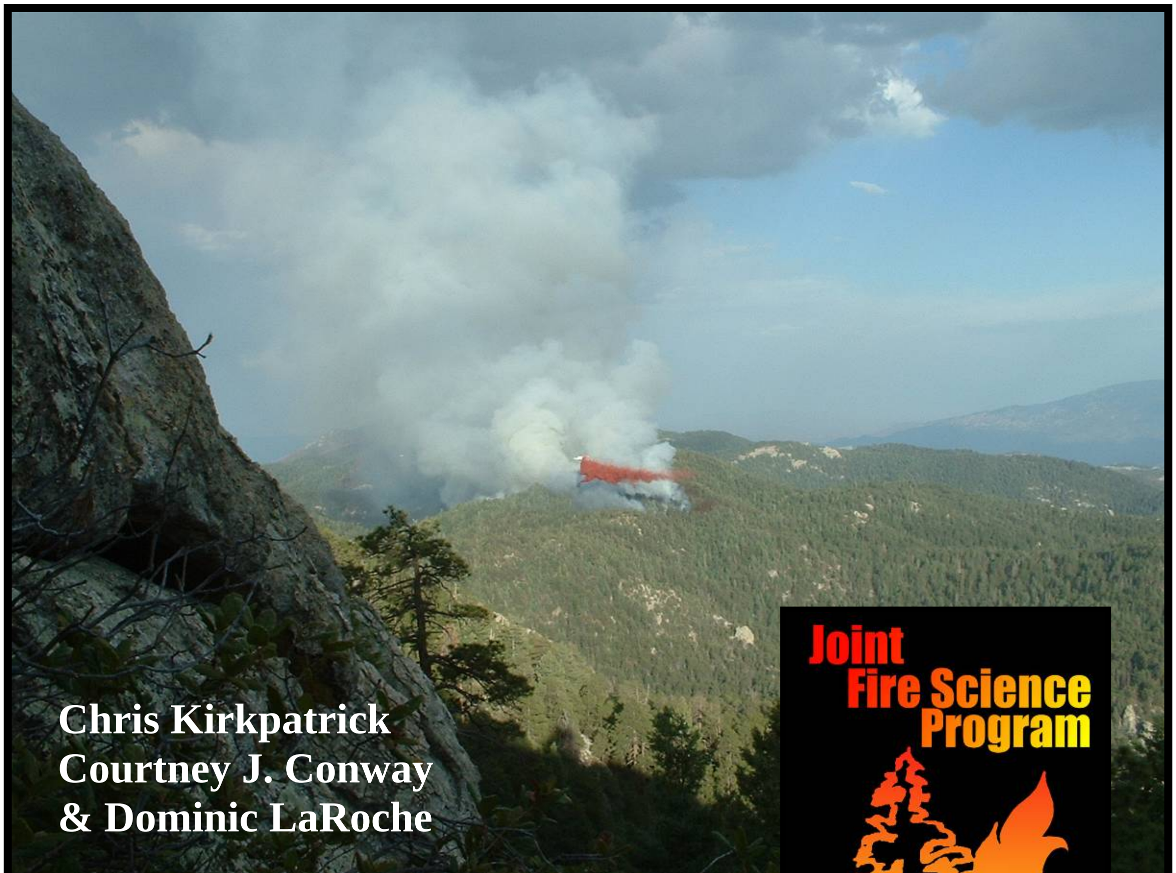
ARIZONA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT - AUGUST 2006

# EFFECTS OF WILDLAND FIRES ON BUFF-BREASTED FLYCATCHERS AND OTHER FOREST BIRDS IN SOUTHEASTERN ARIZONA



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**Wildlife Research Report #2006-05**

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# EFFECTS OF WILDLAND FIRES ON BUFF-BREASTED FLYCATCHERS AND OTHER FOREST BIRDS IN SOUTHEASTERN ARIZONA

Final Report

Submitted to:

USDA/USDI Joint Fire Sciences Program (JFSP)
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**EXECUTIVE SUMMARY**

Long-term fire suppression in forests of the southwestern U.S. is thought to have influenced the distribution and abundance of many bird species, including rare species such as the buff-breasted flycatcher (*Empidonax fulvifrons*). Few studies have examined the effect of wildfires on buff-breasted flycatchers or other forest bird species in the Southwest, despite the historical importance of wildfires in shaping these forest ecosystems and the recent increase in large wildfires in the region. We took advantage of the extreme wildfire seasons of 2002, 2003, and 2004 in southeastern Arizona to examine the role of recent (1-3 years post-burn) fires of varying severities on the distribution and relative abundance of buff-breasted flycatchers and other forest bird species. We conducted post-burn surveys in 2004 and 2005 along survey routes established in 2000 so that we could compare relative abundance of forest birds before and after the recent wildfires. We also collected samples from fire-scarred trees in forests with and without buff-breasted flycatchers to examinee the role of fire history in influencing the current distribution of buff-breasted flycatchers in southeastern Arizona. We found that most forest bird species were negatively associated with recently burned areas and were associated more strongly (either positively or negatively) with areas affected by severe as opposed to less-severe fires. Recent wildfires appear to have had little immediate effect on the distribution and relative abundance of buff-breasted flycatchers in southeastern Arizona. However, we found evidence (based on fire-scar records) suggesting that buff-breasted flycatchers prefer forests that have been burned more frequently within the last 30 years compared to adjacent forests that have burned less frequently. In addition, we found that the number buff-breasted flycatchers has increased from 2 to 5 birds (including a mated pair) in the Rincon Mountains since 2000. These detections represent the first records of buff-breasted flycatchers in this mountain range since 1911, suggesting that this rare species has re-colonized a portion of its historical breeding range. We suspect that the recent colonization and population increase in the Rincon Mountains by buff-breasted flycatchers is due, in part, to a recent increase in the frequency of fires within this mountain range. Our results add to a growing body of correlative and anecdotal evidence supporting the hypothesis that fire suppression has been responsible, in part, for the range contraction and population declines of buff-breasted flycatchers in the southwestern U.S. during the 20$^{th}$ century. Furthermore, our results indicate that buff-breasted flycatchers may ultimately benefit from recent wildfires in southeastern Arizona (and elsewhere in the State) as forest succession transforms recently burned areas into potential buff-breasted flycatcher habitat. Further research is needed to confirm or refute the hypothesis that buff-breasted flycatchers prefer burned forests and continued monitoring of buff-breasted flycatcher populations is warranted given the small population size and restricted geographic range of this rare species in the U.S.

## PROJECT DELIVERABLES

The following deliverables were produced during the research project. Copies (both paper and electronic) of the final technical report and the 2 publications will be sent to the USDA/USDI Joint Fire Sciences Program (JFSP). These documents will also be available at the project website (see below for web address).

1) Final Technical Report:

- Kirkpatrick, C., C. J. Conway, and D. LaRoche. 2006. Effects of wildland fires on buff-breasted flycatchers and other forest birds in southeastern Arizona. Wildlife Research Report #2006-05, U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, Tucson, AZ.

2) Publications:

- Kirkpatrick, C., C. J. Conway, and D. LaRoche. 2007. Range expansion of the buff-breasted flycatcher (*Empidonax fulvifrons*) into the Rincon Mountains, Arizona. *Southwestern Naturalist*, in press.

- Conway, C. J., and C. Kirkpatrick. 2007. Forest fire suppression as a cause of population decline in buff-breasted flycatchers. *Journal of Wildlife Management,* in press.

3) Presentations:

- Kirkpatrick C., D. LaRoche, and C. J. Conway. 2005. Range expansion of the buff-breasted flycatcher (*Empidonax fulvifrons*) into the Rincon Mountains, Arizona: a response to recent fire? Presentation given to staff and volunteers at Saguaro National Park, Arizona.

- LaRoche, D., C. Kirkpatrick, and C. J. Conway. 2005. Proposed evaluation of methods for measuring burn severity in forests during avian surveys. 4th USGS Wildland Fire Sciences Workshop, Tucson, Arizona. Poster presentation.

4) Project Website:

- http://www.ag.arizona.edu/srnr/research/coop/azfwru/cjc/

  Follow link to “Research” and then links to Research Projects “2” and “13”.

**INTRODUCTION**

The distribution of buff-breasted flycatchers (*Empidonax fulvifrons*) in the U.S. once extended from the Mexico border north to Prescott, Arizona, east to west-central New Mexico, and south along the Continental Divide (Conway and Kirkpatrick 2006). However, the distribution of buff-breasted flycatchers decreased markedly in Arizona between the late 1800s and 1970 (Phillips et al. 1964, Bowers and Dunning 1994, Martin 1997, Conway and Kirkpatrick 2006). Distribution in the U.S. has been reduced by 91% from 98,630 $km^2$ to only 8,471 $km^2$ and 98% of the U.S. population is now restricted to 2 relatively small mountain ranges (Chiricahua and Huachuca) in southeastern Arizona (Conway and Kirkpatrick 2006). Indeed, the buff-breasted flycatcher has one of the most restricted breeding distributions of any bird in the U.S. (Bowers and Dunning 1994).

In addition to their greatly reduced distribution, buff-breasted flycatchers have experienced a substantial population decline in recent years. Range-wide surveys of the known U.S. population found a total of 86 individuals in 1995-96 (Martin 1997) but only 55 individuals in 2000 (Conway and Kirkpatrick 2001) and mean decline in areas with buff-breasted flycatchers was estimated to be 10.5% per year between the 2 survey efforts (Conway and Kirkpatrick 2001). Consequently, buff-breasted flycatchers are considered a “very high priority” among species most in need of conservation action or study in the U.S. (Hunter et al. 1992), are listed as a USFWS species of concern, and were a former “Category 2” species for consideration to be listed as a federally threatened or endangered species (Federal Register 1994, 1996). Buff-breasted flycatchers are also considered “wildlife of special concern in Arizona” (endangered category), and are ranked 13$^{th}$ out of 230 breeding birds in Arizona based on their conservation need (Arizona Game and Fish Department 1988, 1996; Latta et al. 1999).

Buff-breasted flycatchers in Arizona are susceptible to extirpation because of their limited distribution, small population size, and continuing population decline. Preventing extirpation of buff-breasted flycatchers from the U.S. requires population increases and/or recolonization of their historical range. However, expansion of buff-breasted flycatcher populations may require active management efforts to restore sub-optimal habitat. Several authors have suggested that long-term fire suppression may have caused population declines by reducing the amount of optimal foraging habitat available to buff-breasted flycatchers (Phillips et al. 1964, Phillips 1968, Bowers and Dunning 1994, Martin 1997). For example, lack of fire allows oak saplings to colonize the understory in pine forests (Covington and Moore 1994). Dense understory vegetation is thought to reduce foraging efficiency of flycatchers (Bowers and Dunning 1994, Martin 1997) and buff-breasted flycatchers are negatively associated with oak cover in the understory (Martin 1997). Periodic fires may reduce understory vegetation and thereby benefit buff-breasted flycatchers. Indeed, examining the effects of fire is considered a research and conservation priority for this species (Bowers and Dunning 1994, Martin 1997).

Results from a recent study suggest that buff-breasted flycatchers prefer burned forests in southeastern Arizona, particularly those areas affected by severe fires (Conway and Kirkpatrick 2006). Although these correlative data are highly suggestive, we still do not know definitely whether fire (especially severe fire) influences the distribution and abundance of buff-breasted flycatchers in southeastern Arizona because buff-breasted flycatchers may be responding to variables unrelated to fire that have not been measured. Therefore, we need to evaluate the role of fire in influencing buff-breasted flycatcher populations by controlling for potential confounding variables and testing the predictions that: 1) buff-breasted flycatcher presence and abundance increases following wildfire and 2) that these increases are greatest in areas affected by severe fire. The large wildfires that burned throughout Arizona from 2002 to 2004 provided us with a unique opportunity to test these predictions.

We evaluated the effects of recent (1-3 years post-burn) wildfires on buff-breasted flycatchers by examining the effects of 2 wildfires that burned in southeastern Arizona in areas that contained established buff-breasted flycatcher survey routes (Conway and Kirkpatrick 2001). Repeating surveys for buff-breasted flycatchers in burned areas following wildfire is considered a research priority for the species. In fact, buff-breasted flycatcher survey routes were established in southeastern Arizona in 2000 with the intention that they would be repeated following future wild or prescribed fires in the region (Conway and Kirkpatrick 2001). We evaluated the effects of the recent wildfires on the relative abundance of buff-breasted flycatchers by replicating surveys on established survey routes (both burned and unburned) in 2 Sky Island Mountain ranges (Chiricahua and Huachuca Mountains) in southeastern Arizona. We compared post-burn data collected on survey routes in 2004 and 2005 with pre-burn data collected on the same survey routes in 2000.

Beyond the immediate effect of recent wildfires on buff-breasted flycatchers, researchers have speculated that acquiring information on the time required between burning an area and that area becoming suitable habitat for buff-breasted flycatchers would enhance management strategies for the species (Martin 1997). Although buff-breasted flycatchers are known to be associated with burned forest in southeastern Arizona (Conway and Kirkpatrick 2006), we lack information on how the particular fire history (e.g., time since fire, fire frequency) in these burned areas affects the distribution and relative abundance of buff-breasted flycatchers. In other words, we do not know whether buff-breasted flycatchers are positively associated with areas that have been affected by recent or older fires or with areas affected by a single or multiple fires. We attempted to answer these questions by determining the fire history in areas with and without buff-breasted flycatchers in 3 Sky Island Mountain ranges (Chiricahua, Huachuca, and Rincon Mountains) in southeastern Arizona using data collected from fire-scarred trees.

Long-term suppression of naturally-occurring ground fires is also thought to have affected the distribution of many other bird species in southeastern Arizona (Marshall 1957, 1963; Ganey et al. 1996), yet few studies have examined this issue (but see Kirkpatrick et al. 2006). Researchers have noted striking differences in the composition of forest bird communities between adjacent mountain ranges in southeastern Arizona and northern Mexico that appear to correspond to differences in historical fire regimes (Marshall 1957, 1963). If suppression of ground fires has been responsible for these dramatic differences in bird diversity and abundance, we need information on the effects of these low-severity fires on forest birds to better manage and conserve this unique avian. In addition, because the frequency of high-severity crown fires is increasing in southeastern Arizona, we need additional information on the effects of severe wildfires to better predict the impact of future wildfires on populations of forest bird species in the region.

The recent wildfires in southeastern Arizona provided us with a unique opportunity to look at the effects of a range of fire severities on many forest bird species in the region, including species of conservation concern such as the band-tailed pigeon (*Patagioenas fasciata*), elegant trogon (*Trogon elegans*), and northern goshawk (*Accipiter gentiles*). Because detections of all bird species were recorded during a broad-scale buff-breasted flycatcher survey in 2000 (Conway and Kirkpatrick 2001), we had the opportunity to examine the effect of recent wildfires on the entire forest bird community by replicating surveys on established bird survey routes (both burned and unburned) in 4 Sky Island Mountain ranges (Huachuca, Pinaleno, Rincon, and Santa Catalina Mountains) in southeastern Arizona. We compared post-burn data collected for all bird species on the survey routes in 2004 and 2005 with pre-burn data collected on the same survey routes in 2000.

In addition to our evaluation of the effect of recent wildfires on buff-breasted flycatchers and other forest birds in southeastern Arizona, we also estimated buff-breasted flycatcher population size and trend across the species' breeding range by repeating surveys on all established survey routes in southeastern Arizona on which buff-breasted flycatchers had been detected during previous survey efforts (Bowers 1983, Martin 1997, Conway and Kirkpatrick 2001). In addition, we estimated population size and trend in the Rincon Mountains by repeating surveys along all survey routes established in this mountain range in 2000 (Conway and Kirkpatrick 2001). Finally, we examined the effect of recent wildfires of varying severities on breeding bird habitats by measuring forest structure in both recently burned and unburned areas.

**PROJECT OBJECTIVES**

1) Test the prediction that buff-breasted flycatchers are positively associated with recently burned forests in southeastern Arizona, especially in areas affected by severe fire.

2) Determine whether fire history (e.g., time since previous fires, frequency of previous fires) influences buff-breasted flycatcher distribution in southeastern Arizona.

3) Evaluate the effect of recent wildfires of varying severities on the relative abundance of other forest bird species in southeastern Arizona.

4) Estimate population size and trend of buff-breasted flycatchers in southeastern Arizona.

5) Examine the effect of recent wildfires of varying severities on forest structure in southeastern Arizona.

## STUDY AREA

We conducted this study in pine-oak woodland, ponderosa pine (*Pinus ponderosa*) forest, and mixed-conifer forest between 1,600 and 2,600 m elevation in 5 "Sky Island" Mountain ranges in southeastern Arizona (Chiricahua, Huachuca, Pinaleno, Santa Catalina, and Rincon Mountains; Fig. 1). The "Sky Islands" are a group of approximately 40 high-elevation mountain ranges scattered throughout the southwestern U.S. and northern Mexico that are separated from one another by low-elevation desert basins (Warshall 1995). Climate throughout much of the region is arid or semi-arid but high-elevation forests in the Sky Islands are substantially cooler and wetter than surrounding deserts. Annual precipitation varies among mountain ranges (average of approximately 80 cm in the Santa Catalina Mountains) and most of the precipitation falls during a brief summer season of localized thunderstorms and during a longer winter season of widespread frontal storms. Common tree species in the study area included Apache pine (*P. englemannii*), Chihuahua pine (*P. leiophyllus*), ponderosa pine, southwestern white pine (*P. strobiformis*), white fir (*Abies concolor*), Douglas fir (*Pseudotsuga menziessi*), Arizona sycamore (*Plantanus wrightii*), alligator juniper (*Juniperus deppeana*), and several species of oak (*Quercus* spp.).

High-elevation forests within the Huachuca, Pinaleno, Rincon, and Santa Catalina Mountains were affected by several large wildfires between 2002 and 2004. In 2002, the Oversite wildfire burned 886 ha from 1 March to 15 March in the Huachuca Mountains and the Bullock wildfire burned 12,368 ha from 21 May to 5 June in the Santa Catalina Mountains. In 2003, the Aspen wildfire burned 34,297 ha from 17 June to 12 July in the Santa Catalina Mountains (see photo of start of Aspen wildfire on cover of report) and the Helen's 2 fire burned 1,416 ha from 17 June to 1 July in the Rincon Mountains. In 2004, the Nuttall and Gibson wildfires burned a total of 11,898 ha from 22 June to 20 July in the Pinaleno Mountains. All told, 60,865 ha of forest were burned during a 3-year period in these 4 mountain ranges. Unlike historical wildfires, recent wildfires were particularly severe, often burning through the canopies of large tracts of forest.

## METHODS

*Surveying birds*--We conducted surveys along a total of 63 established buff-breasted flycatcher survey routes from 21 April to 9 July in 2004 and from 14 April through 6 July in 2005 (see Conway and Kirkpatrick 2001 for exact locations of these survey routes). We surveyed 37 of the 63 survey routes to examine the effect of recent wildfires on buff-breasted flycatchers and other forest birds in southeastern Arizona (Table 1). We surveyed 26 of the 63 surveys routes to estimate buff-breasted flycatcher population size and trend (Table 2; data from these 26 routes were combined with data from a subset of the previous 37 routes to generate estimates). To reduce temporal variance, we conducted surveys within 5 days of the date when surveys were originally conducted in 2000 (Conway and Kirkpatrick 2001). A total of 4 observers surveyed birds during the 2004 and 2005 field seasons. Before each field season began, observers practiced identifying Arizona breeding bird species by listening to recorded songs and calls on audio CDs. We tested observers on their knowledge of these songs and calls, subjected observers to hearing tests to ensure normal levels of hearing ability, and conducted practice bird

Figure 1. Map of study area in southeastern Arizona showing the 1) Chiricahua, 2) Huachuca, 3) Pinaleno, 4) Rincon, and 5) Santa Catalina Mountains.

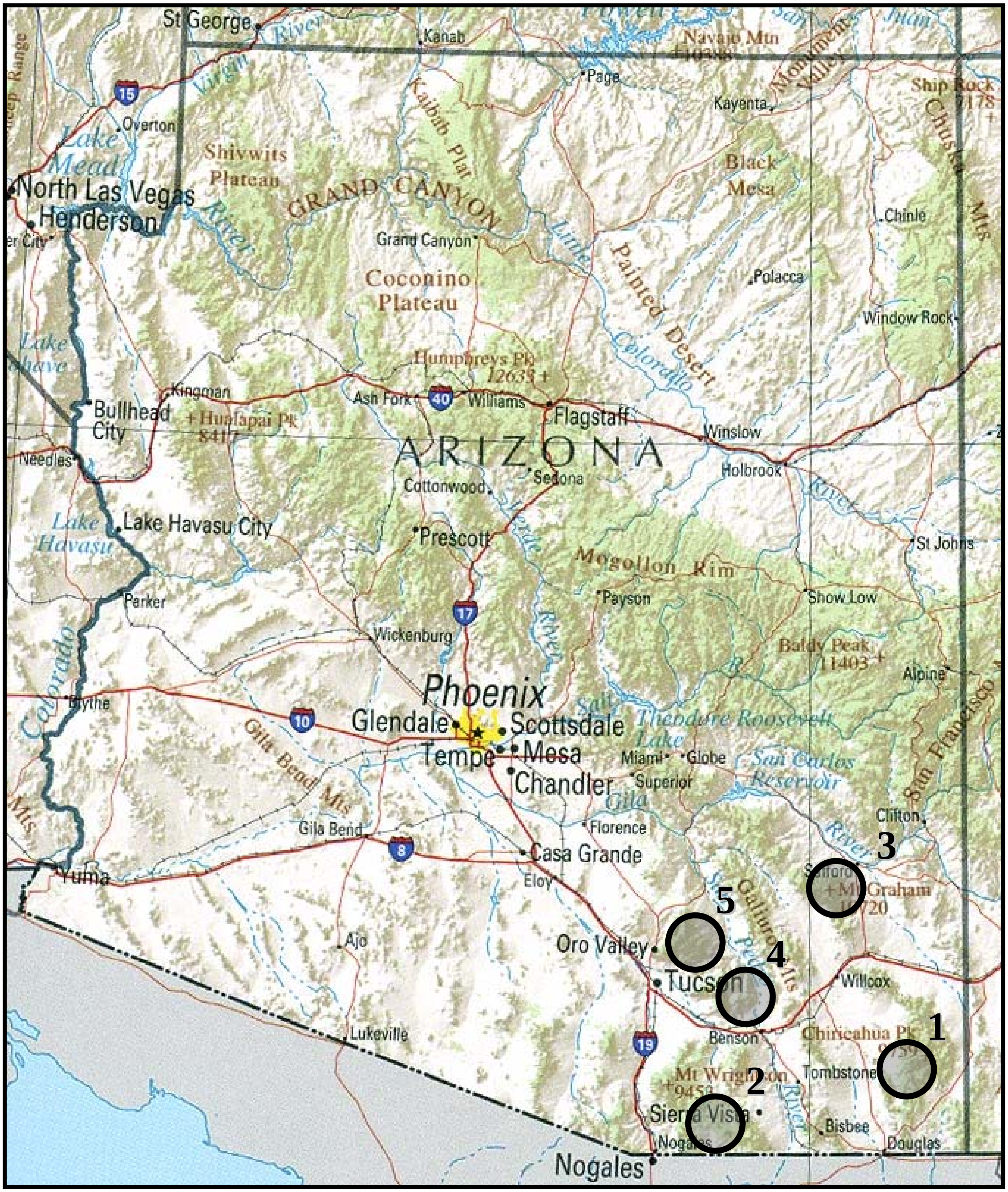


Table 1. Thirty-seven survey routes (18 burned and 19 unburned) in the Huachuca, Pinaleno, and Santa Catalina Mountains that we surveyed to examine the effect of recent wildfires on buff-breasted flycatchers and other forest birds in southeastern Arizona. The table shows the names of recent wildfires that affected survey routes and the dates that replicate surveys were conducted before (2000) and after (2004 and 2005) the wildfires.

| | | | Survey Date | | |
|---|---|---|---|---|---|
| Mt. Range | Route Name | Fire[1] | 2000 | 2004 | 2005 |
| Huachuca | Carr Canyon | - | 5/25 | 5/27 | 5/27 |
| | Crest Trail | - | 5/24 | 5/26 | 5/26 |
| | Garden Canyon | - | 5/10 | 5/10 | 5/12 |
| | Garden Pond | - | 5/9 | 5/10 | - |
| | Lower Garden Canyon | - | 5/12 | 5/11 | 5/13 |
| | Lower Oversite Canyon | - | 6/29 | 6/24 | 6/28 |
| | Lower Ramsey Canyon | - | 5/2 | 5/12 | 5/12 |
| | Miller Canyon | O | 4/20 | - | 4/23 |
| | Oversite Canyon | O | 6/29 | 6/7 | 6/28 |
| | Ramsey Canyon | O | 5/25 | 5/28 | 5/26 |
| | Rock Springs Canyon | - | 6/6 | 6/8 | - |
| | Sawmill Canyon | - | 5/9 | 5/10 | - |
| | Scheelite Canyon | - | 6/28 | 6/23 | 6/28 |
| | Scotia Canyon | - | 5/24 | 5/26 | - |
| | Upper Sunnyside Canyon | - | 4/18 | - | 4/19 |
| Pinaleno | Ash Creek | NG | 6/14 | - | 6/20 |
| | Arcadia/Wet Creek | - | 6/15 | - | 6/21 |
| | Noon Creek | - | 6/15 | - | 6/21 |
| | Riggs Lake | NG | 6/14 | - | 6/20 |
| Rincon | Cowhead Saddle Trail | H | 5/31 | 6/1 | 6/1 |
| | Devil’s Bathtub Trail | - | 6/2 | 6/1 | 6/3 |
| | Heartbreak Ridge Trail | - | 5/31 | 6/2 | 6/1 |
| | Manning Camp Trail | - | 5/30 | 5/31 | 5/31 |
| | Spud Rock Trail | H | 5/30 | 5/31 | 5/31 |
| | West Manning Camp | - | 6/1 | 6/2 | 6/2 |
| Santa Catalina | Bear Canyon | B | 5/4 | 5/4 | 5/3 |
| | Box Camp Trail | A | 5/18 | 5/20 | 5/18 |
| | Butterfly Trail | B | 5/19 | 5/20 | 5/20 |
| | Canada del Oro | A | 6/28 | 7/1 | 7/1 |
| | Forest Service Road 38 | B | 6/15 | 6/16 | 6/15 |
| | Organization Ridge | B | 5/5 | 5/6 | 5/4 |
| | Rose Canyon | A | 6/9 | - | 6/15 |
| | Sabino Canyon | A | 5/24 | 5/24 | 5/27 |
| | Samaniego Ridge | - | 6/30 | 6/30 | 6/30 |
| | Spencer Canyon | A | 6/16 | 6/16 | 6/17 |
| | Sycamore Canyon | A | 5/16 | 5/17 | 5/22 |
| | Willow Canyon | A | 4/29 | 5/1 | 4/29 |

[1] B = Bullock wildfire (2002), O = Oversite wildfire (2002), A = Aspen wildfire (2003), H = Helen’s 2 wildfire (2003), and NG = Nuttall-Gibson wildfires (2004).

Table 2. Twenty-six unburned surveys routes in the Chiricahua, Huachuca, and Rincon Mountains that we surveyed for a range-wide population and trend estimate (2004)[1] and a Rincon Mountain population and trend estimate (2004 and 2005)[2]. The table shows the dates that surveys were originally conducted in 2000 and dates that we conducted surveys in 2004 and 2005.

| | | Survey Date | | |
|---|---|---|---|---|
| Mt. Range | Route Name | 2000 | 2004 | 2005 |
| Chiricahua | Bear Canyon | 5/23 | 5/25 | - |
| | East Turkey Creek | 6/8 | 6/10 | - |
| | Horsefall Canon | 5/16 | 5/15 | - |
| | Lower Pinery Canyon | 5/15 | 5/14 | - |
| | Lower Rucker Canyon | 5/22 | 5/24 | - |
| | Middle Fork Cave Creek | 6/7 | 6/9 | - |
| | Pine Canyon | 5/4 | 4/30 | - |
| | Polebridge Canyon | 5/2 | 5/3 | - |
| | Red Rock Canyon | 6/20 | 6/22 | - |
| | Saulsbury Canyon | 5/3 | 5/13 | - |
| | South Fork Cave Creek | 6/7 | 6/9 | - |
| | Sulpher Draw | 6/21 | 6/21 | - |
| | Upper Pinery Canyon | 5/15 | 5/14 | |
| | Upper Rucker Canyon | 5/22 | 5/24 | - |
| | Ward Canyon | 5/16 | 5/13 | - |
| | West Turkey Creek | 5/2 | 4/28 | - |
| | Whitetail Canyon | 6/23 | 6/21 | - |
| Huachuca | Miller Ridge | 6/28 | 6/22 | 6/29 |
| | Sunnyside Canyon | 6/5 | 6/7 | - |
| Rincon | Chiminea Canyon | 6/2 | - | 6/4 |
| | Dear Spring Trail | 6/1 | - | 6/2 |
| | Italian Springs | 5/31 | - | 6/1 |
| | Mica Meadow | 5/30 | 5/31 | 5/31 |
| | Mica Mountain | 6/1 | 6/1 | 6/2 |
| | Miller Creek | 6/1 | - | 6/4 |
| | Rincon Peak | 6/2 | - | 6/3 |

[1] For range-wide population and trend estimates, we used survey data collected in 2004 along 21 of the 26 survey routes in addition to survey data collected in 2004 from surveys along 30 of the 37 survey routes from our study examining the effect of recent wildfires on forest birds in southeastern Arizona (see Table 1)

[2] For Rincon Mountain population and trend estimates, we used survey data collected in 2004 from 2 of the 7 Rincon Mountain survey routes and survey data collected in 2005 from all 7 Rincon Mountain survey routes in addition to survey data collected in 2004 and 2005 from 6 Rincon Mountain survey routes from our study examining the effect of recent wildfires on forest birds in southeastern Arizona (see Table 1).

surveys with observers before the start of each field season. During the field season, we surveyed birds beginning at sunrise and continued until 1100 if necessary. We recorded the temperature, wind speed, and percent cloud cover at the start and end of each morning survey and we did not conduct surveys on days with precipitation or with wind speeds >19 km/hr.

At each survey point, we recorded visual and aural detections of all birds during a 3-minute passive survey period (sensu Conway and Kirkpatrick 2001). Immediately following the passive survey period, we broadcast recorded calls of buff-breasted flycatchers during a 3-minute call-broadcast survey period (sensu Conway and Kirkpatrick 2001). The 3-minute call-broadcast survey period consisted of 30 seconds of calls followed by 30 seconds of silence, with this sequence repeated 3 times. Each 30-second calling period consisted of the 2 primary songs (7 repetitions of *chee-lick-chou* and 3 repetitions of *chee-lick*; Bowers and Dunning 1994) and 9 repetitions of the most common call (*pit*) of buff-breasted flycatchers. Buff-breasted flycatcher songs and calls were broadcast at 90 decibels (measured at 1 m from broadcast source) using a CD player (Phillips AX5111/17) and amplified computer speakers (Radio Shack 40-1404 or 40-1432). We recorded visual and aural detections of all buff-breasted flycatchers detected during the 3-minute call-broadcast survey period.

We also attempted to identify the sex of each buff-breasted flycatcher detected during surveys. We identified the sex of buff-breasted flycatchers primarily by the song or call type given by the bird. We classified a bird as a male if it gave a *chee-lick* or *chee-lick-chou* song and we classified a bird as a female if it was closely associated (i.e., paired) with a singing male and gave only *pit* calls. Buff-breasted flycatchers that only gave *pit* calls but were not associated with a singing male were classified as sex unknown.

*Quantifying burn severity at survey points*--We recorded the severity with which vegetation was burned by recent wildfires at each survey point along our survey routes using a method developed for use during previous bird surveys conducted in the region (Conway and Kirkpatrick 2001, Kirkpatrick et al. 2006). This visual assessment of burn severity is similar to the system used by the National Park Service to estimate burn severity in forests immediately following fire (U.S. Department of Interior 2003). We classified the severity of fire at each survey point using the following 4 Burn Severity Index (BSI) classes:

0) no evidence of recent fire
1) evidence of low-severity surface fire (e.g., fire-charring roughly 0-0.3 m above ground on a few trees)
2) evidence of moderate-severity surface fire (fire-charring roughly 0.3-1.5 m above ground on most trees; a few small oaks or pines killed in understory)
3) evidence of high-severity surface fire (e.g., fire charring often >1.5 m above ground on trees; almost all understory oaks or pines killed [some oaks re-sprouting]; a few large trees killed [burned snags or fallen trunks])
4) evidence of high-severity crown fire (e.g., all above-ground vegetation killed with some re-growth from roots or seeds)

Because burn severity sometimes differed from one side of the survey route to the other, we recorded 2 BSI values at each survey point; one for each side of the survey route at each survey point.

*Effects of recent wildfires on buff-breasted flycatchers*--We used a modified Before-After-Control-Impact (BACI) design (Underwood 1994) to evaluate the effect of recent wildfires on populations of buff-breasted flycatchers in the Huachuca and Rincon Mountains; the 2 mountain ranges within our study area that had populations of buff-breasted flycatchers and also experienced wildfires between 2002 and 2004. Prior to the start of the fieldwork, we selected 6 survey routes that were located entirely or partially within the perimeters of the Oversite and Helen's 2 wildfires (Table 3). On half of these burned survey routes, we detected ≥1 buff-breasted flycatcher during surveys in 2000, and on the other half of these burned survey routes, we detected no buff-breasted flycatchers in 2000 (however, we detected buff-breasted flycatchers on an adjacent survey route within 2.5 km of the burned survey route). We paired each of the 6 burned survey routes with 2 nearby unburned survey routes to serve as spatial controls (Table 3). To select the 2 unburned control survey routes, we first assigned a rank to each of the 6 burned routes using a random number generator. Starting with the first burned survey route, we chose the closest unburned survey route that had ≥1 buff-breasted flycatcher detected in 2000 to serve as the first control route and the closest unburned survey route that had no buff-breasted flycatchers detected in 2000 to serve as the second control route (some burned survey routes could only be paired with one type of control route). If ≥2 possible control routes were located at approximately the same distance from the burned survey route, we selected the unburned survey route that best matched the aspect and/or elevation of the burned survey route.

*Fire history in areas with and without buff-breasted flycatchers*--The vegetation structure (and hence the habitat for buff-breasted flycatchers) in an area is a product of more than just the most recent fire and the most recent fire is just one component of the fire history of an area. To determine how fire history may have influenced the distribution of buff-breasted flycatchers in southeastern Arizona, we sampled fire-scarred trees in plots with and without buff-breasted flycatchers in the Chiricahua, Huachuca, and Rincon Mountains and compared the number and age of previous fires in each plot. We establish 13 6-ha plots (100 x 600 m) centered on "used" areas where buff-breasted flycatchers had been detected previously in 2000 or 2004 (Conway and Kirkpatrick 2001, Conway, unpublished data; Table 4). We then selected 13 additional 6-ha plots in adjacent "unused" areas that contained potential buff-breasted flycatcher habitat but had no recent records of buff-breasted flycatchers (based on surveys in previous years; Conway and Kirkpatrick 2001). We used buff-breasted flycatcher habitat characteristics identified by Martin (1997) to select plots with potential buff-breasted flycatcher habitat (e.g., forest patches that had an open canopy of pines, a gradual slope, and were >150 m wide). We located the unused plots ≥500 m away from areas occupied by buff-breasted flycatchers (randomly selected either up or down canyon) or in the nearest canyon or an adjacent side canyon (Table 4).

Table 3. Eighteen survey routes (6 burned and 12 unburned) selected from 63 established survey routes for inclusion in the BACI study design, Rincon and Huachuca Mountains, Arizona (2004-2005). We placed survey routes into 6 replicate groupings. The table shows the percentage of survey points along each survey route in 1 of 2 general burn-severity classes (BS; burned less-severely = 1; burned severely = 2)[1] and dates that surveys were originally conducted in 2000 and dates that we conducted surveys in 2004 and 2005.

| | | | | | | | | Survey Date | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Mt. Range | Rep. Group | Route Name | Burn or Control Route[2] | Fire[3] | No. Survey Pts | % Pts Burned (BS = 1) | % Pts Burned (BS = 2) | 2000 | 2004 | 2005 |
| Huachuca | 1 | Miller Canyon | B1 | O | 22 | 36% | - | 4/20 | 5/28 | 4/23 |
| | | Carr Canyon | C1 | - | 23 | - | - | 5/25 | 5/27 | 5/27 |
| | | Lower Oversite Canyon | C2 | - | 5 | - | - | 6/29 | 6/24 | 6/28 |
| | 2 | Miller Ridge[4] | B1 | O | 19 | 26% | 74% | 6/28 | 6/22 | 6/29 |
| | | Crest Trail | C1 | - | 19 | - | - | 5/24 | 5/26 | 5/26 |
| | | Lower Ramsey Canyon | C2 | - | 21 | - | - | 5/2 | 5/12 | 5/12 |
| | 3 | Oversite Canyon | B2 | O | 11 | 36% | - | 6/29 | 6/7 | 6/28 |
| | | Upper Sunnyside Canyon | C1 | - | 16 | - | - | 4/18 | 4/21 | 4/19 |
| | | Lower Garden Canyon | C1 | - | 22 | - | - | 5/12 | 5/11 | 5/13 |
| | 4 | Ramsey Canyon | B2 | O | 14 | 71% | 29% | 5/25 | 5/28 | 5/26 |
| | | Scheelite Canyon | C1 | - | 21 | - | - | 6/28 | 6/23 | 6/28 |
| | | Garden Canyon | C2 | - | 16 | - | - | 5/10 | 5/10 | 5/12 |
| Rincon | 5 | Cowhead Saddle Trail | B1 | H | 29 | 10% | 55% | 5/31 | 6/1 | 6/1 |
| | | West Manning Camp | C1 | - | 12 | - | - | 6/1 | 6/2 | 6/2 |
| | | Manning Camp Trail | C2 | - | 14 | - | - | 5/30 | 5/31 | 5/31 |
| | 6 | Spud Rock Trail | B2 | H | 21 | 14% | 38% | 5/30 | 5/31 | 5/31 |
| | | Devil's Bathtub Trail | C2 | - | 13 | - | - | 6/2 | 6/1 | 6/3 |
| | | Mica Mountain Trail | C2 | - | 6 | - | - | 6/1 | 6/1 | 6/2 |

[1] See Data Analysis Section for complete description of the general burn-severity index classes.
[2] B1= burned route with buff-breasted flycatchers present during previous surveys; B2 = burned route without buff-breasted flycatchers present during previous surveys; C1 = control route with buff-breasted flycatchers present during previous surveys; and C2 = control route without buff-breasted flycatchers present during previous surveys.
[3] O = Oversite wildfire (2002) and H = Helen's 2 wildfire (2003).
[4] Miller Ridge survey route was burned by a previous wildfire (<2000). Survey points along the route were likely burned during the Oversite fire, but we could not be certain that the burn we observed was due to the Oversite wildfire, the previous wildfire, or both.

Table 4. Twenty-six plots (100 x 600 m each) used to compare fire-history data (collected from fire-scarred trees) in areas that either had or did not have records of buff-breasted flycatchers (BBFL) based on previous years' surveys. Each plot was centered on a survey point located along an established buff-breasted flycatcher survey route in the Chiricahua, Huachuca, or Rincon Mountains, Arizona.

| Mt. Range | Plot Pair | BBFL? | Route Name | Survey Point | Dist. (km) Between Plots in Each Pair |
|---|---|---|---|---|---|
| Chiricahua | 1 | Y | Upper Rucker Canyon | 5 | 0.5 |
| | | N | North Fork Rucker Canyon[1] | 5 | |
| | 2 | Y | Lower Pinery Canyon | 12 | 5.4 |
| | | N | Rhyolite Canyon[1] | 6 | |
| | 3 | Y | Upper Pinery Canyon | 3 | 1.9 |
| | | N | Pine Canyon[1] | 27 | |
| | 4 | Y | Hoovey Canyon[1] | 1 | 0.6 |
| | | N | Pine Canyon | 12 | |
| | 5 | Y | Ward Canyon | 6 | 0.6 |
| | | N | Saulsbury Canyon | 9 | |
| Huachuca | 6 | Y | Carr Canyon | 8 | 1.9 |
| | | N | Lower Ramsey Canyon | 21 | |
| | 7 | Y | Scotia Canyon | 18 | 2.4 |
| | | N | Lyle Canyon[1] | 3 | |
| | 8 | Y | Miller Ridge | 13 | 0.8 |
| | | N | Crest Trail | 13 | |
| | 9 | Y | Sawmill Canyon | 13 | 1.4 |
| | | N | Garden Canyon | 6 | |
| Rincon | 10 | Y | West Manning Camp | 5 | 0.5 |
| | | N | Chiminea Canyon | 5 | |
| | 11 | Y | Manning Camp Trail | 7 | 1.0 |
| | | N | Heartbreak Ridge Trail | 10 | |
| | 12 | Y | Mica Meadow Trail | 6 | 1.0 |
| | | N | Mica Mountain Trail | 5 | |
| | 13 | Y | Cowhead Saddle Trail | 4 | 4.5 |
| | | N | Spud Rock Trail | 12 | |

[1] These routes were not surveyed during the current study; see Conway and Kirkpatrick (2001) for description and locations of these survey routes and survey points.

During the 2005 breeding season (April to July), we broadcast calls of buff-breasted flycatchers within each unused plot to ensure that no buff-breasted flycatchers were actually present on the plots before collecting fire-scar samples. We then searched each used and unused plot completely to locate, identify, and map all living trees that were scarred by fire. We collected the following data for each fire-scarred tree: tree species, diameter of tree at breast height (DBH), number of visible fire scars on tree, UTM coordinates of tree, and a subjective quality code for the tree (0 = "poor", 1 = "acceptable", 2 = "good"). The subjective quality code was based on the soundness of the wood, the potential to extract a good fire-scar sample with permitted tools, and the clarity of the visible fire scar(s).

Once the entire plot had been mapped, we selected up to 3 of the "best" fire-scarred trees to be sampled. We ranked fire-scarred trees based on the following selection criteria (in order of importance): 1) tree species, 2) subjective quality code (see above), 3) number of visible fire scars, 4) location of tree (see below), and 5) DBH of tree. We selected ponderosa pine trees whenever possible because they are known to scar well during fires (Arno and Sneck 1977). However, we selected other fire-scarred pine trees and even oak trees for sampling when ponderosa pines trees were unavailable. We selected fire-scarred trees with the greatest number of visible fire scars, and given a choice, we selected fire-scarred trees that were far apart from one another to obtain a sample that was more representative of the entire plot, instead of fire-scarred trees that were clustered together. Finally, we selected large trees (i.e., >DBH) over smaller trees because large trees are better able to recover from this type of sampling. At many of our plots, we were able to collect only a single fire-scar sample due to the lack of multiple fire-scarred trees within our small study plots.

Using standard sampling methods (Arno and Sneck 1977), we used a chainsaw or a handsaw (in wilderness areas) to cut a small section along the fire scar (<7 cm thick and <8% of tree's cross-sectional area; Heyerdahl and McKay 2001). We brought the tree sections back to the University of Arizona and prepared the samples for dating using methods outlined by Arno and Sneck (1977). We dried samples for a week and used a belt sander and finishing sander with course (80 grit) to fine (400 grit) sand paper and used a 30x dissecting microscope to count the number of fire scars and number of annual growth rings to determine the time since fire for each previous fire. We were careful not to double-count tree rings associated with the annual monsoon rains (i.e., an extra growth ring found in some trees in the Southwest; E. Margolis, University of Arizona Tree Ring Lab, personal communication). Using these techniques, we were able to extract information on the number and age (but not the severity) of previous fires on each plot.

To the best of our knowledge, we are the first to examine how fire history may influence the distribution of a presumed fire-dependent bird species (e.g., buff-breasted flycatchers) by collecting and analyzing data from fire-scarred trees in burned and unburned forests. Therefore, we should highlight several potential limitations that may constrain inferences from our results. First, the absence of fire-scarred trees within a particular forest does not necessarily imply that the forest has never burned because individual trees may not scar during even high-severity fires. Second, even if previously fire-scarred trees are present within a recently burned area, they may not record a scar for a subsequent fire event. Third, oaks and several other species of trees (e.g., conifers other than ponderosa pine) are difficult to age, rendering dates between fire-scar records less accurate for these species (Grissino-Mayer 1993). However, these sources of inaccuracy should be consistent among areas, and hence, shouldn't bias our comparison between areas with or without buff-breasted flycatchers. Finally, our sample size of fire-scarred trees was small during the current study.

*Effects of recent wildfires on other forest bird species*--We evaluated the effect of recent wildfires on populations of other forest bird species by comparing pre-burn data collected along survey routes before (2000) and after (2002, 2003, and 2004) the recent wildfires. For this part of the study, we were not constrained in our selection of survey routes by the contemporary distribution of buff-breasted flycatchers in southeastern Arizona as with the BACI analysis (see above). Thus, we surveyed for birds along 37 established survey routes in burned and unburned forest in the Huachuca, Rincon, Pinaleno, and Santa Catalina Mountains (Table 1). Our original study design entailed surveying birds on burned and unburned survey routes in the Huachuca and Santa Catalina Mountains that had been affected by the Oversite and Bullock wildfires, respectively, in 2002. Following these wildfires, both mountain ranges contained a relatively even mix of both burned and unburned survey routes. However, subsequent wildfires during 2003 and 2004 in the Pinaleno, Rincon, and Santa Catalina Mountains forced us to change our study design. Although we were able to include additional burned routes from other mountain ranges (e.g., Pinaleno Mountains) into the study and increase the scope of our research, virtually all of our unburned survey routes in the Santa Catalina Mountains were burned during the Aspen wildfire of 2003, thus eliminating any option for spatial controls in this mountain range.

*Buff-breasted flycatcher population estimate and trend*--To estimate range-wide population size and trend of buff-breasted flycatchers in southeastern Arizona, we conducted bird surveys in 2004 along 21 survey routes in the Chiricahua, Huachuca, Rincon, and Santa Catalina Mountains that had ≥1 buff-breasted flycatcher detected during surveys in 2000 (Conway and Kirkpatrick 2001) or during surveys in previous years (Martin 1997, Bowers 1983; Table 2). We combined our survey data from these 21 survey routes with survey data collected in 2004 from 30 of the 37 survey routes from our study examining the effect of recent wildfires on forest birds in southeastern Arizona (Table 1). To estimate population size and trend of buff-breasted flycatchers in the Rincon Mountains, we conducted surveys on all 13 established survey routes in the Rincon Mountains in 2004 and 2005 (we surveyed only 8 of the 13 routes in 2004 due to logistical constraints; Tables 1 and 2).

*Effects of recent wildfires on forest structure*--During the 2004 field season, we compared the effect of recent wildfires of varying severities on forest structure by estimating vegetation cover at burned and unburned survey points along survey routes in the Huachuca, Rincon, and Santa Catalina Mountains (we also estimated vegetation cover at 25 survey points from survey routes located in the Chiricahua Mountains to give us a larger sample size of unburned survey points). We estimated vegetation cover because it is one of the most common measures of forest structure and has the advantage of equalizing the contribution of species that are small but abundant and species that are large but uncommon (Elzinga et al. 2001).

Following the completion of a bird survey and the collection of BSI values for each survey point along the survey route, we selected at random ≥1 survey point from each BSI class along the survey route and measured vegetation cover by species at these survey points. Because some survey routes had no survey points with evidence of recent fire or only a few survey points with evidence of recent fire in 1 or 2 BSI classes, the total number of survey points at which we measured vegetation varied among survey routes. We estimated vegetation cover within a 50-m radius surrounding each of the selected survey points using the point-line-intercept method (sensu Martin 1997, Elzinga et al. 2001). Using a 5-m graduated pole as a reference, we measured vegetation "hits" by species within a 0.5-m diameter vertical column (centered around the vertical pole) at 5 points spaced at 10-m intervals along 4 50-m transects running in each of the cardinal directions from the survey point (20 points total). Vegetation "hits" occurred when live vegetation from a plant intercepted the area within the vertical column. We separated vegetation "hits" within the vertical column into 4 height categories (1.5-2, 2-5, 5-10, and >10 m).

**DATA ANALYSIS**

*Quantifying burn severity at survey points*--Before analyzing our bird data, we collapsed our values for the BSI recorded at each survey point into 3 general burn-severity categories to increase the power of our tests (sensu Kirkpatrick et al. 2006). These 3 burn-severity categories were: 1) no evidence of fire (BSI class 0); 2) evidence of less-severe fire (BSI classes 0.5 to 2); and 3) evidence of severe fire (BSI classes 2.5 to 4; Kirkpatrick et al. 2006).

*Effects of recent wildfires on buff-breasted flycatchers*--For the analysis of our BACI data, we excluded repeat detections of buff-breasted flycatchers from our analyses (i.e., birds that were detected at a survey point after being detected already at a previous survey point). We estimated relative density of buff-breasted flycatchers along each survey route in each year of the study (number of buff-breasted flycatchers on survey route/number of survey points along survey route) to control for variation in length of survey routes. We took a weighted average (weighted by number of survey points) of our relative density estimates for the two control plots that were paired with each burned plot to achieve a balanced design (i.e., 12 relative density estimates for both burned and associated unburned survey routes). We calculated a Wilks' Lambda *F*-statistic for within-subjects, year-by-treatment interactions using a repeated measures ANOVA with time (i.e., years 1, 2, and 3) as the within-subjects factor and treatment (i.e., burned and unburned) as the between-subjects factor. We ran the analysis with and without data from the Carr Canyon control survey route because we consider the 19 bird increase on the Carr Canyon survey route between 2000 and 2004 to be an outlier. Carr Canyon was the only survey route in our BACI design that supported a large colony of buff-breasted flycatchers, and consequently, this survey route was more susceptible to large, random fluctuations in abundance from year to year compared to the other BACI survey routes.

*Fire history in areas with and without buff-breasted flycatchers*--We constructed a fire history for each of our used and unused buff-breasted flycatcher plots using the records of previous fires found within the fire-scar sample(s) collected from each plot. For plots with multiple fire-scar samples, we considered records of previous fires from different fire-scarred trees to be records of the same fire event if the records were estimated to be within 3 years of one another. We calculated the median time since the most-recent, the second most-recent, and the third most-recent fire on plots that had evidence of ≥1 previous fire based on fire-scar samples. We used a paired *t*-test to determine if the frequency of fires differed between used and unused plots during 3 historical time periods (within the last 30 years, the last 31-60 years, and the last 61-90 years). We used a one-tailed *t*-test because buff-breasted flycatchers are positively associated with burned areas (Conway and Kirkpatrick 2006) and we were testing an *a priori* prediction that buff-breasted flycatchers would increase in burned forests following fires. We conducted this analysis with and without fire-scar data collected from oak trees because of the inherent difficultly in interpreting fire-scar samples from oaks (Grissino-Mayer 1993). Several of our paired used and unused plots were dropped from our analysis because we discovered buff-breasted flycatchers inhabiting areas that were inappropriately classified as being unused by the species (e.g., John Long Canyon, Chiricahua Mountains).

*Effects of recent wildfires on other forest bird species*--Although we collected data at survey points with evidence of older fires (i.e., survey points that had evidence of a previous fire recorded during surveys conducted in 2000; Conway and Kirkpatrick 2001), we excluded these survey points from our analyses because we were interested primarily in the effects of the most recent (2002-2004) wildfires on forest birds. Excluding these survey points from our analysis reduced our sample size of survey points in the first (from $n$ = 489 to $n$ = 276) and second (from $n$ = 550 to $n$ = 298) years post-burn but allowed us to avoid any potential confounding effects that previous (<2000) wildfires may have had on the relative abundance of forest birds. We did not analyze data collected in the third year post-burn (i.e., data collected from surveys conducted in 2005 along routes that were burned in 2002) because our sample size of burned survey routes was very small ($n$ = 3). We eliminated migrant bird species (e.g., Towsend's warbler) from analyses and restricted analyses to those species for which we detected ≥30 birds during each year of the study (2000, 2004, and 2005).

We calculated the difference in relative abundance for each bird species at each survey point by subtracting the relative abundance data collected in the first and second years post-burn from the relative abundance data collected before the wildfires (in 2000). The difference between pre- and post-burn relative abundance (i.e., our response variable) was between -2.0 and 2.0 at most (>95%) survey points. Because of the small variation in our response variable, we could not model the data continuously using linear regression (even using a Poisson model). Therefore, logistic regression was the most appropriate method for the analysis of our relative abundance data. We treated relative abundance data as an ordinal response variable in logistic regression models and created 5 ordinal relative abundance categories for each bird species that we analyzed: 1) ≤-2 birds, 2) -1 bird, 3) 0 birds, 4) 1 bird, and 5) ≥2 birds. We treated burn severity as a categorical explanatory variable in logistic regression models with 3 levels (no fire, less-severe fire, and severe fire; see above). We adjusted the contrast coding to compare differences in relative abundance values (year 1 post-burn minus pre-burn and year 2 post-burn minus pre-burn) across the 3 levels of the categorical explanatory variable.

We based our conclusions on the combined evidence of *P*-values from statistical hypothesis testing and magnitudes of differences (odds ratios) generated from parameter estimation. An odds ratio of 1.0 indicates no difference between the proportion of birds detected at survey points across a range of burn severities, and an odds ratio close to 0 or substantially >1.0 indicates a large difference. For bird species in which relative abundance was positively associated with burn severity, we considered an odds ratio ≥1.5 (i.e., ≥50% increase in relative abundance associated with an increase in 1 burn-severity category) to indicate a biologically significant effect. For bird species in which relative abundance was negatively associated with burn severity, we considered an odds ratio ≤0.66 (i.e., ≥50% decrease in relative abundance associated with an increase in 1 burn-severity category) to indicate a biologically significant effect.

*Effects of recent wildfires on forest structure*--As with the bird survey data, we sampled vegetation at survey points with evidence of older fires (i.e., survey points that had evidence of a previous fire recorded during surveys conducted in 2000; Conway and Kirkpatrick 2001). We excluded these survey points from our analyses because we were interested primarily in the effects of recent wildfires on forest structure. Because we recorded 2 BSI values at each survey point, we reclassified survey points that had BSI values that differed from one side of the survey route to the other to the higher BSI class for analyses (e.g., we reclassified a survey point with both BSI class 3 and BSI class 4 values to a BSI class 4).

We combined vegetation “hits” of different plant species into 3 general vegetation cover groups for analyses: 1) oaks, 2) conifers, and 3) all tree species. Oak species included silver-leaf oak (*Q. hypoleucoides*), Arizona white oak (*Q. arizonica*), Emory oak (Q. *emoryi*), Gambel oak (*Q. gambelii*), and net-leaf oak (*Q. rugosa*). Conifer species included Ponderosa pine, southwestern white pine, Apache pine, Chihuahua pine, pinyon pine (*P. edulis*), Mexican pinyon pine (*P. cembroides*), white fir, Douglas fir, alligator juniper, and Arizona cypress (*Cupressus arizonica*). For each survey point, we calculated average percent cover values for each of the 3 vegetation cover groups in each of the 4 height classes (i.e., 1.5-2, 2-5, 5-10, and >10 m) by first dividing the number of vegetation hits in each group by the total number of point-line-intercept points ($n$ = 20) at each survey point and then multiplying the quotient by 100. For example, oak “hits” at 10 out of a possible 20 point-line-intercept points in the 5-10 m height category would result in an estimate of 50% oak cover at 5-10 m height within 50 m of the survey point.

**RESULTS**

*Effects of recent wildfires on buff-breasted flycatchers*--We conducted one replicate survey per year in 2004 and 2005 on our 18 BACI survey routes in the Huachuca and Rincon Mountains (Table 3). We detected a total of 33 buff-breasted flycatchers on these survey routes in 2004 and 26 buff-breasted flycatchers on these survey routes in 2005 (Table 5). A total of 14 buff-breasted flycatchers were originally detected on these survey routes in 2000 (Conway and Kirkpatrick 2001). When we examined the number of buff-breasted flycatchers detected in 2000, 2004, and 2005 (excluding the Carr Canyon survey route data), we found that buff-breasted flycatchers appeared to decline on burned survey routes (from 4 to 2 birds), whereas buff-breasted flycatchers appeared to increase on control survey routes (from 6 to 8 birds) during the first year post-burn (Table 5). Despite this apparent trend, we were unable to detect a statistically-significant effect (either negative or positive) of recent wildfires on the relative density of buff-breasted flycatchers when we analyzed our BACI data both with Carr Canyon survey data ($F$ = 1.8, $df$ = 1, $P$ = 0.204) and without Carr Canyon survey data ($F$ = 1.6, $df$ = 1, $P$ = 0.237). Beyond the 18 BACI survey routes in the Huachuca and Rincon Mountains, we detected no buff-breasted flycatchers on any of the recently burned survey routes in the Santa Catalina and Pinaleno Mountains.

*Fire History in areas with and without buff-breasted flycatchers*--We collected a total of 31 fire-scar samples (23 from pines, 6 from oaks, and 2 from Douglas Fir) from our 13 paired used/unused plots to provide data on the frequency and age of previous fires (Fig. 2; Table 6). Eighty-five percent of unused plots and 62% of used plots had evidence of previous fires based on the presence of ≥1 fire-scarred tree. Previous fires occurred more recently in used plots than in unused plots. For example, median time to the most recent fire in the 9 used plots with evidence of ≥1 previous fire was 12 years (10 years if the single oak sample was excluded), to the 2$^{nd}$ most-recent fire was 29 years, and to the 3$^{rd}$ most-recent fire was 55 years. Whereas, median time to the most-recent fire in the 11 unused plots with evidence of ≥1 previous fire was 28 years (32 years if the 2 oak samples were excluded), to the 2$^{nd}$ most-recent fire was 56 years, and to the 3$^{rd}$ most-recent fire was 130 years.

Results from paired $t$-tests revealed that plots with buff-breasted flycatchers had a greater frequency of previous fires during the last 30 years than plots without buff-breasted flycatchers. This difference was greatest when we analyzed fire-scar data only from conifers (mean of 0.92 fires in used areas versus 0.50 fires in unused areas; paired one-tailed $t$ = 1.8, $df$ = 11, $P$ = 0.048) and was less when we analyzed fire-scar data from both conifers and oaks (mean of 1.0 fire in used areas versus 0.67 fires in unused areas; paired one-tailed $t$ = 1.3, $df$ = 11, $P$ = 0.110). Most of the observed difference was attributable to used plots in the Rincon Mountains that had more fires in the last 30 years than unused plots. We were unable to detect a difference in the frequency of previous fires between used and unused plots within the last 31-60 years (mean of 0.25 fires in used areas versus 0.42 fires in unused areas; paired one-tailed $t$ = -1.0, $df$ = 11, $P$ = 0.169) or within the last 61-90 years (mean of 0.17 fires in used areas versus 0.33 fires in unused areas; paired one-

Table 5. Number of buff-breasted flycatchers (BBFL) detected during surveys before (2000)[1] and after (2004 and 2005) recent wildfires on 6 replicate groups of survey routes (each with 1 burned and 2 unburned routes) that comprised our BACI study design in the Rincon and Huachuca Mountains, southeastern Arizona.

| Mt. Range | Rep. Group | Route Name | Burn or Control Route[2] | # BBFL Detected 2000 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| Huachuca | 1 | Miller Canyon | B1 | 1 | 0 | 0 |
| | | Carr Canyon | C1 | 4 | 23 | 16 |
| | | Lower Oversite Canyon | C2 | 0 | 0 | 0 |
| | 2 | Miller Ridge | B1 | 2 | 1 | 3 |
| | | Crest Trail | C1 | 2 | 0 | 0 |
| | | Lower Ramsey Canyon | C2 | 0 | 0 | 0 |
| | 3 | Oversite Canyon | B2 | 0 | 0 | 0 |
| | | Upper Sunnyside Canyon | C1 | 1 | 0 | 0 |
| | | Lower Garden Canyon | C1 | 1 | 1 | 1 |
| | 4 | Ramsey Canyon | B2 | 0 | 0 | 0 |
| | | Scheelite Canyon | C1 | 1 | 3 | 0 |
| | | Garden Canyon | C2 | 0 | 2 | 1 |
| Rincon | 5 | Cowhead Saddle Trail | B1 | 1 | 1 | 2 |
| | | West Manning Camp | C1 | 1 | 1 | 3 |
| | | Manning Camp Trail | C2 | 0 | 1 | 0 |
| | 6 | Spud Rock Trail | B2 | 0 | 0 | 0 |
| | | Devil's Bathtub Trail | C2 | 0 | 0 | 0 |
| | | Mica Mountain Trial | C2 | 0 | 0 | 0 |
| Totals | | | | | | |
| All routes | | | | 14 | 33 | 26 |
| Burn routes[3] | | | | 4 | 2 | 5 |
| Control routes[3] | | | | 10 | 31 | 21 |
| Burn routes[4] | | | | 4 | 2 | 5 |
| Control routes[4] | | | | 6 | 8 | 5 |

[1] Data from Conway and Kirkpatrick (2001).
[2] B1= burned route with buff-breasted flycatchers present during previous surveys; B2 = burned route without buff-breasted flycatchers present during previous surveys; C1 = control route with buff-breasted flycatchers present during previous surveys; and C2 = control route without buff-breasted flycatchers present during previous surveys.
[3] Including Carr Canyon survey route data.
[4] Not including Carr Canyon survey route data.

Figure 2. A fire-scar sample taken from a ponderosa pine in 2005 showing records of 3 previous fires (dating from 1916, 1865, and 1842) in Lyle Canyon, Huachuca Mountains, Arizona.

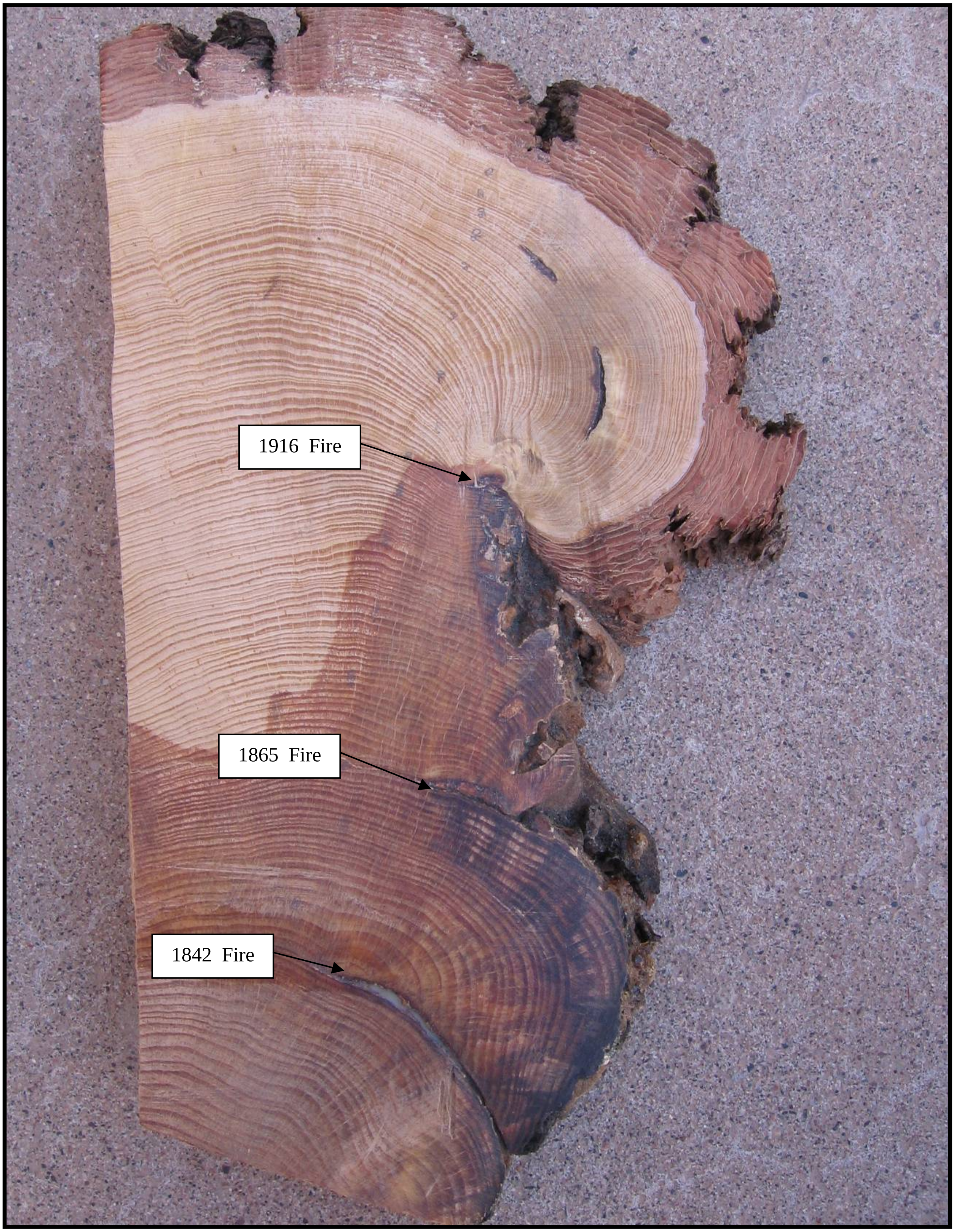


Table 6. Records of previous fires collected from fire-scarred trees sampled on 13 paired plots with and without buff-breasted flycatchers (BBFL) in the Chiricahua, Huachuca, and Rincon Mountains in 2005. For plots with multiple fire-scar samples, we considered records of fires from different trees to be records of the same fire if records were estimated within 3 years of one another.

| | | | | Years Since Previous Fires | | | | | Years Since Previous Fires | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mt Range | Plot Pair | Plots with BBFL | Fire-scar Tree Species[1] | Fire #1 | Fire #2 | Fire #3 | Plots without BBFL | Fire-scar Tree Species[1] | Fire #1 | Fire #2 | Fire #3 | Fire #4 | Fire #5 | Fire #6 |
| Chiricahua | 1 | Upper Rucker Canyon | - | - | - | - | North Fork Rucker Cyn | PINENG | - | 42 | 96 | 128 | 145 | - |
| | | | | | | | | QUEARI | 16 | - | - | - | - | - |
| | 2 | Lower Pinery Canyon | - | - | - | - | Rhyolite Canyon | PINCHE | 35 | - | - | - | - | - |
| | 3 | Upper Pinery Canyon | QUEARI | 30 | - | - | Pine Canyon[2] | PINSTR | 28 | 61 | - | - | - | - |
| | 4 | Hoovey Canyon | - | - | - | - | Pine Canyon[2] | - | - | - | - | - | - | - |
| | 5 | Ward Canyon | PINENG | 10 | - | - | Saulsbury Canyon | PSEMEN | - | 12 | - | - | - | - |
| | | | QUEHYP | 10 | - | - | | QUEHYP | - | 11 | - | - | - | - |
| | | | | | | | | QUEHYP | - | 13 | - | - | - | - |
| | | | | | | | | QUEHYP | 7 | - | - | - | - | - |
| Huachuca | 6 | Carr Canyon | PINSTR | 15 | 29 | - | Lower Ramsey Canyon | PINPON | - | 28 | - | - | - | - |
| | | | PINPON | 15 | - | 83 | | PSEMEN | 5 | - | - | - | - | - |
| | | | PINPON | 12 | 27 | - | | | | | | | | |
| | 7 | Scotia Canyon | - | - | - | - | Lyle Canyon | PINENG | 89 | 140 | 163 | - | - | - |
| | 8 | Miller Ridge | PINPON | - | 27 | - | Crest Trail | PINSTR | 11 | - | - | - | - | - |
| | | | PINSTR | 4 | 29 | - | | PINSTR | 11 | - | - | - | - | - |
| | 9 | Sawmill Canyon | - | - | - | - | Garden Canyon | - | - | - | - | - | - | - |
| Rincon | 10 | West Manning Camp | PINPON | 3 | - | 46 | Chiminea Canyon | PINPON | 35 | 65 | 83 | 112 | 134 | 154 |
| | | | PINPON | - | 7 | 45 | | | | | | | | |
| | 11 | Manning Camp Trail | PINPON | 3 | 7 | 55 | Heartbreak Ridge Trail | PINSTR | 10 | 52 | - | - | - | - |
| | | | PINSTR | - | 9 | - | | | | | | | | |
| | 12 | Mica Meadow Trail | PINPON | 18 | 65 | - | Mica Mountain Trail | PINPON | 59 | - | - | - | - | - |
| | 13 | Cowhead Saddle Trail | PINPON | 13 | 33 | - | Spud Rock Trail | PINSTR | 107 | 178 | 188 | - | - | - |

[1] PINENG = Apache pine; PINPON = ponderosa pine; PINSTR = southwestern white pine; PSEMEN = Douglas fir; QUEGAM = Gambel oak; QUEHYP = silver-leafed oak.

[2] The Pine Canyon plot paired with the Upper Pinery Canyon plot was located 1.7 km up canyon from the Pine Canyon plot paired with the Hoovey Canyon plot.

tailed $t$ = -0.7, $df$ = 11, $P$ = 0.252). Results were the same for these 2 time periods whether we excluded or included fire-scar data from oak trees in our analyses.

*Effects of recent wildfires on other forest bird species*--We conducted a total of 65 replicate surveys along 37 burned and unburned survey routes in the Huachuca, Rincon, Pinaleno and Santa Catalina Mountains in 2004 and 2005 (Table 1). We detected a total of 85 breeding bird species during these surveys. The ten most widely distributed species were black-headed grosbeak (*Pheucticus melanocephalus*; 57% of points), yellow-eyed junco (*Junco phaeonotus*; 53% of points), spotted towhee (*Pipilo maculates*; 52% of points), red-faced warbler (*Cardellina rubrifrons*; 49% of points), western tanager (*Piranga ludoviciana*; 47 % of points), American robin (*Turdus migratorius*; 41% of survey points), Steller's jay (*Cyanocitta stelleri*; 38% of points), hermit thrush (*Catharus guttatus*; 37% of survey points), cordilleran flycatcher (*Empidonax occidentalis*; 37% of survey points), and Grace's warbler (*Dendroica graciae*; 37% of survey points).

We detected biologically-significant responses in the relative abundance of 15 species of forest birds to recent wildfires (Table 7). Of these 15 species, most (82% in the first year and 92% in the second year post-burn) were less abundant following fire and most (64%) responded more strongly to severe as opposed to less-severe wildfire in the first year post-burn. Species that responded negatively to severe wildfire during the first year post-burn, in order of decreasing strength of responses, were warbling vireo, black-headed grosbeak, American robin, spotted towhee, hermit thrush, and Grace's warbler. Species that responded negatively to less-severe wildfire during the first year post-burn, in order of decreasing strength of responses, were house wren, black-headed grosbeak, plumbeous vireo, and Grace's warbler. Only Northern Flicker, Steller's jay, and white-breasted nuthatch responded positively to wildfire during the first year post-burn (Steller's jays and Northern flickers responded positively to both severe and less-severe wildfire whereas white-breasted nuthatches responded positively to severe wildfire).

Species that responded negatively to severe wildfire during the second year post-burn, in order of decreasing strength of responses, were hermit thrush, warbling vireo, American robin, western tanager, Grace's warbler, cordilleran flycatcher, black-headed grosbeak, and yellow-eyed junco. Species that responded negatively to less-severe wildfire during the second year post-burn, in order of decreasing strength of responses, were Cordilleran flycatcher, plumbeous vireo, yellow-eyed junco, American robin, house wren, white-breasted nuthatch, spotted towhee, hermit thrush, and black-headed grosbeak. Only northern flicker responded positively to wildfire (both severe and less-severe) during the second year post-burn. We were unable to detected biologically significant responses or we lacked sufficient data to run analyses for the remaining bird species, including the 3 species of conservation concern (elegant trogon, northern goshawk, and band-tailed pigeon). Because these species are rare, detecting effects of fire on abundance is difficult.

*Buff-breasted flycatcher population estimate and trend*--We conducted surveys on a total of 51 survey routes to estimate population size of buff-breasted flycatchers in southeastern Arizona in 2004 (Tables 1 and 2). We detected 74 buff-breasted flycatchers during

Table 7. Number of survey points in 3 general classes of burn severity (BS; no fire [0], less-severe fire [1], and severe fire [2])[1] at which we detected birds along 37 survey routes in 4 mountain ranges during surveys in southeastern Arizona (April-July 2000, 2004, and 2005) and results of ordinal logistic regression analyses showing the effect of no fire, less-severe fire, and severe fire on bird relative abundance through time (first and second year's post-burn relative abundance data minus pre-burn relative abundance data).

| | | | Year 1 Post-burn Minus Pre-burn | | | | | | Year 2 Post-burn Minus Pre-burn | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Coefficient | | Odds Ratio | | | | | Coefficient | | Odds Ratio | | | |
| Species | BS | Pts w/ Birds | *b* | SE | Exp *b* | 95% CI | Wald $\chi^2$ | *P* | Pts w/ Birds | *b* | SE | Exp *b* | 95% CI | Wald $\chi^2$ | *P* |
| Black-headed grosbeak | 0 | 81 | | | | | | | 56 | | | | | | |
| | 1 | 43 | -0.94 | 0.3 | 0.4 | 0.2-0.8 | 7.2 | 0.007 | 75 | -0.67 | 0.3 | 0.5 | 0.3-1.0 | 4.1 | 0.044 |
| | 2 | 37 | -1.21 | 0.4 | 0.3 | 0.1-0.6 | 10.7 | 0.001 | 55 | -0.97 | 0.4 | 0.4 | 0.2-0.8 | 7.4 | 0.007 |
| Spotted towhee | 0 | 64 | | | | | | | 59 | | | | | | |
| | 1 | 34 | -0.14 | 0.4 | 0.9 | 0.4-1.8 | 0.1 | 0.713 | 47 | -0.64 | 0.4 | 0.5 | 0.3-1.1 | 3.3 | 0.070 |
| | 2 | 20 | -0.88 | 0.5 | 0.4 | 0.2-1.1 | 3.3 | 0.070 | 37 | -0.40 | 0.4 | 0.7 | 0.3-1.4 | 1.1 | 0.291 |
| Yellow-eyed junco | 0 | 33 | | | | | | | 32 | | | | | | |
| | 1 | 38 | -0.4 | 0.4 | 0.6 | 0.3-1.5 | 1.0 | 0.309 | 66 | -1.6 | 0.4 | 0.3 | 0.1-0.5 | 14.8 | <0.001 |
| | 2 | 35 | -0.34 | 0.4 | 0.7 | 0.3-1.7 | 0.6 | 0.439 | 49 | -0.9 | 0.4 | 0.4 | 0.2-0.9 | 4.5 | 0.034 |
| Red-faced warbler | 0 | 39 | | | | | | | 25 | | | | | | |
| | 1 | 56 | 0.36 | 0.4 | 1.4 | 0.7-3.0 | 1.0 | 0.329 | 73 | 0.54 | 0.4 | 1.7 | 0.7-3.9 | 1.6 | 0.199 |
| | 2 | 35 | -0.67 | 0.4 | 0.5 | 0.2-1.2 | 2.6 | 0.110 | 44 | -0.62 | 0.5 | 0.5 | 0.2-1.3 | 1.8 | 0.178 |
| Cordilleran flycatcher | 0 | 28 | | | | | | | 29 | | | | | | |
| | 1 | 44 | 0.24 | 0.4 | 1.3 | 0.5-3.0 | 0.31 | 0.577 | 47 | -1.07 | 0.4 | 0.3 | 0.1-0.8 | 5.5 | 0.019 |
| | 2 | 33 | 0.21 | 0.5 | 1.2 | 0.5-3.1 | 0.21 | 0.649 | 31 | -0.94 | 0.5 | 0.4 | 0.2-1.0 | 3.7 | 0.055 |
| American robin | 0 | 46 | | | | | | | 29 | | | | | | |
| | 1 | 30 | -0.42 | 0.4 | 0.7 | 0.3-1.5 | 0.98 | 0.323 | 51 | -1.30 | 0.4 | 0.3 | 0.1-0.6 | 8.7 | 0.003 |
| | 2 | 25 | -0.91 | 0.5 | 0.4 | 0.2-1.0 | 3.92 | 0.048 | 32 | -1.11 | 0.5 | 0.3 | 0.1-0.8 | 5.3 | 0.020 |
| Steller's jay | 0 | 31 | | | | | | | 37 | | | | | | |
| | 1 | 28 | 1.40 | 0.5 | 4.1 | 1.4-11.2 | 7.4 | 0.006 | 49 | -0.07 | 0.4 | 0.9 | 0.4-2.0 | 0.04 | 0.849 |
| | 2 | 24 | 1.28 | 0.5 | 3.6 | 1.3-10.2 | 5.8 | 0.016 | 35 | -0.29 | 0.4 | 0.8 | 0.3-1.7 | 0.46 | 0.499 |
| Hermit thrush | 0 | 25 | | | | | | | 28 | | | | | | |
| | 1 | 33 | -0.21 | 0.5 | 0.8 | 0.3-2.1 | 0.2 | 0.665 | 50 | -0.79 | 0.4 | 0.5 | 0.2-1.1 | 3.28 | 0.070 |
| | 2 | 26 | -0.86 | 0.5 | 0.4 | 0.2-1.2 | 2.8 | 0.097 | 33 | -1.45 | 0.5 | 0.2 | 0.1-0.6 | 8.95 | 0.003 |

Table 7. Cont.

| | | Year 1 Post-burn Minus Pre-burn | | | | | | | Year 2 Post-burn Minus Pre-burn | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Coefficient | | Odds Ratio | | | | | Coefficient | | Odds Ratio | | | |
| Species | BS | Pts w/ Birds | *b* | SE | Exp *b* | 95% CI | Wald $\chi^2$ | *P* | Pts w/ Birds | *b* | SE | Exp *b* | 95% CI | Wald $\chi^2$ | *P* |
| Grace's warbler | 0 | 39 | | | | | | | 23 | | | | | | |
| | 1 | 27 | -0.78 | 0.5 | 0.5 | 0.2-1.1 | 2.8 | 0.091 | 57 | -0.55 | 0.5 | 0.6 | 0.2-1.4 | 1.5 | 0.227 |
| | 2 | 16 | -1.02 | 0.6 | 0.4 | 0.1-1.1 | 3.0 | 0.085 | 27 | -0.91 | 0.5 | 0.4 | 0.1-1.1 | 2.9 | 0.087 |
| House wren | 0 | 20 | | | | | | | 20 | | | | | | |
| | 1 | 19 | -1.45 | 0.6 | 0.2 | 0.1-0.8 | 5.5 | 0.019 | 28 | -1.06 | 0.6 | 0.4 | 0.1-1.0 | 3.6 | 0.056 |
| | 2 | 23 | -0.60 | 0.6 | 0.5 | 0.2-1.7 | 1.1 | 0.291 | 38 | 0.33 | 0.5 | 1.4 | 0.5-3.8 | 0.4 | 0.532 |
| Plumbeous vireo | 0 | 35 | | | | | | | 27 | | | | | | |
| | 1 | 25 | -1.05 | 0.5 | 0.4 | 0.1-0.9 | 4.3 | 0.037 | 38 | -1.22 | 0.5 | 0.3 | 0.1-0.8 | 6.4 | 0.011 |
| | 2 | 16 | -0.26 | 0.6 | 0.8 | 0.2-2.4 | 0.2 | 0.656 | 23 | -0.25 | 0.8 | 0.8 | 0.3-2.2 | 0.2 | 0.624 |
| Warbling vireo | 0 | 18 | | | | | | | 18 | | | | | | |
| | 1 | 23 | -0.38 | 0.6 | 0.7 | 0.2-2.2 | 0.4 | 0.512 | 32 | 0.11 | 0.5 | 1.1 | 0.4-3.2 | 0.04 | 0.832 |
| | 2 | 11 | -2.14 | 0.8 | 0.1 | 0.1-0.5 | 7.7 | 0.006 | 14 | -1.17 | 0.7 | 0.3 | 0.1-1.2 | 2.95 | 0.086 |
| White-breasted nuthatch | 0 | 34 | | | | | | | 34 | | | | | | |
| | 1 | 17 | 0.47 | 0.6 | 1.6 | 0.5-5.4 | 0.6 | 0.454 | 31 | -0.80 | 0.8 | 0.4 | 0.2-1.1 | 2.9 | 0.090 |
| | 2 | 18 | 0.98 | 0.6 | 2.6 | 0.8-8.6 | 2.7 | 0.103 | 24 | -0.28 | 0.5 | 0.8 | 0.3-2.0 | 0.3 | 0.566 |
| Western tanager | 0 | 39 | | | | | | | 44 | | | | | | |
| | 1 | 35 | 0.16 | 0.4 | 1.2 | 0.5-2.7 | 0.1 | 0.710 | 52 | -1.03 | 0.4 | 0.4 | 0.2-0.8 | 6.5 | 0.010 |
| | 2 | 27 | 0.23 | 0.5 | 1.3 | 0.5-3.1 | 0.2 | 0.620 | 47 | -1.07 | 0.4 | 0.3 | 0.2-0.8 | 6.7 | 0.009 |
| Northern flicker | 0 | 43 | | | | | | | 28 | | | | | | |
| | 1 | 20 | 0.85 | 0.5 | 2.3 | 0.8-6.6 | 2.5 | 0.113 | 32 | 1.07 | 0.5 | 2.9 | 1.1-8.0 | 4.3 | 0.038 |
| | 2 | 12 | 0.92 | 0.6 | 2.5 | 0.7-8.7 | 2.0 | 0.148 | 18 | 1.90 | 0.6 | 6.4 | 1.9-2.1 | 9.3 | 0.002 |

[1] Less severe fire = burn severity index classes 0.5 to 2 and severe fire = burn severity index classes 2.5 to 4 (see Methods and Data Analysis Section for complete description of burn severity index).

surveys (Tables 8 and 9) and detected several buff-breasted flycatchers incidentally when not conducting surveys (e.g., when we were sampling vegetation; Appendix 1). We found buff-breasted flycatchers in areas where the species has not been reported previously, including Mica Meadow in the Rincon Mountains and Temporal Gulch in the Santa Rita Mountains (birds originally located by M. Brown). During the 2005 field season, we found several additional buff-breasted flycatchers incidentally in areas where the species had not been recorded previously, including John Long Canyon and Lower West Turkey Creek in the Chiricahua Mountains, Upper Huachuca Canyon and Miller Ridge (just below Carr Peak) in the Huachuca Mountains, and Deerspring and Heartbreak Ridge Trails in the Rincon Mountains (Appendix 2).

We also conducted 21 replicate surveys on 13 survey routes in 2004 and 2005 to estimate population size and trend in the Rincon Mountains (Tables 1 and 2). During the 2 years of surveys in the Rincon Mountains, we detected buff-breasted flycatchers at 6 survey points along 4 of the 13 survey routes. We also detected a male in the Manning Camp campground in 2004. We detected a total of 2 males in 2000, 5 males in 2004 (including the male at Manning Camp; Tables 8 and 9), and 4 males and 1 female in 2005. The female buff-breasted flycatcher that we observed in 2005 appeared to be paired with the male buff-breasted flycatcher on the Cowhead Saddle Trail survey route. Most of the male buff-breasted flycatchers that we detected each year were located in areas that were isolated (i.e., 1-2 km) from one another except for 3 males that we detected within 600 m of one another along the West Manning Camp survey route in 2005. The two birds detected incidentally on the Deerspring and Heartbreak Ridge Trails in early April 2005 (see above) were not detected during subsequent surveys along these routes in May/June 2005. Thus, we did not include these birds into our overall estimate of population size for the Rincon Mountains in 2005 because the birds may have moved by the time we conducted surveys in May/June and we did not want to run the risk of double-counting these individuals.

*Effects of recent wildfires on forest structure*--We sampled forest structure at a total of 106 survey points of which 36 were unburned (BSI class 0), 11 were burned by a recent low-severity surface fire (BSI class 1), 20 were burned by a recent moderate-severity surface fire (BSI class 2), 20 were burned by a recent high-severity surface fire (BSI class 3), and 19 were burned by a recent high-severity crown fire (BSI class 4). All of the newly burned survey points were located in the Huachuca, Rincon, or Santa Catalina Mountains. As expected, we found that recent wildfires, especially severe wildfires, had a strong effect on the structure of forests in southeastern Arizona (Figs. 3-5).

High-severity crown fires (BSI class 4) had the greatest overall effect on total vegetation cover (from oaks, conifers, and other tree species; Fig. 3). Total vegetation cover was reduced 16%, 94%, 92%, and 81% in the 1.5-2 m, 2-5 m, 5-10 m, and >10 m height categories, respectively, when comparing survey points with high-severity crown fires to those that were unburned. High-severity crown fires appeared to have had a stronger affect on oak cover compared to conifer cover in most height categories (Figs. 4 and 5). However, oak cover was approximately similar in the 1.5-2 m height category at survey points with high-severity crown fire (7%) compared to unburned survey points (9%);

Table 8. Number of buff-breasted flycatchers (BBFL) detected during surveys along 37 survey routes (18 burned and 19 unburned) in the Huachuca, Pinaleno, and Santa Catalina Mountains for our examination of the effect of recent wildfires on forest birds in southeastern Arizona.

| | | | # BBFL Detected | | |
|---|---|---|---|---|---|
| Mt. Range | Route Name | Wildfire[1] | 2000[2] | 2004 | 2005 |
| Pinaleno | Ash Creek | NG | 0 | - | 0 |
| | Arcadia/Wet Creek | - | 0 | - | 0 |
| | Noon Creek | - | 0 | - | 0 |
| | Riggs Lake | NG | 0 | - | 0 |
| Santa Catalina | Bear Canyon | B | 0 | 0 | 0 |
| | Box Camp Trail | A | 0 | 0 | 0 |
| | Butterfly Trail | B | 0 | 0 | 0 |
| | Canada del Oro | A | 0 | 0 | 0 |
| | Forest Service Road 38 | B | 0 | 0 | 0 |
| | Organization Ridge | B | 0 | 0 | 0 |
| | Rose Canyon | A | 0 | - | 0 |
| | Sabino Canyon | A | 0 | 0 | 0 |
| | Samaniego Ridge | - | 0 | 0 | 0 |
| | Spencer Canyon | A | 0 | 0 | 0 |
| | Sycamore Canyon | A | 0 | 0 | 0 |
| | Willow Canyon | A | 0 | 0 | 0 |
| Huachuca | Carr Canyon | - | 4 | 23 | 0 |
| | Crest Trail | - | 2 | 0 | 0 |
| | Garden Canyon | - | 2 | 0 | 0 |
| | Garden Pond | - | 2 | 0 | - |
| | Lower Garden Canyon | - | 2 | 0 | 0 |
| | Lower Oversite Canyon | - | 1 | 0 | 0 |
| | Lower Ramsey Canyon | - | 0 | 0 | 0 |
| | Miller Canyon | O | 1 | 0 | 0 |
| | Oversite Canyon | O | 0 | 0 | 0 |
| | Ramsey Canyon | O | 0 | 0 | 0 |
| | Rock Springs Canyon | - | 1 | 3 | - |
| | Sawmill Canyon | - | 7 | 7 | - |
| | Scheelite Canyon | - | 1 | 3 | - |
| | Scotia Canyon | - | 4 | 5 | - |
| | Upper Sunnyside Canyon | - | 1 | 8 | 0 |
| Rincon | Cowhead Saddle Trail | H | 1 | 1 | 2 |
| | Devil's Bathtub Trail | - | 0 | 0 | 0 |
| | Heartbreak Ridge Trail | - | 0 | 0 | 0 |
| | Manning Camp Trail | - | 0 | 1 | 0 |
| | Spud Rock Trail | H | 0 | 0 | 0 |
| | West Manning Camp | - | 0 | 1 | 3 |

[1] B = Bullock wildfire (2002), O = Oversite wildfire (2002), A = Aspen wildfire (2003), H = Helen's 2 wildfire (2003), and NG = Nuttall-Gibson wildfires (2004).
[2] 2000 survey data from Conway and Kirkpatrick (2001).

Table 9. Buff-breasted flycatchers (BBFL) detected during surveys along 26 survey routes in the Chiricahua, Huachuca, and Rincon Mountains, Arizona for our range-wide population and trend estimate (2004) and Rincon Mountain population and trend estimate (2004 and 2005).

| | | # BBFL Detected | | |
|---|---|---|---|---|
| Mt. Range | Route Name | 2000[1] | 2004 | 2005 |
| Chiricahua | Bear Canyon | 0 | 0 | - |
| | East Turkey Creek | 0 | 0 | - |
| | Horsefall Canon | 2 | 0 | - |
| | Lower Pinery Canyon | 3 | 1 | - |
| | Lower Rucker Canyon | 5 | 6 | - |
| | Middle Fork Cave Creek | 2 | 3 | - |
| | Pine Canyon | 2 | 0 | - |
| | Polebridge Canyon | 2 | 0 | - |
| | Red Rock Canyon | 0 | 0 | - |
| | Saulsbury Canyon | 2 | 0 | - |
| | South Fork Cave Creek | 0 | 0 | - |
| | Sulpher Draw | 0 | 0 | - |
| | Upper Pinery Canyon | 4 | 2 | - |
| | Upper Rucker Canyon | 2 | 2 | - |
| | Ward Canyon | 3 | 0 | - |
| | West Turkey Creek | 0 | 3 | - |
| | Whitetail Canyon | 0 | 0 | - |
| Huachuca | Miller Ridge | 2 | 1 | 3 |
| | Sunnyside Canyon | 1 | 8 | - |
| Rincon | Chiminea Canyon | 0 | - | 0 |
| | Dear Spring Trail | 0 | - | 0 |
| | Italian Springs | 0 | - | 0 |
| | Mica Meadow | 0 | 1 | 0 |
| | Mica Mountain | 0 | 0 | 0 |
| | Miller Creek | 0 | - | 0 |
| | Rincon Peak | 0 | - | 0 |

[1] 2000 survey data from Conway and Kirkpatrick (2001).

Figure 3. Mean percent cover (±1 SE) of all live vegetation in 4 height classes at survey points that were unburned (BSI class 0), burned by a low-severity surface fire (BSI class 1), a moderate-severity surface fire (BSI class 2), a high-severity surface fire (BSI class 3), or a high-severity crown fire (BSI class 4). Vegetation data were collected at 106 survey points located in forests in the Chiricahua, Huachuca, Rincon, and Santa Catalina Mountains in 2004 following wildfires in 2002 and 2003.

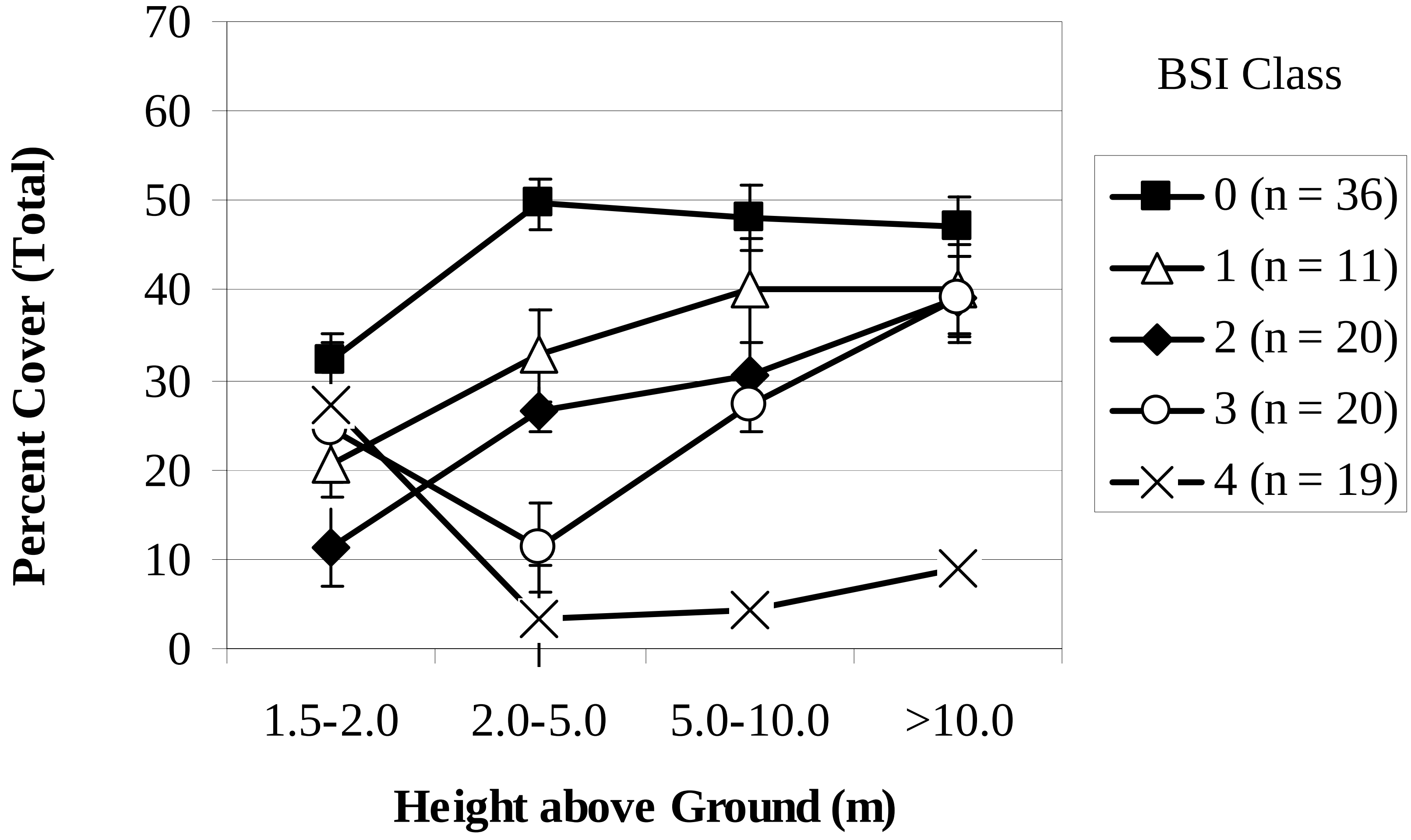


Figure 4. Mean percent cover (±1 SE) of oak vegetation in 4 height classes at survey points that were unburned (BSI class 0), burned by a low-severity surface fire (BSI class 1), a moderate-severity surface fire (BSI class 2), a high-severity surface fire (BSI class 3), or a high-severity crown fire (BSI class 4). Vegetation data were collected at 106 survey points located in forests in the Chiricahua, Huachuca, Rincon, and Santa Catalina Mountains in 2004 following wildfires in 2002 and 2003.

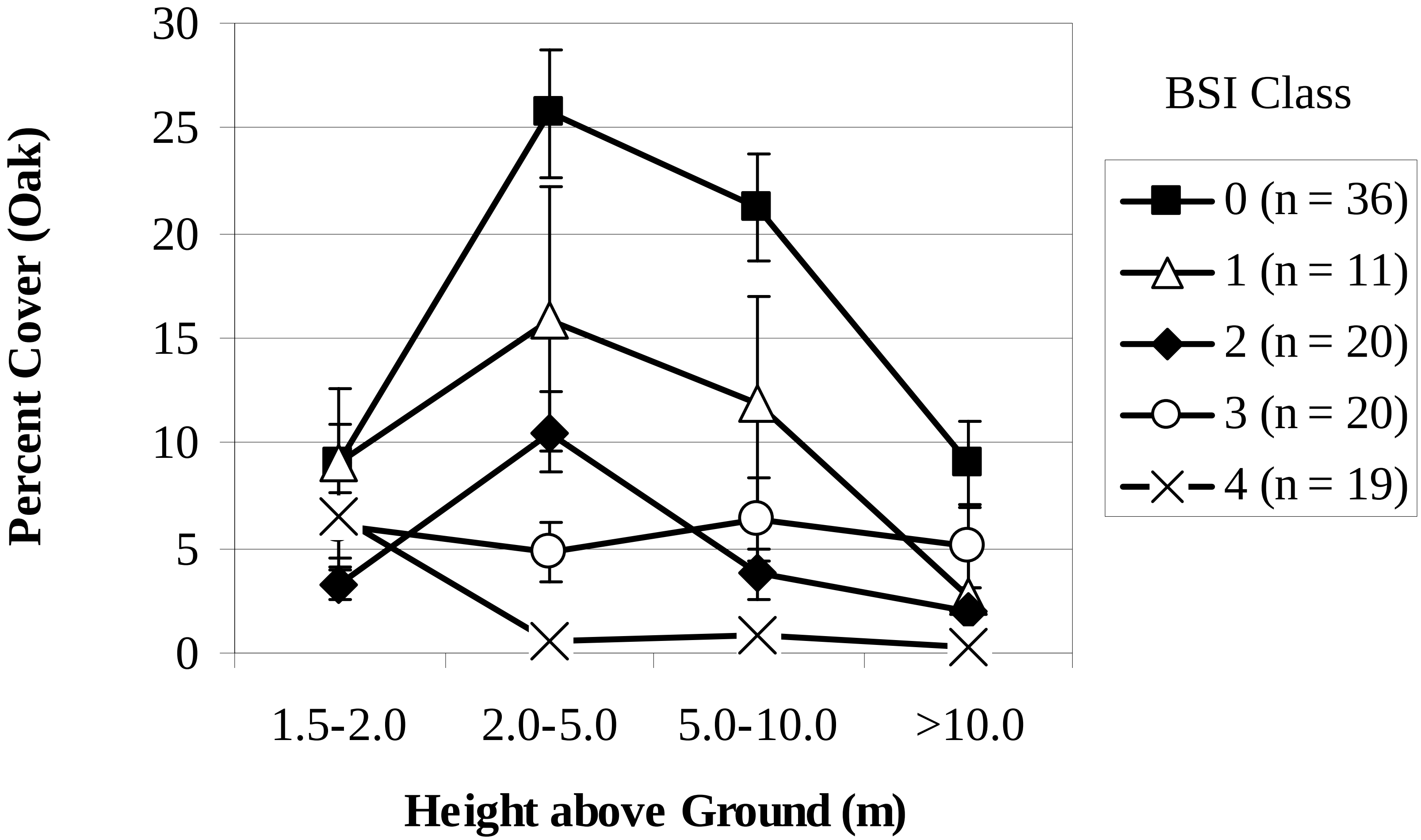
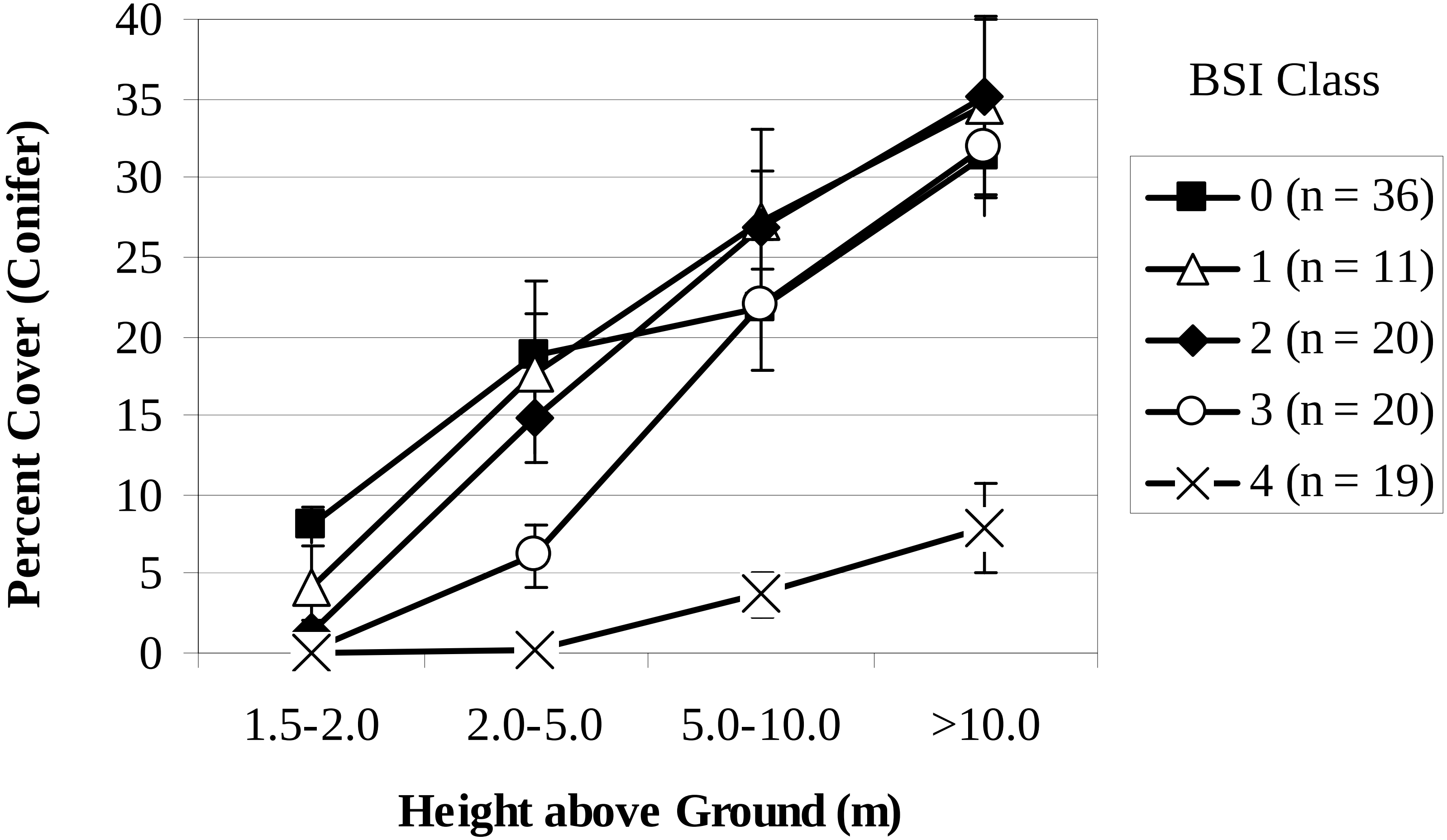


Figure 5. Mean percent cover (±1 SE) of conifer vegetation in 4 height classes at survey points that were unburned (BSI class 0), burned by a low-severity surface fire (BSI class 1), a moderate-severity surface fire (BSI class 2), a high-severity surface fire (BSI class 3), or a high-severity crown fire (BSI class 4). Vegetation data were collected at 106 survey points located in forests in the Chiricahua, Huachuca, Rincon, and Santa Catalina Mountains in 2004 following wildfires in 2002 and 2003.



whereas, average conifer cover was reduced 100% (8% to 0%) in this height category. In addition, some conifer cover (4-8%) persisted in the 5-10 m and >10 m height categories, whereas virtually no oak cover persisted in these height categories after high-severity crown fire.

High-severity surface fires (BSI class 3) had a moderate overall effect on total vegetation cover (from oaks, conifers, and other tree species; Fig. 3). Total vegetation cover was reduced 22%, 78%, 44%, and 17% in the 1.5-2 m, 2-5 m, 5-10 m, and >10 m height categories, respectively, when comparing survey points with high-severity surface fires to those that were unburned. High-severity surface fires appeared to have had a stronger affect on average oak cover compared to average conifer cover in most height categories (Figs. 4 and 5). As with survey points with high-severity crown fire, we found that oak cover was approximately similar in the 1.5-2 m height category at survey points with high-severity surface fire (6%) compared to unburned survey points (9%), whereas conifer cover was reduced 100% (8% to 0%) in this height category.

Finally, low and moderate-severity surface fires (BSI classes 1-2) had the least effect on total vegetation cover (from oaks, conifers, and other tree species; Fig. 3). For moderate-severity surface fires, total vegetation cover was reduced 66%, 46%, 37%, and 17% in the 1.5-2 m, 2-5 m, 5-10 m, and >10 m height categories, respectively, when comparing survey points with moderate-severity surface fires to those that were unburned. For low-severity surface fires, total vegetation cover was reduced 38%, 35%, 17%, and 15% in the 1.5-2 m, 2-5 m, 5-10 m, and >10 m height categories, respectively, when comparing survey points with low-severity surface fires to those that were unburned. In general, low- and moderate-severity surface fires appeared to have had a stronger affect on average oak cover compared to average conifer cover in all height categories (Figs. 4 and 5).

## DISCUSSION

*Effects of recent wildfires on buff-breasted flycatchers*--Recent wildfires (1-3 years post-burn) appear to have had little immediate effect on the distribution and relative abundance of buff-breasted flycatchers in the Sky Island Mountains of southeastern Arizona. We found that buff-breasted flycatchers did not expand their distribution into burned forests in the Pinaleno or Santa Catalina Mountains in the first few years following recent wildfires. In addition, we were unable to detect a difference in the relative abundance of buff-breasted flycatchers on our burned versus unburned BACI survey routes following recent wildfires in the Huachuca and Rincon Mountains. Conway and Kirkpatrick (2006) also found no difference in buff-breasted flycatcher presence/absence between a small sample of recently burned (<10 years post-burn) and unburned plots in the Chiricahua Mountains. Because we were unable to detect any effect of recent wildfires on buff-breasted flycatchers, we were also unable to determine whether or not buff-breasted flycatchers were associated more strongly with areas burned by high-severity surface and crown fires, a correlation reported previously for the species (Conway and Kirkpatrick 2006). However, results from our BACI study must be viewed as tentative because of the relatively small sample size of burned survey routes in the study design and the fact that many of our burned survey routes were only partially burned during recent wildfires.

Although we did not observe an immediate effect of recent wildfires on buff-breasted flycatcher populations, frequency of fire and time since fire may be important factors in determining if and when a burned area becomes suitable or even optimal habitat for buff-breasted flycatchers (Martin 1997, Conway and Kirkpatrick 2006). Recently burned forests in southeastern Arizona may provide some but not all of the habitat characteristics required for buff-breasted flycatcher occupancy and persistence. For example, buff-breasted flycatchers prefer forests characterized by an open canopy of pines (Marshall 1957, Bowers and Dunning 1994, Martin 1997). Looking at the aftereffects of recent high-severity surface fires (1 of 2 burn-severity class shown to be positively correlated with buff-breasted flycatcher abundance; Conway and Kirkpatrick 2006), we found that forests that had been recently burned had 17% less total canopy cover >10 m compared to unburned forests, resulting in a more open forest canopy post-burn. Thin-barked trees such as oaks are more susceptible to mortality from wildfires than thick-barked conifers (Whelan 1995) and the reduction in total canopy cover that we observed post-burn was due almost entirely to a reduction in oak cover >10 m. Thus, not only did the forest canopy become more open following high-severity surface fire, but the ratio of oaks to pines in the forest canopy decreased; both habitat characteristics purportedly preferred by buff-breasted flycatchers (Marshall 1957, Bowers and Dunning 1994, Martin 1997).

However, buff-breasted flycatchers also prefer forests with an open understory of oaks (Martin 1997) and buff-breasted flycatchers have been observed using understory oaks as a substrate for perching, foraging, and occasionally nesting (Martin 1997, Conway and Kirkpatrick 2001). Martin (1997) found that buff-breasted flycatchers were negatively associated with dense understory oak cover yet still preferred to inhabit forests with 15% and 9% oak cover between 2-5 and 5-10 m, respectively. In fact, Martin (1997) found that buff-breasted flycatchers never inhabited forests that lacked oak cover in the understory. We found that areas affected by high-severity surface fires had oak cover that averaged only 5% and 6% between 2-5 and 5-10 m height, respectively. We speculate that high-severity surface fire may reduce understory oak cover (and possible other unmeasured habitat variables) below some minimum level deemed suitable by buff-breasted flycatchers during the first few years post-burn. With time, understory oak cover between 2-10 m should increase, as evidenced by the rapid sprouting of oaks from burned stumps that we observed in the 1.5-2 m height class following high-severity surface fires.

Although our sample size of fire-scarred trees was small, results from our analysis of fire history data indicate that buff-breasted flycatchers were, in fact, associated with forests in southeastern Arizona that have been burned more frequently in the last 30 years than adjacent control areas. In areas where we observed buff-breasted flycatchers (and evidence of ≥1 previous fire), we found that median time to the most recent fire was earlier (12 versus 28 years) and the frequency of fire within the last 30 years was greater (1.0 versus 0.67 fires) compared to areas without buff-breasted flycatchers. Interestingly, we found that that some buff-breasted flycatchers in the Chiricahua and Huachuca Mountains, including a relatively large colony of birds in Sawmill Canyon, are breeding in areas that appear to have no evidence of previous fires (at least in the last 50-100 years) based on our failure to find any fire-scarred trees. The presence of buff-breasted flycatchers in these areas suggests one or more of the following: 1) buff-breasted flycatchers are selecting habitat characteristics independent of those influenced by fires, 2) buff-breasted flycatchers are inhabiting forests that are unburned but nevertheless provide optimal habitat (e.g., forests near campgrounds or picnic areas that have a maintained, open understory; Martin 1997), or 3) buff-breasted flycatchers are selecting sub-optimal habitat because optimal habitat has been limited in mountains of southeastern Arizona following almost a century of fire suppression in the region.

Anecdotal evidence also suggests that increased time since fire (approximately 10-30 years) is conducive to increases in buff-breasted flycatcher presence and relative abundance in forests of southeastern Arizona. For example, Carr Canyon in the Huachuca Mountains has seen a substantial increase in the number of buff-breasted flycatchers since the severe Carr wildfire in 1976 (Bowers and Dunning 1994) and a subsequent fire circa 1990 (as recorded in our fire-scar samples). Before the Carr wildfire, a maximum of 1-2 pairs of buff-breasted flycatchers were detected in the area (Bowers and Dunning 1994). After the wildfire, 5 adults were detected in 1980, 9 adults were detected in 1983 (Bowers and Dunning 1994), 9 adults were detected in 2000, and 23 adults were detected in 2004 (Conway and Kirkpatrick 2006). We observed a similar, albeit less dramatic, increase in the number of buff-breasted flycatchers detected in the Rincon Mountains (from 2 to 5 birds) during the 3 years that surveys were conducted in this mountain range (i.e., 2000, 2004, and 2005). We believe that buff-breasted flycatchers may already be breeding within the Rincon Mountains as evidenced by the presence of a mated pair and a small colony of male buff-breasted flycatchers that we observed during surveys in 2005 (buff-breasted flycatchers often breed in loose colonies; Bowers and Dunning 1994).

The recent observations of buff-breasted flycatchers in the Rincon Mountains represent the first documented records of this species in this mountain range since 18 August 1911, when a juvenile buff-breasted flycatcher was collected by H. Brown at Manning Camp (Marshall 1957, Conway and Kirkpatrick 2006). The continuing presence, increasing number of birds, and possible breeding of buff-breasted flycatchers in the Rincon Mountains likely represents the first northward range expansion of buff-breasted flycatchers within the U.S. following the contraction of this species' breeding range during the last century (Kirkpatrick et al. in press). Based on records from the National Park Service and U.S. Forest Service, the Rincon Mountains have experienced more wild and prescribed fires in the last few decades compared to other mountain ranges in southeastern Arizona (Kirkpatrick et al. 2006). Fire-scar data from the current study also support this contention. We suspect that the recent colonization of the Rincon Mountains by buff-breasted flycatchers is due, in part, to recent changes in the fire regime within this mountain range. If so, the wildfires that burned across southeastern Arizona (and elsewhere in the State) from 2002-2004 may ultimately serve to create potential buff-breasted flycatcher habitat and facilitate re-colonization of buff-breasted flycatchers in other parts of the species' historical range (e.g., the Santa Catalina Mountains or even the White Mountains in east-central Arizona).

In conclusion, we found tentative evidence (e.g., results from our BACI study) that populations of buff-breasted flycatchers were unaffected in the short term by recent wildfires in the Sky Island Mountains of southeastern Arizona. We also found tentative evidence (e.g., fire history data and Rincon Mountain population trend data) to suggest that buff-breasted flycatchers prefer forests that have been burned more frequently within the last 30 years compared to adjacent forested areas. Our results add to a growing body of correlative (Conway and Kirkpatrick 2006) and anecdotal (Bowers and Dunning 1994) evidence supporting the hypothesis that fire suppression has been responsible, in part, for the range contraction and population declines of buff-breasted flycatchers in the southwestern U.S. during the 20th century. Furthermore, our results indicate that buff-breasted flycatchers may ultimately benefit from the recent wildfires in southeastern Arizona (and elsewhere in the State) as forest succession transforms recently burned areas into potential buff-breasted flycatcher habitat.

*Effects of recent wildfires on other forest bird species*--Of the 15 species for which we had sufficient data for analyses, we found that most species responded more strongly (either positively or negatively) to severe as opposed to less-severe fire, especially in the first year post-burn. Similarly, Kirkpatrick et al. (2006) found that bird species showed stronger associations (either positive or negative) to burned areas with evidence of severe as opposed to less-severe fire in southeastern Arizona, a pattern that has been reported for other forest bird communities in the western U.S. (Hejl 1994, Hutto 1995). We also found that most species responded negatively to recent wildfires. In contrast, Kirkpatrick et al. (2006) found that most bird species were positively associated with burned areas in montane forests of southeastern Arizona. However, the post-burn data collected during this study were collected in burned areas that had experienced fires that were on average several years older (median time since fire was 6 years; Kirkpatrick et al. 2006) than the wildfires studied here.

As with buff-breasted flycatchers, time since fire appears to be an important variable in the response of many other bird species to fire in southeastern Arizona. Some species, such as the northern flicker, may benefit from the immediate effects of recent fires (as seen during the current study and previous studies; Raphael and White 1984). In contrast, other species such as house wrens and Grace's warblers may initially decline in abundance in burned areas after fire (as seen during the current study) but then increase in abundance in these burned areas after several years (as observed in previous studies; Kirkpatrick et al. 2006). Still other species are consistently less abundant in burned areas whether immediately or several years after fire (e.g., warbling vireo; Kirkpatrick et al. 2006). Results from our study provide managers with information that can be used to make and test predictions about the immediate effects of future wild and prescribed fires (of varying severities) on forest birds in the southwestern U.S.

## MANAGEMENT IMPLICATIONS

We recommend that wildlife managers continue to monitor populations of buff-breasted flycatchers on a regular basis (e.g., once every 3 years) by replicating surveys along established buff-breasted flycatcher survey routes in southeastern Arizona (Conway and Kirkpatrick 2001). Results from our population estimate indicate that buff-breasted flycatchers were more abundant along survey routes in 2004 ($n$ = 74) than in 2000 ($n$ =

55; Conway and Kirkpatrick 2001). However, population size in 2004 was still less than the estimated population size reported from the 1995/1996 survey effort ($n$ = 86; Martin 1997). Continued monitoring of buff-breasted flycatcher populations is warranted given the small population size and restricted geographic range of this rare species in the U.S. We also recommend that wildlife managers replicate surveys along established buff-breasted flycatcher survey routes in the Santa Catalina Mountains starting in the next 5-10 years to further evaluate the effects of the recent wildfires on buff-breasted flycatchers. We predict that buff-breasted flycatchers will begin to colonize recently burned forests, especially those affected by severe surface fires, within the next 10-15 years in this mountain range.

The Santa Catalina Mountains seem especially well suited for colonization by buff-breasted flycatchers because the mountain range is part of the species' historical range and contains several broad canyons and ridges with pine forest or pine-oak woodland that were burned during the recent Aspen and Bullock wildfires (e.g., Bear Canyon, Box Camp Trail, Rose Canyon, and Sabino Canyon). In addition, several male buff-breasted flycatchers have been reported incidentally in the Santa Catalina Mountains during the 1990s (Martin 1997, Benesh 1997), so we know that buff-breasted flycatchers occasionally disperse through this mountain range. Recent wildfires have created a mosaic of post-burn conditions in forests in the Santa Catalina Mountains and 48% of our burned survey points in this mountain range were affected entirely or partially by high-severity surface or crown fires. High-severity surface and crown fire are the burn-severity classes shown to be positively correlated with buff-breasted flycatcher abundance (Conway and Kirkpatrick 2006) and the burn-severity classes that may have the best potential to create habitat characteristics preferred by buff-breasted flycatchers (e.g., an open canopy of pines with an open understory of oaks; Martin 1997).

Additional research is needed to confirm or refute the hypothesis that buff-breasted flycatchers prefer burned forests in the southwestern U.S. because 1) buff-breasted flycatchers did not colonize newly burned areas immediately after fire during our study, and 2) results from our analysis of fire-scar data are tentative given our small sample size of fire-scarred tress. Recent wildfires on the periphery of the species range (e.g., in the Santa Catalina Mountains) provide a natural experiment with which to test this hypothesis further during the next few decades. We also need to determine the reproductive success of buff-breasted flycatchers within burned areas because the mere presence or increased abundance of the species within a burn does not necessarily indicate that the area represents optimal habitat for the species (Van Horne 1983). Finally, we need additional data on the effects of fire on many other species of forest birds in southeastern Arizona, including species of conservation concern such as the band-tailed pigeon, elegant trogon, and northern goshawk. The Burn Severity Index refined during our study may provide a useful method for the rapid assessment of burn severities during future bird surveys.

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Appendix 1. Locations and dates of buff-breasted flycatcher detections (during 6-min surveys and incidentally) in the Chiricahua, Huachuca, Rincon, and Santa Rita mountains, Arizona from April-July 2004.

| | | | Number of Adult Birds Detected | | | | UTM Coordinates[1] | | |
|---|---|---|---|---|---|---|---|---|---|
| Location (Survey Route or Incidental Point)[2] | Nearest Survey Point | Date Detected | 6-Min Survey | Incid. | Total | Male/ Female/ Sex Unknown | East | North | Elev. (m) |
| Chiricahua Mountains | | | | | | | | | |
| Lower Pinery Canyon | 12 | 5/14 | 1 | 0 | 1 | 1/ 0/ 0 | 659075 | 3537406 | 1761 |
| Lower Rucker Canyon | 7 | 5/24 | 1 | 0 | 1 | 0/ 0/ 1 | 657592 | 3514937 | 1755 |
| Lower Rucker Canyon | 8 | 5/24 | 1 | 1 | 2 | 0/ 1/ 1 | 657458 | 3514852 | 1756 |
| Lower Rucker Canyon | 9 | 5/24 | 1 | 1 | 2 | 1/ 0/ 1 | 657327 | 3514792 | 1754 |
| Lower Rucker Canyon | 14 | 5/24 | 1 | 0 | 1 | 0/ 1/ 0 | 656602 | 3514660 | 1737 |
| Lower Rucker Canyon | 15 | 5/24 | 1 | 0 | 1 | 1/ 0/ 0 | 656503 | 3514558 | 1731 |
| Lower Rucker Canyon | 23 | 5/24 | 1 | 0 | 1 | 1/ 0/ 0 | 655154 | 3514453 | 1710 |
| Middle Fork Cave Creek | 4 | 6/9 | 2 | 0 | 2 | 1/ 0/ 1 | 669004 | 3528851 | 1659 |
| Middle Fork Cave Creek | 6 | 6/9 | 1 | 0 | 1 | 1/ 0/ 0 | 668725 | 3528660 | 1685 |
| Upper Pinery Canyon | 2 | 5/14 | 1 | 0 | 1 | 1/ 0/ 0 | 660119 | 3535912 | 1832 |
| Upper Pinery Canyon | 4 | 5/14 | 1 | 0 | 1 | 1/ 0/ 0 | 660408 | 3535824 | 1839 |
| Upper Rucker Canyon | 2 | 5/24 | 1 | 0 | 1 | 1/ 0/ 0 | 659705 | 3516570 | 1825 |
| Upper Rucker Canyon | 6 | 5/24 | 1 | 0 | 1 | 1/ 0/ 0 | 659882 | 3517107 | 1837 |
| West Turkey Creek | 5 | 4/28 | 1 | 0 | 1 | 1/ 0/ 0 | 658145 | 3525429 | 1961 |
| West Turkey Creek | 7 | 4/28 | 2 | 0 | 2 | 1/ 1/ 0 | 658318 | 3525156 | 1997 |
| Huachuca Mountains | | | | | | | | | |
| Carr Canyon | 1 | 5/27 | 1 | 0 | 1 | 1/ 0/ 0 | 566108 | 3477365 | 2252 |
| Carr Canyon | 6 | 5/27 | 1 | 0 | 1 | 1/ 0/ 0 | 566419 | 3477040 | 2246 |
| Carr Canyon | 7 | 5/27 | 2 | 0 | 2 | 1/ 0/ 0 | 566497 | 3477026 | 2245 |
| Carr Canyon | 8 | 5/27 | 2 | 0 | 2 | 1/ 0/ 1 | 566551 | 3476970 | 2247 |
| Carr Canyon | 9 | 5/27 | 2 | 0 | 2 | 1/ 0/ 0 | 566648 | 3476915 | 2257 |
| Carr Canyon | 10 | 5/27 | 2 | 0 | 2 | 1/ 0/ 0 | 566672 | 3476993 | 2253 |
| Carr Canyon | 13 | 5/27 | 1 | 0 | 1 | 1/ 0/ 0 | 566608 | 3477218 | 2237 |

Appendix 1. Cont.

| | | | Number of Adult Birds Detected | | | | UTM Coordinates[1] | | |
|---|---|---|---|---|---|---|---|---|---|
| Location (Survey Route or Incidental Point)[2] | Nearest Survey Point | Date Detected | 6-Min Survey | Incid. | Total | Male/ Female/ Sex Unknown | East | North | Elev. (m) |
| Carr Canyon | 16 | 5/27 | 1 | 0 | 1 | 1/ 0/ 0 | 566832 | 3477270 | 2200 |
| Carr Canyon | 17 | 5/27 | 1 | 0 | 1 | 1/ 0/ 0 | 566886 | 3477231 | 2202 |
| Carr Canyon | 18 | 5/27 | 1 | 0 | 1 | 1/ 0/ 0 | 566966 | 3477247 | 2194 |
| Carr Canyon | 20 | 5/27 | 1 | 0 | 1 | 1/ 0/ 0 | 567100 | 3477318 | 2195 |
| Carr Canyon | 22 | 5/27 | 2 | 2 | 4 | 1/ 0/ 3 | 567259 | 3477312 | 2190 |
| Carr Canyon | 24 | 5/27 | 2 | 0 | 2 | 1/ 0/ 1 | 567341 | 3477292 | 2192 |
| Carr Canyon | 25 | 5/27 | 1 | 0 | 1 | 1/ 0/ 0 | 567506 | 3477225 | 2191 |
| Carr Canyon | 26 | 5/27 | 2 | 0 | 2 | 1/ 1/ 0 | 567556 | 3477295 | 2193 |
| Carr Canyon | 27 | 5/27 | 1 | 0 | 1 | 1/ 0/ 0 | 567614 | 3477380 | 2195 |
| Garden Canyon | 1 | 5/10 | 2 | 0 | 2 | 1/ 1/ 0 | 559075 | 3480173 | 1900 |
| Lower Garden Canyon | 4 | 6/8 | 1 | 0 | 1 | 1/ 0/ 0 | 561270 | 3482085 | 1644 |
| Miller Ridge | 13 | 6/22 | 1 | 0 | 1 | 0/ 0/ 1 | 565486 | 3474368 | 2600 |
| Rock Spring Canyon | 1 | 6/8 | 1 | 0 | 1 | 1/ 0/ 0 | 559622 | 3485858 | 1942 |
| Rock Spring Canyon | 11 | 6/8 | 2 | 0 | 2 | 1/ 0/ 0 | 559034 | 3484839 | 2239 |
| Scheelite Canyon | 14 | 6/23 | 2 | 0 | 2 | 1/ 0/ 0 | 562560 | 3479779 | 2099 |
| Scheelite Canyon | 16 | 6/23 | 1 | 0 | 1 | 1/ 0/ 0 | 562491 | 3479499 | 2120 |
| Sawmill Canyon | 10 | 5/10 | 3 | 0 | 3 | 1/ 0/ 1 | 559513 | 3479648 | 1924 |
| Sawmill Canyon | 18 | 5/10 | 1 | 0 | 1 | 1/ 0/ 0 | 559938 | 3479084 | 1957 |
| Sawmill Canyon | 21 | 5/10 | 2 | 0 | 2 | 1/ 0/ 1 | 560087 | 3478888 | 1980 |
| Sawmill Canyon | 8 | 5/10 | 1 | 0 | 1 | 1/ 0/ 0 | 559393 | 3479740 | 1915 |
| Scotia Canyon | 12 | 5/10 | 1 | 0 | 1 | 1/ 0/ 0 | 557353 | 3480173 | 1849 |
| Scotia Canyon | 14 | 5/10 | 1 | 0 | 1 | 0/ 0/ 1 | 557166 | 3479959 | 1938 |
| Scotia Canyon | 17 | 5/10 | 1 | 0 | 1 | 1/ 0/ 0 | 556915 | 3479557 | 1814 |
| Scotia Canyon | 18 | 5/26 | 1 | 0 | 1 | 0/ 0/ 1 | 556923 | 3479414 | 1829 |

Appendix 1. Cont.

| | | | Number of Adult Birds Detected | | | | UTM Coordinates[1] | | |
|---|---|---|---|---|---|---|---|---|---|
| Location (Survey Route or Incidental Point)[2] | Nearest Survey Point | Date Detected | 6-Min Survey | Incid. | Total | Male/ Female/ Sex Unknown | East | North | Elev. (m) |
| Scotia Canyon | 19 | 5/26 | 1 | 0 | 1 | 1/ 0/ 0 | 556885 | 3479272 | 1824 |
| Sunnyside Canyon | 1 | 6/7 | 1 | 0 | 1 | 1/ 0/ 0 | 556655 | 3478035 | 1777 |
| Sunnyside Canyon | 2 | 6/7 | 1 | 0 | 1 | 1/ 0/ 0 | 556779 | 3478172 | 1780 |
| Sunnyside Canyon | 3 | 6/7 | 1 | 0 | 1 | 1/ 0/ 0 | 556865 | 3478344 | 1789 |
| Sunnyside Canyon | 4 | 6/7 | 1 | 0 | 1 | 0/ 0/ 1 | 557018 | 3478421 | 1793 |
| Sunnyside Canyon | 8 | 6/7 | 2 | 0 | 2 | 1/ 0/ 0 | 557621 | 3478761 | 1815 |
| Sunnyside Canyon | 9 | 6/7 | 2 | 0 | 2 | 1/ 1/ 0 | 557812 | 3478813 | 1819 |
| Upper Sunnyside Canyon | 11 | 4/21 | 0 | 1 | 1 | 1/ 0/ 0 | 559636 | 3477709 | 2005 |
| <u>Rincon Mountains</u> | | | | | | | | | |
| Cowhead Saddle Trail | 4 | 6/1 | 1 | 0 | 1 | 1/ 0/ 0 | 540642 | 3564014 | 2341 |
| Manning Camp Trail | 1 | 6/1 | 0 | 1 | 1 | 1/ 0/ 0 | 541996 | 3563462 | 2415 |
| Manning Camp Trail | 7 | 5/31 | 1 | 0 | 1 | 1/ 0/ 0 | 542694 | 3564268 | 2484 |
| Mica Meadow Trail | 5 | 5/31 | 1 | 0 | 1 | 1/ 0/ 0 | 543410 | 3564041 | 2548 |
| West Manning Camp | 8 | 6/2 | 1 | 0 | 1 | 1/ 0/ 0 | 541233 | 3563246 | 2301 |
| <u>Santa Rita Mountains</u> | | | | | | | | | |
| Temporal Gulch | 6 | 7/3 | 3 | 1 | 4 | 2/ 1/ 1 | 515142 | 3502795 | 1903 |

[1] NAD 83 datum.

[2] For description of survey routes see Conway, C. J., and C. Kirkpatrick. 2001. Population status, detection probability, and effects of fire on buff-breasted flycatchers. Final report. Arizona Game and Fish Department, Phoenix, AZ.

Appendix 2. Locations and dates of buff-breasted flycatcher detections (during 6-min surveys and incidentally) in the Chiricahua, Huachuca, Rincon, and Santa Rita mountains, Arizona from April-July 2005.

| | | | Number of Adult Birds Detected | | | | UTM Coordinates[1] | | |
|---|---|---|---|---|---|---|---|---|---|
| Location (Survey Route or Incidental Point)[2] | Nearest Survey Point | Date Detected | 6-Min Survey | Incid. | Total | Male/ Female/ Sex Unknown | East | North | Elev. (m) |
| <u>Chiricahua Mountains</u> | | | | | | | | | |
| John Long Canyon | 3 | 7/12 | 0 | 1 | 1 | 1/ 0/ 0 | 655067 | 3518700 | 1918 |
| Lower West Turkey Creek | 1 | 7/11 | 0 | 1 | 1 | 1/ 0/ 0 | 656403 | 3526790 | 1839 |
| Lower Pinery Canyon | 13 | 7/22 | 0 | 1 | 1 | 1/ 0/ 0 | 659004 | 3537609 | 1755 |
| Upper Pinery Canyon | 4 | 7/20 | 0 | 1 | 1 | 1/ 0/ 0 | 660408 | 3535824 | 1839 |
| <u>Huachuca Mountains</u> | | | | | | | | | |
| Carr Canyon | 3 | 5/27 | 1 | 0 | 1 | 1/ 0/ 0 | 566212 | 3477180 | 2245 |
| Carr Canyon | 7 | 4/14 | 2 | 0 | 2 | 1/ 1/ 0 | 566497 | 3477026 | 2245 |
| Carr Canyon | 8 | 4/14 | 1 | 0 | 1 | 1/ 0/ 0 | 566551 | 3476970 | 2247 |
| Carr Canyon | 10 | 4/14 | 1 | 0 | 1 | 1/ 0/ 0 | 566672 | 3476993 | 2253 |
| Carr Canyon | 12 | 5/27 | 2 | 0 | 2 | 2/ 0/ 0 | 566659 | 3477144 | 2246 |
| Carr Canyon | 13 | 5/27 | 1 | 0 | 1 | 0/ 1/ 0 | 566608 | 3477218 | 2237 |
| Carr Canyon | 16 | 4/14 | 1 | 0 | 1 | 1/ 0/ 0 | 566832 | 3477270 | 2200 |
| Carr Canyon | 17 | 4/14 | 1 | 0 | 1 | 1/ 0/ 0 | 566886 | 3477231 | 2202 |
| Carr Canyon | 21 | 4/14 | 1 | 0 | 1 | 0/ 1/ 0 | 567189 | 3477346 | 2190 |
| Carr Canyon | 22 | 5/27 | 2 | 0 | 2 | 1/ 1/ 0 | 567259 | 3477312 | 2190 |
| Carr Canyon | 23 | 4/14 | 2 | 0 | 2 | 1/10/ 0 | 567430 | 3477252 | 2191 |
| Carr Canyon | 24 | 4/14 | 1 | 0 | 1 | 1/ 0/ 0 | 567341 | 3477292 | 2192 |
| Carr Canyon | 26 | 5/27 | 2 | 0 | 2 | 1/ 1/ 0 | 567556 | 3477295 | 2193 |
| Garden Canyon | 8 | 6/12 | 1 | 0 | 1 | 1/ 0/ 0 | 558827 | 3481158 | 1948 |
| Lower Garden Canyon | 8 | 6/13 | 1 | 0 | 1 | 0/ 1/ 0 | 561165 | 3481586 | 1679 |
| Miller Ridge | 5 | 6/29 | 1 | 0 | 1 | 0/ 0/ 1 | 565421 | 3475409 | 2726 |

Appendix 2. Cont.

| Location (Survey Route or Incidental Point)[2] | Nearest Survey Point | Date Detected | Number of Adult Birds Detected: 6-Min Survey | Incid. | Total | Male/ Female/ Sex Unknown | UTM Coordinates[1]: East | North | Elev. (m) |
|---|---|---|---|---|---|---|---|---|---|
| Miller Ridge | 6 | 6/29 | 1 | 0 | 1 | 0/ 0/ 1 | 565260 | 3475328 | 2710 |
| Miller Ridge | 11 | 6/29 | 1 | 0 | 1 | 0/ 0/ 1 | 565210 | 3474589 | 2654 |
| Miller Ridge | 12 | 7/1 | 0 | 1 | 1 | 1/ 0/ 0 | 565340 | 3474466 | 2651 |
| Miller Ridge | 13 | 7/1 | 0 | 1 | 1 | 1/ 0/ 0 | 565486 | 3474368 | 2600 |
| Upper Huachuca Canyon | 14 | 9/2 | 0 | 1 | 1 | 1/ 0/ 0 | 557755 | 3483945 | 2234 |
| Upper Huachuca Canyon | 16 | 9/2 | 0 | 2 | 2 | 2/ 0/ 0 | 557857 | 3483704 | 2297 |
| Upper Huachuca Canyon | 17 | 9/2 | 0 | 1 | 1 | 1/ 0/ 0 | 557832 | 3483559 | 2314 |
| <u>Rincon Mountains</u> | | | | | | | | | |
| Cowhead Saddle Trail | 4 | 6/1 | 2 | 0 | 2 | 1/ 1/ 0 | 540642 | 3564014 | 2341 |
| Heartbreak Ridge Trail | 26 | ~4/10 | 0 | 1 | 1 | 0/ 0/ 1 | 543940 | 3562833 | 2301 |
| Deerhead Spring Trail | 13 | ~4/10 | 0 | 1 | 1 | 0/ 0/ 1 | 544147 | 3562396 | 2199 |
| West Manning Camp | 6 | 6/2 | 1 | 0 | 1 | 1/ 0/ 0 | 541302 | 3563567 | 2323 |
| West Manning Camp | 7 | 6/2 | 1 | 0 | 1 | 1/ 0/ 0 | 541252 | 3563388 | 2315 |
| West Manning Camp | 8 | 6/2 | 1 | 0 | 1 | 1/ 0/ 0 | 541233 | 3563246 | 2303 |

[1] NAD 83 datum.

[2] For description of survey routes see Conway, C. J., and C. Kirkpatrick. 2001. Population status, detection probability, and effects of fire on buff-breasted flycatchers. Arizona Game and Fish Department, Phoenix, AZ.