Bio-monitoring report, Griffith Park

Birds

2007-2008

Prepared for:

Los Angeles Dept. of Recreation and Parks

by:

Daniel S. Cooper
Cooper Ecological Monitoring, Inc.
5850 W. 3rd St., #167
Los Angeles, CA 90036
wwwcooperecological.com
dan@cooperecological.com

March 2, 2009

Abstract
In May 2007, a wildfire burned 20% of 1,700-hectare Griffith Park, a large area of rugged native chaparral and woodland in the city of Los Angeles. Bird surveys were conducted in and around the burn area during the following winter and spring (late 2007 and 2008) to characterize the overall burned and unburned bird communities, and to identify species which were likely most affected by the fire, using two methods, point counts along roads and walking transects of canyon sites. Species diversity was higher overall on unburned sites, though this difference was reduced during winter on the canyon surveys. Species diversity was similar across seasons (breeding and winter). Two chaparral-obligate bird species, Wrentit *Chamaea fasciata* and California Thrasher *Toxostoma redivivum* were found in significantly lower numbers at burned sites by both survey methods. Most of the other species found significantly less frequently at burned sites are also brush-dwelling and/or ground-nesting birds, but several winter frugivores such as Hermit Thrush *Catharus guttatus* were also reduced, perhaps limited by fruit production here. This represents the first published bird survey of Griffith Park.

Introduction
With more than 1,700 hectares of undeveloped open space at the eastern end of the Santa Monica Mountains, Griffith Park in Los Angeles represents the largest U.S. park located wholly within an urban area. On May 8, 2007, approximately 340 hectares of mostly-native habitat burned in an arson-caused wildfire, the largest burn in the park in over 70 years. This fire, which threatened surrounding homes and closed several popular hiking trails for months, resulted in a surge of interest in the park's ecosystems on the part of both public officials and area residents, and led the city of Los Angeles to immediately convene a postfire recovery team of city employees, local scientists, and others to develop a strategy for restoring the park's natural areas. Just prior to the fire, a modest, citizen-led initiative to monitor wildlife in the park had been established by various neighborhood groups (the "Griffith Park Natural History Survey"), and by late 2007, these efforts were combined into a program of biological monitoring in the burn area and throughout the park, which included the drafting of a wildlife management plan (Cooper and Mathewson 2009). This report represents a portion of this monitoring effort.

Because the area surrounding the park has become even more urbanized in recent decades (new housing continuing to shrink the amount of open space in the entire Santa Monica Mountains each year), future extirpations of the species that remain seem highly likely. Therefore, it is essential to understand which remaining species might be vulnerable to disturbance and local extinctions, including from frequent and extensive wildfire.

Though considerably less well-studied than the effects of urban sprawl, wildfire may have a similar effect on bird communities or individual species, particularly in urban areas where immigration of wildland species is limited. The effects of wildfire on birds and other wildlife may come from direct mortality, or, more likely, by converting an existing habitat to a type that is unsuitable for certain species present prior to the fire. For birds, fires have the immediate effect of directly killing weak-flying individuals, including young incapable of moving out of the path of the flames. Mammals unable to burrow or ran away from approaching flames would likewise by killed outright. However, many small mammals and herptiles no doubt survived just below the soil surface, and the large amount of unburned

native vegetation elsewhere in the park provided a ready pool of species for immediate re-colonization.

A reduction in woody-plant density would presumably affect the ability of these shrubs to serve as cover for scrub-dwelling species like California Quail *Callipepla californica* and Wrentit *Chamaea fasciata*, and might eliminate (at least temporarily) a more diverse or abundant pre-fire insect community required by insectivores. Fruit, normally be available for species like American Robin *Turdus migratorius*, Hermit Thrush *Catharus guttatus* and Cedar Waxwing *Bombycilla cedrorum*, as well as acorns for species like Acorn Woodpecker *Melanerpes formicivorus* and Oak Titmouse *Baeolophus inornatus*, would be reduced in burned canyons during the first winter after the fire, since many of the regenerating trees and shrubs (e.g. toyon) would might skip a year of fruit production. Finally, macro-invertebrate and small mammal prey might also be temporarily reduced in the burn zone, leading to poor hunting conditions for species like the Red-tailed Hawk *Buteo jamaicensis*.

Based simply on observation, herbaceous and woody vegetation within the burn were almost totally removed by the fire, save for the largest trees and shrubs, especially along canyons (which were charred but not killed outright) and scattered patches of scrub, generally on steep or rocky slopes which escaped the flames; by late winter (i.e., early 2008), a thick layer of herbaceous plants (esp. *Eucrypta chrysanthemifolia* and the non-native poison hemlock *Conium maculatum*) had invaded several of the sites where before there had been mature chaparral or woodland species, and most large chaparral shrubs (e.g. lemonadeberry *Rhus integrifolia*, toyon *Heteromeles arbutifolia*) were vigorously resprouting. Most trees (esp. western sycamore *Platanus racemosa*) were resprouting a year after the fire, and by fall 2008, the herbaceous layer was even more in evidence, particularly after a significant rainstorm in late November 2008 provided ample moisture for regrowth (pers. obs.).

Previous research

Previous research on the response of wildlife to fires has largely focused on the effects on overall community structure of burn areas by looking at changes in species richness or foraging guild diversity, both popular ecological metrics since the early 1980s (e.g., Moriarty et al. 1985, Vreeland and Tietje 2002). However, since a landmark study of species persistence in scrub patches in the San Diego, California area (Soule et al. 1988), investigators have given more attention to the individual species affected (e.g., Bolger et al. 1997). Post-fire studies are less common, but Knick and Rotenberry (1995) identified strong differences in the ability of certain bird species to re-colonize burned and fragmented sagebrush scrub in the Great Basin, particularly scrub which has been invaded by non-natives grasses following fire. In Europe, research in Mediterranean scrub communities has assessed the dispersal ability of various scrub-dwelling species to colonize burned habitat post-fire (Herrando 2001), showing that scrubland specialists to exhibit a higher spatial variability in their distribution across a landscape as compared to the more evenly-distributed woodland-dwelling species (Herrando et al. 2003, Brotons et al. 2005), a trait that may therefore contribute to extinction events and failure to colonize what appears to be good habitat.

Still, published studies of the response of individual species (as opposed to overall species richness, or foraging guild response) to fire in the unique and often threatened scrub and woodland communities of the California Floristic Province are practically non-existent,

except for those focusing on a very few endangered species which have received a disproportionate amount of research such as the California Gnatcatcher (e.g., Wirtz et al. 1997). Moriarty et al. (1985) and Stanton (1986) examined areas of burned scrub on the campuses of the Univ. of California, Riverside and California Polytechnical University, Pomona, respectively, both located the low hills of the eastern Los Angeles Basin in habitat broadly similar to that of Griffith Park.

Our study seeks to census and characterize the avifauna of Griffith Park, to identify differences between the bird communities in the 2007 burn zone and surrounding unburned sites; and to develop a preliminary list of species most vulnerable to fire in the scrub and woodland habitats of Griffith Park, based on their occurrence in burned and unburned habitats. This work should help inform bird conservation action in southern California, and may help direct future investigation into the role of fire in determining bird communities, and least in the short term.

Methods

Study Area

Griffith Park is essentially a lower-foothill site, with elevations ranging from near 100 meters a.s.l. along the Los Angeles River (northern and eastern boundary) up to just over 500 meters a.s.l. atop several peaks along a central ridge. The park features numerous steep seasonal drainages flowing down from ridges, a few of which have running water year-round (Figure 1). The channelization of the Los Angeles River, which forms the northern and eastern border of the park, in the mid-1900s, essentially eliminated lowland habitat such as freshwater marsh and willow scrub within the park, though important remnants and (in the case of willows) re-growing patches persist. Daytime temperatures are hot and dry from late spring through fall, with cooler periods in late winter; average low/high temperatures are 58/75 degrees F in May, and 48/69 F in December. Most precipitation (from Pacific storms) falls in January and February, and averages around 15 inches per year (with many years much drier; source: www.weather.com; data from Glendale, CA). Graded fireroads and numerous trails and footpaths provide access to the entire park, save the steepest slopes along the north slope, where the park borders land owned by Forest Lawn Cemetery and other non-public parcels.

The natural communities of Griffith Park have only recently been formally described and mapped (Melendrez 2004, AIS 2007) with a recent assessment identifying more than 20 major plant associations within four main vegetation types including "chaparral" (dominated by bigpod ceanothus *Ceanothus megacarpus*), "coastal sage scrub" (incl. laurel sumac *Malosma laurina* and coast buckwheat *Eriogonum fasciculatum*), "mesic scrub" (associated with seeps, often with Mexican elderberry *Sambucus mexicanus* and poison-oak *Toxicodendron diversilobum*); and "woodland" (mainly coast live oak *Quercus agrifolia*) [AIS 2007; based on Keeler-Wolf and Evans 2006]. Most native woodland is located along the lower portions of the drainages and on shady, north-facing slopes, though non-native trees (esp. pines and eucalyptus) have been widely planted, particularly in the eastern portion of the park, and irrigated for several decades in the late 1900s by an extensive network of metal pipes and sprinklers which still cover the hills.

Characteristic chaparral and oak woodland species were found to be common and conspicuous throughout the park; essentially all of the birds species found in numbers in the park are typical of the native scrub and woodland of the hills surrounding the Los Angeles Basin (e.g., Stralberg 1999, Cooper 2000), with urban-adapted species typical of developed areas (see Scott and Cooper 1999) being rather scarce. The mammal and herptile community also appears to be relatively intact and typical of extensive wildland, including a large population of mule deer *Odecoileus hemionus*, two species of woodrats (*Neotoma fuscipes* and *N. lepida*; per M. Rood, County of Los Angeles), Pacific rattlesnake *Crotalus viridus*, and other species typical of large blocks of undeveloped open space (Mathewson et al. 2008). This suggests a relatively low level of degradation and fragmentation, especially when compared to smaller open space patches in the region such as Elysian Park and the Repetto Hills, located closer to downtown Los Angeles (Cooper 2008). Perhaps the absence of such urban-adapted species such as European Starling *Sturnus vulgaris*, and non-native predators such as domestic cat *Felis domesticus* and rats *Rattus spp.* allows species dependent on larger blocks of intact habitat to thrive.

However, the park may yet be something of an island, isolated from the rest of the Santa Monica Mountains to the west by two freeways (U.S. 101 and U.S. 405). Several species known historically (prior to 1950) from the park and adjacent hills are now apparently extirpated here, including breeding (or presumably breeding) populations of Golden Eagle *Aquila chrysaetos*, Greater Roadrunner, Blue-gray Gnatcatcher *Polioptila caerulea* and Black-chinned Sparrow *Spizella atrogularis*; and reptiles such as coast patch-nose snake *Salvadora hexalepis virgultea*, coast horned lizard *Phrynosoma coronatum blainvillii*, and side-blotched lizard *Uta stansburiana* (Cooper, in prep.). Each of these have all been shown to be susceptible to fragmentation, or no longer occur over much of the Los Angeles Basin, and have suffered major declines in the region to the point of extirpation in the eastern Santa Monica Mountains (various sources).

Please refer to the appendix for Latin names of all bird species.

Surveys

Birds were surveyed for one year during two seasons, winter (Oct. - Mar. 2007-08) and spring (April - June 2008), using two methods. We used a modified area-search technique (see Nur et al. 1999) for all canyons in the park (called "canyon surveys" hereafter). We selected canyons to survey because they tend to concentrate birds in arid regions, and both bird and habitat diversity is typically highest along even seasonal drainages. Canyons were considered "burned" if the vegetation along the canyon sides was eliminated or seriously impacted by the May 2007 fire, regardless of the condition of the (often-unburned) oaks and other trees along the canyon bottoms. For this reason, the Bird Sanctuary portion of Vermont Canyon was considered burned, since the fire charred the surrounding slopes of the canyon yet only burned a portion of the canyon's trees. In all, we censused nine burned canyons and eight unburned canyons, and all canyons in the park were visited twice per season for 20 - 30 minutes each between 06:30 AM and 10:30 AM. Numbers of all species of birds recorded either visually or aurally (by ear) during this time were noted in a field notebook, and all breeding activity was noted. Locations of canyons surveyed, their burn status, and the dates surveyed are in Table 1; basic habitat characteristics of each are provided in Table 2.

Complimenting canyon surveys, ridge and hillside areas were surveyed using point counts modeled after the standardized Breeding Bird Survey (USGS), with three-minute counts conducted every 0.5 miles along a road. In this case, 21 survey points were located along several roads through interior of the park (incl. Vista del Valle, Mt. Hollywood Dr., and Western Canyon Dr.; see Appendix for coordinates). Five of the 21 points were sampled burned vegetation, judged (visually) to be more than 50% burned, and 16 points were in unburned areas. Unlimited-distance point counts were conducted at each point five times - three times in winter (15 and 21 Nov. 2007, and 11 Mar. 2008) and twice in spring (07 May and 11 June 2008). Point counts were conducted between 06:30 AM and 10:30 AM, with the entire route taking around three hours. All species detected visually or aurally were noted in a field notebook, and all breeding activity was noted.

Figure 1. Relief map of Griffith Park showing approximate locations of canyons surveyed. 1. Oak; 2. Boys Camp; 3. Spring - North Fork; 4. Spring - Main; 5. Fern - North Fork/Amphitheater; 6. Fern - South Fork; 7. Fern - East Fork; 8. Beacon; 9. Coolidge - North; 10. Coolidge - Main; 11. Aberdeen; 12. Tennis Court; 13. Bird Sanctuary; 14. Western - Observatory Tr.; 15. Western - North Loop; 16. Brush; 17. Royce. The point counts were conducted along secondary roads through the interior of the park. Map courtesy of Cartifact, Inc.

Analysis

In an effort to use only the species that actually formed the winter and spring/breeding bird communities, we deleted species typically recorded as wide-ranging aerial foragers or flying over the study area (e.g., Yellow-chevroned Parakeet, swifts, swallows, Common Raven); those detected as transient migrants whose do not winter or summer in the park (e.g., Wilson's Warbler), and those encountered on fewer than two survey points during point counts or on fewer than two canyon surveys (see Appendix B for complete list). While these scarce species obviously contribute to the diversity of the area as a whole, they represent a

fraction of the overall bird community, and were probably poorly-surveyed by these methods (more intensive, specialized searches would be required for some of these, such as Great Horned Owl and Canyon Wren). In the analysis, for each canyon or point, we considered on the high count (rather than the average) of each species on the two or three visits for each season to represent the count of each species at each canyon/point.

We analyzed the winter and breeding-season bird communities separately to minimize seasonal variability in each (many species which summer in the park are absent in winter, and vice-versa), and because many species become difficult to detect in winter, or change their ecology entirely (e.g., switching from insect- to fruit-/seed-eating). For each survey type (point count/canyon survey), we generated two indices of similarity - Jacard and Sorensen - (following Nur et al. 1999) to compare the burned and unburned communities for both the winter and breeding-season visits. We also generated a Shannon Diversity Index for each burned vs. unburned community (by season); all indices are summarized in Table 3.

We then examined which bird species were more abundant in either burned or unburned sites (separately for the canyon surveys and the point counts) by using a t-test to compare the number of species detected per point or canyon. This test compares a series of samples taken from an "experimental" pool (i.e., birds recorded at burned sites) to that from a "control" pool (those at unburned sites), and evaluates the likelihood of a given sample coming from a pool with the same average as the other pool.

Table 1. Schedule of canyon surveys, 2007-08

		Coordinates	Winter Survey 1	Winter Survey 2	Breeding Survey 1	Breeding Survey 2
Burned Canyons						
	Coolidge - Main	34.120243, -118.277392	10 Oct. 2007	09 Dec. 2007	14 Apr. 2008	05 June 2008
	Coolidge - North Fork	34.122996, -118.278422	10 Oct. 2007	09 Dec. 2007	14 Apr. 2008	05 June 2008
	Beacon Canyon	34.123867, -118.275483	10 Oct. 2007	09 Dec. 2007	14 Apr. 2008	05 June 2008
	Bird Sanctuary	34.125678, -118.29679	07 Oct. 2007	10 Dec. 2007	20 Apr. 2008	04 June 2008
	Fern - East Fork	34.129071, -118.28162	14 Oct. 2007	11 Dec. 2007	14 Apr. 2008	22 May 2008
	Fern - South Fork	34.128538, -118.283765	14 Oct. 2007	11 Dec. 2007	14 Apr. 2008	22 May 2008
	Fern - North Fork/Amphitheater	34.129799, -118.284688	14 Oct. 2007	11 Dec. 2007	20 Apr. 2008	22 May 2008
	Aberdeen	34.123973, -118.289537	07 Oct. 2007	10 Dec. 2007	20 Apr. 2008	04 June 2008
	Tennis Court	34.124364, -118.292949	07 Oct. 2007	10 Dec. 2007	20 Apr. 2008	04 June 2008
Unburned Canyons						
	Spring - Main	34.133938, -118.290353	16 Oct. 2007	07 Jan. 2008	14 Apr. 2008	11 June 2008
	Oak	34.148856, -118.305631	31 Oct. 2007	07 Jan. 2008	18 Apr. 2008	11 June 2008
	Royce	34.142214, -118.306446	31 Oct. 2007	07 Jan. 2008	18 Apr. 2008	11 June 2008
	Boys Camp	34.140971, -118.293614	31 Oct. 2007	07 Jan. 2008	18 Apr. 2008	22 May 2008
	Brush	34.129782, -118.309257	27 Oct. 2007	01 Feb. 2008	03 May 2008	11 June 2008
	Western - Observatory Tr.	34.11534, -118.305148	27 Oct. 2007	31 Jan. 2008	20 Apr. 2008	04 June 2008
	Western - North Loop	34.118706, -118.30429	(unsurveyed)	31 Jan. 2008	20 Apr. 2008	04 June 2008
	Spring - North Fork	34.135572, -118.291082	13 Nov. 2007	08 Feb. 2008	14 Apr. 2008	22 May 2008

Table 2. Basic habitat characteristics of canyons surveyed.

		Permanent water	Tree canopy (dominant species)
Burned Canyons			
	Coolidge - Main	Yes	Coast live oak
	Coolidge - North Fork	No	Coast live oak, black walnut
	Beacon	No	Black walnut
	Bird Sanctuary	No	California bay, coast live oak, western sycamore, conifer (planted)
	Fern - East Fork	No	Coast live oak, western sycamore
	Fern - South Fork	No	Coast live oak, western sycamore
	Fern - North Fork/Amphitheater	Yes	Coast live oak, western sycamore, conifer (planted)
	Aberdeen	No	California bay, western sycamore, conifer (planted)
	Tennis Court	No	None
Unburned Canyons			
	Spring - Main	Yes	Coast live oak, western sycamore, eucalyptus (planted)
	Spring - North Fork	No	Coast live oak, western sycamore, eucalyptus (planted)
	Oak	No	Coast live oak, western sycamore
	Royce	No	Coast live oak, western sycamore
	Boys Camp	No	Western sycamore, willow, eucalyptus (planted), conifer (planted)
	Brush	Yes	Coast live oak, western sycamore
	Western - Observatory Tr.	No	Coast live oak, western sycamore
	Western - North Loop	No	Coast live oak, western sycamore, eucalyptus (planted)

Results

A total of 94 bird species were recorded during the study. This represents most of the regularly-occurring species known from the park (exclusive of the Los Angeles River, not part of this study), and about one-fifth of all species ever recorded in Los Angeles County (*fide* K.L. Garrett). Looking at the results by season, of the 94 bird species, 62 were recorded in canyon surveys during the breeding season, with 34 of these recorded in two or more canyons total (omitting obvious transients and winter visitors). On the point counts, 48 were found during the two breeding-season surveys, and 32 species after deleting obvious transients and fly-overs.

On the winter surveys, a total of 61 species were recorded on the canyon surveys; of these, only 28 were presumably over-wintering species recorded at two or more canyons (winter surveys began in October, when several fall migrant species were still in the park; these were omitted for the analysis). Winter point counts found 49 bird species during three visits; however, after deleting transients, aerial-foragers, etc., 37 species were likely over-wintering (Complete survey results in the Appendix).

Bird community of Griffith Park

The most widely-detected bird species during the breeding season[1] included Red-tailed Hawk, Allen's Hummingbird, Black-chinned Hummingbird, Ash-throated Flycatcher, Oak

[1] Found on 8-9 burned or 7-8 unburned canyons, and 4-5 burned points or 10+ unburned points.

Titmouse, House Wren, California Thrasher, Orange-crowned Warbler, Black-headed Grosbeak, Song Sparrow, Lazuli Bunting, and House Finch. In winter, the most widespread species included: Anna's Hummingbird, Western Scrub-Jay, Hermit Thrush, Ruby-crowned Kinglet, and Yellow-rumped Warbler. In addition to these, Nuttall's Woodpecker, Bewick's Wren, Bushtit, Wrentit, Spotted Towhee, California Towhee and Lesser Goldfinch were among the most widespread species during both the breeding and winter seasons.

Using two measures of similarity to compare burned and unburned sites, the results were mixed depending on the survey method. Using data from canyon surveys (un-weighted for species' abundance), indices of similarity between burned and unburned sites were highest during winter (Table 3), suggesting a more even distribution across the entire park (including the burn area) then, a pattern that held using point count data in the park. However, a weighted index (Renkonen index) revealed no such pattern (Table 3).

Species diversity was higher on unburned sites using both survey methods, though this pattern was reduced in winter on the canyon surveys (Table 3; see Appendix for more complete data tables).

Table 3. Similarity and diversity indices for burned vs. unburned sites, based on point counts and canyon surveys, by season.

Season	Index		Canyon surveys	Point counts
Breeding				
	Jacard / Sorensen indices of similarity		0.912 / 0.954	0.463 / 0.745
	Renkonen similarity index		0.598	0.673
	Shannon Diversity Index			
		Burned sites	2.890	2.515
		Unburned sites	3.134	3.071
Winter	Jacard / Sorensen indices of similarity		0.964 / 0.982	0.757 / 0.862
	Renkonen similarity index		0.748	0.593
	Shannon Diversity Index			
		Burned sites	2.713	2.598
		Unburned sites	2.742	3.029

Species response

To assess the impact of fire on individual species, rather than on the overall bird community, we employed a t-test to determine which bird species were significantly more common in unburned rather than burned sites.

Looking separately at each season, breeding-season surveys revealed several species found in lower numbers on burned sites, with the Wrentit showing significantly lower detections using both survey methods ($p<0.05$ during canyon surveys and point counts) (Table 4). Other species detected in significantly higher numbers in unburned canyon surveys during the breeding season were Black-chinned Hummingbird, Bewick's Wren, California Thrasher, Bushtit, Orange-crowned Warbler, Spotted Towhee and Song Sparrow. Point count data added California Quail to this list (Table 4).

During the winter, again the Wrentit and the California Thrasher were found significantly more frequently found in unburned sites using both survey methods (Table 5). Canyon surveys found significantly fewer Hermit Thrush, Spotted Towhee, Fox Sparrow and House Finch during winter, while point counts recorded significantly fewer Red-tailed Hawk, Oak Titmouse, American Robin, Yellow-rumped Warbler and Dark-eyed Junco (Table 5).

Few species were found to be more numerically more common at *burned* canyons than unburned ones (and no species was found on significantly more burned point counts); but they included (breeding season) Allen's Hummingbird ($p = 0.011$) and House Finch ($p = 0.036$) during the breeding season; and Nuttall's Woodpecker ($p = 0.024$) in winter (all involved canyon surveys).

Table 4. Selected species abundance in unburned and burned sites during the breeding season (2008). Significant P-values in bold.

Species	**Survey Method (breeding season)**					
	Canyon Surveys			**Point Counts**		
	# Indiv. (# burned canyons; n=9)	# Indiv. (# unburned canyons; n=8)	P-value	# Indiv. (# burned point; n = 5)	# Indiv. (# unburned points; n = 16)	P-value
California Quail	1 (1)	11 (2)	P = 0.255	0	5 (5)	**P = 0.020**
Red-tailed Hawk	5 (5)	8 (7)	P = 0.106	0	6 (4)	P = 0.054
Black-chinned Hummingbird	7 (4)	26 (8)	**P = 0.016**	0 (0)	1 (1)	P = 0.333
Allen's Hummingbird*	18 (8)	2 (2)	**P = 0.011**	0	6 (5)	**P = 0.029**
Bewick's Wren	10 (5)	26 (8)	**P = 0.001**	1 (1)	8 (7)	P = 0.268
California Thrasher	1 (1)	18 (7)	**P = 0.004**	0	5 (4)	P = 0.055
Bushtit	11 (8)	21 (7)	**P = 0.037**	2 (1)	16 (8)	P = 0.245
Wrentit	8 (5)	44 (8)	**P < 0.001**	3 (2)	29 (15)	**P = 0.034**
Orange-crowned Warbler	10 (5)	20 (8)	**P = 0.027**	0	5 (4)	P = 0.055
Spotted Towhee	28 (9)	40 (8)	**P = 0.009**	10 (5)	29 (14)	P = 0.650
Song Sparrow	11 (4)	23 (8)	**P = 0.018**	2 (1)	3 (2)	P = 0.637

* Mixed results; recorded more frequently on burned canyon surveys, and on unburned point counts.

Table 5. Selected species abundance in unburned and burned sites during winter (2007-08). Significant P-values in bold.

Species	Survey Method (winter)					
	Canyon Surveys			Point Counts		
	# indiv. (# burned canyons; n=9)	# indiv. (# unburned canyons; n=8)	P-value	# Indiv. (# burned point; n = 5)	# Indiv. (# unburned points; n = 16)	P-value
Red-tailed Hawk	7 (6)	2 (2)	P = 0.076	0	10 (7)	**P = 0.028**
Oak Titmouse	5 (12)	5 (10)	P = 0.903	0	11 (9)	**P = 0.001**
Hermit Thrush	10 (5)	26 (8)	**P = 0.015**	1 (1)	9 (8)	P = 0.186
American Robin	1 (1)	0 (0)	P = 0.347	0	7 (5)	**P = 0.029**
California Thrasher	1 (1)	17 (6)	**P = 0.030**	0	6 (5)	**P = 0.029**
Wrentit	2 (1)	43 (8)	**P < 0.001**	1 (1)	24 (14)	**P = 0.001**
Yellow-rumped Warbler	86 (9)	145 (8)	P = 0.160	12 (5)	75 (16)	**P = 0.013**
Spotted Towhee	6 (2)	24 (8)	**P = 0.004**	4 (3)	13 (11)	P = 0.977
Fox Sparrow	1 (1)	11 (6)	**P = 0.012**	2 (1)	2 (2)	P = 0.535
Dark-eyed Junco	12 (9)	10 (8)	P = 0.944	0	4 (4)	**P = 0.040**
House Finch	2 (1)	15 (6)	**P = 0.032**	44 (5)	22 (9)	P = 0.164

Pre-fire surveys

A small number of informal surveys were conducted within the May 2007 burn zone during March and April of that same year. However, because these were not standardized as the canyon surveys and point counts reported here, the results should not be directly compared. However, they are nonetheless informative, and provide the only direct comparison of the pre- and post-fire bird communities. The results of each are presented in the Appendix (Tables A3-A5).

Discussion

Overall bird community

Griffith Park appears to support an intact chaparral and oak woodland bird community comparable with that of other large blocks of open space in the Los Angeles area (e.g., Puente-Chino Hills; see Cooper 2000, Scott and Cooper 1999), with the addition of several species more typical of foothill and montane sites (Garrett and Dunn 1981), including Canyon Wren and breeding populations of Dark-eyed Junco and Purple Finch. Though a handful of taxa have been extirpated in one or more roles since the late 1800s (Cooper, unpubl. data), the avifauna is remarkably intact given the decades of isolation from more extensive natural habitats of the Santa Monica Mountains to the east and the Verdugo Hills/San Gabriel Mountains to the north.

Similarity and Diversity

Measures of similarity between burned and unburned canyon sites revealed little difference in their bird communities during either the breeding or the winter season (indices > 0.9). Though the results were mixed, in general more divergence was detected by point counts, possibly because they included a wider range of habitats, including ridgetops and hillsides, whereas canyon surveys were only conducted in canyons, which were typically wooded and

often held water, even if largely or partially burned, and thus attracted more birds which would normally not have been found in burned chaparral.

Using the Shannon Diversity Index to compare burned and unburned sites, we found that unburned sites supported a consistently more diverse bird community (using either survey methods), presumably because of the wider variety of microhabitats and food resources, at least the first year after the burn. Though no vegetation surveys were conducted, the wildfire presumably simplified the original vegetation by eliminating living shrubs and leaving weedy, quickly-regenerating herbaceous species which are not utilized by the diversity of specialists that would occur in native scrub. However, winter surveys at canyon sites revealed little difference in species diversity in burned vs. unburned canyons, perhaps because birds are much less specific in their habitat requirements during the non-breeding season. During winter, many sites - both burned and unburned - are populated by habitat-generalist species such as flocks of wintering sparrows and flocking, opportunistic foragers such as Yellow-rumped Warbler.

Species response to fire

Considerable research has been published on the persistence of chaparral bird species in habitat fragments within urban areas of coastal-slope southern California (e.g., Soule 1988, Bolger et al. 1997, Crooks et al. 2001), and from these studies and more local investigations (e.g., Cooper 2008), we know that even certain chaparral-dwelling bird species can persist in small and isolated pockets of habitat and readily re-invade patches following extirpation (e.g, Bewick's Wren *Thryomanes bewickii* and California Towhee *Pipilo crissalis*). Others cannot, and suffer extinctions as the landscape becomes increasingly urban and open spaces become smaller and farther apart (e.g., Greater Roadrunner *Geococcyx californianus*).

At Griffith Park, the two species consistently affected most by the fire (based on under-representation at burned sites, across both survey methods during both seasons of occurrence) were the California Thrasher and Wrentit. These two highly-sedentary species were also identified by Unitt as being "most affected" by the massive 2003 wildfires in San Diego County (in addition to Bushtit and Bewick's Wren, which also showed a preference for unburned sites at Griffith Park), based on several years of data collection (see: http://www.sdnhm.org/research/birdatlas/recovery.html). Most of the species found by Stanton (1986) as more common on an unburned site east of Los Angeles were also similarly under-represented at burned sites at Griffith Park (including these four), many of them significantly so (Table 6).

The California Thrasher and Wrentit were also among those found to have been more common in large habitat blocks than small ones in studies of urban patches of chaparral in the San Diego area (Soule 1998, Crooks et al. 2001). Other species identified by these prior studies as most susceptible to extinction in small habitat blocks in San Diego were either rarely detected during this study (e.g., California Quail), or have been long extirpated in the park and the eastern San Fernando Valley (e.g., Greater Roadrunner, Cactus Wren, California Gnatcatcher; see Cooper and Mathewson 2009).

Table 6. Birds found significantly more commonly at an unburned coastal sage scrub site than at a nearby burned site (Reproduced from Stanton 1986).

	Cal Poly Pomona*			Griffith Park (this study)
	Control	Burn	Chi-square	++ significantly more common on unburned sites during B(reeding) and/or W(inter) season
California Quail	482	43	365.4	++ (B)
Red-tailed Hawk	30	3	20.5	++ (B/W)
Mourning Dove	73	44	6.7	
Anna's Hummingbird	95	60	7.4	
Western Scrub-Jay	112	65	12.0	
Bewick's Wren	27	3	17.6	++(B)
House Wren	35	13	9.2	
Bushtit	376	110	144.5	++(B)
Wrentit	125	0	123.0	++(B/W)
Ruby-crowned Kinglet	57	1	52.2	
American Robin	97	11	66.9	++ (W)
Northern Mockingbird	129	33	55.7	
California Thrasher	65	15	30.0	++ (B/W)
Black-headed Grosbeak	27	9	8.0	
Spotted Towhee	134	22	79.0	++ (B/W)
California Towhee	223	141	18.0	
Rufous-crowned Sparrow	57	27	10.0	
Song Sparrow	20	4	9.4	++ (B)

* Does not include the following species not regularly recorded on Griffith Park surveys but found by Stanton (1986) to prefer unburned habitat: Cactus Wren, Cedar Waxwing, and White-crowned Sparrow.

The variety of species found less commonly at burned sites during this study would suggests that mere reduction of habitat extent is not the sole cause of a species' rarity in burned areas (Table 7); indeed, the birds showing significant differences in abundance at burned vs. unburned sites exhibit a variety of life-history traits, making generalization difficult. For example, lower numbers at burned sites were noted not only for sedentary, brush-dwelling residents such as the Wrentit, but also for urban-adapted species like the Bushtit, and for highly mobile and migratory birds (e.g., American Robin, Yellow-rumped Warbler). While the lack of brush in the burn zone would clearly explain the rarity of chaparral species at both breeding and winter seasons, it is possible that winter-season frugivores like the American Robin, Hermit Thrush and Yellow-rumped Warbler were responding to the dearth of fruiting shrubs in the burn zone (esp. toyon and laurel sumac).

Notable is the paucity of strict woodland-obligate species among the list of birds found in lower numbers on burned sites, mirroring findings from similar studies in the Mediterranean region (e.g., Herrando et al. 2003). With the notable exception of Oak Titmouse, cavity-nesting species were rather evenly at burned and unburned sites (incl. Nuttall's Woodpecker and House Wren), but so too were cup-nesting woodland songbirds such as Pacific-slope Flycatcher and Black-headed Grosbeak (Table A1a). This would suggest, perhaps counter-intuitively, that California woodland bird communities may more resilient to scrubland communities when recovering from wildfire, which may help explain previous findings of a lack of a fire effect on oak woodland birds (e.g., Vreeland 2002).

Table 7. Life-history traits of species found at significantly more unburned than burned sites (canyons/points), 2007-08.

Species	Season of occurrence	Habitat preference (from Garrett and Dunn 1981)
California Quail	Year-round	"Brushy areas, chaparral, river bottoms, oak woodlands, suburban gardens."
Red-tailed Hawk	Year-round	"Widespread and generalized"; "a common suburban bird."
Black-chinned Hummingbird	Summer	"Canyon and lowland riparian woodland dominated by willows, sycamores and cottonwoods."
Allen's Hummingbird	Year-round	"Coastal sage, willows, and oak-riparian woodlands...gardens and eucalyptus groves."
Oak Titmouse	Year-round	"Oak and oak-conifer woodland."
Bewick's Wren	Year-round	"Brushy habitats."
Hermit Thrush	Winter	"A variety of brush and woodland habitats, especially where plentiful supplies of berries occur."
American Robin	Winter*	"Parks and suburban plantings...winter flocks exploit crops of berries and other fruit."
California Thrasher	Year-round	"Chaparral...lowland riparian thickets and other brushy habitats."
Bushtit	Year-round	"Brush and woodlands."
Wrentit	Year-round	"Coastal sage scrub and chaparral."
Orange-crowned Warbler	Summer	"Brushlands, willow thickets, oak woodlands, and taller chaparral."
Yellow-rumped Warbler	Winter	"Widespread; brush and woodland habitats, residential areas, brushy fields."
Spotted Towhee	Year-round	"Dense, tall brush in well-developed chaparral, riparian thickets, and oak woodland...suburban areas where shrubs are dense enough."
Song Sparrow	Year-round	"Riparian thickets and a variety of other wet, brushy situations."
Fox Sparrow	Winter	"Taller, denser chaparral."
Dark-eyed Junco	Winter*	"Oak woodlands, eucalyptus groves."
House Finch	Year-round	N/A ("Adaptable, and fares well even in urban centers.")

* Occurs year-round in adjacent urban/developed areas, but not in natural areas of the park.

Future work at Griffith Park should determine the lasting effect, if any, on bird species decline and overall species diversity in the burn area or in the park as a whole. More surveys could also lead to increased detections of scarce or poorly-censused species which are probably being negatively affected by frequent fire in the Los Angeles area (e.g., California Quail, Hutton's Vireo), at least based on their scarcity in small habitat patches and in degraded habitat. Because the majority of the park did *not* burn in the 2007 fire, and because the burn area is contiguous with a large area of high-quality native and natural habitat (covering several thousand acres), re-colonization would be expected to be high for most species, including those most dramatically affected such as Wrentit, which remains very common throughout the unburned areas of the park (D.S. Cooper, pers. obs.). And, because no local habitat type was wholly eliminated by this fire (i.e., "duplicate" areas of oak woodland, sycamore-riparian woodland, chaparral, coastal sage scrub, and walnut woodland all survived elsewhere in the park), the prospects of the burn zone reverting its original, pre-

fire condition seem high as species expand fro unburned portions of the park and surrounding open space.

Acknowledgments

Funding for this study was provided by the Los Angeles Department of Recreation and Parks (Contract #2930) as part of the Griffith Park Wildlife Management Plan. Special thanks are due to Chief Ranger Albert Torres who facilitated access to the interior of the park and enthusiastically supported this study. Dr. Jonathan Feenstra designed and conducted all of the point counts and Kimball Garrett performed several canyon surveys.

Literature Cited

AIS 2007. Mapping descriptions, USGS-NPS Vegetation mapping program, Santa Monica Mountains National Recreation Area. Report by Aerial Information Systems, Inc., 112 First St., Redlands, CA 92373 (submitted to SMMNRA, Thousand Oaks, CA).

Bolger, D.T., T. Scott and J. Rotenberry. 1997. Breeding bird abundance in an urbanizing landscape in coastal southern California. Conservation Biology 11:406-421.

Brotons, L., Pons, P. and Herrando, S. 2005. Colonization of dynamic Mediterranean landscapes: where do birds come from after fire? Journal of Biogeography 32: 789-798.

Cooper, D.S. 2000. Breeding landbirds of a highly-threatened open space: The Puente-Chino Hills, California. Western Birds 31:213-234.

Cooper, D.S. 2008. Ecological assessment of open space remnants in northeastern Los Angeles. Prepared by Cooper Ecological Monitoring, Inc. for the Mountains Recreation and Conservation Authority, Los Angeles, California. 15 November 2008.

Cooper, D.S. and P. Mathewson. 2009. Griffith Park Wildlife Management Plan (Final). Prepared by Cooper Ecological Monitoring, Inc. for the Los Angeles Dept. of Recreation and Parks. 22 January 2009. Available online at: http://www.griffithparkwildlife.org.

Crooks, K.R., A.V. Suarez, D.T. Bolger, and M.E. Soule. 2001. Extinction and colonization of birds on habitat islands. Conservation Biology 15:159-172.

Garrett, K. and J. Dunn. 1981. Birds of Southern California: Status and distribution. Los Angeles Audubon Society.

Herrando, S. 2001. Habitat disturbance in Mediterranean landscapes: Effects of fire and fragmentation on birds. Doctoral thesis, University of Barcelona. February 2001.

Herrando, S., L. Brotons and S. Llacuna. 2003. Does fire increase the spatial heterogeneity of bird communities in Mediterranean landscapes? Ibis 145:307-317.

Keeler-Wolf, T. and J.M. Evans. 2006. Vegetation Classification of the Santa Monica Mountains National Recreation Area and Environs in Ventura and Los Angeles Counties, California. Version 1-Association Level and Specific Alliances (Report submitted to the National Park Service, SMMNRA, Thousand Oaks, CA).

Knick, S.T. and J.T. Rotenberry. 1995. Landscape characteristics of fragmented shrubsteppe habitats and breeding passerine birds. Conservation Biology 9:1059-1071.

Mathewson, P.D., S.N. Spehar and D.S. Cooper. 2008. An initial carnivore survey of Griffith Park, Los Angeles, California, Bulletin of Southern California Academy of Sciences 107:57-67.

Melendrez Design Partners. 2004. Griffith Park Master Plan. 2nd draft. Available online at: http://www.lacity.org/RAP/dos/parks/griffithPK/masterplan2005/masterplan2005.htm.

Moriarty, D.J. R.E. Farris, D.K. Noda and P.A. Stanton. 1985. The Southwestern Naturalist 30:452-453

Nur, N. S.L. Jones and G.R. Geupel. 1999. A statistical guide to data analysis of avian monitoring programs. U.S. Dept. of the Interior, Fish and Wildlife Service, BTP-R6001-1999, Washington, DC.

Scott, T.A. and D.S. Cooper. 1999. Summary of avian resources of the Puente-Chino Hills Corridor. January 1999. Available online: http://www.hillsforeveryone.org.

Soule, M.E., D.T. Bolger, A.C. Alberts, J. Wright, M. Sorice, and S. Hill. 1988. Reconstructed dynamics of rapid extinctions of chaparral-requiring birds in urban habitat islands. Conservation Biology 2:75-92.

Stanton, P.A. 1986. Comparison of avian community dynamics of burned and unburned coastal sage scrub. The Condor 88:285-289.

Stralberg, D. 1999. A landscape-level analysis of urbanization influence and spatial structure in chaparral breeding birds of the Santa Monica Mountains, CA: Submitted in partial fulfillment for the degree of Master of Science (Natural Resources and Environment). Thesis (M.S.). University of Michigan, 1999.

Vreeland, J.K. and W.D. Tietje 2002. Numerical response of small vertebrates to prescribed fire in a California oak woodland. USDA Forest Service Gen. Tech. Rep. PSW-GTR-184. 2002.

Wirtz, W.O., A.L. Mayer, M.M. Raney and J.L. Beyers. 1997. Effects of fire on the ecology of the California gnatcatcher, *Polioptila californica*, in California sage scrub communities. *In*: Proceedings--Fire Effects on Rare and Endangered Species and Habitats Conference, Nov. 13-16, 1995. Coeur d'Alene, Idaho.

Appendix.

Table A1a. Summary statistics for breeding-season canyon surveys.

	# Individuals recorded			Burned		Unburned	
Species	**Burned canyons (n = 9)**	**Unburned canyons (n = 8)**	**Min Pa or Pb**	**Pa**	**Pa ln Pa**	**Pb**	**Pb ln Pb**
Red-tailed Hawk	5	8	0.012	0.012	-0.053	0.017	-0.070
Cooper's Hawk	3	4	0.007	0.007	-0.036	0.009	-0.041
California Quail	1	11	0.002	0.002	-0.015	0.024	-0.089
Anna's Hummingbird	8	15	0.019	0.019	-0.076	0.033	-0.111
Allen's Hummingbird	18	2	0.004	0.044	-0.137	0.004	-0.024
Black-chinned Hummingbird	7	26	0.017	0.017	-0.069	0.056	-0.162
Northern Flicker	1	0	0.000	0.002	-0.015	0.000	0.000
Acorn Woodpecker	4	2	0.004	0.010	-0.045	0.004	-0.024
Nuttall's Woodpecker	19	19	0.041	0.046	-0.142	0.041	-0.131
Pacific-slope Flycatcher	10	7	0.015	0.024	-0.090	0.015	-0.064
Black Phoebe	5	1	0.002	0.012	-0.053	0.002	-0.013
Ash-throated Flycatcher	11	17	0.027	0.027	-0.097	0.037	-0.122
Hutton's Vireo	1	7	0.002	0.002	-0.015	0.015	-0.064
Western Scrub-Jay	6	26	0.015	0.015	-0.061	0.056	-0.162
American Crow	2	0	0.000	0.005	-0.026	0.000	0.000
Oak Titmouse	14	19	0.034	0.034	-0.115	0.041	-0.131
House Wren	13	18	0.031	0.031	-0.109	0.039	-0.127
Bewick's Wren	10	26	0.024	0.024	-0.090	0.056	-0.162
Northern Mockingbird	5	1	0.002	0.012	-0.053	0.002	-0.013
California Thrasher	1	18	0.002	0.002	-0.015	0.039	-0.127
Bushtit	11	21	0.027	0.027	-0.097	0.046	-0.141
Wrentit	8	44	0.019	0.019	-0.076	0.095	-0.224
Orange-crowned Warbler	10	20	0.024	0.024	-0.090	0.043	-0.136
Black-headed Grosbeak	15	15	0.033	0.036	-0.120	0.033	-0.111
Lazuli Bunting	13	5	0.011	0.031	-0.109	0.011	-0.049
Spotted Towhee	28	40	0.068	0.068	-0.182	0.087	-0.212
California Towhee	14	23	0.034	0.034	-0.115	0.050	-0.150
Song Sparrow	11	23	0.027	0.027	-0.097	0.050	-0.150
Rufous-crowned Sparrow	4	2	0.004	0.010	-0.045	0.004	-0.024
Dark-eyed Junco	8	2	0.004	0.019	-0.076	0.004	-0.024
Hooded Oriole	2	0	0.000	0.005	-0.026	0.000	0.000
Lesser Goldfinch	23	25	0.054	0.056	-0.161	0.054	-0.158
House Finch	120	12	0.026	0.291	-0.359	0.026	-0.095
Purple Finch	2	2	0.004	0.005	-0.026	0.004	-0.024
Summations	413	461	0.598	1.000	-2.890	1.000	-3.134
Total individuals/species	413/34	461/31					
Species in common	31						
Jacard Similarity Coeff. (Cj)		0.911764706					
Sorenson Sim. Coeff. (Cs)		0.953846154					
Renkonken Index (P)			0.598				
Shannon Div. (H)					2.89		3.134

Table A1b. Summary statistics for breeding-season point counts.

	# Individuals recorded			Burned		Unburned	
Birds:	**Burned points (n = 5)**	**Unburned points (n = 16)**	**Minimum Pa or Pb**	**Pa**	**Pa ln Pa**	**Pb**	**Pb ln Pb**
California Quail	0	5	0.000	0.000	0.000	0.017	-0.068
Red-tailed Hawk	0	6	0.000	0.000	0.000	0.020	-0.078
Mourning Dove	2	9	0.019	0.019	-0.076	0.030	-0.105
Anna's Hummingbird	3	14	0.029	0.029	-0.102	0.046	-0.142
Allen's Hummingbird	0	6	0.000	0.000	0.000	0.020	-0.078
Acorn Woodpecker	0	2	0.000	0.000	0.000	0.007	-0.033
Nutall's Woodpecker	2	7	0.019	0.019	-0.076	0.023	-0.087
Ash-throated Flycatcher	2	5	0.019	0.019	-0.076	0.017	-0.068
Cassin's Kingbird	2	0	0.000	0.019	-0.076	0.000	0.000
Western Kingbird	0	6	0.000	0.000	0.000	0.020	-0.078
Western Scrub-Jay	3	10	0.029	0.029	-0.102	0.033	-0.113
Oak Titmouse	2	8	0.019	0.019	-0.076	0.026	-0.096
Bushtit	2	16	0.019	0.019	-0.076	0.053	-0.156
Canyon Wren	2	0	0.019	0.019	-0.076	0.000	0.000
Bewick's Wren	1	8	0.010	0.010	-0.045	0.026	-0.096
House Wren	0	4	0.000	0.000	0.000	0.013	-0.057
American Robin	0	3	0.000	0.000	0.000	0.010	-0.046
Wrentit	3	29	0.029	0.029	-0.102	0.096	-0.225
Northern Mockingbird	2	2	0.007	0.019	-0.076	0.007	-0.033
California Thrasher	0	5	0.000	0.000	0.000	0.017	-0.068
Cedar Waxwing	22	26	0.086	0.212	-0.329	0.086	-0.211
Orange-crowned Warbler	0	5	0.000	0.000	0.000	0.017	-0.068
Spotted Towhee	10	29	0.096	0.096	-0.225	0.096	-0.225
California Towhee	4	13	0.038	0.038	-0.125	0.043	-0.135
Rufous-crowned Sparrow	1	2	0.007	0.010	-0.045	0.007	-0.033
Song Sparrow	2	3	0.010	0.019	-0.076	0.010	-0.046
Dark-eyed Junco	0	2	0.000	0.000	0.000	0.007	-0.033
Lazuli Bunting	6	11	0.036	0.058	-0.165	0.036	-0.121
Black-headed Grosbeak	2	9	0.019	0.019	-0.076	0.030	-0.105
Purple Finch	0	3	0.000	0.000	0.000	0.010	-0.046
House Finch	18	23	0.076	0.173	-0.304	0.076	-0.196
Lesser Goldfinch	9	29	0.087	0.087	-0.212	0.096	-0.225
Summations	104	302	0.673	1.000	-2.515	1.000	-3.071
Total individuals/species	100/21	300/30					
Species in common	19						
Jacard Similarity Coeff. (Cj)	0.463414634						
Sorenson Sim. Coeff. (Cs)	0.745098039						
Renkonken Index (P)			0.673				
Shannon Div. (H)					2.515		3.071

Table A2a. Summary statistics for winter canyon surveys.

	# Individuals recorded			Burned		Unburned	
Species	**Burned canyons (n = 9)**	**Unburned canyons (n = 8)**	**Min Pa or Pb**	**Burned Pa**	**Pa ln Pa**	**Unburned Pb**	**Pb ln Pb**
Red-tailed Hawk	7	2	0.004	0.023	-0.087	0.004	-0.021
American Kestrel	3	0	0.000	0.010	-0.046	0.000	0.000
Anna's Hummingbird	18	24	0.046	0.059	-0.168	0.046	-0.142
Allen's Hummingbird	4	1	0.002	0.013	-0.057	0.002	-0.012
Northern Flicker	14	7	0.013	0.046	-0.142	0.013	-0.058
Acorn Woodpecker	2	9	0.007	0.007	-0.033	0.017	-0.070
Nuttall's Woodpecker	20	9	0.017	0.066	-0.179	0.017	-0.070
Black Phoebe	3	5	0.010	0.010	-0.046	0.010	-0.045
Hutton's Vireo	3	5	0.010	0.010	-0.046	0.010	-0.045
Western Scrub-Jay	13	16	0.031	0.043	-0.135	0.031	-0.107
Oak Titmouse	12	10	0.019	0.040	-0.128	0.019	-0.076
White-breasted Nuthatch	3	4	0.008	0.010	-0.046	0.008	-0.037
Bewick's Wren	10	11	0.021	0.033	-0.113	0.021	-0.082
Ruby-crowned Kinglet	20	18	0.035	0.066	-0.179	0.035	-0.117
Hermit Thrush	10	26	0.033	0.033	-0.113	0.050	-0.150
California Thrasher	1	17	0.003	0.003	-0.019	0.033	-0.112
Bushtit	19	45	0.063	0.063	-0.174	0.087	-0.212
Wrentit	2	43	0.007	0.007	-0.033	0.083	-0.206
Audubon's Warbler	86	145	0.279	0.284	-0.357	0.279	-0.356
Spotted Towhee	6	24	0.020	0.020	-0.078	0.046	-0.142
California Towhee	18	27	0.052	0.059	-0.168	0.052	-0.154
Fox Sparrow	1	11	0.003	0.003	-0.019	0.021	-0.082
Golden-crowned Sparrow	3	12	0.010	0.010	-0.046	0.023	-0.087
Song Sparrow	1	7	0.003	0.003	-0.019	0.013	-0.058
Dark-eyed Junco	12	7	0.013	0.040	-0.128	0.013	-0.058
Lesser Goldfinch	9	15	0.029	0.030	-0.104	0.029	-0.102
House Finch	2	15	0.007	0.007	-0.033	0.029	-0.102
Purple Finch	1	4	0.003	0.003	-0.019	0.008	-0.037
Summations	303	519	0.748	1.000	-2.713	1.000	-2.743
Total individuals/species	303/28	519/27					
Species in common		27					
Jacard Similarity Coeff. (Cj)		0.964285714					
Sorenson Sim. Coeff. (Cs)		0.981818182					
Renkonken Index (P)			0.748				
Shannon Div. (H)					2.713		2.742

Table A2b. Summary statistics for winter point counts.

	# Individuals recorded			Burned		Unburned	
Birds:	**Burned points (n = 5)**	**Unburned points (n = 16)**	**Minimum Pa or Pb**	**Pa (burned)**	**Pa ln Pa**	**Pb (unburned)**	**Pb ln Pb**
California Quail	0	2	0.000	0.000	0.000	0.005	-0.027
Sharp-shinned Hawk	1	2	0.005	0.007	-0.035	0.005	-0.027
Red-tailed Hawk	0	10	0.000	0.000	0.000	0.026	-0.095
Mourning Dove	0	2	0.000	0.000	0.000	0.005	-0.027
Anna's Hummingbird	5	20	0.035	0.035	-0.118	0.052	-0.154
Allen's Hummingbird	1	4	0.007	0.007	-0.035	0.010	-0.048
Acorn Woodpecker	1	5	0.007	0.007	-0.035	0.013	-0.057
Nutall's Woodpecker	5	10	0.026	0.035	-0.118	0.026	-0.095
Northern Flicker	2	1	0.003	0.014	-0.060	0.003	-0.015
Black Phoebe	1	4	0.007	0.007	-0.035	0.010	-0.048
Western Scrub-Jay	6	14	0.043	0.043	-0.134	0.036	-0.121
Mountain Chickadee	0	2	0.000	0.000	0.000	0.005	-0.027
Oak Titmouse	0	11	0.000	0.000	0.000	0.029	-0.102
Bushtit	7	32	0.050	0.050	-0.149	0.083	-0.207
White-breasted Nuthatch	2	1	0.003	0.014	-0.060	0.003	-0.015
Bewick's Wren	1	9	0.007	0.007	-0.035	0.023	-0.088
House Wren	1	1	0.003	0.007	-0.035	0.003	-0.015
Ruby-crowned Kinglet	6	12	0.031	0.043	-0.134	0.031	-0.108
Hermit Thrush	1	9	0.007	0.007	-0.035	0.023	-0.088
American Robin	0	7	0.000	0.000	0.000	0.018	-0.073
Wrentit	1	24	0.007	0.007	-0.035	0.063	-0.173
Northern Mockingbird	1	1	0.003	0.007	-0.035	0.003	-0.015
California Thrasher	0	6	0.000	0.000	0.000	0.016	-0.065
Orange-crowned Warbler	1	3	0.007	0.007	-0.035	0.008	-0.038
Yellow-rumped Warbler	12	75	0.085	0.085	-0.210	0.195	-0.319
Spotted Towhee	4	13	0.028	0.028	-0.101	0.034	-0.115
California Towhee	8	19	0.049	0.057	-0.163	0.049	-0.149
Fox Sparrow	2	2	0.005	0.014	-0.060	0.005	-0.027
Song Sparrow	1	1	0.003	0.007	-0.035	0.003	-0.015
Lincoln's Sparrow	3	1	0.003	0.021	-0.082	0.003	-0.015
White-crowned Sparrow	3	2	0.005	0.021	-0.082	0.005	-0.027
Golden-crowned Sparrow	2	4	0.010	0.014	-0.060	0.010	-0.048
Dark-eyed Junco	0	4	0.000	0.000	0.000	0.010	-0.048
Purple Finch	2	12	0.014	0.014	-0.060	0.031	-0.108
House Finch	44	22	0.057	0.312	-0.363	0.057	-0.164
Lesser Goldfinch	17	32	0.083	0.121	-0.255	0.083	-0.207
American Goldfinch	0	5	0.000	0.000	0.000	0.013	-0.057
Summations	141	384	0.593	1.000	-2.598	1.000	-3.029
Total individuals/species	141/28	384/37					
Total # species	28	37					
Species in common		28					
Jacard Similarity Coeff. (Cj)		0.756756757					
Sorenson sim. Coeff. (Cs)		0.861538462					
Renkonken index (P)			0.593				
Shannon Div. (H)					2.598		3.029

Table A3. Comparison of pre-/post-fire bird surveys, Fern Canyon - North Fork (fly-overs, obvious transients, and those which would not yet have been on territory at the site have been omitted).

	Pre-fire	**Post-fire**			
	07 March 2007	**14 Oct. 2007**	**11 Dec. 2007**	**20 Apr. 2008**	**22 May 2008**
Species					
Mallard				2	2
Cooper's Hawk	Ad. calling				
Red-tailed Hawk	2 pr.	2	1	1	1
American Kestrel		1			
Anna's Hummingbird		3	1		
Allen's Hummingbird				1	3
Mourning Dove				1	
Northen Flicker		9			
Downy Woodpecker	1				
Nuttall's Woodpecker	6	3	2		
Acorn Woodpecker	6				
Black Phoebe	2	1	1		
Hutton's Vireo	1 pr.				1
Western Scrub-jay	3	1			
Oak Titmouse	5	1		2	1
House Wren				3	2
Bewick's Wren	4	4	1		
Ruby-crowned Kinglet		4	4		
Hermit Thrush		1	2		
California Thrasher	5				
Phainopepla					
Bushtit	30		6	1	
Wrentit	5				
Orange-crowned Warbler	8				1
Yellow-rumped Warbler	30	27	4		
Common Yellowthroat					2
Spotted Towhee	6			2	2
California Towhee	4	1		1	3
Fox Sparrow		1			
Golden-crowned Sparrow	4				
Song Sparrow	3				1
Lincoln's Sparrow	1				
Dark-eyed Junco			2		
Lesser Goldfinch		1		1	8
House Finch				4	35

Table A4. Comparison of pre-/post-fire bird surveys, Coolidge Cyn. - Main (fly-overs, obvious transients, winter (-only) visitors, and those which would not yet have been on territory at the site have been omitted).

	Pre-fire	**Post-fire**			
Species	**23 Apr. 2007**	**10 Oct. 2007**	**09 Dec. 2007**	**14 Apr. 2008**	**05 June 2008**
Red-tailed Hawk	1 pr.	1		1	
Anna's Hummingbird	2	3	2		
Allen's Humingbird		1	2	4	
Black-chinned Hummingbird	10				
Northern Flicker		1			
Acorn Woodpecker		1			
Nuttall's Woodpecker	2	3	1	2	3
Pacific-slope Flycatcher	1			3	2
Ash-throated Flycatcher				1	1
Hutton's Vireo	1				
Western Scrub-Jay	3	6	2		1
Oak Titmouse	1	4	4	2	1
Bewick's Wren	8	2		3	1
Northern Mockingbird				2	
Bushtit	6	3	4	1	
Wrentit	8	2	1	1	2
Orange-crowned Warbler	4				3
Black-headed Grosbeak	2			4	2
Spotted Towhee	5	5	2	4	4
California Towhee	10	2	2		
Song Sparrow	3	1		3	3
Dark-eyed Junco		2		2	
Lesser Goldfinch	6				
House Finch	#?			3	30

Table A5. Comparison of pre- and post-fire bird surveys, Vermont Cyn. "Bird Sanctuary" (fly-overs, obvious transients, winter (-only) visitors, and those which would not yet have been on territory at the site have been omitted).

	Pre-fire	**Post-fire**			
Species	**25 Apr. 2007**	**07 Oct. 2007**	**10 Dec. 2007**	**20 Apr. 2008**	**04 June 2008**
Red-tailed Hawk	1 pr.				
Cooper's Hawk	1			1	1
Anna's Hummingbird	1	3			1
Allen's Hummingbird	1	1	1		2
Black-chinned Hummingbird	4			3	1
Acorn Woodpecker	1			3	
Nuttall's Woodpecker	2		2	1	
Pacific-slope Flycatcher	2 pr.			1	
Black Phoebe	1			1	
Hutton's Vireo	4				
Western Scrub-Jay		1			
Oak Titmouse	6				3
Bewick's Wren	3				
House Wren	3 pr.			4	
Bushtit				1	
Wrentit	4				
Spotted Towhee	2	1		2	2
California Towhee	8	4	1	1	1
Song Sparrow	2				
Rufous-crowned Sparrow					1
Dark-eyed Junco					1
Lesser Goldfinch	5	2	1	2	1
House Finch		2		1	2
Purple Finch	2			2	1

Table A6. Locations of point counts

Point	N	W
1	34º 07.296'	118º 17.265'
2	34º 07.255'	118º 16.954'
3	34º 07.433'	118º 17.026'
4	34º 07.666'	118º 17.389'
5	34º 07.828'	118º 17.718'
6	34º 08.011'	118º 17.775'
7	34º 08.167'	118º 17.955'
8	34º 08.184'	118º 18.329'
9	34º 08.288'	118º 18.340'
10	34º 08.428'	118º 18.290'
11	34º 08.638'	118º 18.348'
12	34º 08.730'	118º 18.457'
13	34º 08.927'	118º 18.136'
14	34º 09.002'	118º 18.546'
15	34º 07.948'	118º 18.057'
16	34º 07.717'	118º 18.279'
17	34º 07.483'	118º 18.227'
18	34º 07.420'	118º 18.376'
19	34º 07.146'	118º 18.473'
20	34º 07.030'	118º 18.437'
21	34º 06.542'	118º 18.438'

Table A7. Bird species and their status at Griffith Park (2007-08)

[names listed according to A.O.U. 7th Checklist, 49th Supplement; see: http://www.aou.org/checklist/north/index.php]

W = Winter (Oct. - Feb.)
B = Breeding season (Apr. - June)
T = Transient (spring and/or fall; omitted from analysis)
* Other species omitted from the analysis (too few records, fly-overs only, etc.)

Mallard *Anas platyrhynchos* T
California Quail *Callipepla californica* WB
Northern Harrier *Circus cyaneus* T
Sharp-shinned Hawk *Accipiter striatus* W
Cooper's Hawk *Accipiter cooperii* WB
Red-shouldered Hawk *Buteo lineatus* WB*
Red-tailed Hawk *Buteo jamaicensis* WB
American Kestrel *Falco sparverius* W
Merlin *Falco columbariu*s W*
Band-tailed Pigeon *Patagioenas fasciata* WB*
Mourning Dove *Zenaida macroura* WB
Yellow-chevroned Parakeet *Brotogeris chibi* WB*
Great Horned Owl *Bubo virginianus* WB*
Vaux's Swift *Chaetura vauxi* T
White-throated Swift *Aeronautes saxatalis* WB*

Black-chinned Hummingbird *Archilochus alexandri* B
Anna's Hummingbird *Calypte annae* WB
Costa's Hummingbird *Calypte costae* T
Allen's Hummingbird *Selasphorus sasin* WB
Acorn Woodpecker *Melanerpes formicivorus* WB
Red-naped Sapsucker *Sphyrapicus nuchalis* W*
Red-breasted Sapsucker *Sphyrapicus ruber* W*
Nuttall's Woodpecker *Picoides nuttallii* WB
Downy Woodpecker *Picoides pubescens* W*
Northern Flicker *Colaptes auratus* W
Olive-sided Flycatcher *Contopus cooperi* T
Western Wood-pewee *Contopus sordidulus* T
Hammond's Flycatcher *Empidonax hammondii* T
Pacific-slope Flycatcher *Empidonax difficilis* B
Black Phoebe *Sayornis nigricans* WB
Say's Phoebe *Sayornis saya* W*
Ash-throated Flycatcher *Myiarchus cinerascens* B
Cassin's Kingbird *Tyrannus vociferans* WB
Western Kingbird *Tyrannus verticalis* B
Loggerhead Shrike *Lanius ludovicianus* T
Cassin's Vireo *Vireo cassinii* T
Hutton's Vireo *Vireo huttoni* WB
Warbling Vireo *Vireo gilvus* T
Western Scrub-Jay *Aphelocoma californica* WB
Common Raven *Corvus corax* WB*
Northern Rough-winged Swallow *Stelgidopteryx serripennis* B*
Cliff Swallow *Petrochelidon pyrrhonota* B*
Mountain Chickadee *Poecile gambeli* W
Oak Titmouse *Baeolophus inornatus* WB
Bushtit *Psaltriparus minimus* WB
White-breasted Nuthatch *Sitta carolinensis* W
Brown Creeper *Certhia americana* T
Rock Wren *Salpinctes obsoletus* W*
Canyon Wren *Catherpes mexicanus* WB
Bewick's Wren *Thryomanes bewickii* WB
House Wren *Troglodytes aedon* WB
Winter Wren *Troglodytes troglodytes* T
Golden-crowned Kinglet *Regulus satrapa* W*
Ruby-crowned Kinglet *Regulus calendula* W
Blue-gray Gnatcatcher *Polioptila caerulea* T
Western Bluebird *Sialia mexicana* WB*
Swainson's Thrush *Catharus ustulatus* T
Hermit Thrush *Catherus guttatus* W
American Robin *Turdus migratorius* WB
Wrentit *Chamaea fasciata* WB
Northern Mockingbird *Mimus polyglottus* WB
California Thrasher *Toxostoma redivivum* WB
Cedar Waxwing *Bombycilla cedrorum* W
Phainopepla *Phainopepla nitens* B*
Orange-crowned Warbler *Vermivora celata* WB

Nashville Warbler *Vermivora ruficapilla* T
Yellow Warbler *Dendroica petechia* T
Yellow-rumped Warbler *Dendroica coronata* W
Black-throated Gray Warbler *Dendroica nigrescens* T
Townsend's Warbler *Dendroica townsendi* T
Hermit Warbler *Dendroica occidentalis* T
Common Yellowthroat *Geothlypis trichas* T
Wilson's Warbler *Wilsonia pusilla* T
Western Tanager *Piranga ludoviciana* T
Spotted Towhee *Piplio maculatus* WB
California Towhee *Piplio crissalis* WB
Rufous-crowned Sparrow *Aimophila ruficeps* WB
Fox Sparrow *Passerella iliaca* W
Song Sparrow *Melospiza melodia* WB
Lincoln's Sparrow *Melospiza lincolnii* W
White-crowned Sparrow *Zonotrichia leucophrys* W
Golden-crowned Sparrow *Zonotrichia atricapilla* W
Dark-eyed Junco *Junco hyemalis* WB
Black-headed Grosbeak *Pheucticus melanocephalus* B
Lazuli Bunting *Passerina amoena* B
Brewer's Blackbird *Euphagus cyanocephalus* W
Hooded Oriole *Icterus cucullatus* B
Bullock's Oriole *Icterus bullockii* B
Purple Finch *Carpodacus pupurea* WB
House Finch *Carpodacus mexicanus* WB
Red Crossbill *Loxia curvirostra* T
Lesser Goldfinch *Carduelis psaltria* WB
Lawrence's Goldfinch *Carduelis lawrencei* T
American Goldfinch *Carduelis tristis* W