Natural and Anthropogenic Fire Regimes, Vegetation Effects, and Potential Impacts on the Avifauna of California Oak Woodlands[1]

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Introduction

Fire was once an important component of the disturbance regime in oak woodlands of the Sierra Nevada foothills. In addition to lightning-ignited fires, anthropogenic sources of ignition have historically been important until fire suppression activities in the mid-20th century lengthened fire return intervals. Few fire history studies have addressed oak woodlands, and studies of the effects of fire on birds of oak woodlands are even more scarce. We review existing information on changes in the fire regime of California's oak woodlands and the effects of fire on the vegetation and attempt to predict the response of the bird community to fire and fire suppression.

Native Americans used fire to modify oak woodland vegetation for at least 3000 years (Johnston 1970, Lewis 1973). We do not know to what extent fires ignited by Native Americans were a significant factor in modifying oak woodlands, but ethno-ecological evidence indicates that these fires were very common. Fire frequency is believed to have been annual in some areas (Lewis 1982, Kay 1995), and the timing was usually in late summer or early fall (Lewis 1980, Timbrook et al. 1982, Lewis 1985). The spatial extent of burning is unknown. The high frequency of fires resulted in low-intensity fires and little damage to mature oaks. Understory woody vegetation was reduced. Tree density was lowered, although trees of all sizes were present. Recruitment was low but relatively continuous (Mensing 1992). The overall resulting pattern was a fine-grained mosaic of vegetation patches. Burning by Native Americans declined in the mid-19th century because of the reduction in the Native American population due to disease and genocide and also as a result of early state regulations (Sampson 1944, Lewis 1993).

Increased fire frequency occurred in some areas following settlement by Euro-Americans subsequent to the discovery of gold in 1848. Studies of burning by Euro-American settlers have revealed average fire return intervals of 8–15 years during this period (Sampson 1944, McClaran and Bartolome 1989, Stephens 1997). The objectives of burning generally were to increase forage production for livestock and for vegetation type conversions (Cooper 1922, Biswell 1989). Ranchers used fire to reduce the area covered by shrubs and to increase grassland area. Large areas were converted into grasslands or savannas. These fires were probably of low intensity but spread extensively because of the high horizontal fuel continuity from introduced grasses and forbs. Differences in patterns of burning by the Native Americans and Euro-Americans are related to differing objectives: ranchers burned to increase forage for livestock, whereas the Native Americans burned to increase numerous plant and animal species (Lewis 1985).

Fire suppression began in earnest on private ranch lands in the 1940s to 1950s. Suppression has resulted in increases in surface and crown fuels and changes in species composition (Kilgore 1981, Biswell 1989, Stephens 1997). The invasion of woody vegetation in the understory has probably been the most noticeable change (Dodge 1975, Griffin 1976, Rotenberry et al. 1995). Tree density has also increased (Byrne et al. 1991, Lewis 1993). The end result is that high-intensity fires are more likely (Rossi 1980).

Interest in prescribed burning has increased recently owing to concerns about fuel accumulation. Current land ownership patterns complicate prescribed burning plans in many areas. With careful planning and attention, however, low-intensity prescribed fires can be safely implemented and the desired results achieved. Prescribed burning can reduce the risk of wildfire and potentially restore habitat conditions similar to those under which many bird species of the oak woodlands evolved.

In the absence of studies of the fire effects on birds in oak woodlands, knowledge of avian habitat relations should enable us to predict the response of birds to fire by examining the expected changes in vegetation structure and comparing those changes to known habitat associations of birds (Rotenberry et al. 1995). The most obvious and agreed-upon effect of fire, regardless of its intensity, is reduced brush cover (Lawrence 1966,

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Lewis 1973, Dodge 1975, Griffin 1976, Vreeland and Tietje 1998). With frequent fire we also expect a reduction in the density of trees of all sizes, resulting in decreased total basal area and increased spacing of trees (Jepson 1923, Byrne et al. 1991, Lewis 1993). Mean tree size will be larger because larger trees are more likely to survive following fire, and saplings may be fewer. Fire also reduces the number of snags, logs, and woody debris (Fry 2002, Vreeland and Tietje 2002). At the landscape scale, we expect a complex mosaic of habitats to result from fire, with an overall structure of irregular patches and abundant edges.

Methods

To the extent that nesting habitat relates to habitat requirements for these species, we examined the expected responses of 17 common oak woodland bird species to fire. We collected habitat data at nest sites for these species at the San Joaquin Experimental Range in Madera County from 1988 through 1994.

Results

Our results suggest that Western Kingbirds (see *fig. 1* for scientific names), Western Bluebirds, and Violet-green Swallows would benefit from fire, because they consistently nested in habitat similar to that expected to result from frequent, low-intensity fires. These three species nested in open areas with the lowest shrub cover (*fig. 1*) and the lowest tree density (see Purcell and Stephenson [in press] for details). Bluebird nest sites had intermediate cover of logs, but nest sites of swallows and kingbirds had low log cover. All three species nested in areas with few snags and saplings. Despite the paradigm of the importance of snags to birds in coniferous forests, oak snags are not commonly used by cavity nesters. The species predicted to be negatively affected by fire varied widely among the variables examined. Species nesting in areas with the highest shrub cover were Western Scrub Jays, California Towhees, and Bewick's Wrens (*fig. 1*). Bewick's Wrens, Nuttall's Woodpeckers, and Common Bushtits nested in areas with dense trees. Ash-throated Flycatchers, Nuttall's Woodpeckers, and House Wrens selected nesting areas with high snag densities, and California Towhees and Nuttall's Woodpeckers nested in areas with numerous saplings. House Wrens, Bewick's Wrens, and Acorn Woodpeckers nested in areas with more logs.

In short, our results consistently predicted that the same three fire-adapted species will benefit from the effects of fire, whereas the negatively affected species vary widely among the variables examined. If fire produces a mosaic of habitat patches, rather than a homogeneous landscape, we expect that most species' habitat needs will be provided for.

As with fire, grazing also reduces brush cover (Duncan and Clawson 1980, Purcell and Verner 1998). On the basis of our work at the Experimental Range, the most obvious change resulting from excluding livestock was an increase in shrub cover. A site ungrazed for more than 60 years had nearly nine times the cover of wedgeleaf ceanothus (*Ceanothus cuneatus*), the most common shrub species (Purcell and Verner 1998). The question that naturally arises is, to what extent does livestock grazing create habitat similar to that created by historical fire? We know little about how other effects of grazing may differ from those of fire. Grazing impacts are selective and differ from those of fire primarily because of livestock behavior and selectivity. Cattle seek out shade and water, form trails, compact the soil, and eat and trample oak seedlings, saplings, and acorns (Wells 1962). Other differences relate to differences in nutrient cycling. These differences between the effects of fire and grazing remain unstudied.

More fire-history research is needed to understand past fire regimes of oak woodlands in the time periods discussed above. The effects of prescribed fire on the vegetation and the bird community clearly require more research. Perhaps most importantly, the effects of grazing and the extent to which grazing mimics fire require more study. To conserve avian diversity, we need to monitor bird population trends in oak woodlands and understand the conditions needed to maintain healthy, diverse populations. Finally, we need to test our working hypothesis that a mosaic of habitat patches will provide the habitat conditions needed to sustain high avian diversity in oak woodlands.

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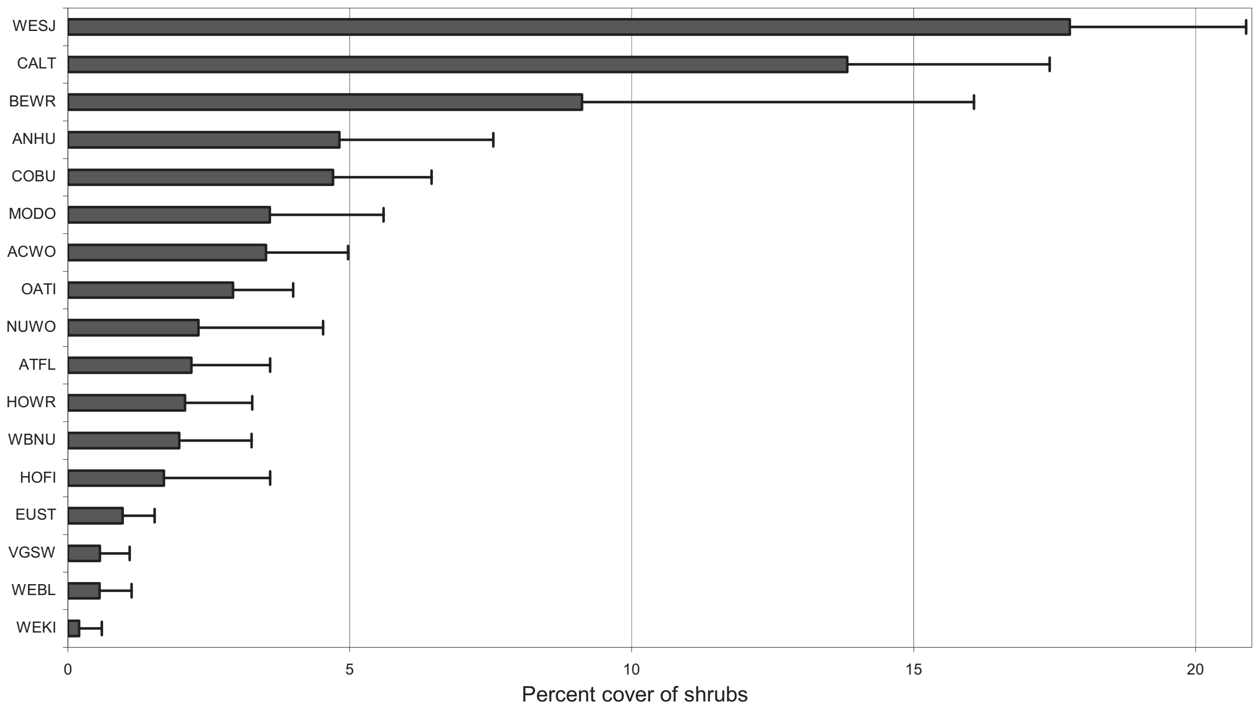

Figure 1— Percent cover of shrubs in a 0.04-ha circle centered on nests. Error bars represent 2 se. Low shrub cover is expected to result from fire, high cover from lack of fire. Species codes (scientific names and sample sizes) are as follows: ACWO = Acorn Woodpecker (*Melanerpes formicivorus*; 92), ANHU = Anna's Hummingbird (*Calypte anna*; 33), ATFL = Ash-throated Flycatcher (*Myiarchus cinerascens*; 47), BEWR = Bewick's Wren (*Thryomanes bewickii*;17), CALT = California Towhee (*Pipilo crissalis*; 73), COBU = Common Bushtit (*Psaltriparus minimus*; 126), EUST = European Starling (*Sturnus vulgaris*; 107), HOFI = House Finch (*Carpodacus mexicanus*; 20), HOWR = House Wren (*Troglodytes aedon*; 39), MODO = Mourning Dove (*Zenaida macroura*; 60), NUWO = Nuttall's Woodpecker (*Picoides nuttallii*; 19), OATI = Oak Titmouse (*Baeolophus inornatus*; 112), VGSW = Violet-green Swallow (*Tachycineta thalassina*; 23), WBNU = White-breasted Nuthatch (*Sitta carolinensis*; 42), WEBL = Western Bluebird (*Sialia mexicana*; 32), WESJ = Western Scrub Jay (*Aphelocoma californica*;118), WEKI = Western Kingbird (*Tyrannus verticalis*; 20).

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