) are known to have failed, and the outcome of 2 nests was unknown. Median fledging date was between 9 July and 14 July. Eight nests were known to be subsequent attempts after failure of an earlier attempt. No subsequent attempts after a successful first attempt were observed in 1996. I found 3 nests (2 successful) made by 3 pairs in Cave Creek Canyon, 7 nests (3 successes) made by 5 pairs in Pinery Canyon, 6 nests (3 successes and 1 unknown) made by 4 pairs in Rucker Canyon, and 11 nests (4 successes and 1 unknown) built by 7 pairs in West Turkey Creek Canyon. The first nest that I monitored in 1996 was found (while under construction) on 5 May (though nest construction was observed on 13 April 1996 in Sawmill Canyon, Huachuca Mountains). The first fledglings of 1996 were seen on 9 June.

At 20 of the 36 failed nests observed in 1995 and 1996, I found evidence of probable jay predation (usually the remains of the nest on the ground). Of these 20, 3 were depredated with young in the nest, 7 were under incubation, 8 were depredated after construction was complete but before incubation was observed, and 2 were found destroyed before construction was known to be complete. Two nests were probably destroyed by severe weather. One nest was destroyed when the nest tree was cut during campground maintenance-related tree cutting. I have no evidence for cause of failure of the remaining 13 failed nests, but cannot rule out predation.

I examined the contents of 10 nests. Four nests contained 3 eggs each, 4 nests contained 4 eggs each, and 2 nests contained 3 nestling each. I found no cowbird eggs or young in buff-breasted flycatcher nests. In addition, I saw adult buff-breasted flycatchers feeding 21 broods of fledglings from nests the contents of which I did not check, and saw no fledgling cowbirds. Distance up to nearest vegetation over the rim of the nest averaged 8.5 cm, and ranged from 3-20 cm. Only 4 of the checked nests and 60% of the nests I found had vegetation $\leq$5 cm above the rim of the nest.

Habitat Characteristics

Coarse-grained variable analyses. --At 574 survey broadcast points, in 26 canyons, 13 different vegetation types were recorded. I recorded widths ranging from 50 m to 2000 m of the forest patch containing the survey transect. Not every 50-m interval in this 1950-m interval was encountered: I recorded 14 different width categories of the 20 possible. I found that buff-breasted flycatchers occurred more frequently than expected in the Madrean pine-oak forest vegetation type (Table 6), in patches >150 m wide (Table 7), under moderately open canopy cover (Table 8), and in mid-aged to old forest structural stages (Table 9). All of the aforementioned ^{2} tests, except that testing for association between canopy cover category and buff-breasted flycatcher presence, had >10% of their cells with frequency <5. Buff-breasted flycatcher numbers were not significantly different from expected by mountain range. When I restricted my analysis to vegetation types with a pine component (Madrean pine-oak forest, Madrean pine forest, Madrean pine-juniper forest, and Madrean oak-pine woodland) I found that buff-breasted flycatchers occurred more frequently than expected in forest patches >150 m wide (Table 10). They also occurred more frequently than expected in Madrean pine-oak forest (Table 11), in mid-aged and older forests (Table 12), and in moderately open canopy forests (Table 13).

Used vs. available. --Analyses comparing used areas to available areas in each of the 8 canyons considered selected from 3-9 variables (Table 14). Several of the variables indicated or were correlated with: (1) more tall pine cover in used than available areas; (2) less vegetative cover (except grass) from 0-5 m in used than available areas; and (3) less steep slopes in used than available areas. Correct overall classification rates ranged from 77.8- 97.6%. Sixteen variables were selected in >1 model. Total live cover 0-1 m appeared in 5 models, shrub species total and a negative association with oak cover 0-1 m appeared in 4, and presence of yucca (Yucca schottii) and a negative association with slope appeared in 3. The use vs. availability model incorporating data from the 4 canyons sampled in the Huachuca Mountains in 1995 selected 13 variables and had a correct overall classification rate of 84.2%, a correct used classification rate of 83.3%, and a correct availability classification rate of 85.4% (Table 15). The use vs. availability model incorporating data from the 4 canyons sampled in the Chiricahua Mountains in 1996, selected 17 variables and had a correct overall classification rate of 97.1%, a correct used classification rate of 94.4%, and a correct availability classification rate of 98.3% (Table 16). The use vs. availability model incorporating all 8 canyons selected 23 variables (but only 10 for which R>.10), including total live cover 0-1 m and a negative association with oak cover 0-1 m, and gave a correct overall classification rate of 84.4%, a correct used area classification rate of 75.9%, and a correct available area classification rate of 88.9% (Table 17). In the canyon-specific models, mountain range specific models, and the model incorporating all 8 canyons, 65 different variables were selected, many of them in more than one model (Table 18).

Ten variables met the criteria for input into the overall used vs. available model (Table 19). The LR procedure selected 7 of these variables for inclusion in the overall used vs. available model (Table 20). The overall model correctly classified 60.3% of the used area plots, 84.2% of the available sampling plots, and 74.9% of all of the sampling plots. The 2 most important variables (indicated by highest partial correlation coefficients) were slope, and chihuahua and apache pine cover >10 m. Median slope in used areas was 9.5 $\pm$ 8.6, whereas in available areas median slope was 18 $\pm$ 10.5. Median chihuahua and apache pine cover >10 m in used areas was 17% $\pm$ 20%, and 3.5% $\pm$ 14% in available areas (Tables 20-21). Next in importance were 2 negative associations with oak: number of oak trees 10-20 cm dbh (median 3.0 $\pm$ 7.5 in used areas, 8.0 $\pm$ 12.3 in available areas) and % cover of oak 5-10 m (median 3.5% $\pm$ 12% in used areas, 10% $\pm$ 16% in available areas). Buff-breasted flycatcher used areas showed slight associations ($R<.07$) with presence of yucca (median probability of occurrence 0.0 $\pm$ 0.34 in used areas, 0.0 $\pm$ 0.48 in available areas) and number of trees 20-30 cm dbh (median 7.0 $\pm$ 4.3 in used areas, 5.0 $\pm$ 4.1 in available areas). Number of chihuahua and apache pine trees 40-50 cm dbh (median 1.0 $\pm$ 2.3 in used areas, 0.0 $\pm$ .91 in available areas) accounted for 4.6% of the variation between buff-breasted flycatcher used areas and available areas. Used areas were characterized by an open-canopy forest of chihuahua and/or apache pine with an open understory of oak, on a relatively flat area. When I examined the validity of the overall used vs. available model, the average correct classification rate of used areas was 59.56% $\pm$ 4.9. In the 10 trials, slope and % cover apache and chihuahua pine >10 m were selected in 10 trials, no. of oak trees 10-20 cm dbh (-) and % cover oak 5-10 m (-) were selected in 8 trials, shrub yucca present was selected in 6 trials, no. of trees 20-30 cm dbh was selected in 5 trials, no. of apache and chihuahua pines 40-50 cm dbh and distance to opening were selected in 3 trials, and no. of apache pines was selected in 2 trials.

When only pine-dominated sampling plots in all 8 canyons were included in a comparison of used to available areas, the model contained 30 variables. and gave a correct overall classification rate of 98.2%, a correct used area classification rate of 98.7%, and a correct available area classification rate of 97.8% (Table 23). Most of the partial correlation coefficients were between 0.10-0.19. The pine-dominated and all-inclusive models comparing used and available areas shared 9 common variables, including negative associations with oak cover 0-1 m and number of oaks 10-20 cm dbh.

Seven variables met the criteria for input into the overall model of pine-dominated used areas vs. pine-dominated available areas. The LR procedure correctly classified 72.4% of used area plots, 71.6% of available area plots, and 72.0% of all of the sampling plots, and selected 4 variables for inclusion in the overall model (Table 24). The variable that explained the most variation between used and available areas was a negative association with slope (median 10 $\pm$ 9.1 in used areas, 17.0 $\pm$ 11.3 in available areas). Number of apache and chihuahua pines 30-40 cm dbh (median 2.0 $\pm$ 3.1 in used areas, 1.0 $\pm$ 1.7 in available areas) accounted for 15.6% of the variation between used and available areas. Two negative associations with oak: % oak cover 5-10 m (median 3.5% $\pm$ 12% in used areas, 17% $\pm$ 15% in available) and number of oak trees 10-20 cm dbh (median 3.0 $\pm$ 8.1 in used areas, 12.0 $\pm$ 12.2 in available) accounted for 8.9% and 12.1% of the variation, respectively, between used and available pine-dominated areas. When I examined the validity of the overall pine-dominated used vs. available area model, the average correct used area classification rate was 63.49% $\pm$ 7.66. In the 10 trials, slope was selected in 10 trials, % cover oak 5-10 m (-) and no. of oak trees 10-20 cm dbh (-) were selected in 7 trials, % cover apache and chihuahua pine >10 m was selected in 6 trials, shrub yucca present was selected in 3 trials, and distance to opening and no. of apache and chihuahua pines 40-50 cm dbh were selected in 1 trial.

Nest sites vs. used areas --The 8 analyses comparing nest sites to used areas within canyons selected 1-9 variables per model, with correct overall classification rates from 86.4-100% (Table 25). Nine variables were selected in >1 model, with number of chihuahua and apache pines 10-20 cm dbh and negative associations with number of oaks 10-20 cm dbh and small dead branch 0-1 m all selected in 3 models. The nest site vs. used area model incorporating data from the 4 canyons sampled in the Huachuca Mountains in 1995 selected 9 variables and showed a correct nest site classification rate of 68.3%, a correct used area classification rate of 92.7%, and a correct overall classification rate of 85.3% (Table 26). The nest site vs. used area model incorporating the 4 canyons sampled in the Chiricahua Mountains in 1996 selected 11 variables, and showed a correct overall classification rate of 96.2%, a correct nest site classification rate of 96.1%, and a correct used area classification rate of 96.3% (Table 27). The nest site vs. used area model incorporating all 8 canyons selected 8 variables, including number of chihuahua and apache pines 10-20 cm dbh and a negative association with small dead branch 0-1 m, and correctly classified 96.1% of nest sites, 96.3% of used areas, and 96.2% of all sampling plots (Table 28). Combined, the canyon-specific models, mountain range specific models, and the model incorporating all 8 canyons selected 38 different variables, several in more than one model (Table 29)

Five variables met the criteria for input to create the overall nest site vs. used area model. The LR procedure selected 4 variables, constructing a model that correctly classified 30.0% of nest sites, 91.0% of used areas, and 72.6% of all sampling plots (Table 30). Chihuahua and apache pine cover >10 m (median 34.5% ± 19% at nest sites, 17.2% ± 20% at used areas) (Table 31, 21) accounted for 18% of the difference between groups. Number of chihuahua and apache pines 10-20 cm dbh (median 3.0 ± 4.8 at nest sites, 2.0 ± 3.6 at used areas) accounted for 17% of the variation. Negative associations with shrub species total (median 6.0 ± 3.1 at nest sites, 7.0 ± 3.3 at used areas) and number of oak trees 10-20 cm dbh (median 3.0 ± 5.3 at nest sites, 3.0 ± 7.5 at used areas) accounted for 14% and 6% of the difference, respectively. When I examined the validity of the overall nest site vs. used area model, the average correct classification rate of nest sites was 13.1% ± 9.5. In the 10 trials, % cover apache and chihuahua pine >10 m was selected in 10 trials, no. of apache and chihuahua pines 50-60 cm dbh was selected in 3 trials, slope and no. of apache pines were selected in 2 trials, and shrub yucca present and no. of apache and chihuahua pines 40-50 cm dbh were selected in 1 trial.

Characteristics associated with successful reproduction --LR analyses comparing successful to unsuccessful used areas in 8 canyons combined correctly classified 85.2% of the sampling plots and selected 6 variables (Table 32). Two of these variables satisfied the criteria for input into the overall successful used area vs. unsuccessful used area model. Presence of chihuahua pine as a shrub (mean probability .72 ± .45 in successful used areas, .39 ± .49 in unsuccessful), accounting for 25% of the difference between groups, was the only variable selected by the LR procedure. The model correctly classified 72.2% of successful used areas, 60.6% of unsuccessful used areas, and 72.6% of all sampling plots (Table 33).

When I compared successful to unsuccessful nest sites, the model contained 4 variables and showed a correct classification rate of 76.1% (Table 34). Three of these variables met the criteria for input into the overall successful vs. unsuccessful nest site model. The model contained 2 variables: total live cover <1 m (median 41% ± 19% at successful nest sites, 29% ± 16% at unsuccessful nest sites), and shrub species total (median 7.0 ± 3.3 at successful nest sites, 5.0 ± 2.6 at unsuccessful nest sites) (Tables 35-37). The model correctly classified 51.8% of successful nest sites, 85.0% of unsuccessful nest sites, and 71.6% of all the sampling plots. Though the variables grass cover (29% in successful sites, 18% in unsuccessful), oak cover 0-1 m (2% in successful sites, 4% in unsuccessful), juniper cover 0-1 m (<1% in successful and unsuccessful), non-oak deciduous shrub cover 0-1 m (2.5% in successful and 2.9% in unsuccessful), and apache and chihuahua pine cover 0-1 m (<1% in successful and unsuccessful) were not selected in the model, their values show that most of the difference in total live cover 0-1 m was due to a difference in grass cover.

The stepwise multiple regression analysis examining the relationship between habitat variables in used areas and reproductive success ranks of those used areas selected 8 variables. The R^2 value indicated that 42% of the variation in reproductive success rank is due to distance to opening, vigor of tallest Arizona white oak (Quercus arizonica) on the plot, presence of manzanita (Arctostaphylos pungens), Douglas-fir (Pseudotsuga mensieszii) and apache pine as shrubs, Douglas-fir cover 1-2 m, slope position, and number of apache and chihuahua pines 10-20 cm dbh (Table 38). The equation buff-breasted flycatcher reproductive success rank = 4.54 +.006(distance to opening)- .327(vigor of tallest Arizona white oak) + 2.70(% cover douglas-fir, 1-2 m)+ 0.972(probability of presence of manzanita) + 1.10(probability of presence of douglas-fir as a shrub) - 1.98(slope position) - 1.01(probability of presence of apache pine as a shrub) + 0.85(no. of apache and chihuahua pines, 10-20 cm dbh)

described the relationship between buff-breasted flycatcher reproductive success rank and the selected habitat variables.

When I compared my truncated data set (with equal numbers of point-intercepts in inner and outer halves of the vegetation sampling plot) to my complete set, I found that 87 variables showed insignificant differences between the 2 sets, no variables showed significant differences, and 84 variables were not tested due to empty groups or insufficient number of cases for processing.

DISCUSSION

Abundance and Distribution

I found some evidence that even within the last 20 years, some small populations (isolated groups of 1-2 breeding pairs) of buff-breasted flycatchers have disappeared from the aforementioned mountain ranges. Either these small populations have indeed disappeared, or my survey technique is not effective. A comparison of the numbers of birds detected during surveys in canyons where I subsequently monitored birds, and the number of birds I found while monitoring, suggests that the surveys were reasonably effective (Table 3). A comparison of the numbers of buff-breasted flycatchers detected on surveys with the number found in subsequent monitoring suggests that surveys detect nearly 30% fewer birds than are present in the surveyed area, but records suggest that surveys more accurately assess the number of breeding pairs in the area. On many occasions, only 1 buff-breasted flycatcher responded to a survey broadcast, but in subsequent monitoring I found the area to be occupied by a breeding pair. The female of the pair may not have responded because she was incubating or laying eggs and did not wish to draw attention to the nest. This postulated sex-dependent difference in responsiveness may be responsible for the difference in numbers of birds detected on the survey and in subsequent monitoring. If so, my survey technique was not as inferior to intensive monitoring as the 27.5% difference suggests. In addition, Bowers also used a tape-broadcast survey technique, so my failure to detect buff-breasted flycatchers in 1995-96 in the areas in which he found them in 1980-83 is probably not due to difference in survey technique. Observations of buff-breasted flycatchers in other areas (i.e., the junction of Pine and Hoovey canyons, Sprung Spring) were made by birders who were not specifically searching for this species, and were not using taped calls. It might be argued that taped calls actually repelled some buff-breasted flycatchers, but I have no evidence that this is the case. my trials with 2 observers (1 of whom watched a pair or individual bird while the other played a tape of the call 100 m away) suggested that the birds usually responded to a broadcast <100 m away, but were reluctant to leave their territory to respond to a more distant broadcast. Buff-breasted flycatchers seemed quite responsive to broadcasts of taped calls.

Though there is evidence that some small populations have disappeared in the last 15 years, there is also evidence that in areas where they still occur, buff-breasted flycatchers are more abundant than they were when Bowers studied this species 15 years ago. In 6 out of the 7 canyons in which I and Bowers both found the species, I found more birds than he did. The most substantial increases were in Carr Canyon (from 9 birds to 17), Sawmill Canyon (from 11 birds to 20), Rucker Canyon (from 1 bird to 8), and West Turkey Creek Canyon (including Saulsbury and Ward canyons)(from 5 birds to 14). However, these differences may reflect inter-observer variability rather than actual differences in buff-breasted flycatcher abundance.

These conflicting lines of evidence of buff-breasted flycatcher population trends, and the paucity of specific survey data on buff-breasted flycatchers point out the need for continued monitoring of this species. Studies have shown that bird populations are quite dynamic. Wilcove and Terborgh (1984) developed the hypothesis that populations at the edge of a species' range (like those of buff-breasted flycatchers in Arizona) should be the first to decrease when overall numbers of the species fall, before a decline is observed in populations toward the core of a species' range. These small populations of breeding buff-breasted flycatchers may persist over the long term due to a "rescue effect" (i.e.,disappear temporarily, to be re-established in subsequent years by colonists from other concentrations of birds) (Brown and Kodric-Brown 1977). my short-term study and that of Bowers and Dunning (1994) taken in conjunction are insufficient to draw conclusions regarding long-term population trends of buff-breasted flycatchers in Arizona. Longer-term surveys are needed to determine whether the decline in Arizona buff-breasted flycatcher numbers that began in the early 20th century continues. I have surveyed all locations in the Santa Catalina, Rincon, Santa Rita, Huachuca and Chiricahua mountains with published records of buff-breasted flycatcher occurrence, and most, if not all of the locations with unpublished records [except Miller Canyon, which I was reasonably sure was not of major importance to buff-breasted flycatchers. L.

Christoferson, who conducted intensive bird studies in Miller Canyon in the Huachuca Mountains in 1994, found no buff-breasted flycatchers there. Buff-breasted flycatchers were not detected in neotropical migratory bird surveys conducted in Miller Canyon in 1994-1995 (L. Christoferson, L. Hall, J. Martin, M. Morrison and R. Mannan. 1996. unpublished ms.)]. my survey results constitute a baseline from which to assess future buff-breasted flycatcher population trends. In light of the evidence for a decline in populations in the last 15 years, the need for surveys and monitoring to maintain current knowledge of buff-breasted flycatcher numbers and distribution has become more important.

I strongly re-affirmed that the buff-breasted flycatcher is discontinuous and patchy in distribution. Swarth (1914) states that the buff-breasted flycatcher is "nowhere very common . . . very locally distributed--thus it may be fairly common in one canyon and almost unknown in an adjoining one." Marshall (1957) writes that "The environmental conditions of the few places of record are duplicated within practically every mountain range studied, yet the species shows erratic and unpredictable occurrence." S. M. Russell (pers. commun.) reiterates that the species' distribution is spotty and unpredictable, and some apparently suitable habitat is unoccupied. Swarth's observations date from the period prior to the buff-breasted flycatcher's disappearance from the White Mountains, and suggest that this pattern is not a recent phenomenon. Both Marshall and Russell were referring to the buff-breasted flycatcher's distribution in Sonora, Mexico as well as in Arizona, so the species shows this distributional pattern at least 250 km south of its largest concentrations in Arizona. Perhaps this species is, and always has been, naturally rare, for reasons not well understood. Unfortunately, data from central and southern Mexico and Central America are almost entirely lacking for this species.

Habitat Characteristics

My LR analyses identified habitat characteristics that differed between buff-breasted flycatcher home ranges (used areas) and available areas. The most important of the 7 variables selected by my overall used vs. available model was percent cover of chihuahua and apache pine >10 m [though pine cover in all height categories above 2 m was greater in used areas than avialable areas (Fig. 1)]. Many observers (Marshall 1957, Phillips et al. 1964, Bowers and Dunning 1994) have noted the buff-breasted flycatcher's preference for open-canopy pine forest. Where I found buff-breasted flycatchers, Pinus englemanni or Pinus leiophylus were always present within 100 m. They use the trees as foraging perches, as song perches, as foraging substrates, and as nest substrates. Eighty-nine percent of nests I found were in these tree species. Presence of either or both of these tree species may be a proximate factor (i.e., a cue eliciting a settling response) (Hilden 1965) in habitat selection by buff-breasted flycatchers.

Slope was another important component of the model. As the maps in Appendix G indicate, used areas were usually clustered in the bottom of a canyon. Buff-breasted flycatchers tend to inhabit flatter areas, on the canyon bottom, though they were found nesting successfully in areas with slopes as steep as 35 .

Two of the variables chosen reflected negative associations with oak. Though 5 oak species were abundant in mountain ranges and canyons inhabited by buff-breasted flycatchers, and some oak was found in nearly every sampling plot, there was less oak cover between 5-10 m, and fewer oak trees 10-20 cm dbh in used areas than available.

On average, there were just over half as many of these small oak trees in used areas as in available areas. Oak cover 5-10 m differed by only 6% absolutely between used and available areas, but the relative difference was 40%. In all height categories below 10 m. oak cover was greater in available areas than used areas (Fig. 2). On 6.5% of the used area sampling plots no oak trees were detected and % cover of oak was 0. I have no quantitative data on use of oaks by buff-breasted flycatchers, but I saw them use oaks frequently as song perches, as foraging perches, and as foraging substrates. Though buff-breasted flycatchers are known to use Arizona white oak as a nest substrate (Bowers and Dunning 1994) none of the 67 nests I found were in oaks. Number of chihuahua and apache pines 40-50 cm dbh was nearly 3 times as great in used areas than in available, though the absolute difference was about 1 such pine per sampling plot. Results of the validation procedure suggest that the overall used vs. available model is valid. The correct used area classification rate of the model (60.26%) falls easily within one standard deviation (4.9) of the mean correct used area classification rate of the 10 validation trials (59.56%). The number of trials in which they were selected re-affirms that slope, % cover apache and chihuahua pine >10 m, no. of oak trees 10-20 cm dbh (-) and % cover oak 5-10 m (-) were the most important variables separating used from available areas.

My analysis of the differences between used and available pine forest areas found that used pine forest areas have less oak understory, indicated in the overall used vs. available model by negative associations with number of oak trees 10-20 cm dbh and with oak cover 5-10 m. Pine forest available areas, like overall available areas, had a more pronounced slope than used areas. Results of the validation procedure suggest that the model distinguishing between used and available pine-dominated areas is valid. Variables selected re-affirmed that within pine forest areas, negative association with slope, negative association with mid-story oak cover, and pine cover > 10 m were important features distinguishing buff-breasted flycatcher habitat from available areas. Areas used by buff-breasted flycatchers were characterized by an open canopy of apache and/or chihuahau pine > 10 m tall, and an open understory of oak (Fig. 3).

My analysis may have failed to detect some differences between used and unused pine forest, because I compared used to available, rather than used to unused. Areas that buff-breasted flycatchers use are available to them. My availability plots were sometimes placed (independently of buff-breasted flycatcher use) in areas inhabited by buff-breasted flycatchers, even within the polygons I established for sampling used areas. A study design comparing used to unused areas would have more clearly determined if availability of suitable habitat is limiting buff-breasted flycatchers. Conversely, the sampling of availability within areas inhabited by the birds may mean that differences the model indicated between the 2 groups are more pronounced between used and unused areas (i.e., that openness of oak understory is more important to the flycatchers than my model indicates). Also, if I had compared used to unused instead of used to available, the proportion of unused plots incorrectly classified as used may have elucidated whether the amount of suitable potential habitat is limiting the distribution and abundance of buff-breasted flycatchers. A low misclassification rate for unused plots would suggest that most of the unused areas are distinctly different from used areas, thus availability of potential habitat may limit the species' abundance.

My overall nest site vs. used area model suggested that nest sites differ from used areas in the same ways in which used areas differ from available areas but the differences were not as pronounced. Descriptive statistics showed that nest sites had a denser pine canopy and a slightly less dense oak understory than used areas. They also had more small (10-20 cm dbh) pines and fewer species of shrubs. The low rate of correct classification for nest sites suggests that at the scale I measured, nest sites did not differ markedly from the used areas in which they were situated. Results of the validation procedure suggested that the poor performance of the overall nest site vs. used area model was valid, and indicated that there were not pronounced differences between nest sites and used areas. Correct nest site classification rates were consistently poor in 10 trials, and only one variable (% cover apache and chihuahua pine >10 m) was consistently selected as distinguishing between nest sites and used areas. Because nest sites were within areas used by the birds, nest site and used area sampling plots could and sometimes did overlap. I may have missed differences between nest sites and used areas, and the differences I found may be more pronounced than my figures indicate, because of this overlap.

The most important finding of my analysis of coarse-grained variables at survey broadcast points was that buff-breasted flycatchers prefer wider areas of pine forest. When I restricted my analysis to vegetation types with a pine component (Madrean pine-oak forest, Madrean pine forest, Madrean pine-juniper forest, and Madrean oak-pine woodland) I found that buff-breasted flycatchers occurred more frequently than expected in forest patches >150 m wide.

<u>Characteristics associated with successful reproduction</u> --As stated in Morrison et

al. (1992) definition of habitat, it is important that the area provide for successful reproduction. Simple presence of a species, or even presence in high densities, is not a reliable indicator of habitat of sufficient quality to sustain a population (Van Horne 1983). Therefore I evaluated reproductive success of the buff-breasted flycatchers found, and determined the habitat variables most significantly correlated with successful reproduction. To determine whether availability of quality nest sites might be limiting buff-breasted flycatchers, I looked for differences between successful and unsuccessful nest sites. The 2 variables selected for the model (total live cover 0-1 m and shrub species total) both indicate a difference in the understory between successful and unsuccessful nests, and surprisingly show a trend opposite that found when I compared nest sites to used areas. Total live cover was 10% greater absolutely, but 29% greater relatively, at successful nest sites. Most of this difference is accounted for by grass cover, which is greater at successful nests. Because most nest failures (at least 55%) appeared to result from predation, I doubt that the greater grass cover at successful nests was biologically significant. The low correct classification rate for successful nest sites suggested that at the scale I measured, differences in habitat variables between successful and unsuccessful nests were not biologically significant.

The single variable selected in the model comparing successful used areas to unsuccessful used areas was presence of chihuahua pine as a shrub. This is probably not biologically significant. Chihuahua pine cover 0-1 m (a different variable: not necessarily a shrub) shows the opposite trend: greater in successful (1%) than in unsuccessful (0.5%) used areas. Buff-breasted flycatchers occasionally use seedling and sapling chihuahua pines as foraging substrates and foraging perches, but I have no quantitative data on the extent to which they do so.

Our multiple regression model regressing habitat variables on reproductive success rank selected 8 variables and did not include presence of Chihuahua pine as a shrub (i.e., no variables were shared between this model and the successful used area vs. unsuccessful used area LR model). Distance to opening had the highest correlation coefficient of the variables selected (0.328). The forest-opening interface was often an abrupt edge. Proximity to an edge is correlated with increased nest predation rates in some passerine birds (Gates and Gysel 1978). The positive correlation between reproductive success rank in buff-breasted flycatchers and distance to opening may be due to increased nest predation rates at the edge of the patch of pine forest. Other possible factors contributing to this correlation are differences in microclimate or prey availability related to forest patch size, though I have no data addressing these factors.

Possible Limiting Factors

Brood parasitism --Brood parasitism negatively affects populations of many species of passerine birds, and so warrants consideration in buff-breasted flycatcher conservation. Two species of brood parasites are known to occur in buff-breasted flycatcher habitat: the brown-headed cowbird (Molothrus ater), and the bronzed cowbird (M. aeneus). The brown-headed cowbird has parasitized buff-breasted flycatcher nests (Bowers and Dunning 1984). Bowers and Dunning also observed a female bronzed cowbird attempting to gain access to a buff-breasted flycatcher nest. Bowers and Dunning (1984) recorded the fate of 29 buff-breasted flycatcher nests. Of their 14 nests with known contents, 13 (93%) were unparasitized while one (7%) was parasitized. I found no evidence of cowbird parasitism on buff-breasted flycatchers. Cowbirds were common in the canyons occupied by buff-breasted flycatchers, and parasitized other passerine species. Christoferson (unpubl. data) found 20% of solitary vireo (Vireo solitarius) and 25% of painted redstart (Myioborus pictus) nests parasitized in the Huachuca Mountains, 1994-1995. Her study sites included Sawmill, Sunnyside, and Scotia canyons (occupied by buff-breasted flycatchers).

The low parasitism rate observed may have been due to a peculiar nest placement, characteristic of the buff-breasted flycatcher (Bowers and Dunning 1984). The birds frequently placed their nests so that an overhanging branch passed within 5 cm of the rim of the nest. Of the 29 nests they examined, 21 (72%) were so situated. Of the 67 nests I examined, 38 (60%) were so situated. Earlier observers (Willard 1923, Brandt 1951) also noted buff-breasted flycatcher nests similarly overhung. The proximity of the overhanging branch prevents a bird as large as a cowbird from sitting on the nest, while allowing access for the much smaller flycatcher. While this nest placement may have arisen as a simple rain shelter or a thermoregulatory strategy, [as Calder (1973) has hypothesized for hummingbirds], it is apparently effective in excluding brood parasites from buff-breasted flycatcher nests. However, a large proportion of nests are not protected in this way. Bowers and Dunning did not determine how close to the rim of the nest the overhang must be to exclude cowbirds, but their estimate of 5 cm is reasonable. Most of the nests that I knew to be unparasitized, and 40% of the nests I found, were free of overhanging vegetation $\leq$5 cm above the nest. Evidently protective nest placement was not the only reason for the low parasitism rate.

The low rate of cowbird parasitism Bowers and Dunning (1984) and I observed suggests that buff-breasted flycatchers were not limited by cowbird parasitism. However, because buff-breasted flycatcher populations were so small, cowbird parasitism was potentially extremely detrimental. Robinson et al. (1993) stated that cowbird parasitism rates >25% may lead to a negative population growth rate and eventual extirpation. Thus, the 40% of buff-breasted flycatcher nests not protected by an overhanging branch afforded cowbirds the opportunity to threaten persistence of buff-breasted flycatcher populations in the U. S. Continued monitoring of cowbird parasitism rates on buff-breasted flycatchers is warranted.

Predation --Martin (1992) noted that nest predation was the primary source of nestling mortality in most of North American passerines for which nesting success has been studied, and is thus perhaps the most important decimating factor for such birds. Bowers (1983) witnessed 2 Mexican jays (Aphelocoma ultramarina) in the act of depredating a buff-breasted flycatcher nest. Willard's (1923) observations suggested that Steller's jays (Cyanocitta stelleri) prey upon eggs or nestlings. He also mentioned a nest destroyed by "jays or squirrels." I witnessed 1 instance of nest predation on buff-breasted flycatchers, by a Steller's Jay, in Sunnyside Canyon, nest SU #2, on 15 May, 1995. Contents of the nest were unknown. I was not aware of the presence of the nest until I saw 2 buff-breasted flycatchers, uttering frequent "pit" calls, flitting excitedly within 1 m of a Steller's jay. For about 1 minute, the jay tore the nest apart, dropping the fragments. The jay then departed and the buff-breasted flycatchers remained within 50 m of the nest site for at least 20 minutes, singing occasionally. Since I witnessed this instance of nest predation, I considered any nest of which remains were found on the ground to have been depredated. I found many such destroyed nests, suggesting that predation (probably by Steller's and Mexican jays) was an important decimating factor. At Carr Canyon in 1995, the 100% nest failure rate (n = 15) may have been attributable to an artificially elevated jay population. I did not measure the jay population, but noted that jays were abundant, tame, and accustomed to finding supplementary food at the 2 popular campgrounds which were situated about 1.5 km apart, on opposite ends of the area inhabited by the buff-breasted flycatchers under observation.

I found no records of predation on adult buff-breasted flycatchers. Sharp-shinned Hawks nested successfully within 1 km of 4 nesting pairs of buff-breasted flycatchers in Pinery Canyon in 1996. A probable breeding pair of sharp-shinned hawks occupied an area within 1 km of 2 nesting pairs of buff-breasted flycatchers in Sawmill Canyon, Huachuca Mountains, in 1995. Cooper's hawks were known to nest in close proximity to buff-breasted flycatcher nests. Nest SU #6 (which successfully fledged young) was built about 20 m from a Cooper's hawk nest. I saw no caution on the part of the buff-breasted flycatchers toward the Cooper's hawks. The flycatchers may have gained some protection from nest predation by jays due to their proximity to the hawks' nest. I also saw a Cooper's hawk and a buff-breasted flycatcher perched about 3 m apart in upper Sunnyside Canyon. Neither bird showed any interest in the other. However, both were hatch-year birds, only about 2 weeks out of the nest, and the observer was visible to both birds, sitting about 10 m away.

Escape cover may be important in allowing buff-breasted flycatchers to persist in the presence of predators. my observations suggest that the pine cover >10 m that characterized buff-breasted flycatcher habitat served this purpose. I did not observe any attempts at predation of adult buff-breasted flycatchers, and therefore don't know what avoidance strategies they use in response to predators. However, in several (about 10) chases I observed of buff-breasted flycatchers by greater pewees (Contopus pertinax) (birds large enough to injure a buff-breasted flycatcher) the buff-breasted flycatchers remained in the canopy of the pines, using a rapid, erratic flight among the branches to escape attacks.

Competition --Competition may be a factor in the buff-breasted flycatcher's decline. But if competition with another species has caused the buff-breasted flycatcher's range contraction and population decline, there should have been a concomitant increase in the population of a species or group of species that uses similar resources to those used by the buff-breasted flycatcher. Phillips et al. (1964) did not mention a population increase, range expansion, or habitat shift into transition-zone coniferous forests by any species of flycatcher currently breeding in Arizona. However, due to the buff-breasted flycatcher's rarity, its competitive exclusion from an area may have had a minimal effect on a more abundant competitor's population.

The buff-breasted flycatcher's tendency to occur in clusters of several pairs in close proximity to one another may be competition-related. Sherry and Holmes (1985) observed a population of least flycatchers (Empidonax minimus) that showed a highly aggregated distribution, like buff-breasted flycatchers. Sherry and Holmes found that least flycatcher aggression toward competing American redstarts (Setophaga ruticilla) reduced redstart abundance within least flycatcher aggregations. Buff-breasted flycatcher aggregations may have a similar effect on a competitor. However, exclusion of competitors may not be the reason that least flycatchers aggregate, but a beneficial effect of their aggregation. Least flycatchers are known to be aggressive toward other small birds, especially American redstarts (Sherry 1979). However, in buff-breasted flycatchers interspecific aggression was infrequent unless another bird approached a buff-breasted flycatcher nest. I have no quantitative data on interspecific aggression, but I have observed buff-breasted flycatchers chasing other species when the other bird approached a buff-breasted flycatcher nest within 5 m.

I saw several instances of interspecific aggression, perhaps competition-related, directed toward buff-breasted flycatchers by 2 other flycatcher species: western wood-pewee (Contopus sordidulus) and greater pewee. The larger flycatchers occasionally chased the buff-breasted flycatchers 5-20 m. These chases may have been prompted by the buff-breasted flycatcher's close approach to the other flycatcher's nest, but I did not see nests close to the site of the chases. Though the 2 species frequently occurred together, chases between buff-breasted flycatchers and the congeneric cordilleran flycatcher (Empidonax occidentalis) were not observed.

If the buff-breasted flycatcher population is being reduced through competition, rigorous proof demands removal of a hypothesized competitor, wazzu followed by monitoring of flycatcher populations, to see if they increase in response to the decrease in the competitor's numbers (Terborgh 1989). According to James and Boeklen (1984) correlational analyses seldom conclusively demonstrate competition. Investigations into habitat requirements are more likely to yield results that can be applied to buff-breasted flycatcher management. Proliferation of woody understory vegetation in Arizona's pine forests may have allowed a competitor to exclude buff-breasted flycatchers from areas they formerly occupied. If the buff-breasted flycatcher's range in Arizona has been diminished through the influence of a competitor, its current range may represent environmental conditions under which the competitive interference does not exist. A study similar to Sherry and Holmes' (1985) investigation of least flycatchers may elucidate factors affecting the buff-breasted flycatcher's declining population and aggregated distribution.

Changes in vegetation structure and floristics. --Second-order selection consists of selecting a home range. Ideally, this area must contain all resources necessary for the bird to survive and successfully reproduce. Many of these resources are in some way related to structure and floristics of the vegetation. In my discussion of all of the aforementioned resources (nest site availability, food availability, escape cover, exclusion of competition, and avoidance of cowbird parasitism), I have cited evidence that vegetation structure and floristics influence the effect of these resources on birds. Changes in structure and floristics of Arizona pine-oak forests may have affected resources important to buff-breasted flycatchers, causing their range contraction and numerical decline.

Phillips et al. (1964, 1968) suggested that fire suppression and "other ingenious programs of misuse" may have reduced the amount of potential habitat available to buff-breasted flycatchers. Livestock grazing and fire suppression in the birds' former and current range have allowed shrubs to proliferate, reducing the openness of pine forests, and thus their suitability to buff-breasted flycatchers. Many observers (Lusk 1901, Swarth 1904, Willard 1923, and Bent 1942) also noted this bird's occurrence in open pine forests.

It is widely accepted that fire suppression has reduced the openness of southwestern pine forests (Cooper 1960, Bahre 1991, Savage 1991, Covington and Moore 1994). Prescribed burning may improve suitability of an area as potential buff-breasted flycatcher habitat, by reducing the oak understory. Horton (1987) investigated the effect of prescribed burning in pine-oak forest in the Santa Catalina Mountains, an area potentially habitable by buff-breasted flycatchers. He found that prescribed burning reduced the number of oak trees <15 cm dbh by approximately 50%. I found the number of oak trees 10-20 cm dbh in buff-breasted flycatcher used areas to be about 50% of that in available pine-dominated areas.

Grazing by domestic livestock, in combination with fire suppression in open ponderosa pine (Pinus ponderosa) forests with a lush herbaceous understory of perennial graminoids, is known to change the vegetation structure of the forest (Bock et al. 1992). The result is a denser forest, without the openness with which buff-breasted flycatchers are associated. Pine seeds germinate in a variety of soil types, but soon desiccate if their roots fail to reach mineral soils. Removal of grasses and trampling by livestock exposes mineral soil, creating favorable conditions for growth of seedling pines. Additionally, competition for water from established grasses is thought to inhibit pine seedling growth (Cooper 1960). Jameson (1968) and Reitveld (1975) presented evidence that established grasses may chemically inhibit the germination and root growth of pines. Established grass cover may inhibit establishment of oaks and junipers by similar mechanisms. Madanay and West (1983), working in Zion National Park, Utah, compared vegetation structure between a ponderosa pine stand that had undergone heavy grazing by livestock in the late 19^{th} and early 20^{th} centuries, and 2 stands in the same area and elevation that had never been grazed. On the grazed area, they found more than 250 ponderosa pines

<100 years old/ ha, while the never-grazed stands had <40 such young trees/ ha. Oaks and junipers were also considerably more abundant on the grazed area. Due to the fact that the ungrazed forest remained relatively open despite long (average 69 years) fire-free intervals, Madanay and West concluded that livestock grazing was the primary agent in the process of reducing herbaceous cover and encouraging the proliferation of woody species. This shift in vegetation structure concurrently reduced flammability and was facilitated by decreased fire frequency. Rummell (1961) conducted a similar comparison of 2 ponderosa pine stands in eastern Washington: 1 with a 40-year history of livestock grazing and 1 that had never been grazed. On the grazed area he found <14% herbaceous ground cover and more than 8000 trees/ ha <10 cm dbh, while the ungrazed area had >35% herbaceous ground cover and 212 trees/ ha <10 cm dbh.

These grazing and fire suppression-induced changes to vegetation structure and floristics in Arizona pine-oak forests may not be entirely responsible for the buff-breasted flycatcher's rarity. my observations suggest that apparently suitable habitat in my study area is unoccupied. S. M. Russell (Professor Emeritus, University of Arizona, pers. commun.) noted that in the pine-oak forests of Sonora, where lack of fire suppression creates a very open understory, buff-breasted flycatchers are uncommon and local. Future investigators should compare pine forests in areas formerly occupied by buff-breasted flycatchers (i.e., the White Mountains) with my model to see if reduction in habitat quality or availability is responsible for the species' range contraction.

RESEARCH RECOMMENDATIONS

1. Further studies on the buff-breasted flycatcher should investigate the effect of fire history on the distribution of buff-breasted flycatchers. The recent "Rattlesnake burn" in

the Chiricahuas, and the 1994 fire in upper Miller Canyon have the potential to provide opportunity for such an investigation. Many Arizona biologists have speculated that buff-breasted flycatchers may respond positively to fire. This is reasonable, given the role of fire in maintaining the open pine forests that buff-breasted flycatchers inhabit. An understanding of the time required between burning an area and that area becoming suitable potential buff-breasted flycatcher habitat, as well as effects of frequency and intensity of fire, would enhance buff-breasted flycatcher management strategies.

2. Buff-breasted flycatcher numbers should be monitored in areas with prior records of occupancy, to detect further population changes. my findings suggest that the survey technique I used (see Methods) adequately detected clusters of breeding buff-breasted flycatchers, but an accurate assessment of numbers demands further visits during the breeding season, to determine if single birds responding to the broadcast are paired with birds that did not respond to the survey broadcast. Further comparisons of numbers of birds found during surveys and in subsequent monitoring may enable managers to determine a correction factor so that subsequent visits may not be necessary to ascertain numbers of buff-breasted flycatchers.

3. In light of findings that grazing by cattle may facilitate proliferation of woody understory vegetation in some western North American ponderosa pine forests, investigations into the effects of cattle grazing on buff-breasted flycatchers, their habitat and resources might prove profitable.

MANAGEMENT RECOMMENDATIONS

1. Current buff-breasted flycatcher breeding habitat should be protected from destruction or degradation by development, catastrophic fire, clear-cutting, or other such

activities.

2. If trees must be cut in areas currently occupied by buff-breasted flycatchers, such as campgrounds in Rucker, Carr, and West Turkey Creek canyons, they should be cut in late August through March, while the birds are absent or not actively nesting.

3. Because nest predation by jays appears to be a very important cause of nest failure, artificial support of jay populations through feeding at campgrounds should be discouraged. Buff-breasted flycatchers nest in or near several campgrounds in the vicinity of Rucker Lake, Sycamore Campground in West Turkey Creek, John Hands Campground in Cave Creek Canyon, Reef Campground and Ramsey Vista Campground in Carr Canyon, and the frequently used picnic facilities near the cabin at Sawmill Canyon. Perhaps signs at these campgrounds informing campers of the detrimental effects of feeding jays would decrease nest predation pressure on nearby nesting buff-breasted flycatchers.

4. If future research indicates that intervention is necessary to prevent the extirpation of buff-breasted flycatchers from the U.S., a jay control program in the vicinity of groups of nesting buff-breasted flycatchers may result in higher nesting success for buff-breasted flycatchers.

5. Thinning of understory in stands of chihuahua pines and thinning of branches from mature chihuahua pines has been recommended by Schemnitz and Zornes (1995) to create more favorable roosting sites for Gould's turkey (Meleagris gallopavo mexicana). Turkey roost sites share some characteristics with buff-breasted flycatcher habitat (e.g., stands of open-crowned, mature chihuahua pines with an open understory), and buff-breasted flycatchers have nested in areas used as roosts by Gould's turkeys (e.g.,

Sunnyside Canyon, Huachuca Mountains, buff-breasted flycatchers nested within 100 m of a site where Gould's turkeys roosted in 1995). Whereas thinning of understory vegetation in stands of chihuahua pines may be beneficial to buff-breasted flycatchers, thinning of closely spaced limbs to improve turkey access to the crown of the tree may reduce the number of nest substrates available to buff-breasted flycatchers. Regardless, managers should keep in mind that habitat modifications made to improve Gould's turkey roosting habitat may impact buff-breasted flycatchers, but management activities for 1 species probably are not incompatible with the other.

6. Additional quality habitat for buff-breasted flycatchers should be created. In areas with a relatively gradual slope (about 10), managers should promote the development of open forests (canopy cover about 20% above 10 m, 20% 5-10 m, and <10% cover below 5 m) of apache and chihuahua pine of medium-age structural stage (trees 30-45 cm dbh) or older. These forests should have an open understory of oak (primarily Arizona white oak or silverleaf oak), with about 80-85 small oaks (10-20 cm dbh) per hectare, and oak canopy cover of about 1% at 0-1 m, about 5% at 1-2 m, about 15% at 2-5 m, about 9% at 5-10 m, and negligible above 10 m. Development of woody vegetation less than 2 meters should be discouraged. Ideally, these forest patches should be >150 m wide, because larger patches of forest tended to promote greater reproductive success and higher probability of occupancy.

Suggestions for possible areas for buff-breasted flycatcher habitat enhancement include Sunnyside Canyon (near UTM coordinates 557.0 E, 3478.0 N), Cave Creek (middle fork) (near UTM coordinates 669.25E, 3528.7N), Pinery Canyon (near UTM coordinates 659.3E, 3536.5N), and Rucker Canyon (near UTM coordinates 658.0E, 3514.8N, near the junction with Red Rock Canyon). The area suggested in Sunnyside Canyon was inhabited by 2 pairs of buff-breasted flycatchers in 1995, and the other 3 suggested areas were occupied by 1-3 pairs in 1996. The suggested areas in Sunnyside, Rucker, and Pinery canyons are all within 1-4 km of larger clusters of breeding buff-breasted flycatchers, that might serve as sources of birds to colonize newly developed potential habitat. All of the suggested areas are in Madrean pine-oak forest, in canyon bottoms with a relatively gradual slope. I do not have quantitative vegetation data specific to these areas, but in my estimation, they could be made more suitable for buff-breasted flycatchers by reduction of the understory (i.e., by thinning or prescribed fire) in Sunnyside and Rucker canyons, and/or thinning of small pines to promote more rapid growth of the remaining trees in Pinery and Cave Creek canyons.

7. Though I know of no studies providing quantitative documentation, broadcasts of taped bird calls may have deleterious effects on a bird's territorial defense, energetics, or nesting success. Buff-breasted flycatchers' responsiveness to broadcasts of taped calls of conspecifics suggests that use of taped calls to attract buff-breasted flycatchers into view for recreational bird-watching should be prohibited, at least in areas that are visited by many bird-watchers (e.g., Sawmill Canyon, which is regarded among bird-watchers as the most reliable and accessible place to find buff-breasted flycatchers). I have encountered recreational bird-watchers using taped calls of buff-breasted flycatchers in Sawmill and Carr canyons. Perhaps signs indicating that the broadcast of taped bird calls is prohibited in these areas would discourage such activity. Successful nesting by buff-breasted flycatchers in busy campgrounds and picnic areas (e.g., Cypress Grove in

Rucker Canyon, the cabin at Sawmill Canyon) suggests that presence of campers and picnickers has little or no negative effect on buff-breasted flycatchers.

Table 1. Results of buff-breasted flycatcher surveys in Huachuca, Santa Rita, and Whetstone mountains, 1995.

site	date surveyed	area surveyed (ha)	no. buff-breasted flycatchers
Huachuca Mts.			
Garden Cyn.[a]	95/05/13	50.3	0
Carr Cyn.[a]	95/05/19	37.7	13
Sunnyside Cyn.[a]	95/05/04	48.7	4
Huachuca Cyn.[a]	95/06/04	53.4	0
Sawmill Cyn.[a]	95/05/04	53.4	24
Ramsey Cyn.[a]	95/05/15	31.4	0
Lutz Cyn.	95/06/01	72.3	0
Lyle Cyn.	95/05/08	58.1	0
Parker Cyn. Lake [a]	95/06/02	100.5	0
Rock Spring Cyn. [a]	95/05/31	53.4	0
Scotia Cyn.[a]	95/05/13	65.9	1
Mclure Cyn.	95/05/18	69.1	0
Oversite Cyn.	95/05/20	37.7	0
Montezuma Cyn.	95/06/01	31.4	0
Wakefield Camp	95/05/30	59.6	0
Coyote Cyn.	95/06/20	43.9	0
Rough Cyn.	95/06/21	43.9	0
Brown Cyn.	95/06/26	47.1	0
Blacktail Cyn.	95/06/26	34.6	0
Santa Rita Mountains			
Madera Cyn.[a]	95/06/07	47.1[b]	0
Sprung Spring[a]	95/06/07	47.1	0
Josephine Saddle[a]	95/06/07	47.1	0
Cave Creek Cyn.	95/06/25	84.8	0
Whetstone Mountains			
French Joe Cyn.[a]	95/05/25	50.3	0

[a] Sites from which buff-breasted flycatchers have been reported prior to this study.

[b] Madera Canyon, Josephine Saddle, and Sprung Spring were all included in one survey transect.

Table 2. Results of buff-breasted flycatcher surveys in Chiricahua, Santa Catalina, and Rincon mountains, 1996.

site	date surveyed	area surveyed (ha)	no.buff-breasted flycatchers
Chiricahua Mts.			
Rucker Cyn.(lower)	96/06/29	72.0	7
Rucker Cyn.(upper)[a]	96/05/05	100.0	6
Cave Crk.(middle fork)[a]	96/05/14	88.0	4
Cave Crk.(south fork)[a]	96/06/06	120.0	0
Bear Cyn.	96/06/08	60.0	3
Red Rock Cyn.[a]	96/06/07	80.0	10
Pine Cyn.[a]	96/05/22	156.0	1
Horseshoe Cyn.	96/06/15	136.0	0
John Long Cyn.	96/05/06	120.0	0
Mormon Ridge Trail	96/06/10	60.0	0
Price Cyn.	96/06/09	100.0	0
East Whitetail Cyn.[a]	96/06/13	124.0	0
Sulphur Draw	96/06/20	140.0	0
East Turkey Creek	96/06/28	112.0	1
Saulsbury Cyn.[a]	96/04/20	40.0	3
Ward Cyn.	96/04/20	48.0	1
West Turkey Creek	96/04/21	84.0	2
Pinery Cyn.(upper)[a]	96/05/12	120.0	1
Pinery Cyn.(lower)	96/06/12	80.0	3
Horsefall Cyn.	96/06/01	48.0	0
Barfoot[a]/Rustler/ Long Parks	96/15/13	116.0	0
Santa Catalina Mountains			
Sycamore Cyn.	96/06/21	60.0	2
Bear Cyn.[a]	96/06/25	36.0	0
Organization Ridge	96/06/20	28.0	0
Spencer Cyn.	96/06/08	60.0	0
Butterfly Trail[a]	96/06/17	52.0	0
Sabino Cyn.	96/06/21	68.0	0
Marshall Gulch	96/06/02	68.0	0
Rose Cyn.[a]	96/05/08	68.0	0

Table 2. - *continued*

Forest Service Rd. 38	96/06/28	52.0	0
Stratton Cyn.	96/06/17	96.0	0
Rincon Mountains			
Manning Camp[a]/ Fire Loop Trail	96/07/01	80.0	0

[a] Sites from which buff-breasted flycatchers have been reported prior to this study.

Table 3. Numbers of buff-breasted flycatchers detected on surveys and in subsequent monitoring within the area surveyed, Huachuca and Chiricahua mountains. 1995-1996.

canyon	number found on survey	number found during monitoring
Carr Cyn.	13	18
Sawmill Cyn.	24	20
Scotia Cyn.	1	4
Sunnyside Cyn.	4	4
Cave Creek Cyn.	4	6
Pinery Cyn.	4	2
Rucker Cyn.	6	8
West Turkey Creek Cyn.	6	16
Total	58	80

Table 4. Areas with records of buff-breasted flycatcher occupation, in which I did not find buff-breasted flycatchers in 1995-1996.

location	date of record	source
Huachuca Mountains		
Garden Cyn.[a]	1982-83	Bowers and Dunning (1994)
Huachuca Cyn.	1947	Brandt (1951)
Rock Spring Cyn.	1981	Bowers and Dunning (1994)
Parker Cyn Lake	1994	C. Williamson (pers. comm.)
Santa Rita Mountains		
Madera Cyn.	1984	G. Monson (pers. comm.)
Josephine Saddle	1985	G. Monson (pers. comm.)
Sprung Spring	1992-94	J. Murray (pers. comm.)
Chiricahua Mountains		
South Fork Cave Creek Cyn.	1980	Bowers and Dunning (1994)
East Whitetail Cyn.	1981	Bowers and Dunning (1994)
Barfoot Park	1919-21	Hubbard (1972)
jct. Pine and Hoovey Cyn.	1994	H. Snyder (pers. comm.)
Santa Catalina Mountains		
Rose Cyn.	1980-82	Bowers and Dunning (1994)
Butterfly Trail	?	Davis and Russell (1984)
Bear Cyn.	1971	G. Monson (pers. comm.)
Rincon Mountains		
Manning Camp	1911	Marshall (1956)

[a] Location where Bowers found buff-breasted flycatchers is outside the area I surveyed.

Table 5. Reproductive success ranks associated with areas used by buff-breasted flycatchers, Huachuca and Chiricahua mountains, 1995-1996.

Canyon	used area no.	rank[a]
Carr	CR01	1
	CR02	4
	CR03	3
	CR04	3
	CR05	0
	CR06	3
	CR07	3
	CR08	3
	CR09	3
	CR10	3
Sawmill		
	SA01	0
	SA02	5
	SA03	4
	SA04	0
	SA05	5
	SA06	4
	SA07	1
	SA08	0
	SA09	7
	SA10	5
	SA11	5
	SA12	5
	SA13	0
	SA14	5
	SA15	5
	SA16	3
Scotia		
	SC01	6
	SC02	1
	SC03	1
Sunnyside		
	SU01	5

Table 5. - *continued*

	SU02	0
	SU03	3
	SU04	3
	SU05	1
	SU06	5
	SU07	5
	SU08	7
Cave Creek		
	CC01	5
	CC02	5
	CC03	3
Pinery		
	PY01	3
	PY02	0
	PY03	5
	PY04	4
	PY05	5
	PY06	5
Rucker		
	RU01	5
	RU02	5
	RU03	4
	RU04	5
West Turkey Creek		
	WT01	5
	WT02	5
	WT03	5
	WT04	3
	WT05	5
	WT06	4
	WT07	4

[a] ranks: 1: occupation of territory, 2: pair formation, 3: nest-building and/or egg-laying and/or incubation, 4: nestlings present, 5: successful fledging, 6: second nesting attempt following successful fledging, 7: second brood successfully fledged.

Table 6. Contingency table of buff-breasted flycatcher occurrence by vegetation type[a] at survey points, Huachuca and Chiricahua mountains, 1995-1996.

	BBFL occurrence					
	absent			present		
vegetation type[a]	observed	expected	%	observed	expected	%
Interior manzanita chaparral (1,133.322)	3	3.6	75.0	1	0.4	25.0
Madrean douglas-fir/mixed conifer forest (1,122.611)	87	77.0	100.0	0	9.0	0.0
Madrean oak-pine woodland (1,123.324)	45	44.8	90.0	5	5.2	10.0
Madrean oak woodland (1,123.311 or 1,123.315)	21	20.6	91.3	2	2.4	8.7
Madrean oak-pinion-juniper woodland (1,123.316)	102	90.4	100.0	0	10.6	0.0
Madrean pine forest (1,122.62)	13	11.6	100.0	0	1.4	0.0
Madrean pine-juniper forest (1,122.625)	10	9.9	90.9	1	1.1	9.1
Madrean pine-oak forest (1,122.624)	211	232.8	81.2	49	27.2	18.8
Madrean subalpine coniferous forest (1,121.5)	3	2.7	100.0	0	0.3	0.0
Relict cypress forest (1,123.521)	9	9.0	90.0	1	1.0	10.0
Riparian deciduous forest (1,223.222)	10	6.3	100.0	0	0.7	0.0

Table 6. - *continued*

Chi-Square	Value	DF	Significance
Pearson	48.90497	13	0.00000
Likelihood Ratio	66.24633	13	0.00000

ells with expected frequency < 5 : 15 of 28 (53.6%)
minimum expected frequency = .105

[a]after Brown, Lowe and Pase (1982).

Table 7. Contingency table of buff-breasted flycatcher occurrence by width of forest patch at survey points, Huachuca and Chiricahua mountains, 1995-1996.

	BBFL occurrence					
	absent			present		
width	observed	expected	%	observed	expected	%
<50 m	118	111.9	94.4	7	13.1	5.6
50-100 m	99	95.8	92.5	8	11.2	7.5
100-150 m	60	58.2	92.3	5	6.8	7.7
150-200 m	42	43.0	87.5	6	5.0	12.5
200-250 m	19	24.2	70.4	8	2.8	29.6
250-300 m	17	24.2	63.0	10	2.8	37.0
300-350 m	5	8.1	66.7	3	0.9	33.3
350-400 m	9	11.6	69.2	4	1.4	25.0
450-500 m	9	9.9	81.8	2	1.1	18.2
700-750 m	0	0.9	0.0	1	0.1	100.0
950-1000 m	47	43.9	95.9	2	5.1	4.1
1200-1250 m	0	0.9	0.0	1	0.1	100.0
1950-2000 m	85	77.9	97.7	2	9.1	2.3

Table 7. - *continued*

Chi-Square	Value	DF	Significance
Pearson	73.70539	13	.00000
Likelihood Ratio	55.63084	13	.00000

Minimum Expected Frequency = 0.105
Cells with Expected Frequency < 5 : 11 of 28 (39.3%)

Table 8. Contingency table of buff-breasted flycatcher occurrence by canopy cover category at survey points, Huachuca and Chiricahua mountains, 1995-1996.

	BBFL occurrence					
	absent			present		
canopy cover	observed	expected	%	observed	expected	%
no vegetation > 10 m	106	95.8	99.1	1	11.2	0.9
open canopy: 0-30% cover	134	128.9	93.8	9	15.1	6.3
semi-open canopy: 30-60% cover	201	223.9	80.4	49	26.1	19.6
closed canopy: > 60% cover	72	65.4	98.6	1	7.6	1.4

Chi-square	Value	DF	Significance
Pearson	41.85507	3	.00000
Likelihood Ratio	47.85272	3	.00000

minimum expected frequency = 7.631

Table 9. Contingency table of buff-breasted flycatcher occurrence by vegetation structural stage at survey points, Huachuca and Chiricahua mountains, 1995-1996.

structural stage	BBFL occurrence					
	absent			present		
	observed	expected	%	observed	expected	%
not coniferous forest (0-2.54 cm dbh)	91	82.4	98.9	1	9.6	1.1
seedling-sapling (2.54-12.7 cm dbh)	18	17.9	90.0	2	2.1	10.0
young forest (12.7- 30.48 cm dbh)	41	38.5	95.3	2	4.5	4.7
mid-age forest (30.48- 45.72 cm dbh)	133	137.9	96.4	21	16.1	13.6
mature forest (45.72 - 60.96 cm dbh)	86	94.0	81.9	19	11.0	18.1
old forest (>60.96 cm dbh)	145	143.3	90.6	15	16.7	9.4

Chi-square	Value	DF	Significance
Pearson	18.59015	5	0.00229
Likelihood Ratio	22.74278	5	0.00038
Mantel-Haenszel	7.93592	1	0.00485

Cells with expected frequency < 5 : 2 of 12 (16.7%)
minimum expected frequency = 2.091

Table 10. Contingency table of buff-breasted flycatcher occurrence by forest patch width at survey points with pine-dominated vegetation, Huachuca and Chiricahua mountains, 1995-1996.

	BBFL occurrence					
	absent			present		
width	observed	expected	%	observed	expected	%
<50 m	91	81.0	93.8	6	16.0	6.2
50-100 m	78	71.8	90.7	8	14.2	9.3
100-150 m	40	36.8	90.9	4	7.2	9.1
150-200 m	30	30.1	83.3	6	5.9	16.7
200-250 m	15	19.2	65.2	8	3.8	34.8
250-300 m	9	15.9	47.4	10	3.1	52.6
300-350 m	3	5.0	50.0	3	1.0	50.0
350-400 m	2	5.0	33.3	4	1.0	66.7
400-450 m	1	1.7	50.0	1	0.3	50.0
450-500 m	6	6.7	75.0	2	1.9	25.0
700-750 m	0	0.8	0.0	1	0.2	100.0
950-1000 m	4	4.2	80.0	1	0.8	20.0
1200-1250 m	0	0.8	0.0	1	0.2	100.0

Chi-square	Value	DF	Significance
Pearson	64.22560	12	0.00000
Likelihood Ratio	52.58747	12	0.00000
Mantel-Haenszel	28.88100	1	0.00000

minimum expected frequency = 0.165

Table 10. - *continued*

cells with expected frequency < 5 : 13 of 26 (50%)

Table 11. Contingency table of buff-breasted flycatcher occurrence by vegetation type at survey points with pine-dominated vegetation, Huachuca and Chiricahua mountains, 1995-1996.

	BBFL occurrence					
	absent			present		
vegetation type	observed	expected	%	observed	expected	%
Madrean oak-pine woodland (1,123.324)[a]	45	41.8	90.0	5	8.2	10.0
Madrean pine forest (1,122.620)	13	10.9	100.0	0	2.1	0.0
Madrean pine-juniper forest (1,122.625)	10	9.2	90.9	1	1.8	9.1
Madrean pine-oak forest(1,122.624)	211	217.2	81.2	49	42.8	18.8

Chi-square	Value	DF	Significance
Pearson	5.58789	3	.13348
Likelihood Ratio	7.93713	3	.04733

minimum expected frequency = 1.811
cells with expected frequency < 5 : 2 of 8 (25.0%)

[a] Vegetation types after Brown et al. 1982.

Table 12. Contingency table of buff-breasted flycatcher occurrence by structural stage at survey points with pine-dominated vegetation, Huachuca and Chiricahua mountains, 1995-1996.

	BBFL occurrence					
	absent			present		
structural stage [a]	observed	expected	%	observed	expected	%
young forest (12.7- 30.48 cm dbh)	27	24.2	93.1	2	4.8	6.9
mid-age forest (30.48- 45.72 cm dbh)	109	108.6	83.8	21	21.4	16.2
mature forest (45.72 - 60.96 cm dbh)	69	73.5	78.4	19	14.5	21.6
old forest (>60.96 cm dbh)	71	70.2	84.5	13	13.8	15.5

Chi-square	Value	DF	Significance
Pearson	4.27126	3	0.37054
Likelihood Ratio	5.08493	3	0.27869
Mantel-Haenszel	1.15330	1	0.28286

minimum expected frequency = .494
cells with expected frequency < 5 : 3 of 10 (30.0%)

[a] Structural stage: Structural stages correspond to those used by the USFS in Reynolds *et al* 1992 (Management recommendations for the northern goshawk in the southwestern United States).

Table 13. Contingency table of buff-breasted flycatcher occurrence by canopy cover category at survey points with pine-dominated vegetation, Huachuca and Chiricahua mountains, 1995-1996.

	BBFL occurrence					
	absent			present		
canopy cover [a]	observed	expected	%	observed	expected	%
open (0-39% cover)	102	90.2	94.4	6	17.8	5.6
moderately closed (40-59% cover)	158	172.9	76.3	49	34.1	23.7
closed (>60% cover)	19	15.9	100.0	0	3.1	0.0

Chi-square	Value	DF	Significance
Pearson	20.90434	2	0.00003
Likelihood Ratio	25.90742	2	0.00000

minimum expected frequency = 3.129
cells with expected frequency < 5 : 1 of 6 (16.7%)

[a] Canopy coverage: Categories used in Reynolds *et al* 1992. (Management recommendations for the northern goshawk in the southwestern United States).

Table 14. Variables, parameters, and classification results of canyon-specific logistic regression models, areas used by buff-breasted flycatchers vs. available areas.

			Classification Results	
Variable correct	Coefficient	R	group	%
Cave Creek Canyon, Chiricahua Mountains, 1996.				
% total live cover, 0-1 m	0.5290	0.2293	used	77.78
no. of trees 20-30 cm dbh	0.9757	0.2601	available	93.33
% cover bare ground	0.4700	0.1789	overall	89.74
% cover pinion pine, 2-5 m	6.8945	0.2218		

Model Chi-Square= 27.151 (P = 0.0000)
Goodness of Fit = 21.382

Pinery Canyon, Chiricahua Mountains, 1996.				
% total live cover, 0-1 m	0.8685	0.218	used	86.67
no. of apache pines	0.6801	0.188	available	96.67
% cover alligator juniper	2.3702	0.134	overall	93.33

Model Chi-Square = 40.910 (P = 0.0000)
Goodness of Fit = 15.838

Table 14. - *continued*

Rucker Canyon, Chiricahua Mountains, 1996.

% cover oak, 0-1 m	-4.7758	0.000	used	91.67
% cover bare ground	1.7117	0.200	available	100.00
no. of apache and chihuahua pines, 40-50 cm dbh	2.1322	0.168	overall	97.62

Model Chi-Square = 39.756 (P = 0 .0000)
Goodness of Fit = 12.830

West Turkey Creek, Chiricahua Mountains, 1996.

% cover apache and chihuahua pines, > 10 m	2.2308	0.178	used	94.44
% total live cover	1.6040	0.161	available	96.67
no. of shrub species	3.7809	0.152	overall	95.83
shrub silverleaf oak present	9.8630	0.169		
shrub mimosa present	-25.2235	0.000		

Model Chi-Square = 53.372 (P = 0.000)
Goodness of Fit = 9.791

Carr Canyon, Huachuca Mountains, 1995.

no. of apache and chihuahua pines >60 cm dbh	-30.6863	-0.036	used	92.59
% cover oak, 5-10 m	-3.6343	-0.054	available	96.77

Table 14. - *continued*

distance to opening	0.5832	0.082	overall	94.83
slope	-1.0442	-0.082		
% cover rock	-1.8684	-0.032		
dbh of largest apache pine	0.4340	0.000		
no. of shrub species	-4.4943	-0.086		
shrub yucca present	-18.8569	-0.035		

Model Chi-Square = 71.815 (P = 0.0000)
Goodness of Fit = 6.909
Sawmill Canyon, Huachuca Mountains, 1995.

% cover oak 0-1 m	-2.5825	-0.188	used	92.86
% cover oak 2-5 m	-0.3325	-0.117	available	91.67
no. of oak trees 10-20 cm dbh	-0.6250	-0.173	overall	92.31
% cover pinion pine, 2-5 m	-3.4962	-0.194		
% cover silverleaf oak, 1-2 m	3.3641	0.178		
height of tallest alligator juniper	0.7296	0.154		
vigor of tallest chihuahua pine	-1.5791	-0.156		
no. of shrub species	1.8803	0.121		
shrub yucca present	15.8273	0.197		

Model Chi-Square = 87.489 (P = 0.0000)
Goodness of Fit = 17.372

Scotia Canyon, Huachuca Mountains, 1995.

Table 14. - *continued*

slope	-0.2570	-0.277	used	77.78
% cover sycamore, 5-10 m	1.2898	0.202	available	96.67
dbh of tallest chihuahua pine	0.0651	0.255	overall	92.31

Model Chi-Square = 23.784 (P = 0.0000)
Goodness of Fit = 31.307

Sunnyside Canyon, Huachuca Mountains, 1995.

% cover apache and chihuahua pine, 5-10 m	-4.4477	-0.061	used	95.83
no. of apache and chihuahua pines, 10-20 cm dbh	2.6723	0.051	available	96.67
no. of apache and chihuahua pines, 30-40 cm dbh	5.5237	0.045	overall	96.30
% cover medium dead branch, 0-1 m	-19.4867	-0.037		
% cover Arizona white oak, 1-2 m	-15.0754	-0.062		
% total live cover, 2-5 m	5.5209	0.053		
dbh of tallest chihuahua pine	2.8485	0.008		

Model Chi-Square = 65.501 (P = 0.0000)
Goodness of Fit = 8.450

Table 15. Variables, parameters, and classification results of logistic regression model, areas used by buff-breasted flycatchers vs. available areas, Huachuca Mountains, 1995.

Variable	Coefficient	R	Classification Results group	Classification Results % correct
slope	-0.1174	-0.230	used	83.33%
medium dead branch, 0-1 m	-0.6561	-0.081	available	85.04%
height of tallest chihuahua pine	-0.3356	-0.086	overall	84.28%
% cover manzanita, 0-1 m	-0.1986	-0.120		
% cover Arizona white oak, 1-2 m	-0.3050	-0.078		
height of tallest alligator juniper	0.1515	0.118		
vigor of tallest pinion pine	-0.4508	-0.159		
dbh of tallest chihuahua pine	0.1698	0.142		
dbh of tallest apache pine	0.0168	0.059		
height of tallest Emory oak	0.1822	0.077		
dbh of tallest silverleaf oak	-0.0332	-0.080		
shrub Emory oak present	1.9225	0.133		
shrub yucca present	1.0877	0.092		

Model Chi-Square = 146.336 (= 0.0000)
Goodness of Fit 225.524

Table 16. Variables, parameters, and classification results of logistic regression model, areas used by buff-breasted flycatchers vs. available areas, Chiricahua Mountains, 1996.

			Classification Results	
Variable	Coefficient	R	group	% correct
distance to opening	0.1222	0.112	used	94.44%
% cover coffeeberry, 1-2 m	13.8802	0.091		
% cover oak, 0-1 m	-14.4571	-0.112	available	98.33%
% total live cover, 0-1 m	2.3497	0.105		
no. of trees 20-30 cm dbh	3.2005	0.115	overall	97.13%
% cover alligator juniper, 2-5 m	2.9265	0.111		
% cover douglas-fir, 1-2 m	-20.1145	0.000		
% cover apache and chihuahua pine, 2-5 m	4.8438	0.103		
no. of apache and chihuahua pines, 50-60 cm dbh	7.1033	0.087		
% cover leaf litter	-1.8030	-0.091		
vigor of tallest netleaf oak	11.7141	0.068		
no. of apache and chihuahua pines, 40-50 cm dbh	7.2625	0.109		
vigor of tallest white pine	6.3947	0.096		
shrub manzanita present	-32.8210	0.000		
shrub Arizona grape present	-10.6783	-0.113		
shrub Arizona creeper present	-17.5050	0.000		
shrub agave present	11.9342	0.091		

Model Chi-Square = 196.579 (P = 0.0000)
Goodness of Fit = 17.369

Table 17. Variables, parameters, and classification results of logistic regression model, areas used by buff-breasted flycatchers vs. available areas, Huachuca and Chiricahua mountains, 1995-1996.

Variable	Coefficient	R	Classification Results group	% correct
% cover oak, 0-1 m	-0.5666	-0.164	used	75.97
% cover apache and chihuahua pine, 2-5 m	0.2194	0.055	available	88.98
% cover apache and chihuahua pine, >10 m	0.1324	0.112	overall	84.38
% total live cover, 0-1 m	0.0634	0.094		
no. of apache pines	0.0745	0.049		
no. of oak trees, 10-20 cm dbh	-0.0872	-0.092		
no. of oak trees, 30-40 cm dbh	-0.7846	-0.110		
no. of Arizona white oak trees	0.1226	0.092		
% cover oak, >10 m	-1.0489	-0.045		
Vigor of tallest pinion pine	-0.6073	-0.172		
Dbh of tallest Arizona white oak	-0.0219	-0.059		
% cover alligator juniper, 1-2 m	0.7733	0.139		
% cover alligator juniper, 2-5 m	0.1396	0.079		
% cover douglas-fir, 1-2 m	-1.8043	-0.073		
Height of tallest chihuahua pine	0.1157	0.158		
Height of tallest silverleaf oak	-0.1254	-0.086		
% cover non-oak non-coniferous shrubs	-0.3445	-0.087		
Vigor of tallest white pine	0.4305	0.119		
No. of shrub species	0.1229	0.057		
Shrub apache pine present	1.0281	0.102		
Shrub Emory oak present	1.4259	0.136		
Shrub yucca present	1.1448	0.096		
Shrub Arizona white oak present	-1.5001	-0.132		

Table 17. - *continued*

Model Chi-Square = 228.696 (P = 0.0000)
Goodness of Fit = 301.156

Table 18. Variables chosen in canyon-specific and mountain range-specific logistic regression models of buff-breasted flycatcher used areas vs. available areas, and no. of models in which they were chosen, Huachuca and Chiricahua mountains, 1995-1996.

variable	no. of models
% total live cover, 0-1 m	5
% cover oak, 0-1 m (-)	4
no. of shrub species	3
slope (-)	3
shrub yucca present	3
dbh of tallest chihuahua pine	3
no. of trees 20-30 cm dbh	2
% cover bare ground	2
% cover pinion pine, 2-5 m	2
no. of apache pines	2
no. of apache and chihuahua pines, 40-50 cm dbh	2
% cover apache and chihuahua pines, > 10 m	2
distance to opening	2
dbh of tallest apache pine	2
no. of oak trees 10-20 cm dbh(-)	2
height of tallest alligator juniper	2
% cover medium dead branch, 0-1 m (-)	2
% cover Arizona white oak, 1-2 m(-)	2
shrub Emory oak present	2
% cover alligator juniper, 2-5 m	2
% cover douglas-fir, 1-2 m (-)	2
% cover apache and chihuahua pine, 2-5 m	2
vigor of tallest pinion pine (-)	2
% cover alligator juniper	1
% total live cover	1
shrub silverleaf oak present	1
shrub mimosa present (-)	1
no. of apache and chihuahua pines >60 cm dbh (-)	1
% cover oak, 5-10 m (-)	1
% cover rock (-)	1
shrub yucca present (-)	1
% cover oak 2-5 m (-)	1
% cover silverleaf oak, 1-2 m	1
vigor of tallest chihuahua pine (-)	1
% cover sycamore, 5-10 m	1
% cover apache and chihuahua pine, 5-10 m (-)	1

Table 18. - *continued*

no. of apache and chihuahua pines, 10-20 cm dbh	1
no. of apache and chihuahua pines, 30-40 cm dbh	1
% total live cover, 2-5 m	1
height of tallest chihuahua pine (-)	1
% cover manzanita, 0-1 m (-)	1
height of tallest alligator juniper	1
height of tallest Emory oak	1
dbh of tallest silverleaf oak (-)	1
% cover coffeeberry, 1-2 m	1
no. of apache and chihuahua pines, 50-60 cm dbh	1
% cover leaf litter (-)	1
vigor of tallest netleaf oak	1
vigor of tallest white pine	1
shrub manzanita present (-)	1
shrub Arizona grape present (-)	1
shrub Arizona creeper present (-)	1
shrub agave present	1
no. of oak trees, 30-40 cm dbh (-)	1
no. of Arizona white oak trees	1
% cover oak, >10 m (-)	1
dbh of tallest Arizona white oak (-)	1
% cover alligator juniper, 1-2 m	1
Height of tallest chihuahua pine	1
Height of tallest silverleaf oak (-)	1
% cover non-oak deciduous shrubs (-)	1
Vigor of tallest white pine	1
Shrub apache pine present	1
Shrub Arizona white oak present (-)	1

Table 19. Variables input into logistic regresssion procedures to create overall models of buff-breasted flycatcher habitat, Huachuca and Chiricahua mountains, 1995-1997.

used areas vs. available	used areas vs. available (pine-dominated)	nest sites vs. used areas	successful nest sites vs. unsuccessful nest sites	successful used areas vs. unsuccessful used areas
SLO	SLO	OAKT1	TLC1	0AKT1
SHYU	TOAK4	PINET1	SHSPTOT	SHPL
DBH2T	PINET3	TPINE5	SHPE	
TPINE5	PINET5	SHSPTOT		
DTO	OAKT1	TPINE4		
OAKT1	QHTOT			
PETOT	OAKT2			
PINET4				
PINET5				
TOAK				

Table 20. Variables, parameters, and classification results of overall logistic regression model, areas used by buff-breasted flycatchers vs. available areas, Huachuca and Chiricahua mountains, 1995-1996.

			Classification Results	
Variable	Coefficient	R	group	% correct
Slope	-0.0541	-0.166	used	60.26%
Shrub yucca present	0.6526	0.065	available	84.21%
No. of trees, 20-30 cm dbh	0.0657	0.066	overall	74.94%
% cover apache and chihuahua pine, >10 m	0.1012	0.125		
No. of oak trees, 10-20 cm dbh	-0.0393	-0.082		
No. of apache and chihuahua pine trees, 40-50 cm dbh	0.2024	0.046		
% cover oak, 5-10 m	-0.0885	-0.086		

Model Chi-Square = 120.659 (P = 0.0000)
Goodness of Fit = 402.161

Table 21. Descriptive statistics of variables used to build logistic regression models of buff-breasted flycatcher habitat: values for available areas, Huachuca and Chiricahua mountains, 1995-1996.

variable	mean	standard deviation	range	skewness	kurtosis	significance of Lilliefors
% total live cover, 0-1 m	0.47	0.31	1	0.892	0.438	0.0000
% cover oak, 0-1 m	0.05	0.07	0.48	2.389	8.468	0.0000
No. of shrub species	8.0	3.3	18	0.011	0.499	0.0000
Slope	17.8	10.5	45	0.338	-0.724	0.0013
Shrub yucca present	0.35	0.48	1	0.622	-1.625	0.0000
No. of trees 20-30 cm dbh	6.0	4.1	22	0.670	0.304	0.0000
% cover bare ground	0.08	0.11	0.55	1.843	3.542	0.0000
% cover pinion pine, 2-5 m	0.03	0.07	0.41	2.774	8.193	0.0000
% cover alligator juniper, 1-2 m	0.01	0.02	0.10	2.060	3.805	0.0000
% cover apache and chihuahua pine, >10 m	0.09	0.14	0.65	1.784	2.913	0.0000
% cover alligator juniper, 2-5 m	0.07	0.09	0.38	1.199	0.895	0.0000
Distance to opening	47.8	57.4	250	1.184	0.261	0.0000
% cover apache and chihuahua pine, 2-5 m	0.02	0.04	0.24	2.427	7.814	0.0000
No. of oak trees, 10-20 cm dbh	11.4	12.3	76	1.926	5.697	0.0000
Dbh of tallest chihuahua pine	38.1	16.2	80	0.597	0.130	0.0073
Shrub Emory oak present	0.36	0.48	1	0.567	-1.692	0.0000
No. of apache pines	4.6	3.9	21	1.712	3.443	0.0000
No. of apache and chihuahua pines, 40-50 cm dbh	0.55	0.91	5	1.864	3.624	0.0000
Shrub silverleaf oak present	0.74	0.44	1	-1.082	-0.835	0.0000
% cover oak, 5-10 m	0.15	0.16	0.72	1.164	0.764	0.0000
% cover coffeeberry, 1-2 m	0.0007	0.0058	0.0690	9.231	92.968	0.0000

Table 21. - *continued*

Shrub agave present	0.31	0.46	1	0.817	-1.342	0.0000
No. of apache and chihuahua pines, 50-60 cm dbh	0.26	0.64	4	2.844	8.916	0.0000
Vigor of tallest white pine	3.5	1.0	5	-1.289	2.736	0.0003
Shrub Arizona grape present	0.25	0.44	1	1.130	-0.727	0.0000
Vigor of tallest chihuahua pine	3.3	1.0	5	-1.313	2.770	0.0000
Height of tallest alligator juniper	8.0	2.0	10	0.002	-0.105	0.0000
% cover silverleaf oak, 1-2 m	0.04	0.07	0.41	2.544	7.683	0.0000
% cover oak, 2-5 m	0.22	0.19	0.93	1.132	1.045	0.0000
% cover sycamore, 5-10 m	0.01	0.03	0.17	3.539	12.063	0.0000
% cover apache and chihuahua pine, 5-10 m	0.12	0.14	0.72	1.391	1.692	0.0000
No. of apache and chihuahua pines, 10-20 cm dbh	2.2	3.2	20	2.288	6.613	0.0000
% cover Arizona white oak, 1-2 m	0.04	0.06	0.34	2.398	7.072	0.0000
% total live cover, 2-5 m	0.39	0.20	1	0.139	-0.335	0.0004
% cover medium dead branch, 0-1 m	0.35	0.71	4	2.540	7.428	0.0000
Height of tallest chihuahua pine	12.4	3.0	13	0.124	-0.344	0.0000
Dbh of tallest apache pine	45.0	19.7	118	0.484	0.783	0.0087
Height of tallest Emory oak	7.3	2.5	9	0.116	-0.881	0.0651
Dbh of tallest silverleaf oak	21.5	7.8	44	1.394	3.453	0.0000
Shrub apache pine present	0.48	0.50	1	0.073	-2.011	0.0000
No. of oak trees, 30-40 cm dbh	0.51	0.94	8	3.289	17.917	0.0000
No. of Arizona white oak trees	9.5	6.8	32	0.801	0.181	0.0005
Vigor of tallest pinion pine	3.7	0.9	5	-0.919	2.396	0.0000
Dbh of tallest Arizona white oak	29.1	16.0	87	1.635	2.838	0.0000
% cover douglas-fir, 1-2 m	0.0056	0.0191	0.1380	4.102	18.515	0.0000
Height of tallest silverleaf oak	7.6	2.2	11	0.387	0.200	0.0000
% cover non-oak, non-coniferous shrubs	0.07	0.12	0.76	2.828	9.291	0.0000
Shrub Arizona white oak present	0.68	0.47	1	-0.757	-1.438	0.0000
% cover alligator juniper, 1-2 m	0.01	0.02	0.10	2.060	3.805	0.0000

Table 22. Descriptive statistics of variables used to build logistic regression models of buff-breasted flycatcher habitat: values for used areas, Huachuca and Chiricahua mountains, 1995-1996.

variable	mean	standard deviation	range	skewness	kurtosis	significance of Lilliefors
% total live cover, 0-1 m	0.46	0.26	1.69	1.014	2.295	0.0000
% cover oak, 0-1 m	0.03	0.06	0.52	4.461	28.625	0.0000
No. of shrub species	7.9	3.3	16	0.74	0.44	0.0000
Slope	11.3	8.6	35	0.882	0.199	0.0000
Shrub yucca present	0.13	0.34	1	2.161	2.708	0.0000
No. of trees 20-30 cm dbh	7.1	4.3	20	0.498	-0.282	0.0005
% cover bare ground	0.09	0.12	0.72	2.343	7.192	0.0000
% cover pinion pine, 2-5 m	0.01	0.03	0.21	3.083	10.901	0.0000
% cover alligator juniper, 1-2 m	0.02	0.03	0.21	2.758	9.64	0.0000
% cover apache and chihuahua pine, >10 m	0.22	0.20	0.83	0.914	0.199	0.0000
% cover alligator juniper, 2-5 m	0.10	0.11	0.59	1.424	2.299	0.0000
Distance to opening	69.8	67.1	500	2.303	10	0.0000
no. of apache and chihuahua pines, 50-60 cm dbh	0.05	0.07	0.31	1.941	3.848	0.0000
No. of oak trees, 10-20 cm dbh	5.9	7.5	32	1.620	2.132	0.0000
Dbh of tallest chihuahua pine	44.1	13.2	75	0.299	0.448	> 0.2000
Shrub Emory oak present	0.34	0.47	1	0.683	-1.553	0.0000
No. of apache pines	7.1	7.2	38	1.848	3.875	0.0000
No. of apache and chihuahua pines, 40-50 cm dbh	1.5	2.3	13	2.960	11.297	0.0000
Shrub silverleaf oak present	0.75	0.43	1	-1.165	1.649	0.0000
% cover oak, 5-10 m	0.09	0.12	0.59	1.581	2.269	0.0000

Table 22. - *continued*

% cover coffeeberry, 1-2 m	0.0007	0.0048	0.0345	7.069	48.601	0.0000
Shrub agave present	0.26	0.44	1	1.126	-0.740	0.0000
No. of apache and chihuahua pines, 50-60 cm dbh	0.61	0.95	5	1.918	3.007	0.0000
Vigor of tallest white pine	3.2	1.7	5	-1.176	0.077	0.0727
Shrub Arizona grape present	0.29	0.46	1	0.908	-1.190	0.0000
Vigor of tallest chihuahua pine	3.1	1.0	5	-1.578	2.989	0.0000
Height of tallest alligator juniper	8.62	2.01	15	0.071	2.631	0.0001
% cover silverleaf oak, 1-2 m	0.02	0.05	0.21	2.409	5.190	0.0000
% cover oak, 2-5 m	0.14	0.15	0.72	1.272	1.581	0.0000
% cover oak sycamore, 5-10 m	0.02	0.04	0.28	3.245	11.389	0.0000
% cover apache and chihuahua pine, 5-10 m	0.20	0.16	0.59	0.477	-0.783	0.0000
No. of apache and chihuahua pines, 10-20 cm dbh	3.1	3.6	19	1.720	3.216	0.0000
% cover Arizona white oak, 1-2 m	0.02	0.04	0.21	2.463	7.030	0.0000
% total live cover, 2-5 m	0.34	0.21	0.86	0.321	-0.462	0.0906
% cover medium dead branch, 0-1 m	0.27	0.59	3	2.456	6.235	0.0000
Height of tallest chihuahua pine	13.95	2.63	15	-0.075	0.194	0.1879
Dbh of tallest apache pine	46.9	16.5	92	-0.108	0.230	> 0.2000
Height of tallest Emory oak	7.7	1.9	8	0.526	0.085	0.1680
Dbh of tallest silverleaf oak	24.9	13.0	52	1.216	0.904	0.0063
Shrub apache pine present	0.45	0.50	1	0.182	-1.992	0.0000
No. of oak trees, 30-40 cm dbh	0.31	1.1	10	6.268	49.167	0.0000
No. of Arizona white oak trees	6.6	6.2	28	1.451	1.969	0.0000
Vigor of tallest pinion pine	2.5	1.2	4	-0.987	0.899	> 0.2000
Dbh of tallest Arizona white oak	25.6	12.9	74	1.889	4.622	0.0000
% cover douglas-fir, 1-2 m	0.0011	0.0061	0.0345	5.365	27.133	0.0000
Height of tallest silverleaf oak	7.6	2.8	16	1.318	3.329	0.0000
% cover non-oak, non-coniferous shrubs	0.04	0.07	0.45	3.266	12.300	0.0000
Shrub Arizona white oak present	0.74	0.44	1	-1.126	-0.740	0.0000

Table 22. - *continued*

% cover alligator juniper, 1-2 m	0.02	0.03	0.21	2.758	9.645	0.0000

Table 23. Variables, parameters, and classification results of logistic regression model, used areas vs. available areas, pine-dominated areas only, Huachuca and Chiricahua mountains.

			Classification Results	
Variable	Coefficient	R	group	% correct
Slope	-0.0380	-0.0501	used	78.81
% cover oak, 0-1 m	-0.4607	-0.1394	available	87.58
No. of apache and chihuahua pines, 50-60 cm dbh	0.3111	0.1839	overall	83.87
No. of trees, 20-30 cm dbh	0.1046	0.0729		
No. of shrub species	0.2503	0.1274		
% cover alligator juniper, 1-2 m	0.8666	0.1447		
% cover oak, 5-10 m	-0.1375	-0.1170		
% cover apache and chihuahua pine, 2-5 m	0.3306	0.0972		
% cover forbs	0.1625	0.0688		
Height of tallest silverleaf oak	-0.1396	-0.1112		
% cover pinion pine, 2-5 m	0.9593	0.1686		
% cover non-oak non-coniferous shrubs, 1-2 m	-0.3779	-0.0727		
Vigor of tallest pinion pine	-0.4592	-0.0845		
No. of pinion pines	-0.7757	-0.1334		
No. of trees, 40-50 cm dbh	0.2423	0.0544		
No. of oak trees, 30-40 cm dbh	-0.5922	-0.0765		
Vigor of tallest white pine	0.4448	0.1247		
Shrub Arizona white oak present	-1.5644	-0.1507		
Shrub ash present	1.2313	0.0711		
Shrub apache pine present(1)	1.2473	0.1190		
Shrub Emory oak present(1)	1.9948	0.1868		
Shrub yucca present	2.1520	0.1910		

Table 23. - *continued*

Model Chi-Square = 167.325 (P = 0.0000)
Table 23. - *continued*

Goodness of Fit = 230.466

Table 24. Variables, parameters, and classification results of overall logistic regression model, areas used by buff-breasted flycatchers vs. available areas, pine-dominated sampling plots only, Huachuca and Chiricahua mountains, 1995-1996.

Variable	Coefficient	R	Classification Results group	% correct
Slope	-0.0512	-0.167	used	72.41%
% cover oak, 5-10 m	-0.1032	-0.089	available	71.58%
No. of apache and chihuahua pines, 30-40 cm dbh	0.2428	0.156	overall	71.98%
No. of oak trees, 10-20 cm dbh	-0.0524	-0.120		

Model Chi-Square = 47.753 (P = 0.0000)
Goodness of Fit = 176.479

Table 25. Variables, parameters, and classification results of canyon-specific logistic regression models, buff-breasted flycatcher nest sites vs. used areas.

			Classification Results	
Variable	Coefficient	R	group	% correct
Cave Creek Canyon, Chiricahua Mountains, 1996				
No. of oak trees, 10-20 cm dbh	-3.5752	a	nests	100.00
Shrub pinion pine present	39.5228		used	100.00
			overall	100.00
Model Chi-Square = 13.496 (P = 0.0012)				
Goodness of Fit = 0.000				
Pinery Canyon, Chiricahua Mountains, 1996.				
Height of tallest chihuahua pine	0.529	0.054	nests	57.14
Shrub silverleaf oak present	10.6346	0.000	used	100.00
Shrub Arizona white oak present	7.4599	0.000	overall	86.36
Shrub squawbush present	5.3395	0.000		
Model Chi-Square = 14.467 (P = 0.0059)				
Goodness of Fit = 11.739				
Rucker Canyon, Chiricahua Mountains, 1996.				
% cover oak, 0-1 m	3.5622	0.285	nests	100.00
No. apache and chihuahua pines, 10-20 cm dbh	0.3282	0.237	used	91.67
			overall	94.12

Table 25. - *continued*

Model Chi-Square = 9.685 (P = 0.0079)
Goodness of Fit = 15.791)

West Turkey Creek, Chiricahua Mountains, 1996.

% cover douglas-fir, 1-2 m	99.9281	0.000	nests	100.00
% cover forbs	-21.6402	0.000	used	88.89
Shrub silktassel present	-82.8895	0.000	overall	93.10
Shrub douglas-fir present	33.8649	0.000		
Shrub sycamore present	43.9736	0.000		

Model Chi-Square = 31.904 (P = 0.0000)
Goodness of Fit = 5.000

Carr Canyon, Huachuca Mountains, 1995.

% cover apache and chihuahua pine, 5-10 m	35.3340	0.000	nests	93.33
No. of apache and chihuahua pines, 50-60 cm dbh	30.5806	0.000	used	100.00
% cover oak, 0-1 m	7.5606	0.000	overall	97.62
% cover small dead branch, 0-1 m	-111.537	0.000		
Height of tallest alligator juniper	-46.6425	0.000		

Model Chi-Square = 51.975 (P = 0.0000)
Goodness of Fit = 2.000

Table 25. - *continued*

Sawmill Canyon, Huachuca Mountains, 1995.

% cover apache and chihuahua pine, 5-10 m	-3.6186	-0.052	nests	81.25
No. of apache and chihuahua pines, 50-60 cm dbh	-17.8133	0.000	used	95.24
No. apache and chihuahua pines, 10-20 cm dbh	4.5735	0.049	overall	91.38
No. of apache and chihuahua pines, 20-30 cm dbh	5.8665	0.000		
% cover oak, 2-5 m	-7.2900	0.000		
% cover small dead branch, 1-2 m	-10.1344	0.000		
% cover alligator juniper, 5-10 m	2.4399	0.083		
% cover apache pine, >10 m	2.5771	0.008		
Shrub manzanita present	-14.4102	0.000		

Model Chi-Square = 54.292 (P = 0.0000)
Goodness of Fit = 11.631

Scotia Canyon, Huachuca Mountains, 1995.

% cover apache and chihuahua pine, 2-5 m	9.4457	0.000	nests	100.00
			used	88.89
			overall	90.91

Model Chi-Square = 7.658 (P = 0.0057)
Goodness of Fit = 2.000

Sunnyside Canyon, Huachuca Mountains, 1995.

No. of apache and chihuahua pines, 50-60 cm dbh	0.4140	0.224	nests	62.50
No. apache and chihuahua pines, 10-20 cm dbh	0.5112	0.078	used	95.83

Table 25. - *continued*

% cover small dead branch, 0-1 m	-1.2053	0.000	overall	87.50

Model Chi-Square = 20.308 (P = 0.0001)
Goodness of Fit = 14.225

[a] This coefficient not computed when a perfect fit is achieved

Table 26. Variables, parameters, and classification results of logistic regression model, buff-breasted flycatcher nest sites vs. used areas, Huachuca Mountains, 1995.

			Classification Results	
Variable	Coefficient	R	group	% correct
% cover apache and chihuahua pine, 0-1 m	-1.3539	-0.174	nests	68.29
No. of apache and chihuahua pines, 50-60 cm dbh	0.1624	0.229	used	92.16
No. apache and chihuahua pines, 10-20 cm dbh	0.4160	0.268	overall	85.31
% cover forbs	0.3181	0.128		
% cover small dead branch, 0-1 m	-1.0392	-0.183		
% cover small dead branch, 2-5 m	0.5133	0.087		
% cover medium dead branch, 0-1 m	-1.9105	-0.130		
Dbh of tallest apache pine	0.0241	0.071		
Shrub Arizona grape present	10.8236	0.000		

Model Chi-Square = 69.435 (P = 0.0000)
Goodness of Fit = 131.817

Table 27. Variables, parameters, and classification results of logistic regression model, buff-breasted flycatcher nest sites vs. used areas, Chiricahua Mountains, 1996.

			Classification Results	
Variable	Coefficient	R	group	% correct
Vigor of tallest Arizona white oak	19.2288	0.147	nests	96.15
No. of shrub species	-7.8680	-0.167	used	96.30
% cover alligator juniper, 1-2 m	18.5296	-0.123	overall	96.25
% cover leaf litter	2.7742	0.158		
No. of oak trees, 10-20 cm dbh	-2.5700	-0.187		
Vigor of tallest netleaf oak	-12.6834	0.000		
Dbh of tallest sycamore	0.7355	0.159		
% cover small dead branch, 0-1 m	-27.5052	-0.130		
No. of white pines	-34.3687	-0.143		
Shrub silktassel present	-5.8035	0.000		
Shrub pinion pine present	19.3897	0.147		

Model Chi-Square = 90.334 (P = 0.0000)
Goodness of Fit = 10.351

Table 28. Variables, parameters, and classification results of logistic regression model, buff-breasted flycatcher nest sites vs. used areas, Huachuca and Chiricahua mountains, 1995-1996.

Variable	Coefficient	R	Classification Results group	% correct
No. of oak trees, 10-20 cm dbh	-2.5700	-0.187	nests	96.15
No. of white pines	-34.3687	-0.143	used	96.30
% cover leaf litter	2.7742	0.158	overall	96.25
% cover small dead branch, 0-1 m	-27.5052	-0.130		
Vigor of tallest Arizona white oak	19.2288	0.147		
% cover alligator juniper, 1-2 m	-18.5296	-0.123		
Vigor of tallest netleaf oak	-12.6834	0.000		
Dbh of tallest sycamore	0.7355	0.159		

Model Chi-Square = 90.334 (P = 0.0000)
Goodness of Fit = 10.351

Table 29. Variables chosen in canyon-specific and mountain range-specific logistic regression models of buff-breasted flycatcher nest sites vs. used areas, and no. of models in which they were chosen, Huachuca and Chiricahua mountains, 1995-1996.

variable	no. of models
% cover small dead branch, 0-1 m (-)	5
No. of apache and chihuahua pines, 50-60 cm dbh	4
No. apache and chihuahua pines, 10-20 cm dbh	4
No. of oak trees, 10-20 cm dbh (-)	3
Shrub pinion pine present	2
% cover leaf litter	2
Vigor of tallest netleaf oak (-)	2
Dbh of tallest sycamore	2
No. of white pines (-)	2
% cover oak, 0-1 m	2
Shrub silktassel present (-)	2
Height of tallest chihuahua pine	1
Shrub silverleaf oak present	1
Shrub Arizona white oak present	1
Shrub squawbush present	1
% cover douglas-fir, 1-2 m	1
% cover forbs (-)	1
% cover forbs	1
Shrub douglas-fir present	1
Shrub sycamore present	1
% cover apache and chihuahua pine, 5-10 m (-)	1
% cover apache and chihuahua pine, 5-10 m	1
Height of tallest alligator juniper	1
No. of apache and chihuahua pines, 20-30 cm dbh	1
% cover oak, 2-5 m	1
% cover small dead branch, 1-2 m	1
% cover alligator juniper, 5-10 m	1
% cover apache pine, >10 m	1
Shrub manzanita present (-)	1
% cover apache and chihuahua pine, 2-5 m	1
% cover small dead branch, 2-5 m	1
% cover medium dead branch, 0-1 m (-)	1
Dbh of tallest apache pine	1
Shrub Arizona grape present	1
Vigor of tallest Arizona white oak	1
No. of shrub species (-)	1

Table 29. - *continued*

% cover alligator juniper, 1-2 m	1
% cover alligator juniper, 1-2 m (-)	1

Table 30. Variables, parameters, and classification results of overall logistic regression model, buff-breasted flycatcher nest sites vs. used areas, Huachuca and Chiricahua mountains, 1995-1996.

Variable	Coefficient	R	Classification Results	
			group	% correct
No. of oak trees, 10-20 cm dbh	-0.0483	-0.062	nests	29.85%
No. apache and chihuahua pines, 10-20 cm dbh	0.1332	0.177	used	91.03%
% cover apache and chihuahua pine, >10 m	0.0892	0.181	overall	72.65%
No. of shrub species	-0.1519	-0.142		

Model Chi-Square = 34.077 (P = 0.0000)
Goodness of Fit = 209.115

Table 31. Descriptive statistics of variables used to build logistic regression models of buff-breasted flycatcher habitat: values for nest sites, Huachuca and Chiricahua mountains, 1995-1996.

variable	mean	standard deviation	range	skewness	kurtosis	significance of Lilliefors
No. of oak trees, 10-20 cm dbh	4.5	5.3	22	1.476	1.648	0.0000
No. of apache and chihuahua pines, 10-20 cm dbh	4.5	4.8	20	1.314	1.424	0.0001
% cover small dead branch, 0-1 m	0.0088	0.0219	0.1380	3.741	18.162	0.0000
Vigor of tallest Arizona white oak	3.2	1.0	5	-1.641	4.096	0.0003
% cover alligator juniper, 1-2 m	0.0088	0.0184	0.0690	2.040	3.385	0.0000
% cover leaf litter	0.83	0.15	0.72	-1.732	4.183	0.0099
Dbh of tallest sycamore	64.0	25.0	73	-0.109	-1.462	>0.2000
No. of white pines	2.5	2.1	7	2.226	5.744	0.0083
% cover apache and chihuahua pine, >10 m	0.34	0.19	0.83	-0.096	-0.410	>0.2000
Shrub pinion pine present	0.51	0.50	1	-0.030	-2.061	0.0000
Height of tallest chihuahua pine	14.9	2.2	12	0.833	1.541	0.0010
% cover oak, 0-1 m	0.03	0.04	0.21	1.812	4.015	0.0000
No. of shrub species	6.4	3.1	16	0.471	0.916	0.0176
Shrub pinion pine present	0.51	0.50	1	-0.030	-2.061	0.0000
% cover apache and chihuahua pine, 5-10 m	0.25	0.16	0.72	0.769	0.947	0.0252
% cover alligator juniper, 5-10 m	0.09	0.13	0.65	2.248	6.029	0.0000
% cover apache and chihuahua pine, 0-1 m	0.0051	0.0150	0.07	3.062	9.166	0.0000
% cover forbs	0.04	0.06	0.31	2.846	8.913	0.0000
% cover small dead branch, 2-5 m	0.01	0.03	0.14	2.620	8.165	0.0000
% cover medium dead branch, 0-1 m	0.10	0.31	1	2.645	5.152	0.0000
Dbh of tallest apache pine	50.8	18.7	113	1.576	5.570	0.0422

Table 32. Variables, parameters, and classification results of logistic regression model, successful vs. unsuccessful used areas, Huachuca and Chiricahua mountains.

Variable	Coefficient	R	Classification Results group	% correct
Vigor of tallest apache pine	1.1664	0.1827	successful	88.89
% cover leaf litter	0.5294	0.2890	unsuccessful	77.78
No. of oak trees, 10-20 cm dbh	-0.2116	-0.1501	overall	85.19
% cover small dead branch, 1-2 m	-2.7068	-0.2898		
Shrub pinion pine present	12.6735	0.0000		
Shrub chihuahua pine present	-16.2564	0.0000		

Model Chi-Square = 41.685 (P = 0.0000)
Goodness of Fit = 24.489

Table 33. Variables, parameters, and classification results of overall logistic regression model, areas used by buff-breasted flycatchers that bred successfully vs. areas used by unsuccessfully breeding buff-breasted flycatchers, Huachuca and Chiricahua mountains, 1995-1996.

Variable	Coefficient	R	Classification Results	
			group	% correct
Shrub chihuahua pine present	-1.3863	-0.255	successful	72.22%
			unsuccessful	60.61%
			overall	66.67%

Model Chi-Square = 15.370 (P = 0.0001)
Goodness of Fit = 138.000

Table 34. Variables, parameters, and classification results of logistic regression model, successful nest sites vs. unsuccessful nest sites, Huachuca and Chiricahua mountains.

Variable	Coefficient	R	Classification Results group	% correct
% cover silverleaf oak, 1-2 m	-1.3790	-0.1507	successful	66.67
% total live cover, 0-1 m	0.1337	0.1591	unsuccessful	82.50
No. of shrub species	0.2578	0.1170	overall	76.12
Shrub apache pine present(1)	-1.1677	-0.0843		
Shrub Gambel's oak present	-10.6210	0.0000		

Model Chi-Square = 31.211 (P = 0.0000)
Goodness of Fit = 58.668

Table 35. Variables, parameters, and classification results of overall logistic regression model, successful vs. unsuccessful buff-breasted flycatcher nest sites, Huachuca and Chiricahua mountains, 1995-1996.

Variable	Coefficient	R	Classification Results group	% correct
% total live cover, 0-1 m	0.1035	0.122	successful	51.85%
No. of shrub species	0.2769	0.228	unsuccessful	85.00%
			overall	71.64%

Model Chi-Square = 14.376 (P = 0.0008)
Goodness of Fit = 72.427

Table 36. Descriptive statistics of variables used to build logistic regression models of successful buff-breasted flycatcher nest sites vs. unsuccessful nest sites, successful cases only, Huachuca and Chiricahua mountains, 1995-1996.

variable	mean	standard deviation	range	skewness	kurtosis	significance of Lilliefors
% cover silverleaf oak, 1-2 m	0.0051	0.0125	0.03	2.099	2.594	0.0100
% total live cover, 0-1 m	0.41	0.19	0.76	0.396	-0.109	>0.2000
No. of shrub species	7.8	3.3	16	0.064	1.210	>0.2000
Shrub apache pine present	0.55	0.51	1	-0.237	-2.106	0.0000

Table 37. Descriptive statistics of variables used to build logistic regression models of successful buff-breasted flycatcher nest sites vs. unsuccessful nest sites, unsuccessful cases only, Huachuca and Chiricahua mountains, 1995-1996.

variable	mean	standard deviation	range	skewness	kurtosis	significance of Lilliefors
% cover silverleaf oak, 1-2 m	0.03	0.05	0.21	1.911	3.685	0.0000
% total live cover, 0-1 m	0.30	0.16	0.62	0.202	-0.504	>0.2000
No. of shrub species	5.4	2.6	14	0.585	1.980	>0.2000
Shrub apache pine present	0.20	0.40	1	1.559	0.450	0.0000
Shrub Gambel's oak present	0.05	0.22	1	4.292	17.285	0.0000

Table 38. Results of multiple regression of habitat variables on reproductive success rank in areas used by buff-breasted flycatchers, Huachuca and Chiricahua mountains, 1995-1996.

Variable	B	SE B	Beta	T	Sig T
Distance to opening	.006539	.001579	.326815	4.141	.0001
Vigor of tallest Arizona white oak	-.327078	.071840	-.358478	-4.553	.0000
% cover douglas-fir, 1-2 m	2.699887	.827299	.247698	3.263	.0015
Shrub manzanita present	.972739	.296027	.258540	3.286	.0014
Shrub douglas-fir present	1.104542	.275716	.343444	4.006	.0001
Slope position	-1.984091	.521840	-.324532	-3.802	.0002
Shrub apache pine present	-1.011267	.246780	-.349843	-4.098	.0001
No. of apache and chihuahua pines, 10-20 cm dbh	.085523	.029717	.223650	2.878	.0048

Multiple R	.64852
R Square	.42058
Adjusted R Square	.37644
Standard Error	1.13500

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	8	98.18422	12.27303
Residual	105	135.26315	1.28822

F = 9.52712 Signif F = .0000

Table 38. - *continued*

Correlation matrix

	DTO	QZVIG	PMP2	SHAP	SHPM	SLPO	SHPE	PINET1
RANK	0.328	-0.253	0.160	0.052	0.262	-0.047	-0.084	0.157

Figure 1. Percent cover pine, used vs. available areas

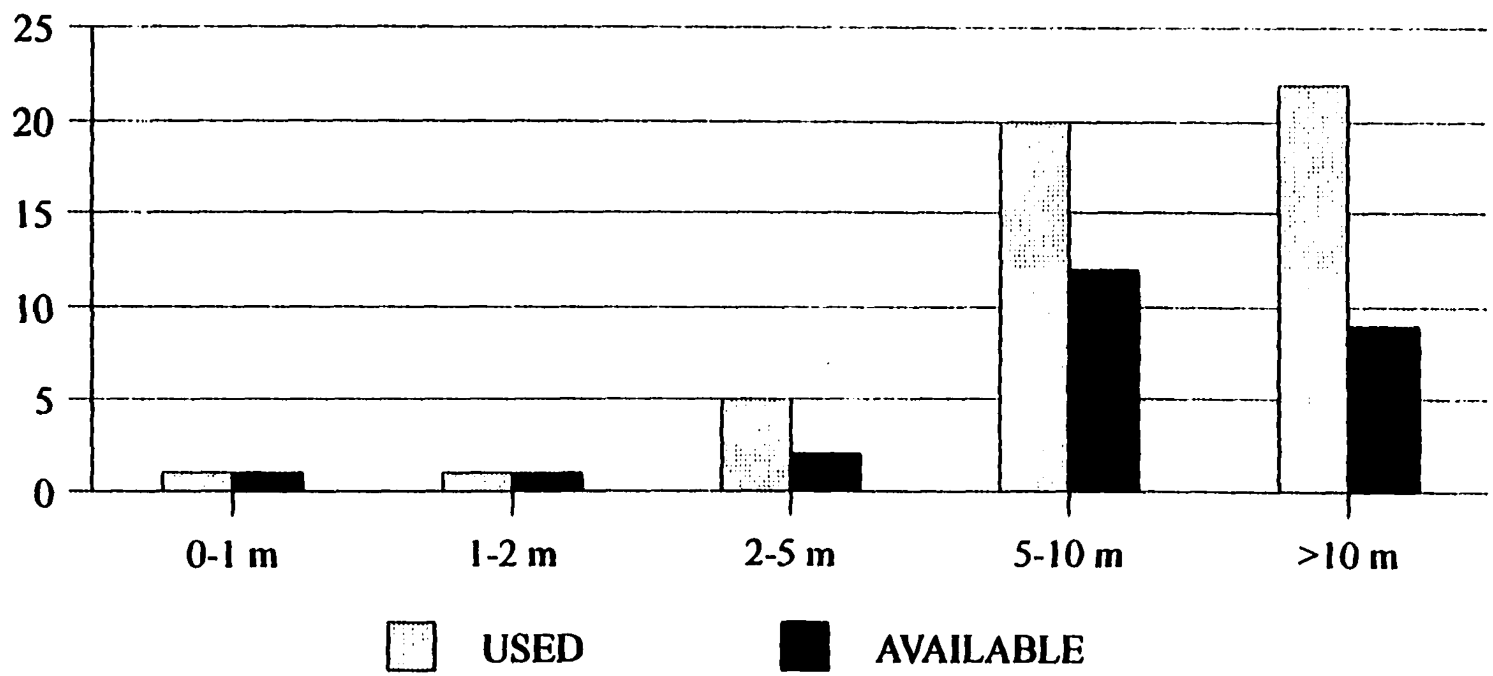


Figure 2. Percent cover oak, used vs. available areas

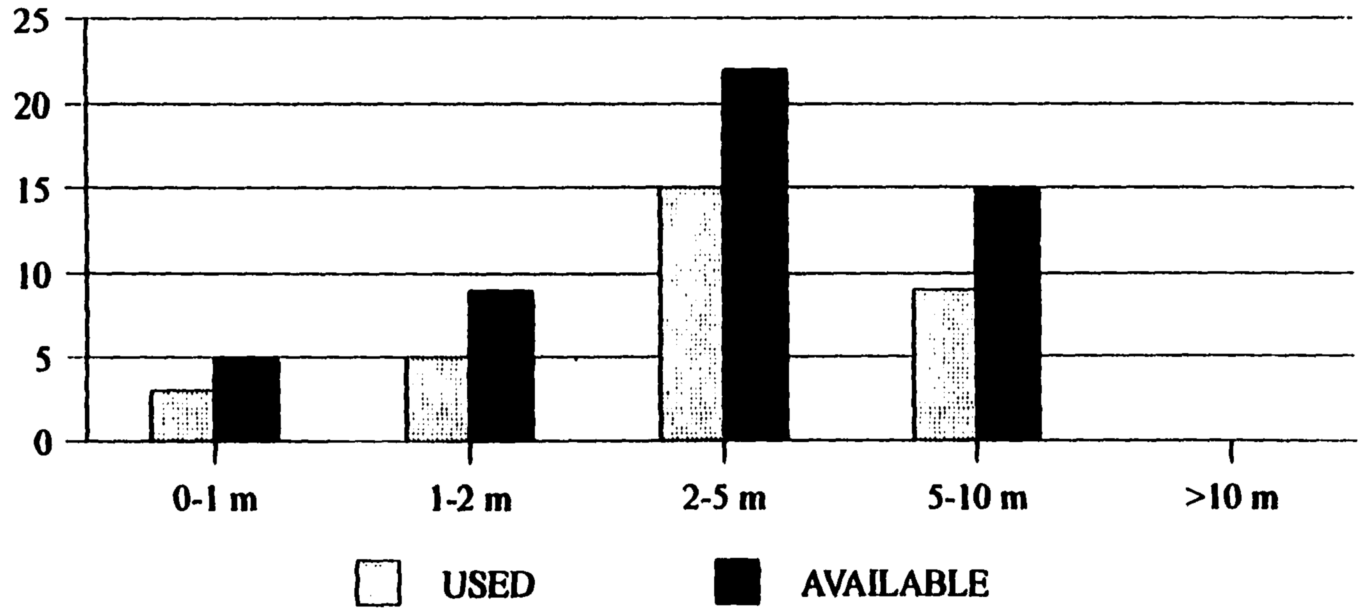
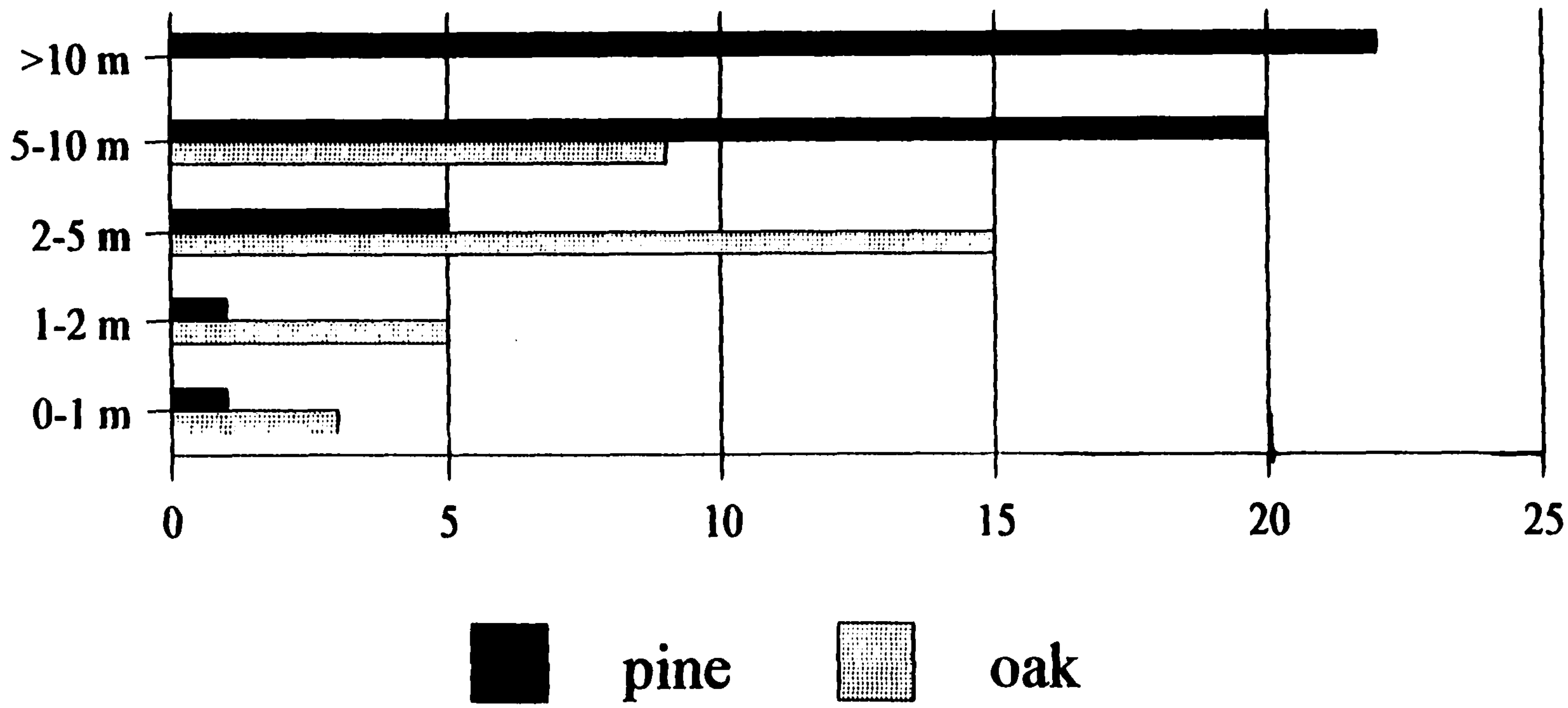


Figure 3. Percent pine and oak cover in areas used by buff-breasted flycatchers



Appendix A. List of variables measured on buff-breasted flycatcher nest sites, used areas, and available areas in the Huachuca and Chiricahua mountains, 1995-1996.

DTR: distance to the primary riparian area in the canyon.
DTO: distance to an area > .04 ha without vegetation exceeding 10 m in height.
SLO: slope.
SLPO: slope position.
ELEV: elevation
ASP: aspect

The following variables were measured only at nest sites:

NTS: nest tree species.
NTH: nest tree height.
NTDBH: nest tree dbh.
NH: nest height.
NDTR: nest distance from trunk.
NDRTR: nest direction from trunk.
NDEF: distance from the nest to the distal ends of the branches of the nest tree.
NDUV: distance from the rim of the nest up to the closest vegetation.
NDSB: diameter of branch supporting the nest.

The following variables (with a capital "P" for the third letter) represent point-intercept data. The data are entered as the number of "hits" in 29 vertical point-intercept lines in the 15-m radius circle.

AAP1: Arbutus arizonica, 0-1 m
AAP2: Arbutus arizonica, 1-2 m
AAP3: Arbutus arizonica, 2-5 m
AAP4: Arbutus arizonica, 5-10 m
AAP5: Arbutus arizonica, >10 m
APP1: Arctostaphylos pungens, 0-1 m
APP2: Arctostaphylos pungens, 1-2 m
AVP1: Agave parryi, 0-1 m
BEP1: Nolina microcarpa, 0-1 m
CBP1: Cercocarpus betuloides, 0-1 m
CBP2: Cercocarpus betuloides, 1-2 m
CBP3: Cercocarpus betuloides, 2-5 m
CBP4: Cercocarpus betuloides, 5-10 m
CFP1: Ceanothus fendleri, 0-1 m
DFP1: dead forb, 0-1 m
DTP1: dead tree, 0-1 m

Appendix A. - *continued*

DTP2: dead tree, 1-2 m
DPT3: dead tree, 2-5 m
DPT4: dead tree, 5-10 m
DTP5: dead tree, > 10 m
FCP1: Populus fremontii, 0-1 m
FCP2: Populus fremontii, 1-2 m
FCP3: Populus fremontii, 2-5 m
FPC4: Populus fremontii, 5-10 m
FCP5: Populus fremontii, > 10 m
FOP1: forb, 0-1 m
FSP1: Fraxinus velutina, 0-1 m
FSP2: Fraxinus velutina, 1-2 m
FSP3: Fraxinus velutina, 2-5 m
FSP4: Fraxinus velutina, 5-10 m
FSP5: Fraxinus velutina, > 10 m
GDP1: bare ground
GRP1: grass, 0-1 m
GWP1: Garrya wrightii, 0-1 m
GWP2: Garrya wrightii, 1-2 m
GWP3: Garrya wrightii, 2-5 m
JDP1: Juniperus deppeana, 0-1 m
JDP2: Juniperus deppeana, 1-2 m
JDP3: Juniperus deppeana, 2-5 m
JDP4: Juniperus deppeana, 5-10 m
JDP5: Juniperus deppeana, > 10 m
JMP1: Juglans major, 0-1 m
JMP2: Juglans major, 1-2 m
JMP3: Juglans major, 2-5 m
JMP4: Juglans major, 5-10 m
LLP1: leaf litter
PCP1: Pinus cembroides, 0-1 m
PCP2: Pinus cembroides, 1-2 m
PCP3: Pinus cembroides, 2-5 m
PCP4: Pinus cembroides, 5-10 m
PCP5: Pinus cembroides, > 10 m
PEP1: Pinus englemanii, 0-1 m
PEP2: Pinus englemanii, 1-2 m
PEP3: Pinus englemanii, 2-5 m
PEP4: Pinus englemanii, 5-10 m
PEP5: Pinus englemanii, > 10 m

Appendix A. - *continued*

PLP1: Pinus leiophyllus, 0-1 m
PLP2: Pinus leiophyllus, 1-2 m
PLP3: Pinus leiophyllus, 2-5 m
PLP4: Pinus leiophyllus, 5-10 m
PLP5: Pinus leiophyllus, > 10 m
PMP1: Pseudotsuga mensiesii, 0-1 m
PMP2: Pseudotsuga mensiesii, 1--2 m
PMP3: Pseudotsuga mensiesii, 2-5 m
PMP4: Pseudotsuga mensiesii, 5-10 m
PMP5: Pseudotsuga mensiesii, > 10 m
PSP1: Pinus strobiformis, 0-1 m
PSP2: Pinus strobiformis, 1-2 m
PSP3: Pinus strobiformis, 2-5 m
PSP4: Pinus strobiformis, 5-10 m
PSP5: Pinus strobiformis, > 10 m
PVP1: Prunus virginiana, 0-1 m
PVP2: Prunus virginiana, 1-2 m
PVP3: Prunus virginiana, 2-5 m
PVP4: Prunus virginiana, 5-10 m
QEP1: Quercus emoryi, 0-1 m
QEP2: Quercus emoryi, 1-2 m
QEP3: Quercus emoryi, 2-5 m
QEP4: Quercus emoryi, 5-10 m
QEP5: Quercus emoryi, > 10 m
QGP1: Quercus gambeli, 0-1 m
QGP2: Quercus gambeli, 1-2 m
QGP3: Quercus gambeli, 2-5 m
QGP4: Quercus gambeli, 5-10 m
QGP5: Quercus gambeli, > 10 m
QHP1: Quercus hypoleucoides, 0-1 m
QHP2: Quercus hypoleucoides, 1-2 m
QHP3: Quercus hypoleucoides, 2-5 m
QHP4: Quercus hypoleucoides, 5-10 m
QHP5: Quercus hypoleucoides, > 10 m
QRP1: Quercus reticulata, 0-1 m
QRP2: Quercus reticulata, 1-2 m
QRP3: Quercus reticulata, 2-5 m
QRP4: Quercus reticulata, > 10 m
QZP1: Quercus arizonica, 0-1 m
QZP2: Quercus arizonica, 1-2 m

Appendix A. - *continued*

QZP3: Quercus arizonica, 2-5 m
QZP4: Quercus arizonica, 5-10 m
QZP5: Quercus arizonica, > 10 m
TRP1: Rhus radicans, 0-1 m
RMP1: Rubus neomexicana, 0-1 m
RMP2: Rubus neomexicana, 1-2 m
RNP1: Robinia neomexicana, 0-1 m
RNP2: Robinia neomexicana, 1-2 m
RNP3: Robinia neomexicana, 2-5 m
RNP4: Robinia neomexicana, 5-10 m
ROP1: rock
RTP1: Rhus trilobata, 0-1 m
RTP2: Rhus trilobata, 1-2 m
RVP1: Rhus choriophylla, 0-1 m
RVP2: Rhus choriophylla, 1-2 m
SOP1: Dasylirion wheeleri, 1-2 m
VAP1: Vitis arizonica, 0-1 m
VAP2: Vitis arizonica, 1-2 m
VAP3: Vitis arizonica, 1-5 m
VAP4: Vitis arizonica, 5-10 m
YUP1: Yucca schottii, 0-1 m
YUP2: Yucca schottii, 1-2 m
WAP1: water
SAP1: Salix sp., 0-1 m
SAP2: Salix sp., 1-2 m
SAP3: Salix sp., 2-5 m
RBP1: Rhamnus californica, 0-1 m
RBP2: Rhamnus californica, 1-2 m
SDB1: small (< 2 cm diameter) dead branch, 0-1 m
SDB2: small (< 2 cm diameter) dead branch, 1-2 m
SDB3: small (< 2 cm diameter) dead branch, 2-5 m
SDB4: small (< 2 cm diameter) dead branch, 5-10 m
MDB1: medium (2-10 cm diameter) dead branch, 0-1 m
MDB2: medium (2-10 cm diameter) dead branch, 1-2 m
MDB3: medium (2-10 cm diameter) dead branch, 2-5 m
MDB4: medium (2-10 cm diameter) dead branch, 5-10 m
LDB1: large (> 10 cm diameter) dead branch, 0-1 m
LDB2: large (> 10 cm diameter) dead branch, 1-2 m
LDB3: large (> 10 cm diameter) dead branch, 2-5 m
LDB4: large (> 10 cm diameter) dead branch, 5-10 m

Appendix A. - *continued*

CAP1: Cupressus arizonica, 0-1 m
CAP2: Cupressus arizonica, 1-2 m
CAP3: Cupressus arizonica, 2-5 m
CAP4: Cupressus arizonica, 5-10 m
CAP5: Cupressus arizonica, > 10 m
OPP1: Opuntia sp., 0-1 m
PTP3: Populus tremuloides, 2-5 m
PWP1: Platanus wrightii, 0-1 m
PWP2: Platanus wrightii, 1-2 m
PWP3: Platanus wrightii, 2-5 m
PWP4: Platanus wrightii, 5-10 m
PWP5: Platanus wrightii, > 10 m
TOAK1: oak species in aggregate, 0-1 m
TOAK2: oak species in aggregate, 1-2 m
TOAK3: oak species in aggregate, 2-5 m
TOAK4: oak species in aggregate, 5-10 m
TOAK5: oak species in aggregate, > 10 m
TOAK: oak species in aggregate, all heights
TPINE1: Pinus englemanii and Pinus leiophyllus in aggregate, 0-1 m
TPINE2: Pinus englemanii and Pinus leiophyllus in aggregate, 1-2 m
TPINE3: Pinus englemanii and Pinus leiophyllus in aggregate, 2-5 m
TPINE4: Pinus englemanii and Pinus leiophyllus in aggregate, 5-10 m
TPINE5: Pinus englemanii and Pinus leiophyllus in aggregate, > 10 m
TPINE: Pinus englemanii and Pinus leiophyllus in aggregate, all heights
OTHDEC1: deciduous trees other than oaks, 0-1 m
OTHDEC2: deciduous trees other than oaks, 1-2 m
OTHDEC3: deciduous trees other than oaks, 2-5 m
OTHDEC4: deciduous trees other than oaks, 5-10 m
OTHDEC5: deciduous trees other than oaks, > 10 m
SHRUB1: any shrub, 0-1 m
SHRUB2: any shrub, 1-2 m
SHRUB3: any shrub, 2-5 m
SHRUB4: any shrub, 5-10 m
TLC1: total live cover, 0-1 m
TLC2: total live cover, 1-2 m
TLC3: total live cover, 2-5 m
TLC4: total live cover, 5-10 m
TLC5: total live cover, > 10 m
AAHGT: Arbutus arizonica, height of tallest specimen in plot
AADBH: Arbutus arizonica, dbh of tallest specimen in plot

Appendix A. - *continued*

AAVIG: Arbutus arizonica, vigor of tallest specimen in plot
AAT1: number of Arbutus arizonica 10-20 cm dbh
AAT2: number of Arbutus arizonica 20-30 cm dbh
AAT3: number of Arbutus arizonica 30-40 cm dbh
AAT4: number of Arbutus arizonica 40-50 cm dbh
AAT5: number of Arbutus arizonica 50-60 cm dbh
AATOT: number of Arbutus arizonica
CBHGT: Cercocarpus betuloides, height of tallest specimen in plot
CBDBH: Cercocarpus betuloides, dbh of tallest specimen in plot
CBT1: number of Cercocarpus betuloides 10-20 cm dbh
CBT2: number of Cercocarpus betuloides 20-30 cm dbh
CBTOT: number of Cercocarpus betuloides
DTHGT: dead tree, height of tallest specimen in plot
DTDBH: dead tree, dbh of tallest specimen in plot
AAVIG: dead tree, vigor of tallest specimen in plot
DTT1: number of dead trees, 10-20 cm dbh
DTT2: number of dead trees, 20-30 cm dbh
DTT3: number of dead trees, 30-40 cm dbh
DTT4: number of dead trees, 40-50 cm dbh
DTT5: number of dead trees, 50-60 cm dbh
DTT6: number of dead trees, > 61 cm dbh
DTTOT: number of dead trees
FSHGT: Fraxinus velutina, height of tallest specimen in plot
FSDBH :Fraxinus velutina, dbh of tallest specimen in plot
FSVIG: Fraxinus velutina, vigor of tallest specimen in plot
FST1: number of Fraxinus velutina, 10-20 cm dbh
FST2: number of Fraxinus velutina, 20-30 cm dbh
FST3: number of Fraxinus velutina, 30-40 cm dbh
FST4: number of Fraxinus velutina, 40-50 cm dbh
FST5: number of Fraxinus velutina, 50-60 cm dbh
FSTOT: number of Fraxinus velutina
JDHGT: Juniperus deppeana, height of tallest specimen in plot
JDDBH: Juniperus deppeana, dbh of tallest specimen in plot
JDVIG: Juniperus deppeana, vigor of tallest specimen in plot
JDT1: number of Juniperus deppeana, 10-20 cm dbh
JDT2: number of Juniperus deppeana, 20-30 cm dbh
JDT3: number of Juniperus deppeana, 30-40 cm dbh
JDT4: number of Juniperus deppeana, 40-50 cm dbh
JDT5: number of Juniperus deppeana, 50-60 cm dbh
JDT6: number of Juniperus deppeana, > 60 cm dbh

Appendix A. - *continued*

JDTOT: number of Juniperus deppeana
JMHGT: Juglans major, height of tallest specimen in plot
JMDBH: Juglans major, dbh of tallest specimen in plot
JMVIG: Juglans major, vigor of tallest specimen in plot
JMT1: number of Juglans major, 10-20 cm dbh
JMT2: number of Juglans major, 20-30 cm dbh
JMT3: number of Juglans major, 30-40 cm dbh
JMTOT: number of Juglans major
PCHGT: Pinus cembroides, height of tallest specimen in plot
PCDBH: Pinus cembroides, dbh of tallest specimen in plot
PCVIG: Pinus cembroides, vigor of tallest specimen in plot
PCT1: number of Pinus cembroides, 10-20 cm dbh
PCT2: number of Pinus cembroides, 20-30 cm dbh
PCT3: number of Pinus cembroides, 30-40 cm dbh
PCT5: number of Pinus cembroides, 40-50 cm dbh
PCTOT: number of Pinus cembroides
PEGHT: Pinus englemanii, height of tallest specimen in plot
PEDBH: Pinus englemanii, dbh of tallest specimen in plot
PEVIG: Pinus englemanii, vigor of tallest specimen in plot
PET1: number of Pinus englemanii, 10-20 cm dbh
PET2: number of Pinus englemanii, 20-30 cm dbh
PET3: number of Pinus englemanii, 30-40 cm dbh
PET4: number of Pinus englemanii, 40-50 cm dbh
PET5: number of Pinus englemanii, 50-60 cm dbh
PET6: number of Pinus englemanii, > 60 cm dbh
PETOT: number of Pinus englemanii
PLGHT: Pinus leiophyllus, height of tallest specimen in plot
PLDBH: Pinus leiophyllus, dbh of tallest specimen in plot
PLVIG: Pinus leiophyllus, vigor of tallest specimen in plot
PLT1: number of Pinus leiophyllus, 10-20 cm dbh
PLT2: number of Pinus leiophyllus, 20-30 cm dbh
PLT3: number of Pinus leiophyllus, 30-40 cm dbh
PLT4: number of Pinus leiophyllus, 40-50 cm dbh
PLT5: number of Pinus leiophyllus, 50-60 cm dbh
PLT6: number of Pinus leiophyllus, > 60 cm dbh
PLTOT: number of Pinus leiophyllus
PMHGT: Pseudotsuga mensiesii, height of tallest specimen in plot
PMDBH: Pseudotsuga mensiesii, dbh of tallest specimen in plot
PMVIG: Pseudotsuga mensiesii, vigor of tallest specimen in plot
PMT1: number of Pseudotsuga mensiesii, 10-20 cm dbh

Appendix A. - *continued*

PMT2: number of Pseudotsuga mensiesii, 20-30 cm dbh
PMT3: number of Pseudotsuga mensiesii, 30-40 cm dbh
PMT4: number of Pseudotsuga mensiesii, 40-50 cm dbh
PMT5: nu mber of Pseudotsuga mensiesii, 50-60 cm dbh
PMT6: number of Pseudotsuga mensiesii, > 60 cm dbh
PMTOT: number of Pseudotsuga mensiesii
PSHGT Pinus strobiformis:, height of tallest specimen in plot
PSDBH: Pinus strobiformis, dbh of tallest specimen in plot
PSVIG: Pinus strobiformis, vigor of tallest specimen in plot
PST1: number of Pinus strobiformis, 10-20 cm dbh
PST2: number of Pinus strobiformis, 20-30 cm dbh
PST3: number of Pinus strobiformis, 30-40 cm dbh
PST5: number of Pinus strobiformis, 40-50 cm dbh
PSTOT: number of Pinus strobiformis
PVHGT: Prunus virginiana, height of tallest specimen in plot
PVDBH: Prunus virginiana, dbh of tallest specimen in plot
PVVIG: Prunus virginiana, vigor of tallest specimen in plot
PVT1: number of Prunus virginiana, 10-20 cm dbh
PVT3: number of Prunus virginiana, 30-40 cm dbh
PVT5: number of Prunus virginiana, 50-60 cm dbh
PVTOT:number of Prunus virginiana
PWHGT: Platanus wrightii, height of tallest specimen in plot
PWDBH: Platanus wrightii, dbh of tallest specimen in plot
PWVIG: Platanus wrightii, vigor of tallest specimen in plot
PWT1: number of Platanus wrightii, 10-20 cm dbh
PWT2: number of Platanus wrightii, 20-30 cm dbh
PWT3: number of Platanus wrightii, 30-40 cm dbh
PWT4: number of Platanus wrightii, 40-50 cm dbh
PWT5: number of Platanus wrightii, 50-60 cm dbh
PWT6: number of Platanus wrightii, > 60 cm dbh
PWTOT: number of Platanus wrightii
QZHGT: Quercus arizonica, height of tallest specimen in plot
QZDBH: Quercus arizonica, dbh of tallest specimen in plot
QZVIG: Quercus arizonica, vigor of tallest specimen in plot
QZT1: number of Quercus arizonica, 10-20 cm dbh
QZT2: number of Quercus arizonica, 20-30 cm dbh
QZT3: number of Quercus arizonica, 30-40 cm dbh
QZT4: number of Quercus arizonica, 40-50 cm dbh
QZT5: number of Quercus arizonica, 50-60 cm dbh
QZT6: number of Quercus arizonica, > 60 cm dbh

Appendix A. - *continued*

QZTOT: number of Quercus arizonica
QEHGT: Quercus emoryi , height of tallest specimen in plot
QEDBH: Quercus emoryi, dbh of tallest specimen in plot
QEVIG: Quercus emoryi, vigor of tallest specimen in plot
QET1: number of Quercus emoryi, 10-20 cm dbh
QET2: number of Quercus emoryi, 20-30 cm dbh
QET3: number of Quercus emoryi, 30-40 cm dbh
QET4: number of Quercus emoryi, 40-50 cm dbh
QETOT: number of Quercus emoryi
QGHGT: Quercus gambeli, height of tallest specimen in plot
QGDBH: Quercus gambeli, dbh of tallest specimen in plot
QGVIG: Quercus gambeli, vigor of tallest specimen in plot
QGT1: number of Quercus gambeli, 10-20 cm dbh
QGT2: number of Quercus gambeli, 20-30 cm dbh
QGT3: number of Quercus gambeli, 30-40 cm dbh
QGT4: number of Quercus gambeli, 40-50 cm dbh
QGTOT: number of Quercus gambeli
QHHGT: Quercus hypoleucoides, height of tallest specimen in plot
QHDBH: Quercus hypoleucoides, dbh of tallest specimen in plot
QHVIG: Quercus hypoleucoides, vigor of tallest specimen in plot
QHT1: number of Quercus hypoleucoides, 10-20 cm dbh
QHT2: number of Quercus hypoleucoides, 20-30 cm dbh
QHT3: number of Quercus hypoleucoides, 30-40 cm dbh
QHT4: number of Quercus hypoleucoides, 40-50 cm dbh
QHT5: number of Quercus hypoleucoides, 50-60 cm dbh
QHTOT: number of Quercus hypoleucoides
QRHGT: Quercus reticulata, height of tallest specimen in plot
QRDBH: Quercus reticulata, dbh of tallest specimen in plot
QRVIG: Quercus reticulata, vigor of tallest specimen in plot
QRT1: number of Quercus reticulata, 10-20 cm dbh
QRT2: number of Quercus reticulata, 20-30 cm dbh
QRT3: number of Quercus reticulata, 30-40 cm dbh
QRT4: number of Quercus reticulata, 40-50 cm dbh
QRTOT: number of Quercus reticulata
DBH1T: total number of trees, 10-20 cm dbh
DBH2T: total number of trees, 20-30 cm dbh
DBH3T: total number of trees, 30-40 cm dbh
DBH4T: total number of trees, 40-50 cm dbh
DBH5T: total number of trees, 50-60 cm dbh
DBH6T: total number of trees, > 60 cm dbh

Appendix A. - *continued*

GRNDTOT: total number of trees
SHSPTOT: number of shrub species
SHAA: Arbutus arizonica, present as a shrub
SHAP: Arctostaphylos pungens, present as a shrub
SHAV: Agave parryi, present as a shrub
SHBL: Baccharis glutinosa, present as a shrub
SHCB: Cercocarpus betuloides, present as a shrub
SHCF: Ceanothus fendleri, present as a shrub
SHCT: Echinocactus sp., present as a shrub
SHFC: Populus fremontii, present as a shrub
SHFS: Fraxinus velutina, present as a shrub
SHGW: Garrya wrightii, present as a shrub
SHJD: Juniperus deppeana, present as a shrub
SHJM : Juglans major, present as a shrub
SHLO: Lonicera arizonica, present as a shrub
SHPC Pinus cembroides, present as a shrub
SHPE : Pinus englemanii, present as a shrub
SHPL : Pinus leiophyllus, present as a shrub
SHPM : Pseudotsuga mensiesii, present as a shrub
SHPS : Pinus strobiformis, present as a shrub
SHPV : Prunus virginiana, present as a shrub
SHPW : Platanus wrightii, present as a shrub
SHQE : Quercus emoryi, present as a shrub
SHQG : Quercus gambeli, present as a shrub
SHQH : Quercus hypoleucoides, present as a shrub
SHQR : Quercus reticulata, present as a shrub
SHQZ : Quercus arizonica, present as a shrub
SHRM : Rubus neomexicana, present as a shrub
SHRN : Robinia neomexicana, present as a shrub
SHRT : Rhus trilobata, present as a shrub
SHRV : Rhus choriophylla, present as a shrub
SHSA : Salix sp., present as a shrub
SHSO : Dasylirion wheeleri, present as a shrub
SHTR : Rhus radicans, present as a shrub
SHYU : Yucca schottii, present as a shrub
SHBE : Nolina microcarpa, present as a shrub
SHOP: Opuntia sp., present as a shrub
SHVA : Vitis arizonica, present as a shrub
SHMB: Mimosa biuncifera, present as a shrub
SHVC: Parthenocissus arizonica, present as a shrub

Appendix A. - *continued*

SHOL: unidentified leguminous shrub, present
SHRB: Rhamnus californica, present as a shrub
OAKT1: all oak tree species in aggregate, 10-20 cm dbh
OAKT2: all oak tree species in aggregate, 20-30 cm dbh
OAKT3: all oak tree species in aggregate, 30-40 cm dbh
OAKT4: all oak tree species in aggregate, 40-50 cm dbh
OAKT5: all oak tree species in aggregate, 50-60 cm dbh
OAKT6: all oak tree species in aggregate, > 60 cm dbh
OAKT: all oak tree species in aggregate
PINET1: Pinus englemanii and Pinus leiophyllus in aggregate, 10-20 cm dbh
PINET2: Pinus englemanii and Pinus leiophyllus in aggregate, 20-30 cm dbh
PINET3: Pinus englemanii and Pinus leiophyllus in aggregate, 30-40 cm dbh
PINET4: Pinus englemanii and Pinus leiophyllus in aggregate, 40-50 cm dbh
PINET5: Pinus englemanii and Pinus leiophyllus in aggregate, 50-60 cm dbh
PINET6: Pinus englemanii and Pinus leiophyllus in aggregate, > 60 cm dbh
PINET: Pinus englemanii and Pinus leiophyllus in aggregate

Appendix B. Summary of nesting attempts by pairs of buff-breasted flycatchers in the Huachuca and Chiricahua mountains, 1995-1996.

canyon	used area[a]	attempt no.	date found	last date active	outcome[b]	evidence of predation	contents[c]
Carr	2	1	05/19/95	05/19/95	F	N	
	2	2	05/24/95	05/30/95	F	N	
	2	3	06/14/95	06/24/95	F	Y	
	2	4	06/29/95	07/14/95	F	Y	
	2	5	07/09/95	07/02/95	F	Y	3E
	3	1	05/19/95	05/24/95	F	Y	
	3	2	06/14/95	06/09/95	F	Y	
	3	3	06/19/95	06/29/95	F	Y	
	4	1	05/19/95	05/24/95	F	Y	
	6	1	05/24/95	05/14/95	F	N	
	7	1	05/30/95	07/04/95	F	N	
	7	2	07/09/95	07/19/95	F	Y	
	8	1	06/24/95	06/29/95	F	Y	3E
	9	1	06/24/95	07/09/95	F	Y	4E
	10	1	07/09/95	07/14/95	F	Y	
Sawmill	2	1	05/11/95	06/17/95	S		
	3	1	05/29/95	06/02/95	F	Y	
	3	2	06/22/95	07/12/95	F	N	4E
	5	1	05/21/95	06/17/95	S		
	5	2	07/07/95	08/01/95	S		
	6	2	05/29/95	07/02/95	F	N	
	6	1	05/21/95	05/21/95	F	Y	
	6	3	07/02/95	07/17/95	F	N	3E

9 1 06/02/95 06/17/95 S

Appendix B. - *continued*

canyon	used area[a]	attempt no.	date found	last date active	outcome[b]	evidence of predation	contents[c]
	9	2	07/07/95	07/27/95	S		
	10	1	06/27/95	06/29/95	S		
	11	1	05/19/95	06/22/95	S		
	12	1	05/22/95	07/02/95	S		4E
	14	1	06/17/95	07/07/95	S		4E
	15	1	06/17/95	06/27/95	S		
	16	1	07/07/95	07/12/95	F	N	
Scotia	1	1	05/23/95	06/18/95	S		
	1	2	06/29/95	07/38/95	F	N	
Sunnyside	1	1	05/13/95	06/03/95	F	Y	
	1	2	06/07/95	07/13/95	S		3E
	3	1	05/15/95	05/15/95	F	Y	
	3	2	07/08/95	07/13/95	F	N	
	6	1	06/23/95	07/03/95	S		
	7	1	06/14/95	06/18/95	F	N	
	7	2	06/23/95	07/28/95	S		
	8	1	05/29/95	06/23/95	S		
	8	2[d]	07/08/95	08/12/95	S		
Cave Cr.	1	1	05/30/96	06/18/96	S		
	2	1	05/30/96	07/09/96	S		
	3	1	06/07/96	06/18/96	F	Y	
Pinery	1	1	05/23/96	05/29/96	F	Y	
	3	1	06/02/96	06/28/96	S		3N

4 1 05/29;96 06/02/96 F Y

Appendix B. - *continued*

canyon	used area[a]	attempt no.	date found	last date active	outcome[b]	evidence of predation	contents[c]
	4	2	07/09/96	07/24/96	F	N	
	5	1	05/29/96	06/02/96	F	Y	
	5	2	06/12/96	07/09/96	S		
	6	1	06/12/96	07/17/96	S		
Rucker	1	1	05/05/96	05/05/96	F	[e]	
	1	2	05/20/96	06/29/96	S		
	2	1	06/14/96	06/14/96	F	Y	
	2	2	06/09/96	07/16/96	S		
	3	1	06/04/96	07/04/96	U	N	
	4	1	06/08/96	07/25/96	S		
W Turkey	1	1	05/15/96	06/04/96	S		
	2	1	07/25/96	08/05/96	S		
	3	1	06/38/96	07/09/96	S		
	4	1	05/10/96	06/04/96	F	N	
	5	1	15/21`/96	05/21/96	F	N	
	5	2	06/09/96	06/14/96	F	N	
	5	3	06/20/96	06/20/96	F	N	
	5	4	07/09/96	07/28/96	S		
	6	1	06/04/96	06/04/96	F	N	
	6	2	07/09/96	07/09/96	U	N	
	7	1	07/12/96	07/12/96	F	Y	

Appendix B. - *continued*

[a] These used area numbers represent breeding pairs. Not all used areas were occupied by breeding pairs, hence used area numbers are not necessarily consecutive. [b] F= failed, S = successful fledging, U = unknown. [c] E = eggs, N = nestlings. [d] Same nest as previous attempt by same pair. [e] Nest tree cut down..

Appendix C. Characteristics of buff-breasted flycatcher nest sites.

	mean	SD	min.	max.
nest tree dbh (cm)	34.0	13.3	5	22
nest tree height (m)	12.8	3.5	5	22
nest height (m)	7.5	2.6	2	14
nest distance from trunk (m)	0.8	1.0	0.0	3.5
nest direction from trunk ( )	195	107	0	352
nest distance from edge of foliage (drip line) (m)	1.7	0.98	0.0	4.0
diameter of support branch (cm)	4.1	1.4	1.0	9.0
distance up to overhanging vegetation (cm)	11.2	23.2	1.0	150

Appendix D. Tree species in which buff-breasted flycatcher nests were located.

tree species	no. of nests
apache pine (Pinus englemannii)	27
chihuahua pine (Pinus leiophyllus)	33
alligator juniper (Juniperus deppeana)	7
arizona sycamore (Platanus wrightii)	1

Appendix E. List of vegetation types used in chararcterizing vegetation along buff-breasted flycatcher survey transects (after Brown, Lowe, and Pase, 1982), and criteria used in determining vegetation type.

MSCF: Madrean subalpine coniferous forest (1,121.5)(characterized by presence of Abies in conjunction with Pseudotsuga and Pinus).

MDFC: Madrean douglas-fir/mixed conifer forest (1,122.611)(characterized by coniferous tree species composition ≥ 30% Pseudotsuga)

MPF: Madrean montane pine forest (1,122.622)(characterized by Pinus englemannii-Pinus leiphyllus-dominated forest, with estimated <10 oaks/ha)

MPOF: Madrean pine-oak forest (1,122.624)(characterized by Pinus englemannii-Pinus leiphyllus-dominated forest with an understory of primarily Quercus spp.

MPJF: Madrean pine-juniper forest (1,122.625)(characterized by Pinus englemannii-Pinus leiphyllus-dominated forest with an understory of primarily Juniperus spp.

MOPW: Madrean oak-pine woodland (1,123.324)(characterized by presence of Pinus englemannii and/or Pinus leiphyllus at <10% cover, among a woodland composed primarily of Quercus spp).

MOW: Madrean oak woodland (1,123.311 or 1,123.315)(woodland dominated by Quercus spp).

MOYJ: Madrean oak-pinion-juniper woodland (1,123.316)(woodland of mixed Quercus spp., Pinus cembroides, and Juniperus deppeana).

OJW: Madrean oak-juniper woodland (1.123.318)(woodland of mixed Quercus spp. and Juniperus deppeana).

RCF: Relict cypress forest (1,123.521)(characterized by coniferous tree species composition ≥25% Cuppressus arizonica).

IMC: Interior manzanita chapparal (1,133.322)(non-forest vegetation dominated by Arctostaphylos pungens).

RDF: Riparian deciduous forest (1,223.222)(riparian forest dominated by Platanus wrightii, Populus fremontii, Fraxinus velutina, and/or Juglans major).

Appendix F. UTM coordinates and elevations of areas used by buff-breasted flycatchers. Huachuca (1995), Chiricahua, and Santa Catalina Mountains (1996), Arizona. UTM coordinates correspond with locations marked on maps in Appendix G.

Canyon	number	UTME	UTMN	elevation (m)
Carr	01	566.140	3477.060	2255
	02	566.360	3476.900	2248
	03	566.760	3476.680	2255
	04	566.700	3476.520	2316
	05	566.260	3477.040	2255
	06	566.740	3477.040	2248
	07	566.800	3476.980	2240
	08	567.320	3477.260	2187
	09	567.140	3477.300	2187
Sawmill	01	559.340	3479.750	1890
	02	559.340	3479.700	1890
	03	559.700	3479.440	1920
	04	559.580	3479.500	1890
	05	559.650	3479.450	1905
	06	559.680	3479.420	1912
	07	559.770	3479.310	1912
	08	559.340	3479.860	1890
	09	559.430	3479.560	1890
	10	560.000	3478.860	1920
	11	559.730	3479.250	1920
	12	559.370	3479.880	1890
	13	559.500	3479.390	1920
	14	562.020	3477.580	2469
	15	562.100	3478.000	2469
Scotia	01	557.080	3479.520	1829
	02	557.000	3479.060	1821
	03	557.380	3479.940	1844
Sunnyside	01	557.060	3478.220	1798
	02	557.120	3478.240	1798

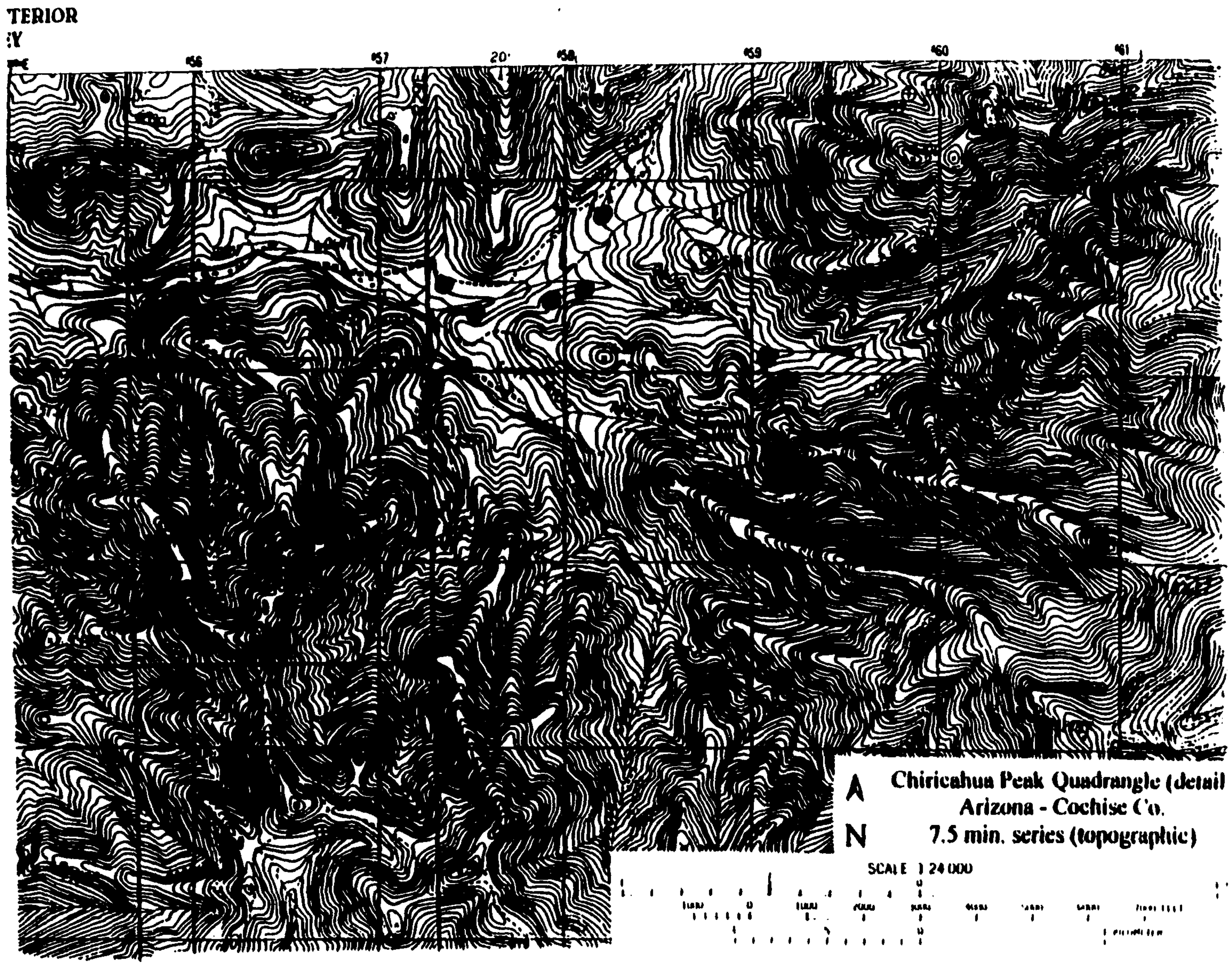
Appendix F. - *continued*

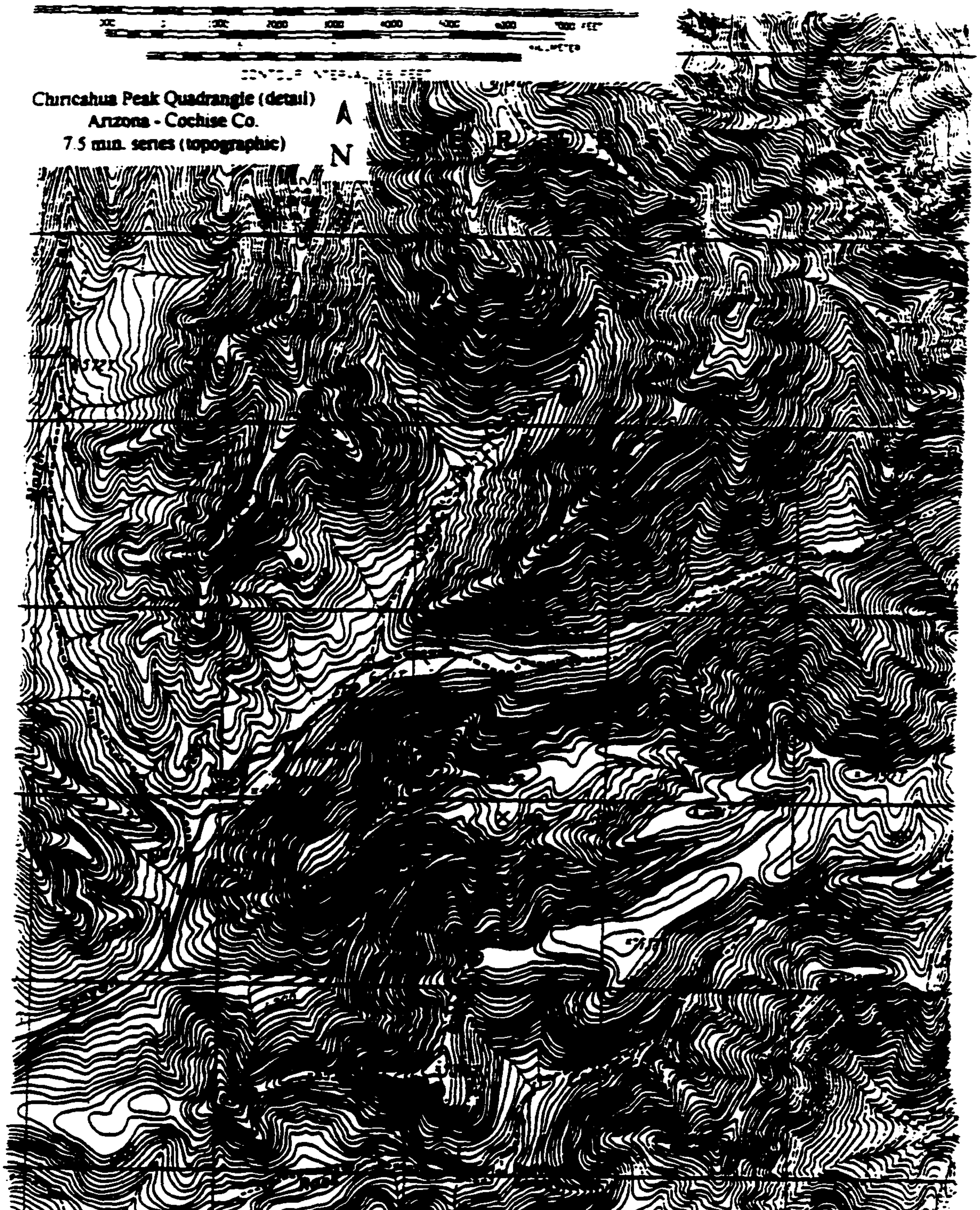
Canyon	number	UTME	UTMN	elevation (m)
	03	556.940	3478.040	1798
	04	556.920	3478.020	1798
	05	559.880	3477.440	2012
	06	560.020	3477.400	2012
	07	560.060	3477.360	2019
	08	559.780	3477.600	2019
Cave Cr.	01	668.6	3528.55	1670
	02	668.7	3528.5	1658
	03	669.25	3528.7	1658
Pinery	01	660.0	3535.7	1829
	03	660.65	3535.5	1841
	04	660.45	3535.6	1829
	05	660.25	3535.6	1829
	06	659.10	3537.3	1756
Rucker01		660.05	3517.0	1865
	02	659.9	3516.8	1829
	03	660.35	3517.2	1853
	04	659.8	3516.5	1829
West	01	657.4	3526.1	2220
Turkey	02	657.2	3526.1	2158
Cr.	03	658.1	3526.45	1926
	04	657.4	3526.3	1878
	05	657.9	3526.4	1938
	06	657.4	3526.5	2158
	07	659.1	3526.1	1951
	08	658.2	3526.8	1951
Red Rock		658.25	3515.2	1768
		659.8	3514.7	1841
		661.6	3515.3	1951

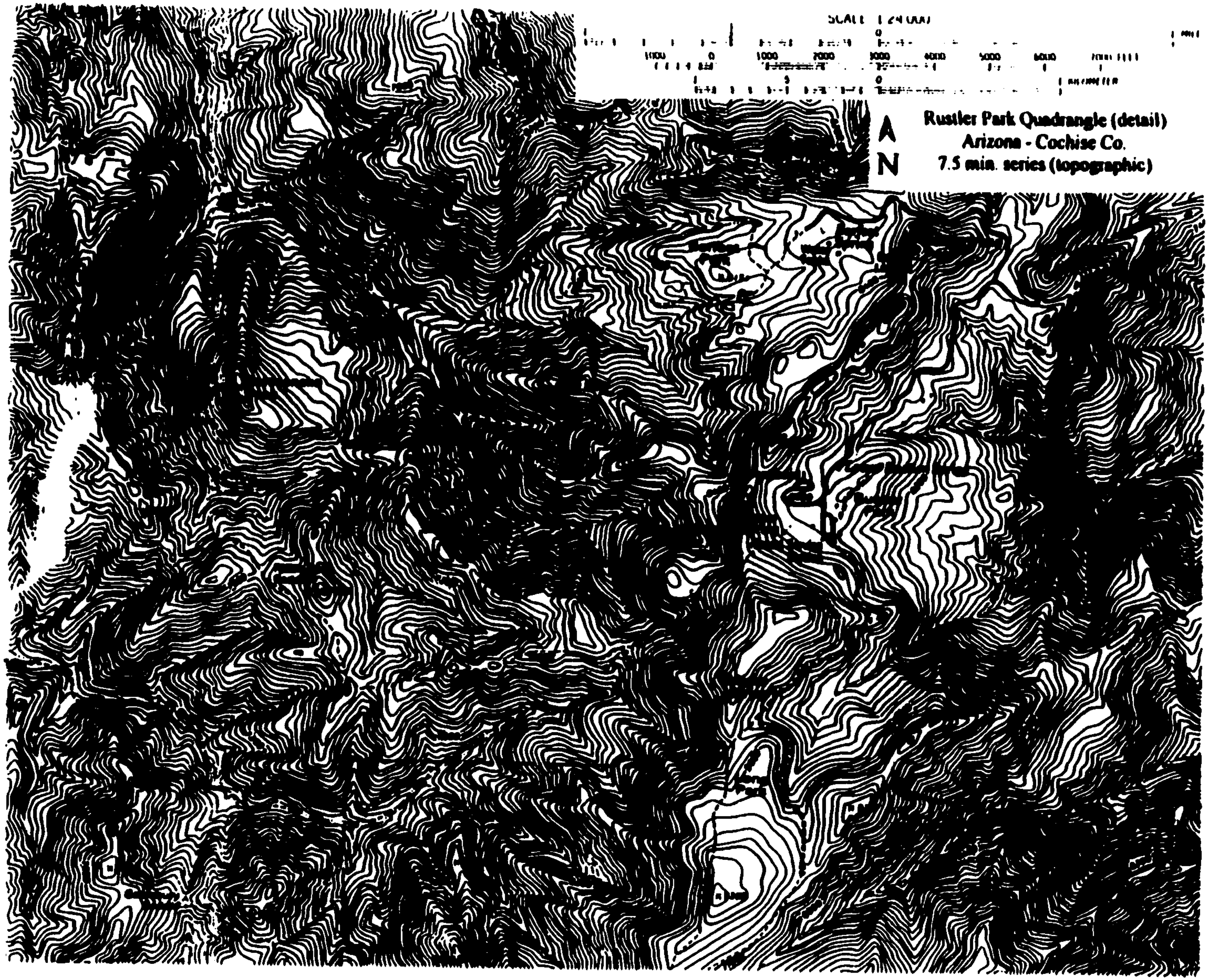
Appendix F. - continued

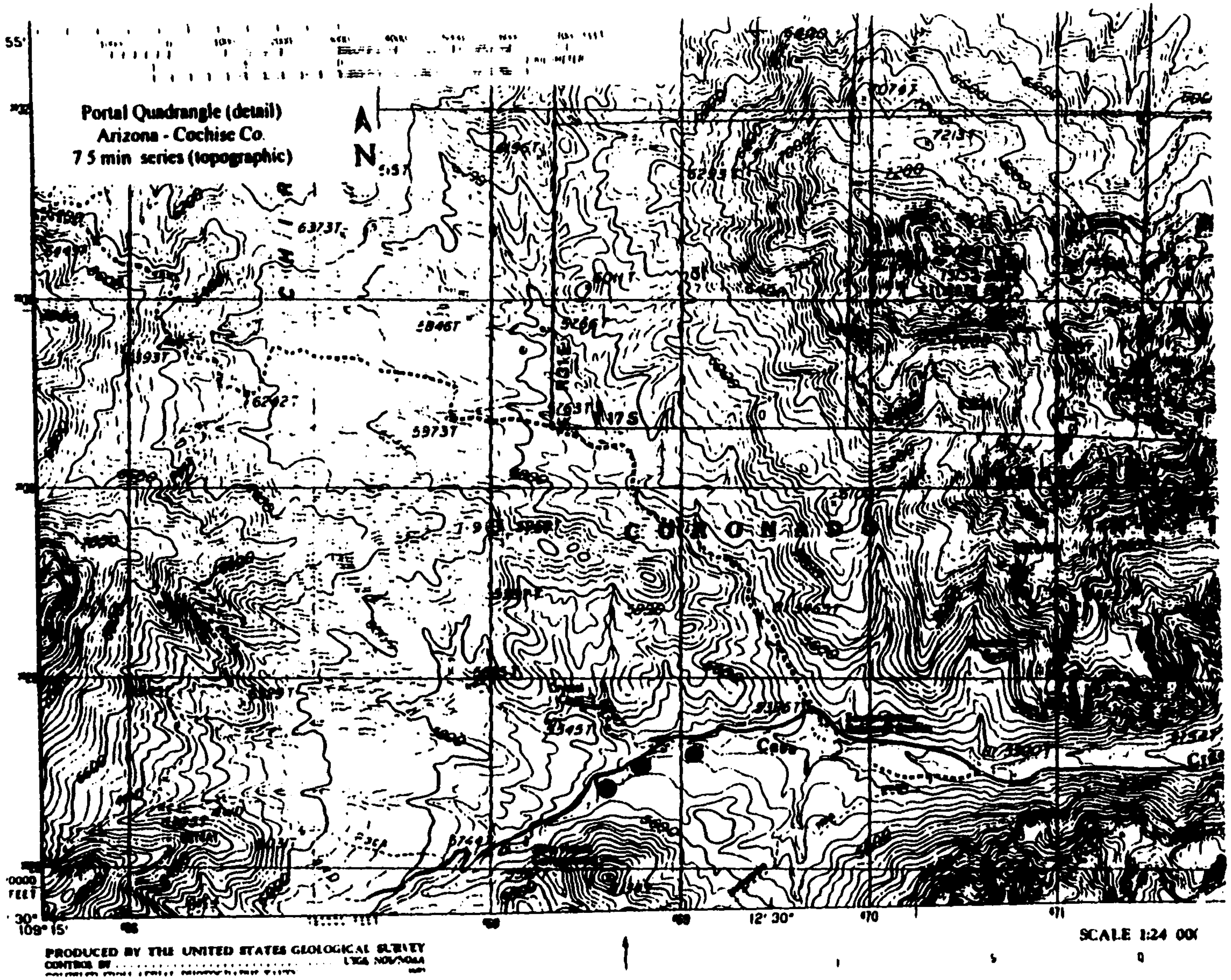
Bear	661.75	3519.2	2085
	662.1	3519.7	2268
Pine	659.6	3532.5	1987
Sycamore	527.0	3584.1	2134

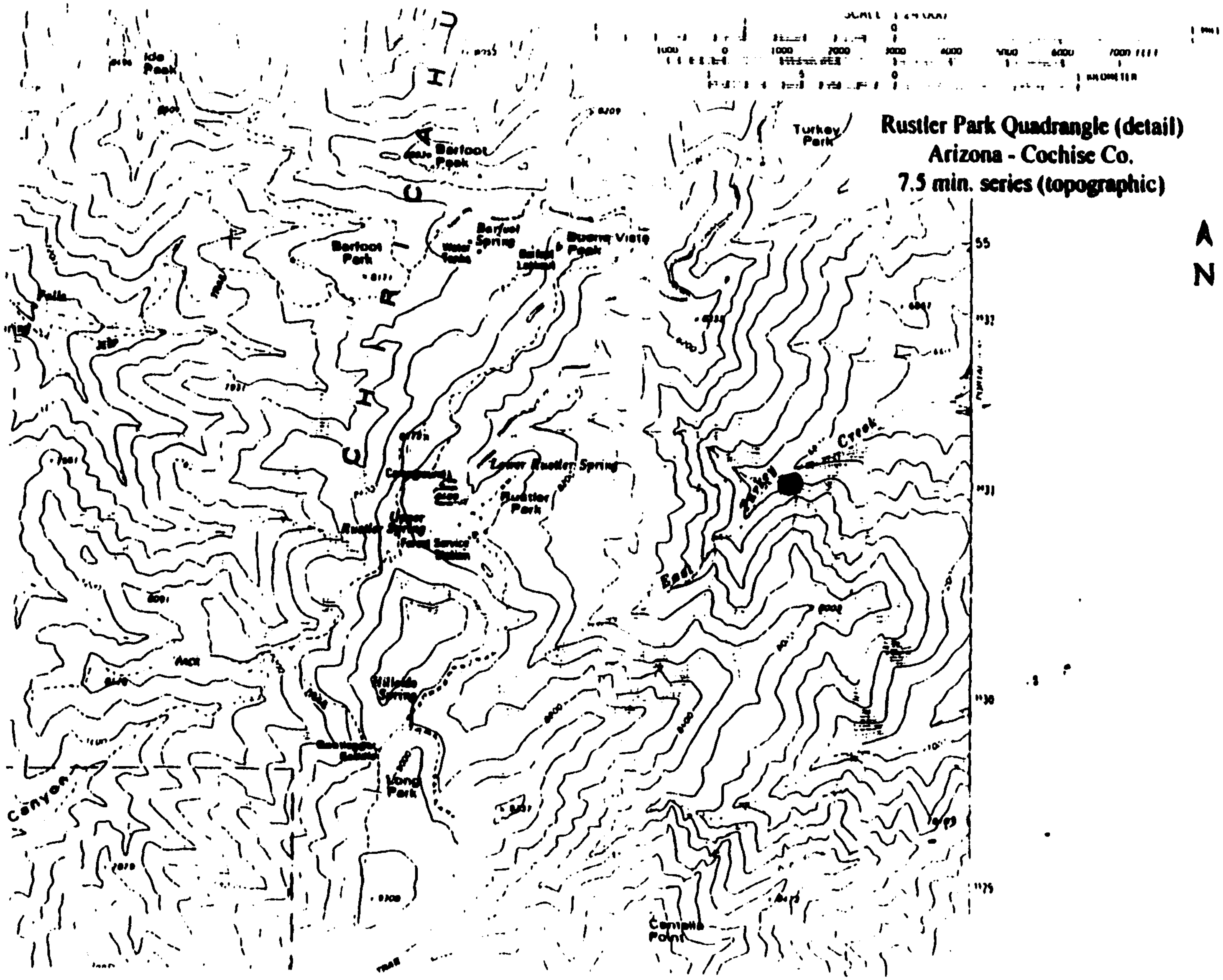
Appendix G. Maps depicting locations of buff-b reasted flycatchers found in 1995-1996.

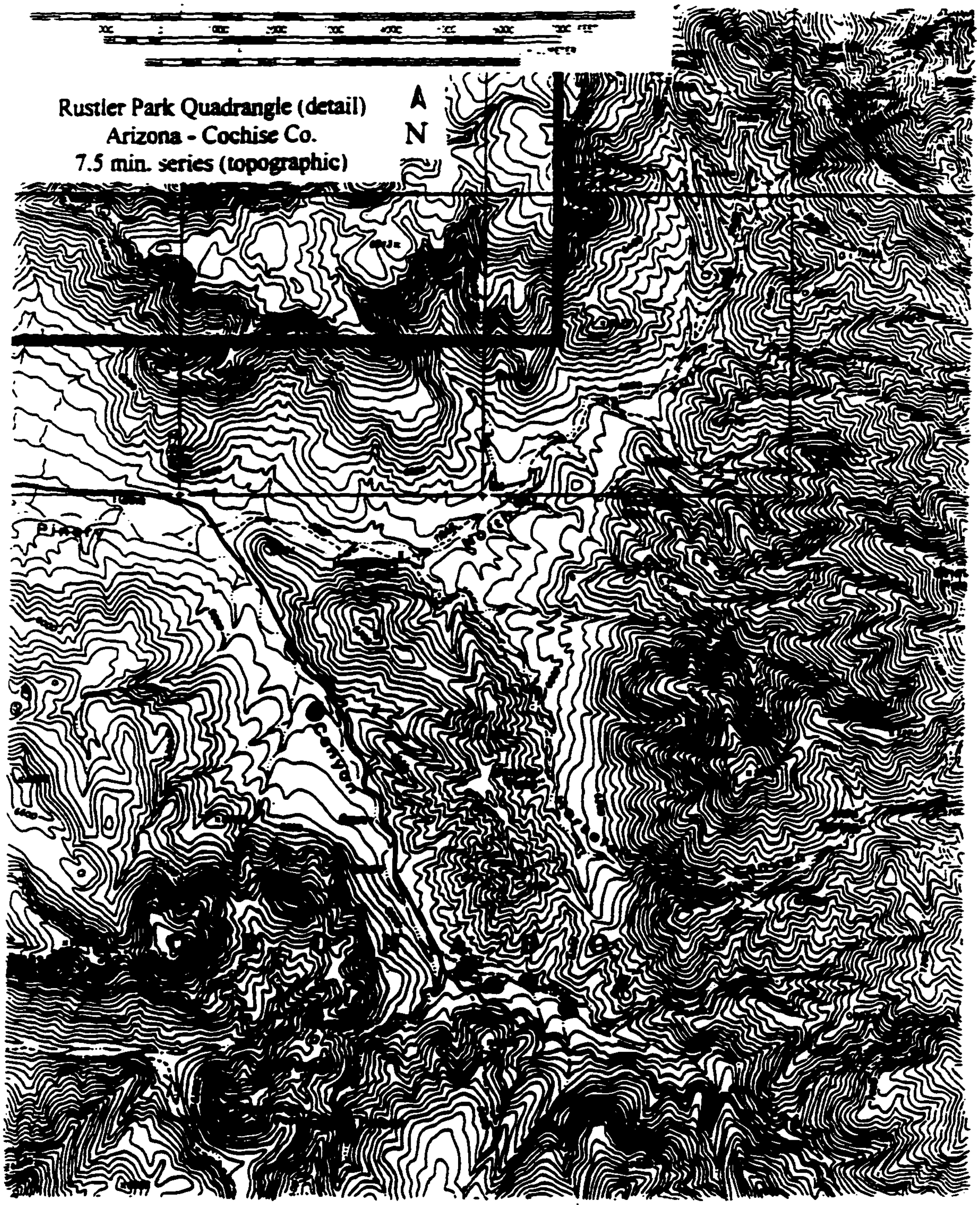

TERIOR
:Y
Chiricahua Peak Quadrangle (detail
Arizona - Cochise Co.
7.5 min. series (topographic)
SCALE 1:24 000

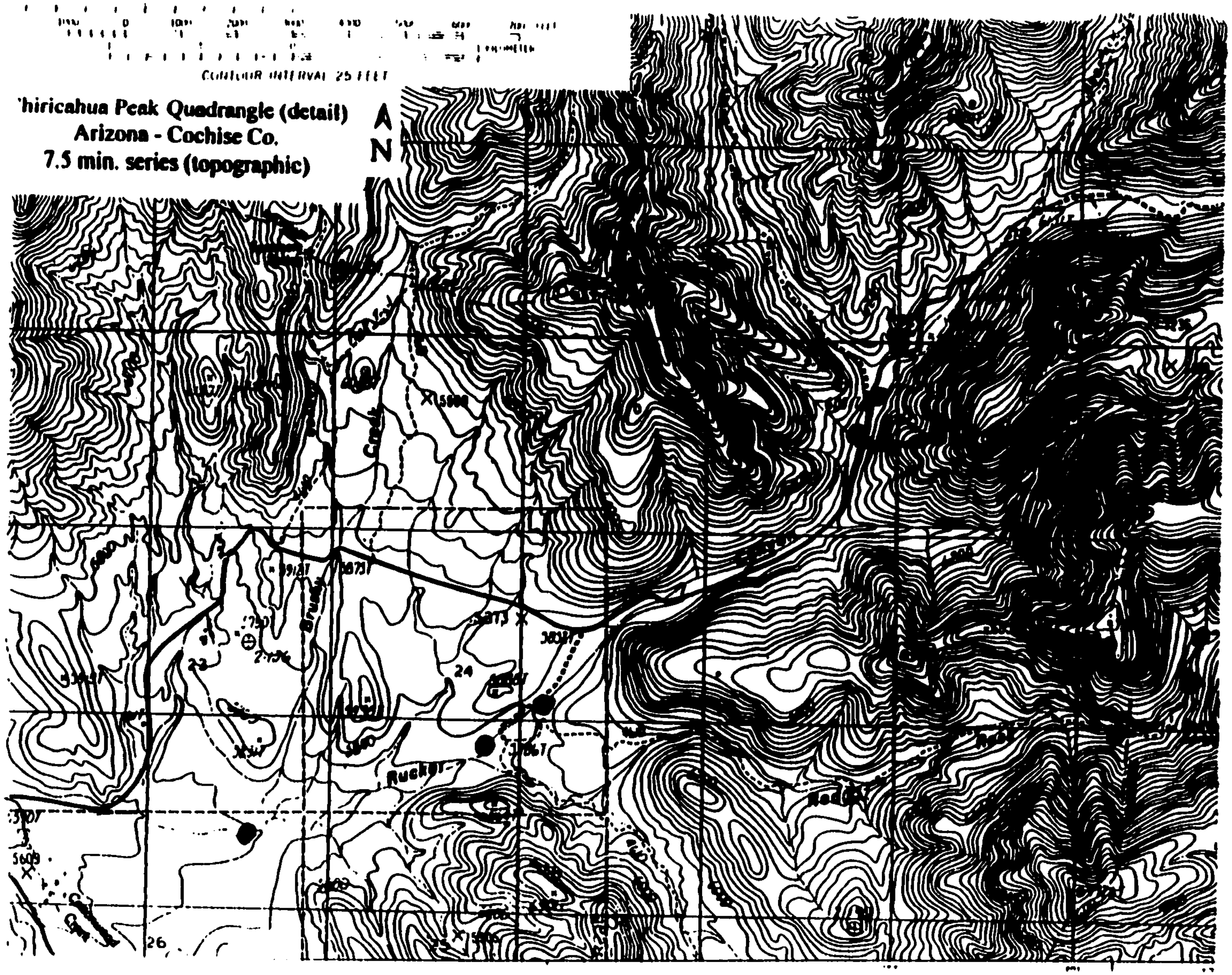

Chiricahua Peak Quadrangle (detail)
Arizona - Cochise Co.
7.5 min. series (topographic)
N

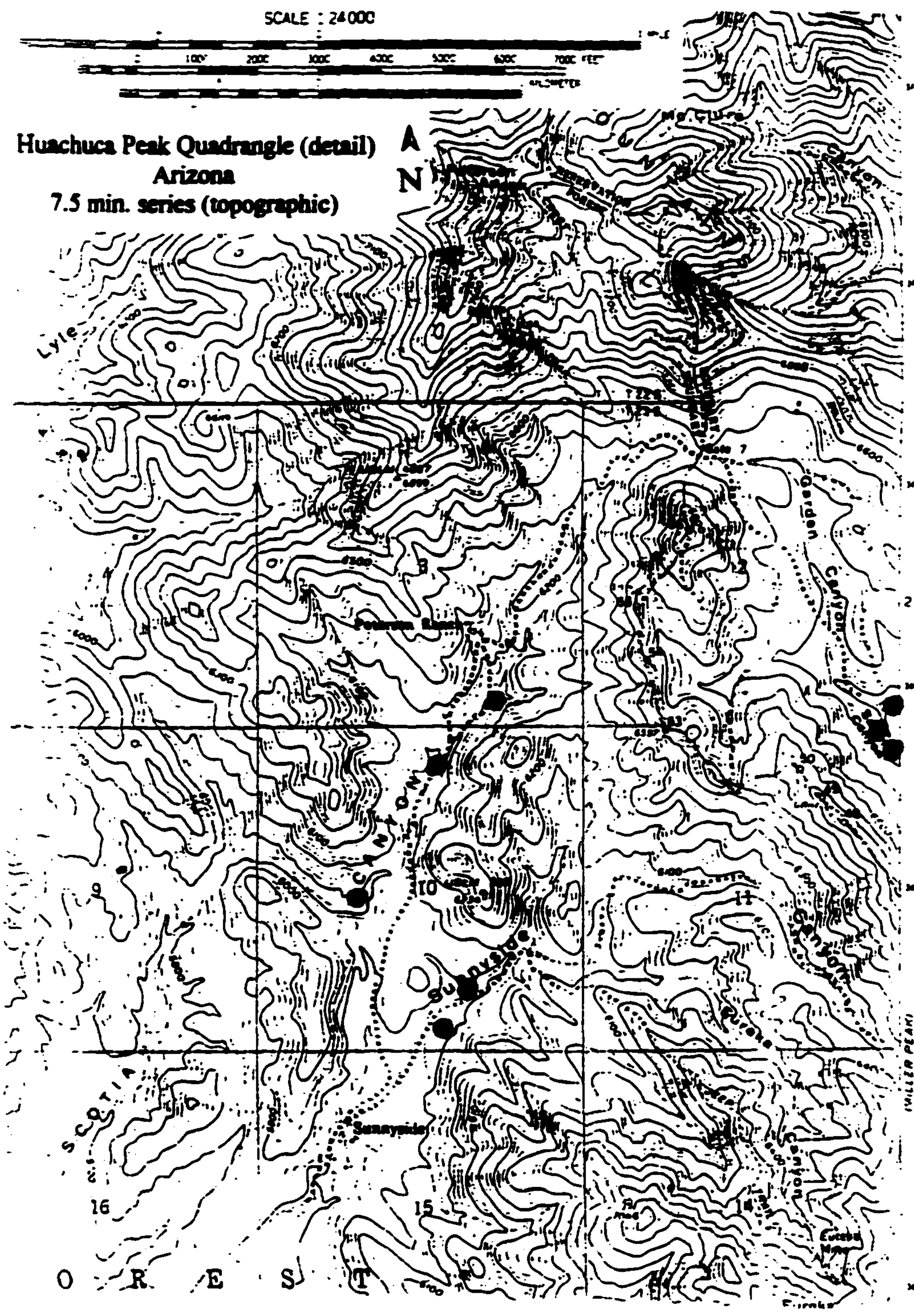

Rustler Park Quadrangle (detail)
Arizona - Cochise Co.
7.5 min. series (topographic)
N

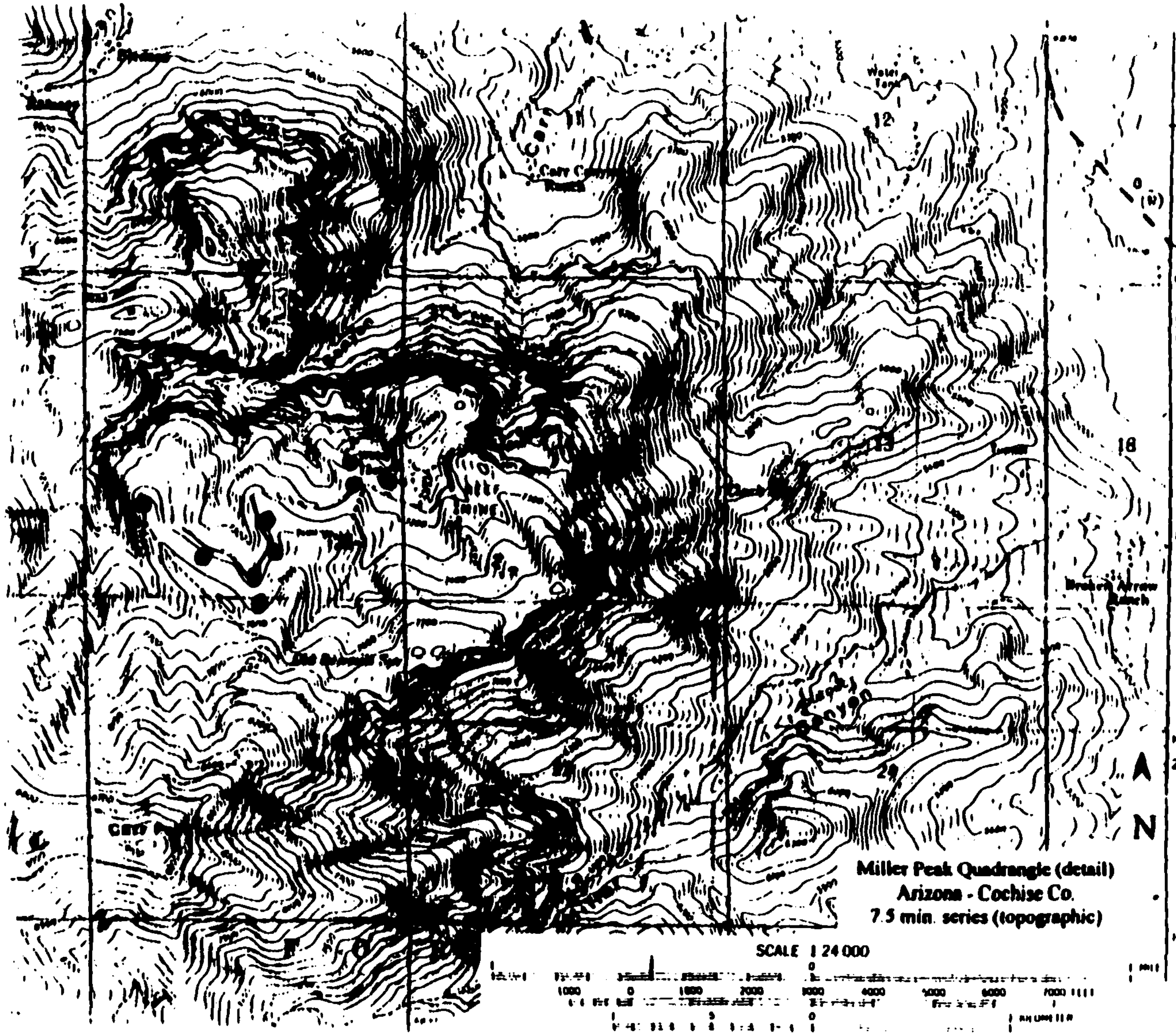

Portal Quadrangle (detail)
Arizona - Cochise Co.
7 5 min series (topographic)
N
55'
CORONADO
Cave
109° 15'
12' 30"
SCALE 1:24 00(
PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY


Rustler Park Quadrangle (detail)
Arizona - Cochise Co.
7.5 min. series (topographic)
N
Barfoot Peak
Barfoot Park
Barfoot Spring
Buena Vista Peak
Turkey Park
Lower Rustler Spring
Rustler Park
Upper Rustler Spring
Forest Service Station
Hillside Spring
Long Park
Creek
Canyon
Centella Point

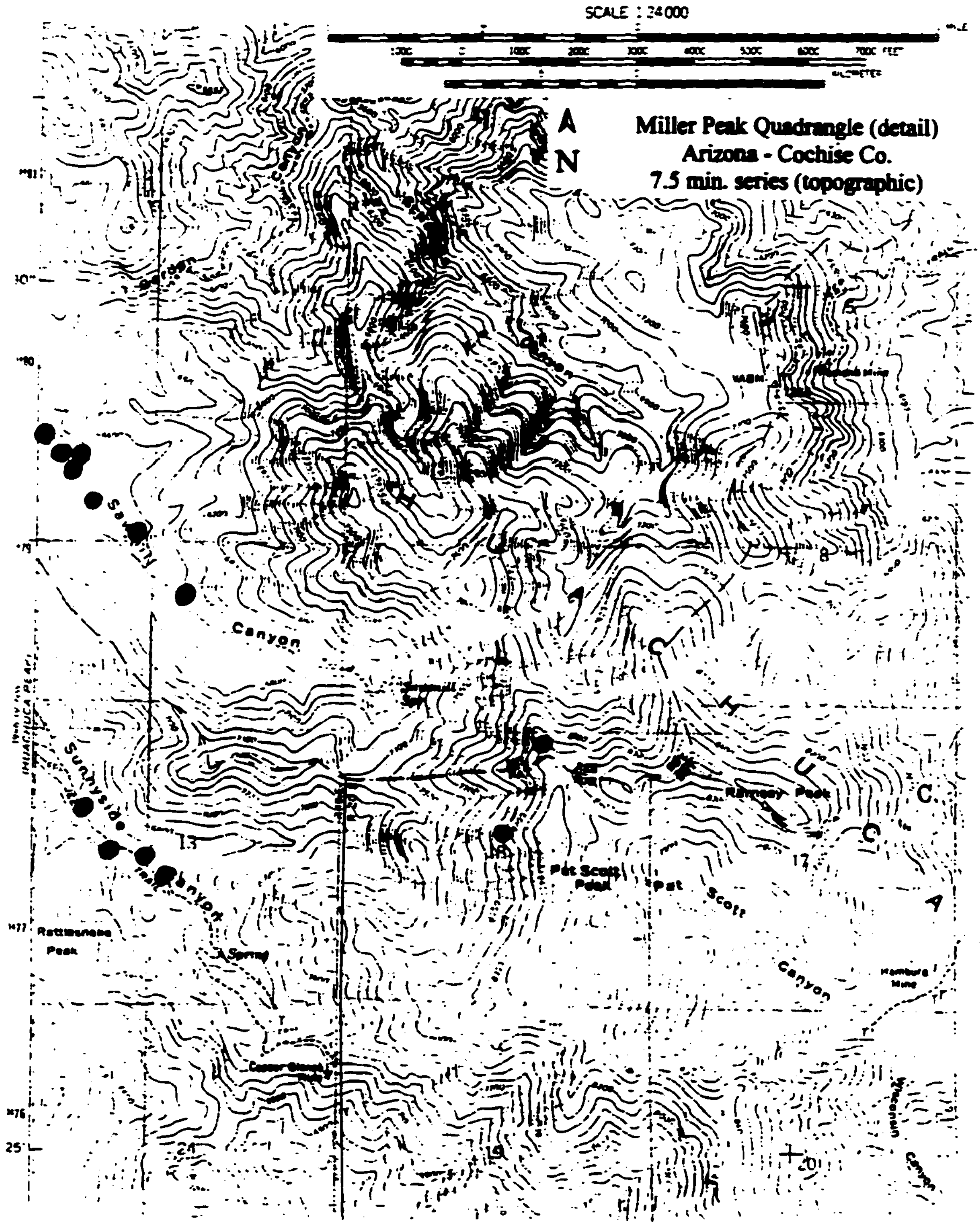

Rustler Park Quadrangle (detail)
Arizona - Cochise Co.
7.5 min. series (topographic)
N

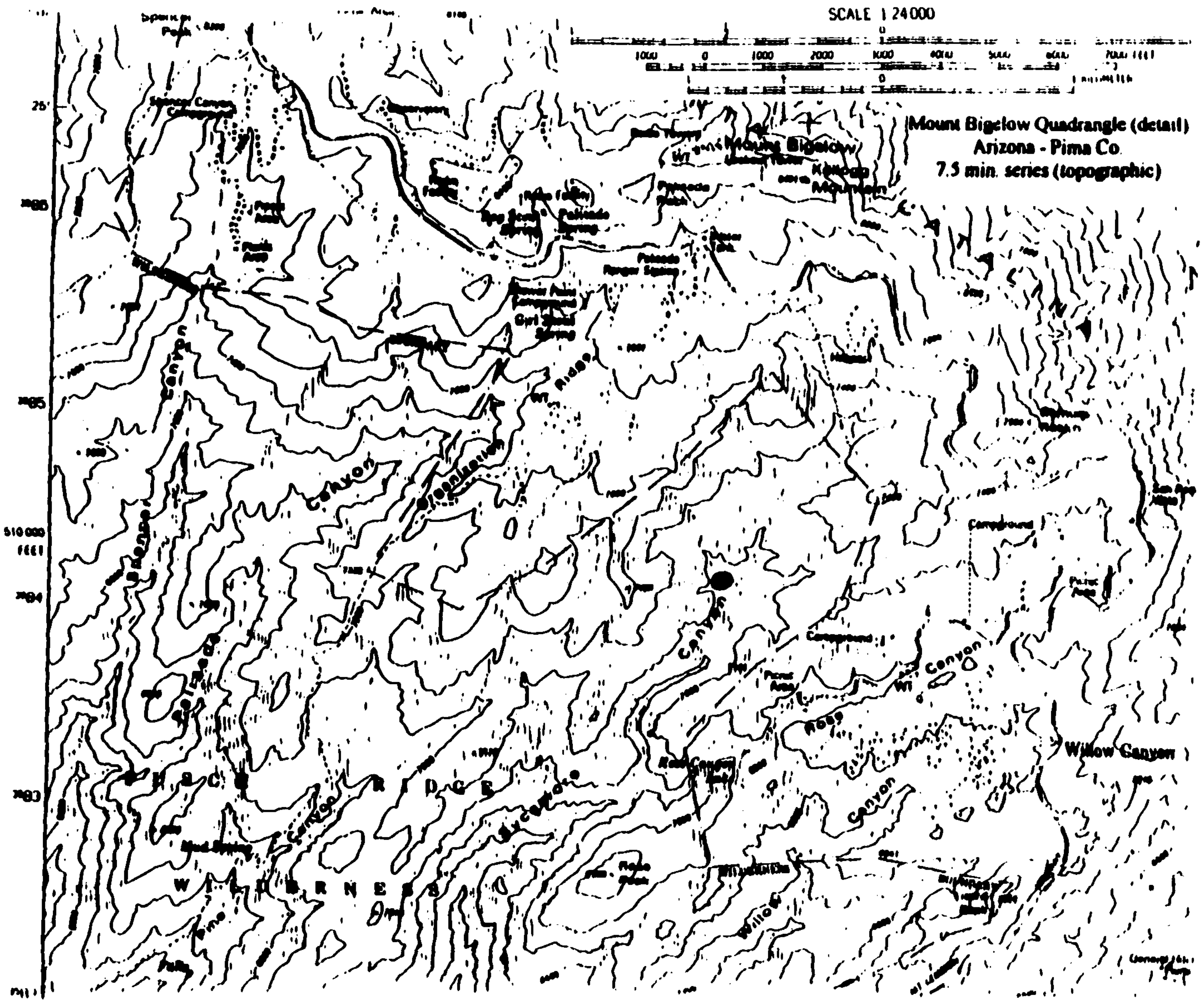

CONTOUR INTERVAL 25 FEET
'hiricahua Peak Quadrangle (detail)
Arizona - Cochise Co.
7.5 min. series (topographic)
N
Rucker
Brush
Creek
24
26
25


SCALE 1:24000
Huachuca Peak Quadrangle (detail)
Arizona
7.5 min. series (topographic)
N
Lyle
Garden
Canyon
Sunnyside
SCOTIA
9
10
11
16
15
14
O R E S T



Miller Peak Quadrangle (detail)
Arizona - Cochise Co.
7.5 min. series (topographic)


SCALE 1:24 000
Miller Peak Quadrangle (detail)
Arizona - Cochise Co.
7.5 min. series (topographic)
A
N
Canyon
Sunnyside Canyon
Ramsey Peak
Pat Scott Peak
Pat Scott Canyon
Rattlesnake Peak
Spring
Hamburg Mine
C
H
U
C
A


SCALE 1:24000
Mount Bigelow Quadrangle (detail)
Arizona - Pima Co.
7.5 min. series (topographic)
Canyon
Ridge
Willow Canyon
Canyon
Canyon
Canyon
Campground
Picnic Area

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