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Wildlife Corridor Design and Implementation in Southern Ventura County, California

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Project Significance

Human activities are altering global landscapes more rapidly than ever before (*1, 2*). One of the most harmful anthropogenic impacts is the formation of isolated and fragmented habitats, which can interrupt landscape connectivity and increase species extinction rates (*3*). Large portions California are recognized as global biodiversity hotspots, and have experienced similar rapid development and increased fragmentation for many decades (*4*). Wildlife corridors seek to mitigate the negative effects of habitat fragmentation by establishing connectivity, thereby enhancing and maintaining species viability (*5*). The design of effective corridors must integrate sound ecological science with socioeconomic data and policy tools in order to account for the biological and social realities of a region.

Background

In November 2000, The Nature Conservancy, South Coast Wildlands Project and other organizations created the *Missing Linkages* initiative to maintain and restore core habitat areas throughout California by protecting a network of wildlife corridors. This project addresses two linkage areas identified within southern Ventura County that connect the Los Padres National Forest to the South Mountain and Santa Susana Mountains (Figures 1 and 2).

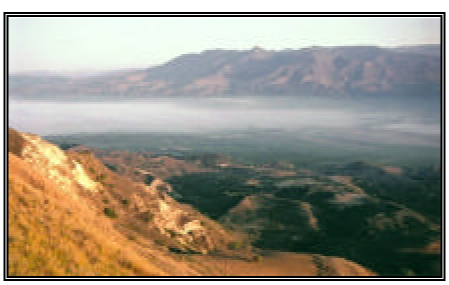

Figure 1: Photograph of the linkage areas

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Problem Statement and Research Approach

The purpose of this project is to designate wildlife corridors within the focus area and create an implementation plan to protect them (Figure 2).

This brief describes the robust, focal species methodology used to designate wildlife corridors and examines the feasibility of implementing a corridor by highlighting the relationship between ecological and socioeconomic factors. Lastly, a spatially explicit implementation plan is created to provide an array of corridor implementation strategies. This three-step process is intended to be a scalable solution used to design and implement wildlife corridors throughout the state of California.

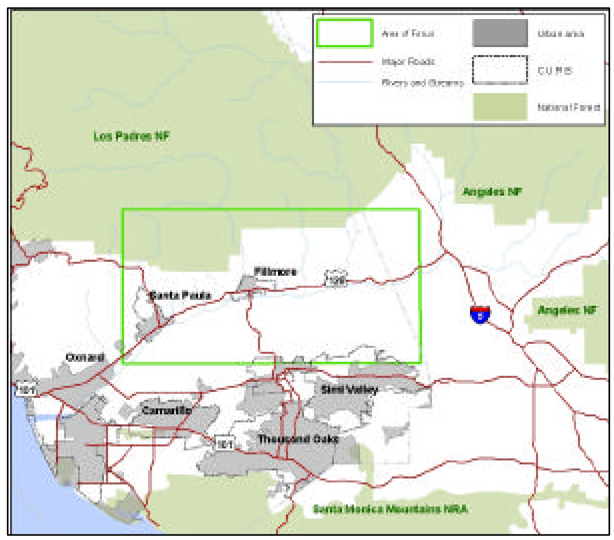

Figure 2: Project study area in southern Ventura County

Ecological Analysis

Our ecological approach to designating a focal species wildlife corridor is illustrated in Figure 3. The ecological analysis uses a GIS-based least-cost path (LCP) modeling process, conducts a sensitivity analysis using Monte Carlo simulations and validates results with aerial photographs and expert interviews. Lastly, these corridors are analyzed for their potential to preserve the habitat of non-focal species.

The corridor design process begins by creating a GIS-based, spatially explicit ecological model to determine areas within which to implement a corridor. We have chosen a least-cost path based approach because multiple inputs can easily be included, and weights can be assigned to these inputs to reflect their relative importance to our focal species. Additionally, LCP is a standard function in many GIS software packages that provides a systematic methodology to evaluate and compare the ecological cost, or "ecological goodness" of many potential wildlife corridors.

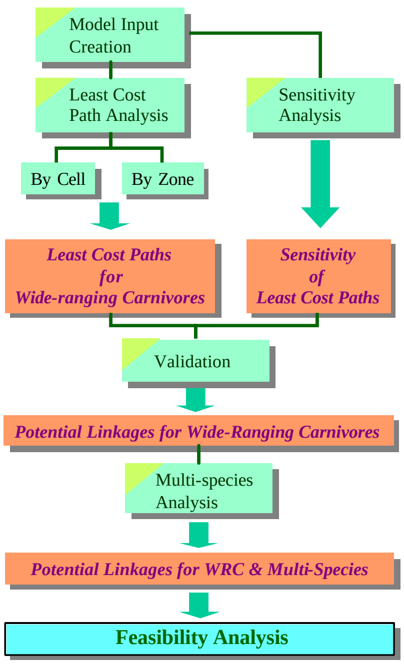

Figure 3: Ecological Modeling Process

The ecological cost of a corridor represents the degree of difficulty for species movement depending on the character of the terrain. The LCP analysis utilizes a cost surface to represent this varying terrain according to ecological and physical variables that affect species movement. Among the variables that affect ecological cost the literature highlights the following three as most significant (*6*):

- Habitat Suitability (HS)
- Road Density (RD)
- Slope (SL)

The path with the lowest total cost indicate the most likely movement route, and therefore determines the "least cost path" for the species to move between two core areas in a landscape.

The modeling efforts are primarily based upon consideration of large wide-ranging carnivores that serve as umbrella species, or those whose presence confers protection upon other species in the area (*7*).

Mountain lion, gray fox, and bobcat are used as the focal species of our model because they are the species present in the study area that we believe to have the greatest potential umbrella effect.

Corridor source and destination targets are delineated based on habitat suitability. One source is identified along the southern border of the Los Padres National Forest, and three destinations are placed the opposite side of State Highway 126 (Figure 4).

Three LCP approaches are utilized:

- **By-Zone** – Single path from one point on the source line to a selected destination line.
- **By-Cell** – Set of paths from every cell on the source line to the selected destination line.
- **Sensitivity Analysis** – Set of paths generated by Monte Carlo simulation of variations in the model input weights (Figure 4).

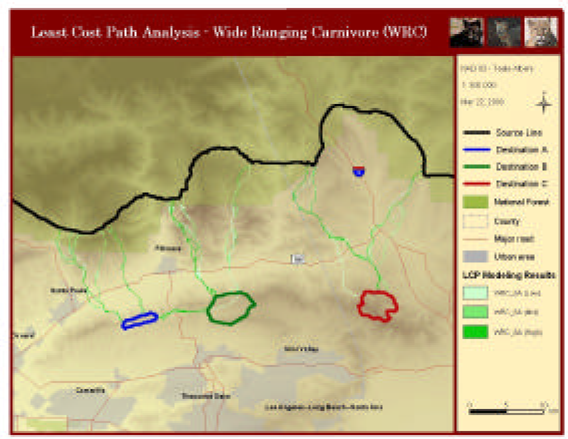

Figure 4: Sensitivity Analysis LCPs

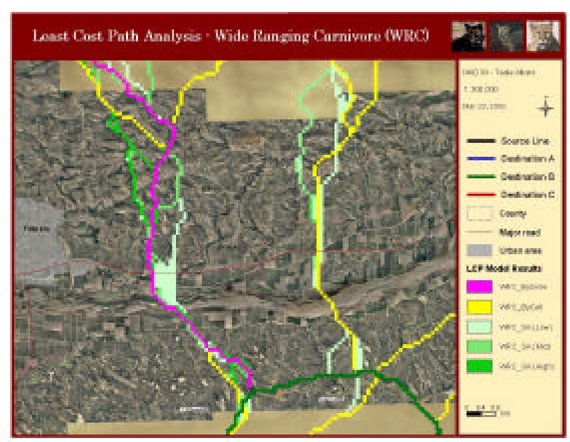

Figure 5: WRC Least Cost Path Analysis

Figure 5 illustrates all three LCP modeling approaches overlaid upon aerial photographs.

After reviewing the model outputs and discussing the results with experts we examine how non-focal species may potentially utilize each corridor. One approach used to accomplish this is to examine the amount of suitable habitat a proposed corridor protects for a given species. Figure 6 displays this statistic for three proposed linkages from the Los Padres National Forest to each of the three core areas in the Santa Susana Mountains. Although these linkages were designed for wide-ranging carnivores they demonstrate that corridors vary in their ability to protect suitable habitat for non-focal species present in the area.

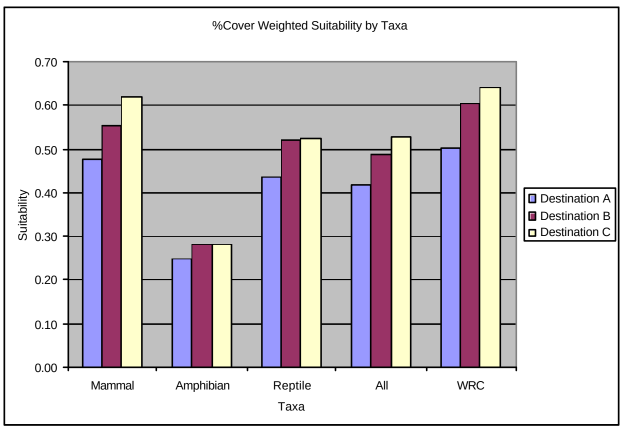

Figure 6: Multi-Species Analysis

Feasibility Analysis

An effective corridor must be feasible to implement, however the most favorable ecological corridor locations do not consider the ease or difficulty of protecting the designated land. The feasibility analysis assesses the likelihood, or difficulty of implementation of the ecological corridor. The process utilizes criteria to evaluate the ecological corridors for their ease of implementation, adjusts the corridors using decision-making criteria and presents applicable strategies that can be utilized within these areas.

This analysis uses land value as a proxy for 'corridor feasibility' by assuming that land value is a conservative estimate of the 'cost' of land conservation. Land value data are used to highlight the relationship between the ecological and economic costs of specific corridors. This relationship is displayed in a graph entitled the Conservation Possibilities Frontier (CPF) (Figure 7). The CPF graph consists of more than 3000 randomly generated LCPs. These include LCPs created for the ecological sensitivity analysis as well as the best ecological and economic LCPs. The CPF also establishes a broader trend that emphasizes the tradeoffs that must be made between the best ecological and most feasible corridors. Lastly, the CPF is used as a tool to adjust the ecologically designated corridors to better accommodate the challenges associated with corridor implementation.

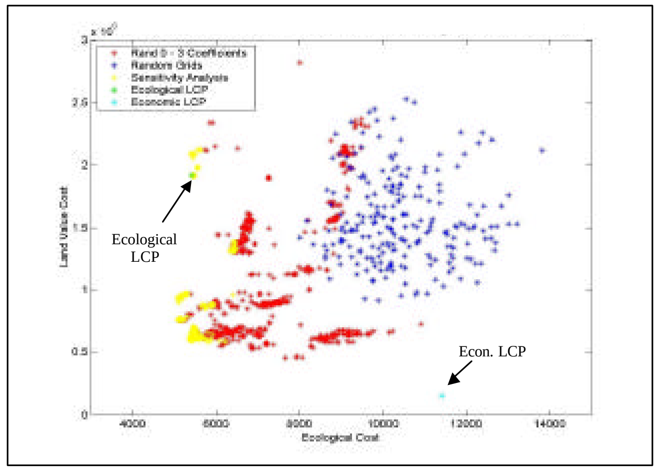

Figure 7: Conservation Possibilities Frontier

However land value is not a comprehensive measure of the feasibility of a corridor's implementation. Therefore other socioeconomic and policy factors such as land use, zoning designations, parcel and City Urban Restriction Boundaries (CURB) boundaries, proximity to preserved land, and quantity of owners and parcels are also evaluated to determine corridor feasibility. An assumption is made for each criterion stating the characteristics that makes corridors easier to implement. These assumptions include:

- **Land Use** – Native vegetation is optimal
- **Zoning** – Open space is better than agricultural
- **Preserved Land** – Currently preserved lands are optimal
- **CURB Boundary** – Outside the CURB is optimal
- **Number of Parcels** – Less parcels are optimal
- **Ownership** – Contiguous owners are optimal

Examination of all the feasibility criteria produces a characterization of the land management scheme within the study area. This information is used to guide the adjustment of the best ecological corridors to avoid potential conflicts and utilize beneficial aspects, thereby making implementation more likely.

Land Characterization of the Study Area

- High-density agriculture
- Urban encroachment
- SOAR-related land use restrictions

The adjusted corridors are then incorporated into the CPF graph. In this case, the CPF provides a framework through which to view the tradeoffs between the economic and ecological costs, and make knowledgeable decisions about the final corridor options. In addition to these tradeoffs each option is validated with regional knowledge and aerial photographs. The result is a final recommendation of four corridor options (Figure 8). These options are prioritized and compared to the original ecological least cost paths created in the ecological model.

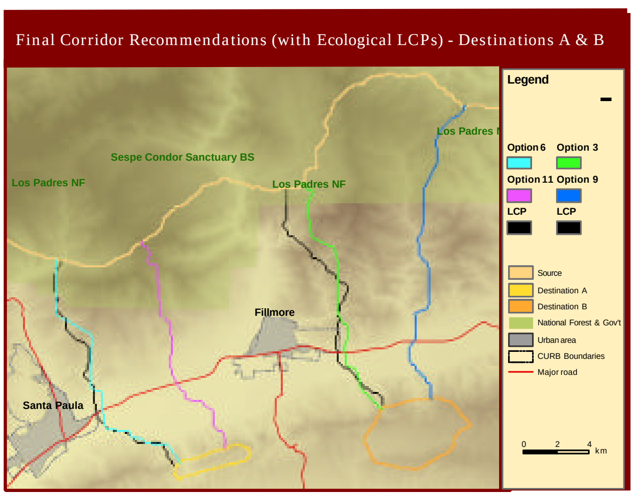

Figure 8: Final Recommendations with Ecological LCPs

After modifying the corridors to incorporate feasibility, applicable implementation strategies are identified and examined. These strategies include:

- Mitigation
- Planning and Zoning
- Farm Bill
- Transferable Development Rights (TDR)
- Preferential Taxation
- Restoration

A strategy characterization matrix is created that establishes a connection between each individual implementation technique and the land disposition (Figure 9). The matrix indicates the social/economic/political land characteristics upon which each strategy can most benefit the implementation of the corridor through greater feasibility. After identifying the characteristics of the land within the corridor, the characteristics are cross-referenced with optimal strategies that can be used for implementation.

		Land Characteristic								
		Zoning			Land Value		Land Use		Development Possibility (CURB)	
Strategy		Ag	Open Space	Urban	High	Low	Native Vegetation	Other	Outside CURB	Inside CURB
Acquisition			X			X	X		X	
Zoning	Overlay Zone	X		X	X		X		X	
	Cluster Development	X	X		X		X	X		X
TDR		X			X		X		X	
Mitigation	Development Fees		X			X	X		X	
	Development Permits		X			X	X		X	
	Land Exchange		X			X	X		X	
Farm Bill	Farmland Protection Program	X				X		X	X	
	Wetlands Reserve Program	X			X			X	X	
	Wildlife Habitat Incentives Program	X			X			X	X	
Preferential Taxation	Williamson Act	X			X			X	X	
	Farmland Security Zone	X			X			X	X	
	Tax Relief for Conservation Easement	X	X		X		X	X	X	
	Wildlife Habitat Contract	X	X		X		X		X	

Figure 9: Strategy Characterization Matrix

Conclusion

This project integrates ecological, socioeconomic and policy-based factors to designate and implement wildlife corridors in southern Ventura County. Missing Linkage managers can apply this methodology to linkages statewide. Additional research and adaptive-monitoring schemes will enhance this process and ensure that wildlife connectivity persists in California.

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