EFFECTS OF SUBDIVIDING PRIVATE PROPERTY ON BIODIVERSITY IN CALIFORNIA'S NORTH COAST OAK WOODLANDS

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ABSTRACT: Much of California's biodiversity is found in oak (*Quercus* spp.) woodland vegetation. Residential development is expanding in northwestern California, resulting in a larger number of houses and roads in wooded areas. To examine the effects of this type of habitat fragmentation on biodiversity, 12 low-elevation oak woodland sites with gentle slopes were identified using remote sensing and a geographic information system. These sites were stratified across a gradient of differing lot sizes including large continuous parcels of relatively undisturbed hardwood rangeland in private parcels greater than 122 hectares; ranchettes on 4 to 16-hectare lots; and suburban areas with single-family homes on 0.20 to 1.0 hectare lots. Level of development was shown to have a significant effect on plant and bird species composition, and to be independent of stand structure and tree cover in the surrounding landscape.

Key Words: birds, butterflies, suburban, indicator taxa, disturbance, Sonoma County.

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INTRODUCTION

Throughout the United States there has been an increase in non-metropolitan human populations that exceeds that expected by the national population growth rate (Long and DeAre 1982). In California, increased demand for property in rural areas has raised property values and resulted in land fragmentation and conversion of oak woodlands to housing, roads, and recreational development (Standiford et al. 1987). The majority of oak woodlands in the north coast are privately owned (Thorne 1997), making them especially vulnerable to habitat fragmentation. Historically, persons interested in natural habitat and resource conservation were primarily preservationists attempting to set aside undeveloped land in protected areas (Beazley 1997, Lockwood et al. 1997). Protected-area planning is only part of the solution and alone will not ensure the long-term preservation of California's wildlands or wildlife (Forbes et al. 1996, Wear et al. 1996). A more effective approach to habitat and wildlife conservation in areas such as the California's north coast is to reduce the impacts of habitat fragmentation and detrimental land-use practices on rural private lands. Developing a better understanding of the consequences of widespread reductions in parcel size and resulting habitat fragmentation is essential for developing policy and educational programs that will minimize the loss of biodiversity on private land.

A large number of new residences in California are being developed in oak woodlands because these areas are predominately in private ownership and are often near population centers (Standiford et al. 1987, Scott et al. 1995). The amount of development and degree of habitat fragmentation that results from scattered subdivisions in California's oak woodlands threaten wildlife conservation (Tietje et al. 1996). However, degradation of oak woodlands often goes unnoticed by state resource agencies because oaks do not have a high commercial value (e.g., $30 per thousand board feet compared to $300 to $600 for conifers; Anonymous 1998), and most of this vegetation type is found beyond state and federal protected areas (Thorne 1997).

Many state and federal wildlife habitat monitoring efforts are using remote sensing, geographic information systems (GIS), and urban expansion modeling to address the consequences of population growth on natural resources and to improve county planning strategies (Landis and Zhao 1994). This most likely is a result of many public agencies and non-governmental organizations relying on remote sensing as a tool to measure the extent and connectivity of natural habitat. In particular, Landsat Thematic Mapper (TM) satellite imagery with a 30-m resolution is most commonly used to identify areas of forest cover as distinct from urban or deforested areas. Most of these efforts consider non-urban areas as homogeneous wildlands (Cogan 1997). This type of remote monitoring does not permit detection of land-use and population density changes in areas with large amounts of tree cover. Clearly, however, property size and related human population density are variables that influence natural resource use and management and in turn influence habitat quality and wildlife abundance. For example, oak woodlands are no longer reserved for livestock ranchers but are now home to many suburban residents. This change is not being effectively monitored because of the limitations of widely used remote sensing techniques.

The research for this study was conducted in Sonoma County, located in northwestern California. This is one of the fastest growing counties in California with a population increase of 282% from 1960 to 1995 according to the Bureau of the Census (Information Services Oregon State University, (unpubl.) report, 1997). Approximately 30% of Sonoma County supports hardwood forest (122,193 hectares) (Pillsbury et al. 1991). In addition, over 90% of Sonoma County is privately owned, making integration of wildlife conservation with private land management imperative. Continuing subdivision or "parcelization" of large private ranches to meet the housing needs of a growing population has led to increased habitat fragmentation and land modification. Additional buildings, higher road density, more fences, the spread of exotic plants and animals, and clearing of vegetation are some of the impacts associated with property parcelization and influences on habitat quality.

To examine the effects of this type of parcelization on biodiversity in Sonoma County's oak woodlands, we measured vegetative structure and collected biodiversity data in suburban neighborhoods, ranchettes, and undeveloped sites in low-elevation oak woodlands. These three treatment areas were studied to determine if property parcelization significantly affects: (1) hardwood cover measured from TM satellite data; (2) tree density measured in the field; (3) plant species richness and composition; (4) bird species richness, abundance, and composition; and (5) butterfly species richness.

Our selection of plants, birds, and butterflies as indicator taxa was influenced by the limitations that sampling on small private land parcels presents. Trees and shrubs account for habitat structure, and plant community composition is often sensitive to fragmentation (Van Jaarsveld et al. 1998). Also, vegetation cover across large landscapes and stand structure can affect animal and plant community composition (Bolger et al. 1997). Therefore, we examined vegetation structure at each sampling point and percent cover of the entire surrounding study site.

Bird communities were selected because they are well studied, expertise was readily available, and bird habitat requirements span a wide range of landscape scales (Patton 1993, O'Connor 1990). Butterflies were used as indicator taxa because their life history traits can make them good indicators of habitat condition and therefore useful for conservation planning (Kremen et al. 1993). Another important advantage to using butterflies is that the data can be collected reliably, quickly, and inexpensively.

METHODS

Site Selection

We used a GIS to stratify sampling sites across a gradient of varying lot sizes in study areas with the same elevation range, slope class, and vegetation type. The GIS database included: (1) digital elevation models for the study area (USGS, 1:100,000); (2) a vegetation map based on TM satellite imagery classified by Pacific Meridian Resources (Anonymous 1994); and (3) parcel lot lines (Sonoma County Information Systems Department). Using ARC/INFO software (Environmental Systems Research Institue, Inc., Redlands, CA USA), we identified areas with hardwood tree cover within 5-15 degrees slope and between 100-200-m elevation. Within this vegetation type and physiography, areas with property sizes in three different treatments were identified from the county lot line data: (1) suburbs consisting of 0.20 ha to 1.0 ha home lots; (2) ranchettes 4 to 16 ha in size; and (3), undeveloped private land parcels of > 122 ha. Each suburban site was comprised of a neighborhood consisting of multiple single-family residents (Fig 1). Every ranchette site encompassed an area approximately 16 ha in size, comprised of contiguous properties that themselves were between 4 and 16 ha in size (Fig 1). Each undeveloped site was located on a property > 122 ha under single ownership.

Since the objective of this study was to examine the effects of property subdivision on biodiversity in areas that have retained substantial tree cover, all sites selected had some amount of hardwood cover. After we identified these sites using GIS, we made field visits to measure variables that are difficult to assess from satellite imagery, such as dominant oak species and extent of shrub cover. We selected sites with an overstory of mixed oak species dominated by live oak (*Quercus agrifolia* and *Quercus wislizenii*). This process resulted in 12 study sites, four within each of the three treatments - suburban, ranchette, and undeveloped (Fig 2). All undeveloped sites selected had no livestock grazing for the past five or more years. Permission to conduct our study on private property was obtained from the individual property owners with the exception of the small lot subdivisions (0.20 - 1.0 ha lots) where data was collected immediately adjacent to the private parcel rather than on the private land.

These sites were located in the foothills of the Mayacmus Mountains. A mix of dense hardwood forests and more open oak woodland were common at lower elevations; chamise (*Adenostaoma fasciculatum*) (chaparral) was more common at higher elevations. The predominant land uses in the surrounding areas were rural residential, vineyards, rangeland, and wildlands.

Flora

We calculated percent of hardwood cover that existed across the landscape for each study area by combining the percent cover for the following vegetation classes from classified satellite imagery: blue oak

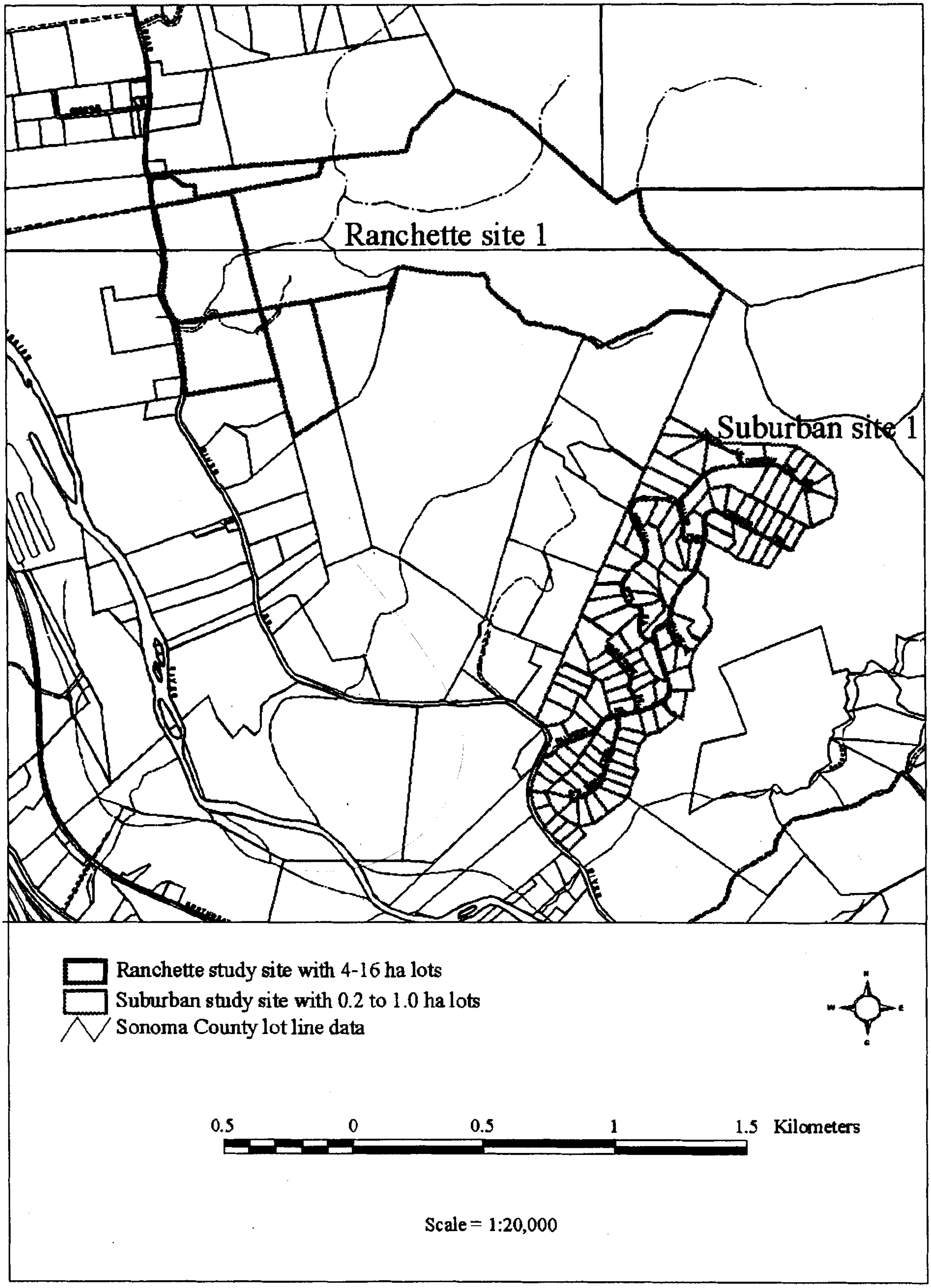

Figure 1. Example of typical lot sizes for a ranchette and suburban study site.

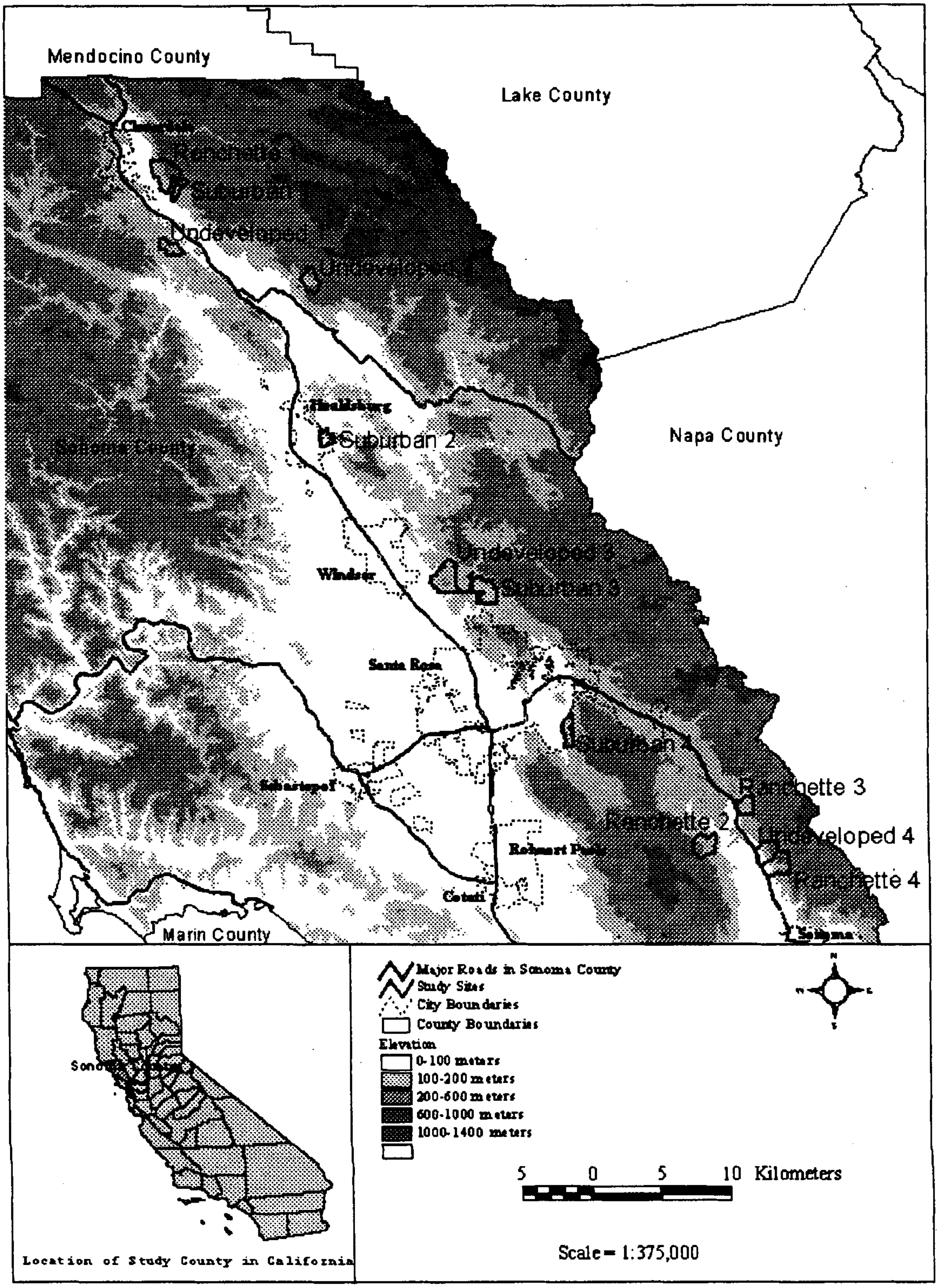

Figure 2. Location of study sites in Sonoma County, California

(*Quercus douglasii*) woodland, coastal oak (*Quercus agrifolia*) woodland, montane hardwood, and potential hardwood (Anonymous 1994). Potential hardwood areas have the spectral signature for hardwoods but fall outside the Pillsbury hardwood polygons (Pillsbury et al. 1991). The study areas encompassed contiguous parcels with similar lot sizes within the designated elevation and slope cutoffs. Therefore, the landscape level measure of percent hardwood cover was based on different sized areas for each of the 12 study sites.

We established 8 sampling points at least 250 m apart at each study site in 1997 to collect field data. At each point, we estimated cover percent for all vascular plant species within a 10 x 10-m macroplot. Tree density at each point was calculated using the point-centered quarter method (Cottam and Curtis 1956). We also measured tree height, canopy diameter, and diameter at breast height (dbh). This resulted in a plant species list with cover scores for 8 points within each site, and tree height, canopy diameter, and dbh for 64 trees per site.

Fauna

We sampled birds using 10 minute point counts (Ralph et al. 1993) conducted at all 96 sampling points once during the spring breeding season (May) and once in the winter (Juanuary-February) 1997. This resulted in 32 sample points for each of the three property-size treatments. One very experienced bird observer noted all bird species and numbers seen or heard within a 50-m radius of the plot center for 10 minutes.

We recorded the presence of butterfly species at each sampling point and collected individuals using a butterfly net when necessary for species identification. This was done through visual observation three times at all 96 sampling points from April through June 1997 within 50 m of plot centers for 15 minutes.

Plant and animal diversity and abundance were analyzed using nested analyses of variance with treatment as level one and replicated sites within each treatment as level two. The arc-sine square root transformation was used on percent data (Sokal and Rohlf 1995). Kruskal-Wallace statistics were used when significant heteroscedasticity could not be corrected by transforming the data (Sokal and Rohlf 1995). Differences were considered significant when $P \leq 0.05$.

RESULTS

Flora

The dominant hardwood vegetation types found at all sites were coastal oak woodland (23.4%$\pm$18%) and montane hardwood (17.2% $\pm$ 21.8%) followed by potential hardwood (9.6% $\pm$ 7.4%) and blue oak (0.24% $\pm$ 0.63%) woodland classes. Mean percent hardwood cover calculated from the TM pixel data (Anonymous 1994) was 55.5% $\pm$ 29.9% for the suburban sites, 42.4% $\pm$ 6.5% for ranchette sites, and 71.2% $\pm$ 15.3% for undeveloped. Percent hardwood cover for each study site could not be explained by treatment type ($F_{2,9} = 2.00$, $P = 0.19$).

Three hundred and sixty-four plant species were identified from all 96 sampling points. The average number of plants observed for each treatment is presented in Fig 3. Plant species richness was similar among treatments. However, a significant effect of lot size treatment on vegetation structure and composition was observed: smaller lot sizes had lower tree density than ranchettes; and large undeveloped woodlands had the greatest overall stand tree density (Adjusted $H = 32.62$, $df = 2$, $P<0.01$). Percent of exotic plant species was significantly higher in suburban areas, and ranchettes had significantly more exotic species than undeveloped sites ($F_{2,9} = 15.8$, $P < 0.001$) (Fig 4). Percent shrub cover was not significantly different between treatments ($F_{2,9} = 3.17$, $P = 0.09$). There was a trend for more shrubs in suburban sites due to planting by residents.

Fauna

Eighty-five bird species were identified among the 96 sampling points (Table 1). The average number of birds and butterflies observed for each treatment is presented in Fig 3. Species richness for birds ($F_{2,9} = 0.70$, $P = 0.52$) identified in spring 1997 was similar among treatments. However, species composition was significantly affected by the lot size: percent of neotropical migrant birds, species that winter in Central and South America, was significantly higher ($F_{2,9} = 5.0$, $P = 0.03$) at undeveloped sites (32.5% $\pm$ 15.2%) than at ranchettes (24.4% $\pm$ 12.4%) and small suburban lots (13.9% $\pm$ 11.3%). Other variables such as percent shrub cover and tree density did not help explain the bird species richness or composition differences between sites. Winter bird species richness differed by treatment ($F_{2,9} = 8.23$, $P < 0.01$), with more winter resident species found in suburban areas as compared to ranchettes, and with the fewest species observed in undeveloped woodland sites (Fig 3). Several bird species were more abundant in suburban than in undeveloped sites (Table 2). However, we did find more Cassin's vireos (*Vireo cassini*) in undeveloped woodlands (16) than in ranchettes (2) and suburban areas (2) during the spring census. No butterfly species demonstrated a similar trend across the study sites.

Only 29 butterfly species were identified in total (Table 3). While total species richness for butterflies was not significantly different between treatments ($F_{2,9} = 2.48$, $P = 0.14$), each species was observed more often at sampling points in undeveloped sites (mean = 7.48 ± 10.86) as compared to ranchette (mean = 5.48 ± 7.87) and suburban sites (mean = 4.45 ± 7.87) (paired t-test for undeveloped and ranchette: t_{28}=-2.25, P = 0.03). Twenty six of the species detected are considered common butterflies in California (Stewart 1997). One of the less common species, editha checkerspot (*Occidryas editha*), was only found in undeveloped areas.

DISCUSSION

GIS applications

A geographic information system was used to stratify sampling sites across a gradient of varying lot sizes in areas with the same elevation range, slope class, and vegetation type. This selection method resulted in sites that were as homogeneous as possible with respect to slope, aspect, and overstory vegetation given the heterogeneity that exists across Sonoma County. This is an essential step in a study such as this, because other urban gradient studies often have control sites at higher elevation and therefore in a different vegetation type than where the effects of development are measured (Blair 1994).

Percent hardwood cover detected on the TM imagery and the various vegetation classifications varied; however, no difference was detected among treatments. This verifies that remote imagery estimates of percent hardwood cover should not be used as a surrogate measure of disturbances such as housing density, and cannot always provide an accurate estimate of fragmentation in oak woodlands.

Biodiversity Data

Stand structure differences among treatments were documented by a trend of decreasing tree density in areas of greater housing density. Tree density calculated from field measurements differed among treatments, whereas percent tree cover, based on TM data, did not. This was most likely due to the limited 30-m resolution of the TM data that is commonly used for vegetation mapping.

Plant composition also was affected by treatment. As expected, suburban neighborhoods had a marked increase in exotic plants due to residential gardens. However, we did not expect that exotic plants would be significantly more prevalent in ranchettes as compared to un-

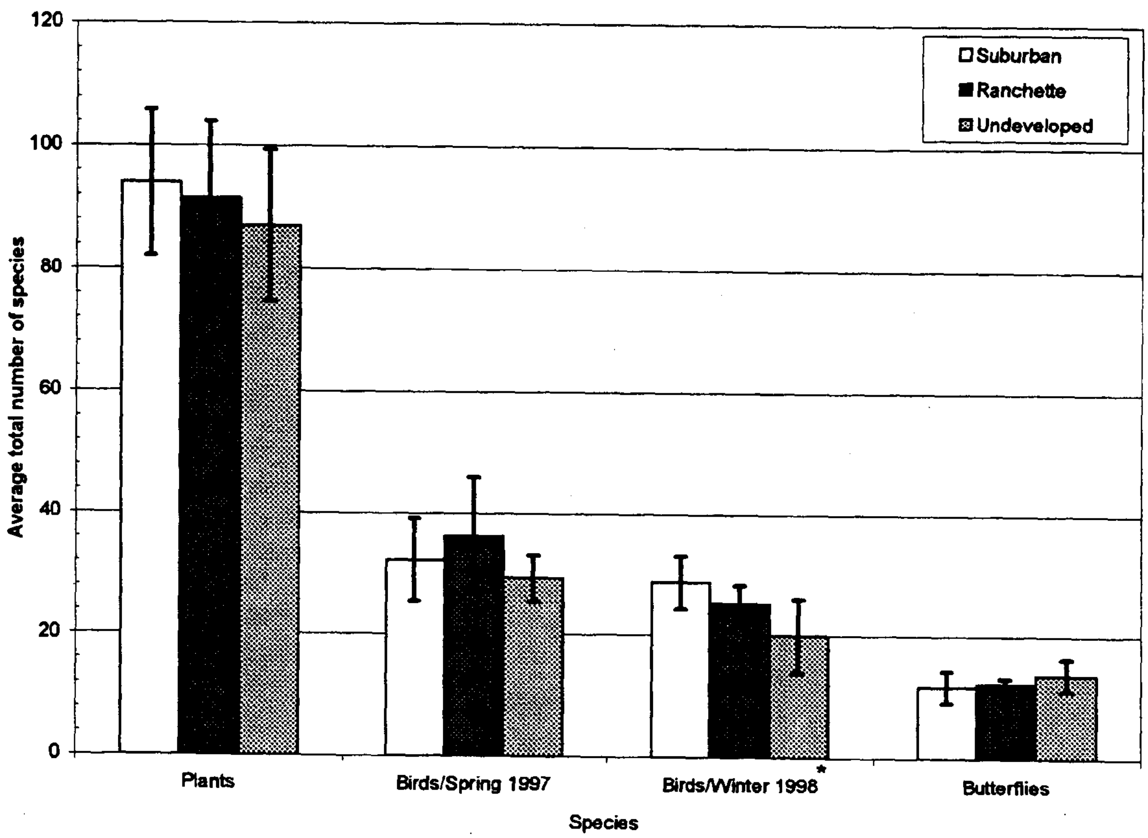

Figure 3. Average total number of plant, bird, and butterfly species found in the four replicates for the three treatments. Values include error bars showing +/- one standard deviation. The star indicates a significant effect of treatment on total number of species.

developed sites. This likely is the result of increased road density (Tinker et al. 1998) and the impact of a variety of land use activities on vegetation community integrity. Shrub cover was not useful in differentiating treatments in oak woodlands. This may be due to the fact that historical grazing and fire suppression has lead to a widespread depletion of shrub cover across California's oak woodlands (Callaway and Davis 1993).

The shrub layer has been shown to be an important structural component for bird assemblages (Lloyd et al. 1998, Sanders and Edge 1998). However, it is not common in upland oak-dominated woodlands in our study area, and therefore provides little explanatory power for bird species richness or community composition. Likewise, tree density had no relationship with bird richness or composition.

The number of plants, birds, or butterfly species was not significantly affected by the three treatments. Many researchers have pointed out the difficulties of using species richness to detect changes in ecosystem health or effects of disturbance (Schluter and Ricklefs 1993, Conroy and Noon 1996). Often, species adapted to a higher level of disturbance replace species that require undisturbed habitat leading to a change in species composition without an overall change in richness. In addition, habitat that is more frequently disturbed or has a greater mosaic of vegetation types within it will often support a larger number of species as a result of the increased habitat diversity (Abugov 1982, Wiens 1985).

Plant and bird species composition was different among treatments, illustrating the consequences of subdividing private land. Declining neotropical bird populations have been a concern in North America for the past 15 years (Furness and Greenwood 1993). Many explanatory variables for these declines have been proposed, including habitat fragmentation in both breeding and non-breeding locations (Robinson and Wilcove 1994). Oak woodland fragmentation often is caused by continued subdivision of private land in California. Therefore, smaller property sizes and associated disturbances (e.g., increased road density, impact of house cats [*Felis catus*], and human activity) likely reduce the diversity and abundance of sensitive bird species such as some of the neotropical migrants. This effect is clearly demonstrated by our data where suburban lots supported a lower percent of neotropical birds than ranchette properties, and the greatest number of neotropical species was observed in undeveloped woodlands.

Certain bird species were found to be more common in suburban neighborhoods than in ranchettes or undeveloped oak woodlands. Some of these species are associated with human disturbance and their increase may serve as indicators of disturbance. This type of research is worth pursuing for monitoring ecosystem health because these indicator species will be easier to find, quantify, and manipulate, and might provide data over a larger

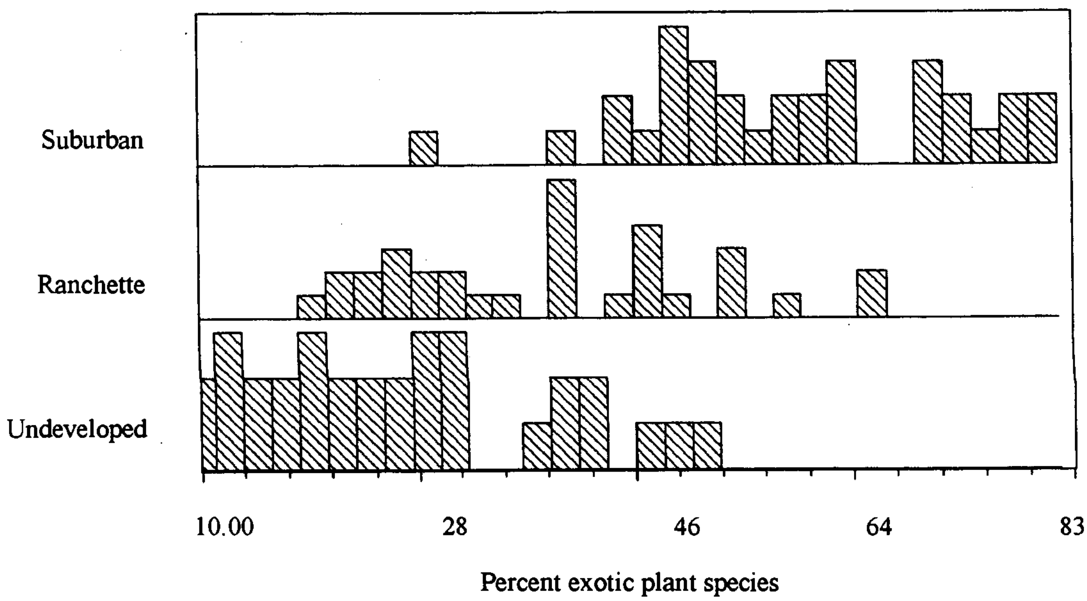

Figure 4. Histogram of number of sampling points with a certain percent exotic plant species in each treatment. This demonstrates that a higher percent of exotic plants were found at more sampling points in suburban sites than in ranchette sites, and the same was true for ranchette sites as compared to undeveloped sites.

Table 1. Bird species identified across all study sites during May, 1997 and January-February, 1998.

Common Name	Scientific Name	Common Name	Scientific Name
Acorn Woodpecker	*Melanerpes formicivorus*	Mallard	*Anas platyrhynchos*
Allen's Hummingbird	*Selasphorus sasin*	Mourning Dove	*Zenaida macroura*
American Crow	*Corvus brachyrhynchos*	Mountain Quail	*Oreortyx pictus*
American Robin	*Turdus migratorius*	Northern Flicker	*Colaptes auratus*
Anna's Hummingbird	*Calypte anna*	Northern Mockingbird	*Mimus polyglottos*
Ash-throated Flycatcher	*Myiarchus cinerascens*	Northern Oriole	*Icterus galbula*
Band-tailed Pigeon	*Columba fasciata*	Nuttall's Woodpecker	*Picoides nuttallii*
Barn Swallow	*Hirundo rustica*	Olive-sided Flycatcher	*Contopus borialis*
Bewick's Wren	*Thryomanes bewickii*	Orange-crowned Warbler	*Vermivora celata*
Black Phoebe	*Sayornis nigricans*	Pacific-slope Flycatcher	*Empidonax difficilis*
Black-throated Gray Warbler	*Dendroica nigrescens*	Pileated Woodpecker	*Dryocopus pileatus*
Black-headed Grosbeak	*Pheucticus melanocephalus*	Oak Titmouse	*Baeolophus inornatus*
Blue-gray Gnatcatcher	*Poliopila caerulea*	Purple Finch	*Carpodacus purpureus*
Brewer's Blackbird	*Euphagus cyanocephalus*	Red-breasted Sapsucker	*Sphyrapicus ruber*
Brown Creeper	*Certhia americana*	Red-shouldered Hawk	*Buteo lineatus*
Brown-headed Cowbird	*Molothrus ater*	Red-tailed Hawk	*Buteo jamaicensis*
Bushtit	*Psaltriparus minimus*	Red-winged Blackbird	*Agelaius phoeniceus*
California Quail	*Callipepla californica*	Ring-necked Pheasant	*Phasianus colchicus*
California Towhee	*Pipilo fuscus*	Ruby-crowned Kinglet	*Regulus calendula*
Canada Goose	*Branta canadensis*	Rufous-crowned Sparrow	*Aimophila ruficeps*
Cedar Waxwing	*Bombycilla cedrorum*	Rufous-sided Towhee	*Pipilo erythropthalmus*
Chestnut-backed Chickadee	*Parus rufescens*	W. Scrub Jay	*Aphelocoma californica*
Chipping Sparrow	*Spizella passerina*	Song Sparrow	*Melospiza melodia*
Cliff Swallow	*Hirundo pyrrhonota*	Steller's Jay	*Cyanocitta stelleri*
Common Raven	*Corvus corax*	Towsend's Warbler	*Dendroica townsendi*
Cooper's Hawk	*Accipiter cooperii*	Tree Swallow	*Tachycineta bicolor*
Cassin's Vireo	*Vireo cassini*	Turkey Vulture	*Cathartes aura*
Dark-eyed Junco	*Junco hyemalis*	Violet-green Swallow	*Tachycineta thalassina*
Downy Woodpecker	*Picoides pubescens*	Warbling Vireo	*Vireo gilvus*
European Starling	*Sturnus vulgaris*	Western Bluebird	*Sialia mexicana*
Fox Sparrow	*Passerella iliaca*	Western Kingbird	*Tyrannus verticalis*
Golden-crowned Kinglet	*Regulus satrapa*	Western Meadowlark	*Sturnella neglecta*
Golden-crowned Sparrow	*Zonotrichia atricapila*	Western Tanager	*Piranga ludoviciana*
Grasshopper Sparrow	*Ammodramus savannarum*	Western Wood Pewee	*Contopus sordidulus*
Great Blue Heron	*Ardea herodias*	White-breasted Nuthatch	*Sitta carolinensis*
Hairy Woodpecker	*Picoides villosus*	White-crowned Sparrow	*Zonotrichia leucophrys*
Hermit Thrush	*Catharus guttatus*	White-tailed Kite	*Elanus leucurus*
House Finch	*Carpodacus mexicanus*	Wild Turkey	*Meleagris gallopavo*
House Wren	*Troglodytes aedon*	Winter Wren	*Troglodytes troglodytes*
Hutton's Vireo	*Vireo huttoni*	Wood Duck	*Aix sponsa*
Lark Sparrow	*Chondestes grammacus*	Wrentit	*Chamaea fasciata*
Lesser Goldfinch	*Carduelis psaltria*	Yellow Warbler	*Dendroica petechia*
		Yellow-rumped warbler	*Dendroica coronata*

Table 2. Bird species more commonly detected in Suburban areas. Numbers reflect number of individuals detected at all four study sites. Suburban (0.10 to 1.0 ha lots), Ranchette (8-16 ha parcels), and Undeveloped (>122 ha parcels), designations reflect the three treatments.

Common Name	Spring			Winter		
	Suburban	Ranchette	Undeveloped	Suburban	Ranchette	Undeveloped
American Crow	31	11	9	55	12	3
Anna's Hummingbird	31	11	9	33	19	16
Bushtit	41	12	7	60	27	16
California Towhee	23	8	6	23	7	3
Common Raven	20	4	1	0	4	0
European Starling	34	11	0	0	0	0
Golden-crowned Sparrow	0	0	0	33	6	0
House Finch	25	16	1	32	10	2
Plain Titmouse	48	24	26	37	34	24
Scrub Jay	48	12	9	38	15	5
Turkey Vulture	13	5	0	24	31	5
Violet-green Swallow	70	72	27	0	0	0
White-crowned Sparrow	0	0	0	11	0	0
Wood Duck	10	0	0	0	0	0

range of habitat disturbance. These are traits that may increase the statistical power of single-species monitoring programs. While American crows (*Corvus brachyrhynchos*) and turkey vultures (*Cathartes aura*) often are sighted flying over a woodland census point, they often roost in relatively disturbed areas such as livestock ranches and suburban neighborhoods. Some birds find a greater amount of food resources in suburban areas. For example, Anna's hummingbirds (*Calypte anna*) are attracted to nectar that may be more abundant in cultivated garden plants or at feeders. In addition, other species such as house finches (*Carpodacus mexicanas*) and European starlings (*Sturnus vulgaris*) find suitable nesting sites in disturbed surroundings (Trozer 1997, Veit and Lewis 1996).

We did not detect an overall effect of treatment on butterfly richness or composition with the exception of one species. There did appear to be a higher probability of detecting a species at sampling points in undeveloped sites, and this may suggest that butterflies are more abundant in undeveloped sites. However, this should not be overstated since determining butterfly abundance in the field is difficult. While the use of butterflies as indicators presents several advantages, they proved not to be effective indicators of habitat disturbance due to housing density in upland oak woodlands. Only a limited number of species use woodland habitat away from riparian zones; therefore, detecting the presence of particular species requires extensive sampling, and butterfly abundance could not be detected reliably across a large number of sampling points. The low number of butterfly species detected severely limited our ability to analyze the butterfly data.

Conclusions

This study demonstrates that the size of private property lots affected plant and bird species composition in a mixed rural-suburban landscape. It is important to note that vegetation maps based on classified TM satellite data did not allow us to differentiate between areas with high housing densities or to quantify the effect of land parcelization. Therefore, one should not use these types of data to assess oak woodland integrity.

The future of California's oak woodlands depends on maintaining large continuous parcels of privately owned land. Therefore, reducing habitat fragmentation and employing practices that maintain continuous habitat is important. Economic incentive programs and county planning initiatives that minimize property subdivision are ways for Californians to maintain the ecological integrity of privately owned oak woodland vegetation.

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Table 3. Butterfly species identified across all study sites during April-June, 1997.

Common Name	Scientific Name	Common Name	Scientific Name
Anise Swallowtail	*Papilio zelicaon*	Leanira Checkerspot	*Thessalia leanira*
Cabbage White	*Pieris rapae*	Monarch	*Danaus plexippus*
California Hairstreak	*Satyrium californicum*	Mournful Duskywing	*Erynnis tristis*
California Ringlet	*Coenonympha californica*	Mourning Cloak	*Nymphalis antiopa*
California Sister	*Adelpha bredowii*	Mustard White	*Pieris napi*
Common Buckeye	*Junonia coenia*	Mylitta Crescent	*Phyciodes mylitta*
Common Wood-Nymph	*Cercyonis pegala boopis*	Northern Checkerspot	*Chlosyne palla*
Common-Checkered Skipper	*Pyrgus communis*	Orange Sulfur	*Colias eurytheme*
Crown Fritillary	*Speyeria coronis*	Pale Swallowtail	*Papillo eurymedon*
Dusky Wing	*Erynnis* sp.	Pipevine Swallowtail	*Battus philenor*
Editha Checkerspot	*Occidryas editha*	Propertius Duskywing	*Erynnis propertius*
Farmer (orange skipper)	*Ochlodes agricola*	Purplish Copper	*Lycaena helloides*
Green Hairstreak	*Callophrys dumetorum viridis*	Spring Azure	*Celastrina ladon echo*
		Tiger Swallowtail	*Papillo rutulus*
Large Marble	*Euchloe ausonides*	Variable Checkerspot	*Euphydryas chalcedona*

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