BIRD USE OF LONE OAK TREES IN VINEYARD VS. SAVANNA IN CENTRAL-COASTAL CALIFORNIA OAK WOODLAND—A PILOT STUDY

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ABSTRACT: During the vineyard expansion on the California central and north coasts the past decade, many growers left individual trees within newly established vineyards. Recent research in several habitat types worldwide has documented the ecological contributions of lone or residual trees to habitat structure, connectivity, and aesthetics in the highly-modified landscape. During spring, 2008, we used point counts and behavioral observations to compare bird diversity and abundances from three replicate vineyards at 17 valley oak (*Quercus lobata*) trees within the vineyards vs. 17 valley oaks of similar size in adjacent oak savanna. Our measurements of bird species diversity and abundances were similar in both treatments, including on those of several insectivorous bird species potentially beneficial to growers. Several bird species, however, that may be sensitive to development were detected substantially more in savanna or were unique to savanna. To further evaluate the costs to the grower and the contribution to biodiversity of lone trees in the vineyard landscape, we are using the results of this pilot study to develop an expanded study, including more replication, a measure of bird reproductive fitness, experimental habitat enhancement, and cost-benefit analyses.

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Key words: oak woodland, vineyard, *Quercus* spp., bird diversity, habitat management, pest management, agroecosystem.

INTRODUCTION

As the amount of woodland in California, and elsewhere, is modified by land use, it becomes increasingly important to understand how biodiversity can be managed in agroecosystems. During the vineyard expansion on the central and north coasts during the last decade, many growers left individual oak trees (*Quercus* spp.) on the margins of vineyards and even within the planted vines. Today, these trees incur a cost to grape production and are perceived by many growers as encouraging vineyard pests. Without economic and ecologic valuing of these trees, they will decline and not be replaced. With value, growers will maintain the trees, with mostly unknown benefits to biodiversity and agriculture.

The ecological and aesthetic value of lone trees has been of increasing research interest the past decade. They have been implicated as keystone structures (*sensu* Manning et al. 2006) in otherwise impoverished landscapes. Several contributions to species diversity have been attributed to lone trees. They may function as foci of activity for several taxa of animals (Dean et al. 1999, Dunn 2000). The lone tree may also provide a link or connection between isolated woodland patches, thereby increasing landscape level connectivity as described by Hilty and Merenlender (2004) for riparian corridors in California oak woodland. Interestingly, bird diversity was correlated with the level of isolation in grass fields of Willamette Valley, Oregon, the most isolated oak trees harboring the most diversity (DeMars 2008).

Here we report the results of a spring 2008 pilot study on lone valley oak architectural attributes and breeding bird use of these oaks within three replicate vineyards in San Luis Obispo County, compared to the same measurements on valley oak trees of similar size and spacing in adjacent oak savanna. This pilot study was prompted by our desire to use the information to design a well-replicated and longer-term study with cost-benefit and experimental components. Our longer term objective is to provide growers and other land-use managers with information on the balancing of agricultural production with the maintenance of biodiversity.

STUDY AREA

During April to June, 2008, we used GIS satellite maps and field reconnaissance to select study trees within three vineyards and the adjacent oak savanna. The vineyards are located in north San Luis Obispo County near Templeton and Paso Robles, California, and a minimum of 10 km apart (Figure 1). The study sites comprised approximately 210 ha of planted vines and support facilities, and 129 ha of oak savanna. Topography in the vineyard-savanna mosaics varies from flat to gently rolling to fairly steep (<20%). The climate of the study sites is Mediterranean, characterized by cool, wet winters and warm, dry summers. Mean annual temperature is 15.3 C°. Total annual precipitation occurs mostly as rain between November and March and averages approximately 38 cm (66 year range = 11 to 74 cm. (Western Regional Climate Center 2001).

The predominant trees within vineyards are valley oak, with occasional to rare instances of coast live oak (*Quercus agrifolia*) and blue oak (*Q. douglasii*). These remnant oaks occupy circular areas approximately 30 m in diameter (approx. 0.07 ha) within the vines. Annual grasses and several species of forbs, including milkweed (*Asclepias* spp.), Italian thistle (*Carduus pygnocephalus*), and milk thistle (*Silybum mariamum*), are the only ground cover within these circular areas. Bare ground is common. Cover crops are planted and maintained in the vineyard rows. In the adjacent portions of oak savanna habitat, an overstory of valley oak dominates, with a small but consistent contribution of coast live oak and blue oak. Understory along these rolling savannas is an array of exotic annuals, including ripgut brome (*Bromus diandrus*), star-thistle (*Centaurea* spp.), and avena (*Avena* spp.). Ground cover beneath the canopies of savanna oaks is comprised of similar proportions of the same exotic species occurring beneath vineyard oaks, but generally of greater densities and with poison oak (*Toxicodendron diversilobum*) occasionally occurring under the canopy of an individual savanna tree.

METHODS

Habitat Measurements

Because valley oak was the dominant species within and outside of vineyards, we selected only valley oaks for our study. Our criteria for selection of a study tree follows: ≥50 m from the vineyard edge, ≥5m from a neighboring tree, ≥50 cm dbh, and ≥18 m tall. We measured both the distance from vineyard's edge to the base of each sample tree, and the distance to the nearest neighboring tree using GIS maps. We measured dbh with a D-Tape and height using a clinometer. To assess the architecture of vineyard and savanna trees, we took the following measurements: Crown Diameter, the average of the maximum and minimum crown diameters projected on the ground; Crown Density, the percent of light blocked by branches, assessed ocularly following the method of Zarnoch et al. (2004); and Live Crown Ratio, the percentage of the tree height supporting live green foliage (e.g., 45 ft of foliage/60-ft tree = 75%), assessed ocularly. Finally, we counted all clumps of oak mistletoe (*Phoradendron villosum*), recorded all dead limbs ≥13 cm basal diameter and ≥0.7 m long that we calibrated with measurements of dead branches of similar size on the ground (Garrison et al. 2002), and counted nesting cavities ≥3 cm diameter using binoculars from three viewpoints around the oak.

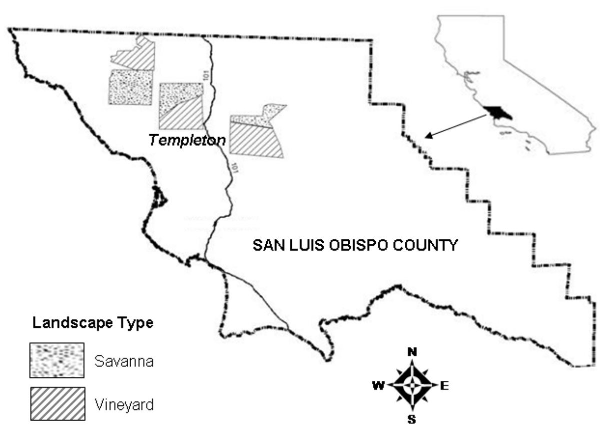

Figure 1 – Location of 3 study sites comprising approximately 339 ha of vineyard (striped) and oak savanna (stippled) habitat, used to assess vegetative and avian diversity in northern San Luis Obispo County, California, spring 2008. Study sites enlarged (not to scale) to illustrate shape and composition.

Bird Measurements

To survey avian diversity and abundance, we counted only individuals perched within the tree, or perched on the ground within the crown diameter. During official sunrise to ≤1100 and following the protocol of Ralph et al. (1995), we conducted five 10-minute point counts per study tree on five separate days, each at a location within 15 m of the trunk that afforded good visibility of the crown. If necessary, for ≤5 minutes after counts, we confirmed species identifications and the presence of active nests. We recorded the following indicators of breeding status: copulations, nest visits (cavity or cup), wing begging, parents feeding young, fledgling molt patterns, fecal sac removal, and nesting vocalizations. We did not conduct point counts on windy or rainy days, or when heavy fog interfered with visibility. We rotated count times among study trees to avoid the potential for declining bird detections during later morning hours.

Data Analyses

We calculated means, ranges, 95% confidence intervals (CI), and standard errors (SE) for tree size and selected architectural attributes (n=17 vineyard oaks and 17 savanna oaks), and bird species detections. We report the number of detections of birds from both vineyard and savanna trees as means of the total count of detections and as percentages of each sample. We also compared treatments by linear regression to determine if comparable numbers of cavity nesting species were using similar numbers of suitable cavities.

RESULTS

Lone Trees

Tree size and architecture were similar between vineyard and savanna trees, with a slight but consistent trend toward larger trees among savanna oaks. Savanna oaks also tended toward higher crown densities, higher live crown ratios, and fewer clumps of mistletoe, but the overlapping 95% CI's indicate that these differences are not statistically significant (Figure 2).

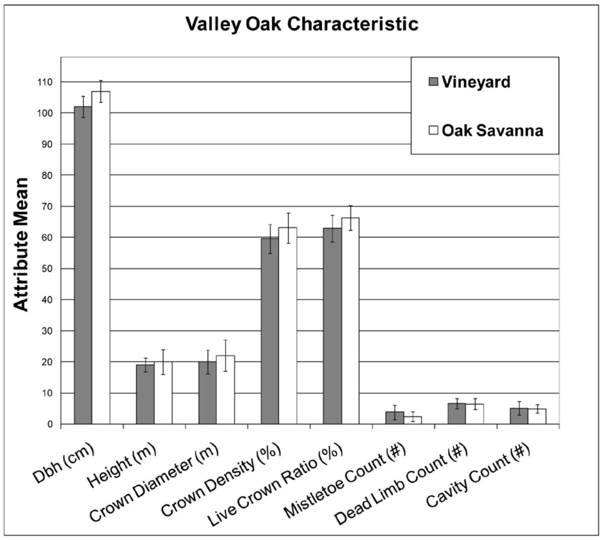

Figure 2 – CI (95%) comparing selected valley oak architectural attributes on vineyard and oak savanna study sites. No characteristic's mean was significantly different ($P \geq 0.05$) based on our sampling.

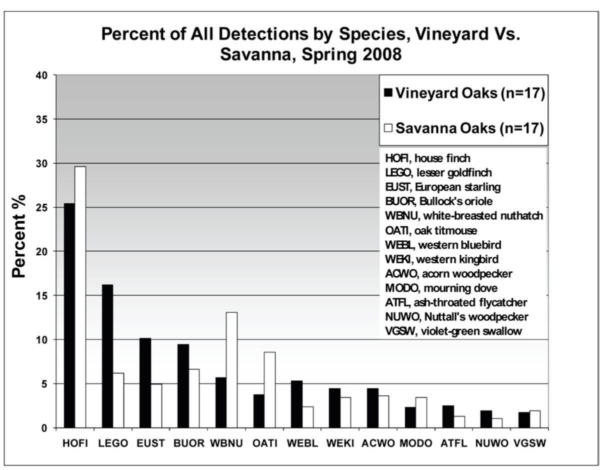

Figure 3 – Percent of all detections for vineyard oaks (562) and savanna (466) oaks. Both treatments were sampled with equal effort (17 trees, 5 counts/tree). These 13 species comprise approximately 90% of the sample (927 of 1,028 detections), with each species representing ≥1.5% of the total.

Birds

Lesser goldfinch (*Carduelis psaltria),* European starling (*Sturnis vulgaris*), Bullock's oriole (*Icterus bullockii*), and western bluebird (*Sialia mexicana*) were substantially more abundant in vineyard oaks than their savanna counterparts, while white-breasted nuthatch (*Sitta carolinensis*) and oak titmouse (*Baeolophus inornatus*) were notably more abundant in savanna trees (Figure 3). House finch (*Carpodacus mexicanus*) appeared on both sets of trees in similar proportions, and was detected in much higher numbers than any other species. House finch, lesser goldfinch, and European starling comprised 51.7% of vineyard detections, compared to 40.7% within savanna. White-breasted nuthatch and oak titmouse comprised a higher proportion of detections in the savanna (21.7%) compared to vineyard (9.4%) (Figure 3). Mean numbers of species, active nests, and active breeders were also similar (Table 1). Cavity nesters from both savanna and vineyard were detected in increasing numbers within those oaks with larger numbers of cavities (25 of 34 oak trees) (Figure 4).

Lark sparrow (*Chondestes grammacus*), lazuli bunting (*Passerina amoena*) American robin (Turdus migratorius), black-headed grosbeak (*Pheucticus melanocephalus*), Cooper's hawk (*Accipiter cooperii*), and loggerhead shrike (*Lanius ludovicianus*) were unique to vineyard, whereas house sparrow (*Passer domesticus*), Lawrence's goldfinch (*Carduelis lawrencei*), red-winged blackbird (*Agelaius phoeniceus*), spotted towhee (*pipilo maculatus*), western scrub-jay (*Aphelocoma californica*), western meadowlark (*Sturnella neglecta*), great-horned owl (*Bubo virginianus*), California quail (*Callipepla californica*), and Wilson's Warbler (*Wilsonia pusilla*) were unique to savanna (Table 2).

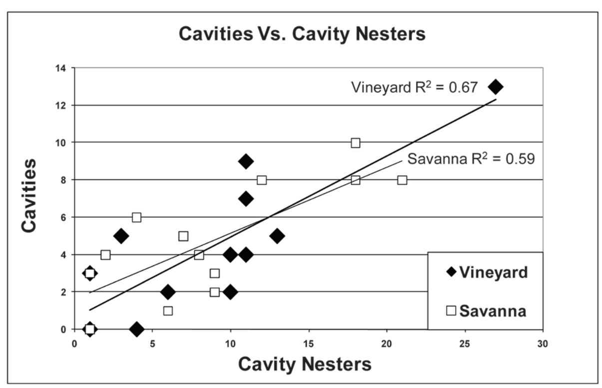

Figure 4 – Regression between the number of cavities counted and the number of cavity nesters detected per oak tree at 3 vineyard and 3 savanna sites in north San Luis Obispo County. Two data points are represented by points 1,0 and 1,3. Similar r^2 values indicate similar usage rates of cavities by cavity nesters on both treatments.

DISCUSSION

Our data indicate that the composition and numbers of bird species using isolated oak trees in our vineyard and oak savanna sites are comparable (respectively, 26 vineyard vs. 29 savanna species; 562 vs. 466 detections; 10 vs. 14 breeding species). Number of nesting cavities and breeding activity were also similar in vineyards and savanna. House finches were notably and similarly abundant in vineyard and in savanna and, although less abundant, we detected similar numbers of individuals in the two treatments for most bird species. However, not surprisingly, there are several notable differences that the data suggest. Four additional species not observed breeding in vineyards were observed breeding in savanna. Several species, most notably lesser goldfinch, European starling, Bullock's oriole, and western bluebird showed a preference for vineyards, whereas white-breasted nuthatch and oak titmouse preferred savanna. These preliminary findings are in line with species preferences that studies have documented for the spectrum of undeveloped woodland, to semi-developed, to urbanized (Blair 1996, Bolger et al.1997). Overall, differences in bird responses between vineyard and savanna sites may result from factors other than trees *per se*, including the proximity to other vegetative characteristics, anthropogenic activities, and the behavioral inclinations of each species. These factors were not assessed in this pilot study.

European Starlings are closely associated with human habitations (Rising 2001) and specialize in ground foraging for insects that may be readily accessible on bare or only lightly vegetated vineyard soil (Purcell and Stephens 2006). We observed most communally nesting starlings at large decadent oaks with large numbers of cavities and sparse canopy foliage, suggesting that starlings may become more common in vineyards as the trees decline. House finches, western bluebirds, and lesser goldfinches similarly prefer widely spaced woodland edges over interior forest (Groth 2001). Western bluebirds readily utilize nesting boxes in vineyards and savanna almost equally and successfully (Fiehler et al. 2006). Boxes were often in close proximity to oaks in our study vineyards, potentially accounting for higher detection rate of bluebirds in vineyards. Bullock's orioles are leaf gleaning insectivores, and this should discount any concerns growers have over their presence. California quail, although not detected often in or under trees, were seen in substantial numbers along rows of vines. Cover provided by the vines may rival that of savanna in terms of what quail prefer. Our observations suggest that oak trees in vineyard or savanna with abundant grass and forb ground cover provided more detections of ground foragers such as western meadowlarks, red-winged blackbirds, western scrub-jays, mourning doves (*Zenaida macroura*), and California towhees (*Pipilo crissalis*). Oaks in vineyards with little to no ground cover harbored less avian diversity.

The birds that we recorded using vineyard trees occupy various foraging niches. Starlings forage for insects on the ground, woodpeckers and nuthatches probe the bark, Bullock's orioles and others are foliage gleaners, and others, such as violet-green swallows (*Tachycineta thalassina)* sally for insects above the vines. Some birds eat grapes causing either pluck (removal of grapes) or peck (non grape removal) damage, the European starling and house finch being the primary culprits. For the grower, it may be a situation of "take the good with the bad"; surely, providing habitat for the more rare native birds provides some ecological and political values.

This study provides preliminary evidence that even the single, isolated oak tree in the vineyard can be a focus of bird diversity. Further quantification is needed if the trends indicated from this study are to be used for guidelines for the conservation of bird diversity in the agroecosystem. The study pointed out additional areas for study, such as cost-benefit analyses of the maintenance of lone trees; comparison of lone trees within the vines with those on the margin of the

Table 1 ─ Numbers of species, detections, active nests, and breeding species in vineyard oaks vs. savanna oaks within 3 study sites in central-coastal California, spring 2008.

	Vineyard			Savanna		
Per Tree Measure	Mean	95% CI	Range	Mean	95% CI	Range
No. of species	8.1	0.9	4 - 12	7.5	1.3	3 - 11
No. of detections	33.1	6.1	14 - 53	27.4	7.5	7 - 77
No. of active nests	0.5	0.4	0 - 2	0.5	0.3	0 - 2
No. of breeding species	1.4	0.5	0 - 3	1.2	0.5	0 - 3

Table 2 – Species most abundant by landscape type (species included were those detected ≥2 times). We calculated total count as the number of individuals identified over all 170 visits to oak trees. Mean and standard error (SE) are based on the five visits to 17 oaks at each of the three vineyards and savannas. We counted 562 individuals in vineyard oaks and 466 individuals in savanna oaks. Specific breeding activity (X) included variables mentioned previously in the text.

Vineyard Oaks

Species	Count	Mean	SE	Breeding
House Finch *(Cardopacus mexicanus)*	143	8.4	1.78	X
Lesser Goldfinch *(Carduelis psaltria)*	91	5.4	1.07	X
European Starling *(Sturnus vulgaris)*	57	3.4	1.31	X
Bullock's Oriole *(Icterus bullockii)*	53	3.1	0.71	X
White-breasted Nuthatch *(Sitta carolinensis)*	32	1.9	0.66	X
Western Bluebird *(Sialia mexicana)*	30	1.8	0.6	X
Western Kingbird *(Tyrannus verticalis)*	25	1.5	0.63	X
Acorn Woodpecker *(Melanerpes formicivorus)*	25	1.5	0.38	X
Oak Titmouse *(Baeolophus inornatus)*	21	1.2	0.54	X
Ash-throated Flycatcher *(Myiarchus cinerascens)*	14	0.8	0.23	
Mourning Dove *(Zenaida macroura)*	13	0.8	0.34	
Nuttall's Woodpecker *(Picoides nuttallii)*	11	0.6	0.44	X
Violet-green Swallow *(Tachycineta thalassina)*	10	0.6	0.37	
Northern Mockingbird *(Mimus polyglottos)*	7	0.4	0.26	
California Towhee *(Pipilo crissalis)*	7	0.4	0.24	
Lark Sparrow *(Chondestes grammacus)* *	6	0.4	0.19	
Steller's Jay *(Cyanocitta stelleri)*	4	0.2	0.24	
Dark-eyed Junco *(Junco hyemalis)*	3	0.2	0.13	
Lazuli Bunting *(Passerina amoena)* *	2	0.1	0.08	
Anna's Hummingbird *(Calypte anna)*	2	0.1	0.08	
Total Count	**562**			

Savanna Oaks

Species	Count	Mean	SE	Breeding
House Finch	138	8.1	3.83	X
White-breasted Nuthatch	61	3.6	0.88	X
Oak Titmouse	40	2.4	0.66	X
Bullock's Oriole	31	1.8	0.49	X
Lesser Goldfinch	29	1.7	0.63	X
European Starling	23	1.4	0.53	X
Acorn Woodpecker	17	1.0	0.43	
Western Kingbird	16	0.9	0.44	X
Mourning Dove	16	0.9	0.76	
Western Bluebird	11	0.6	0.36	X
House Sparrow *(Passer domesticus)* *	11	0.6	0.65	X
Lawrence's Goldfinch *(Carduelis lawrencei)* *	10	0.6	0.44	X
Violet-green Swallow	9	0.5	0.26	
Dark-eyed Junco	8	0.5	0.27	X
Ash-throated Flycatcher	6	0.4	0.15	
California Towhee	6	0.4	0.26	
Nuttall's Woodpecker	5	0.3	0.14	X
Red-winged Blackbird *(Agelaius phoeniceus)* *	4	0.2	0.14	
Bushtit (Psaltriparus minimus)	3	0.2	0.13	
Red-tailed Hawk (Buteo jamaicensis)	3	0.2	0.18	X
Spotted Towhee *(Pipilo maculatus)* *	3	0.2	0.10	
Western Scrub-Jay *(Aphelocoma californica)* *	3	0.2	0.10	
Northern Mockingbird	3	0.2	0.13	
Steller's Jay	2	0.1	0.12	
Western Meadowlark *(Sturnella neglecta)* *	2	0.1	0.08	
Anna's Hummingbird	2	0.1	0.08	
Great-horned Owl *(Bubo virginianus)* *	2	0.1	0.12	X
Total Count	**466**			

* Species unique to either vineyard or savanna with a total individual count (from 170 visits) greater than one.

vineyard, and with individual trees within the woodland (in addition to the savanna comparison done here); experimentation, perhaps by use of nest boxes or plantings; and the assessment of relative fitness of birds in all treatments. LeBuhn and Fenter (2008) recorded similar abundances of bumble bees (*Bombus* spp.) within vineyards and in the surrounding landscape. In like manner in our future study of lone trees, a possible covariate of value is arthropod abundances and richness on lone trees. Our longer-term goal is to provide the grower of grapes with some recommendations for optimizing diversity (of native birds) in the vineyard setting, that is, to help the grower maintain and even enhance biodiversity of wildlife while also conducting an economically profitable agricultural enterprise.

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