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The matrix of private, working landscapes surrounding protected “islands” is increasingly recognized as critical for conservation of the full range of biodiversity and the maintenance of ecosystem processes (Knight 1999, Groves 2000). Private lands tend to be more productive, more mesic, and lower in elevation than public lands in the United States (Scott et al. 2001, Knight 1999). My previous research has involved designing assessment tools and experimental research for public forest management. In my dissertation, I plan to expand on these skills to meet new challenges for conserving biodiversity and ecosystem processes on private land.

Despite considerable investment in protected areas for conserving biodiversity, measurements of conservation effectiveness are inconsistent and insufficient (Parrish 2003). Clear measures of conservation outcomes are particularly lacking for conservation easements, a voluntary market-based strategy for conserving private land. Under conservation easements, land is retained in private ownership and land trusts or government agencies acquire non-possessory interest in the property, restricting uses for the preservation of natural resources, agriculture, or social and cultural amenities. In return, private landowners receive reductions in taxes. Since the early 1980s, over 6 million acres have been placed under conservation easements (Gustanski and Squires 2000). Despite the increasing acreage and public investment in conservation easements, little is known about the ecological outcomes of this strategy, particularly at a regional, or landscape scale (Merenlender et al. 2004, Christensen 2004).

The objectives of my research are to measure the ecological effectiveness of conservation easements. Specifically, I will address three questions: 1) What type, amount, spatial configuration, and threat-status of habitat is being conserved through conservation easements?, 2) To what extent do conservation easements reduce threats to biodiversity and ecosystem processes, specifically from residential development and alterations to fire regimes?, and 3) What are the effects of residential development and altered fire regimes on bird and plant indicator communities at the site and landscape scale?

Study Area:

California’s grassland and oak woodland ecosystems in the nine counties surrounding the San Francisco Bay (the Bay Area) are an ideal location in which to study the effectiveness of conservation easements. In the Bay Area, 135,000 acres, or 13% of regional open space, has been conserved through 360 conservation easements. Grasslands and oak woodlands in the Bay Area have high species diversity, a Mediterranean fire-prone climate, and are predominantly privately owned (Pavlik et al. 2000).

Methods:

What type, amount, spatial configuration, and threat-status of habitat is being conserved through conservation easements?

The Bay Area has a detailed Geographic Information System (GIS) with spatial data for all public land and conservation easements. To assess the type, amount, spatial configuration, and threat-status of habitat being conserved through easements, I will identify a typology of easement properties based on size, connectivity, representation of regional vegetation, slope, elevation, and soils, and likelihood of development using a GIS database. To determine the contribution of easements to the connectivity of regional open space at the landscape scale, I will use Patch Analyst, an ArcView GIS software extension (Rempel and Carr 2003), to compare the connectivity of all protected land including easements with that of protected land without easements. This will provide landscape metrics at the patch and landscape scale, such as mean and median patch size, patch size coefficient of variance, edge density, mean shape index, fractal dimension, interspersion and juxtaposition, Shannon’s diversity index, and core area index.

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Next, I will assess how institutional variables relevant to the 24 non-profit organizations and government agencies holding conservation easements relate to the spatial and ecological characteristics of easement properties using multivariate statistical methods. Institutional variables will include the organization's mission, longevity, funding base, and region of operation.

To what extent do conservation easements reduce threats to biodiversity and ecosystem processes, specifically from residential development and alterations to fire regimes?

I hypothesize that conservation easements in the Bay Area significantly reduce residential development while permitting very low density housing (1-3 houses per easement). To test this hypothesis, I will quantify the increase in development on each conservation easement property since the easement's inception, using aerial photographs. I will compare this with development on similarly situated private land without easements. Secondly, I will quantify the additional development permitted on each property according to the terms of the easement. Comparing this with residential density restrictions in the zoning code for each city and county, I will determine the level of housing restricted by easements under current regulations.

Next, I hypothesize that conservation easements in the Bay Area are less likely to allow for prescribed fire, and owners are more likely to put out naturally-started fires, than on public land managed for conservation. To measure fire patterns in the Bay Area, I will survey easement holders, public land managers, and regional fire records to determine the frequency and intensity of fires on easements and public land. I will identify the proportion of easements that allow the land trust or government agency to carry out prescribed burns, and compare this with the existence of policies and implementation programs for prescribed fire on public land.

What are the effects of residential development and altered fire regimes on bird and plant indicator communities at the site and landscape scale?

I will assess the impact of residential development on bird communities at the site and landscape scale in Bay Area grasslands and oak woodlands. I hypothesize that bird communities near residential dwellings will be dominated by species that are more adapted to human contact than the bird community farther from residential dwellings, and that the level of regional development will have a significant effect on the composition of the bird community both near and away from residential dwellings. To test these hypotheses, I will sample the avian community in 5-minute point counts every 200 meters along a 1 mile transect away from residential developments, stratifying by vegetation type, regional development density, and conservation easement status. I will sample vegetation within a 50-meter radius of each point count station to correlate habitat characteristics with bird community characteristics.

In order to assess the impacts of *not* burning on conservation easement properties, I will compare vegetation plots on easement and non-easement protected lands, and experimentally burn small portions of these lands in cooperation with the California Department of Forestry and Fire Protection in order to test the role of prescribed fire in enhancing species diversity and controlling invasive grasses. My hypothesis is that prescribed burns in the spring will increase native grass and forb diversity while controlling exotic invasive grasses such as Medusahead (*Taeniatherum caput-medusae*).

Preliminary and Expected Results:

Preliminary results indicate that conservation easements contain a higher proportion of agriculture, annual grassland, and oak woodlands than other protected properties. Conservation easements are expected to limit residential development to low levels without addressing other threats such as

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invasive plants and the maintenance of fire regimes. Assessing the contribution of managed landscapes requires a landscape level understanding of what is, and what is not, being conserved through this popular tool. Analysis of residential development and fire patterns will provide input on the role of these processes in shaping bird and plant communities, while allowing researchers to assess the effectiveness of conservation easements for the conservation of biodiversity and ecosystem processes.

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