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October 6, 2017

Via Email
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RE: Comments on Biological Resources Policy Update and Oak Resources Management Plan Final EIR

To Whom it May Concern:

I am writing this letter in response to the County of El Dorado's recent Oak Resources Management Plan ("OWNP") and proposed General Plan amendments revising protections for oak woodlands in the County. Let me start by including my background information to clarify my expertise that enables me to comment on this plan. I am a wildlife biologist working in California for the last 30 years. I spent 14 years as the Wildlife Manager and then another 5 years as the Stewardship Department Manager for the East Bay Regional Park District in Oakland, CA. The EBRPD maintains over 100,000 acres of wildland habitat within Alameda and Contra Costa Counties in the Greater San Francisco Bay Area. Additionally, I have served as an expert on numerous technical advisory committees for habitat and endangered species management, wetlands enhancement, and forest management for fire safety and wildlife habitat. I have extensive experience with raptors and have been working as an expert on issues related to the impacts of wind energy development and bird strikes. I maintain several federal and state permits for endangered and threatened species and have served as an expert witness in court. Currently I am working on Conservation Banking and Easements for endangered species in California. A copy of my CV is attached to this letter.

As part of my review of the OWMP and proposed General Plan amendments, I have considered the impact from the planned large scale removal of intact contiguous oak woodland and the "replacement" of this by Priority Conservation Areas (PCA) in areas away from where future clearing of oak woodlands is most likely to occur. In my opinion this approach taken by the County is likely to lead to significant habitat fragmentation in the areas where development pressure is greatest, as discussed below.

Oak woodland is one of the most diverse habitats in the Western United States. Regarding the number of species occurring in oak woodland, only freshwater wetland habitat is as diverse, albeit with some overlapping species. The importance of contiguous oak woodland habitat cannot be overstated, nor can it be supported by small patches of like habitat retained in place. Similar to the structure of a South American rainforest, the oak woodland in El Dorado County is multi-layered canopy with a diverse vegetative understory. This habitat includes both live and dead structures, all of which are extremely important in determining the makeup of vertebrate, invertebrate and plant diversity. These species of plants and animals are interconnected both in structure and age in that their continued existence is entirely reliant on each other. Any disturbance to this relationship, through fire, logging, deforestation, development or conversion to another habitat type, completely disrupts this balance. Choosing to mitigate impacts away from project sites will lead to severe habitat fragmentation and loss of biodiversity at the impacted site. This will not be sufficiently offset by securing property elsewhere. Significant increases from predators both wild and domestic, anthropogenic effects including wildfire and litter, noise and lighting, will continuously degrade these environments.

The oak woodland habitat that covers a large part of El Dorado County is home to many resident and migratory species. It is also occupied by several state and federally-designated sensitive species.

The General Plan amendments proposed by the County will allow for the clearing of oak woodland habitat in exchange for a fee paid into a mitigation banking system, which will acquire land or habitat easements in PCAs. The PCAs have been selected as part of the amendment process to be located in rural areas not subject to development pressure. The County's position is that by locating PCAs in rural areas, the County will be able to preserve larger patches of habitat (>500 acres) at a cheaper price. The County's CEQA documentation further explains that attempting to purchase or obtain easements on oak woodland habitat in the Highway 50 Corridor area will be expensive and will not preserve as much habitat and thus is rejected as a policy direction, in that none of the designated PCAs are located in this area.

In my opinion this approach taken by the County has the potential for significant adverse impacts to plants and wildlife occurring in oak woodland habitat in that it will create, over time, separate blocks of oak woodland habitat in the southern and northern parts of the County, thereby disrupting the existing north-south connectivity of oak woodland habitat in the region.

Habitat connectivity is a key element of biological conservation. Connected habitat ensures that plant and wildlife populations do not become isolated and fragmented over time, thereby leading to loss of gene flow and susceptibility to local extinction based on stochastic events or long term trends such as climate change. In this case, the potential lack of oak woodland habitat connectivity between the northern and southern regions of the County is a significant adverse change to the ability of local plant and

wildlife populations to survive over the long term in the region and will likely lead to the disappearance of some if not many species from the County altogether.

The County's CEQA documents suggest that, although its habitat preservation approach does not plan for preserving lands in the Highway 50 corridor area where development will occur, the County may nevertheless still ensure habitat connectivity through project specific mitigations such as stream setbacks or construction or restoration of specific wildlife movement corridors that will allow for some animals to move between the northern and southern blocks of habitat anticipated to occur in the future. In my opinion, this approach will not avoid significant habitat fragmentation from occurring.

Wildlife movement corridors are a subset of habitat connectivity, but do not themselves ensure that such connectivity will be preserved. The reason for that is that as an area is developed, the remaining habitat becomes degraded in quality due to increasing edge effects, the impacts of roads and invasion of non-native or opportunistic plant and wildlife species that will drive out the native species that used to occur. For example, loss of contiguous habitat and increases in roads and highways will lead to vehicle and animal collisions, loss of animal and human lives, destruction of property and additional animal-human conflicts. Fragmentation of habitat also leads to loss of biodiversity in oak woodlands. Many species require large intact habitat to buffer from noise and mesopredator (raccoons, skunks, rats, feral cats) invasion. Fragmented habitat increases edge effect leading to invasion by ground predators that leads to loss of productivity for many songbird, reptile, and small mammal species (Prugh, 2009). Fragmented habitat also leads to changes in species composition leading to an increase in more disturbance-tolerant species like jays, crows and cowbirds which are predacious or parasitic to other less common songbirds. Increases in mesopredators lead to direct conflict with humans and pets, and increases the likelihood of disease outbreaks and road-killed animals.

Removal of oak woodlands also leads to erosion and siltation of streams and waterways, thereby impacting habitat for amphibian and fisheries. Invasive plants follow ground disturbance and increase in solar exposure associated with deforestation. Common invasive species listed by the California Invasive Plant Council (Cal IPC) are very likely to become established and spread rapidly in areas where oak woodlands have been removed or disturbed. These include yellow star thistle, medusa head grass, goat grass, cape ivy and others, leading to a significant increase in county maintenance funds necessary to control them. Additionally, habitat replacement by these plants significantly reduces the biodiversity of the areas invaded. Replacement of oak woodland by vineyards and other agricultural crops eliminates useable wildlife habitat and increases the human-wildlife conflicts and use of pesticides and herbicides significantly leading to costly management.

Migratory species require contiguous habitat within which to travel from wintering grounds to breeding grounds, to make daily travels in search of food and water, to breed and exchange genetic diversity, and to safely travel within these areas to avoid predators and human-caused deaths (Hilty et al. 2009). As an example, black-tailed and mule deer

occurring within El Dorado and adjacent counties travel through oak woodlands across a broad (multi-mile wide) corridor during winter to escape harsh weather conditions. They have been utilizing oak woodlands for this travel for millennia and cannot be expected to conform to narrow, restricted corridors between small patches of habitat. Many studies have shown limited use of man-made corridors, especially those that are developed as under or over-crossings at a highway junction (Hilty, et al. 2009). As discussed, this is even more true where surrounding development has eliminated the local plant and wildlife populations in the immediate area.

Even if a movement corridor were to be preserved across Highway 50 in an otherwise developed area, it would not be effective in preserving habitat connectivity because local wildlife populations would likely already be heavily disrupted or extirpated from the area due to the development that had occurred. In this case, the significant adverse impacts of fragmenting plant and wildlife populations in the County into northern and southern segments could be avoided by a mitigation plan to preserve connected habitat within the Highway 50 corridor area to ensure that actual north south oak woodland habitat connectivity is not permanently severed. This has been shown to be feasible in earlier studies. *See* Saving and Greenwood, 2002. (a copy is attached to these comments.)

In sum, it is my opinion that mitigation in the form of replacement of oak woodlands or purchasing oak woodlands in areas far from the impact or development site is inappropriate and is likely to lead to significant adverse effects on plants and wildlife occurring in oak woodland habitat due to regional habitat fragmentation that could be feasibly avoided by preserving habitat within the Highway 50 corridor area where most development is expected to occur. As discussed, loss of habitat in this area is not adequately mitigated by the protection of habitat in remote rural areas due to the fragmentation of oak woodland habitat into separate northern and southern regions that will still occur, leading to the decline and even loss of plant and wildlife species populations in the County over time. This is a particularly significant impact in my view given that El Dorado County represents a substantial portion of the oak woodland habitat in the state of California; habitat that is critical to the maintenance of the plant and animal diversity in the state and significantly critical to the diversity of the county. To implement a wide scale conversion and reduction of oak woodland without exhaustive research on the impacts of such actions would show extremely shallow vision and poor long-term planning at a time when existing threats include climate change, Sudden Oak Death Syndrome, extensive susceptibility to forest fire and the increase in human impact to this habitat.

Sincerely,

Joseph E. DiDonato

Digitally signed by Joseph E. DiDonato
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Date: 2017.10.06 15:12:55 -07'00'

Joseph E. DiDonato
Wildlife Biologist

References:

Hilty, J.A., W.J. Lidicker, A. Merenlender, and A. P. Dobson. 2009. Corridor Ecology: The science and practice of linking landscapes for biodiversity conservation. Island Press.

Prugh, L.R.; Stoner, C.J.; Epps, C.W.; Bean, W.T.; Ripple, W.J.; LaLiberte, A.S.; Brashares, J.S. (October 2009). "The Rise of the Mesopredator"(PDF). *BioScience*. **59** (9): 779–79.

Saving, Shawn C. and Gregory B. Greenwood. 2002. The Potential Impacts of Development on Wildlands in El Dorado County, CA. USDA Forest Service Gen. Tech. Rep. PSW-GTR-184.

The Potential Impacts of Development on Wildlands in El Dorado County, California[1]

Shawn C. Saving[2] and Gregory B. Greenwood[3]

Abstract

We modeled future development in rapidly urbanizing El Dorado County, California, to assess ecological impacts of expanding urbanization and effectiveness of standard policy mitigation efforts. Using raster land cover data and county parcel data, we constructed a footprint of current development and simulated future development using a modified stochastic flood-fill algorithm. We modeled combinations of constraints from the 1996 County General Plan and parcel data—slope, stream buffers, oak canopy retention, existing development, public ownership, regional clustering, and acquisition programs—and overlaid development outcomes onto the land cover data. We then calculated metrics of habitat loss and fragmentation for natural land cover types. Rural residential development erodes habitat quality much more than habitat extent. Policy alternatives ranging from existing prescriptions to very restrictive regulations had marginal impact on mitigating habitat loss and fragmentation. Historic land parcelization limits mitigation of impacts by the current General Plan prescriptions that only apply when a parcel requires subdivision before development. County-wide ordinances were somewhat more effective in preserving habitat and connectivity. These solutions may not offer enough extra protection of natural resources to justify the expenditures of "political capital" required for implementation. Custom, parcel based acquisition scenarios minimized habitat loss and maximized connectivity. Better analysis of public policy and planning design may be a more effective "smart growth" tool than generic policy prescriptions.

Introduction

The California Department of Finance projects the State's population to increase from 34 million to over 45 million by the year 2020 (California Department of Finance 2001). During the past 20 years, the spatial distribution of California's population has also changed as more people moved to the periphery of the dense Los Angeles and San Francisco Bay metropolitan areas and to the historically lower density Central Valley and Sierra Nevada foothills (U.S. Census Bureau 1991, 2001). Since the eastern half of many of these Sierran counties is predominantly national forest above 1,500 meters, the vast majority of this additional population will reside in the lower elevation foothills, a region dominated by oak hardwood savannah. The hardwood rangeland region of the Sierra, extending from 100 to 1,500 meters in elevation, is almost exclusively privately owned and has historically been used for grazing and some dryland farming (Duane 1996, Greenwood and others 1993). The switch from large parcel, low to moderate intensity agriculture to small parcel, high intensity urban and ex-urban land use promises great change to the natural

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[1] An abbreviated version of this paper was presented at the Fifth Symposium on Oak Woodlands: Oaks in California's Changing Landscape, October 22-25, 2001, San Diego, California.

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ecosystems of the foothills region. These 5-acre to 40-acre ranchettes will likely contain the majority of naturally functioning hardwood landscape in the near future.

One such region of rapid change is El Dorado County in the Central Sierra Nevada Mountains. We conducted a policy analysis of the El Dorado County General Plan by modeling development in the western, foothill portion of the county. We were interested in two topics: 1) ecological impacts on wildland habitat resulting from expanding urbanization under the County's General Plan; and 2) the effectiveness of commonly proposed land use policy initiatives to mitigate those impacts. Several models exist for projecting development expansion at the county and regional scale (Landis 1994, 1995, 1998a, 1998b; Johnston 2000, 2001; US Environmental Protection Agency 2000). These models focus on dense urban development (1 - 2 acre parcels or smaller) using economic formulas of land values and empirically derived "attractors" of development such as proximity to existing infrastructure (roads, sewer, water, etc.) to guide development probabilistically and incrementally over time. However, in rural areas (5 - 40 acre parcels), where attractors are less obvious or more difficult to model, or where tractable economic factors are not the primary drivers behind development decisions, these models generally ignore rural development or resort to random allocation (Johnston 2001). In El Dorado County, the General Plan designates 23 percent of the county for development in this rural density range. In order to adequately predict impacts in these regions, we needed to place the existing and potential footprint of development as explicitly as possible. We developed a cell-based, empirical model that characterizes development patterns from existing development and then extends those patterns across the landscape onto vacant lands. Because we were primarily concerned with the relative impacts of the county's General Plan and alternative policy proposals, we chose to extend development to full "buildout" of the General Plan, approximately a 20-year time horizon, rather than incorporating an economic component which might allow the phasing of development over time.

We began by determining where development existed in 1996, the most recent year for which digital parcel data were available. We then predicted where development would be at full buildout of the General Plan under various scenarios (e.g., uncontrolled vs. smart growth, strict vs. loose environmental land use policy, and combinations thereof). For any given scenario, our model can assess the implications for a variety of issues ranging from natural ecosystem functions to local and regional economies to general quality of life. At present, we have analyzed a wide range of land use policies in the County and their relative impacts on two major areas of concern, wildland habitat quality (characterized by extent, fragmentation, and configuration) and economic costs and losses due to wildfire. This paper presents our research on the former.

Study Area

El Dorado County is a predominantly rural county in the Central Sierra region of California stretching from the floor of the Central Valley east of Sacramento to the crest of the Sierras and the southern portion of Lake Tahoe (mean latitude 38.75° N, mean longitude 120.5° W). The county's 463,500 hectares cover a wide diversity of habitats including low elevation annual grasslands and blue oak (*Quercus douglasii*) savannah at the western edge, mid-elevation oak woodlands and mixed oak-conifer-shrub complexes in the central region, and Sierran mixed conifer forest dominated by

Figure 1—Location of study area with major highways and cities.

ponderosa pine (*Pinus ponderosa*), Jeffrey pine (*Pinus jeffreyi*), and lodgepole pine (*Pinus contorta*) in the eastern half. According to the 2000 Census (U.S. Census Bureau 2001), 156,299 people lived in El Dorado County at an overall density of 33.7 persons/km^2. However, because the eastern half of the county is almost entirely national forest except for settlements on the southern littoral edge of Lake Tahoe, the average density for private lands is 63.3 persons/km^2. Housing density is 28.9 units/km^2. Our study area encompasses 220,954 ha and is restricted to the predominantly privately owned western foothills region of the county (*fig. 1*).

From the time Gold Rush pioneers settled in the 1850s, the population of El Dorado County fluctuated between 6,000 and 20,000 people until the 1950s. Since that time the decadal growth rate has ranged from 20 percent to 100 percent, with growth rates of 46.8 percent and 24.0 percent in the 1980s and 1990s, respectively (U.S. Census Bureau 1991, 2001). State Department of Finance projections indicate this magnitude of growth continuing for the next two decades resulting in 252,900 residents by 2020 (California Department of Finance 2001).

Methods

Study Design

The purpose of this study was to evaluate the potential impact of El Dorado County's General Plan on wildland habitat in the county (primarily oak woodland) and how policy alternatives might mitigate these impacts. We modeled several

alternative scenarios, three iterations each, by varying one or more of the General Plan prescriptions, as well as the possible spatial configuration of future development (*table 1*), and overlaying the resulting footprint of development onto the land cover data and measuring the core extent, fragmentation and configuration of wildland. As we intended this work to be directly relevant to issues facing the county, many of these scenarios were devised from suggestions by residents and county officials. Thus, we did not attempt to analyze every possible combination of variables, especially as it became apparent that one of them was not proving to be effective in mitigating the impacts on wildland.

We used three main geographic information system (GIS) datasets as inputs: 1) 1990 Hardwood Rangelands Pixel Data (Pacific Meridian Resources 1994) for land cover and current footprint of development (*fig. 2a*); 2) 1996 County Assessor's parcel data for land tenure information; and 3) 1996 Adopted County General Plan for future potential development densities (*fig. 2b*). We converted the parcel and General Plan data to 25 m raster grids and snapped them to the Hardwoods data. We conducted all spatial modeling with ESRI's ARC/INFO and GRID software (vers. 7.1.1 - 8.1) on UNIX workstations except the fragmentation metrics, which we calculated using APACK v. 2.15 (Mladenoff and DeZonia 2000) on a Windows2000 operating system. An in-depth detail of our methodology has been previously published on the CDF-FRAP website (Greenwood and Saving 1999). Here, we present only a basic overview.

Creating the Footprint of Development

In order to model future development, we first had to construct a pixel-based *footprint of current development* which showed as explicitly as possible where structures and other human disturbances to the natural landscape exist. Remote sensing-based pixel data, such as the Hardwoods data, serve this purpose to some degree, especially in rural areas (Merenlender and others 1998, Ridd and Liu 1998), but provide no context of land use. Such data also miss development obscured by tree canopy and tend to confuse some urban and non-urban land cover types (e.g., rock outcrops and concrete) (Bruzzone and others 1997, Fisher and Pathirana 1990, Quarmby and Cushnie 1989). From the parcel data we determined the land use of each parcel and thus derived two binary layers—development status (*developed* or *vacant*) and intensity of use (*intense* or *not intense*) at the parcel level. For *developed* and *intense* parcels smaller than 1 hectare (2.5 acres), we included the entire parcel in the footprint. However, for larger parcels we turned to the Hardwoods data to identify specific areas of human disturbance within the parcel. We compared the classes Urban and Other (U/O) from the Hardwoods data to the development status of the parcel data. Where a U/O pixel(s) existed inside a *developed* parcel, we included those U/O pixels in the *footprint of current development*. Where a U/O pixel(s) existed in a *vacant* parcel, we considered those pixels "false positives" and did not include them in the *footprint of current development*, although they did remain in the land cover layer as Barren. For *developed* parcels with no U/O pixel(s), we simulated a pattern of development in the parcel using the same technique to project future development patterns (see below). Thus, we created a picture of current development composed of three elements: 1) small, intensely used parcels; 2) scattered pixels of development in larger parcels; and 3) stochastically placed pixels in developed parcels within which we could not determine the explicit location of development (*fig. 2c*).

Table 1—*Descriptions of the combinations of restrictions used for each scenario tested.*

	Slope/Stream Restrictions			Canopy Retention[1]			Other Restrictions			Total Area (ha)
Scenario	Description	Extent	Area (ha)	Description	Extent	Area (ha)	Description	Extent	Area (ha)	Restricted[6]
500	Present Condition	-	-	-	-	-	-	-	-	-
503	25 m stream setbacks, < 40% slope	subdiv.	19,567	as per GP	subdiv.	5,980	-	-	-	122,774
504	25 m stream setbacks, < 40% slope	all	26,983	as per GP	subdiv.	5,980	-	-	-	128,389
505	50 m stream setbacks, < 40% slope	subdiv.	23,319	as per GP	subdiv.	5,980	-	-	-	125,988
506	50 m stream setbacks, < 40% slope	all	31,819	as per GP	subdiv.	5,980	-	-	-	132,694
507	25 m stream setbacks, < 40% slope	subdiv.	19,567	as per GP	subdiv.	5,980	Clustering[3]	LDR, subdiv.	12,526	122,774
508	25 m stream setbacks, < 40% slope	subdiv.	19,567	as per GP	subdiv.	5,980	Clustering[4]	LDR, subdiv.	12,526	122,774
509	25 m stream setbacks, < 40% slope	subdiv.	19,567	Increased[2]	subdiv.	7,096	-	-	-	123,920
513	25 m stream setbacks, < 40% slope	subdiv.	19,567	as per GP	all	6,409	-	-	-	123,368
514	25 m stream setbacks, < 40% slope	all	26,983	as per GP	all	6,409	-	-	-	128,944
515	50 m stream setbacks, < 40% slope	subdiv.	23,319	as per GP	all	6,409	-	-	-	126,564
516	50 m stream setbacks, < 40% slope	all	31,819	as per GP	all	6,409	-	-	-	133,217
520	50 m stream setbacks, < 40% slope	all	31,819	as per GP	all	6,409	Clustering[4]	LDR, subdiv	12,526	133,127
543	25 m stream setbacks, < 40% slope	subdiv.	19,657	as per GP	subdiv.	5,980	Acquistion[5]	AOC	2,071	124,513

[1] Canopy retention restricts development by limiting the amount of development. In most cases, this does not mean complete restriction but rather a reduction in density only (*table 2*). See Greenwood and Saving, 1999.

[2] For details, see Greenwood and Saving, 1999.

[3] Proportion (B) of developed cells increased from 9% to 14%. Adjacency (C) increased from 55% to 95%.

[4] Proportion (B) of developed cells increased from 9% to 14%. Adjacency (C) increased from 55% to 98%.

[5] We manually selected parcels to be restricted from development in Areas of Concern (AOC).

[6] Includes all restrictions plus existing *developed* parcels, parcels *closed to development*, public ownership, and areas designated Open Space (OS) in the General Plan.

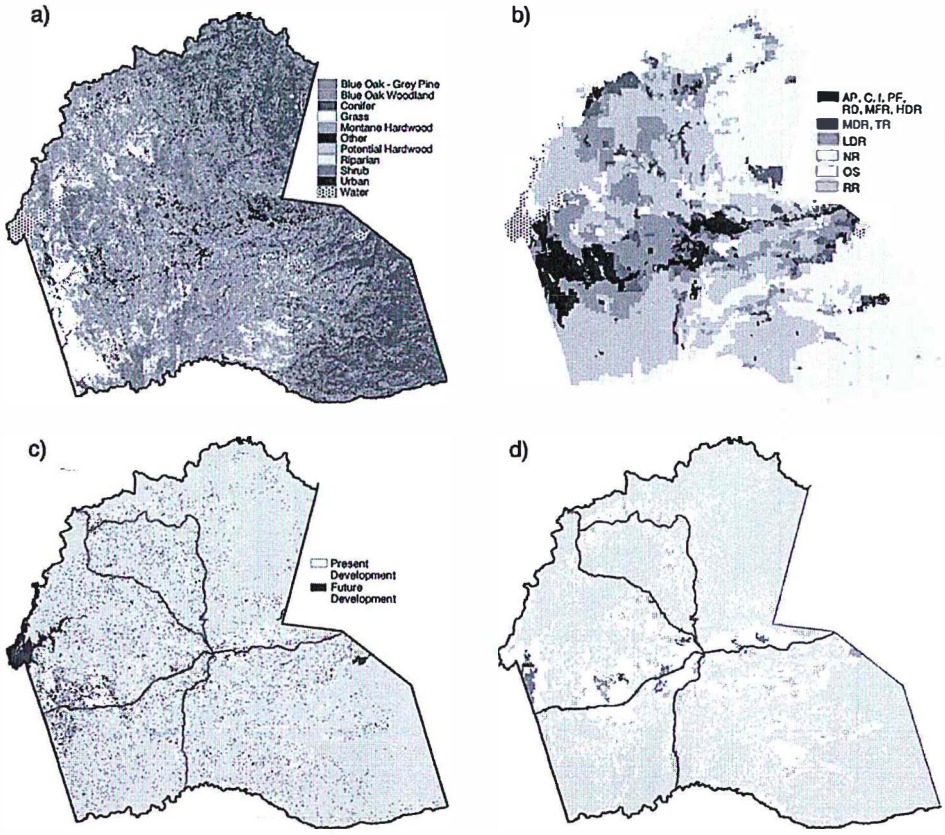

Figure 2—a) Land cover types from 1990 Hardwoods Pixel Data (Pacific Meridian Resources 1994), b) 1996 El Dorado County Adopted General Plan land use classes collapsed to 6 categories (see *table 2* for land use codes), c) footprint of current and future development under General Plan scenario (503), and d) map of current wildland habitat in the study area.

The first step in creating the *footprint of future development* required knowing where development could *not* occur. From the General Plan we derived a restriction status for each parcel. A parcel was *closed to future development* if it were already developed and already at the minimum allowable lot size for that General Plan density class. Alternatively, a parcel was *open to development with restrictions* imposed by the General Plan (i.e., discretionary permit review) if it were *developed* or *vacant* but at least twice as large as the allowable minimum lot size, meaning the lot could be further subdivided. Finally, a parcel was *open to development without restriction* (i.e., ministerial review) if it were *vacant* and already at the minimum allowable lot size for that General Plan density class and therefore could not be subdivided further.

The General Plan contained three major restrictions applying to discretionary permit review that we were able to model spatially – 25 m (1 pixel) stream setbacks,[4]

[4] The Adopted General Plan calls for 100' stream setbacks. Since our model is raster based, we used a one pixel (25 m) buffer as the closest estimate.

Table 2—*Canopy retention guidelines from Adopted General Plan. Values represent percentage of canopy that must be retained for each combination of General Plan Land Use Class and Current Oak Canopy Closure percentage. Where 100 percent of the canopy must be retained, no development can occur on oak pixels.*

	Current oak canopy closure (pct)				
General Plan land use class	**≤ 19**	**20-39**	**40-59**	**60-79**	**80-100**
Multi-family Residential (MFR)	90	85	80	70	60
High Density Residential (HDR)	100	90	80	70	65
Medium Density Residential (MDR)	100	90	80	70	65
Low Density Residential (LDR)	100	100	90	85	80
Rural Residential (RR)	100	100	100	95	90

no development on slopes over 40 percent, and an oak canopy retention guideline based on the density class of development and the existing canopy cover (*tables 1, 2*). We created a separate mask for each of these restrictions which could be turned on or off or, in order to simulate an ordinance, be applied to all parcels *open to development* regardless of restriction class. We also created similar masks reflecting 50 m stream buffers and increased canopy retention. Lastly, some areas were off limits to development in every scenario—areas classified as Urban or Other in the Hardwoods data, parcels that were *developed* and *closed to future development*, public lands, private reserves, easements, and open space designated in the General Plan.

Once we determined where development was allowable, we then determined the spatial configuration of development at the 25 m pixel scale. McKelvey and Crocker (1996) developed a stochastic flood-fill algorithm to create theoretical landscapes burned by fire using two aspects of spatial configuration—proportion (B) of landscape burned by fire, and the spatial adjacency (C) of the burned pixels. Adjacency is defined as the probability that if a cell is burned, an adjacent cell is also burned.[5] We modified their algorithm to create binary neutral landscapes that mimic the development patterns for each housing density class in the General Plan. By overlaying the Urban and Other pixels from the Hardwoods data onto classified 1990 Census block housing density data, we calculated proportion (B) and adjacency (C) for landscapes settled at different densities. The proportion of Urban and Other pixels ranged from 27 percent for housing density classes greater than 1 unit/acre down to 3 percent for density classes less than 1 unit/40 acres (*table 3*). Adjacency values varied to a lesser degree, ranging from 62 percent to 50 percent over the same housing density range (Greenwood and Saving 1999). By masking non-developable areas and inserting portions of these theoretical landscapes into the appropriate General Plan density region, we created potential *footprints of future development* for the study area (*fig. 2c*).

[5] McKelvey and Crocker refer to the adjacency measure (C) as contagion. To avoid confusion with the contagion indices of O'Neill and others (1988) and Li and Reynolds (1993), we have chosen to use the term adjacency.

Table 3—*General Plan land use classes and allowable lot sizes with proportion of cells (B) from the Hardwoods data classified as Urban or Other and likelihood of adjacency (C) of Urban and/or Other cells.*

General Plan land use class	Allowable lot size (ac)	Proportion of urban or other cells (B)	Probability of adjacency (C)
Multi-family Residential (MFR), High Density Residential (HDR)[1]	<= 1	0.27	0.62
Medium Density Residential (MDR)[2]	1 - 5	0.14	0.61
Low Density Residential (LDR)	5 - 10	0.09	0.55
Rural Residential (RR)	10 - 40	0.06	0.55
Natural Resources (NR)	40 - 160	0.03	0.50

[1] Includes these General Plan Land Use Classes - Adopted Plan (AP), Commercial (C), Industrial (I), Public Facilities (PF), and Research and Development (RD)
[2] Includes Tourist Recreation (TR)

For most scenarios, we assumed the spatial configuration of development for a given density class would not be significantly different in the future than at present. In other words, the values of B and C for a given density class did not change. However, the model did not limit us to this assumption. The General Plan allows for the doubling of total housing density in the Low Density Residential (LDR) class (5 - 10 acre parcels) if the development is highly "clustered." Our landscape generator allowed us to easily simulate how this development pattern might appear (scenarios 507 and 508). We created two clustered density patterns for LDR by increasing B from 9 percent to 14 percent to simulate the density bonus, and by increasing C from 55 percent to 95 percent and 98 percent to simulate clustering (*table 1*).

Quantifying Impacts to Wildand Habitat

For this analysis, we defined *habitat* as all land cover types in the 1990 Hardwoods Pixel Data that were not Urban, Other, or Water. We combined Urban and Other pixels, along with developed cells from the *footprint of future development*, into one class called *developed*. Water was masked from the analysis environment. We defined *wildland habitat* as *habitat* more than 50 m (2 pixels) from a *developed* pixel, in patches greater than 100 hectares and containing no constrictions, or narrow necks, of *wildland habitat* narrower than 50 m. *Urban habitat* were those areas of natural vegetation within 50 m of a *developed* pixel. *Marginal habitat* were all areas not defined as *urban* or *wildland habitat* (narrow constrictions or patches less than 100 hectares, and > 50 m from *developed* pixels). This overlay of the footprint of development onto the natural land cover creates a landscape mosaic of *wildland*, *marginal* and *urban habitats*.

A quick review of the landscape ecology literature reveals many highly specialized metrics for capturing specific characteristics of a landscape. Several studies (Hargis and others 1999; McGarigal and McComb 1995, 1999; Ritters and others 1995; Tinker and others 1998) have shown that the simplest, most basic measures are the easiest to understand and serve well to compare and contrast landscapes. We calculated the following fragmentation metrics for wildland habitat for each scenario—total area, number of patches, mean patch size, largest patch size, mean shape index (Frohn 1998, McGarigal and Marks 1995, Ritters 1995), corrected

mean perimeter/area (P/A) ratio (Baker and Cai 1992), and total edge density. Ritters (1995) inverts McGarigal and Marks' (1995) mean shape index for raster data, calling it "average normalized area, square model," to make the values range from 1.0 for a perfectly square patch to 0.0 for patches that are long and narrow. The APACK software calculates Ritters' metric. As this metric measures the same landscape attribute as McGarigal's mean shape index (shape complexity - patch shape relative to a square), we have chosen to use McGarigal's name, mean shape index, when referring to it rather than Ritters' more cumbersome moniker. Although these metrics provide an objective means of comparing landscapes, they do not quantify all aspects of landscape configuration. Therefore, we also assessed model results through visual inspection of the output maps of *wildland habitat* extent.

Results

General Plan

Figure 2d shows the present extent of *wildland habitat* in the study area. The dominant feature of the landscape is a single patch of wildland (mean area of three iterations, 159,535 ha) that extends across the county from north to south and bridges the Highway 50 corridor. The influence of development is substantial yet would appear not to have significantly disrupted the contiguity of wildlands outside of the Highway 50 corridor and the communities of Pilot Hill and Georgetown. *Figure 3a* shows how the county's wildlands might appear if the General Plan were completely built out (scenario 503). The most apparent impact is the increase in number of patches and the cleaving of the wildland into distinctly separate northern and southern regions. Compared to present conditions, mean number of patches per iteration double from 10.0 to 19.67 and mean patch size accordingly drops from 16,182 ha to 6,337 ha (*table 4*). Mean largest patch size similarly declines to 59,603 ha. As patch sizes drop, measures of total edge density and corrected perimeter-to-area (P/A) perforce increase. Mean total edge density rises from 46.6 m/ha to 68.4 m/ha while mean corrected patch P/A ratio increases from 8.97 to 9.76. Mean shape index decreases from 0.070 to 0.043 indicating that not only does wildland shrink and fragment, it also becomes more complex spatially due to low density development perforating the existing wildland matrix. It is important to note, however, that the significant loss of wildland does not mean that large portions of the county have been paved over. While the mean loss of wildland is 23 percent, only 4.5 percent of wildland is actually converted to urban use. For oak woodland land cover types, 40 percent of wildland becomes *marginal* or *urban* woodland but only 4 percent is physically lost to development. In other words, areas that once functioned under a more natural state and presumably provided functional habitat for species are degraded, either due to proximity to urban land uses or by isolation from larger patches of contiguous natural vegetation.

Table 4—*Mean values of wildland habitat landscape metrics for three iterations of the Present Condition (500) and General Plan (503) scenarios.*

	Present condition scenario 500	General Plan scenario 503
Total area	161,825 ha	123,267 ha
Number of patches	10.00	19.67
Mean patch size	16,182 ha	6,337 ha
Largest patch size	159,535 ha	59,603 ha
Mean shape index	0.070	0.043
Mean patch P/A ratio, corrected	8.974	9.762
Total edge density	46.57 m/ha	68.38 m/ha

General Plan Alternatives—Increased Development Restrictions

Figure 3 (*b-d* and *g-k*) shows extents of wildlands for the General Plan alternatives meant to mitigate impacts through increased restrictions to development. The most noticeable aspect of the maps is their similarity to the General Plan scenario. The north and south patches remain highly separated in all scenarios except for scenario 543 where a few small patches come close to reconnecting the north and south patches. The differences become more apparent when the metrics are examined. All scenarios maintain a greater area of wildland than the General Plan. Scenarios that increase the areal extent of development restrictions (504, 505, 506, 509, 513, 514, 515, 516) generally indicate a decrease in fragmentation (mean number of patches decreases slightly and mean patch size increases slightly) (*fig. 4*). However, the range for number of patches and mean patch size for these scenarios is high, indicating site-specific sensitivity to placement of development. Scenarios 506 and 516 show the greatest increase in wildland mean total area (126,716 ha and 126,877 ha, respectively) and mean largest patch size (60,906 ha and 61,105 ha, respectively). Scenarios 506, 509 and 516 have the highest mean patch sizes (6,805 ha, 7,021 ha, and 6,952 ha), although 509 has a large range (1,238 ha). These results are consistent with those expected as the scenarios 506 and 516 restrict the largest amounts of land from development (132,694 ha and 133,217 ha, respectively). Patch shape complexity shows little difference in all scenarios as mean shape index remains virtually unchanged as does the mean corrected patch P/A ratio. Mean total edge density declines slightly with 506 and 516 having the greatest decrease (67.02 m/ha and 67.00 m/ha, respectively).

General Plan Alternatives—Development Clustering

For scenarios 507 and 508 we examined the efficacy of clustering development for mitigating wildland habitat loss. For General Plan density classes of Low Density Residential (LDR), we increased adjacency (C) values to 95 percent and 98 percent, respectively. Because the General Plan allowed for a density bonus to the next higher density class, Medium Density Residential (MDR), we also increased the proportion (B) of developed pixels in LDR from 9 to 14 percent for both scenarios. Neither scenario shows a demonstrable increase in wildland habitat retention over the General Plan scenario, while some metrics indicate increased fragmentation. Mean

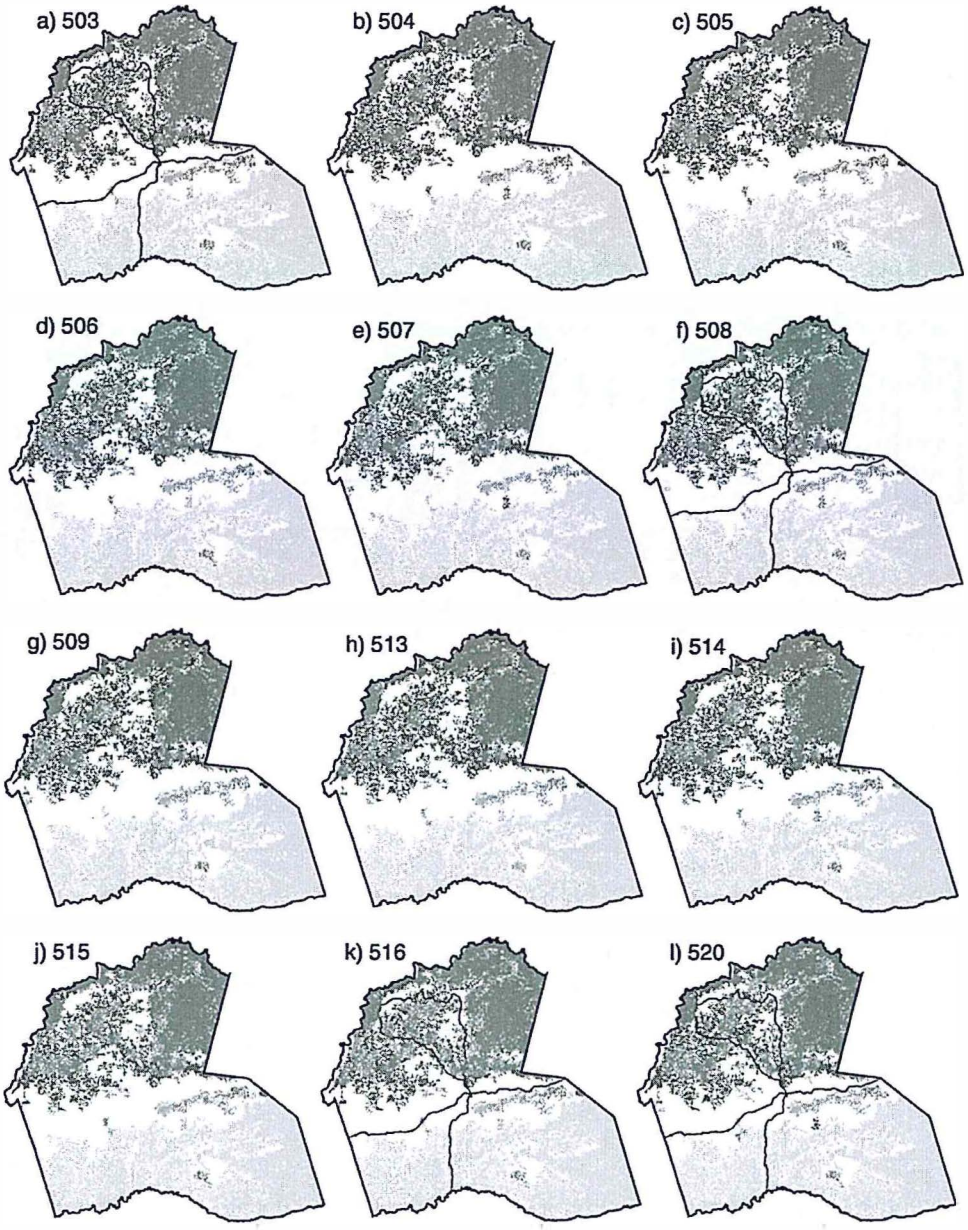

Figure 3—Maps of wildland habitat after full buildout for all scenarios. Areas of the same shade are a contiguous patch.

total area for scenario 507 (123,310 ha) is virtually the same as the General Plan and only slightly higher for scenario 508 (123,831 ha) (*fig. 4*). Mean largest patch size (507 = 59,502 ha, 508 = 59,847 ha) and mean corrected patch P/A ratio (507 = 0.044, 508 = 0.047) show similar behavior while mean total edge density does decrease slightly for 508 (67.39 m/ha). Mean number of patches (507 = 20.67, 508 = 19.0) remains within the range of values of those of the General Plan. Mean patch size actually goes down for 507 (5,979 ha) and remains unchanged for 508 (6,517 ha).

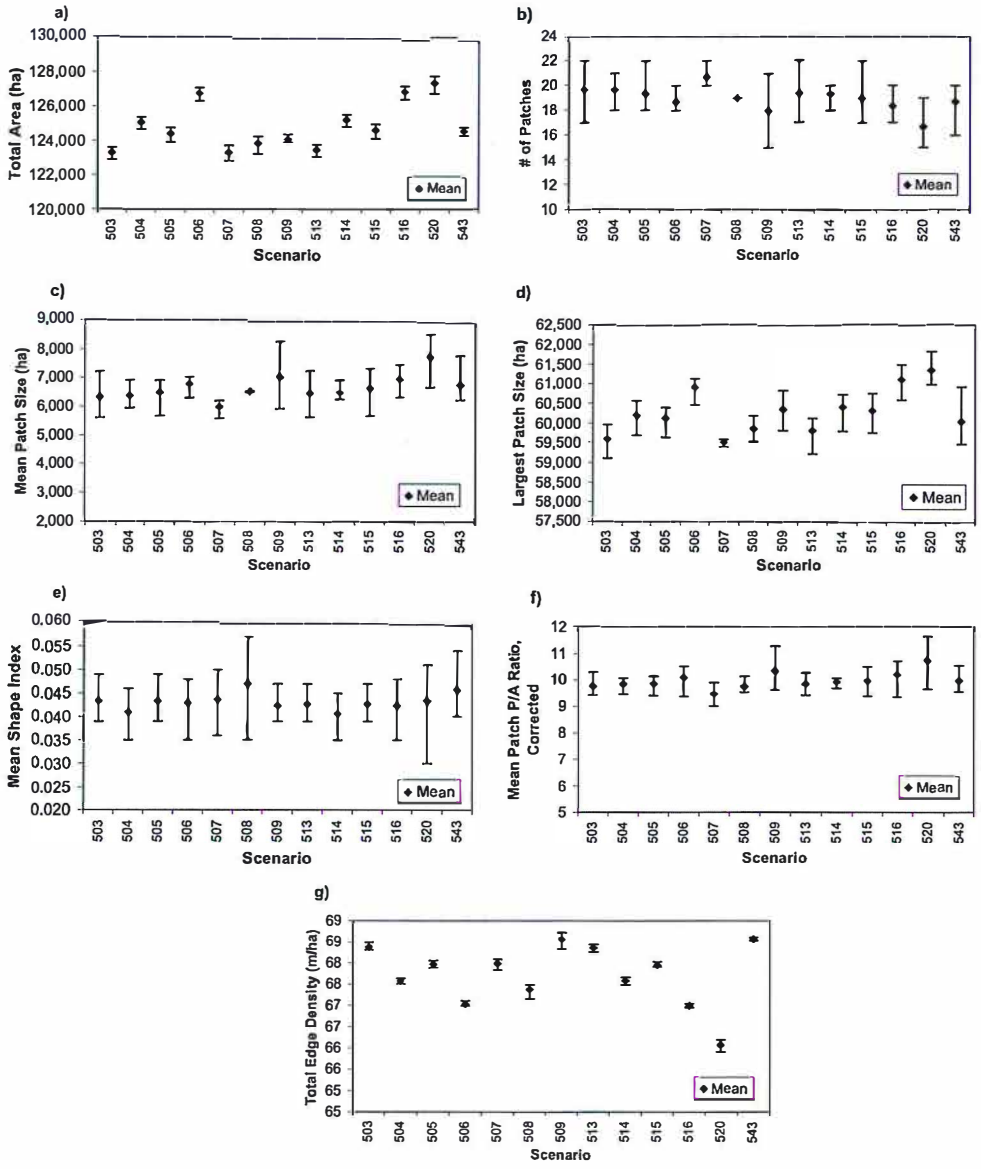

Figure 4—Values of wildland habitat landscape metrics for three iterations of the General Plan scenario (503) and alternatives (504-543). a) total area, b) number of patches, c) mean patch size, d) largest patch size, e) mean shape index, f) mean patch P/A ratio, corrected, and g) total edge density.

One of the iterations for scenario 508 has the highest mean shape index of all scenarios (0.057) but another iteration of 508 has the second lowest (0.035). Neither scenario was effective at maintaining the north-south connection (*figs. 3e, 3f*).

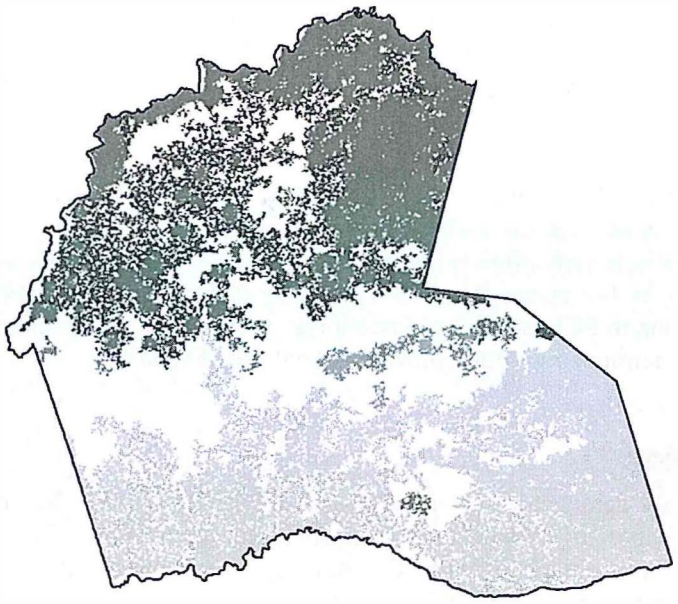

Figure 5—Map of wildland habitat after full buildout for parcel acquisition scenario (543).

General Plan Alternatives—"Kitchen Sink" and Planned Acquisition

Given that scenarios 504-516 were ineffective at increasing wildland habitat retention over the General Plan scenario or at maintaining the north-south connection, we tested two additional approaches. Scenario 520, dubbed the "Kitchen Sink" scenario, combined all of the most restrictive policies yet tested – 50 m stream buffers, 40 percent slope restriction, oak canopy retention for all developable land regardless of restriction status, plus clustering as per scenario 508 (B = 14 percent, C = 98 percent) (*table 1*). In contrast, Scenario 543 took a completely different approach leaving all original General Plan restrictions intact but expanding the area of non-developable land by restricting select parcels from development in key areas of concern. This scenario simulates a planned acquisition approach through the use of easements and/or outright purchase of development rights by the county. We selected several vacant parcels in the Indian Creek canyon area where it crosses Highway 50 between Placerville and Shingle Springs in an attempt to reconnect the northern and southern portions of wildland. In those selected parcels, we only restricted development on oak pixels and areas within 50 meters of oak pixels. This left some parcels still potentially developable.

As expected, scenario 520 retains the highest mean total area (127,376 ha) of wildland because it restricts the greatest area of land from development (133,217 ha) (*table 1*). Mean number of patches (16.67) is the lowest for all scenarios and subsequently mean patch size (7,721 ha) is the highest (*fig. 4*). Mean largest patch size (61,332 ha) is also the highest of all scenarios. Shape complexity does not

decrease, however. Shape index is the same (0.043) as the General Plan scenario and mean corrected patch P/A ratio is the highest of all scenarios (10.74). In contrast, mean total edge density is the lowest of all scenarios (66.1 m/ha). Scenario 520 also does not come close to maintaining the north-south connection (*fig. 3l*).

As we made no attempt to preserve amount, but rather configuration, of wildland, scenario 543 only preserves an average of 1,296 more hectares than the General Plan (mean total area = 124,563 ha) and actually has slightly more average patches (20.0) and a smaller mean patch size (6,229 ha) (*fig. 4*). However, mean shape index is the second highest for all scenarios (0.046) while mean corrected patch P/A ratio is only slightly better than the General Plan (10.013). Mean total edge density is the same as the General Plan (68.57 m/ha). Most importantly, however, scenario 543 comes the closest of all scenarios to maintaining a connection between the northern and southern wildland patches (*fig. 5*).

Discussion

Our study demonstrated that the General Plan for El Dorado County will not allow the county to become one giant suburban subdvision. The General Plan allocates 43.0 percent of private land to development in the 1 unit/5 acre to 1 unit/40 acre density range (LDR and RR). Moreover, only 4 percent of the existing oak canopy will actually be removed by, or converted to, development. However, the configuration of this development is of concern as full buildout could force as much as 40 percent of the County's existing *wildland* oak woodlands into *marginal* or *urban* habitats. When counties are faced with such impacts, a popular mitigation approach is to implement prescriptions in the General Plan that regulate, and/or limit, how and where development can occur (e.g., stream setbacks, slope restrictions, etc.). However, such prescriptions can only apply to development that will undergo discretionary permit review, that is, parcels that have yet to be subdivided to the smallest allowable density in the General Plan. In the case of El Dorado County, 31 percent of *vacant* land that is *open to development* in the county (86 percent of parcels) had been subdivided prior to the adoption of the General Plan and is therefore not subject to these prescriptions. These parcels only require ministerial review (i.e., a building permit) before construction can occur. To impose a restriction that would regulate where development could occur in those parcels would require a county-wide ordinance. Our model allowed us to test both alternative General Plan prescriptions and county-wide ordinances. The former had little effect decreasing wildland habitat loss or fragmentation over existing General Plan policies. We attribute this to the large portion of the county not subject to the prescriptions due to prior subdivision. Ordinances showed greater wildland retention over the General Plan but that increase was still small. Scenario 516, the most restrictive ordinance scenario, only preserved 3,610 hectares more wildland than the General Plan and made little difference to patch configuration, shape complexity or edge density. The political expense in implementing ordinance-type solutions would seem to far outweigh the potential ecological benefits to oak woodlands.

Clustered development is a popular prescription proposed by the smart growth community. By holding overall density constant for an area but decreasing the space between structures, less space is scattered between structures which could otherwise serve as habitat and perform other ecosystem functions. The perceived advantages are so great that in order to promote clustering, El Dorado County offers a density

bonus for clustered development in the Low Density Residential category (5 - 10 acre parcels). We modeled two clustering scenarios allowing densities to increase to the Medium Density Residential level (1 - 5 acre parcels). Neither scenario improved wildland habitat condition over the General Plan and some metrics for scenario 507 (mean number of patches, mean patch size and largest patch size) were actually worse. The increase in density, and therefore the increase in the amount of land developed, offset any benefit that would be gained from clustering. Furthermore, clustering can only occur in *vacant* parcels *open to development with restriction* in LDR. This occurs only in a few small areas in the northern portion of the county.

Scenario 520, the Kitchen Sink scenario, employed the strictest policy restrictions we tested, plus clustering. Looking solely at the fragmentation metrics (*fig. 4*), this scenario offered the most improvement in wildland habitat condition over the General Plan. Yet when examining the maps, we did not notice any significant difference in wildland amount or configuration (*fig. 3l*). Most notably, the north-south separation was still very pronounced. Implementing county-wide ordinances which mandate 50 m stream buffers, 40 percent slope restrictions and oak canopy retention on all undeveloped parcels, plus requiring clustering in LDR, is highly unrealistic, not to mention, very politically expensive. Again, we contend that the political costs of such a scenario are probably greater than the ecological benefits.

Alternatively, we examined a limited parcel acquisition, or easement, strategy (scenario 543) for areas of concern which removes key parcels from the potential development landscape. One such area is the Indian Creek Canyon region. Here, a stringer of oak woodlands presently connects the northern and southern wildland patches. Although this scenario did not actually maintain the connection, several small patches do extend through the area indicating that the concept has the potential to maintain this critical corridor. This area of the county is highly desirable for development, therefore making this scenario potentially fiscally expensive. However, unlike the ordinance approach, an acquisition approach would encounter fewer stakeholders directly and would offer owners compensation for the loss of development rights on their property. Involving private conservation groups or land trusts could greatly reduce costs to the public sector.

Rural residential development erodes habitat quality much more than habitat extent, requiring a more nuanced approach to assessing impacts than when natural habitats are simply removed or paved over. At these low densities, we were unable to use polygons of housing density to determine the relationship of naturalness to density. At certain scales, the landscape still looks much as it once did. Rather, we modeled the real impacts of site alteration which required an entirely unique set of variables and characteristics such as determining the exact footprint of development (e.g., Do lightly used roads count? Do outbuildings?) and establishing the sphere of influence from a structure (e.g., How far from the structure is natural vegetation disturbed? How far does sound travel? What impact does it have? What influence do pets have and at what distance?). We can easily adjust these variables in our model to examine their sensitivity and ability to assess other issues besides wildland connectivity such as impacts to specific species habitat requirements, watershed degradation from increased sediment generation, and changes in wildfire probability due to vegetative fuel alteration. Most people can agree that high density urban and suburban development do not provide much high quality habitat for most species, but seldom can stakeholders, land managers, public officials, or even scientists agree on the thresholds or the degrees at which rural development begins to impact the

landscape. As more of the landscape of California transitions from large extents of wilderness owned by relatively few private individuals to a landscape divided up amongst thousands of owners regularly dotted with houses every few thousand feet, understanding these impacts and enacting policies that are effective, fair, and feasible become ever more important and challenging.

Future Directions

One aspect of development and conversion of natural land cover that we have not addressed is agricultural expansion. In El Dorado County this primarily involves vineyards. Agricultural expansion has the potential for far greater impact to habitat extent and connectivity than residential development as a greater area of land in larger contiguous patches is generally more greatly disturbed. Agricultural expansion can also be more difficult to predict. Heaton and Merenlender (2000) have developed a model to determine site suitability for vineyard expansion in Sonoma County which could be adapted for use in El Dorado County.

More investigation of the effects of riparian corridors on habitat connectivity is needed, including the effectiveness of stream setbacks and the development of methods to characterize linear features, as opposed to the two dimensional patch features analyzed here.

Better knowledge of the likelihood of development would enhance our ability to tailor solutions to specific areas of concern. The incorporation of economic models of development such as Johnston's UPLAN (2001) and Landis's CURBA (1998a, 1998b) would provide more realistic future scenarios as well as the ability to model development in stages over time rather than only at full buildout as we have done. Implementing other constraining factors to development such as water availability and habitat conservation plans could also improve our predictions of future development.

Conclusion

Fine-grained spatial models with highly detailed datasets are required for evaluating impacts of development on ecological, economic, or social systems at the local level. Such large-scale, high-resolution models also enable stakeholders to more easily relate the data portrayed on maps to their perception of the landscape in which they live. However, most site-specific models of development have been created for dense urban areas, using complex economic formulas of land value and empirically derived patterns of past development trends. These models prove less than reliable at predicting low-density development of the rural ranchette variety which is now so prominent in the Sierra foothills and which has such great impact on habitat quality. We have developed a model that is both fine-grained and capable of predicting potential rural ranchette development and its impacts. Moreover, by having a tool that can operate under various assumptions and constraints, we can actually test a proposed solution's efficacy at achieving a desired goal, which in this case is maintaining wildland connectivity. We have also used our model of predicting footprint of development to assess impacts of wildfire on future structure loss. Our explicit model of development could prove useful for studies of water quality and cumulative impacts for watersheds by incorporating elements such as sediment

generation from road development, nutrient loading from septic systems, and conversion of natural land cover to impervious surfaces.

Existing land tenure (the historic parcelization of land) limits effective control of development by General Plan prescriptions that are only applicable when a parcel requires subdivision before development, thus leaving solutions that require large expenditures of political capital such as ordinances or downzoning. The political expense in implementing such solutions would seem to far outweigh the potential benefits. For El Dorado County, our study concludes that the most effective way to maintain wildland oaks in large contiguous patches would be a land acquisition program focused on those critical areas of connectivity, often referred to as habitat corridors. More importantly, broad-brush, "best management practice" type solutions (i.e., the conventional wisdom) applied evenly across the landscape are not necessarily the most effective approach. Site-specific design may be a more effective tool in minimizing negative impacts of development than generic policy prescriptions. "Good" policy should be a process by which better analysis of the problem leads ultimately to better design of the solution.

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QUALIFICATIONS

Highly skilled in wildlife habitat management, identification and research techniques
Extensive field experience at all levels. Management/development of Conservation Banks.
Multiple Federal and State Permits & Certifications for Endangered Species
USFWS: Master Bird Bander (Raptors, including golden eagle telemetry attachment)
Federal 10 A (1) (a) permit for CA Red legged frog, CA Tiger Salamander and Salt Marsh Harvest Mouse
CA State Scientific Collecting Permit and MOU for CA Tiger Salamander,
San Francisco Dusky-footed woodrat, Salt Marsh Harvest Mouse and Berkeley Kangaroo Rat

EDUCATION

B.S. Biology: Pennsylvania State University

PERTINENT EXPERIENCE

1991 – Present: Wildlife Consulting & Photography, Alameda CA — Owner
Owner and operator of consulting business focusing on endangered species of the greater San Francisco Bay region including surveys for federal and state endangered species for compliance and monitoring requirements. Focused studies on raptor and energy development including long-term research on golden eagles and prairie falcons, radio telemetry attachment and monitoring, and impacts from anthropogenic causes. Coordinate with Federal, State and private clients to implement land protection through easements including the development and management of Conservation banks. Published photographer with stock of species and habitat photos, work with public and private media on natural history videos and films, and have served as expert witness in legal cases.

2005-Present: Fletcher Conservation Lands, Livermore, CA — Mr. Robert Fletcher, General Manager
Work with property owner to develop and submit applications for State and Federally-approved Conservation Banks for CA red-legged frog, CA tiger salamander, Alameda whipsnake and Callippe silverspot butterfly within the Alameda watershed (Ohlone Preserve Conservation Bank and Ohlone West Conservation Bank). Also developed and submitted application for the Mountain House Conservation Bank in northeastern Alameda County. This approved Bank includes credits for CA red-legged frog, CA tiger salamander, San Joaquin kit fox, vernal pool fairy shrimp, Swainson's hawk and burrowing owl. Conduct all pre-assessment and post approval surveys for endangered species including egg, larval and adult surveys, pond surveys, spotlight surveys, nesting surveys, camera trap surveys, vegetation measurements, erosion control, dam reconstruction, and development of annual reports to agencies for all Banks. Also involved in marketing and sale of credits to clients.

2016 American Eagle Research Institute — Mr. Daniel Driscoll, Managing Biologist
Conduct monitoring, baiting and trapping of golden eagles, including entering into active nests, to attach GPS CTT radio back packs to eagles in order to assess impacts from wind energy development in the Altamont Pass WRA. Monitoring and active searching for new and established nesting birds. Coordinate camera trap monitoring at bait stations. The current contract is with the East Bay Regional Park District through Dr. Douglas Bell.

2013 Tanner Environmental Services, Alameda, CA — Mr. Richard Tanner, Owner
Worked as an on-site construction monitor for a private development in Napa County, CA. USFWS required a permitted biologist (for red- legged frog) to monitor the removal and replacement of a culvert from Wragg Canyon Creek, serving as the primary access into a parcel scheduled for development of a private residence. Developed and implemented a "worker awareness" training for construction crew including photographs of species life stages from stock photos.

2013-2016 East Bay Regional Park District, Oakland, CA — Mr. Matt Graul, Chief of Stewardship
Work as an on-site construction monitor for the protection of Threatened and Endangered Species. Monitoring was required for CA red-legged frog, Ridgeway's rail, and Alameda whipsnake in the vicinity of the construction. Developed

and implemented a "worker awareness" training for construction crew including photographs of species life stages from stock photos. Currently on contract and continue construction monitoring of projects with the potential to affect T&E species.

2012-2013 East Bay Regional Park District, Oakland, CA — Mr. Matt Graul, Chief of Stewardship
Conducted field assessments for endangered, threatened and state listed species within all areas planned for vegetation management identified in the EBRPD's "Wildfire Hazard Reduction and Resource Management Plan". Mapped all habitats within which listed species occurrences were detected or potential using digital field mapping software and submitted a report for each of 140 areas. Worked closely with staff and agency personnel on the development of FEMA and NEPA documents, CDFW and USFWS permits, and the development of long-term monitoring plans.
I trained District Biological staff in the procedures for salt marsh harvest mouse trapping using Sherman live traps.

2012-2016 ICF International — Mr. Troy Rahmig, Project Manager
Conduct camera trap arrays specifically searching for San Joaquin kit fox on parcels recently acquired by Contra Costa Water District as mitigation for the expansion of the Los Vaqueros reservoir in Contra Costa County. Construct, place and routinely monitor camera stations in appropriate habitat on multiple parcels. Conducted assessment of all parcels (totaling approximately 5,000 acres) for endangered vertebrate species. Conducted CA red-legged frog and tiger salamander surveys in ponds and wetlands and also conducted range utilization surveys across all parcels with contracted certified range manager.

2012 The Nature Conservancy, Simon Newman Ranch, Patterson, CA — Mr. Brent Tadman, Project Manager
Conducted surveys for State protected raptors in the vicinity of water-development projects on a 33,000 acre TNC property. Implemented protocol-level surveys for burrowing owl, Swainson's hawk and golden eagles on the property. Documented, mapped and assessed occupancy of nests within the vicinity of the water developments as well as mapped all incidentally discovered raptors and raven nests on the ranch. Returned annually to band nestlings of eagles and prairie falcons that were detected in 2012 and 2013.

2010 Applied Soil Technologies — Mr. Mark Franchi, Project Manager
Biological assessment of capping a landfill owned by the City of Hayward. Impacts to the endangered salt marsh harvest mouse were assessed in the field and a report was submitted.

2003-2010 City of Oakland, CA — City of Oakland Planning Department
Conducted numerous private parcel assessments for the presence of Alameda whipsnake habitat per a requirement of a building permit by the City of Oakland. Identified as a certified whipsnake habitat specialist by the City and was contracted to private developers and land owners to assess their properties post Tunnel Fire. Developed a report for each parcel and guided owners through CEQA process when necessary.

1989 – 2008 East Bay Regional Park District — Mr. Pat O'Brien, General Manager
Responsible for the management of the natural resources within East Bay Regional Park District (two-county, 100,000+ acres) including rare, threatened and endangered species, control of feral and problem species, and managing various groups of native species in habitats ranging from salt marsh to mountain terrain. I supervised 14 staff in various disciplines including wildlife, fisheries, botany and range management, water quality, environmental permitting and Integrated Pest Management. Oversight on many capital and development projects including implementing conditions under federal and state permits. Conducted research projects including extensive field data collection, and habitat management. Managed several large marsh restoration projects and presented and published scientific papers. Work closely with media, and regional, state and federal regulators. Served as a member of several Federal Endangered Species Recovery Teams. Supervised staff, interns and volunteers. Organized and teach course work to various groups including inter-agency managers, public and volunteer groups. Conducted annual salt marsh harvest mouse trapping within EBRPD marshlands from 1990-2009; trained staff in the procedure, managed salt marsh habitat and was project manager for two marsh restoration projects focused on SMHM habitat.

1988-1989 Judd Howell and Associates — Mr. Judd Howell, Principal/owner
Conducted assessments of raptor numbers and behavior within wind energy developments in Alameda and Solano Counties, CA. Conducted behavioral observations, nesting surveys, scavenging assessments and mortality assessments in developed wind resource areas. Assessed mortality factors and developed reports/recommendations to the clients.

1985-1987 UCSC Predatory Bird Research Group — Mr. Brian Walton, Director
Conducted a year-long raptor survey in Southern Alameda County from Mission Peak in Fremont to Lake del Valle in Livermore, north to SR 84 and south to the county line. Project was initiated through a landmark agreement related to the DeSilva Company's intent to quarry the Apperson Ridge adjacent to EBRPD and SFPUC watershed lands in Alameda County. Performed surveys of raptor nesting, mapped and assessed productivity of all raptor species detected. Identified significant golden eagle population in county and have continued research on raptors to present day.

Current on-going projects:

1. Research on the effects of wind energy and use of the Altamont Pass WRA by radio-telemetered golden eagles.
2. Implement management and monitoring for three State and federally approved Conservation Banks in Alameda County, CA.
3. Field assessment and genetic analysis of the Berkeley kangaroo rat in Southern Alameda County
4. Teach an annual field techniques course to the University of the Pacific, Stockton including bird point count surveys, amphibian and aquatic invertebrate surveys, and small mammal trapping.

RELEVANT PUBLICATIONS

Bobzien, S. and J.E. DiDonato. 2007. The status of the California tiger salamander (*Ambystoma californiense*), California red-legged frog (*Rana draytonii*), foothill yellow-legged frog (*Rana boylii*) and other aquatic herpetofauna in the East Bay Regional park District, CA. EBRPD, Oakland, CA.

Smallwood, K.S., D. Bell, S. Snyder and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-caused avian fatality estimates. Journal of Wildlife Management 74(5):1089–1097; 2010; DOI: 10.2193/2009-266.