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Wildlife Corridor Design and Implementation in Southern Ventura County

A Group Project submitted in partial satisfaction of the requirements for the degree of
Master's in Environmental Science and Management
for the
Bren School of Environmental Science and Management

by

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March 24th, 2003

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The Group Project is required of all students in the Master's of Environmental Science and Management (MESM) Program. It is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:

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ABSTRACT

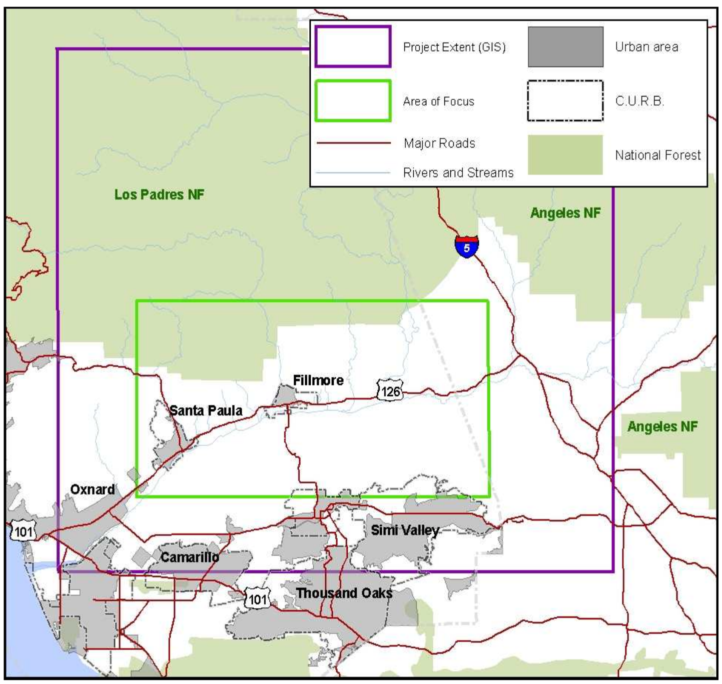
California's landscapes are becoming increasingly fragmented as a result of human activities such as urban sprawl, agricultural expansion, resource extraction, and road building. These disruptions of landscape connectivity are known to significantly impact the persistence and population dynamics of many species. In November of 2000, a diverse group of scientists, agency staff, and conservationists gathered at a conference titled "Missing Linkages: Restoring Connectivity to the California Landscape", where they initiated an effort to identify and protect critical wildlife corridors throughout the state. Working on behalf of The Nature Conservancy and The South Coast Wildlands Project, we evaluate two linkage areas in southern Ventura County. To accomplish this we create a species wildlife corridor based upon sound ecological science and prepare an implementation toolbox to assist linkage managers to implement the corridor.

Our ecological analysis incorporates information from experts at a second round of Missing Linkages workshops, a thorough review of relevant literature, field assessment, and a GIS based model that utilizes least-cost path analysis to identify key corridor locations. The model focuses primarily upon large wide-ranging carnivores as the most suitable umbrella species for wildlife corridors, but also examines potential benefits for a number of additional target species. After designating wildlife corridor locations based exclusively upon ecological factors, we examine the implementation potential or feasibility of protecting the land that could be used for these corridors. This feasibility analysis along with many conservation strategies such as transfer of development rights and restoration opportunities form our implementation toolbox. Our final recommendations identify four corridors modified by feasibility considerations that are prioritized according to comprehensive evaluation of ecological and socio-economic factors.

EXECUTIVE SUMMARY

Human activities are altering the landscapes of the world more rapidly than ever before (Theobald et al. 2000, Dale et al. 2000). One of the most detrimental results of these landscape alterations is the formation of isolated and fragmented habitat (Soulè 1991). The creation of wildlife corridors designed to enhance and maintain the viability of species living within core areas seeks to mitigate this problem of habitat fragmentation (Beier and Noss 1998). Corridors between large core areas allow the passage of individuals among populations, thus maintaining high population numbers while simultaneously preventing inbreeding depression (Simberloff et al. 1992).

The California Floristic Province is recognized as a global biodiversity hotspot (Meyer et al 2000) and has experienced rapid development and increased fragmentation for many decades. In an effort to address this problem, The Nature Conservancy, South Coast Wildlands Project and several other organizations designed the Missing Linkage Initiative to maintain and restore core habitat areas by protecting a statewide network of wildlife corridors. At the first Missing Linkages conference, held in November 2000, a diverse group of scientists, agency staff, and conservationists worked together to create a large-scale map of the most critical areas for connectivity in California. Shortly thereafter, local linkage managers were selected and charged with the task of refining evaluations of the areas identified at the original conference.



Our group evaluates two proposed linkages that are located in southern Ventura County. We first describe a robust, focal species methodology to design an ecological corridor using a simple minimization model, Monte Carlo simulations and GIS technology. Next, we seek to understand the relationship between ecological corridors and socio-economic factors that provide insight into the feasibility of creating potential linkages. Lastly, we create spatially explicit implementation matrices that provide land managers a full host of corridor implementation strategies. This three-step process is designed to be a scalable solution to be utilized in designing and implementing wildlife corridors throughout the state of California.

Our goal is to design a wildlife corridor using landscape scale data that can quickly be applied to other regions around the state to identify highly suitable areas to implement a wildlife corridor. There is a significant body of evidence that suggests corridors are especially important for large, wide-ranging animals with low reproductive capability (Beier 1993, Beier 1996). In accordance with these and other findings, we choose to use wide-ranging carnivores as our focal species. Mountain lions, bobcats and gray fox are examples of these species that exist in our two core areas, the Los Padres National Forest and the Santa Susanna Mountains. Although much of our corridor design process is focused upon these carnivores, we also consider the potential benefits to additional species that exist in the project area.

The corridor design process begins by creating a GIS based, spatially explicit ecological model to determine areas within which to consider implementing a corridor. We have chosen a least-cost path based approach (LCP) because we can easily include multiple inputs and can place weights on these inputs to determine their relative importance to our focal species. Additionally, LCP is a standard function in many GIS software packages, and it provides a systematic methodology to evaluate and compare the ecological cost or "ecological goodness" of many potential wildlife corridors. Least cost path analysis has been recently used in many conservation analysis fields (Singleton et al. 1999, Weber at al. 2000, Wierzchowski et al. 1999, Walker et al. 1997). The fundamental concept of the least cost path analysis is to create a cost surface, resulting from a number of ecological and physical variables that affect species movement, and determine the "least cost path" for the species to move between two core areas in a landscape. Data and GIS layers used in this model incorporate literature and information acquired from experts at the Missing Linkage conferences, California Wildlife Habitat Relationships Program (CWHR), United States Geological Survey (USGS), the Alexandria Digital Map and Imagery Library at UCSB, and field observations made by our team.

Monte Carlo simulations are used to determine the sensitivity of the ecological model to variations in the calculation of cost. This simulation randomly varies the weighting of inputs that combine to create the cost layer for LCP analysis, and records the resulting suitability of the paths generated. We find that our model is relatively insensitive to moderate variations in weighting of the inputs, and also find that some of the paths generated during sensitivity analysis are worthy of consideration as corridor options. Final outputs of the model are evaluated using high resolution aerial photos, additional fieldwork, and expert review. In addition, we assess the potential benefits to other non-focal species for all proposed corridors by comparing the relative habitat suitability contained in the corridor.

Once identification of the most favorable corridor locations according to ecological considerations is completed, we next examine the feasibility of protecting the designated land. Land value is used as a proxy for feasibility in our project because it is important for acquisition strategies, which are usually the most costly conservation technique. We utilize land value data to gain an initial understanding of the relationship between the ecological cost, or essentially the "goodness" of a corridor in an ecological sense, and the economic cost of buying the land within the corridor. We display this relationship in a graph titled the Conservation Possibilities Frontier (CPF). The CPF is then used as a tool to adjust the ecologically designated corridors to better accommodate the challenges associated with feasibility and corridor implementation.

In order to accomplish this we develop criteria that characterize lands in the area that pertain specifically to the implementation of corridors. These criteria include minimizing the number of parcels, maximizing the number of currently preserved parcels and utilizing areas of suitable zoning and land use. In order to keep the broader conservation goals of the project intact, ecological criteria are taken into consideration throughout the implementation analysis process. Comparing these corridors with those on the CPF allow us to adaptively evaluate the tradeoffs between ecological cost and socio-economic criteria. We ultimately recommend four areas as important wildlife corridors, and rank them in order of priority for conservation.

Lastly, we create a spatially explicit implementation toolbox that is relevant to our study area. This includes conservation strategies such as transfer of development rights, restoration opportunities, conservation programs administered by federal statutes such as the Farm Bill and The Transportation Equity Act for the 21st Century (TEA-21), preferential taxation programs, etc. This toolbox is a deliverable which we hope other linkage managers will use in their work.

This project is innovative in its approach to creating wildlife corridors in several ways. First, we design a robust, scalable wildlife corridor designation process using least-cost path modeling. Second, the implementation potential or feasibility of a corridor is incorporated. Lastly, we create a unique socio-economic and policy based toolbox to aid conservation practitioners in corridor implementation. However, the designation of key wildlife corridors and formation of plans to protect them is only one step in an ongoing effort. If maintaining connectivity will ultimately succeed in preserving the viability of core habitat areas, linkage managers should adaptively manage their land, conduct long-term monitoring, and increase public education efforts. We would like for our project to serve as a foundation for others who are presented with the challenge of preserving landscape and regional levels of connectivity.

1 INTRODUCTION

1.1 Purpose and Significance of Project

The purpose of this project is to design a wildlife corridor based upon ecological principles and to prepare an implementation toolbox to assist land managers in implementing the corridor. A November 2000 workshop called *Missing Linkages* (co-sponsored by The Nature Conservancy) identified two things: the key species in the ecoregions across the state which are important with regard to connectivity; and the potential linkage areas that would allow these species to move between core areas. The general project objectives are to designate best possible locations in Southern Ventura County, for the ecological linkages proposed by this workshop and to design an implementation strategy to permanently preserve local and regional connectivity. To accomplish this we first describe a focal species methodology to design the corridor using a least cost path model, Monte Carlo simulations and GIS technology. Next, we seek to understand the relationship between ecological corridors and socio-economic factors that provide insight into the feasibility of potential linkages. Lastly, we create spatially explicit implementation matrices that will provide land managers a full host of corridor implementation strategies. This three-step process is designed to be a scalable solution to be utilized in designing and implementing wildlife corridors throughout the state of California. The project can be regarded to be important not only from the regional but also the global perspective of conservation. The south coast ecoregion is rich in biodiversity being a part of the California floristic province that is recognized as one of the biodiversity hotspots of the world (Meyers et al. 2000). This hotspot is a zone of Mediterranean-type climate and has high levels of plant diversity and endemism characteristic of these regions.

In order for TNC and other organizations to successfully preserve connectivity in the South coast ecoregion the linkage plan and implementation strategies proposed by the project must be based on sound science. This will ensure the success of the adoption of the proposed framework for linkage implementation alternatives for all of California's ecoregions.

1.2 Wildlife Corridors and Conservation Issues

1.2.1 Scientific Reasoning for Protection of Corridors

The destruction of habitat has been targeted as one of the most serious threats to biological diversity worldwide (Wilcove et al. 1998). The large-scale destruction and fragmentation of habitat by humans has brought about an extinction crisis, with an unprecedented rate of extinction (Wilcox and Murphy 1985). A disruption in landscape connectivity has serious consequences for population dynamics and species persistence in fragmented landscapes (With 1997, Weins 1997). The principal concern facing wildlife and land managers in today's increasingly fragmented landscapes is whether a landscape can maintain its functional integrity even if it is not structurally connected (Rochelle et al. 1999). The idea of a corridor, proposed by Wilson and Willis in 1975, is defined as linear habitat that connects two or more core areas of habitat, with the purpose of enhancing or maintaining the viability of wildlife species populations within the core areas (Beier and Noss 1998). This idea was printed in World Conservation Strategy, published by the International Union for the Conservation of Nature and Natural Resources (IUCN). The IUCN, United Nations Environment Program (UNEP) and World Wildlife Fund (WWF) jointly sanctioned the idea of corridors.

Corridors are based on the equilibrium theory of island biogeography, according to which the balance in the number of species is maintained by the rate of immigration and extinction across the habitat islands. Corridors lower extinction rates by allowing movement across them and thus keeping species numbers high (MacArthur and Wilson 1967). In addition, it is thought that corridors lessen demographic stochasticity or random fluctuations in birth and death rates. Small, isolated populations are threatened by extinction due to demographic stochasticity. Corridors allow the movement of populations from one area to another to allow gene flow and population persistence. Corridors prevent inbreeding depression due to the facilitation of gene flow. Also, corridors fulfill an inherent need for movement and might allow some species to avoid potential intraspecific encounters, thus facilitating their dispersal. Corridors make possible movement between larger habitats or between refugia (Simberloff et al. 1992). Corridors can take many forms such as habitats, greenbelts, transmission line right-of-ways or underpasses and culverts. For example, a habitat may function as a corridor and thus deserve protection as a distinct habitat, regardless of its usage for movement (Simberloff and Cox 1987). Linear artificial habitats like railroads and transmission lines can also form corridors (Noss 1992, Anderson et al. 1977).

Greenbelts are also called corridors, however the human use of greenbelt areas, such as hiking and horse trails, could impede their utility as either dispersal or habitat corridors (Simberloff et al. 1992, Budd et al. 1987). Underpasses and tunnels are another type of corridor, and are used to allow animals to cross highways and prevent road kills (Noss 1992).

1.2.2 Debate about the Functionality of Corridors

Despite the potential benefits of corridors there has been considerable amount of debate and speculation regarding their usefulness. One of the arguments against the use of reserves is that corridors can lead to the spread of diseases, invasive species, catastrophes, thereby becoming reservoirs of edge, possibly becoming sinks and traps if they are not of high quality (Hess 1994, Simberloff et al. 1992). Simberloff and Cox (1987) question the need for the facilitation of gene flow by corridors since this may break down the genetic differences between the separate populations that have different genotypes, a phenomenon called out-breeding depression (Noss 1987). Noss (1987) also states several potential advantages and disadvantages of corridors, in addition to the ones mentioned above. Corridors can increase the foraging area for wide-ranging species, provide predator escape cover for movements between patches, and offer a mix of habitats and successional stages accessible to species that need a variety of habitats for different activities or stages of their life cycles. Conversely, corridors may increase exposure of wildlife to hunters and poachers. Riparian strips that are proposed as corridors may not enhance the dispersal or survival of upland species. The costs of preservation may be high and may conflict with conventional land preservation strategy. Beier and Noss (1998) mention that corridor projects can be far more cheaper compared to other alternatives. Some of these are expensive since they are in vicinity of growing human populations.

However, evidence regarding the use of corridors by species is unclear (Simberloff and Cox 1987, Simberloff et al. 1992). Species that have been found to use corridors are usually the ones that are unwilling to cross gaps of unsuitable habitat. The utility of corridors is determined by the nature of the species in question as well as the structure of landscape. This debate is therefore hard to resolve (Rochelle et al. 1999). Nevertheless, a review of evidences from well-designed studies by Beier and Noss (1998) indicates the utility of corridors as a conservation tool, and they state, “All else being equal, in absence of complete information, it is safe to assume that a connected landscape is preferable to a fragmented landscape.”

1.2.3 Implementation of Conservation Measures

Determining how, why and where to take action on biodiversity loss has catalyzed a whole industry of priority-setting: designating areas of conservation importance, identifying hotspots and ecoregions where critical species can be protected, and developing methods for citing areas of protection (Salafsky 2002).

However much of the remaining available habitat within the state that species need to survive is found on privately owned forestland, farmland and rangeland (California Wilderness Coalition 2002). Thus, in order to curtail the current tide of habitat fragmentation and biodiversity loss, conservation and management efforts should focus on the managed landscape consisting of the places where we live, work and play (Robertson and Hull 2001).

The involvement of private landowners in the preservation and stewardship of ecosystems is essential to the conservation of California's biodiversity and habitats. Since a large majority of California's privately owned land lies in agricultural uses, policies and programs are needed to enhance the habitat value of private and agricultural lands while ensuring the profitability of California's agricultural producers (California Wilderness Coalition 2002). Given the emotionally and politically charged atmosphere surrounding the debate regarding agricultural management and land-uses in California, the importance of scientific credibility in advancing conservation goals cannot be over-emphasized. Research also provides public and private landowners with an ecological context for their management activities (Curtin 2002).

Regardless of their research emphasis, many conservation biologists are challenged with integrating their science into public policy. Communication between academia and practitioners undeniably is key to incorporating scientific knowledge gained from research into conservation planning and land management (Fleishman 1999). The roadblock to implementation of conservation recommendations commonly falls under the loose umbrellas of organizational psychology, administrative structure, individual personalities, and politics (Fleishman 1999).

Herein lies the conundrum associated with implementing conservation programs, particularly over a broad area. The science, which forms the foundation for conservation programs, is typically based on large biogeographic scales such as ecoregions that include diverse socio-political boundaries and administrative jurisdictions. This can lead to conflict with stakeholders across cities and counties in which these large-scale conservation programs are being proposed.

At large scales, the scope of conflict associated with implementing conservation programs is too broad for many organizations to address. Thus mangers of conservation programs commonly try to narrow the focus. They do so by localizing the conservation effort, however this is typically done at a cost. In trying to limit social conflict mangers and policy-makers can compromise ecological science, which is the original motivation of the conservation effort. Thus, scaling down the problem without taking ecological analysis into account causes the conservation program to become disconnected from its original conservation goals of habitat conservation at a biogeographic scale.

This project addresses the scope of conflict issue by using ecological analysis in the form of a GIS-based model as the basis for our decision making on where to implement the movement corridors within our study site.

The implementation of conservation programs and policies are rarely integrated into the scientific design of such programs. Our project is unique in that we have incorporated implementation considerations into the design of our movement corridors. In addition, we have expanded upon the traditional implementation tools available to implement conservation programs.

Traditionally conservationists employed one broad approach to meet conservation goals: direct protection through the establishment of parks. However, there is not one tool that will lead to successful biodiversity conservation at all sites, or even at any one site over time. Instead, practitioners need to employ the appropriate mixture of tools to counter specific threats to biodiversity at particular sites. Thus, over time, new approaches have been added to the conservation tool kit, including outright land purchase, conservation easements, legal and policy reform and environmental education efforts. More recently, conservationists have begun trying to find economic and other incentive-based tools that would induce private landowners to act to protect and conserve biodiversity (Salafsky 2002).

Determining what to call a “tool” can be difficult. Specific strategies and conservation techniques under each approach can be defined based on the spatial and temporal scale at which the tool is being used and the practitioner using it, among other factors (Salafsky 2002). Thus, it is important to know the conditions under which each tool works and under which it does not (Salafsky 2002).

2 Background Information

2.1 Regional Geography and Climate

The project site is located in southeastern Ventura County, extending from southern Los Padres National Forest (which accounts for approximately 46% of the area in the county) in the northeast to the Santa Susana Mountains in the southwest. The northern boundary of the study area extends from the city of Santa Paula east towards the LA-Ventura County line. The Santa Clara River Valley lies between the two mountain ranges. The elevation of the site ranges from below 1000 feet in the river valley to over 3000 feet in the National forest. The Santa Susana Mountains are oriented east-west and comprise of eroded Tertiary sedimentary rocks. The Santa Paula Valley contains mainly late Quaternary alluvium.

The region experiences a Mediterranean type of climate characterized by hot and sub-humid marine air. The mean annual precipitation is between 12 to 20 inches, which is comprised primarily of rain. Summer fog is common. Mean annual temperature varies from is about 56°-60° F for the Santa Paula valley and 52°-62° F towards the Santa Susana Mountains. The mean freeze-free period is about 300-350 days. The Santa Clara river watershed is approximately 1200 sq. mi in area, 100 of which comprise the Santa Clara River (see Appendix A, Figure A.1). This river is perennial, but there are no lakes or ponds other than temporary ponding behind the dunes. Run-off is rapid and all streams are generally dry during the summer. The Sespe, Piru and Santa Paula creeks are important tributaries to the river.

2.2 Habitat Types and Wildlife

2.2.1 Habitat Types

The main habitat types and the corresponding dominant plants in the project area are shown in Table 3.1.2 (from "A Guide to Wildlife Habitats of California" 1988).

Mixed Chaparral: It is floristically rich habitat type that supports approximately 240 species of woody plants. Includes scrub oak, chaparral oak, and several species of ceanothus and manzanita. Commonly associated shrubs include chamise, birchleaf mountain mahogany, silk tassel, toyon, yerba-santa, California buckeye, poison-oak, sumac, California buckthorn, hollyleaf, cherry, Montana chaparral- pea and California fremontia.

Coastal scrub: Coastal scrub usually consists of small to medium sized shrubs up to 2 m tall, with canopy cover usually approaching 100%, although bare areas are also present. Common species include sagebrush, purple sage, California buckwheat, and black sage. Golden Yarrow, isocoma, rolled leaf monkey flower and California encelia are typical. Chaparral yucca is found on the slightly drier sites in the Ventura County.

Urban: The structure of urban vegetation is comprised of five types of vegetative structures- tree groves, street strip, shade tree/lawn, lawn and shrub cover. Tree groves have continuous canopy (e.g. eucalyptus). Street tree strips show both continuous and discontinuous canopies. Shade trees and lawns are observed in residential areas. Lawns have variety of grass species. Hedges represent a variation of urban shrub cover type. Some commercial portions of urban areas are without any vegetative cover.

Agriculture: The agriculture in the area consists mostly of orchards of citrus fruits and avocados. Some row crops are also present such as bell peppers, beans, cabbage, strawberries, lettuce, spinach, broccoli, onions, and grain. In addition, flowers, nurseries and Christmas tree farms also exist in the area.

Area by vegetation in the project site

WHRTYPE	WHR Name	km^2
MCH	Mixed Chaparral	1,079.07
CSC	Coastal Scrub	816.29
URB	Urban	428.54
AGR	Agriculture	331.69
AGS	Annual Grassland	227.90
PJN	Pinyon-Juniper	206.78
CRC	Chamise-Redshank Chaparral	163.87
COW	Coastal Oak Woodland	156.41
MHW	Montane Hardwood	83.11
JPN	Jeffrey Pine	78.98
	Top 10	3,572.64
BAR	Barren	58.22
MRI	Montane Riparian	49.31
MHC	Montane Hardwood-Conifer	47.63
SMC	Sierran Mixed Conifer	45.76
MCP	Montane Chaparral	38.64
SGB	Sagebrush	32.13
WAT	Water	29.95
DSC	Desert Scrub	10.67
VOW	Valley Oak Woodland	7.68
VRI	Valley Foothill Riparian	5.33
BOW	Blue Oak Woodland	5.21
DSW	Desert Wash	1.89
JUN	Juniper	1.75
BOP	Blue Oak-Foothill Pine	0.86
EUC	Eucalyptus	0.13
	Other	335.16
	Total	**3,907.80**

Table 2.1 – Habitat Types from CWHR

Annual grassland: Annual grassland habitats are open grasslands composed of annual plant species. Introduced annual grasses are dominant plant species in this habitat. These include wild oats, soft chess, ripgut brome, California poppy, red brome and redstem filaree.

Pinyon Juniper: Pinyon juniper habitat is open woodland of low, round crowned, bushy trees that are needle-leaved evergreen. The species composition consists of oaks (shrub live, California scrub, or canyon live), buckwheat, foothill yucca and grasses.

Chamise redshank chaparral (CRC): Mature Chamise-redshank chaparral is single-layered, generally lacking herbaceous ground cover and overstory trees. CRC may consist of nearly pure stands of chamise or redshank, a mixture of both, or with other shrubs. The purest stands of chamise occur on south facing slopes. White sage, black sage and California buckwheat are common at low elevations and on recently disturbed sites.

Coastal oak woodland: Coastal oak woodlands are extremely variable with the overstory consisting of deciduous and evergreen hardwoods. The trees are dense and form a closed canopy in mesic sites, whereas in drier sites they tend to be widely spaced forming open woodland. The dominant species are Engelmann oak, coast live oak, interior live oak and California walnut.

Montane hardwood: This habitat is composed of a pronounced hardwood tree layer with an infrequent and poorly developed shrub stratum and a sparse herbaceous layer. Overstory associates at middle and higher elevations are Jeffrey pine, ponderosa pine, sugar pie, incense cedar, California white fir, Bigcone Douglas-fir, California black oak and Coulter pine. At lower elevations, associates are white alder, coast live oak, big leaf maple, California-laurel, Bigcone Douglas-fir and valley oak. Understory species are manzanita, poison oak, coffeeberry, current and ceanothus.

Jeffrey pine: This habitat is found at higher elevations and the trees are only a few meters tall. Jeffrey pine is the dominant species found in the upper tree layer. It usually forms pure stands but may have ponderosa pine, Coulter pine, sugar pine, lodge pole pine. The shrub layer is dominated by scrub oak, ceanothus, Sierra chinquapin, manzanita, Parish snowberry, and cherry.

Disturbed or Barren: These areas either lack vegetation or have ruderal species. The vegetation comprises non-natives, natives and weedy species. Disturbed area occurs in the project area along State Highway 126 and dirt roads, along agricultural fields, in underpasses, culverts and beneath the bridges. Mule fat, Tree tobacco, Russian thistle, White sweet clover, Goosefoot, Horseweed, Cheeseweed, Rice grass, Castor bean, Quail bush, Brome, Fennel, willow and buckwheat are some of the plants in these areas.

Montane riparian: Montane riparian zones are narrow, dense groves of broad leaved, winter deciduous trees. Bigleaf maple and California bay are typical dominants of montane riparian habitat and Fremont cottonwood is the most important cottonwood.

Montane hardwood conifer: Montane Hardwood Conifer habitat includes both conifers and hardwoods. The habitat occurs in a mosaic-like pattern with small pure strands of conifers interspersed with small stands of broad-leaved trees. Common associates include canyon live oak, Pacific madrone, coast live oak and to a lesser extent California black oak, ponderosa pine, sugar pine and incense cedar.

Sierran mixed conifer: The Sierran mixed conifer habitat is an assemblage of conifer and hardwood species that forms a multi-layered forest. Forested stands form closed multi-layered canopies with nearly 100% overlapping cover. Shrubs are common in the understory. Five conifers and one hardwood typify the mixed conifer forest-white fir, Douglas fir, ponderosa pine, sugar pine, incense cedar, and California black oak. Understory is made of deerbrush, manzanita and gooseberry.

Montane chaparral: Montane chaparral is characterized by evergreen species, though deciduous or partly deciduous species may be present. Understory vegetation is absent in mature chaparral. Species that characterize this community are whitethorn ceanothus, snowbrush ceanothus, green manzanita, pinemat manzanita, hoary manzanita, bitter cherry, and huckleberry oak.

Sagebrush: Sagebrush stands are typically large, open, discontinuous, stands of big sagebrush of fairly uniform height. Habitat is composed of pure stands of big sagebrush, but many stands include other species of sagebrush, rabbitbrush, horsebrush, and gooseberry.

Desert Scrub: Desert Scrub habitats typically are open scattered assemblages of broad-leaved evergreen or deciduous microphyll shrubs. Creasotebush is often considered a dominant of Desert Scrub habitats. Other species include catclaw acacia, desert agave, coastal bladderpod, cholla, desert sand verbena.

Valley Oak Woodland: The habitat varies from savanna-like to forest-like stands with partially closed canopies, comprised mostly of winter-deciduous, broad-leaved species. Canopies of woodlands are dominated by valley oaks. Shrub understory includes poison oak, blue elder, California wild grape. Wild oats, brome, needle grass dominate the ground cover.

Valley Foothill Riparian: Most trees in this habitat are deciduous. There is a sub-canopy tree layer and an understory shrub layer. Dominant species in the canopy layer are cottonwood, California sycamore and valley oak. Sub-canopy trees include white alder. Understory shrub layer include wild grape, wild rose, California blackberry, blue elderberry, poison oak, buttonbrush and willows. Herbaceous layers consist of sedges, rushes, grasses, and poison hemlock.

Blue Oak Woodland: These woodlands have an overstory of scattered trees. The canopy is dominated by broad leaved trees. Blue oak is the dominant species (85 to 100 %). Common associate is the California Juniper. Shrub species include poison oak, California coffeeberry, vukbrush, redberry, California buckeye and manzanita species. Ground cover is comprised of annuals, such as bromegrass, wild oats, and foxtail.

Desert Wash: Habitats are characterized by the presence of spiny shrubs associated with streams. The plants are relatively taller and denser as compared to desert habitats. Washes have a diverse species composition. Canopy species found in the washes include blue paloverde, little paloverde, desert ironwood, smoketree, catclaw acacia, mesquite and tamarisk. Subcanopy species include desert willow, desert broom, and the ground cover species are Opuntia, bursage, saltbush, GoldenBush as well as forbs and grasses.

Juniper: Habitats are characterized as woodlands of open to dense aggregations of junipers as shrubs or trees. Associated species include whitel fir, Jeffrey, ponderosa, and whitebark pine, and single leaf pinyon. Shrub species include antelope bitterbrush and California buckwheat and forbs and grasses.

Eucalyptus: Eucalyptus habitats range from single species thickets with little or no shrubby understory to scattered trees over a well developed herbaceous and shrub understory. It forms a dense stand with a closed canopy. Overstory composition is typically limited to one species of the same genus or mixed stands composed of other species of the same genus, few native overstory species are present within eucalyptus planted areas. Typical understory species include a host of annual grasses (Mediterranean and European species of the genus Bromus). In native plant communities, the understory species are coastal sage, chamise, manzanita, and buckwheat. Eucalyptus is also known to establish along stream courses, encroaching upon existing riparian vegetation.

2.2.2 Wildlife in the Area

The project area is home to many species of animals, several of which are important for consideration within a wildlife corridor. Originally, the project identified twenty-five species, selected at the Missing Linkages workshop (in November 2000), as important for corridor consideration for the entire south coast ecoregion (see Appendix A, Figure A.2). A revised list of species (See Appendix A, Figure A.3) was then created at another workshop that focused on linkages in the LA-Ventura region. The species considered for the corridor designation in this project are shown in the table below. These species include 5 mammals (badger, desert woodrat, mountain lion, bobcat and gray fox); 3 birds (acorn woodpecker; California thrasher and Loggerhead shrike); 3 amphibians (western toad. Spadefoot toad, arroyo toad); 3 reptiles (southwestern pond turtle, common kingsnake, whiptail lizard) and 2 fish (steelhead trout and three-spine stickleback). A species matrix, described in the ecology section, provides criteria for the relevant species characteristics considered for the purpose of corridor designation. The fully detailed species matrix includes information on habitat preferences, dispersal distances, feeding behavior, reproductive habits, and many other factors (See Appendix A, Figure A.4). A very simplified sample from the full species matrix is shown below in Table 2.2.

Common name	Scientific name	CWHR ID	Status
Mammals			
Badger	Taxidea taxus	M160	
Brush Rabbit	Sylvilagus bachmani	M045	
Desert Woodrat	Neotoma lepida	M126	Special Concern (CA)
Mountain Lion	Puma concolor	M165	Special Concern (CA)
Mule Deer	Odocoileus hemionus	M181	
Bobcat	Lynx rufus	M166	
Gray Fox	Urocyon cinereoargenteus	M149	
Birds			
Acorn Woodpecker	Melanerpes formicivorus	B296	
California Thrasher	Toxostoma redivivum	B398	
Loggerhead Shrike	Lanius ludovicianus	B410	Special Concern (CA)
Amphibians			
Western Toad	Bufo boreas	A032	
Arroyo Toad	Bufo microscaphus californicus	A035	Endangered (FED), Special Concern (CA)
Spadefoot Toad	Scaphiopus hammondii	A028	Special Concern (CA)
Reptiles			
Southwestern Pond Turtle	Clemmys marmorata pallida	R004	Special Concern (CA)
Common Kingsnake	Lampropeltis getula	R058	
Whiptail Lizard	Cnemidophorus tigris	R039	

Table 2.2 – Wildlife found in the study area

2.3 Implementation Considerations

2.3.1 Zoning & Land Use

The landscape of any region is defined by land uses including natural, agricultural, industrial and urban features. The landscape of our study area has changed throughout time due to changes in land use.

Agriculture:

Farming and ranching began in Ventura County with the establishment of Mission San Buenaventura in 1792 as a means to support the mission's colony (Ventura County RCD 2002). Changes were brought to the county's existing agricultural landscape when large-scale irrigation was introduced in the late 1800s (Ventura County RCD 2002). At the same time walnuts and apricots were introduced and were the only major crops until lima beans were later introduced and grown extensively (Ventura County RCD 2002). The proportions of agricultural uses in Ventura County are shown in Figure 2.1**.**

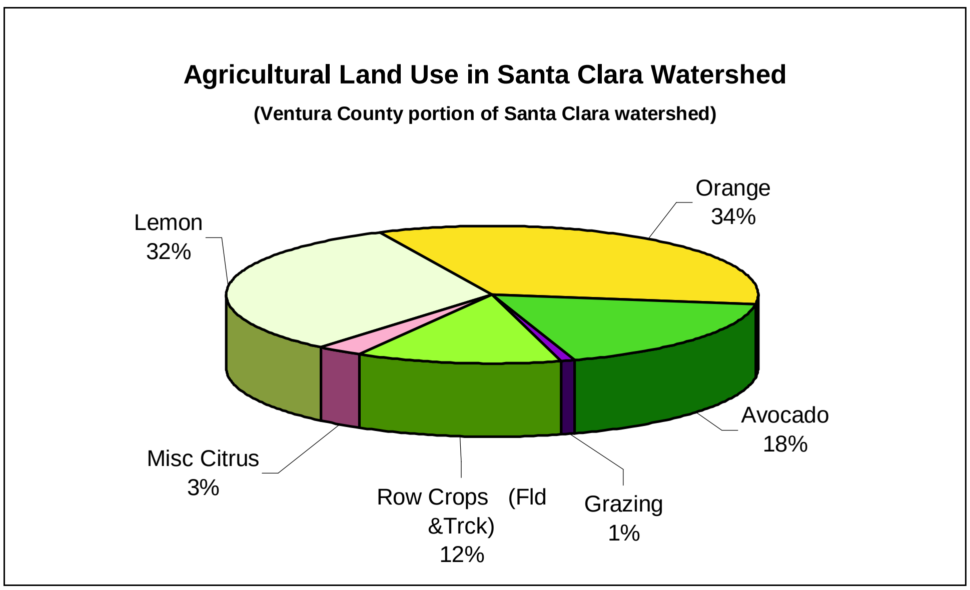


Figure 2.1 – Agricultural Land Use in Ventura County

Orchards:

Since 1932 citrus has been the predominant form of agriculture in the Santa Clara Watershed, which lies mostly within our study area. Currently, eighty seven percent of the agricultural lands in the Santa Clara Watershed are dedicated to citrus and other orchard products such as lemon, orange, and avocado[1]. The citrus groves tend to occur closer to the river, whereas avocado groves are typically situated slightly upslope towards foothill areas.

Row and Truck Crops:

A transition occurred in the composition of row crops (vegetables, grains, berries, and flowers) in the Santa Clara Watershed between 1932-1969. Row crops are often classified into two groups, field and truck crops. In 1932, more land was used for field crops than for truck crops. However, by 1969 truck crops were predominant and by 2001 field crops had decreased to less than 1% of all agricultural lands used.[2]

This transition in the composition of row crops is illustrated in Figure 2.2, where pink areas indicate land devoted to growing field crops, and blue areas indicate land used for growing truck crops. Currently,

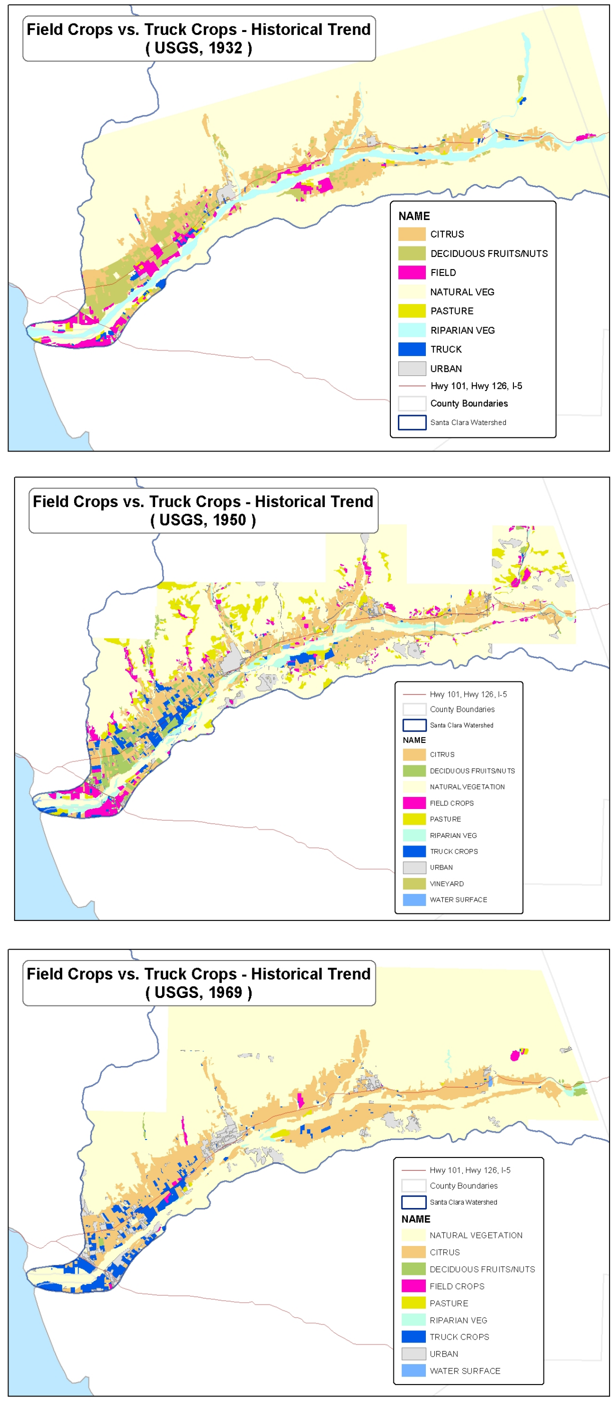


Figure 2.2 – Row vs. Truck Crops in 1932, 1950, 1969

[1] Derived from information contained in the Ventura County 2001 Land Use layer, see Appendix A
[2] See Appendix A for data

field crops occur on 51 of the 34,000 acres of agricultural land in the portion of the Santa Clara Watershed that lies within Ventura County.[3]

Urban Land:

Since the late 1970s, Ventura County has been transformed from an agricultural county to a largely non-farm county supported by a military and high-tech economic base. Urbanization of the county has lead to the increased need for housing, which has led to the disappearance of privately owned agricultural lands. More than 47 square miles of California farmland and rangeland are converted to more non-agricultural uses each year (CA Wilderness Coalition 2002). In Ventura County, between 1969 and 2000, 14,580 acres of cropland were converted to urban uses (Farmland Mapping and Monitoring Program 2002). While urban encroachment has not yet threatened areas within our study area it is likely that the area will have to confront these issues in the next decade due to increased need for housing throughout the county.

The same trend has occurred within our study area. The amount of land devoted to urban land uses has increased steadily in the Santa Clara River Watershed area since 1912 (Table 2.3, Figure 2.3, Figure 2.4).

Farmland Conversions in Ventura County (1969-1988).	
Conversion Type	Acres
Cropland to urban conversions *Pre-conversion crop type*	
Citrus	5,150
Deciduous tree crops	430
Irrigated pasture	220
Irrigated field crops	1,970
Truck crops	5,990
Total	14,580

Table 2.3 – Farmland Conversions in Ventura County (1969-1988)

[3] Appendix A - Ventura County Land Use layer 2001

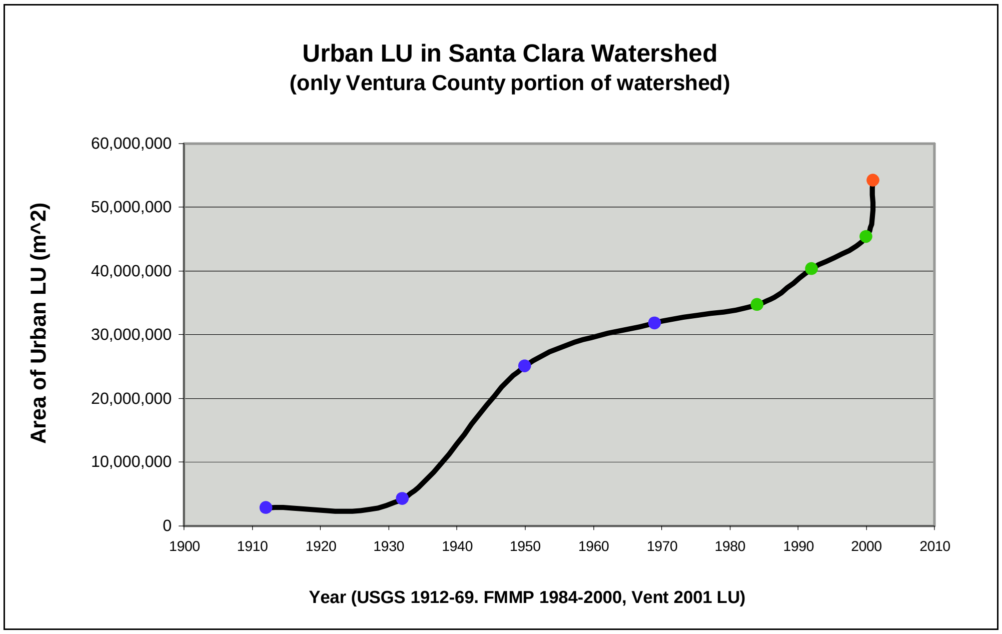


Figure 2.3 – Urban Land Use in Santa Clara River Watershed (1900-2000)

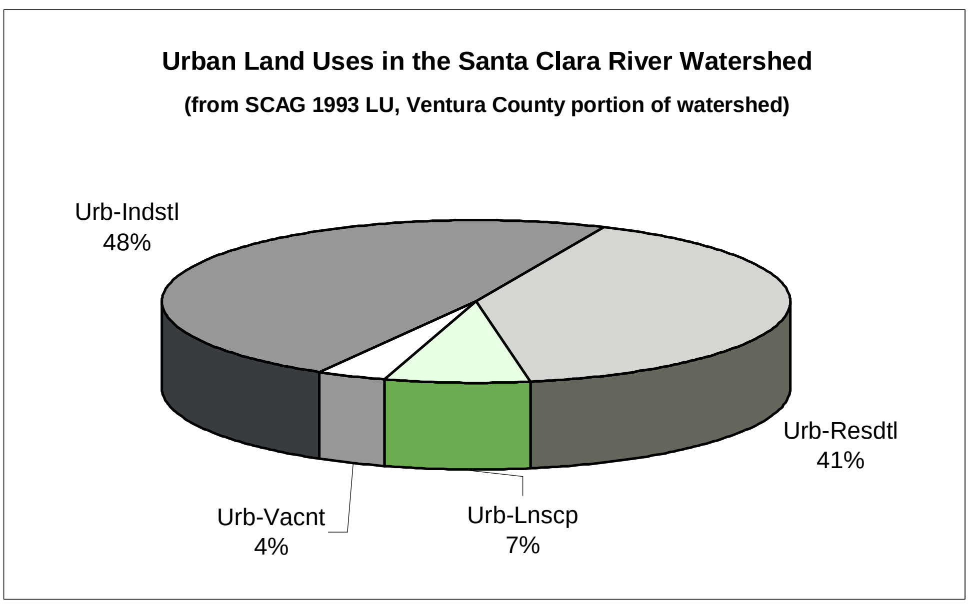
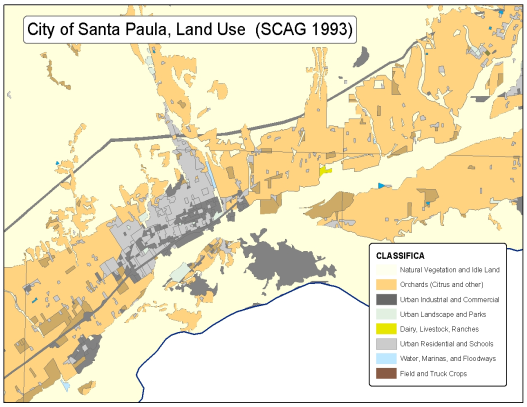


Figure 2.4 – Urban Land Use in the Santa Clara River Watershed



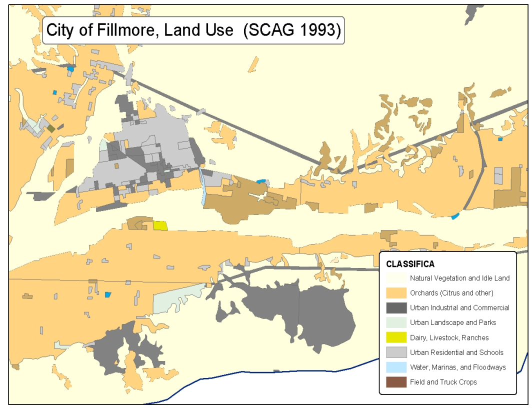


Figure 2.5 – Santa Paula Land Use (2001), Fillmore Land Use (1993)

The conversion of agricultural land to urban land has several impacts. First, farmers and ranchers have less land to farm within the Santa Clara Valley. Thus, farmers and ranchers are moving orchard development into the hillside areas of the county where land is more available. The rapid conversion of rangeland/watershed land to hillside orchards has led to environmental problems, such as soil erosion.

Second, the decline in available land in Ventura County's rural communities has led to a decline in the county's agricultural economy. For example, the prices that farmers receive for their products have been steadily declining while the costs of production, such as labor, energy, machinery, seeds and chemicals, have increased (CA Wilderness Coalition 2002).

Despite urban encroachment, agriculture still remains a viable economy in Ventura County. Twenty-four percent of the county's land area remains in agricultural uses. In addition, Ventura County is ranked as the 10th most productive agricultural county in the state contributing to 3.6 percent of California's agricultural revenue with annual crop sales of $1 billion (CA Department of Finance 2002). In addition, on average agriculture comprises five percent of Ventura County's total work force. Strawberries, avocados and nursery stock crops are presently the main money crops (Ventura County RCD 2002). Refer to Appendix A for more information regarding the economic aspects of agriculture in Ventura County.

2.3.2 Demographics:

The study area includes two cities, Santa Paula and Fillmore. Fillmore is smaller both in population and in area. However, the population density is the same for both cities with approximately one individual per 0.1 acres.

These two cities are predominantly comprised of Hispanic and Caucasian populations with the majority being Hispanic (Ventura County Planning Department 2002). (Refer to Appendix A for information on the demographics of Santa Paula and Fillmore). Santa Paula and Fillmore also both have average total household incomes around $40,000.

The population of both cities is projected by the Ventura County Planning Department to increase over the next twenty years. Interestingly, housing growth has historically increased at about the same rate as population growth (Ventura County Planning Department 2002). However, development forecasts indicate that the rate of housing growth will exceed population growth over the next 20 years (Ventura County Planning Department 2002). Refer to Appendix A for more information related to population and housing data from 1960-2000 and projections for 2010.

2.3.3 SOAR Initiative

Implementation issues, particularly assessments of the ability of local communities to implement a planning vision, are rarely addressed in the debate over growth management. Ventura County serves as an important case study because it has a 30-year history of aggressive, proactive growth management, and is implementing many new growth-management policies, including urban-growth boundaries, "ballot-box zoning," and higher density and mixed-use development. The SOAR, “Save Open-Space and Agricultural Resources” initiative is an example of such a new growth-management policy.

Ventura County's SOAR initiative aims to preserve farmland, open-space and rural areas. The SOAR initiative is an example of a Smart Growth program, which gives voters more control over development. SOAR places restrictions on the expansion of a City Urban Restriction Boundary (CURB). For example, SOAR requires county voter approval before any land located outside the CURB lines can be developed under each city’s jurisdiction for urban purposes. SOAR also restricts the conversion of farmland and open space lands to urban uses. The County SOAR ordinance requires countywide voter approval of any change to the County General Plan involving the Agricultural, Open Space, or Rural land use map designations, or any change to a General Plan goal or policy related to those land use designations. The County SOAR Ordinance does not change the Ventura County General Plan and Zoning regulations governing property, nor do they affect the process by which property is bought and sold.

Despite SOAR’s efforts it has several flaws. First, the SOAR ordinance passed in 1998 and will expire by 2020. Since SOAR is only in effect for a limited amount of time, it does not provide permanent protection for open space or farmland. Second, SOAR does not acquire parkland or provide recreational facilities. Finally, SOAR does not limit the types of uses permitted in agricultural, open space or rural zones.

Despite passing the SOAR initiative in 1998, most cities in Ventura County have not adjusted their general plans or their development approval processes to accommodate expected housing demand. This is likely to create a housing shortage within the next five years. Housing shortages could lead to significant housing-price increases and increased political manipulation of the housing market unless major changes in planning practice or growth management policies are instituted (Reason Public Policy Institute 2001).

2.3.4 Jurisdictions

A jurisdiction is the extent of authority or control of an agency over a physical area. For example, city, county, state and federal agencies each have a designated area in which they have jurisdiction. Often these boundaries overlap (
Figure 2.6) which can lead to administrative issues when the agencies have disparate laws governing their jurisdictions.

Jurisdictional conflicts often arise in the field of conservation planning. This is typically due to the large physical scale that must be dealt with when solving ecological scale problems such as habitat fragmentation. This occurs because physical and biological boundaries do not adhere to politically and economic drawn boundaries or administrative jurisdictions. The larger the physical area the issue pertains to, the larger the jurisdictional overlap becomes and the more conflict occurs between jurisdictional boundaries. This is intimately tied into the notion of "scope of conflict" discussed in the introduction of the paper. Thus, it is important for this project to discuss jurisdictional overlaps and conflicts and how they might both positively and negatively influence the implementation of habitat corridors in Ventura County. We should note that while we focus on Ventura County the theoretical notion of considering jurisdictional issues in the design and implementation of habitat corridors is applicable anywhere in the state as well as the nation.

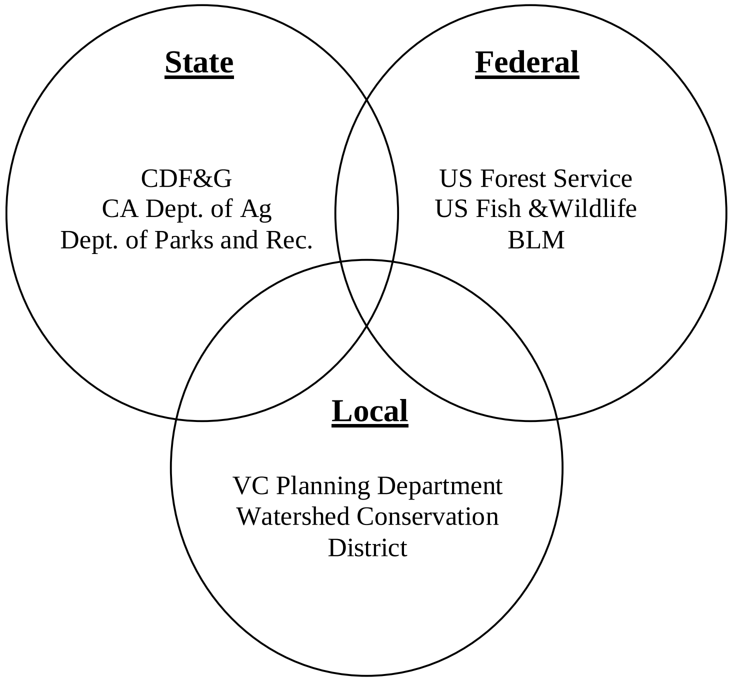


Figure 2.6 **-** Broad Jurisdictional Overlap in the Study Site

In order to understand the complex nature of jurisdictional overlap in our study area it is necessary to discuss the various federal, state and local laws, which affect our study area. In addition, it is necessary to discuss the manner in which these laws are implemented and the different governmental agencies that oversee them.

There are several pieces of federal legislation that are pertinent to understanding how federal jurisdiction operates within our study area. It is important to note that several federal acts are implemented at the state level by California state agencies. Thus, several federal acts have a counterpart in California law. First, is the **National Environmental Policy Act (NEPA)** of 1969 (NEPA 1969). The purpose of NEPA is to establish a national policy, which promotes efforts to prevent or eliminate damage to the environment, and enriches the understanding of the ecological systems and natural resources important to the United States. In order to accomplish this goal, NEPA requires all projects that involve the use of federal funds to assess their projected environmental impact. The **California Environmental Quality Act** (CEQA) is the California's version of NEPA (CEQA 1970). CEQA is used daily to determine the environmental impact of various projects within Ventura County on biological resources.

Our study site includes several areas under federal jurisdiction. These include: Los Padres National Forest, Dick Smith Wilderness, Sespe Wilderness and the Sespe

Creek Wild and Scenic River. In addition, there are several federal agencies that have jurisdiction in these areas including the US Forest Service, the US Fish and Wildlife Service, and the Bureau of Land Management.

Federal	Code	Sections
Endangered Species Act (ESA)	16 U.S.C	§1531-1544
National Environmental Policy Act (NEPA)	42 U.S.C.	§4321-4347
Coastal Zone Management (CZMA)	16 U.S.C	§1451-1465
Fish & Wildlife Conservation Act	16 U.S.C	§2901-2911
State		
California Endangered Species Act (CESA)	Fish & Game	§2050-2116
California Environmenal Quality Act (CEQUA)	PRC	§21000-21178
California Coastal Act (CCA)	PRC	§30000-30824
Native Species Conservation & Enhancement Act	Fish & Game	§1750
California Native Plant Protection Act	Fish & Game	§1900
Fish and Wildlife Habitat Enhancement Act	Fish & Game	§2600-2651

Figure 2.7 – Table of Federal and State laws that apply to Ventura County

The **Endangered Species Act (ESA)** of 1973 is federal legislation that protects species designated by the government as threatened and endangered as well as their habitats (ESA 1973). California implements ESA through its own state legislation called the **California Endangered Species Act** (CESA). A state commission called the California Fish and Game Commission is responsible for listing species as threatened and endangered and the state must consider the protection and preservation of the species as well as its habitat when creating and implementing state projects. The third piece of federal legislation, the **Coastal Zone Management Act (CZMA)** of 1972, promotes states to establish management plans for natural resources and ecosystems within their coastal zone (CZMA 1972). The **California Coastal Act** carries out the mission of the CZMA through a comprehensive program where counties establish local coastal plans that include zoning, land use, ordinances, etc. are outlined for the coastal zone (California Coastal Act 1976). Lastly, the **Fish and Wildlife Conservation Act** of 1980 encourages states to create conservation plans for non-game fish and wildlife (Fish and Wildlife Conservation Act 1980).

The State of California has several acts that are pertinent to conservation in our study area. Several of these laws are part of federal laws and were discussed above. Others include the **Native Species Conservation and Enhancement Act** which outlines California's policies on the protection of native plant populations for their use value to humans as well as their intrinsic and ecological value. The **California Native Plant Protection Act** gives the California Department of Fish and Game the authority to preserve, protect, and restore California's endangered flora (CNPPA 1977). Finally, the **Fish and Wildlife Habitat Enhancement Act** of 1984 provides funding for programs that increase fish and wildlife populations through protection, preservation and restoration efforts (FWHEA 1984).

The state agencies that have jurisdiction within our study area include: California Department of Fish and Game, California Department of Agriculture, and California Department of Parks and Recreation.

Ventura County addresses conservation issues by incorporating laws and regulations into its General Plan. Various local government agencies such as the Planning Department, the Public Works Agency and the Watershed Protection Agency implement and oversee these laws. Finally, individual cities within the county, including Santa Paula and Fillmore, establish general plans that determine the laws and regulations that govern them. However, city general plans must be consistent with the county's general plan.

Reviewing the various local, state and federal legislation governing the protection and conservation of biological resources within our study area it is apparent that jurisdictional overlap has a significant influence on the implementation of any conservation project. In addition, the large physical scale of the project equates to a larger the jurisdictional overlap and potential scope of conflict. Thus, it is pertinent that our project considers a broad range of implementation strategies that reflect this jurisdictional overlap that exists within our study area.

2.4 Stakeholders

Partnership Building:

Addressing the twin challenges of biodiversity conservation and economic feasibility of implementing conservation are among the most difficult conservation problems. A typical conservation project takes place in a complex system that involves biological habitats, human-caused threats and a variety of intervention strategies implemented by various institutional actors. A critical need exists to use scientific principles to determine the specific conditions under which various intervention strategies are effective (Salafsky 2001). Typical conservation programs use a systems-based approach, developed with scientists from many organizations that emphasize conservation of natural processes (Curtin 2002). However, scientists alone cannot put these principles into practice.

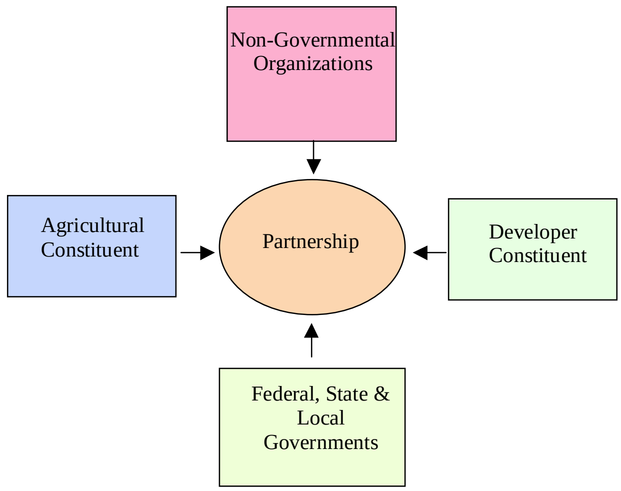


Figure 2.8 – Potential Partnerships in Ventura County

Conservation projects are seldom successful without the involvement of local people. Community-based conservation, in which local citizens and groups take responsibility for conservation efforts, has expanded globally in recent years (Curtin 2002). The implementation of successful conservation projects often includes environmental education and involvement of local communities. Public-private partnerships nurtured between community, sectoral interests, agencies, local, state and federal government can support local community identification and create responsible actions which will lead toward conservation goals and help to improve the implementation and long-term success of conservation initiatives (Brunckhorst, 2000, Vieitas et al. 1998). The continued success of conservation measures is often ensured when the rural population shares its benefits, be they social, environmental or economic.

Community-based conservation has become important in the preservation of farmlands (CA Wilderness Coalition 2002). The interaction between the farming and ranching community and those outside has added to the conventional goal of sustaining local agrarian livelihood.

List of Stakeholders:

Individuals involved in community-based conservation include a variety of stakeholders that fall into several categories. Resource users are a diverse category, that includes field practitioners, program and portfolio managers, researchers, donors, and policymakers. A second category is individuals affiliated with organizations, which include nonprofit organizations, government agencies, for-profit firms, universities, research centers, and foundations. Most organizations do not undertake conservation projects on their own. Instead, they form project alliances with other organizations to implement specific projects. These alliances can take different forms, including informal collaboration, contractual agreements, partnerships and consortia. Finally, there are various networks that enable individuals, organizations and alliances to work and exchange information with one another (Salafsky et al 2002). Our project area in Ventura County has many potential stakeholders that fall into the following categories.

NGO
Friends of the Santa Clara River
The Nature Conservancy
The Wildlands Project
Southern California Wetlands Recovery Project
Ventura Land Trust
Ventura Agricultural Land Trust
Government Organizations
Federal
US Fish and Wildlife Service
US Forest Service
State
California Resource Agency
California Legacy Project
CA Division of Land Resource Protection
CA Coastal Conservancy
CA Department of Agriculture
CA Department of Fish and Game
County
Ventura County Planning Department
Ventura County Watershed Protection District
Ventura County Open Space District
Ventura County Resource Conservation District
Department of Parks and Recreation
Agricultural Constituent
Ventura County Farm Bureau
Ag Futures Alliance
Local farmers and ranchers
Consulting Firms
Developers

Table 2.4 – Potential Stakeholders within our study site

3 ECOLOGICAL ANALYSIS

3.1 Overview

A realization is spreading in California and throughout the world that the preservation of wilderness and ecologically functional landscapes will increasingly rely upon human management of natural resources (Soule and Terborgh 1999). In order for management efforts to succeed, managers need to prioritize opportunities in terms of high importance as well as the potential for the efficient expenditure of human energy and financial resources. Our project exemplifies this necessity. Protecting continuous stretches of undisturbed habitat between large core areas in California requires the thorough identification and evaluation of interrelated biological and sociological factors.

The analysis phase of our project has several purposes. First, it identifies corridors within the predefined linkage areas that are critical for preserving connectivity. This first part of the analysis process is termed "ecological analysis" and involves designating prime corridor locations based exclusively upon movement preferences of individual species and related ecological issues. Second, we consider the feasibility of implementing the designated corridors within our study area. The second part of the analysis incorporates consideration of implementation measures, and is referred to as "feasibility analysis". The ecological analysis is an independent endeavor, while the feasibility analysis relate the ecological analysis with socio-economic and policy based implementation measures.

In order to conduct a thorough ecological analysis, we employ a wide range of approaches. A comprehensive review of available literature on the biology, geography, climate, land use, and other physical characteristics of the study area forms the foundation for our approach. Aerial imagery and GIS layers from government agencies, private companies, and universities provides basic analytical capability. Extensive fieldwork produces useful information about vegetation coverage, culverts/underpasses, and movement barriers present in the study area. These resources are incorporated into our GIS based model. This model identifies favorable corridors using a least-cost path (LCP) function, which evaluates potential paths through a landscape according to the total "cost" of each path. The cost represents factors such as habitat suitability, road density, slope, and presence of culverts/underpasses that facilitate or impede animal movement. The least-cost path (LCP) method allows us to examine the problem in a quantified and systematic manner, provides the ability to evaluate a range of scenarios, and helps overcome difficulties associated with limited access to the lands in our project area. We evaluate final modeling results using aerial photographs and by seeking expert review and critique.

The conclusions drawn from the ecological analysis form the starting point for the feasibility analysis. Feasibility analysis incorporates factors such as land value, development potential, and preservation status to make predictions about the viability of implementation for proposed corridors.

The feasibility analysis involves several steps. The first step incorporates parameters of the feasibility analysis discussed above into the LCP model. Next, a conservation possibility frontier (CPF) graph is created by relating the ecological value with the land value for a set of LCPs. Development potential and preservations status of these LCPs can be used to further understand the feasibility of these LCPs. Finally, conclusions and corridor recommendations are based upon the results of least-cost path analysis and conservation possibility optimization.

3.2 Data Acquisition and Preparation

3.2.1 Species in Project Area

Life History Characteristics:
In order to design the wildlife corridor for particular species or a functional group of species (for e.g. Wide ranging carnivores) the first step was to gather important characteristics pertaining to the life history of the animal. These characteristics are useful for determining which species need connectivity, i.e. if it is sensitive to fragmentation, the type of habitat it needs, whether it is a generalist or specialist. Also useful are information pertaining to species movement, breeding, inter-specific interactions (predator- prey relationships, competition), intraspecific interactions, home range and dispersal. The analysis of the threats and barriers in the project area as well as the sensitivity of the species towards human disturbance and development are also helpful for designating the corridor.

These data were collected from various sources namely: the CWHR, California Department of Fish and Game, The Audubon Society, USFS. Several experts were consulted at a workshop focusing on species present in the project area. Additionally, other documents such as Newhall EIR and Riverside County Integrated Project were used. The data were entered into a “Species matrix” which is an Excel spreadsheet having all the information classified according to the species under different subheadings. The full matrix is presented in Appendix A. A sample section of the species matrix is shown below, using the information for Loggerhead Shrike (Figure 3.1 - Figure 3.4).

TAXONOMIC GROUP		CWHR ID	Characteristics that may make species in this group vulnerable to Habitat Fragmentation (source:original TNC matrix)	Reason why this species was selected (source:workshop)	Habitat Types/ Requirements (source: Cal Fish & Game Notes) Blue=Audobon
BIRDS	__	__	Vagility. Habitat specificity/restriction. Need for cover. Social facilitation.	_____	___
Loggerhead Shrike	Lanius ludovicianus	B410	__	Once widespread, now scarce in linkage region, prey base issues of survival: herps, small mammals, large insects, open habitat specialist, absent from heavily urbanized areas, breeding populations are in rapid decline, mostly sedentary.	open habitats with scattered shrubs, trees, posts, fences, utility lines, or other perches. Highest density occurs in open-canopied valley foothill hardwood, valley foothill hardwood-conifer, valley foothill riparian, pinyon-juniper, juniper, desert riparian, and Joshua tree habitats

Figure 3.1 – subset of species matrix (columns A - E)

Best Habitats that occur in the project area (According to CWHR, high habitat suitability,)	Relavent Life History Characteristics (mostly from Cal Fish and Game and CWHR life history notes) Blue=Audobon	Prey/food (mostly from Cal Fish and Game and CWHR Life history notes) Blue=Audobon	Predators and Competitors (mostly from Cal. Fish and Game and CWHR Life History notes)	Found in Links GP area?(*According to CWHRV7 range maps)	Areas in Region that are Important for Species	Minimun Patch Size Needed to Support an Indvl / Popln (from CWHR & workshop) Blue=Audobon
__				__		
COASTAL OAK WOODLAND,VALLEY OAK WOODLAND, BLUE OAK WOODLAND, BLUE FOOTHILL PINE, PINYON JUNIPER, JUNIPER	Common resident and winter visitor in lowlands and foothills throughout California. Often found in open cropland.Searches for prey atleast 0.6 m above the ground.Yearlong diurnal activity.Territory defended by solitary individuals.	Large insects, small birds, mammals, amphibians, reptiles, fish carrion, inverts.	Predation by magpies(In Colarado) prevented nesting	*Yes	No info available from workshop. Shrubs for nesting, elevated perch sites.	Avg home range: 0.076sq.km. Varying from 0.045 to 0.46km (In Kern County). From workshop:-Adult terrotiral range is 100's of meters to 1+ km in diameter.

Figure 3.2 - subset of species matrix (columns F - L)

Barriers and Threats in the Area (specific info. from workshop, general info. may also be from CAL F&G) Green=workshop	Goals for genetic, individual and population connectivity	Current Distribution and Popln Status (Proj.area) (workshopmaps and notes, mostly. Also from CDFG notes) Green=Workshop	Current Distribution and Popln Status (Region /state/ beyond) (CWHR range maps)	Dispersal Distance (km) ,daily movements, other movements (mostlyWorkshop & Cal Fish and Game) Blue=Audobon Green=Workshop
Avoids continous dense woodland chapparal, urbanized areas.Pesticide senstive, may not survive in many ag. Areas.	Demographic persistance	Not mapped. **Absent** from all urban areas, most or all intensive agricultural areas, densely wooded areas, continuous chapparal,CSS, north slope of mountain ranges. Now absent from large areas of seemingly suitable habitat. **Strongholds:** Maybe Santa Clara river valley.	*mearnsi* subpecies is Federally endangered, *anthonyi* subspecies is Cal. Species of Special Concern. Neither of them occur in the proj. area as these are island subspecies	Juvenile dispersal - no data, probably many kms.Juvenile dispersal has been measured at around 12 to 14.7 km from the natal site with adults dispersing a mean distance of 2.7 km (Yosef 1996; Collister and De Smet 1997). Movement patterns of the shrike indicate that they disperse preferentially along connecting corridors of vegetation rather than between equally sized isolated patches of habitat (Haas 1995). (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_2.0.pdf)

Figure 3.3 – subset of species matrix (columns M - Q)

Other useful info. (various sources) Blue=Audobon Green=Workshop	Management/ Stewardship needs (misc. sources)	Monitoring needs (misc. sources)	Recomendations for Conservation Design (various sources) Green=Workshop
Is a strong flier and easily crosses freeways. The loggerhead shrike is known to forage over open ground within areas of short vegetation, pastures with fence rows, old orchards, mowed roadsides, cemeteries, golf courses, riparian areas, open woodland, agricultural fields, desert washes, desert scrub, grassland, broken chaparral and beach with scattered shrubs (Unitt 1984; Yosef 1996). Individuals like to perch on posts, utility lines and often use the edges of denser habitats (Zeiner, et al. 1990). In some parts of its range, pasture lands have been shown to be a major habitat type for this species, especially during the winter season (Yosef 1996) (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_2.0.pdf)	Management for resident shrikes should include a patchwork of grassy habitats and sparsely vegetated bare areas at the scale of individual shrike territories (Gawlik and Bildstein 1993). (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_2.0.pdf)	Need to monitor the population and occurance in the project area.	Open spaces. Movement patterns of the shrike concluded that they disperse preferentially along connecting corridors of vegetation than between equally sized isolated patches of habitat (Haas 1995). (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_2.0.pdf)

Figure 3.4 - subset of species matrix (columns R - U)

Species Presence and Abundance:
Ideally, any project attempting to designate locations of wildlife corridors would begin by acquiring detailed data about the presence, abundance, and movement patterns of species existing within the study area. A rich data set such as this would allow for designation of corridors based upon current and/or historical movement patterns of animals. Unfortunately, species data of such detail does not exist for our study area. We have gathered all available data from primary literature, government agencies and other sources, and found a dearth of information. Due to the scope and duration of our project, it is not possible for us to gather enough primary data about species in the area to form statistically significant conclusions. This overall lack of access to species data is compensated for with modeling efforts that emphasize analysis of vegetation coverage, habitat suitability ratings, topography, road density, and other factors. Ecological linkage projects in Florida and Maryland have employed similar methodologies (Hoctor 2003, Weber and Wolf 2000). The species presence data that we have acquired is often limited by issues of scale and/or number of species covered. Sources of data include the California Natural Diversity Database, the California Wildlife Habitat Relationships Program, and the WildView database developed by the US Forest Service.

The California Natural Diversity Database (CNDDB) is a continuously updated statewide inventory of the locations and status of rare species and natural communities. The database is maintained by the California Department of Fish & Game. Information can be retrieved by taxa or by United States Geological Survey map (1:24,000, 1:62,500, 1:100,000 or 1:250,000 scale). This data set identifies where animals are known to exist according to confirmed sightings, but does not clearly indicate presence or absence of species in other areas (Figure 3.5). Another limitation is that the project is conducted at a statewide level, and is not well documented for small-scale regions such as our study area.

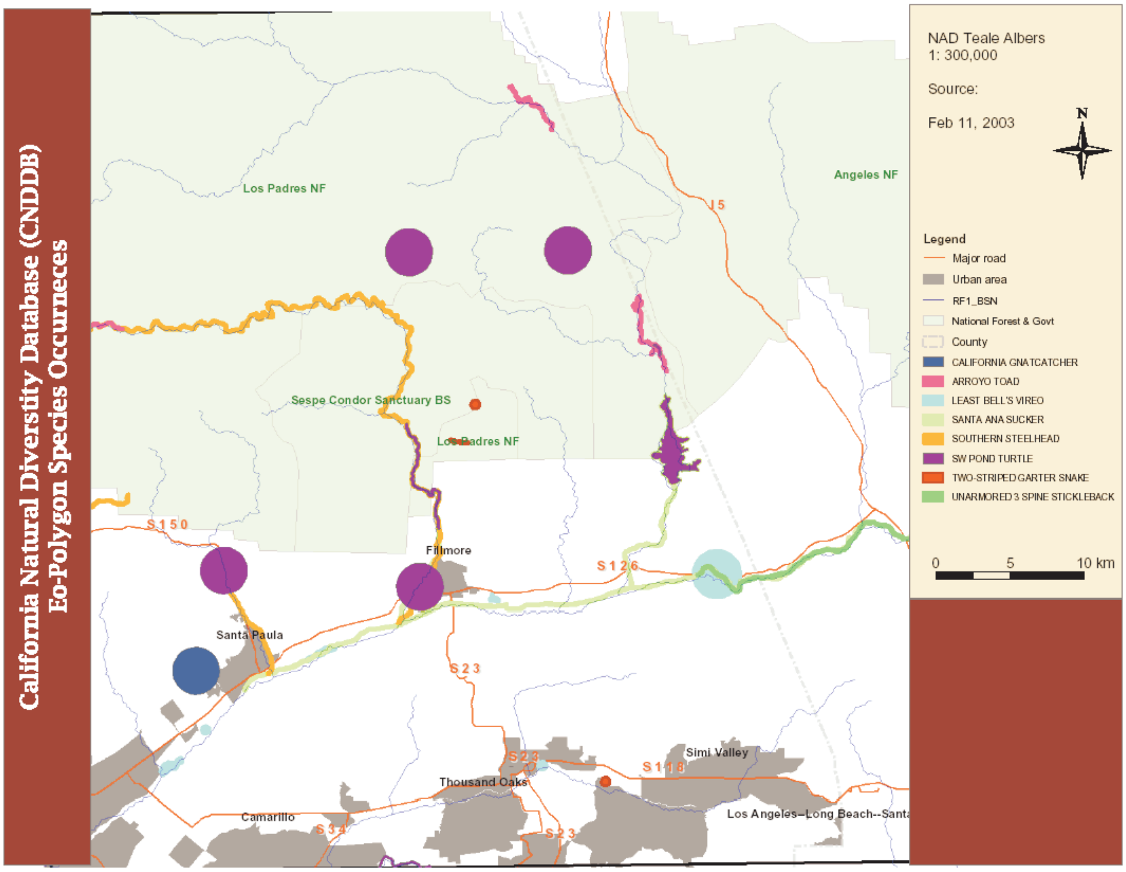


Figure 3.5 – map of CNDDB species occurrences in study area

Additional species data is provided by the WildView database, maintained by the Los Padres National Forest (LPNF). This database primarily tracks occurrences of fish, reptiles, and amphibians in riparian and aquatic ecosystems of specific interest for management objectives of the LPNF. The areas most thoroughly documented by WildView tend to be in the periphery of our project area, or completely outside it. Some potential exists for extrapolation of the findings from Wild-Aid onto landscapes within the spatial domain of our project, although time constrictions may not allow for exploration of this possibility.

Habitat suitability:

Habitat suitability data is generated by the California Department of Fish & Game, in the California Wildlife Habitat Relationships database (CWHR). This database presents a wide variety of information about the habitat characteristics that are favorable or unfavorable for many of the species present in the state of California. Habitat suitability ratings range from 0 to 1, where more favorable habitats receive higher ratings. This systematic classification results from a statewide effort that began in 1980, and is continually updated and improved. These ratings are based upon known life history characteristics for each species, distribution maps for each species, and extensive review by biological experts in each region. The distribution maps provide some information about species presence/absence, but are only recommended for use at large scales. Our study area is of a small enough spatial extent that these distribution maps are of marginal benefit.

Movement Patterns of Area Species:

Common methods used to assess animal movement patterns are examination of roadkill data, and monitoring of suspected corridors by means of track analysis and motion sensor cameras. After conducting an exhaustive inquiry with several government agencies and other organizations, we conclude that no written records exist of roadkill incidents in our study area. Organizations contacted include: CalTrans, The Humane Society, the cities of Santa Paula and Fillmore, and Ventura and Los Angeles Counties. Anecdotal evidence is sparse and inconsistent. Due to financial limitations and time constraints, we do not attempt to monitor actual movements of species in our study area by means of track analysis or motion sensor cameras.

3.3 Study Area

3.3.1 Vegetation

Habitat types are classified according to vegetation, which is the crucial ecological element on which species occurrence depends as the spatial distribution of habitats can have important effects on the growth, reproduction, and dispersal of organisms (Turner et al. 2002). It is widely accepted that vegetation forms the basis for predicting animal distributions, and thus it should be placed the first priority of analyses on species movement (Scott et al. 1991). This notion has led to the development of a habitat suitability index. Quantifying the quality of habitats using a habitat suitability index has been widely used in North America (Kliskey et al. 1999). Regardless of whether a species is a generalist or a specialist, the species preference to habitats varies among vegetation types. Habitat suitability for a given species is determined by life-requisite components such as food requirement (Schamberger and O'Neil 1986). An animal tends to select relatively good habitats for its movement and usage (Maehr et al. 1991, Rosenberg et al. 1997, Schamberger and O'Neil 1986, Kliskey et al. 1999). Although species could pass through unsuitable habitat for one to several days without significant harm, it is assumed that linkages should be comprised primarily of generally preferred habitat types (Walker et al. 1997). Thus, vegetation type plays an essential role in identifying possible linkages.

We use Multi-source Land Cover Data 2002 version 2 (MLCD) as vegetation maps in California, which have been edited by Fire and Resource Assessment Program (FRAP) of The California Department of Forestry and Fire Protection. MLCD is desirable for our analysis since the maps combine various sources to address broad ranges of issues and they adapt the same vegetation classification as California Wildlife Habitat Relationship (CWHR). The vegetation map results from combining habitat distribution data from numerous sources into a single grid format (Department of Forestry and Fire Protection 2002). For MLCD in Ventura County, most of vegetation data originates from CA Land Cover Mapping & Monitoring Program (LCMMP), Vegetation Data, 1995-1998 which is also edited by FRAP. The scale and resolution of LCMMP are 1:60,000 and 2.5 acres, respectively (Department of Forestry and Fire Protection 2002). Vegetation is classified according to CWHR. A grid is 100 m by 100 m in cell size. Map projection is Teale Albers NAD27. FRAP's MLCDs are provided for every county from their web site at free charge.

http://frap.cdf.ca.gov/data/frapgisdata/accept.asp

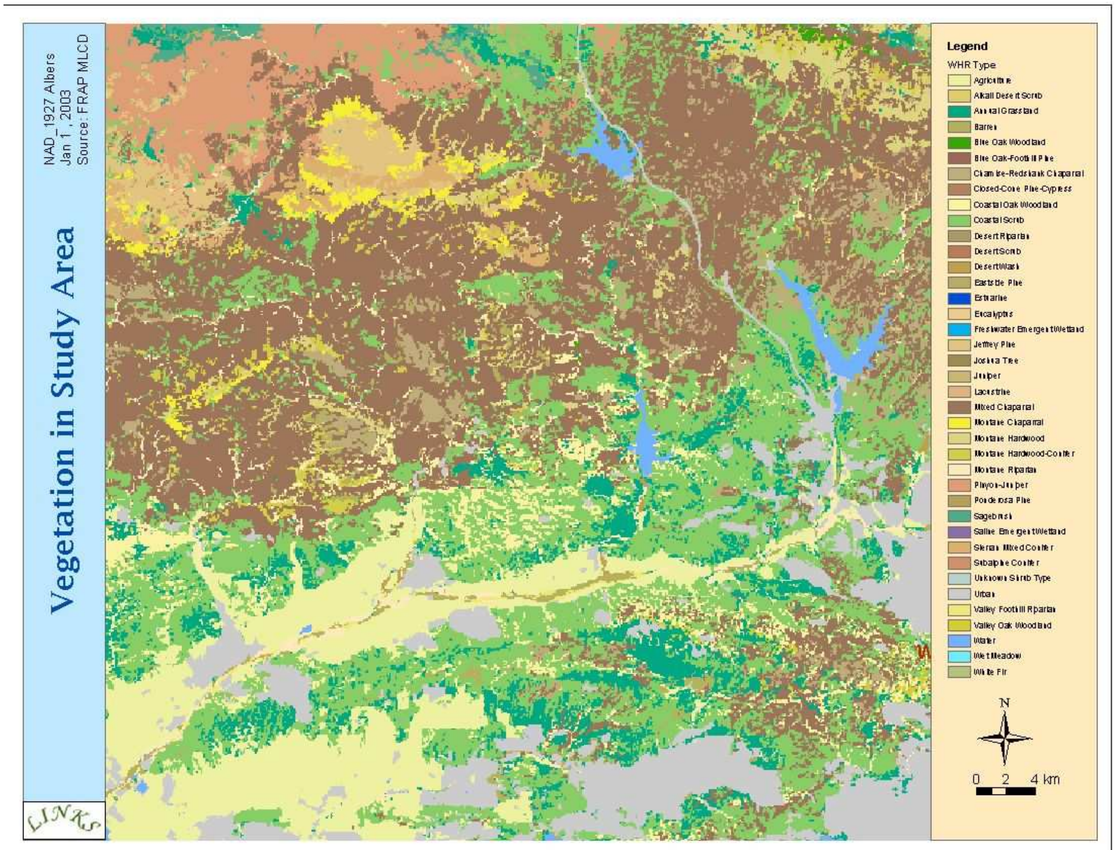


Figure 3.6 – vegetation types in the study area

Our project uses MLCDs in Ventura and Los Angeles counties. The two grid maps are merged into one map encompassing both Ventura and Los Angeles counties, and then clipped by the extent of the study site. Vegetation map is, then, combined with CWHR, which includes habitat suitability database for species occurring in California (Figure 3.6).

3.3.2 Topography

Elevation in the study site ranges from 13 m to 2,250 m with the mean of 790 m and the standard deviation of 500 m. Seventy percent of the study site is below 1,600 m. The slope of the study site ranges from 0 degree to 57 degrees with the mean of 12 degrees and the standard deviation of 9 degree. The slope distribution in the study site is highly skewed to flatter. Slope can affect the ease of movement by an animal, while elevation can affect microclimate, mainly by creating a temperature gradient. We decided not to incorporate elevation into the model for the following reasons. First, because the effects of elevation are thought to be manifested in vegetation (Crumpacker et al. 1988) and therefore the inclusion of elevation is redundant.

Second, no matter how the target species respond to elevation, linkages are supposed to be placed across State Highway 126 where elevation is lowest.

Slope is used as a layer in the modeling, because most animals will expend more energy moving through rugged terrain. It is often recognized that good wildlife corridors will include ridge lines and valleys, where movement is less strenuous (Weber and Wolf 2000, Hay 1991, Noss 1991). The slope layer accounts for this because it delineates ridges and valleys well. There are, however, some exceptions. First, birds obviously care less about slope than animals on land. Second, some terrestrial species prefer steep places to flat places, where they can escape predation. For such exceptions, importance of the slope is reduced by assigning smaller weight than other layers when combined with them to identify linkages. The slope in the study site is derived from 30-meter digital raster elevation data from the National Elevation Dataset (NED) offered by U.S. Geological Survey (USGS). NED data can be downloaded via the Internet for free.

http://edc.usgs.gov/products/elevation.html

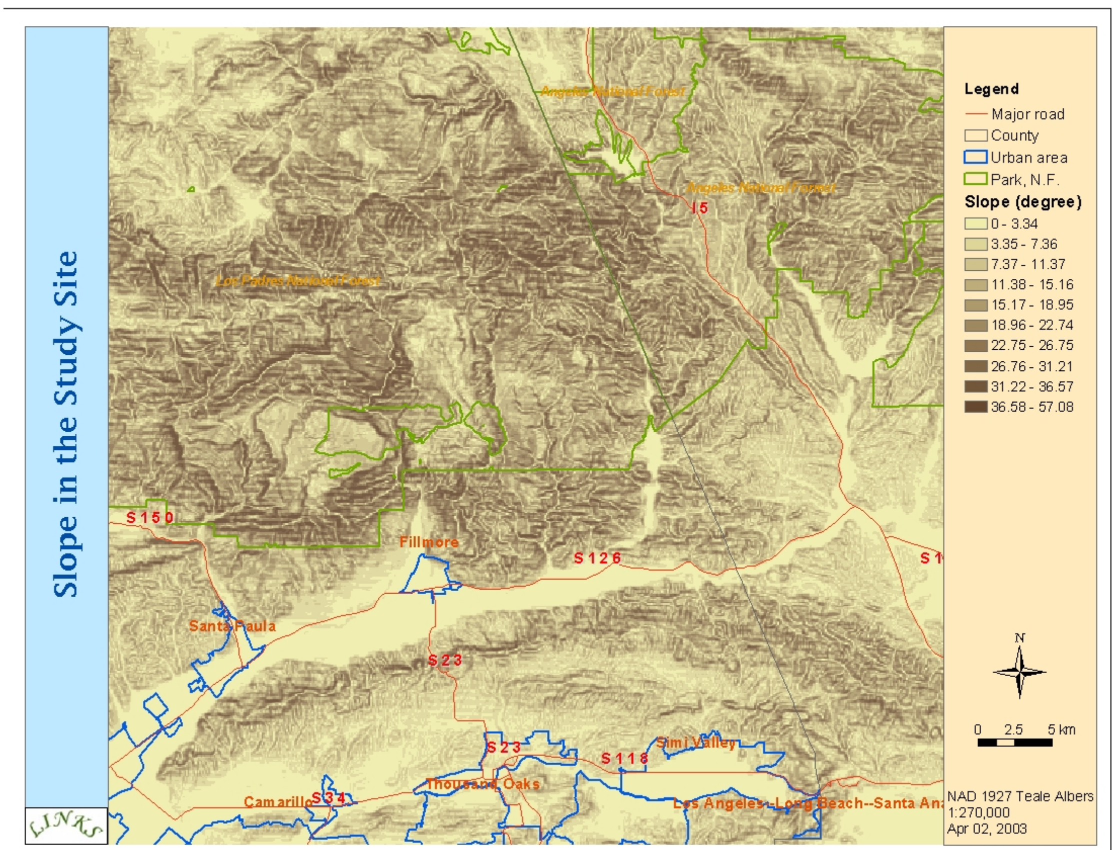


Figure 3.7 - Slope layer, derived from NED elevation data

3.3.3 Roads/underpasses/culverts

Road have significant negative impacts on habitat quality. Roads impede animal movement, resulting in habitat fragmentation. Roads also increase mortality of species due to road kills. It was estimated that about one million vertebrates are road-killed per day in the United States (Forman et al. 1998). The magnitude of impacts of roads on species movement is attributed to two factors: road traffic and road density. Road density can be used as a useful, broad index of ecological effects of roads (Forman et al. 1998, Beauvais 2000). An animal trying to cross roads tends to avoid those with heavy traffic and areas where road density is high. When an animal eventually crosses roads in such areas, it will face more threats. There are, however, slight differences in the impacts of roads among taxonomic groups. Large and mid-sized mammals are especially susceptible on two-lane, high-speed roads, whereas amphibians and reptiles tend to be particularly susceptible on two-lane roads with low to moderate traffic (Forman et al. 1998). Roads, should be given ample consideration from the viewpoint of mitigation because there is an abundance of management options available. Fencing roads, limiting speed, educating drivers constructing and/or improving underpasses/overpasses are a few good examples. (See Maine Interagency Work Group 2001).

There are several species of animals, which tend to avoid places where they can see roads or related light or noise. Forman et al. (1998) attributed the major cause of avoidance by animals to traffic noise. This implies that places relatively remote from high road density area may be less suitable than otherwise expected from their lower road density if the animal can directly see roads in distance or hear noise from roads. In order to include these factors into the model additional influential factors such as altitude and view obstructions were incorporated into the model. These effects are introduced in the model as the notion of a "Viewshed" which is described later.

Underpasses and culverts have been getting more attention for playing an important role in the effort to connect fragmented habitats (Yanes et al. 1995). An underpass is defined as a structure under a road through which animals, as well as human, cross underneath. A culvert is a pathway designed to allow water from rivers or streams to flow below the road. Depending on a species' "willingness" to use underpasses and culverts, they can potentially moderate the negative impacts of roads on animal movement. Moreover, culverts can be an important part of mitigation given that, in many cases, they already exist and require only minor directional fencing or vegetative plantings to enhance their use by wildlife and to provide linkages between fragmented habitats (Smith 1999). Wildlife underpasses in southern Florida have been built and used by Florida panther, resulting in significant reduction of roadkill from 8% - 10% to 2% of its population (Forman et al. 1998). Several attributes associated with culverts/underpasses are identified to be correlated with use of culverts/underpasses by a species (Clevenger and Waltho 2000). Such attributes include dimensions, openness, proximity to urban areas, vegetation covers around entrance and human activities in and near culverts/underpasses. Openness is defined as (Yanes et al. 1995):

$$\text{Openness} = \text{width} \times \text{height} / \text{length}$$

The effect of these attributes on animal movement is species-dependent (Clevenger and Waltho 2000, Rodriguez et al. 1996, Yanes et al. 1995, Ng 2000) and inconsistent results are found in literature.

Due to these controversy and complexity arising from various attributes, the locations of culverts/underpasses and other attributes are more appropriate to be used in feasibility analysis, not in the ecological modeling. As described later, habitat suitability maps incorporate riparian areas. Riparian areas indicate to some extent the locations of culverts/underpasses, especially large ones, which is expected to compensate for absence of culverts/underpasses layer in the ecological modeling.

Road data came from Census 2000 TIGER/Line® Data (Tiger 2000), which can be downloaded from the following web site.

http://www.esri.com/data/download/census2000_tigerline/index.html

Road data (Tiger 2000) are provided by Ventura County. Once the road data are obtained, roads in Ventura County and Los Angeles County are merged. Unfortunately, there is no traffic data available. Thus, traffic volume is estimated from other sources available as described later.

Tiger 2000 data does not include information about underpasses/culverts, which must be collected by field research. The minimum data required to accurately measure are geographical position dimensions, and identification and quantification of the vegetation that covers the gates of underpasses/culverts. GPS devices can be used to measure underpass/culvert dimension. Based on 2-day field research, twenty-three underpasses/culverts were identified in the study area. A record of each underpass/culvert includes properties such as longitude, latitude, height, width, length and openness. These data are edited with a spreadsheet, and imported into ArcGIS as a point shapefile (Figure 3.8).

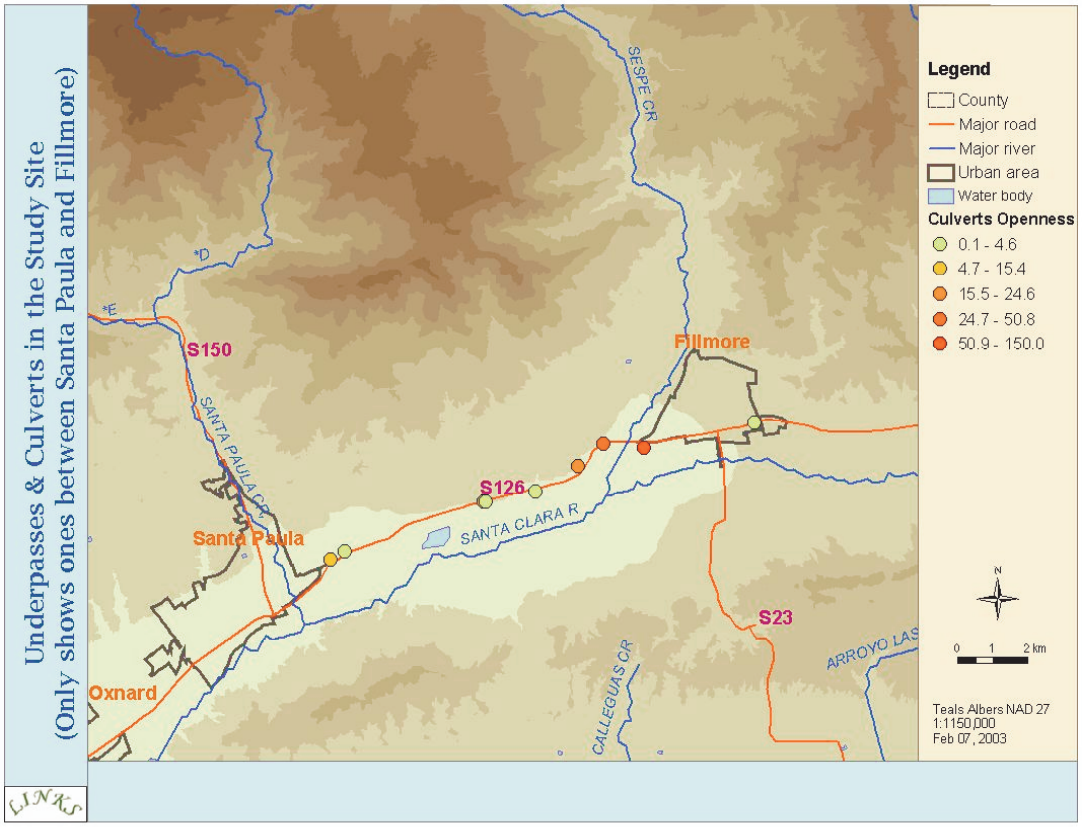


Figure 3.8 - Culverts and underpasses

3.3.4 Hydrology

Lakes, rivers, and streams influence a landscape in a variety of ways. Many species rely upon aquatic environments and riparian areas to provide essential habitat, ecosystem services, and other benefits associated with survival, reproduction, and dispersal. The quantity and quality of hydrological features in a landscape, or lack thereof, are often good indicators of habitat types and potential biological abundance and diversity. An unusually high percentage of animal movement has been shown to occur in riparian corridors (Gilson and Pitway 1996, Hilty 2002). Many reasons are suggested for this phenomenon, including: presence of natural vegetation, availability of water, easier movement through areas of steep topography, and better cover for hidden movement. For several of the species in our study area, it is specifically noted that movement often occurs through riparian corridors.

The primary sources for our hydrological data are the National Hydrography Dataset (NHD), BASINS, and the Tiger 2000 database. The NHD, widely regarded as the most accurate and updated hydrological database, is a feature-based system that identifies and spatially represents all lakes and river and stream segments in the entire drainage system of the United States. It is based upon the USGS 1:100,000 scale Digital Line Graph hydrology data, which is estimated to have an accuracy level of

98.5% (http://nhd.usgs.gov). It also integrates GIS layers from the US Environmental Protection Agency, known as RF3 and RF1 that contain extensive hydrological and geographical information. RF3 is a more fine scale layer that indicates all hydrological features, including smaller streams and ephemeral water bodies. RF1 represents only larger water bodies, rivers, and streams that flow year round. The BASINS and Tiger 2000 databases are both based upon the RF3, with slightly differing data attributes. BASINS is a software package developed by the US EPA for the purpose of monitoring and evaluating water resources throughout the United States. The Tiger 2000 database includes a wide range of data, of which hydrology in only one subset.

3.3.5 Land Use

In order to accurately assess historical and current land use in our study area, we evaluate many different sources of information. Two organizations that gathered data consistently for many decades include the United States Geological Survey (USGS) and the California State Farmland Mapping and Monitoring Program (FMMP). Data from USGS dates back as far as 1912, although their land use classification systems have changed significantly over time. FMMP data has been collected since 1984 and has more consistent classification systems, but lacks extensive characterization of land uses.

Two other sources produced land use data for a single specific year, which provide interesting snapshots in time, but are difficult to use for comparative analysis due to widely ranging systems of classification and differing areas of coverage. The most recently updated and detailed land use data comes from the Ventura County 2001 Land Use Survey. It documents both urban and agricultural land uses. In 1993, the Southern California Association of Governments (SCAG) produced a land use layer of great detail, which focuses primarily upon urban classification but also includes agricultural aspects of land use.

The mapping work done by USGS in the Santa Clara Watershed spans from 1912 to 1969. It is difficult to know for certain whether or not the methodologies employed in creating these maps were consistent over time. However, it is clear that the systems of classification changed significantly (Figure 3.9). In the later years of surveying, agricultural land use was differentiated into several categories. Throughout the duration of these surveys, urban land uses not differentiated. Note an apparent increase in grazing and citrus production, and a corresponding decrease in production of deciduous fruits occurring between 1932 and 1969. Due to the fact that the 1912 survey did not differentiate between various types of agriculture, it is difficult to state what type of agriculture was most favored before 1932.

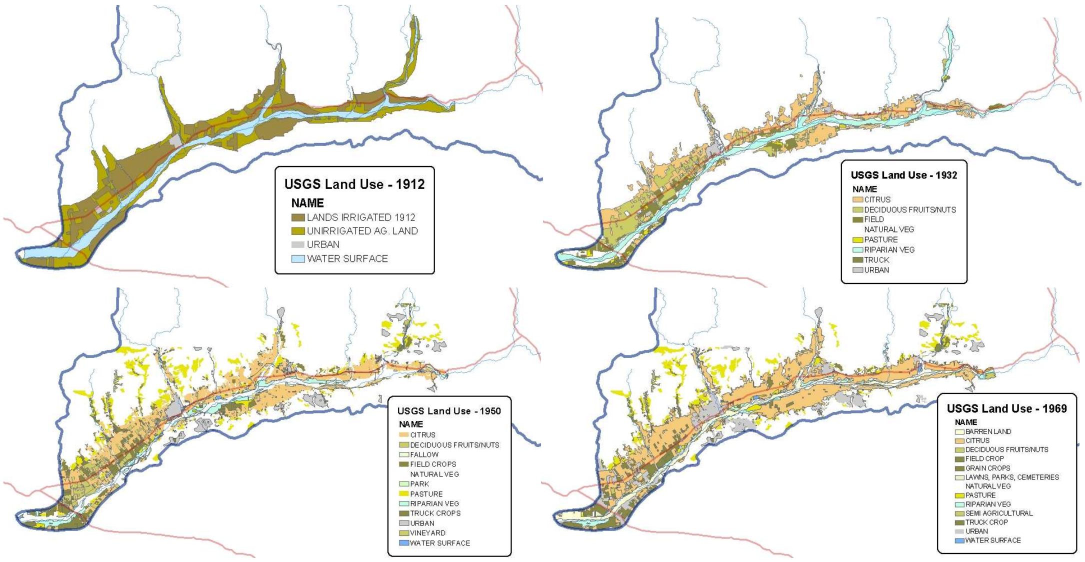


Figure 3.9 – USGS land use layers, 1912-1969

The Farmland Mapping and Monitoring Program was established in 1982 as a non-regulatory program run by the California State Department of Conservation to provide a consistent and impartial analysis of agricultural land use and land use changes throughout the state. It is the only ongoing statewide land use inventory that identifies agricultural and urban land conversions. For this study, the layers from 1984, 1992, and 2000 were used (Figure 3.10). These maps are useful for observing general changes in the amount of land used for agricultural and urban purposes, but do not offer more specific classifications of land use. The primary focus of their classification system is to identify areas according to the potential quality of farmland, rather than the specific use of the land at any given time.

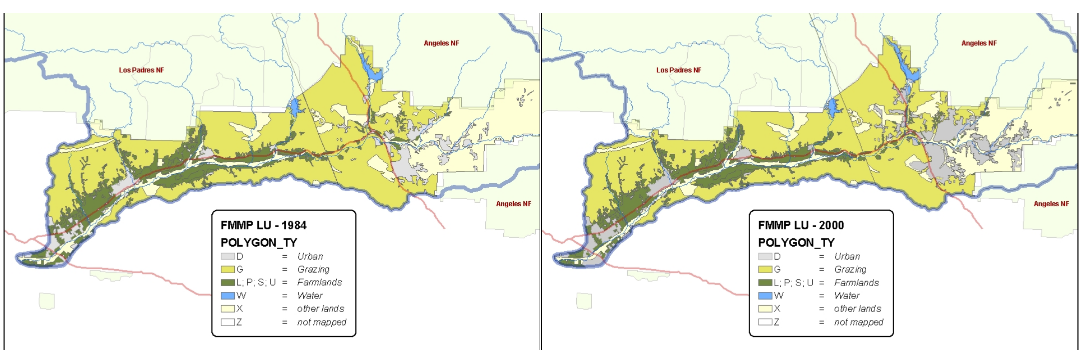


Figure 3.10 – Farmland Mapping and Monitoring Program, 1984 and 2000

The Ventura County 2001 Land Use Survey contains the greatest level of detail and the most finely categorized classification system. The classification system uses a series of letters and numbers to encode information about the type of land use (for example, "D12-YP" is the code that represents land used for "young irrigated almonds that are irrigated with a permanent sprinkler system"). In order to use this layer in conjunction with the others, it was simplified by combining categories and color schemes (Figure 3.11). The primary focus of the classification system is upon agricultural land uses, but urban uses are somewhat broken down as well. Although this layer is only a single snapshot in time, it compares nicely with the SCAG 1993 layer, which uses a similar classification system (but focuses more on urban land uses).

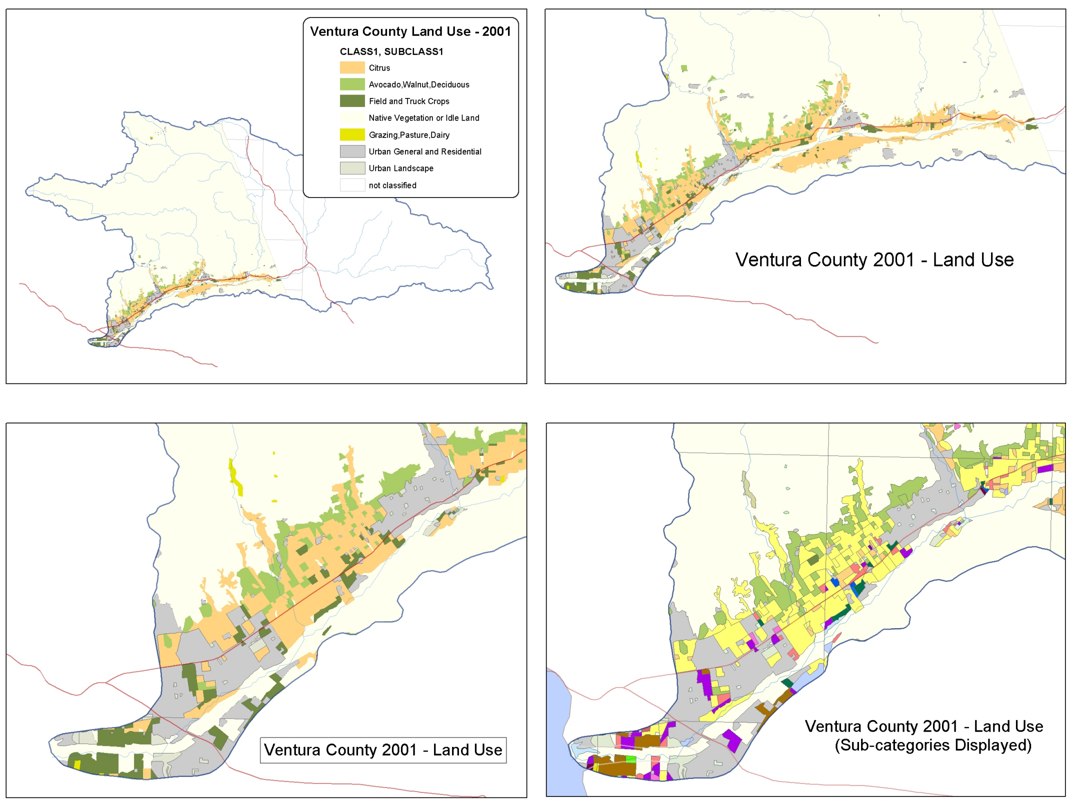


Figure 3.11 – Ventura County Land Use Layer, 2001

The Southern California Association of Governments functions as the Metropolitan Planning Organization for six counties: Los Angeles, Orange, San Bernardino, Riverside, Ventura and Imperial. SCAG is mandated by the federal government to research and draw up plans for transportation, growth management, hazardous waste management, and air quality. Like the Ventura County 2001 layer, the SCAG 1993 layer gives detailed descriptions of land use. Urban land uses that are defined include residential, landscape, commercial, and industrial. The SCAG layer focuses a bit more on urban classifications than the Ventura County 2001 layer, but the two compliment each other nicely. Area of coverage: entire Santa Clara River Watershed, except for region surrounding Santa Clarita (Figure 3.12).

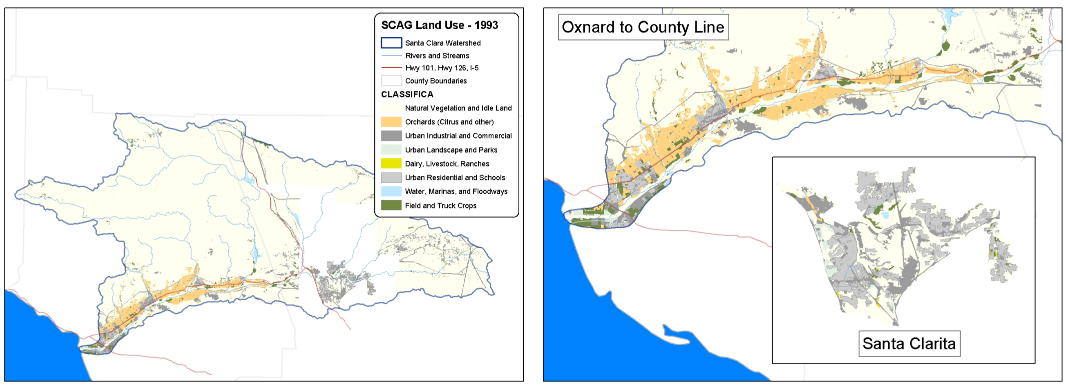


Figure 3.12 – SCAG Land Use data, from 1993

3.4 Ecological Modeling

Ecological modeling is comprised of four main components: least cost path analysis, sensitivity analysis, model validation, and multiple species analysis (Figure 3.13). The final results are passed along for feasibility analysis.

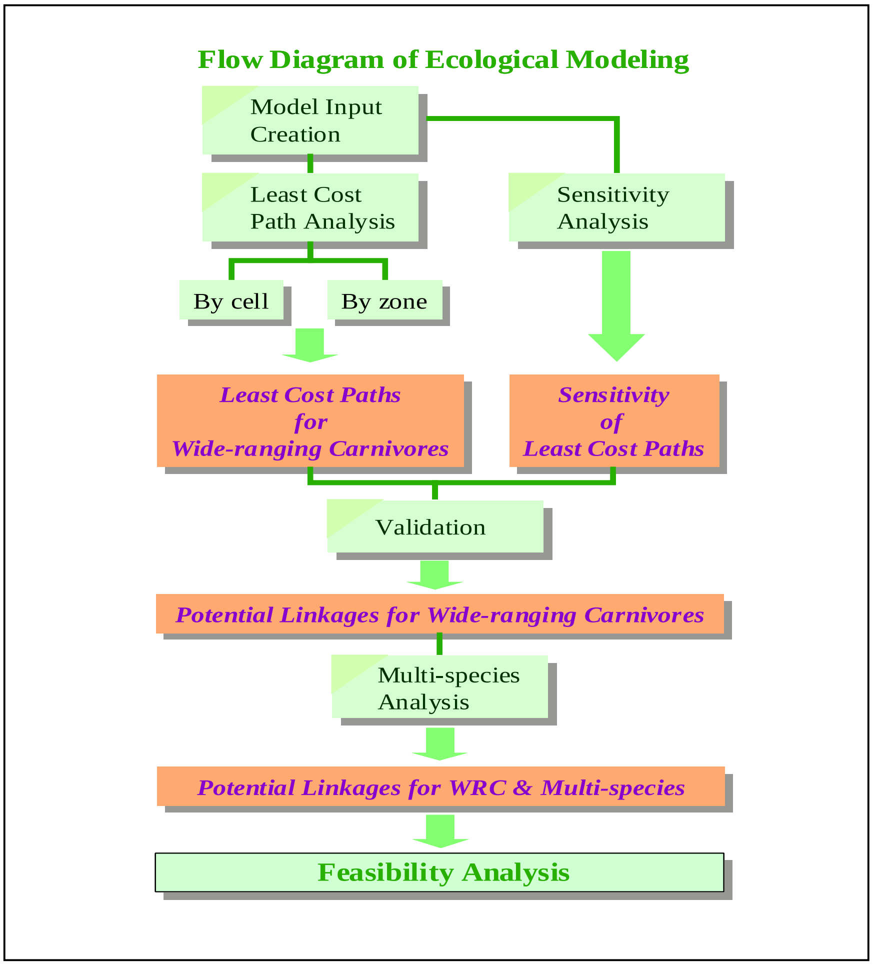


Figure 3.13 – ecological modeling process

3.4.1 Least Cost Path Analysis - Overview

Our ecological modeling efforts aim to identify the most suitable wildlife corridors in the study area by considering primarily those factors known to have significant impacts upon species persistence and movement: suitability of vegetation as species habitat, landscape pattern, topography, and proximity to human disturbances. This phase of our analysis does not consider the interests of stakeholders, potential development scenarios, or socio-economic costs/benefits of implementing linkages. The ecological model is based upon least cost path analysis (LCP), which has been recently used in various conservation fields (Singleton et al. 1999, Weber at al. 2000, Wierzchowski et al. 1999, Walker et al. 1997). The fundamental concept of the least cost path analysis is that an animal traveling through a landscape will encounter varying degrees of difficulty or "cost" depending on the character of the terrain at any given point. Areas with high road density and heavy traffic are very costly for an animal to pass through, whereas intact natural habitats have low cost. In LCP analysis landscapes are subdivided into cells of uniform size, and the cost associated with each cell is calculated according to one or more of the model inputs. The total cost of any path is simply the sum of the costs of each cell in that path. Paths with the lowest total cost indicate the most likely movement routes for the species being considered.

The three primary model inputs that we consider are habitat suitability (HS), road density (RD), and slope (SL). Other factors such as locations of riparian habitats, abundance of vegetative cover, and presence of culverts/underpasses are incorporated into one of the three primary model inputs mentioned above, or are considered during evaluation of model results.

In preparation for LCP analysis, an individual cost layer is constructed for each of the model inputs and those layers are then combined into a cumulative cost layer (CCL) for each species or multi-species group. The cumulative cost layer is obtained by calculating the cost of each cell according to a formula that evaluates the relative importance of the three model inputs. Within this formula, a weighted value is placed on each layer which represents the importance of that layer to the given species. The formula we use is as follows:

$$\text{(Eq. 3-1)} \quad CCL = \sum_i L_i^{\alpha_i}$$

where L_i is an input layer and α_i is the weight of the layer i. The CCL is a summation of i layers. Placing the weights into the formula as exponents exaggerates the cost gradients of the layers. This reduces the tendency for the influence of distance to dominate over the influence of cost, which is a common occurrence in least cost path analysis (Weber et al. 2000) (Hoctor 2003). After lengthy experimentation, we conclude that our formula moderates the predominance of distance more appropriately than any similar linear formula. In fact, a linear formula sometimes yields ecologically implausible results where least cost paths cross through cities or other inhospitable terrain, due only to the reduced distance.

In order to illustrate the entire process, suppose that there are three layers (HS, RD, SL), each of which is relevant to species movement (Figure 3.14). For a particular species, the layer HS exerts less significant effects than the layer RD, and the layer SL is of least significant importance. Then, the three layers may have relative weights of 2, 3, and 1, respectively. We use the following formula to calculate the CCL in this case:

$$\text{(Eq. 3-2)} \quad CCL = HS^2 + RD^3 + SL^1$$

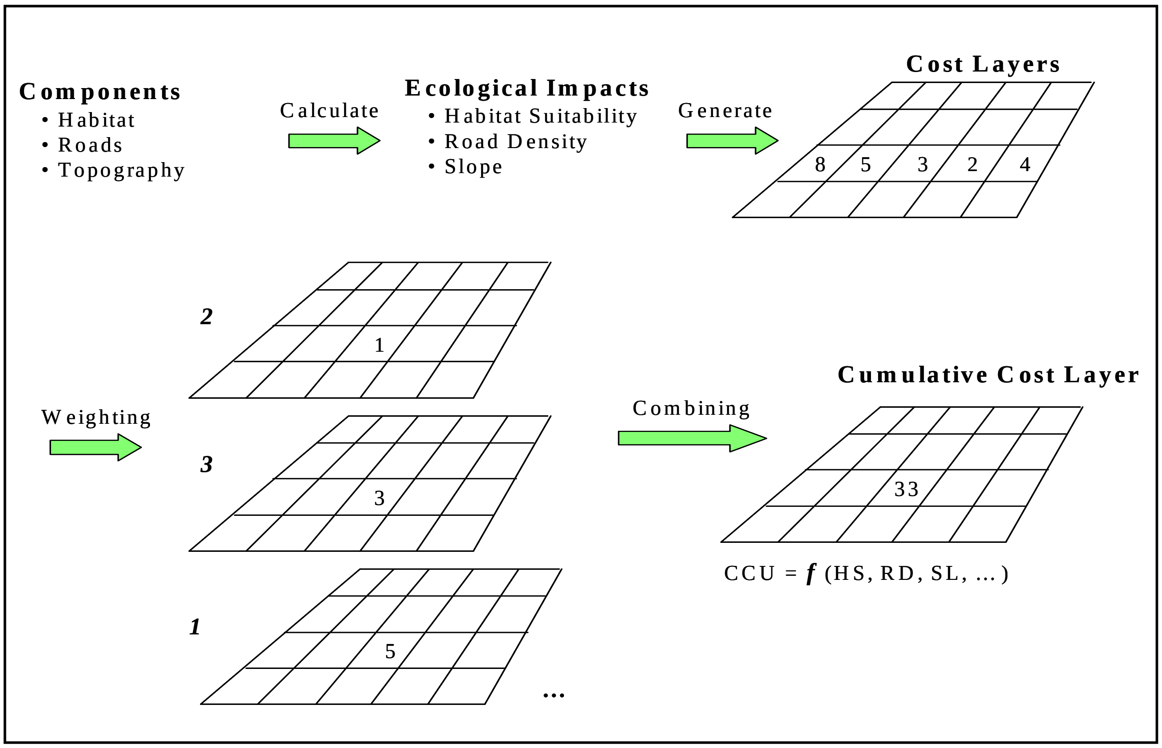


Figure 3.14 - process for creating individual and cumulative cost layers

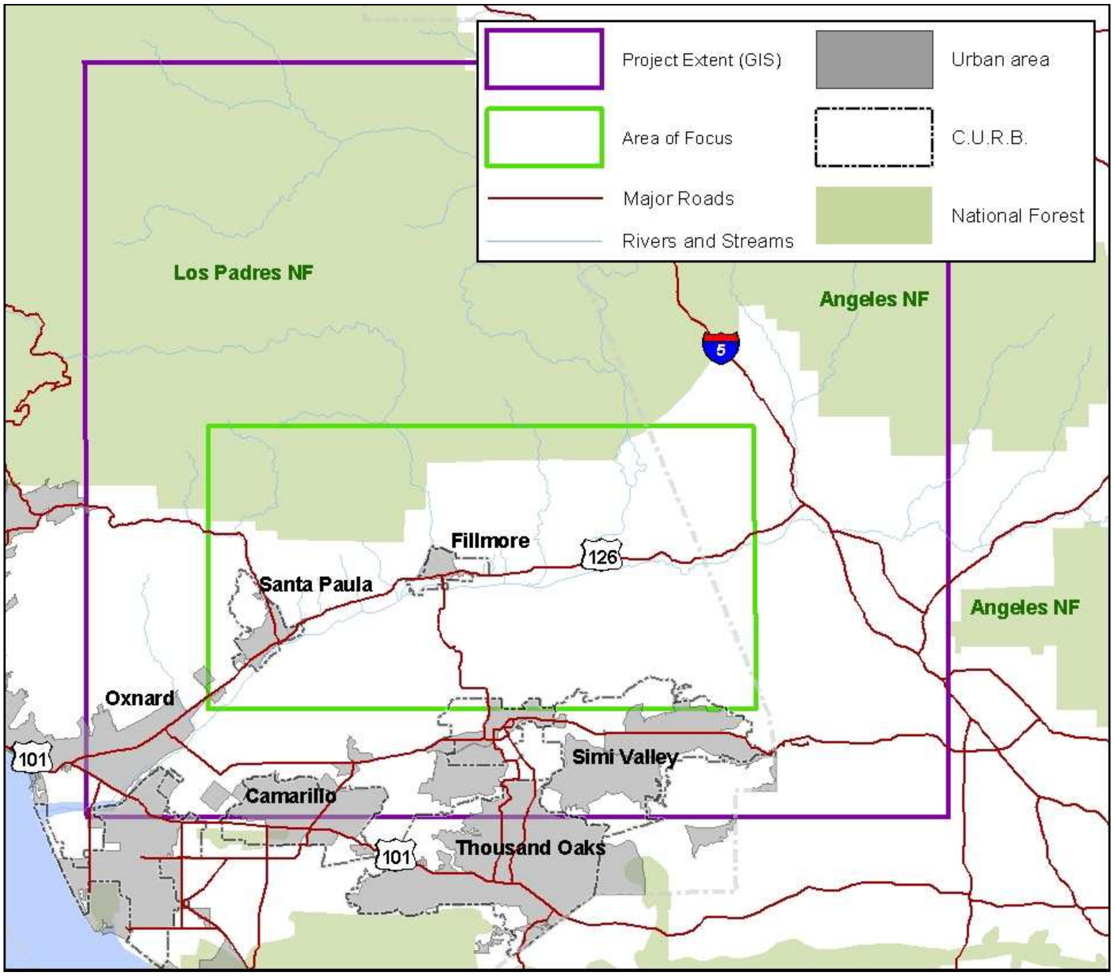


Figure 3.15 – Project area: GIS extent (purple), area of focus (green)

The defined extent of the study site restrains the area of calculation for all modeling efforts. It is roughly bounded by Santa Clarita and Interstate-5 to the east, Oxnard and Ojai to the west, the Los Padres National Forest to the north, and the cities of Camarillo and Simi Valley to the south (Figure 3.15). The extent used for all calculation is outlined in purple, and the primary area of focus is indicated by the green square.

Boundary	Longitude/Latitude
North	34.75
South	34.23
West	-119.21
East	-118.49

We use ESRI's ArcGIS software and associated tools such as ArcMap, ArcTools, ArcCatalog, and ArcInfo to conduct LCP analysis and other GIS based evaluation. All script driven processes were carried out using Arc Macro Language (AML). The Spatial Analyst extension of ArcMap allows us to utilize the cost weighted distance function (LCP) and neighborhood analysis function (moving average).

All layers used in the model are of a raster format with 100m cell size. We select this cell size in order to maintain compatibility with data from the Fire and Resource Assessment Program (FRAP) Multi-source Land Cover Data (MLCD), which is the best vegetation layer available for the region. The extent of the study site includes 585×668 cells. The coordinate system is Teale Albers, whose parameters are shown below (Table 3.1).

Parameters	Setting
Units	Meters
1st Standard Parallel	34 00 00
2nd Standard Parallel	40 30 00
Central Meridian	-120 00 00
Latitude of origin	00 00 00
False easting (meters)	0
False northing (meters)	-4000000
Datum	NAD27
Spheroid	Clarke 1866

Table 3.1 – projection and spheroid used in GIS

Data for each of the three model inputs (HS, RD, SL) are processed in order to generate the individual cost layers necessary for LCP analysis. The values contained in the input layers are first reclassified into ten categories, where a value of 1 indicates low cost and 10 is high cost. The natural breaks method is used for reclassification because it minimizes within-class differences and maximizes between-class differences for any given set of values. This classification is widely used in landscape ecology and conservation planning (Gerrard et al. 2001, Weber et al. 2000, Gallo et al.). Although the number of classes and the value assigned to a class vary in the literature and could lead to different results, Gerrard et al. (2001) found that the results of a sensitivity analysis were quite stable. Additional processes that are specific to each of the input layers are explained in the following sections.

3.4.2 Input Layer - Habitat Suitability (HS)

The habitat suitability of various vegetation types is dependant upon the species being considered. In order to address this issue, we combine the FRAP vegetation data and the habitat suitability ratings from the CWHR database to produce habitat suitability maps by target species (Figure 3.16). Since the FRAP vegetation data uses the CWHR naming convention for describing vegetation types, combining the two data sets is not difficult. There are three primary steps in the process.

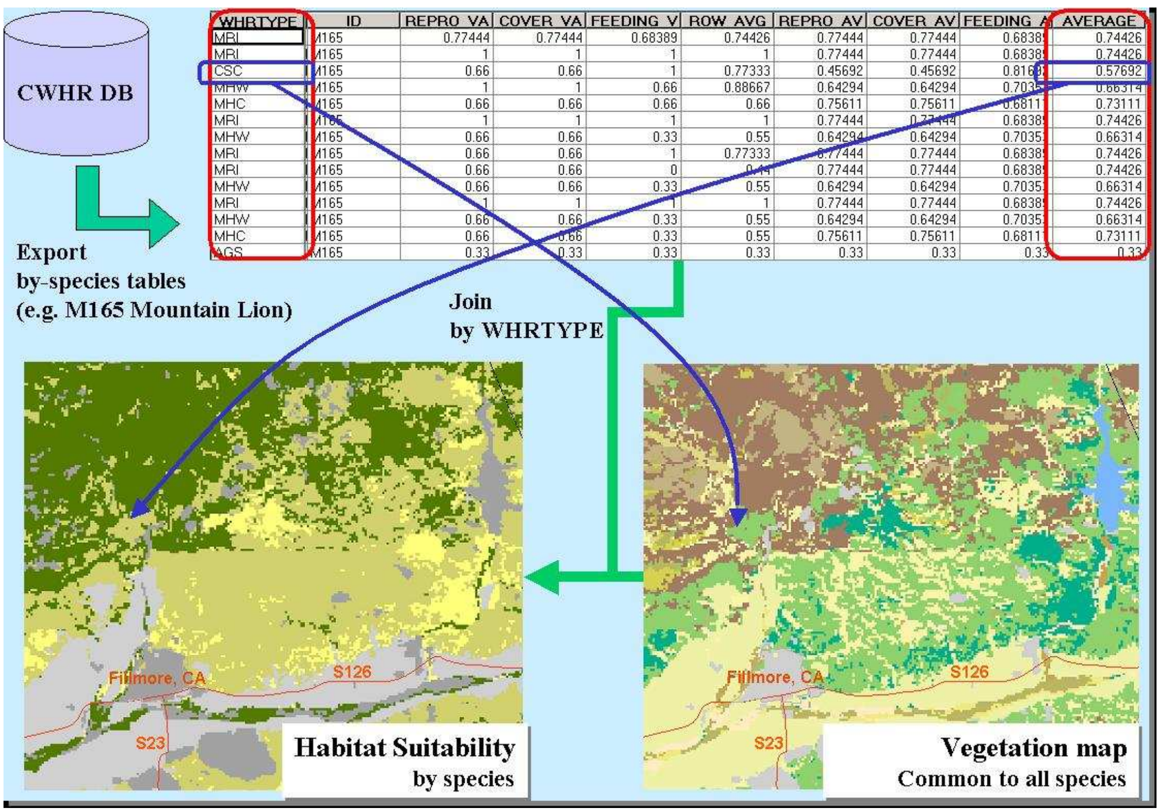


Figure 3.16 - Creation of HS layer

Step 1 - The first step is to export habitat suitability ratings by species from the CHWR database. Although the CWHR software doesn't have functions that allow us to manually operate tables, any database management system, which is able to handle DBF files, can recognize the relationship among tables and extract the dataset. Using Microsoft Access version 2000, we export habitat suitability data by species from CWHR out into new tables. In the CWHR rating system vegetation types are rated according to various stages of existence. When exporting the data, habitat stages are grouped and values are averaged.

Step 2 - Next, we add the suitability ratings from CWHR into the attribute table of the FRAP vegetation layer. Habitat suitability ratings are subdivided according to reproduction, cover, and feeding. Since it is too complicated to consider habitat suitability for reproduction, cover and feeding separately, a new column is created in the table to average these three ratings. Consequently, each species has one value of habitat suitability for each vegetation type.

Step 3 - Finally, we join the vegetation map and habitat suitability databases for each species. The vegetation map is replicated as many times as the number of target species. The species suitability database is then joined to the vegetation map using WHRTYPE as the key. A sample HS map is shown in Figure 3.17.

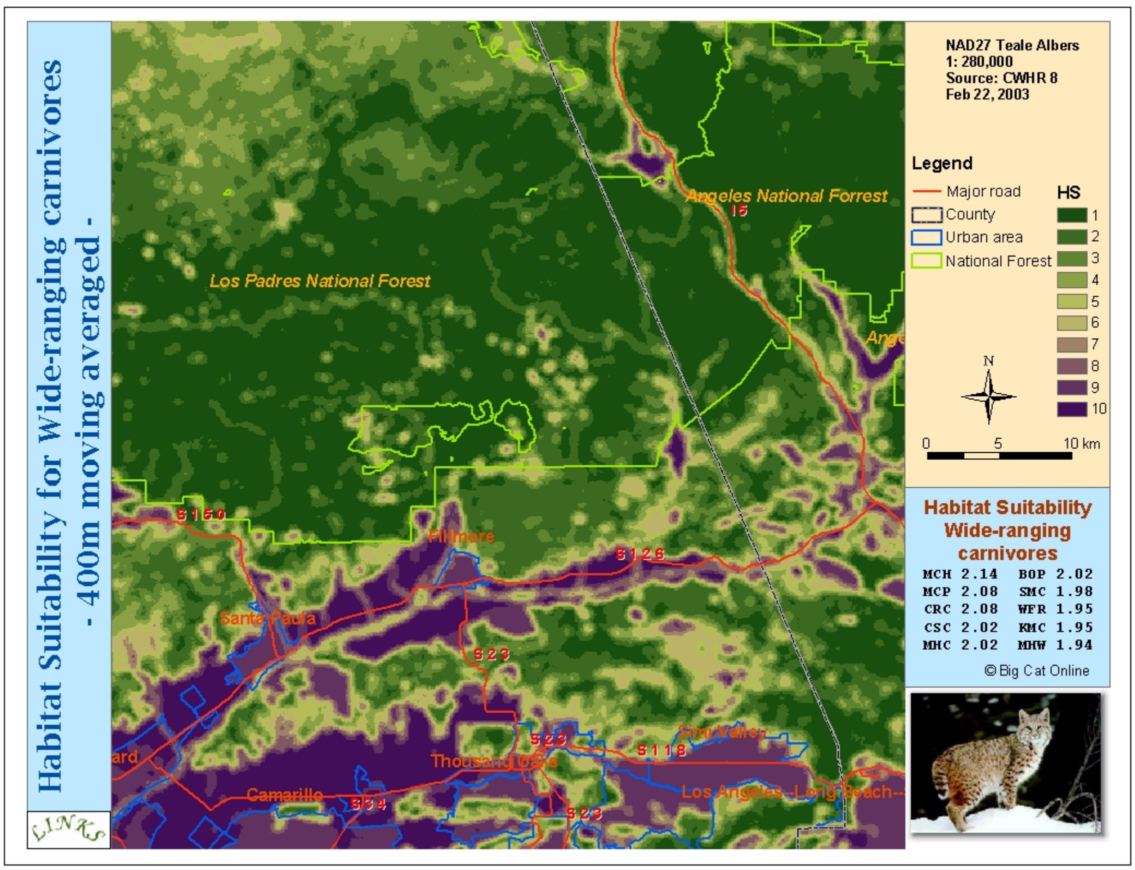


Figure 3.17 – sample habitat suitability map for species M166, bobcat

In addition to the three steps mentioned above, two modifications are done. MLCD classifies agricultural lands as one type: agriculture. On the other hand, CWHR has more than one classification regarding agriculture such as Pasture, Vineyard, several crop lands and several orchards. As a consequence, agriculture in MLCD would be regarded as unsuitable because no CWHR type is matched. Given that most of the agricultural lands in the study site is accounted for as orchards, agriculture in the MLCD is assigned suitability values of orchards in CWHR.

Our vegetation layer (FRAP/MLCD) includes only large riparian areas. Knowing that riparian areas are followed routinely by mammals and will be considered as good places for linkages more detailed delineation is required (Noss 1991, Noss 1993, Hey 1991). Riparian areas derived from hydrology data are converted to a raster format and assigned suitability values of riparian habitat in CWHR. Then, this raster is combined with the habitat suitability map derived from MLCD.

The habitat suitability value of each cell is affected by the value of surrounding cells, due to the fact that an animal almost never remains exclusively within a single cell. Any cell with high suitability surrounded by bad habitat may have a reduced suitability such that an animal would not likely reach that center cell. Gerrard et al. (2001) succinctly explained the effect of the spatial context in which each cell is found, using the terms “intrinsic value” for a single cell and “neighborhood effect” for surrounding cells. It might, therefore, be better to take the average daily movement of a species into account when considering habitat suitability. Neighborhood effect is also related to edge effects of a patch (Gerrard et al. 2001). How far edge effects go into a patch should be derived for each specific organism (Gustafson 1998).

One way to consider neighborhood/edge effects is to take the moving average with a radius approximating the daily movement or width edge effects of a species in question. Some species, especially large mammals, however, move relatively long distances compared to the scale at which we conduct our analysis. Taking the moving average with such a long radius results in a loss of finer-scale information. For example, a natural riparian area that would provide good habitat for many species would be degraded if it were adjacent to urban areas (Figure 3.18). Hence we need to determine a method to retain ecologically important habitats that exists at fine scales. In fact, animals often make compensatory actions to cross-unsuitable places such as roads to get to the opposite habitats. After testing various radii in a moving average of our habitat suitability layer, a radius of 400m was determined most appropriate. Subsequently, habitat suitability layers for all target species are moving-averaged with 400m radius.

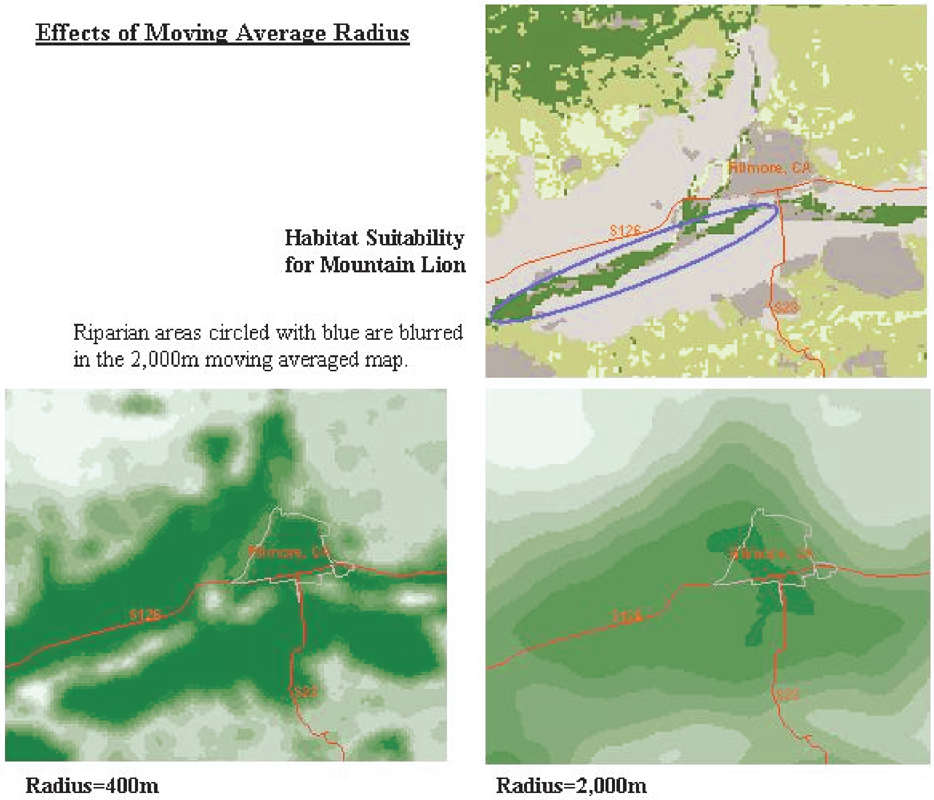


Figure 3.18 - changes in HS layer that result from two different radius values

3.4.3 Input Layer - Road Density (RD)

Road impacts are measured in our model by traffic-weighted road density. In order to account for a lack of traffic data, road type is used to account for traffic volume. Roads in Tiger 2000 are assigned weights ranging from 1 to 6 according to the type of road, with 6 representing the heaviest traffic (Table 3.2). Traffic-weighted road density is then calculated with the unit of km/km^2 using a 400 m search radius. A search radius is thought to reflect an effect zone (the distance from a road at which the impact of the road can be detected). The extent of effect zone is still under debate and depends to a great extent on species, ranging from 300 m to 1000 m for various birds (Forman et al. 1998). A study regarding the installation of underpasses/culverts to restore landscape connectivity in Florida chose a 600m buffer on each side of highways (Smith 1999). This model uses a 400m radius, which is consistent with the radius used in calculating the moving average for habitat suitability. An area that encompasses heavier traffic has higher density than that which includes lighter traffic with the same length of roads, meaning that the resulting value of road density is not the actual density rather it is traffic-weighted.

Weight	Description
1	Local, neighborhood, and rural road, city street, un-separated Local, neighborhood, and rural road, city street, separated
2	Secondary and connecting road, state highways, un-separated Secondary and connecting road, state highways, separated
3	Primary road without limited access, US highways, un-separated
4	Primary road without limited access, US highways, separated
5	Primary road with limited access or interstate highway, un-separated
6	Primary road with limited access or interstate highway, separated

Table 3.2 - System of weighted values assigned to roads of varying size and type

The traffic-weighted road density is a more realistic measure because the study area has such a wide range of road traffic, varying from an interstate highway to a rural road in Los Padres National Forest. If no traffic information were included, it would fail to evaluate the magnitude of the road impacts on wildlife movement. The traffic-weighted road density is converted to ten levels of cost that an animal has to pay when it moves across the road.

Effects of noise and visual disturbance are well represented by a viewshed analysis. The viewshed layer is derived from the Tiger 2000 road map and the DEM. All roads except those with a weight of 1 are used to calculate the viewshed. Roads with weight 1 are eliminated because they have very low levels of traffic. Since direct line of sight to roads is related to the likelihood of noise and light reaching an animal, this layer is not moving-averaged. The viewshed function uses the DEM to determine line of sight exposure of each grid cell to all roads in the study area. Every grid cell receives a score and is reclassified into ten classes, with 10 representing a high species impedance cost.

Both road density and viewshed are associated with roads, so these layers are treated in conjunction. It is assumed that viewshed has fewer impacts on species than road density, due to the fact that viewshed does not consider proximity. Hence two layers are combined with viewshed accounting for 30% of road-related costs.

Note: Roadside fences, road width and speeds are not considered. Road types do not necessarily reflect the traffic; actual traffic data may improve the estimate of road impacts. Location and rates are also ignored. Roadkill data are not taken into accounts. The places where roadkill are frequently observed can be seen as parts of existing corridors.

3.4.4 Input Layer - Topography / Slope (SL)

The slope layer of the study area is derived from a 30m resolution DEM produced by the National Elevation Dataset (NED). The resulting layer is a 100m resolution raster that is restrained to the extent of the study site (Figure 3.7). Steeper places are thought to put more costs on an animals than flatter places, due to the greater expenditure of energy required to travel across regions of convoluted topography. This layer is not taken as a moving average because the slope at any one point is not affected by the slope at surrounding areas, and also because areas such as cliffs are misrepresented by the moving average function.

3.4.5 Selection of Focal Species Approach - Wide Ranging Carnivore (WRC)

Our modeling efforts are primarily based upon consideration of large wide-ranging carnivores, which serve as umbrella species for a variety of reasons. Umbrella species are those that have relatively extensive range requirements and/or biological needs such that their presence confers protection upon other species living in the same habitat or ecoregion (Andelman and Fagan 2000). These carnivores tend to be vulnerable to local extinction in fragmented landscapes because of their large home ranges, low reproductive capability, and high susceptibility to human disturbance and persecution (Noss et al. 1996, Woodroffe and Ginsberg 1998). Ensuring the survival of larger carnivores inherently protects many other species because their territories span a wide range of habitat types and because it is necessary to preserve large connected landscapes in order for them to persist.

Additionally, it is often asserted that the decline and extirpation of these top predators from fragmented systems may lead to trophic cascades which then alter the structure of ecological communities (Crooks and Soulé 1999). In the absence of large carnivores, populations of prey species often increase drastically and sometimes cause alteration of entire ecosystems due to the resulting increase in herbivory. When disease and starvation become the only forces controlling the abundance of these prey species, an unnaturally high percentage of emaciated and unhealthy individuals may result. Removal of large carnivores from an ecosystem can also cause an abnormal increase in the population density of mesopredators such as skunks, opossums, and raccoons - a phenomenon commonly referred to as “mesopredator release” (Soule et al. 1988).

For all of the reasons explained above, we choose to base our model primarily upon the needs of wide-ranging carnivorous mammals that inhabit the region. The three species in our study area that most exemplify these characteristics are mountain lion, gray fox, and bobcat. There are also populations of black bear, coyote, and badger in the region. These species are of secondary importance because they are either non-native, not sensitive to human disturbance, or are not wide-ranging generalists. Ultimately, our approach is to design corridors that provide the greatest amount of benefit to the largest number of species possible, by addressing the needs of these umbrella species.

We model the wide-ranging carnivore group as a single composite species, referred to as the WRC. In order to begin least cost path analysis for the WRC, the necessary habitat suitability layer is created by averaging the HS layers of mountain lion, gray fox, and bobcat.

3.4.6 Determination of Input Weighting Values

In order to model movement behavior for individual species, information from a search of the literature is used to create the Input Weighting Grid (Table 3.3). This grid indicates how important each of the three model input layers is to the target species. When evidence from the literature indicates clearly that a given species is highly sensitive to one of the input categories, a rating of "3" is assigned. If evidence clearly indicates low sensitivity to an input, a rating of "1" is assigned. If no clear evidence of importance is found for a given input, or if conflicting evidence is discovered, the rating of "2" is assigned. Although this process is admittedly somewhat subjective, it is at least systematic and based upon documented scientific evidence.

Common name	**CWHR ID**	**Habitat Suitability (HS)**	**Road Density (RD)**	**Slope (SL)**
Gray Fox	M149	2	2	1
Mountain Lion	M165	2	3	1
Bobcat	M166	2	3	2
W.R.C.	M165	2.0	2.7	1.3

Table 3.3 – Sample from the Input Weighting Grid, shows coefficient/exponent values used in the rastor calculator equation to create the cumulative cost layer for each species

3.4.7 Creation of Source and Destination Targets

In order to conduct LCP analysis it is necessary to spatially define a starting and ending location for each path. We use the term "source line" to indicate the starting point of the LCP, and the term "destination line" refers to the end location (technically, the two are interchangeable in the process). We designate the source and destination lines by identifying likely boundaries of the core habitat areas, according to habitat suitability. The source lines are located in the Los Padres NF, to the north of Santa Paula and Fillmore. Due to the fact that this core area is very large, and relatively homogenous compared to the rest of the study area, a single long source line is drawn for each species (Figure 3.19). The destination lines are located to the south of Santa Paula and Fillmore, Highway 126, and the Santa Clara River. Since this area is more fragmented and spatially heterogeneous, we define three separate destinations for each species. Moving from west to east, they are titled Destination A, Destination B, and Destination C. All the source and destination lines are delineated per species or group according to the respective habitat suitability layer.

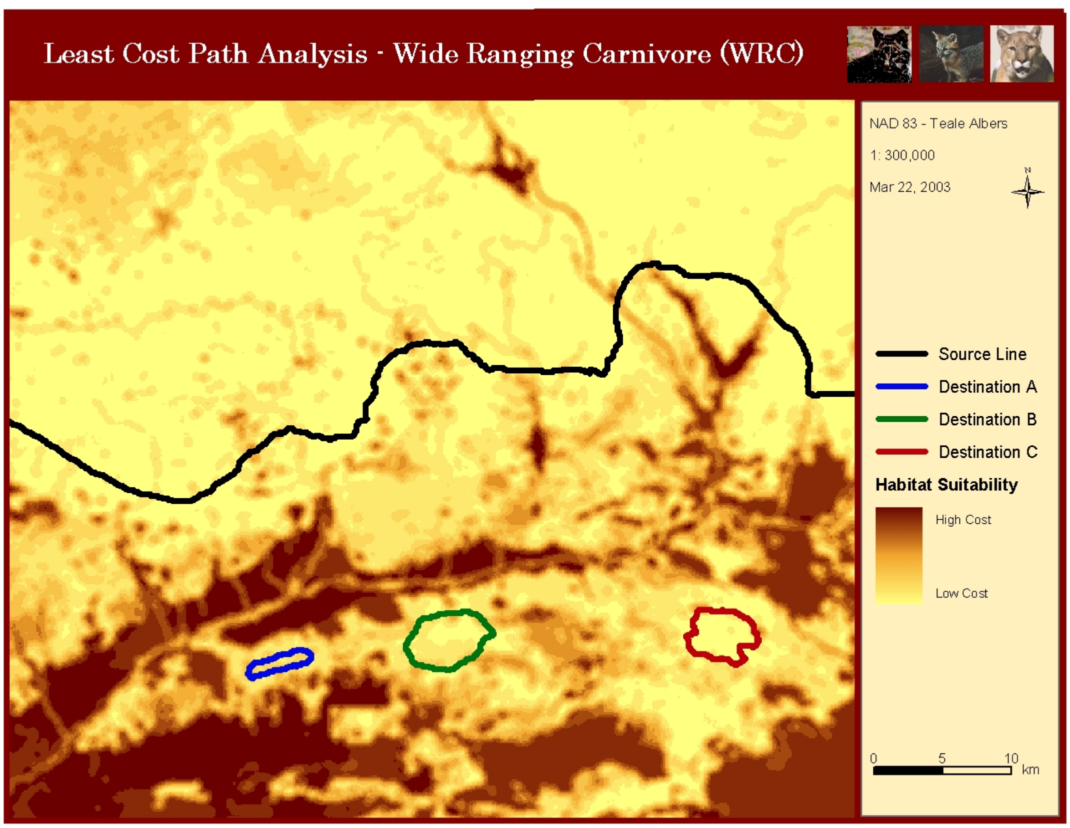


Figure 3.19 - Creation of source and destination lines

3.4.8 Running the LCP Model

We begin modeling potential corridor locations after acquiring all available data, creating the necessary GIS layers, and assigning appropriate weighted values to model inputs. As mentioned in section 3.4.6, these weighted values allow us to include in our model the relative importance of individual inputs to each cumulative cost layer. The cumulative cost layer is then used to generate least cost paths. There are two primary outputs of the ecological LCP model: by-zone paths, and by-cell paths. Each of these outputs has unique and valuable qualities, which assist in analyzing the landscape.

The **by-zone** LCP is a single path that runs from one point on the source line to a selected destination line (Figure 3.20). A by-zone LCP will originate from multiple points when the source is a divided line or consists of several individual locations. Since our source line is continuous, the by-zone LCP function creates a single line for each destination. This output creates the single best LCP from the source line to the selected destination, but does not give information about other paths that could serve as favorable corridors.

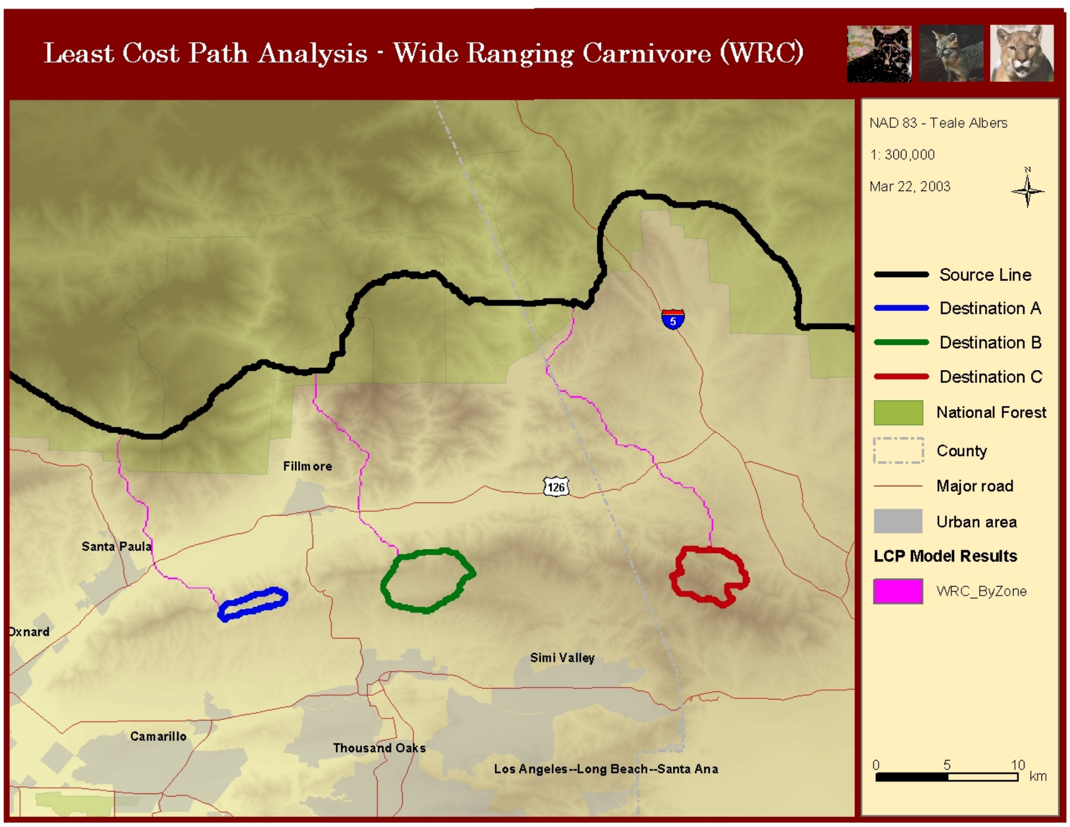


Figure 3.20 – Pink line denotes by-zone LCP for the WRC

The set of LCP's that result from **by-cell** analysis originate from every cell in the source line and run to the selected destination line (Figure 3.21). Note that the by-zone LCP is always amongst the many paths generated in the by-cell analysis. One advantage of by-cell analysis is that it allows for the possibility that animals might disperse outward from many different points along the edge of a core area. Examination of the by-cell analysis often reveals certain paths that are used by a disproportionately high percentage of LCP's, suggesting that some areas might facilitate movement from a wider range of directions than others. In this example, note that the several of the LCP-A paths pass through and/or very near to Destination B and Destination C. This indicates that significant movement occurs in a direction parallel to the river, and suggests that in some instances a single corridor might facilitate movement to multiple target zones.

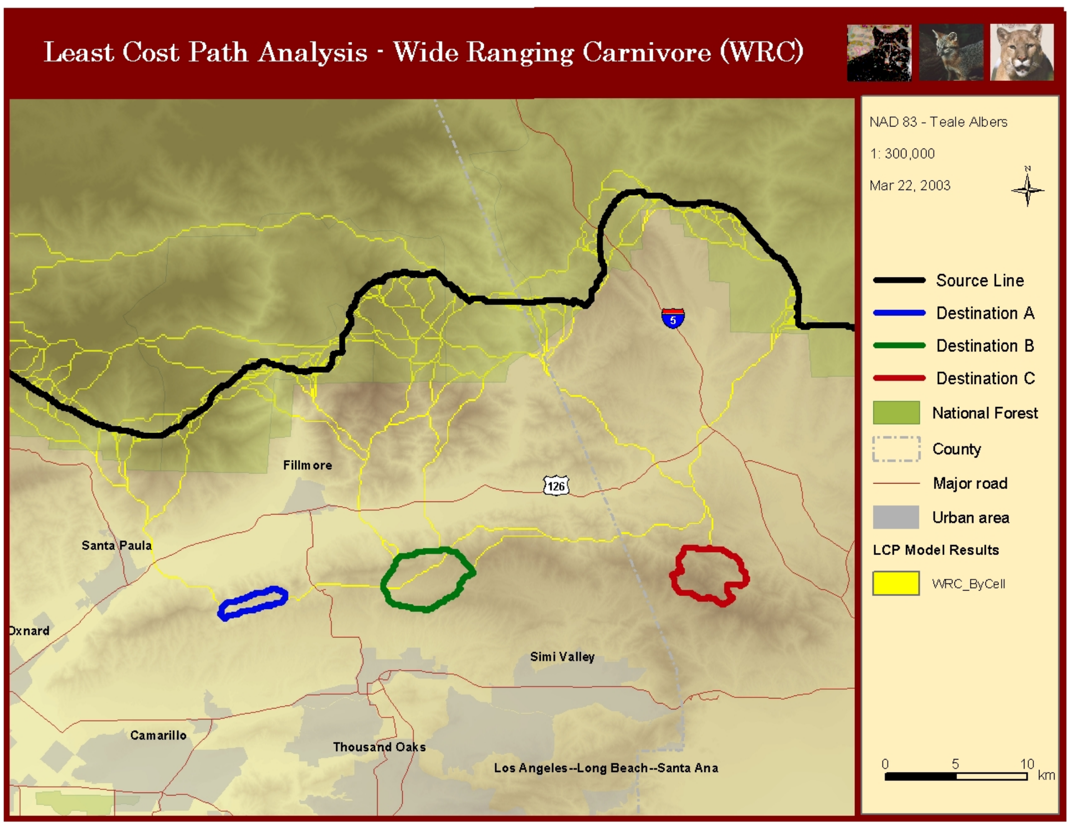


Figure 3.21 – yellow lines denote by-cell LCP for the WRC

3.4.9 Sensitivity Analysis (SA)

We use Monte Carlo simulation to examine how slight variations in the model input coefficients might affect the LCP. The simulation creates 1000 LCP's by randomly varying the model coefficients ± 0.5, a random variation of about 30%. When sensitivity analysis produces paths that are widely dispersed, it suggests that either the cost surfaces used to create the LCP's are very heterogeneous or that a slight variation in the model coefficients results in a significant change in the LCP location. When sensitivity analysis produces a group of tightly clustered paths it suggests that the model is robust enough to withstand slight coefficient variation. Most of the time, we find that the paths generated by sensitivity analysis are relatively well clustered. Like the by-cell method, sensitivity analysis often reveals areas that are consistently used by a high percentage of all LCP's (Figure 3.22). Dark green paths occur where a large number of LCP's overlap, and lighter paths are those that were delineated less frequently. In addition to providing insight about the performance of the model, the SA paths offer information about potential corridor locations not identified in the by-zone or by-cell methods.

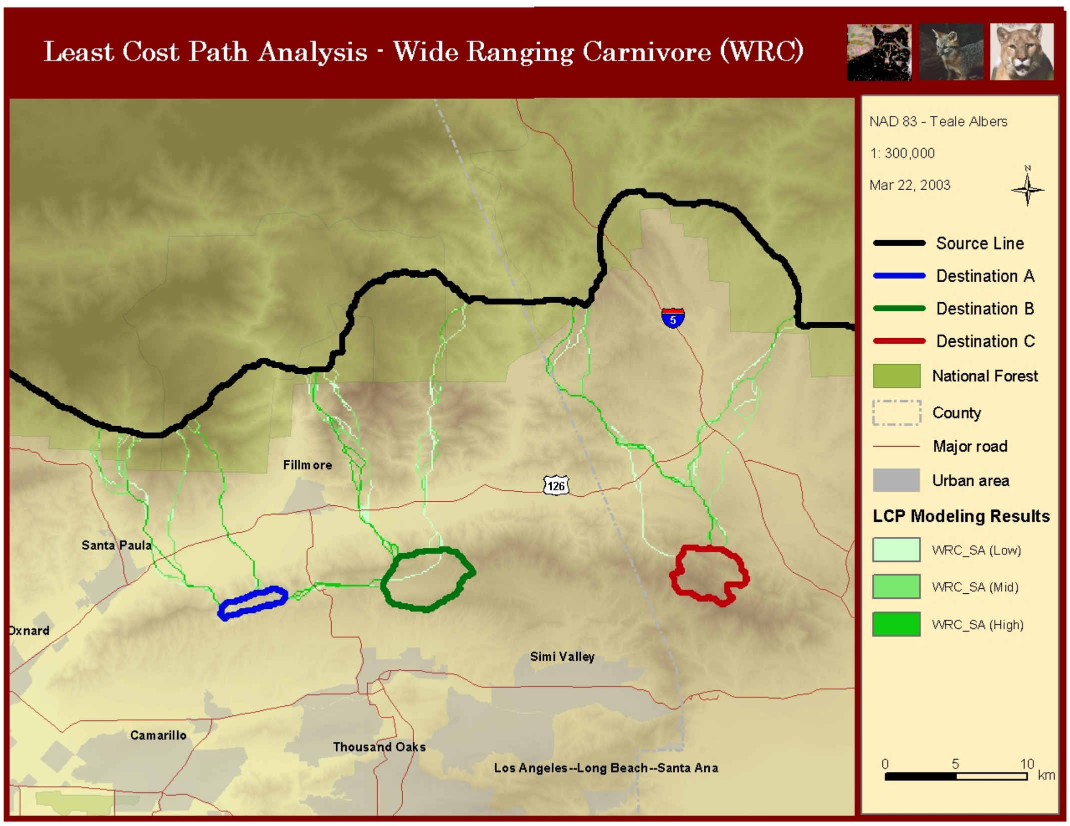


Figure 3.22 – green lines denote LCP paths generated during sensitivity analysis (SA)

The by-zone paths, by-cell paths, and the paths generated by sensitivity analysis are all overlayed together in order to locate areas that are good for animal movement in all possible scenarios (Figure 3.23). In the example shown below, the paths that are identified most frequently across all scenarios occur just to the east of Santa Paula and just to the east of Fillmore. There are also at least two areas where paths are chosen only by a single method.

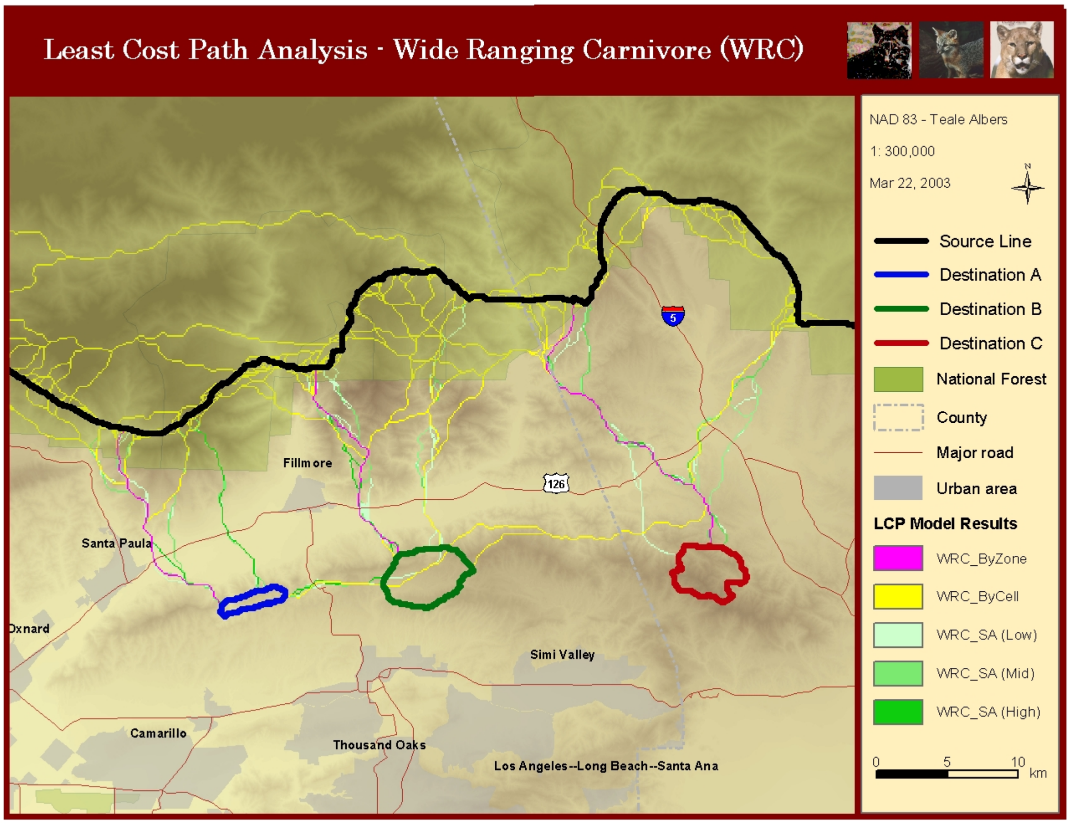


Figure 3.23 – Overlay of all LCP paths for WRC

Note that the sensitivity analysis identifies a dark green set of paths between Santa Paula and Fillmore that are not found in the by-zone or by-cell analysis (as stated earlier, the fact that they are dark green means that many of the 1000 simulated paths chose this same route). Also notice that the by-cell method delineates paths to reach Destination A and Destination B from the far east side of the map that are not selected by either the by-zone or sensitivity methods. This makes sense because the by-cell method is the only one starts paths at all points along the source line. We later examine these paths chosen only by a single methodology, to understand what factors lead to their selection and consider whether or not it might present another valid option. Another interesting observation is that none of the LCP's running parallel to the Santa Clara River travels in the streambed or wash area of the river itself, in spite of the fact that a large amount of relatively undisturbed and natural habitat exists there. The next section also contains a discussion of this issue.

3.4.10 Model Results and Validation - Overview

Once all LCP's and sensitivity analyses are complete, the results are evaluated by means of high-resolution aerial photography and discussion of linkage options with local experts. Aerial photography is an efficient method for ascertaining the legitimacy of our efforts, and helps alleviate the difficulties associated with gaining access to private lands for on-the-ground inspection. Scrutinizing our results through fieldwork will help reveal any potential modeling errors or omissions and more precisely identify locations for inclusion or exclusion from corridors. Expert review and critique alleviates the likelihood of any procedural errors that might compromise the results and generally refines the process.

3.4.11 Discussion of Model Results for **LCP-A**

This linkage area is clearly bounded by Santa Paula to the west and Fillmore to the east. Thus, LCP-A is more significantly impacted by road effects (Figure 3.24). Both the density of roads and the width of agricultural lands increase in this region from west to east. There are by-zone, by-cell, and sensitivity analysis paths all passing through the eastern side of this linkage area, which seems sensible due to the narrower passage across roads and agriculture in that area. One aspect of this route that may not be optimal is that they pass so close to the eastern edge of Santa Paula. It is possible that the combined effects of favorable habitat (including a riparian corridor) and low road density outweighed the relatively close proximity to the city.

It is interesting that only sensitivity analysis paths pass through the more eastern half of the linkage area, and that this set of paths is in the vicinity of two riparian zones but does not directly follow either stream (Figure 3.25). It is difficult to know for sure why this occurs. One likely scenario is that those paths result from variations in the sensitivity analysis where all inputs were weighted lightly, and therefore the line took a more direct path due to the relatively heightened importance of distance reduction. An advantage of paths occurring in this area is that Santa Paula and Fillmore are both more than 2km distant.

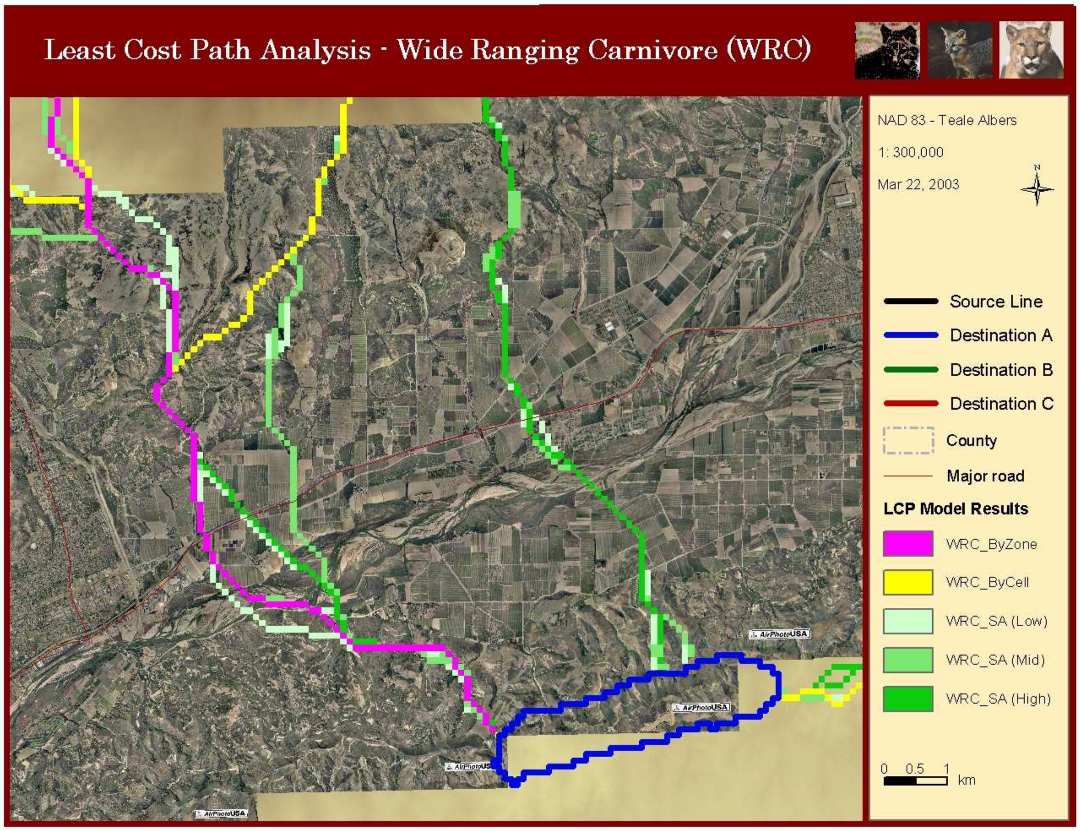


Figure 3.24 – Close up of LCP-A for the WRC

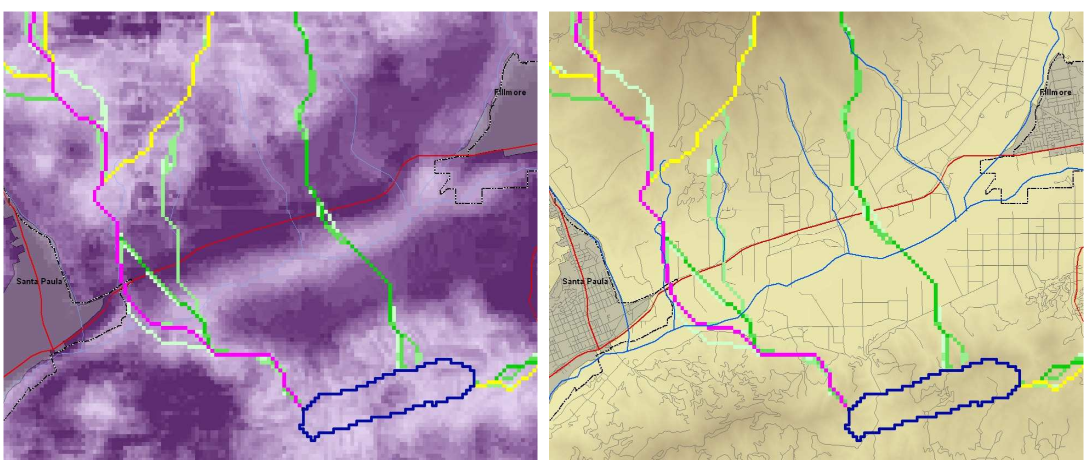


Figure 3.25 – LCP-A, Cost layer (L) and Roads/Riparian Map (R)

3.4.12 Discussion of Model Results for **LCP-B**

This linkage area is much less impacted by roads and agriculture than is LCP-A. One of the most interesting and potentially beneficial aspects of designating corridors in this region is that many of the LCP-A paths from both the by-cell and sensitivity analysis cross through Destination B en route to Destination A (Figure 3.26). This means that protecting this corridor and especially this destination zone might effectively facilitate movement to two different habitat stepping-stones. The set of paths identified for LCP-B that include the by-zone LCP's and the majority of the sensitivity analysis LCP's pass somewhat close to the eastern edge of Fillmore, but this may not present a problem at the present time due to the fact that the terrain is relatively free of any major development.

It is very understandable that the LCP model favors this region, because this location provides one of the shortest crossing distances from natural vegetation across/under the highway to naturally vegetated land on the other side, and there are several riparian corridors present in the area (Figure 3.27).

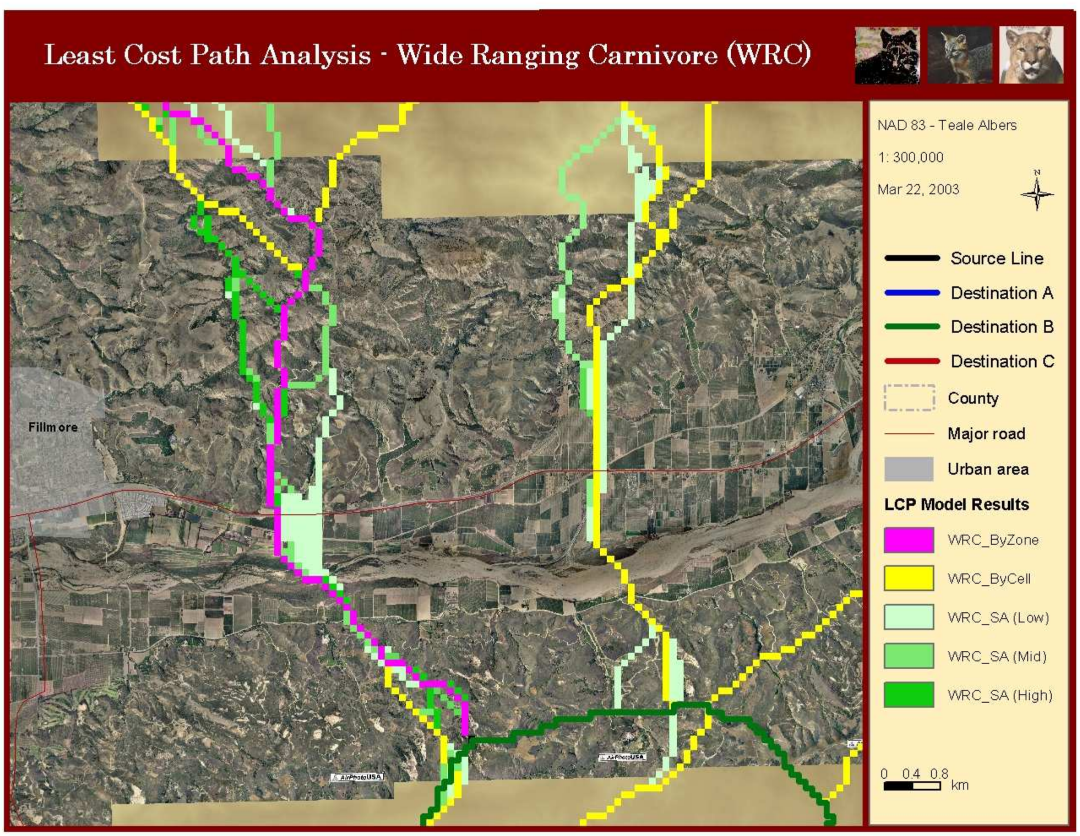


Figure 3.26 – Close up of LCP-B for the WRC

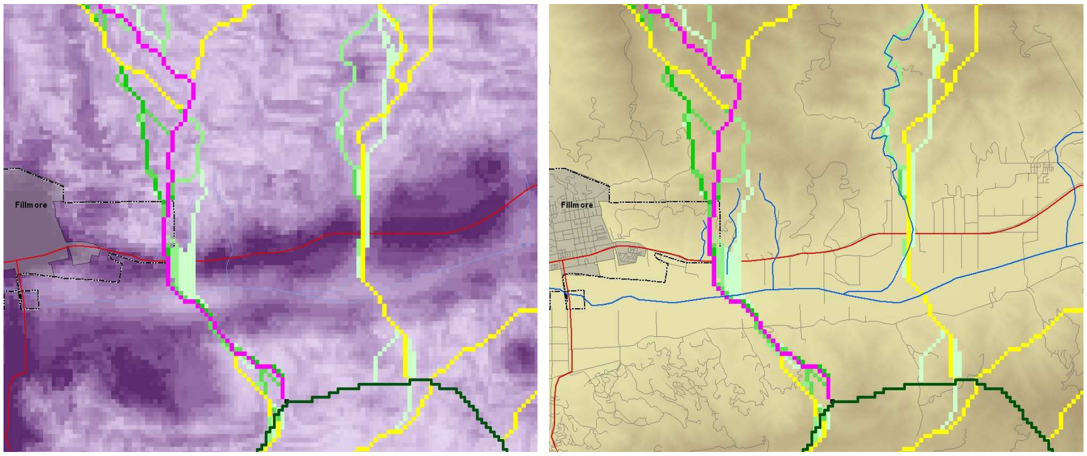


Figure 3.27 - LCP-B, Cost layer (L) and Roads/Riparian Map (R)

3.4.13 Discussion of Model Results for **LCP-C**

Most of the lands for LCP-C lie within Los Angeles County, while the rest of the project area lies within Ventura County. The majority of these lands are almost certain to undergo major development in the near future - the proposed city of Newhall Ranch is in final stages of approval and will eventually become home to more than 60,000 people.

Due to the impending development of this area, we did not acquire aerial imagery for LCP-C, and decided not consider it during feasibility analysis. The results of our initial ecological analysis are shown below (Figure 3.28). After initial presentation of our findings, our clients requested further evaluation of LCP-C, which is included in full detail in **APPENDIX F**.

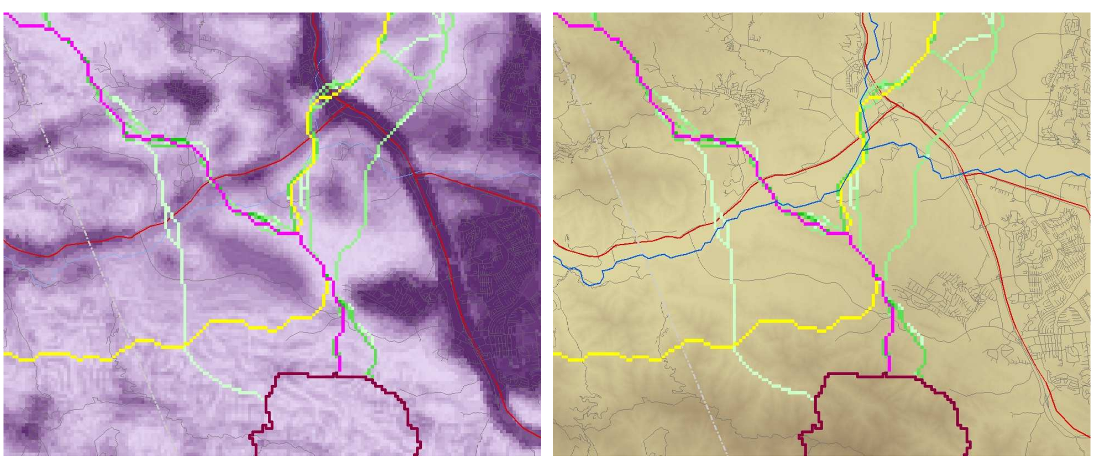


Figure 3.28 - LCP-C, Cost layer (L) and Roads/Riparian Map (R)

3.4.14 Multiple Species Analysis

Although our modeling process focuses upon wide-ranging carnivores, it is important to examine and consider the potential benefits of the proposed corridors for additional target species. Refer to Table 3.4 for a list of these species. The suitability of paths for wide-ranging carnivores is the standard with which suitability to other organisms is compared. When one path is more beneficial to additional target species than another path, the impetus to implement that path is boosted. In a sense, this multiple-species analysis is aimed at providing a criterion for prioritizing potential corridors when implementing all of them is not feasible.

Habitat suitability is the chief determinant used in the multiple species analysis for measuring potential benefits to additional target species of the proposed corridors. One reason for this is that many of these animals move from one core area to another slowly over multiple generations, and thus must be able to reside in the linkage areas. Beyond that, it is assumed that these other organisms exhibit responses to roads and slopes that are roughly comparable to wide-ranging carnivores.

The degree of suitability for additional target species of each WRC by-zone LCP is calculated using CWHR in the following ways. First, the proportion of vegetation types (%cover) that occur "under" each least cost path is calculated by summing the number of cells in the LCP per vegetation type. Each organism has a habitat suitability value for each vegetation type in the CWHR database. The suitability of each least cost path for each organism is calculated by multiplying the habitat suitability by the corresponding %cover, and then summing up for all the vegetation types underlying the path. The suitability of each least cost path by taxonomic group is simply the average of species in the group. The overall suitability of each path is the average of all the species of interest.

CWHR CODE	COMMON NAME	SCIENTIFIC NAME
A028	Spadefoot Toad	Scaphiopus hammondii
A032	Western Toad	Bufo boreas
A035	Arroyo Toad	Bufo microscaphus californicus
B296	Acorn Woodpecker	Melanerpes formicivorus
B398	California Thrasher	Toxostoma redivivum
B410	Loggerhead Shrike	Lanius ludovicianus
M045	Brush Rabbit	Sylvilagus bachmani
M126	Desert Woodrat	Neotoma lepida
M149	Gray Fox	Urocyon cinereoargenteus
M160	Badger	Taxidea taxus
M165	Mountain Lion	Puma concolor
M166	Bobcat	Lynx rufus
M181	Mule Deer	Odocoileus hemionus
R004	Southwestern Pond Turtle	Clemmys marmorata pallida
R039	Whiptail Lizard	Cnemidophorus tigris
R058	Common Kingsnake	Lampropeltis getula

Table 3.4 – target species for Multi-species analysis

Composition of vegetation : The percentage of vegetation cover through which each of the least cost paths travel is shown in Figure 3.29 – Vegetation . LCP-A passes through coastal scrub (WHR Type: CSC) for 42% of its length. Agriculture (AGR), coastal oak woodland (COW) and mixed chaparral (MCH) comprise 19%, 16% and 8%, respectively. Coastal scrub also occupies a large portion of LCP-B and LCP-C. On the other hand, agriculture shows relatively small percentages in LCP-B and LCP-C (7% and 2%, respectively), compared with LCP-A (19%). Mixed Chaparral is the second most abundant in LCP-C (21%). Although Mixed Chaparral is the most abundant habitat in the study site, the proportion of Mixed Chaparral in the paths is not as high as otherwise expected from its abundance, because Mixed Chaparral exists mainly in Los Padres National Forest and neighboring areas.

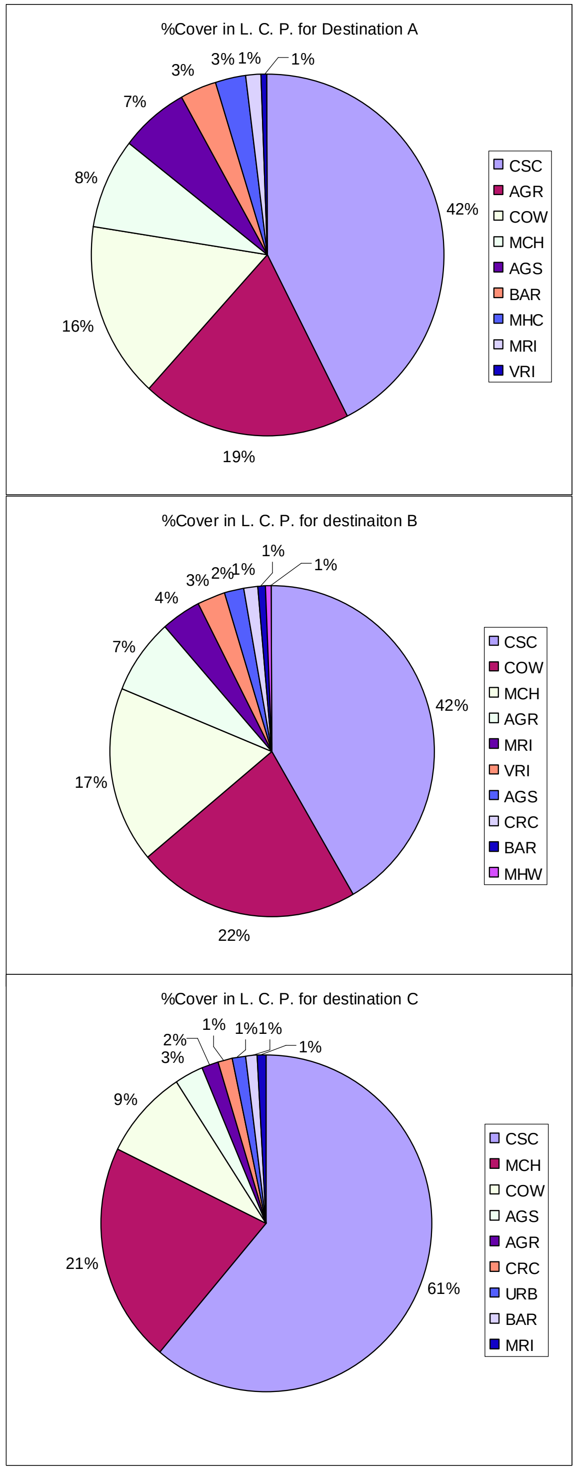


Figure 3.29 – Vegetation types (%cover)

Species specific : The suitability of the least cost paths for each species is shown in Figure 3.30. Although mountain lion (CWHR ID: M165) is a wide-ranging carnivore, the suitability of LCP-A for mountain lion is relatively low. Mixed chaparral (MCH) is the leading vegetation type in terms of its contribution to suitability for mountain lion, because it is one of the preferred habitats for mountain lion and because it is highly abundant in the study area. However, LCP-A has only a small portion of mixed chaparral in its path compared with other paths and has relatively large portion of agriculture, which is undesirable for mountain lion as well as other species.

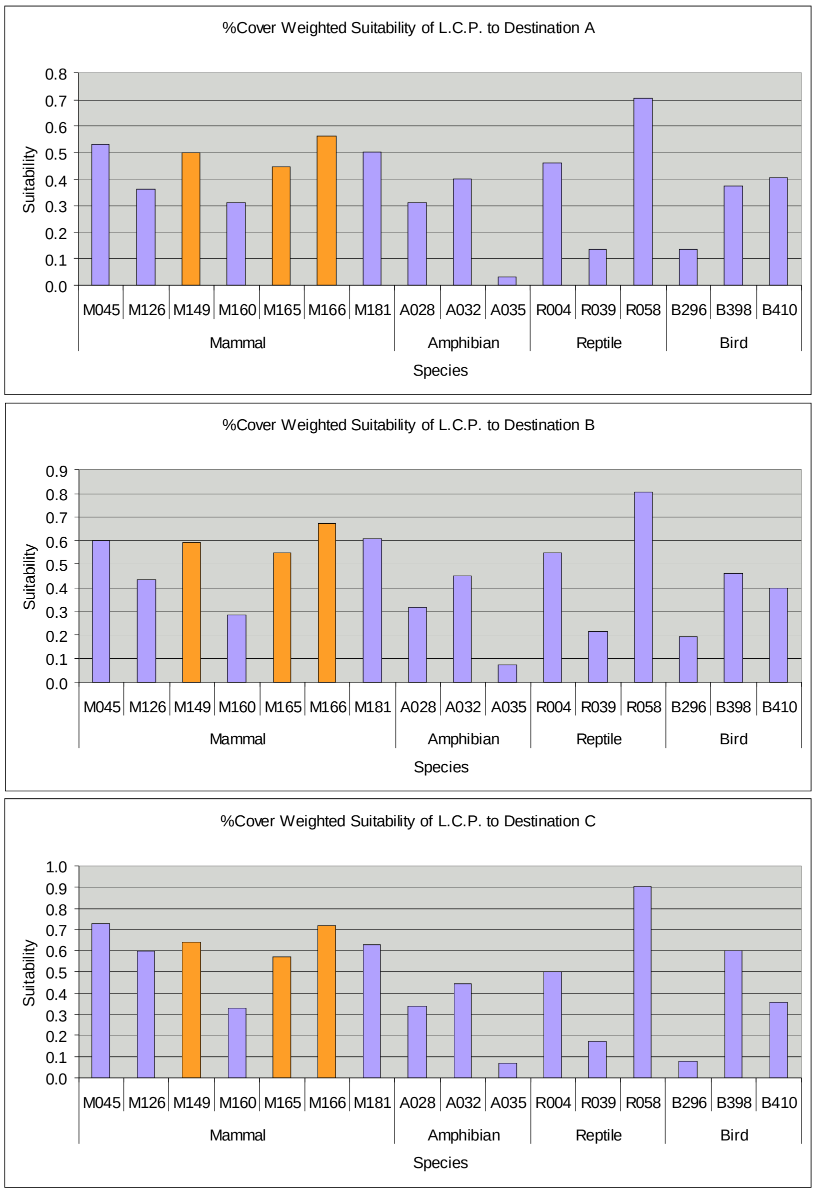


Figure 3.30 - suitability of the least cost paths for species in the analysis

Among mammals, badger (M160) may least benefit from the paths. Badger is a habitat specialist, most often preferring annual grass lands. Consistent with the fact that annual grasses occupies only 6% of the study site, the paths include only small percentages of annual grass (2-7%). Desert woodrat (M126) may not benefit from the paths, especially LCP-A and LCP-B. Desert woodrat, as its name implies, prefers desert habitats as well as Pinyon Juniper, Mixed and Chamise-Redshank Chaparral and Coastal Scrub. As a consequence, only Coastal Scrub and Mixed Chaparral are contributors to the suitability of the paths for desert woodrat. This peculiar habitat preference of desert woodrat retains the suitability of the paths at low levels. Due to the high percentage of Coastal Scrub in LCP-C, the suitability of LCP-C for desert woodrat is relatively high. Suitability of the paths for brush rabbit (M045) and mule deer (M181) is high, which might further benefit wide-ranging carnivores by providing a food source. It is also possible that brush rabbit and mule deer may avoid using the same linkages used by carnivores. A study on wildlife usage of underpasses pointed out that mule deer avoided an underpass most likely due to usage by panthers and bobcats (Foster and Humphrey 1995). Such avoidance by a species in relation to existence of other species can also apply to carnivores. Ng et al. (2002) report that the prevalence of coyotes in a region restricts fox distribution in the area.

The average suitability of the least cost paths for the three amphibian target species is significantly lower than for mammals (0.25, 0.28, 0.28 for LCP-A, B, C). The lower average suitability of amphibians is largely due to arroyo toad. This federally endangered species is limited mainly to Valley Foothill Riparian, which accounts for only 0.1% of area in the study site. Accordingly, Valley Foothill Riparian occupies very little of the least cost paths. More importantly, the scale at which ecological processes relate to amphibians and fine-scale species distributions should be quite different from those for mammals. Put together, it is advisable to seek additional conservation options for this species. Reptiles show a large variance among species. While the suitability for Western Whiptail (R039) is very low, that for common kingsnake (R058) is relatively high. Common kingsnake is a wide ranging species and prefers habitats which are included in the least cost paths such as Coastal Scrub, Coastal Oak Woodland and Mixed Chaparral. Although whiptail is also thought to be a wide-ranging species, its habitat preference is relatively limited to drier habitats. Hence, despite the fact that the suitability of the least cost paths for three reptiles combined is not significantly different from that for mammals, species-specific attention should be paid.

Among bird species, acorn woodpecker shows the least suitability. Acorn woodpecker (B296) is an oak-woodland specialist. Although Coastal Oak Woodland is second or third most dominant vegetation in LCP-A and LCP-B (16% and 22%, respectively), it alone can't make the suitability favorable. Other vegetation types scarcely contribute to the suitability for acorn woodpecker. LCP-C includes Coastal Oak Woodland, but only 9% of all vegetation. By contrast, California thrasher (B398) will largely benefit from LCP-C, compared with LCP-A and LCP-B.

California Thrasher's most favorable habitats are Mixed Chaparral and Coastal Scrub, which occupy more than 80% of LCP-C. Taking an average of the three birds in the analysis, the suitability of the least cost paths for birds is the second lowest following amphibians.

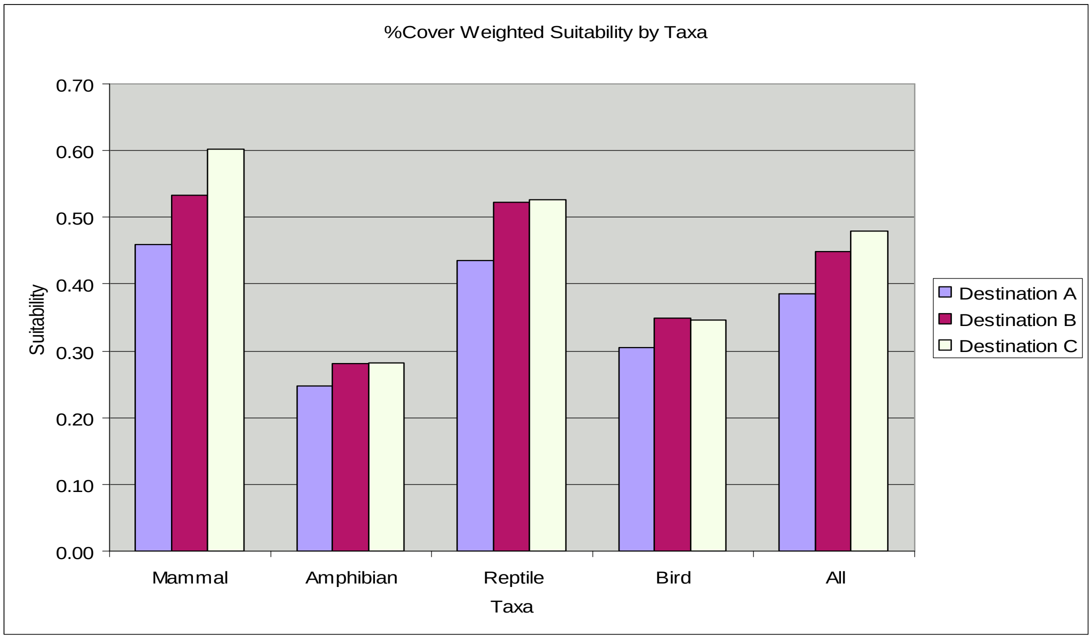


Figure 3.31 – multi-species habitat suitability ratings for LCP-A, B, and C

Inter-path Comparison: There is no apparent difference in the suitability for each species among the three paths (Figure 3.31). However, the overall suitability of the paths, which is the suitability averaged over all the species in the analysis, is highest for LCP-C (0.48), followed by LCP-B (0.45). This result remains true when looking at the suitability by taxonomical group. The differences in suitability among the destinations are largest for mammals, followed by reptiles. For amphibians and birds, the suitability is similar among the destinations. LCP-C goes through coastal scrub for a large portion of the path (61%) and successfully avoids agricultural lands (2%). In addition, the area between Los Padres National Forest and Destination-C is less urbanized than Destinations A and B. Coupled with the fact that most of the mammals in the analysis show relatively high preference toward Coastal Scrub, these conditions result in the highest overall suitability of LCP-C. The proportion of agriculture in LCP-A is relatively large compared with other two paths, because destination A is close to the middle of Santa Paula and Fillmore where extended agricultural lands exist. This appears to be a main reason that the suitability of LCP-A is lowest among three paths as all the species in the analysis exhibit very low suitability for agriculture and for some species agriculture is an unsuitable habitat.

3.4.15 Determination of Corridor Width

Determining the necessary width of a corridor is dependant upon several factors. It is important to keep in mind the needs of the primary species for which the corridor is designed. Some species such as mountain lion are highly sensitive to corridor width, while other species like badger are known to move through drainage pipes that are scarcely larger that their body diameter. A focal species approach which plans for the needs of those target species that are most sensitive to corridor width will inherently serve the needs of other suitable but less sensitive species (Smith and Hellmund 1993). In accordance with our LCP model, we use wide ranging carnivores as the most suitable focal species for identifying corridor width.

A relatively large amount of research has been conducted upon the movement behavior of mountain lions, which are the largest and most widely ranging native carnivore in our study area. Mountain lions are known to use corridors of varying width, according to a number of factors. In general, larger widths are required for longer corridors. Harrison (1992) suggests that regional corridors for mountain lions should be at least as wide as a home range (about 5km wide), and Noss (1992) recommends that regional corridors exceed 1.6 kilometers in width with no bottlenecks less than 400 kilometers wide. Harrison estimates optimal corridor width for bobcats to be about 2.5 kilometers, at the regional scale. Working at landscape scales, Beier (1995) concluded that a mountain lion corridor should be greater than 100 meters wide when the length of the corridor is less than 800 meters, and greater than 400 meters wide for corridors that are 1-7 kilometers in length.

Corridor lengths in our study area range from about 10 kilometers to about 25 kilometers when measured from the northern source line to each of the three different destination zones, and range from 1.8 kilometers to 6 kilometers when measured from the northern edge of agricultural lands to the southernmost edge of agricultural lands. This suggests that appropriate corridor widths for a mountain lion would range from about 400 meters up to several kilometers.

Another important consideration is whether a species requires a movement corridor or a landscape linkage. Movement corridors provide for the minimum needs of an animal that is dispersing from one core area in search of another, but would not necessarily provide suitable habitat for that animal. Landscape linkages contain a complete range of community and ecosystem processes that allow species to move between larger landscapes over a period of generations (Hudson 1991). Although larger carnivores often use movement corridors, many of the other target species in our study area require characteristics associated with landscape linkages. Since landscape linkages must allow for the persistence and reproduction of species within their interior, edge effects are an important consideration.

Corridor width should minimize edge effects such as human disturbances (noise, light, recreational activity), invasion by exotic species, and changes in microclimate which can all affect interior habitat quality. Edge effects are typically measurable as much as 200 meters into a forest, and as much as 600 meters in some situations (Hudson 1991). Even where suitable habitat is encompassed within a corridor, a total width of 200 meters has been found inadequate for some species (Kavanagh 1985). One study found that multiple species wildlife corridors should be more than one kilometer wide and that no portions should be less than 700 meters wide (Shepherd et al 1992).

All corridors in our linkage area must pass through some amount of agricultural lands, which have poor interior habitat value for the target species we have identified. The paths that follow riparian zones through these agricultural zones may offer the most promise for creation of landscape linkages with interior habitat. Although riparian corridors are known to facilitate movement by a wide range of species, narrow riparian strips do not provide habitat suitable or adequate for many other species (Gilmore 1990, Recher et al. 1991, Scotts 1991). For this reason, restoration and expansion of riparian zones might be a key strategy for creating landscape linkages that contain favorable interior habitat.

Ultimately, both ecological and feasibility issues will determine the width of corridors that are implemented. Within certain limits described above, it is fair to say that wider corridors are superior to narrow ones, but it is important to keep in mind that when corridors are reduced to very narrow widths, they may fail to accomplish their purpose for some or many species.

3.4.16 Critique and Evaluation of Ecological Modeling

Issues on Ecological Aspects:

Metapopulation dynamics: The model does not consider species populations and their dynamics. It is impractical at present to get plausible quantitative data on species populations in the study site. Although it is possible to know which parts of the study site are potentially good habitats, the likelihood that a species of concern actually occurs in these areas is uncertain. In order to overcome the lack of information on species populations in the study site, we assume that an individual may occur any place where habitat suitability for the species is the highest among surroundings. As previously explained, sources and destinations are depicted such that they should skirt the places where habitat suitability is highest. Least cost paths can begin and end any place on the source and destination lines.

Linkages to Population Sink: Corridors may act as population sinks that draw dispersing individuals to edge-dominated habitats (See an example of Spotted Owls in Gutiérrez and Harrison 1996). When linkages facilitate animal dispersal to sink habitats, vital rates such as growth rate can decrease. While Los Padres National Forest encompasses relatively intact habitats, the destinations identified in the project are very small areas surrounded by urban areas. Instead of regarding those destinations as core areas of linkages, it would be more appropriate to consider them as stepping stones toward further southern or eastern national forests or parks.

Habitat Quality in Linkages: Survival probability in a patchy landscape increases with quality of corridors which connect patches (Wiens 1996). Dispersing animals may face elevated mortality when the corridor quality is less desirable due to lack of food, predation and human contacts. In addition, despite CWHR defining stages for each vegetation type, the model takes the average of suitability for all stages. In some cases, stages of vegetation may make significant difference in usage of linkages by a given species.

Scales: Because different organisms perceive and respond to changes in landscape patterns and processes at different scales, the model based on habitat suitability should be carried out at an adequate scale associated with a target species (Roloff and Kernohan 1999). Roloff and Kernohan (1999) suggest an appropriate scale be selected based on home range estimates. The ecological model expects linkages designed for wide-ranging carnivores to benefit other taxonomic groups as well. However, amphibians and reptiles are largely different from middle to large size carnivores in terms of home range, dispersal ability and other life history requisites. Linkages for such small organisms would need to be designed at finer scale.

Patch Configuration and Edge Effects:

Species occurrence is predicted not only by vegetation but also by patch size, which is associated with carrying capacity and patch configuration. The least cost path approach does not guarantee that the path meets all elements of life history requisites of target species. Edge effects have been proven in a number of literature, to have substantial impacts on species persistence. The model partially includes edge effects by taking the moving average of habitat suitability. For further improvement, however, habitat suitability based on vegetation type needs to be modulated according to the size of a patch and edge effects perceived by a species in question. In addition, edge effects emerge not only in habitats themselves but also within corridors (Turner et al. 2001). Better design of corridors should be wide enough to mitigate edge effects (Lidicker and Koenig 1996, Csuti 1991).

Issues on Least Cost Path Approach

Focal Species Selection: Selection of target species has been an issue of debate on conservation planning. Although a guild approach is recommended by the Fish and Wildlife Service and others, there has been no specific guidelines on how to choose focal species (Fry et al. 1986). Fry et al. (1986) suggest selecting focal species from various taxonomic groups. Even within carnivores, response to fragmentation differs among species with some being more tolerant to urbanization and others being more susceptible to it (Crook 2002). It should be also noted that the choice of carnivore focal species depends on the scale of fragmentation in an area (Crook 2002).

Interpretation of Costs: In the least cost path approach, costs should explain a species' tendency to avoid a particular place in a component. There is no agreement regarding the relative magnitude of impacts that components have on species. The way of combining layers using the non-linear formula is based on our experimental inferences. The relative weight on each layer ranges subjectively from 1 to 3. Both the formula and weighting scheme may be subject to debate. Moreover, whether impacts have threshold effects or not is unclear. If there were threshold effects, cost gradients would have an abrupt change at a certain level. It should also be noted that costs are not proportional. A cost of 4 is, for example, not double a cost of 2. Thus, classification warrants careful attention.

Inputs: There may be other components that have significant impacts but are not included in the model. Those include elevation, soil type, proximity to water body, and others (Clevenger et al. 2002, Weber and Wolf 2000). Furthermore, components should be independent of each other, otherwise costs may be overestimated its impacts when overlaying components which have some correlation. For example, if the slope were highly correlated to the road density such that the flatter the slope is, the larger the road density is, summing up the costs from the slope layer and the road effect layer would duplicate the cost associated to the impact common to those two layers.

4 CORRIDOR FEASIBILITY ANALYSIS

4.1 Overview

The purpose of this section is to enhance the ecologically designated wildlife corridors by integrating feasibility into the design process, and to suggest strategies to implement these corridors. First, we apply additional socioeconomic variables to the modeled, ecological corridors that make them more feasible to implement. Second, we offer a set of land-specific tools that can assist in making these wildlife corridors a reality.

The ecological modeling phase of the project designates the best paths for maintaining landscape connectivity based on the life history characteristics of wide-ranging carnivores (see Section 3). We use these parameters to ensure the design of biologically viable corridors for species movement, dispersal, and demographic persistence. However, if the specified corridors are not implemented through protection of the land and its inherent resources, such as sources of habitat and water supply, then the conservation goals will not be achieved. Therefore to make these corridors more effective it is necessary to capture the implementation potential, or feasibility of protecting the land for use as a wildlife corridor in the design process.

The corridor feasibility analysis is a process that assesses the likelihood that an ecological corridor can be implemented. The process does this by identifying criteria to evaluate the ecological corridors for their ease of implementation, adjusting the corridors using these decision-making criteria and presenting applicable strategies that can be utilized within these areas.

There are several criteria by which we measure feasibility. First, land value is used to examine and characterize our study area. We assume that high value land has high development potential or is desired by the real estate market for other reasons such as high quality habitat for wildlife, plants or agriculture, proximity to roads, existing infrastructure or scenic value. Our second assumption is that land acquisition is the most expensive conservation tool because all rights are transferred. We conclude that land value can be used as a conservative estimate of the 'cost' of land conservation and thus can be used as a proxy to determine the degree of difficulty of conserving a piece of land.

However, we recognize that land value is not a comprehensive measurement of feasibility. Therefore we include a second set of criteria consisting of other socioeconomic factors. These factors influence the social and economic land disposition of the study area, and provide a view of the current land management plan. The use of this criterion includes the use of GIS data, aerial photographs and planning documents such as the Ventura County General Plan and the Ventura County Non-Coastal Zoning Ordinance. The GIS data includes zoning, parcel lines, land use characteristics, CURB boundaries, and the presence of preserved property within our study area. These are factors that influence the ability to implement a corridor. The study area is examined using all the aforementioned data to characterize the land in terms of circumstances that will confront those attempting to implement the corridor. This analysis produces a qualitative assessment of the feasibility of corridor implementation. Using the assessment results, the corridors designated by the ecological modeling process are adjusted to avoid potential conflicts and to utilize beneficial conditions.

It is critical that each path produced in the ecological modeling process is analyzed and adjusted using these criteria. This presents a problem because all the paths leading toward Destination C (see Section 3.4.7 for identification and creation of destination targets) fall entirely within Los Angeles County. The group is not able to access the comparable land value and other socioeconomic data for Los Angeles County, and therefore did not perform feasibility analysis on these paths. While these corridors are still viable options from an ecological point of view, it is not possible to incorporate implementation considerations into them.

The characterization of the study area during the previous step provides insight into the likelihood that a corridor can be put into action, but also into the method that can be used to do so. Various conservation strategies exist that can help to implement the corridor. Assessment of the strategies reveals that there are certain land characteristics for which a strategy is more easily executed and makes the most impact in achieving the conservation goals. The optimal land characteristics for each strategy are identified in a Strategy Characterization Matrix. This information, coupled with information on the nature of the land characteristics (land use, zoning, land value, etc.), a linkage manager can make informed decisions regarding how to apply conservation strategies to the landscape.

4.2 Data Acquisition and Preparation

The feasibility analysis requires the use of various socioeconomic and policy data. This data, described below, is used to characterize the land management in our study area as a basis for determining the feasibility of implementing a wildlife corridor. Most data exists in a format that can be analyzed within a GIS-based system, however other data is in document-form such as planning documents and hardcopy maps, or as qualitative knowledge such as verbal communication with local officials and conservation agencies.

4.2.1 Preserved Land

Preserved lands are defined as any property within our study area that is currently restricted from development either through easements, or by virtue of the complimentary management goals of the owners. The land is managed for conservation purposes, or at the very least the current land use does not hinder the dual use of the land as a wildlife corridor. This data is important because we assume that it is more feasible to implement a wildlife corridor within land that is already preserved, and not open to development.

There are four owners whose property qualified as 'preserved land' in our analysis: the United States of America (includes land owned by federal agencies such as the Forest Service and the Bureau of Land Management), the State of California, The Nature Conservancy and Friends of the Santa Clara River. The data for land owned by the non-profit groups is gathered directly from the organization, while the federal and state-owned land data is gathered from ownership information collected by the Ventura County Assessor's Office. The non-profit lands include acquisitions made by these groups within the past few years. The other ownership data was part of a larger Ventura County GIS database that the group attained from the Ventura County GIS Division, which was updated in 2002.

4.2.2 Land Value

Land use data is characterized by assessment values of individual parcels of land. The Ventura County Assessors Office collected the data for the year of 2002. Land value data consists of assessed values for the land minus any tax exemptions for that parcel. For example, churches, hospitals, etc. have a tax exemption on their land, which is subtracted from the true land value and becomes the value the assessor uses. In order to have the true land value we did not subtract tax exemptions from land value data for any of the parcels.

The land value data is a proxy for the cost of implementing strategies to create a corridor on any given parcel of land in the study area. The reasoning is that an increase in land value is proportional to the cost or ease of implementation of the corridor.

4.2.3 Feasibility Criteria

This data includes many of the socioeconomic and policy data that are used to characterize the land in our study area. Analysis of this qualitative land characterization, and therefore how the land is being managed determines the ease of implementation of the corridor. This data originated from various sources, however a majority came from the Ventura County GIS Division. This agency is the central source for most GIS data pertaining to Ventura County. Our group entered into an agreement with Ventura County in which we were able to receive a database of the County's base GIS data layers (See Appendix C for complete list). Some of this data includes parcel lines, ownership information, land uses, city and CURB boundaries and road locations. Twenty-five different county agencies such as the Resource Management Agency, the Planning Division and the Public Works Agency, have contributed information to this database. This database was provided on CD in a shapefile format. It was last updated in July 2002.

Other information is more qualitative in nature, and therefore is better analyzed via hardcopy documents. Most of this information consists of County planning and zoning policies; some of the documents used are the Ventura County General Plan, the Ventura County Non-Coastal Zoning Ordinance and the Ventura County Initial Study Assessment Guidelines. All of this data was obtained from the Ventura County Planning Division. These documents are changed on an as needed basis; the General Plan was last amended in 2001 and the Zoning Ordinance in 1999.

Additional data was gathered through personal communication with regional government officials and other local experts. We were able to speak with personnel from several Ventura County agencies such as the Planning Division, the GIS Division, the Assessor's Office, the Resource Management Agency, and the planning committee for the Open Space District. In addition we spoke with local officials from the Bureau of Land Management, the Los Padres National Forest, the California Department of Fish and Game, and the California Department of Transportation. Several non-profit groups assisted our group by supplying regional information. These groups include The Nature Conservancy and Friends of the Santa Clara River. The information gathered from these sources was taken to be local 'expert' knowledge of various land management aspects.

4.2.4 Development Potential

The use of development potential is a valuable parameter that can illustrate the location and type of growth within a particular region. This data helps to prioritize conservation sites given that sites with higher development potential are greater threats and should be given stronger consideration than those with weaker potential. We accessed a development potential model created by John Landis at University of California, Berkeley. However this model was unable to provide the group with helpful information due to the homogeneous nature of our study area.

4.3 Conservation Possibilities Frontier

The best ecological corridors were selected based upon minimizing the cost a species incurs when moving across the landscape in an ecological sense. However, to determine the feasibility of implementing the corridor we need to relate this ecological cost to a socioeconomic cost. We consider two socioeconomic factors in our analysis: threat of development and land value.

We intended to incorporate the threat of development into our analysis but found that the development potential models largely resembled the City Urban Restriction Boundary (CURB) for Santa Paula and Fillmore for projections 20 and 50 years into the future (Landis, personal communication). The ecological corridors avoid the

CURB boundaries and as a result we could not examine the relationship between our best ecological corridors and their potential development threat. As a result we decided not to include development threat in our analysis. However, we feel development threat is an extremely important factor when considering how to prioritize and implement landscape linkages and linkage efforts. Other linkage areas should carefully scrutinize this topic.

Land value data, on the other hand, is relatively easy to obtain and covers our entire project area. We utilize land value to establish a relationship between the ecological cost and the economic cost the corridor. The relationship between the ecological cost of a corridor and its associated land value cost is termed the Conservation Possibilities Frontier (CPF).

The CPF was created to establish a relationship between the economic and ecological costs of a corridor. In order to accomplish this an ecological and economic cost surface were created. The ecological cost surface created for the WRC was used. The economic cost surface was derived from a GIS database of parcels within our study area that was acquired from the Ventura County GIS Division. The parcel layer is an ESRI shapefile. Land value data for the study site was also acquired from the Ventura County GIS Division. This data was incorporated into the GIS parcel layer by spatially joining the attribute tables so that a value could be determined for each parcel within our study area. Lastly, a column containing land value per 1 ha ($/parcel ha) was added to the shapefile and converted to an ESRI 5m raster file.

The total land value of an individual parcel is comprised of “land value”, “improvement value”, “mineral rights value” and “trees and vines values” to determine a total land value for every parcel in our project area. We additionally assign a total land value of zero to all parcels owned and managed by The Nature Conservancy, Friends of the Santa Clara River, California Department of Fish and Game and Federal Agencies such as the Forest Service and the Bureau of Land Management. We assume that these parcels are being managed in an ecologically favorable condition and assign a land value of zero to these parcels because land managers incur zero cost to include them in a wildlife corridor.

After creating the economic and ecological cost surfaces, the next step in creating the CPF is to generate random and semi-random paths. These paths, along with the best ecological LCPs, can be overlain on the cost surfaces and be used to clip out the ecological and economic cost surface grid cell values. The values of these new paths can then be summed to obtain the ecological and economic cost of each path. In order to ensure that an adequate estimation of the relationship between these two cost surfaces is obtained a variety of Monte Carlo simulations are used to create these paths. Three thousand paths are generated using ESRI Arc Macro Language (AML) from three random cost surface generation methods. The 3000 paths are displayed in Figure 4.3.1.

Methods used to create random and semi-random paths.

- Random Grid Paths. Generated using the GRID random grid function. This places a random number into every 100m-grid cell in our study area. These grids then become the cost surface upon which a least cost path is created.
- Sensitivity Analysis Paths. The paths created in the WRCM Corridor Sensitivity Analysis (see Section III.3.3), which vary the WRCM model coefficients by ± 0.5. These paths contain a random component in the coefficient that is used to weight the input layers but are not random in the sense that every cell in the cost surface contains a random value as the cost surface consists of the three model inputs.
- Random 0 – 3 Coefficients. Generated by varying the model input coefficients from 0 – 3 for the WRCM to create an ecological cost surface. These cost surfaces are similarly used to create a least cost path. Much like the Sensitivity Analysis Paths these paths are not random in the true sense as the cost surface they produce is the result of the three model inputs.

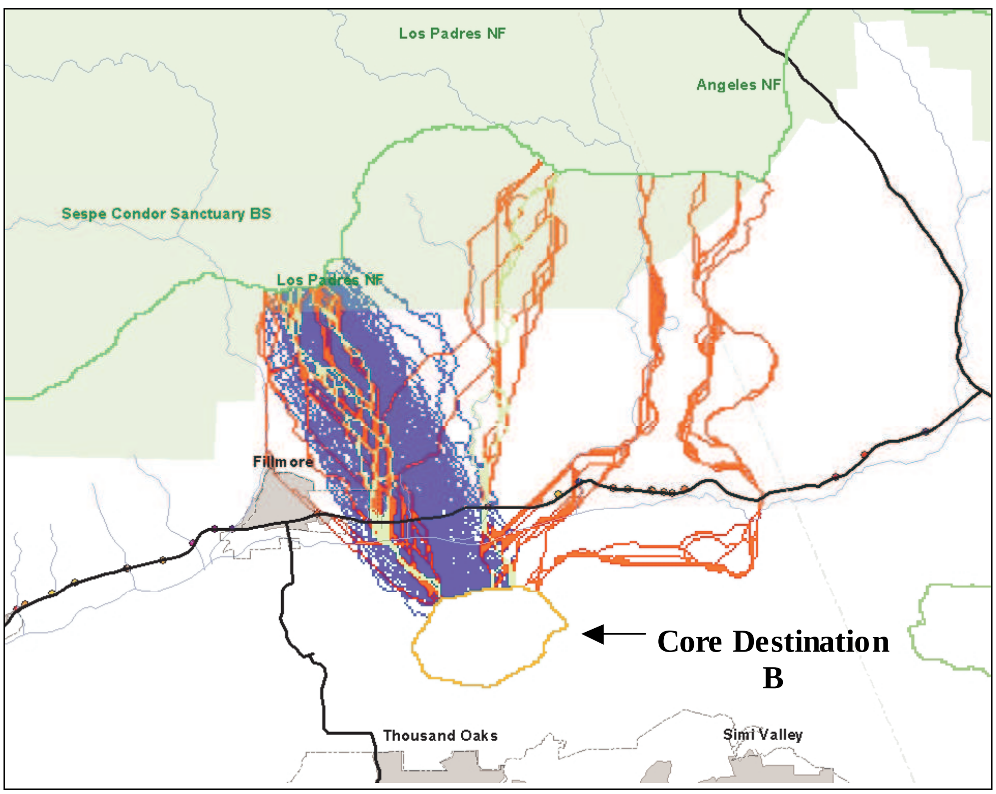


Figure 4.3.1 - Random paths from the Los Padres core area to Destination B. Random Grid Paths are shown in blue, sensitivity analysis paths are in yellow and random 0-3 coefficient paths are in red.

Each of these methods result in 1000 paths that when combined provide a complete foundation upon which to visualize the relationship between the economic and ecological cost of a variety of potential wildlife corridors. Ideally, we could generate every single possible path that can connect our two core areas but are restrained by computing time and software limitations. However, we feel the paths generated by these methods create an adequate representation to allow us to understand this relationship.

After generating the 3000 paths, and clipped out the values of the ecological and economic cost surfaces, we export the values of these paths as text files and import them into MATLAB to analyze their distributions and create the Conservation Possibilities Frontier graph. The distribution of ecological costs for each of the path creation methods is shown in Figure 4.3.2.

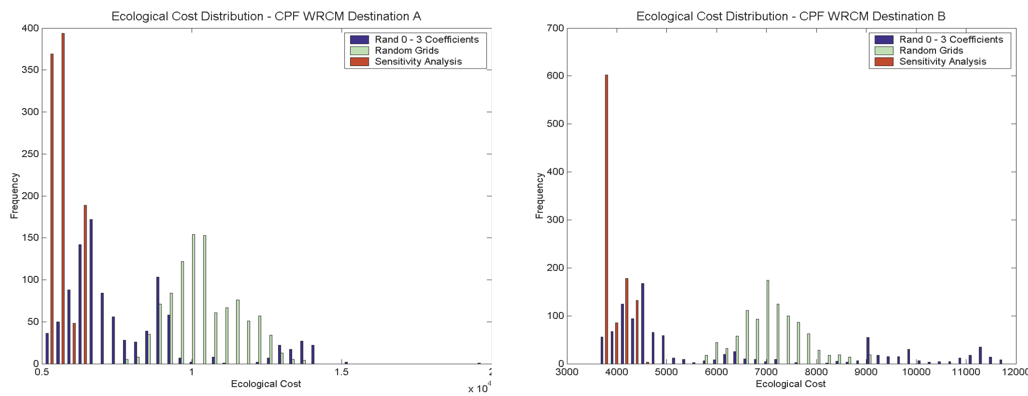


Figure 4.3.2 – Distribution of ecological costs for each of the path creation methods

These graphs illustrate that the paths we generated vary widely in their ecological cost. Low costs represent a corridor that is less resistant for a WRCM type species to move through with high costs representing a corridor with very high movement resistance. These graphs also illustrate that the range of ecological costs vary between destinations, and paths connecting to Destination B have much lower ecological costs. Ecological costs for core Destination A range from 5068 – 19846 compared to the range of Destination B - 3643 – 11843. This intuitively makes sense as a quick observation of the landscape and habitat of these two destinations suggests that the land in Destination A is in a more natural state and should receive a lower ecological cost to traverse the area. The distribution of economic costs for each of the path creation methods is shown in Figure 4.3.3.

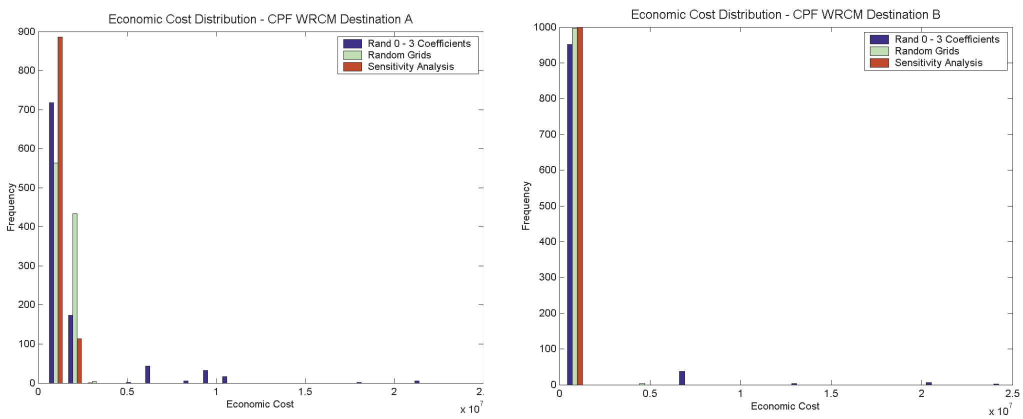


Figure 4.3.3 - Distribution of economic costs for each of the path creation methods

The range and standard deviation of paths for Destination A are $4,567,888 – $22,037,249 and Std. $1,726,214 while those for Destination B are $232,523 – $24,984,820 and Std. $1,386,083. However, there appears to be some outliers with extremely high costs, which we will address after creating the CPF. To create the CPF we relate the ecological and economic costs of the 3000 paths. The CPF for Destination B is shown in Figure 4.3.4. Note that we have also added the best ecological path as well as the best economic path. These are the LCPs of the ecological and economic cost surfaces.

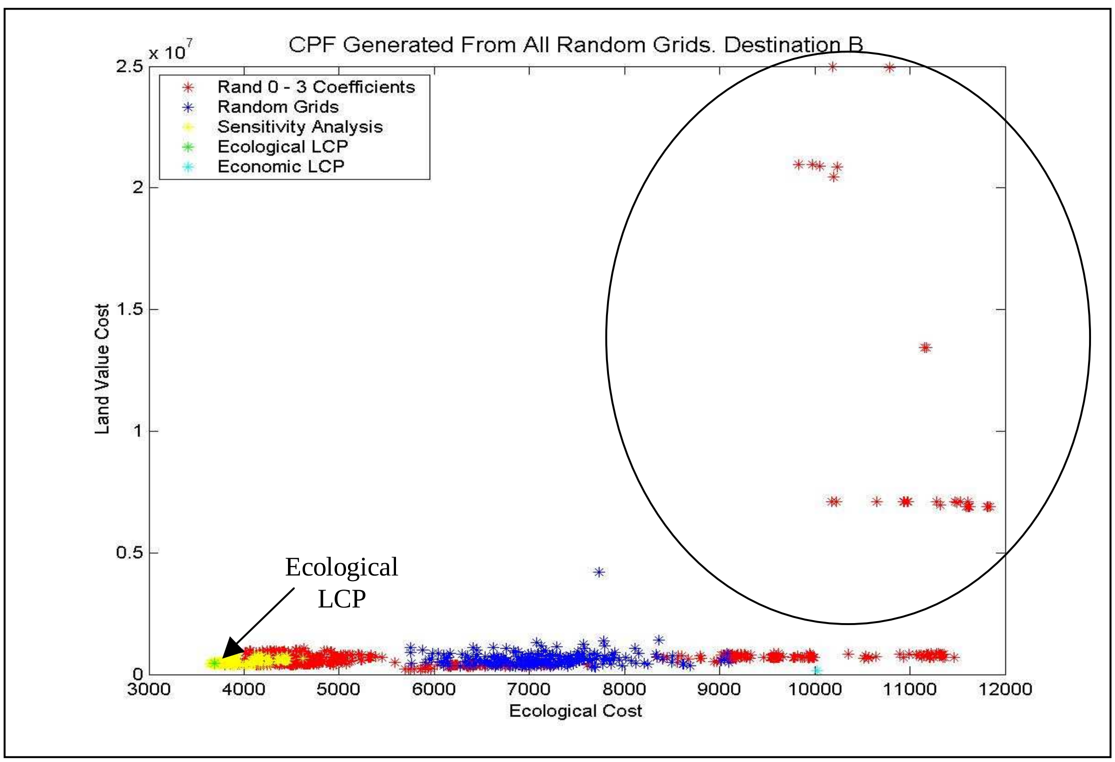


Figure 4.3.4 – CPF for Destination B. Notice the paths with extremely high costs in the circle

Figure 4.3.4 is somewhat skewed as a result of paths with extremely high economic costs. We selected paths with costs above $4,000,000 and investigated them in ArcMap. Figure 4.3.4 illustrates that these paths are usually created from the Random 0-3 Coefficient method and after review have determined they pass through expensive urban areas. Figure 4.3.5 illustrates paths going through the middle of Fillmore.

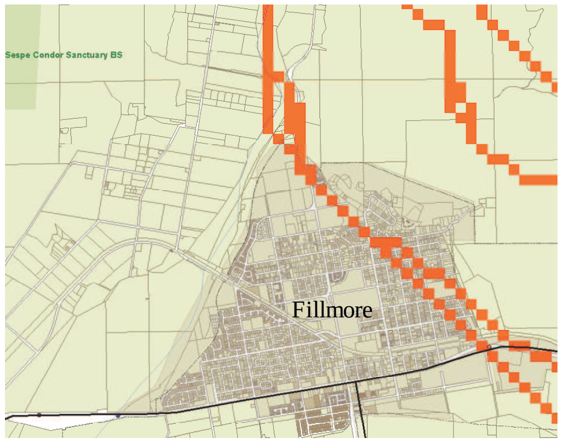


Figure 4.3.5 – Random paths through an urban area

As a result of these paths going through urban areas we removed them from the analysis. This included removing 97 paths that had a total economic value greater than $3 million from Destination A and 38 paths with a total economic value greater than $1.5 million for Destination B. Viewing these graphs, Figure 4.3.6 and Figure 4.3.7 without the outliers provides a much clearer picture of the relationship between the economic and ecological costs of these paths.

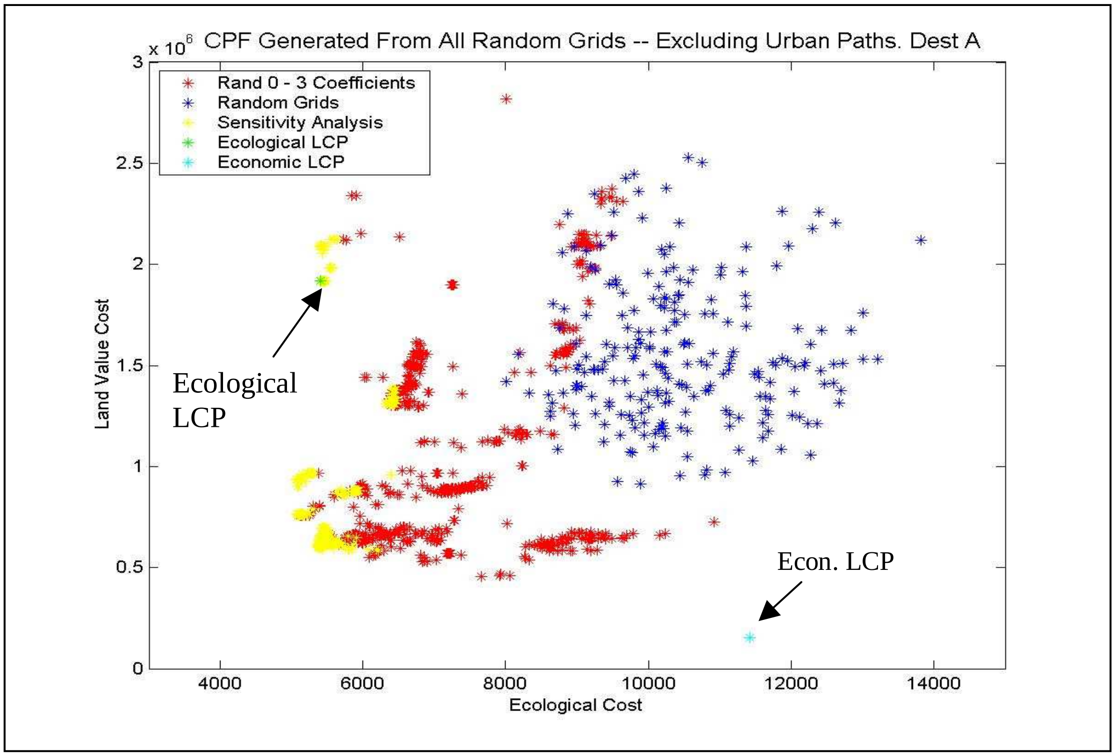


Figure 4.3.6 – CPF for Destination A

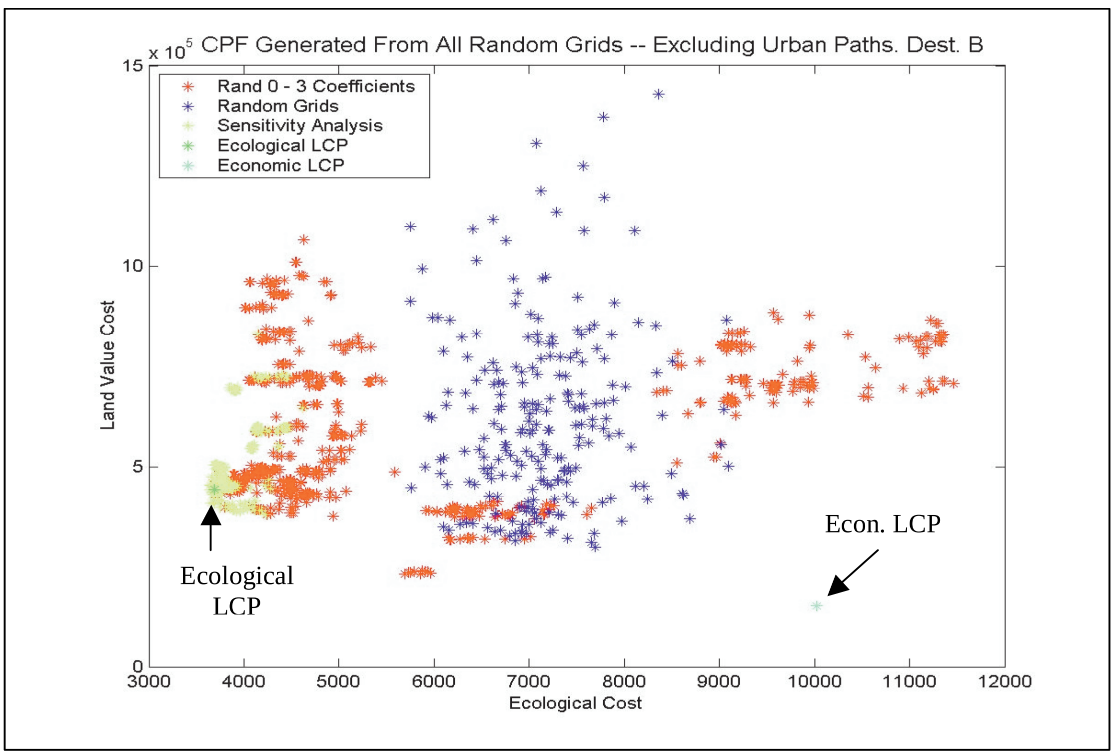


Figure 4.3.7 – CPF for Destination B

Figure 4.3.6 and Figure 4.3.7 illustrate how each of the random path methods completes the picture relating economic and ecological costs for a variety of potential corridors. Notice the economic LCP of the land value surface. This represents the lowest amount a corridor could be created using $/ha as our economic unit. The best ecological LCP similarly should represent the lowest ecological cost of any corridor derived from the ecological cost surface. However in Figure 4.3.8 a number of our sensitivity analysis paths, 298 for Destination A and 135 for Destination B, actually had lower ecological costs than the supposed best ecological LCP.

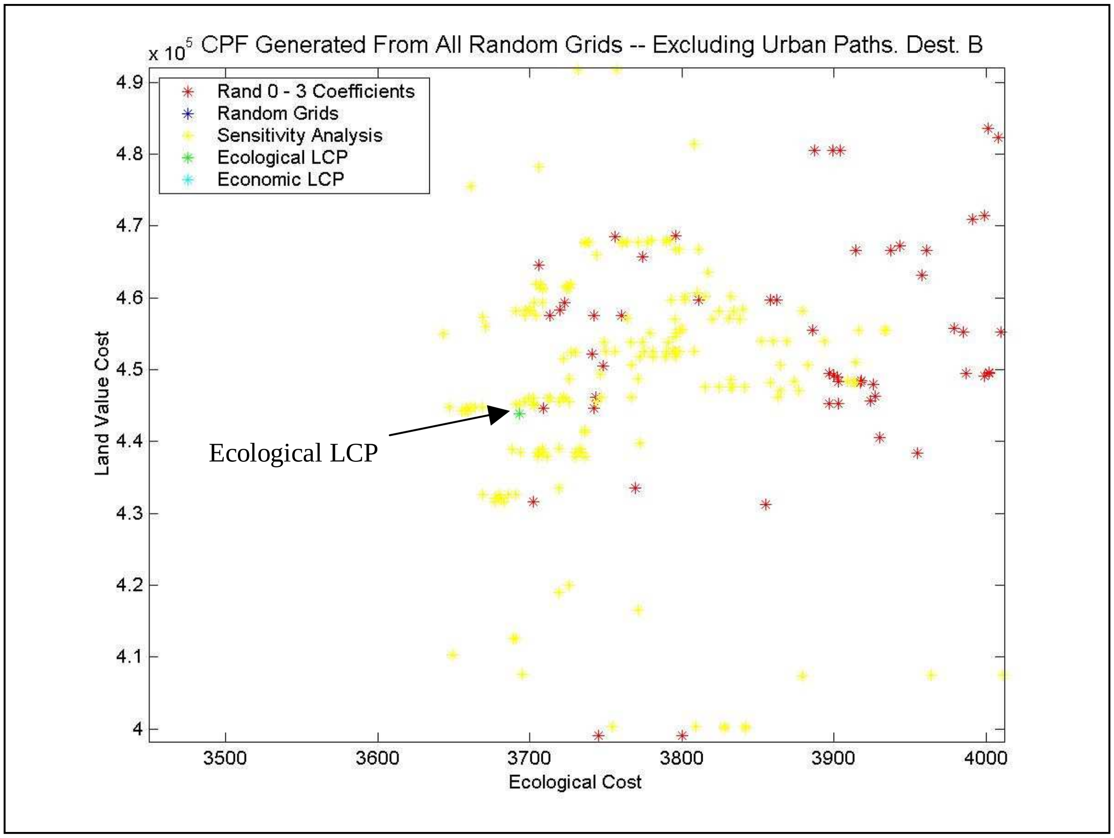


Figure 4.3.8 – Scale-Adjusted CPF for Destination B

This is a result of the ecological cost surface consisting of subtle differences near the destination and core areas, as well as the limitation in the least cost path algorithm. Many of these paths vary slightly from the ecological cost surface LCP, however this result not only validates our decision to conduct a sensitivity analysis of our best ecological LCP, but also provides a wide range of ecologically equivalent and superior paths upon which we can evaluate their implementation feasibility. Lastly, the Ecological LCP for Destination A has a relatively high economic cost compared to other sensitivity analysis paths. This suggests that the ecological LCP may not be the best path a conservation organization should consider implementing.

Now that we have constructed the CPF to understand the relationship between economic (land value) and ecological costs, we can turn our attention to other socioeconomic factors that will further assist us in determining the feasibility of implementing wildlife corridors.

4.4 Corridor Adjustment

Many socioeconomic factors, in addition to land value, can be indicators of the feasibility of implementation of a corridor. Several of these factors are used in a qualitative analysis to develop implementation options. An implementation option is a variation of the LCP that represents one way the corridor could be moved to incorporate feasibility into its design. These implementation options are constrained by the bounds determined by the ecological sensitivity analysis.

Feasibility of implementation of the corridor can be separated into six main categories. Table 4.4.1 shows a list of those six feasibility criteria as well as three ecological criteria that must be taken into account in the feasibility analysis. Table 4.4.1 also describes the assumptions made for each criterion.

Criteria	Statement of Assumptions
Preserved Lands	A path going through parcels that are already preserved is easier to implement than one that does not
Number of Parcels	Decreasing the number of parcels the path goes through will decrease the scope of conflict and make the path easier to implement
Contiguous Ownership	Decreasing the number of owners that the path goes through will decrease the scope of conflict and make the path easier to implement
Zoning	A path going through parcels zoned for Open Space is a higher priority than Ag, and both are a higher priority than Urban
Land Use	A land use of Native Vegetation is better for implementation than other forms of agricultural land use because the possiblity of needing restroation is lower
CURB	Outside the CURB boundary is easier to implement than inside due to the existing restrictions on development
Ecological Considerations	
Riparian Habitat	Riparian habitat is batter habitat for a corridor than non-riparian habitat
Habitat Suitability	Increasing the habitat suitability must be considered for every implementation decision
Total Ecological Cost	Reducing total ecological cost must be considered for every implementation decision

Table 4.4.1 – Feasibility Criteria and Assumptions

Using these criteria, and their respective assumptions, multiple implementation options can be created. These options all fall within a reasonable distance to the ecological feasibility analysis paths and represent alternative ways a corridor could be implemented.

4.4.1 Adjustment Process

The goal of the adjustment process is to use the criteria (Table 4.4.1) to modify the 'best ecological path' of the corridor so that it becomes more likely that it can be implemented.

Using the set of paths identified by sensitivity analysis of the ecological corridors as a guide, the linkage areas to Destinations A and B were each further divided into two smaller areas for more detailed analysis (Figure 4.4.1). The sub-areas are A1 and A2 for Destination A, and B1 and B2 for Destination B: (1) indicates the western set of paths and (2) indicates the paths in the eastern half of the area. Typically these paths also originate from western and eastern sides of the source line respectively.

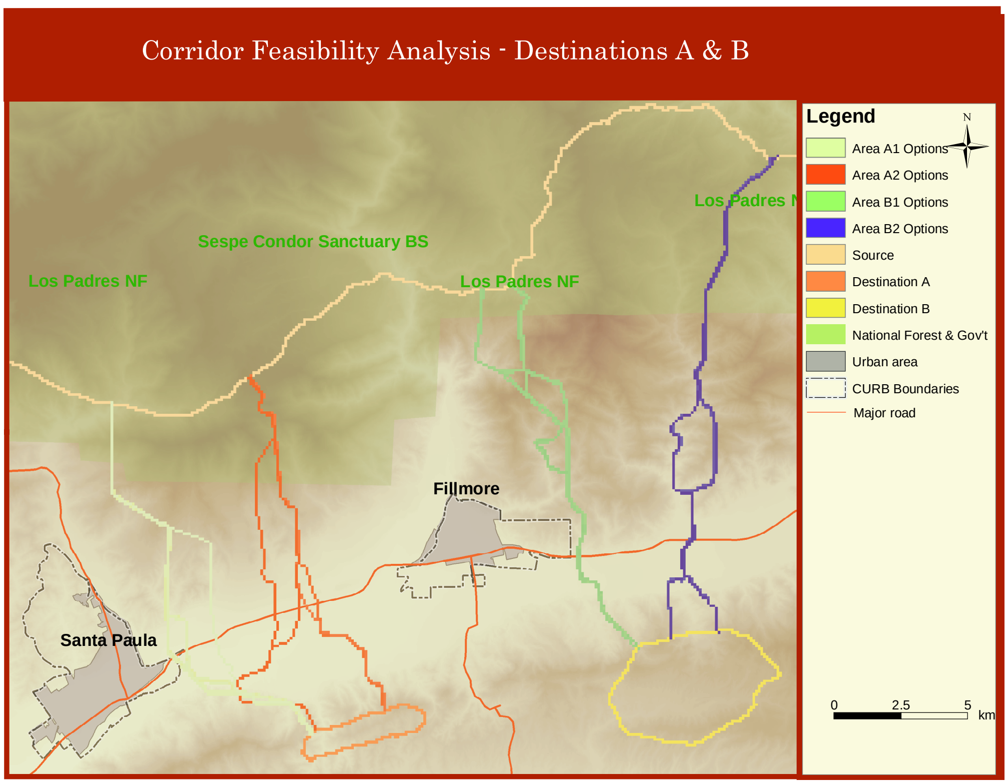


Figure 4.4.1 – Ecological Corridor Feasibility Analysis

The analysis for each sub-area includes prioritization of decision-making criteria, adjustment of the corridors at junction points and designating critical parcels. Each sub-area is characterized geographically into upper, middle and lower zones, each having different issues that were considered important to the feasibility of the designated corridor. Bottlenecks of sensitivity analysis paths and good ecological areas are designated 'critical parcels' and are considered when adjusting the corridor. Also, when no path adjustment is needed, it is implied that the path stays with sensitivity analysis paths.

Feasibility decisions are made continuously along the landscape, however there are points where direction is unclear. At those points junctions are created, resulting in various implementation options. These options will then be evaluated using the CPF and "groundtruthing" methods. This analysis is explained in Section 4.4.

4.4.2 Destination A

Destination A (Figure 4.4.2) is located approximately 4500 meters south of State Highway 126, halfway between Santa Paula and Fillmore. The major issues that affect the feasibility of implementing a corridor to this destination are the linkage-wide presence of high-density agriculture and many small parcels bordering the highway, as well as the socioeconomic pressures of operating between two growing cities such as high land values, the potential for future development and the greater occurrence of unsuitable habitat. However other factors actually facilitate the process of establishing a functional corridor including the presence of currently preserved land along the Santa Clara River, the low southern border of the Los Padres National Forest and the existence of larger parcels and stretches of contiguous owners.

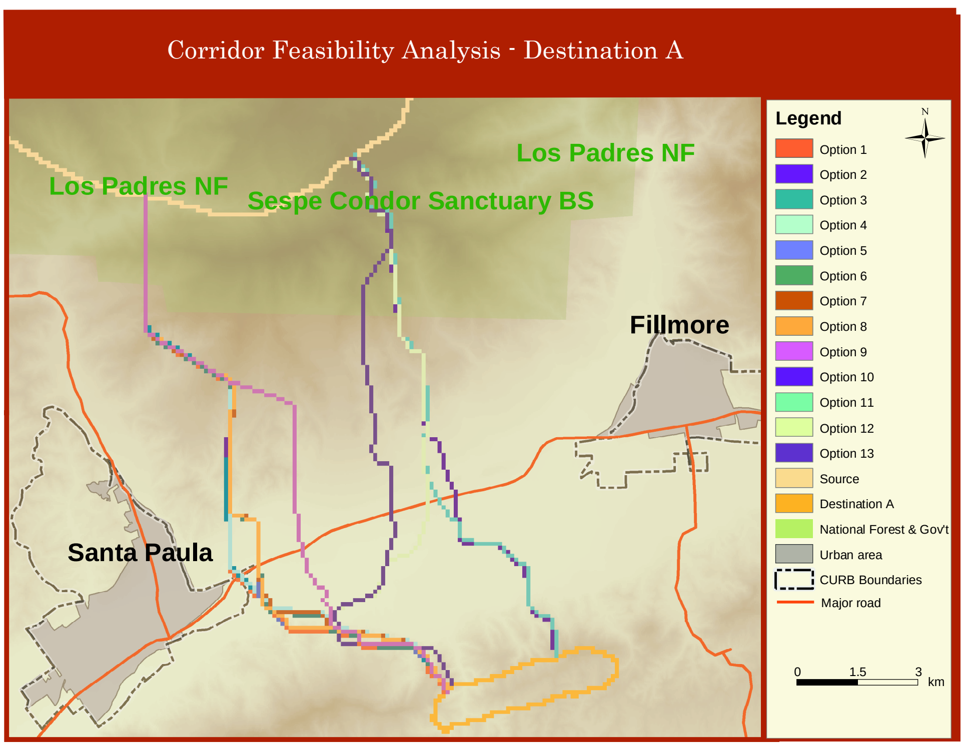


Figure 4.4.2– Map of Corridors to Destination A

<u>Area A1</u>

Parcels with contiguous owners and zoned open space are the dominant factors in the upper zone reaching from the source line to northern borders of Santa Paula and Fillmore. In the middle zone that stretched down to State Highway 126, it is important to minimize the number of parcels that the corridor passes through and to avoid the eastern edge of the Santa Paula CURB boundary. The most important decision-making factor in the lower portion of area A1 is utilization of the lands owned by The Nature Conservancy and Friends of the Santa Clara River, however minimization of owners and parcels is also a high priority.

Junctions

There are three junction points within area A1 that create nine different paths; one junction occurs in the middle zone, and the other two are in the lower zone (Figure 4.4.3).

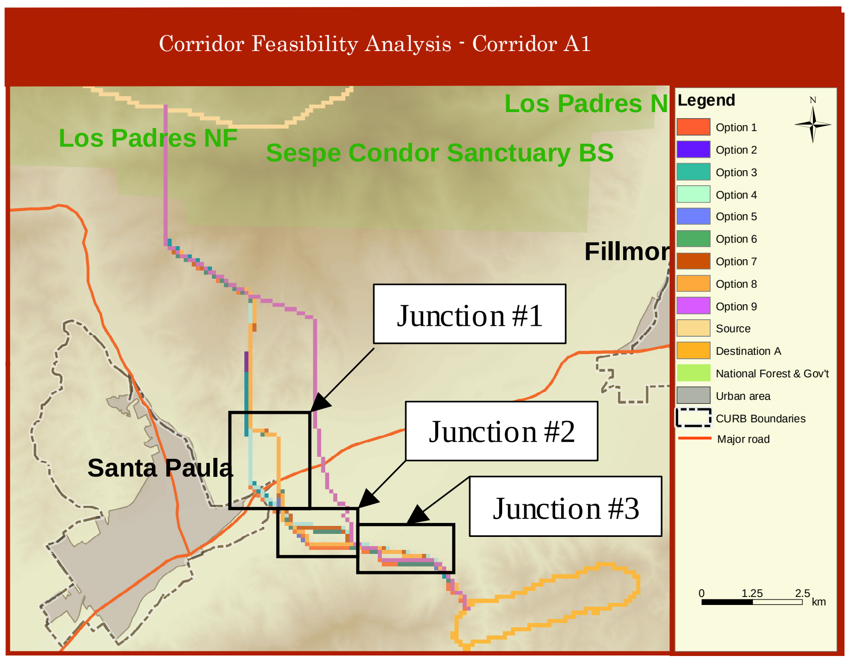


Figure 4.4.3 – Junctions #1,2,3 for Area A1

Junction #1 occurs in an area lying directly on the northeastern edge of the Santa Paula CURB boundary, where the sensitivity analysis paths go through many small parcels (Figure 4.4.4). In order to minimize the number of parcels the paths cross, it is split to access larger parcels on either side of the high-density parcel area. Both of the paths that go around this junction have access to culverts as they cross State Highway 126. After bypassing the junction area, all the paths are adjusted to converge on a currently preserved parcel owned by The Nature Conservancy.

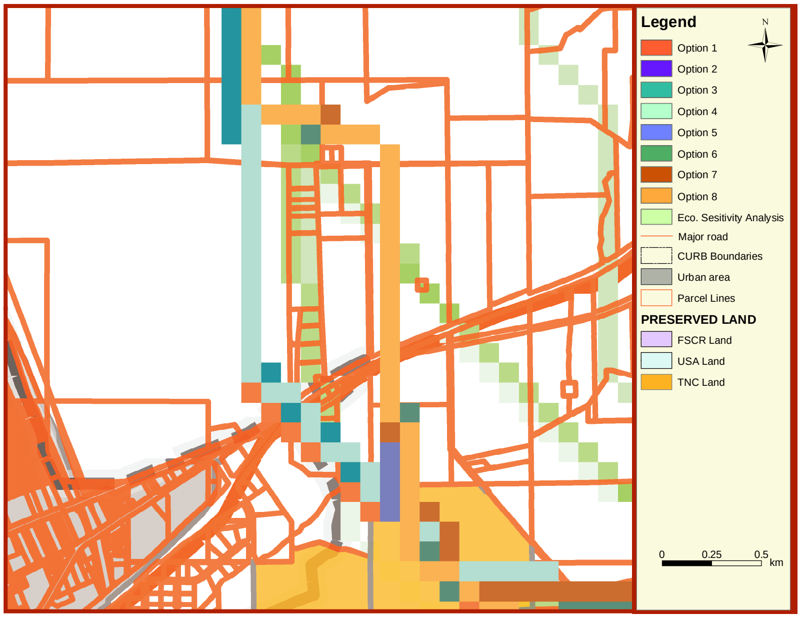


Figure 4.4.4 – Junction #1 for Area A1

Junction #2 occurs at the southeastern edge of the parcel owned by The Nature Conservancy. The decision made at this junction was based upon two paths designated by the sensitivity analysis (Figure 4.4.5), and not any socioeconomic criteria. This junction highlights the feasibility outcomes of various ecological least cost paths.

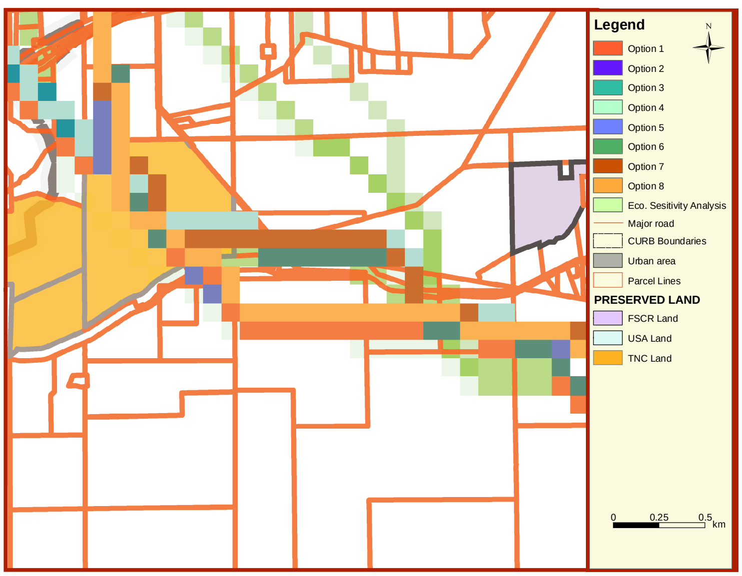


Figure 4.4.5 – Junction #2 for Area A1

Junction #3 is just to the east of junction #2, and is based upon a difference in the total ecological cost (Figure 4.4.6). The northernmost path has a lower ecological cost than the southern path. This decision illustrates the difference in feasibility according to different ecological characteristics.

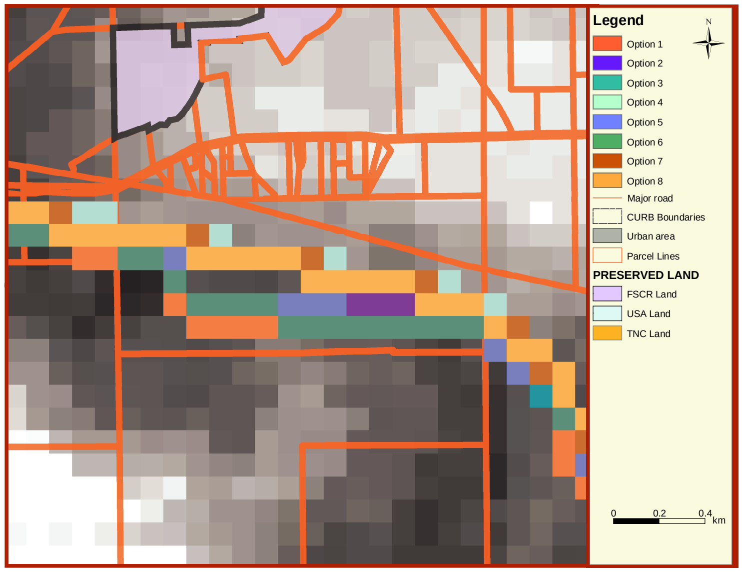


Figure 4.4.6 – Junction #3 for Area A1. Background is the Total Ecological Cost Surface

Each of these three junctions produced two different directional paths, effectively acting as "obstacles" that could be circumvented by going around it. The ninth path of area A1 was created as an addendum after examining the broad scope of the linkage area for destination A. Most of the sensitivity analysis paths that were used as a guide for the first eight adjusted paths skirted the Santa Paula CURB boundary. When viewing these paths within a long time horizon, they most likely will be ineffective when buildout has occurred up to the CURB boundary.

Area A2

Contiguous ownership, minimization of parcels, and zoning are the dominant factors used in the decision-making process in the upper zone. Similarly in the middle zone, particularly near State Highway 126, contiguous ownership and decreasing the number of parcels plays a large part in making the corridor more feasible. The priority in the lower zone of area A2 is utilizing The Nature Conservancy and Friends of the Santa Clara River properties, as well as attempting to adjust the corridor to move through large parcels in order to minimize the number of owners. Altering the path to move through open space zones, rather than agricultural zones is also an important factor in the lower zone.

Junctions

Within area A2 there are only two junction points, resulting in four different paths (Figure 4.4.7).

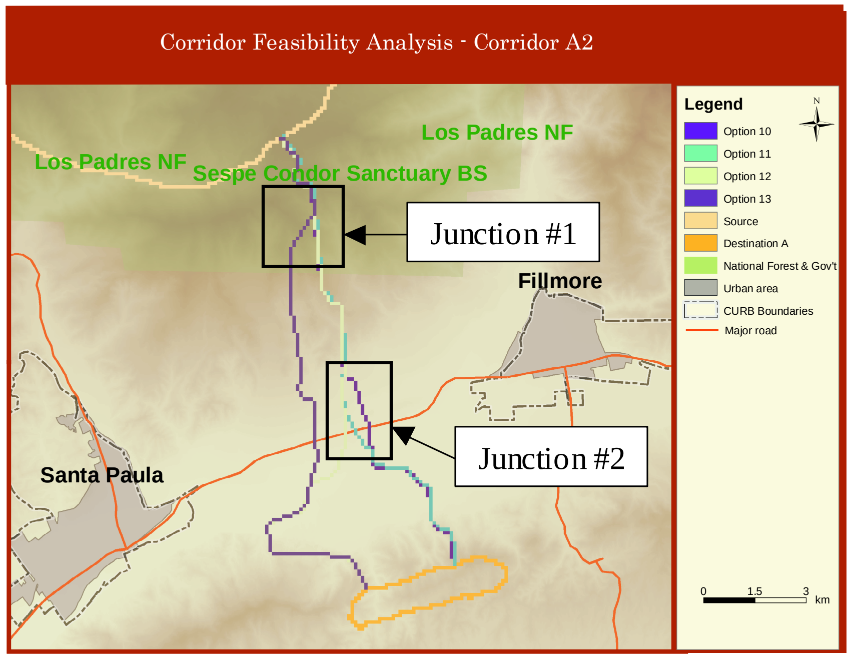


Figure 4.4.7 – Junction #1 and #2 for Area A

Junction #1 occurs in the upper portion of area A2, and is modified to stay within the paths designated by the sensitivity analysis, or to position the paths to take the shortest distance to utilize preserved land in the lower portion of area A2. The sensitivity analysis paths took a relatively straight route to get from the source to the destination, however it did not utilize any of the preserved lands that lay just south of State Highway 126 (Figure 4.4.10). The preserved properties are scattered to the west of the sensitivity paths for approximately 3800 meters. Therefore in order to utilize these parcels the paths were adjusted westward. As shown in Figure 4.4.8, Option 13 is moved to the West to take a more direct route toward the southern preserved land.

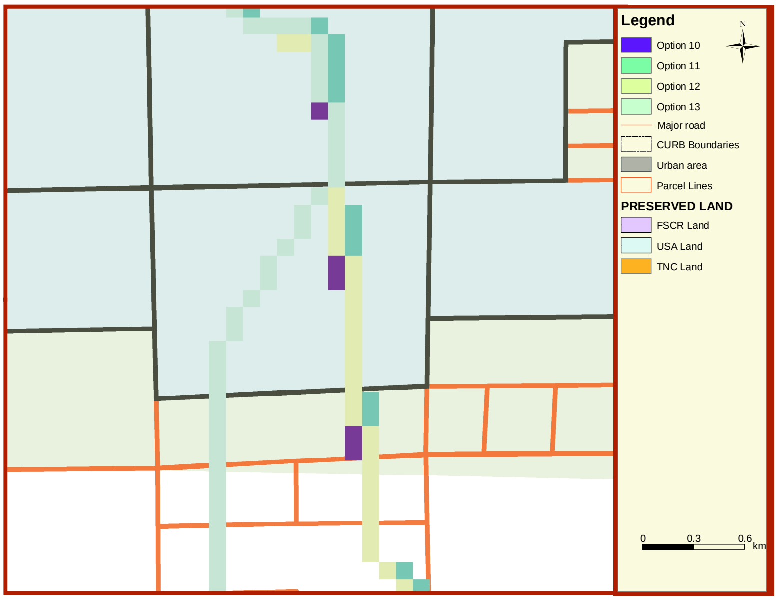


Figure 4.4.8 – Junction #1 for Area A2

Junction #2 represents a decision based on minimizing the number of landowners and attempting to follow the ecological sensitivity analysis (Figure 4.4.9). Option 11 is also at a close proximity to a culvert. The significance of this is described later. In addition to those aspects of Junction #2, seeking out the preserved land in the riverbed was also taken into account at this stage. Option 12 represents an attempt to utilize those parcels from Junction #2.

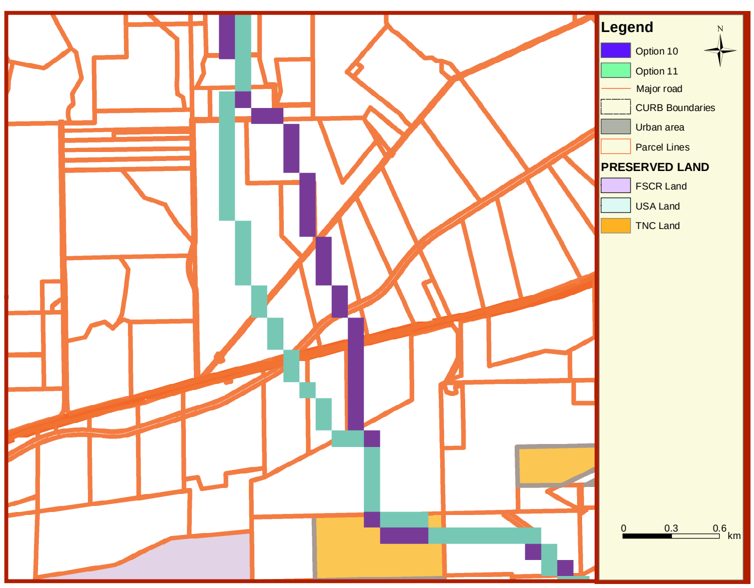


Figure 4.4.9 – Junction #2 for Area A2

Both Junction #1 and #2 indicate an attempt to take advantage of riverfront land owned by TNC and Friends of the Santa Clara River. However in the process of altering the paths they must now consider a large block of high ecological cost land located directly between those parcels and destination A (Figure 4.4.10). Therefore by including ecological factors in the feasibility process, the paths were modified to go around this ecologically unsuitable habitat. The two paths that go to the west must take a circuitous route around this unsuitable area, but are able to utilize three large preserved parcels.

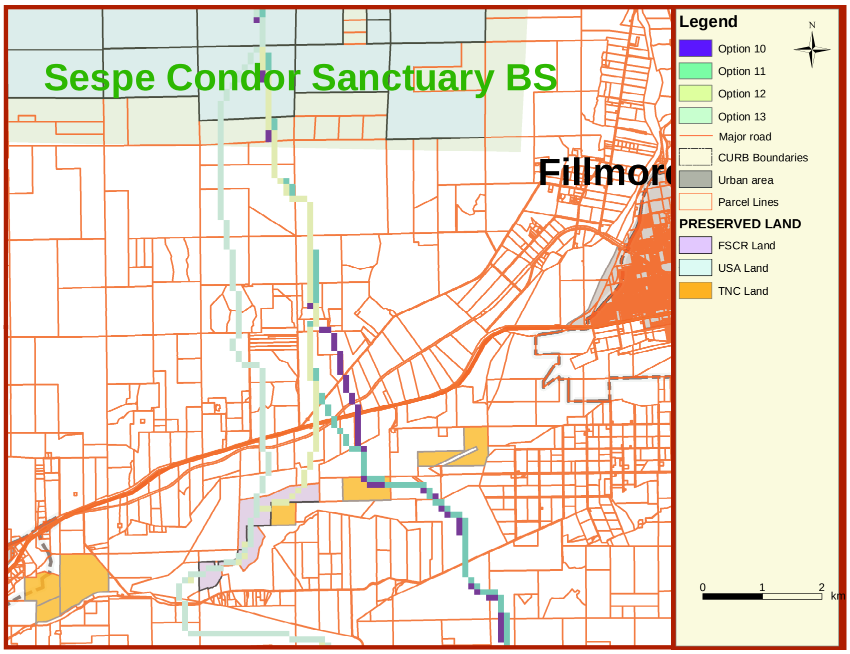


Figure 4.4.10 – Broad overview of Area B2. Notice the preserved parcels along the river.

4.4.3 Destination B

Destination B (Figure 4.4.11) is located approximately 3400 meters south of State Highway 126 between Fillmore and the Ventura/Los Angeles County line. The major issues that affect the feasibility of implementing a corridor to this destination are similar to those affecting Destination A.

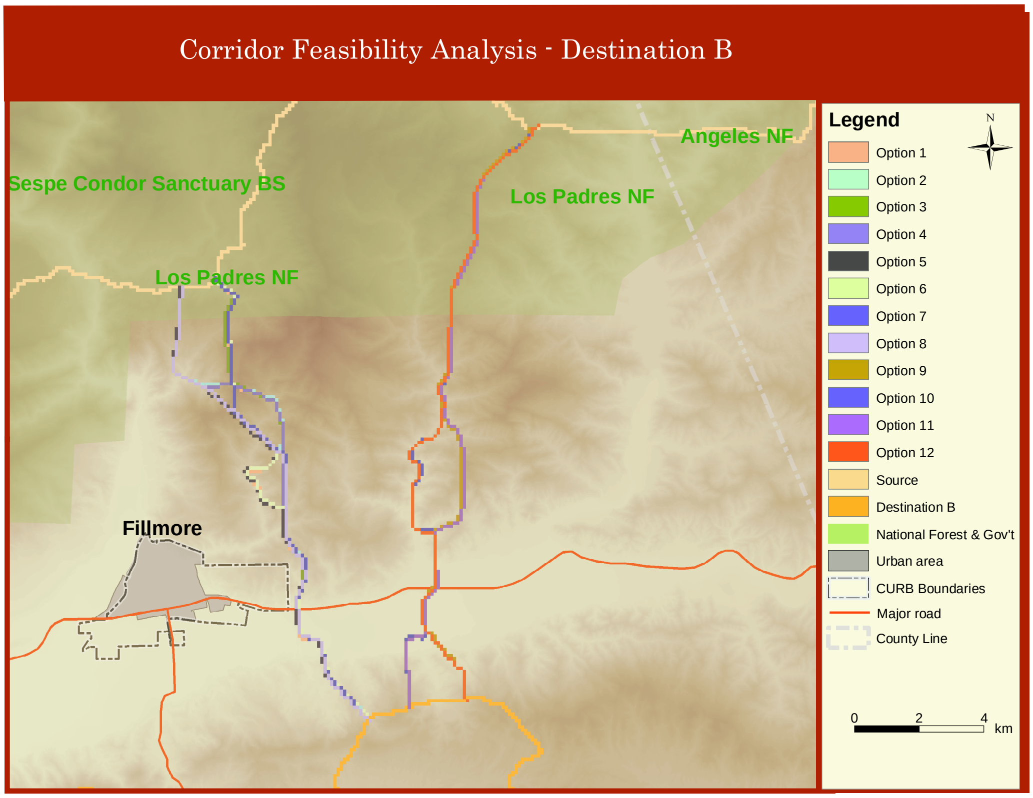


Figure 4.4.11 – Map of Corridors to Destination B

<u>Area B1</u>

Making use of federally owned parcels, parcels with contiguous owners and those zoned open space are the dominant factors in the upper zone to northern borders of Fillmore. In the middle zone that stretched down from the foothills of the Los Padres National Forest to State Highway 126, zoning and riparian areas played a more prominent role, as well as avoiding the eastern edge of the Fillmore CURB boundary. The most important decision-making factor in the lower portion of area B1 is minimization of owners and parcels and the length of the corridor.

Junctions

There are three junction points within area B1 that create eight different paths; all occur in the upper and middle zones (Figure 4.4.12).

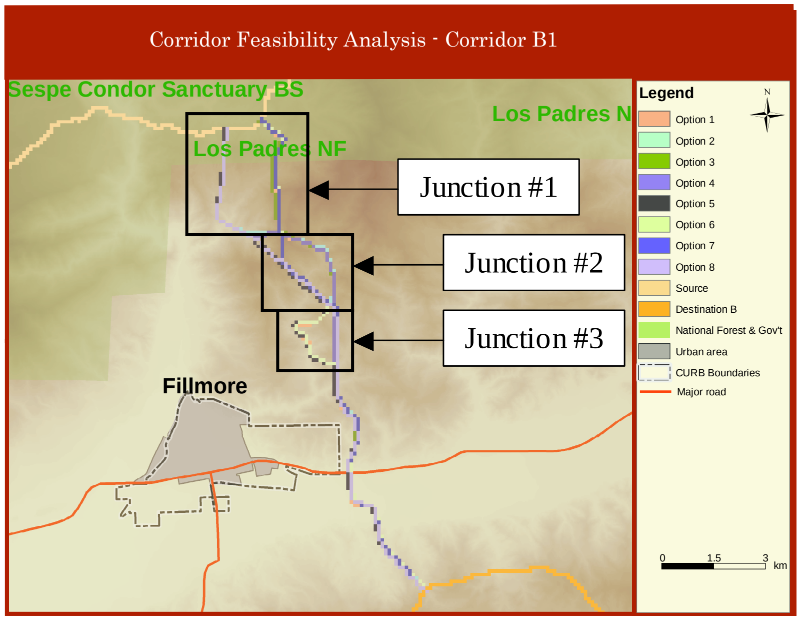


Figure 4.4.12 – Junctions #1,2,3 for Area B1

Junction #1 occurs in the source area within the Los Padres National Forest. The sensitivity analysis takes two different paths here and we felt it was important to include both in the adjustment process (Figure 4.4.13)

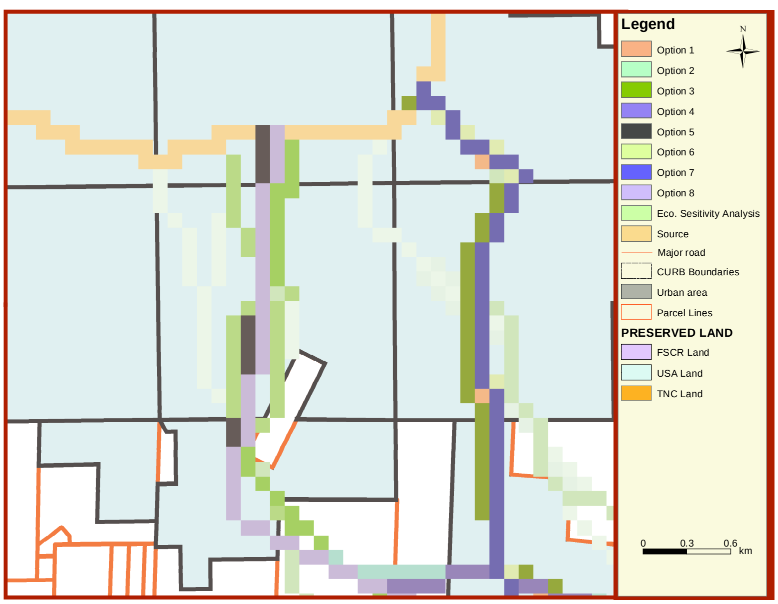


Figure 4.4.13 – Junction #1 for area B1

Junction #2 occurs 3400 meters south of the source line. In order to utilize lands currently under federal jurisdiction, the path is split to the east. At the same time the path is also split to access larger parcels on the right side of path and avoid numerous smaller parcels on the left. At this same junction, all of the paths are moved to converge on a currently preserved parcel owned by the federal government (Figure 4.4.14).

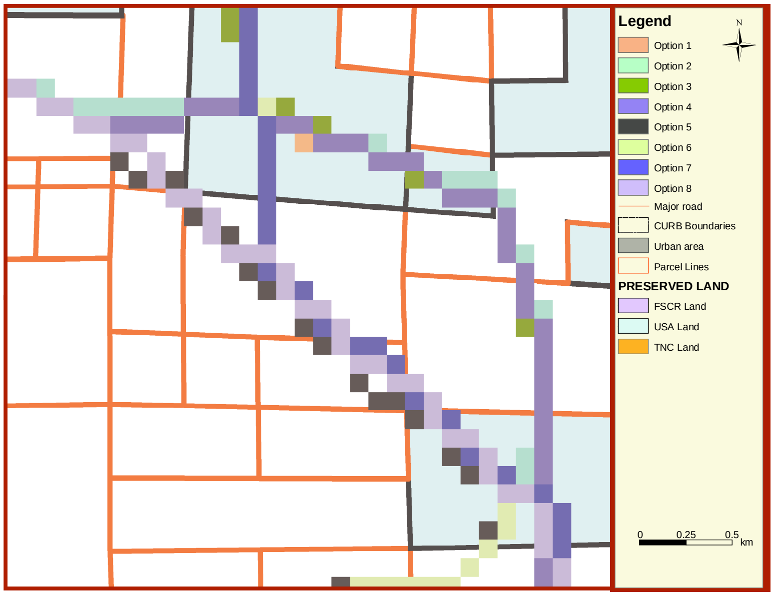


Figure 4.4.14 - Junction #2 for area B1

Junction #3 occurs approximately 3800 meters to the southeast of junction #2. This junction was created to take advantage of riparian area to the west of the line, whereas the eastern portion of the line takes advantage of small number of large parcels that are zoned open space (Figure 4.4.15).

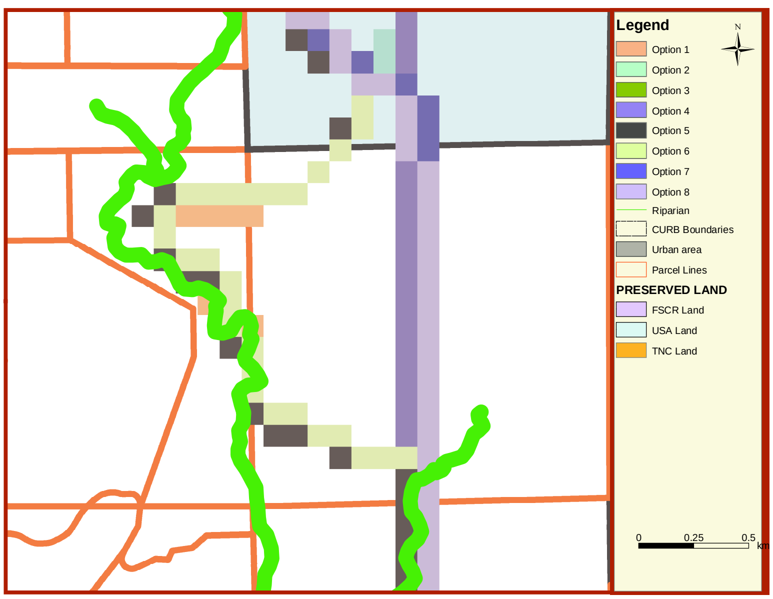


Figure 4.4.15 – Junction #3 for area B1

Area B2

The corridors in area B2 were created in a similar manner as those in B1. In order to create the corridors in the upper part of the path we utilized federally owned land, and tried to minimize the number of parcels and landowners the corridor moved through. In the middle section of the area, the west path followed the riparian habitat and the east followed the most commonly occurring LCP line. We also minimized the number of parcel and owners. In the lower part of the line, we moved the path to the left in order to minimize parcels as well as landowners and contiguous landowners. On the right hand side of the line we followed the LCP line while at the same time minimizing number of parcels and landowners.

Junctions

There are only two junction points within area B2 that create four different paths, both occurring in the middle to lower part of the corridor (Figure 4.4.16).

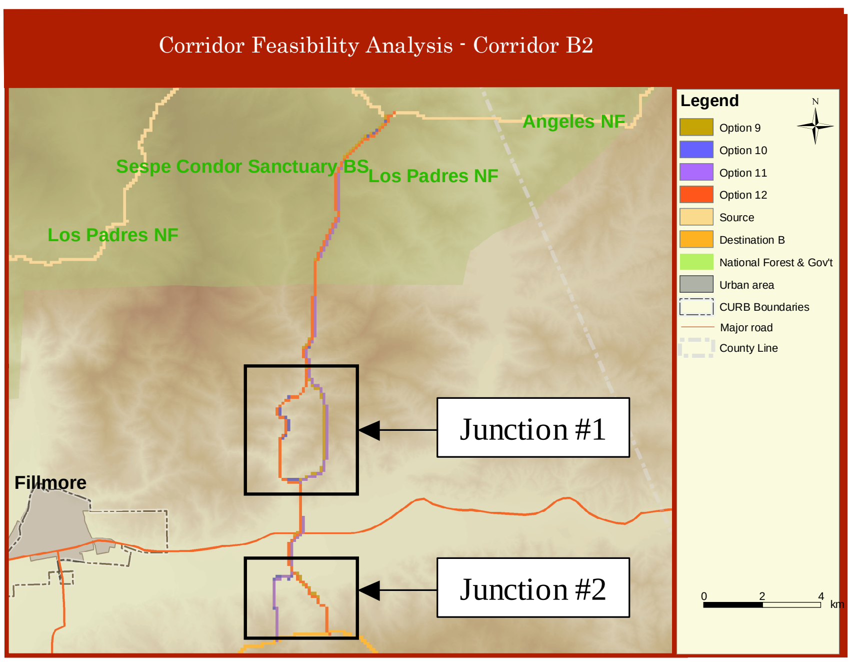


Figure 4.4.16 – Junctions #1 and #2 for Area B2

Junction #1 occurs where there is a separation in the sensitivity analysis paths. In addition, there is a riparian area to the west that is utilized by the deviating path. The corridor, which veers to the east, utilizes preserved land near the destination area (Figure 4.4.17).

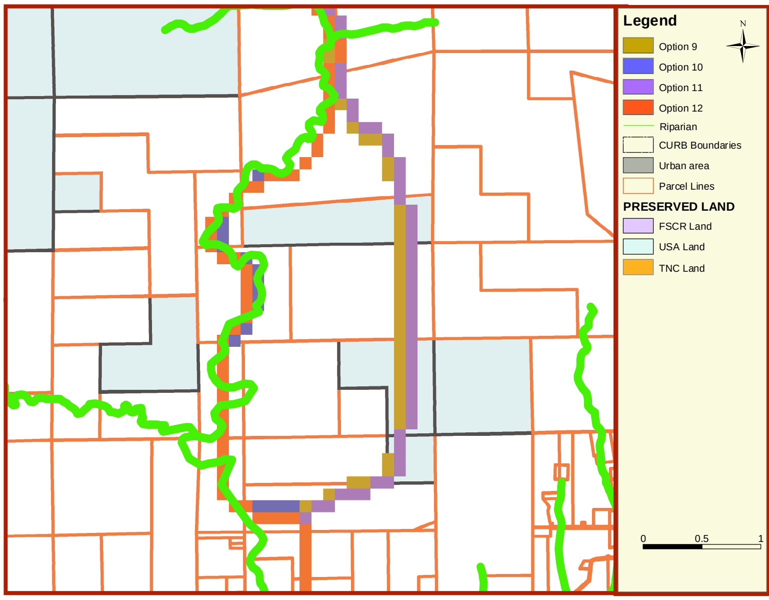


Figure 4.4.17 – Junction #1 for area B2

Junction #2 occurs in the lower section of the corridor near the Santa Clara River. This junction aims to minimize the number of parcels and landowners in this area, as well as utilize riparian areas along the Santa Clara River. The corridor, which veers to the west, utilizes the riparian area along the Santa Clara River and minimizes the number of landowners (Figure 4.4.18).

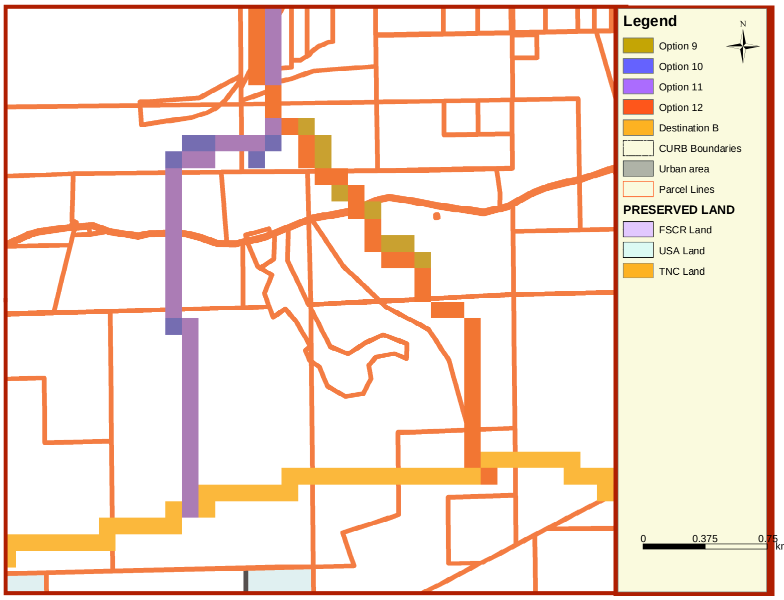


Figure 4.4.18 – Junction #2 for area B2

Critical Parcels

There are two cases in which there is an obvious need to preserve particular parcels throughout the corridor adjustment process. These two cases are when bottlenecks occur and when there is land that has a very high ecological value. Bottlenecks are areas where the sensitivity analysis lines converge in one place. Typically, this occurs because there is a narrow strip of low cost ecological habitat as defined by the total ecological cost surface, surrounded by higher cost ecological habitat. In this case we feel bottlenecks are important areas to conserve because they represent an area that is critical to the corridor since the low cost habitat is too large to shift the corridor around without losing connectivity of the corridor.

Second, the least cost paths generated by the sensitivity analysis are indicators of areas that are the most ecologically desirable paths. There are certain parcels or areas, which are of much higher ecological value than others. Thus, we feel that these areas are worth identifying and deserve preferential consideration in adjusting and implementing the corridor. There are some areas of the corridor, such as the junctions, where the corridor can be moved based on implementation feasibility. The areas of particularly high ecological value are not among them.

4.4.4 Technical Process of Corridor (Path) Creation

The goal of the implementation corridor design process is to construct paths on the map that are similar to the LCP paths created in the ecological analysis. In order to accomplish this a three-step process is used. These goals are achieved through a GIS based process, which incorporates shapefile editing, raster conversion, and LCP analysis. This process is outlined below.

1. Shapefile editing – To begin the process a new shapefile is created in which a polyline is drawn in ArcMap to represent the new path created using the implementation criteria explained above. The polyline is hand-drawn to provide the author with the flexibility to make decisions along the linkage. This shapefile represents one line, or implementation option along the corridor area (Figure 4.4.19).

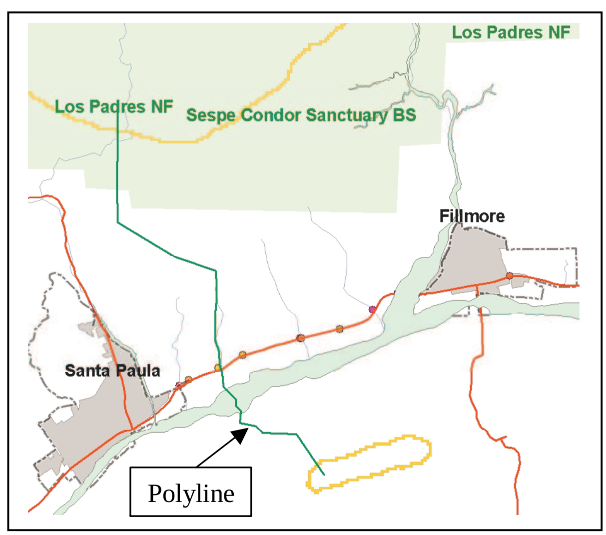


Figure 4.4.19

2. Raster conversion – The polyline shapefile is then converted into a raster using the spatial analyst function in ArcMap. This conversion turns the feature polyline into a series of 100m x 100m cells, similar to the LCP lines created in the ecological analysis. However, as shown in Figure 4.4.20, this line does not represent the shortest path from the source to the destination. The cells identified in Figure 4.4.20 are unnecessary and will increase both the ecological cost and the land value of this path above what a LCP path would possess. Therefore, one more step is needed to finish the process of implementation corridor design.

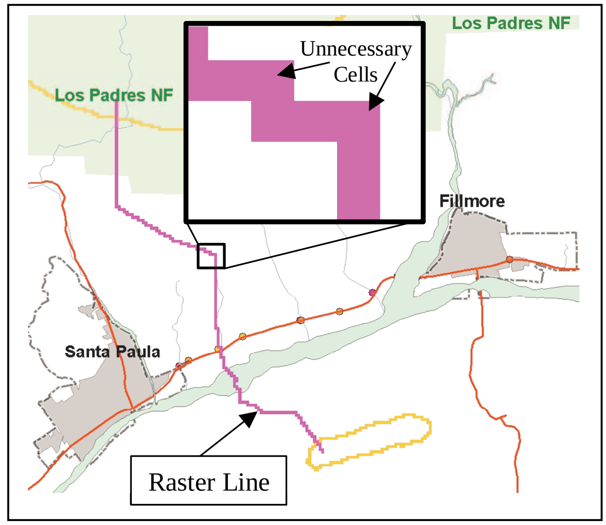


Figure 4.4.20

3. LCP analysis – The least-cost-path function is run on the created raster path to produce a LCP implementation path that is precisely similar to the LCP paths created in the ecological analysis. Figure 4.4.21 shows this new LCP implementation path. Notice that the unnecessary cells created in step two of this process are no longer present.

Once the implementation paths are created, they can then be analyzed using the process previously described.

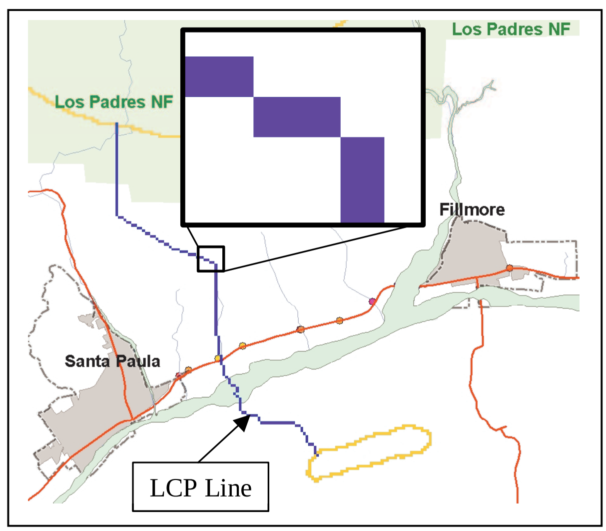


Figure 4.4.21

4.5 Corridor Implementation Strategies

4.5.1 Introduction

To incorporate implementation considerations into the design of the wildlife corridors it is first necessary to characterize the strategies or tools that a can be use to implement the corridors within the given study area. It is clear that there is not one strategy that will serves as a panacea for conserving the entire corridor. Instead utilization of an appropriate combination of conservation tools is needed to counter the specific threats to biodiversity at specific sites. Knowledge of the conditions upon which a strategy is optimally applied is essential to prioritizing strategies and provides a framework within which conservation can be more successful and efficient.

The strategies we chose to focus on within our study area are a representative sample of the recent movement toward providing economic incentives to encourage stakeholders to engage in conservation activities. In addition to these types of incentive-based strategies, strategies based on zoning and mitigation opportunities are examined as well. Brief descriptions of all strategies are explained below and a more thorough analysis of each strategy can be found in Appendix D, including background information and relevance to Ventura County.

4.5.2 Implementation Toolbox

Mitigation Strategies

General Background

Mitigation strategies are used to compensate for activities, which are negatively impacting the habitat of native flora and fauna such as development of houses or roads. Mitigation strategies include: conservation and mitigation banking, land exchanges, purchase of development rights, transferable development credits, impact fees and tradable conservation credits. These strategies will be discussed in greater detail below. Many of these strategies are contingent on the habitat corridor being designated as an overlay zone by the county.

Development Permit

Landowners involved in a development permit program are required to dedicate environmentally sensitive lands as a condition of receiving entitlements. The most common example of the development permit is a requirement of The California Planning, Zoning and Development Laws, known as the Quimby Act, (Government Code § 66477) which permits local agencies to require dedication of parklands as a condition of development approval. Dedication requirements are mandatory because development entitlements are conditioned on satisfying mitigation needs.

Development or Mitigation Fees

The California Planning, Zoning and Development Laws, known as the Quimby Act, Government (Government Code § 66477) allows a city to collect mitigation fees from developers in specified impact or benefit areas in exchange for the rights to develop a property. Mitigation fee programs require a developer to pay a fee for every acre or unit developed. Revenue is used for conservation purposes such as to purchase new land to protect open space and habitat areas. Typically, the habitat or open space is obtained by an acquisition agency that also manages the land and conservation easements for the city.

Wildlife Crossings

The Transportation Equity Act for the 21st Century (TEA-21), among other things, creates new opportunities to improve water quality, restore wetlands and natural habitat, and rejuvenate urban areas through transportation redevelopment, increased transit and sustainable alternatives to urban sprawl.

Programs under TEA-21

- Environmental Streamlining
- Transportation-Environment Cooperative Research Program
- Metropolitan and State-Wide Planning
- Critter Crossings:
- Wetlands Mitigation Banking

Land Exchange

Land exchanges occur when a large public or private agency, that owns land with habitat or open space value for purposes other than resource protection, specifically designates such land for resource protection through legal commitment, or donates that land to a land trust. Alternatively, land owned by a large public or private landowner, which is not suitable or needed for open space conservation, is made available for exchange for private lands needed for conservation. Private landowners can receive tax benefits by donating conservation land to a public or nonprofit entity.

General Plan and Zoning

General Plan and Zoning Ordinance

The General Plan is a jurisdiction's vision for future growth, directing the type, intensity and location of development. The Zoning Ordinance is the tool used to implement the General Plan guidelines. It consists of zone designations that restrict usage in each zone based upon the desired usage. Zoning is one of the most widely used land use controls in the United States, and its regulatory tools can be used to supplement other conservation techniques.

Overlay Zone

An overlay zone is a special mapped zoning district that places additional restrictions on, or removes restrictions from the normal underlying zone. Typically overlay zones are used when there is a unique public interest that is not accounted for in the traditional land use of the area. While the traditional zone may designate the allowable land use, the overlay zone adds limitations such as setbacks, required permits, or other design attributes to this land use. This type of zoning technique can strengthen preservation efforts by allowing the current use of the land to continue, but in a way that facilitates the conservation goals.

Cluster Development

Cluster development is a zoning tool, also known as open space zoning, that restricts the development of houses, or other structures to a specific portion of the land, leaving the remainder of the parcel as open space. Cluster development does not restrict the type of land use, but rather the density of land use. Commonly cluster development is used to preserve farmland by allowing an agricultural parcel to be subdivided, but development is confined to one section and farming continues on the undeveloped land.

Farm Bill

The Farm Security and Rural Investment Act of 2002 (Farm Bill) is legislation which responds to and provides funding for a broad range of emerging natural resource challenges faced by farmers and ranchers, including soil erosion, wetlands, wildlife habitat, and farmland protection. The 2002 Farm Bill places a strong emphasis on the conservation of working lands, ensuring that land remains both healthy and productive. Implemented through the U.S. Department of Agriculture (USDA) the Farm Bills provides landowners with various programs each with its own objectives and incentives. These programs include:

- Conservation Corridor Program.
- The Farmland Protection Program (FPP)
- The Wetlands Reserve Program (WRP)
- Wildlife Habitat Incentives Program (WHIP)

Transferable Development Rights (TDR programs)

A transferable development rights program allows landowners to transfer the right to develop their land to a different property. This kind of program allows for the protection of ecologically sensitive land by diverting its development to a more suitable area, usually around an urban area. TDR programs have many facets that can be manipulated to achieve an end result of successful transfer of development and conservation of ecologically sensitive habitat.

Preferential Taxation

Preferential taxation is any program that favorably affects a landowner's tax profile by reducing their tax burden either through differential assessment, tax deductions and credits or suspension of a tax. These programs have been successfully used to make conservation programs more attractive to landowners and other decision-makers by providing economic incentives.

- **Differential Assessment**: A revised assessment of land value based on a current or restricted land use that allows the landowner to pay taxes on this lower valuation.
- **Tax Deductions**: A set reduction in pre-tax income based upon meeting specific requirements such as donation of land for conservation purposes.
- **Tax Credits**: A predetermined monetary unit that can be subtracted from a landowner's tax payment.
- **Suspension of (Inheritance) Tax**: Typically used for farmland preservation, the deferment of a specific tax, particularly inheritance tax that facilitates the preservation of a current land use by allowing a landowner to pass the specified land on given that it will remain in its current use.

Restoration

Restoration is defined by the National Resource Council as the "return of an ecosystem to a close approximation of its condition prior to disturbance". Restoration encompasses a wide variety of activities aimed at returning disturbed habitat to a more native state. Restoration projects typically include removing exotic invasive plant species and replacing them with native vegetation as well as reintroducing native fauna such as steelhead trout. Restoration projects are funded and implemented by a broad range of organizations such as non-governmental organizations, government agencies or collaboration between government and NGOs.

4.5.3 Relationship between strategies and land disposition

In order too implement any conservation goal a connection must be made between the nature of the land disposition of the study area and the conservation strategies that are relevant to the land disposition. Relevant strategies must be teased out and taken into consideration to achieve the conservation goal. Ventura County, as with most counties within the south coast ecoregion, has unique land characteristics that allow a variety of strategies to be more or less relevant in specific areas. The separation of zoning, land value, land use and the threat of development are necessary to assess the relevance of strategies in these specific areas.

Table 4.5.1 shows each strategy examined using the land disposition characteristics of zoning, land value, land use and the possibility of development. This strategy characterization matrix indicates the optimal land disposition for each strategy and is based on various assumptions about the relevance of each strategy in certain context. Table 4.5.1 does not represent all of the areas a strategy can be applied, rather the optimal area where the strategy can most benefit corridor preservation in the Santa Clara River region. Some strategies can be optimally applied to various characteristics of zoning, land value, land use or the possibility of development. In those cases, multiple indications of their optimal relevance exist within that category. For example, agricultural and conservation easement programs are equally optimal on land zoned Ag or Open Space. The assumptions made when performing this analysis are described in Appendix E.

		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	

Table 4.5.1 – Strategy Characterization Matrix

4.5.4 Using the strategies to implement the corridor

The strategy characterization matrix (Table 4.5.1) is a potent tool that relates conservation strategies to land characteristics upon which they could be optimally used. The next step in this process is to characterize the land in terms of the land disposition categories used in the strategy characterization matrix. A description of the land in terms of zoning, land value, land use and possibility of development is not a difficult task. Information regarding these categories is generally publicly available and can be formatted in a variety of ways. Due to the scale of implementation in this linkage, an assessment of these characteristics at the parcel level proves to be optimal for our evaluation.

By obtaining the zoning, land value, land use and ability to be developed for each parcel in the area, a cross-reference of this data with the strategy characterization matrix will generate optimally relevant strategies for each parcel. Of course these are not the only strategies that can be applied to a parcel, however they represent the optimal strategies for that particular parcel. If, for example, a parcel is zoned Ag, has a high land value, has a land use of native vegetation and is outside of the CURB boundaries, then its optimal relevant strategies are an Overlay Zone, TDR program, tax relief for an easement and a Wildlife Habitat Contract. Integrating these tools is an efficient way to organize and execute the implementation of the corridor (Figure 4.5.1).

Organize and Execute Implementation of Corridor

Strategy Characterization Matrix

		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	

Land Characterization

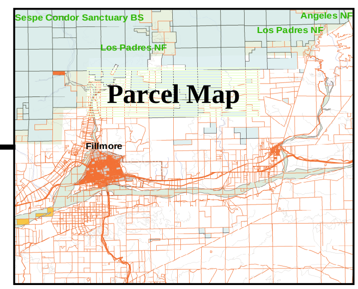


Figure 4.5.1 – Integration of the Land Disposition and Implementation Strategies

4.6 Final Recommendations

4.6.1 Introduction

The adjusted paths produced in the previous section are modified ecological paths based on the socioeconomic factors of the region. These modifications incorporate the human social element into corridors that are created using only biological parameters. This relationship between ecology and feasibility was initially introduced in the CPF, which explains this juxtaposition for each path as a function of economic cost and land value. In Section 4.3 this relationship is used to merely indicate how an ecologically- derived path can incorporate 'ease of implementation'. The theory behind this relationship is that the ecological path has economic components that make it more or less successful in the real world. However the CPF also establishes a broader trend that emphasizes the tradeoffs that must be made between the best ecological and most likely implemented corridors. Often one is unable to clearly see these tradeoffs and their connection, therefore making it difficult to prioritize the options. The CPF provides a framework from which one can view these tradeoffs and make knowledgeable decisions.

The CPF is used to view the tradeoffs for the 25 corridors options that were created in Section 4.4. These paths were created with ecological data and subjectively modified with land characterization criteria. Now we want to increase the efficacy of the potential corridors by exposing the options to the CPF that will highlight the range of differences between ecology and feasibility characteristics. To supplement the learning from the CPF, we also "groundtruthed" the corridor options using our knowledge of the area and 1-meter aerial photographs of the linkage area. This process helps us prioritize certain paths based upon ecological and economic costs. The caveat of this process is that paths that run through preserved land are 'undervalued' because they were assigned a land value of zero based upon the likelihood that there will not be additional costs by incorporating them into our selected corridors. This may incorrectly indicate that the paths running through preserved land have suitable habitat, and therefore would be easier to implement. This is further reason to conduct additional evaluation based upon real data. These tradeoffs must be weighed in terms of how they affect the goal of corridor.

4.6.2 Corridor Recommendations

<u>Destination A</u>

Figure 4.6.1 shows the CPF to Destination A, including the 13 implementation options previously described in detail (black dots). Figure 4.6.2 is an enlarged view of the Destination A options, showing the implementation options at a more practical scale. Each of the 13 options for Destination A are labeled on Figure 4.6.2. All

options to Destination A either fall into the category of A1 or A2 areas of evaluation. Area A1 includes options 1-9, while area A2 includes options 10-13.

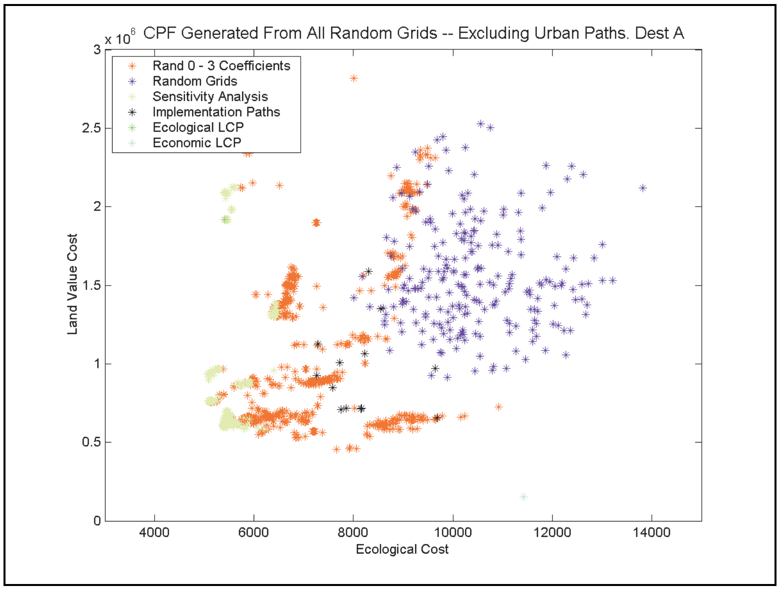


Figure 4.6.1 – CPF for Destination A Paths

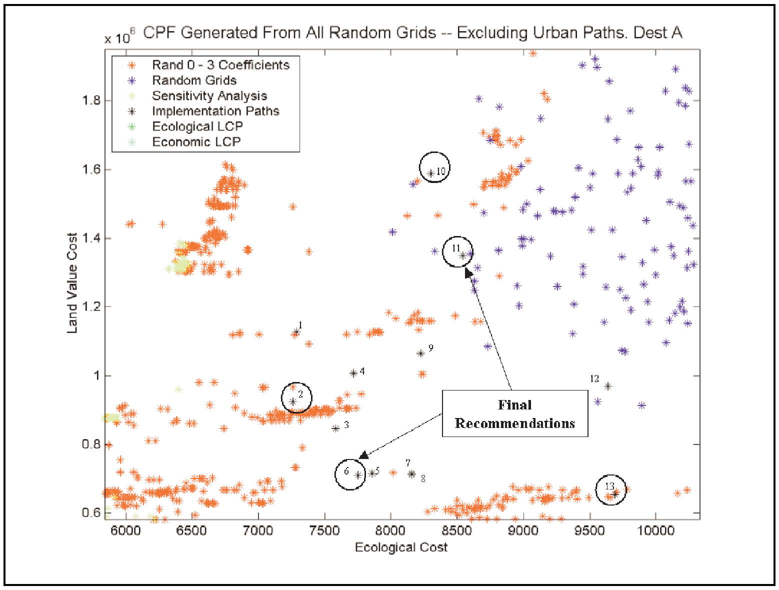


Figure 4.6.2 – CPF for Paths to Destination A (Enlarged View)

Area A1 (options 1-9) has a distinct clustering in the lower left part of the CPF. This indicates that this area provides an excellent balance of good ecological areas and areas of reasonable economic cost. Using the CPF to compare these paths to one another, options 2 and 6 (circled in Figure 4.6.2) represent the optimal tradeoff between ecological and economic cost within area A1. Option 2 represents the best ecological option that minimizes economic cost, while option 6 represents the best economic option that minimizes ecological cost. This provides a good opportunity to consult the aerial photographs and other GIS data to verify if this is actually the case in the real world.

The first issue that may affect the usefulness of the modified paths is their proximity to the eastern edge of the Santa Paula CURB boundary. While not currently a problem, the state of that area at buildout may present unfavorable conditions, such as increased noise and light, that would negatively affect the movement of wildlife through the area. In addition, urban encroachment is currently an issue for options bordering the CURB boundaries. Therefore, options 1, 2, 3 and 4 are removed from consideration. The remaining five paths, options 5 – 9, are located at least 150 meters from the edge of the CURB, excluding a sliver that extends along Highway 126 for approximately 450 meters to accommodate a small commercial area. While 150 meters is not large enough to counteract urban effects, this distance places the path on a preserved parcel that stretches over 800 meters from the CURB, thereby potentially placing greater distance between the individual and the urban effects. There is a culvert, albeit a small one, in the general vicinity of where these paths cross State Highway 126. In addition orange groves occupy both sides of the culvert openings providing some cover for crossing species.
Options 5, 6, 7 and 8 utilize land owned and preserved by The Nature Conservancy. Use of this land is important because it ensures permanent protection, ecological suitable habitat and no feasibility issues. Given the priority placed on this currently preserved land, option 9 was removed because it does not access any of these properties.

At this point options 5, 6, 7 and 8 traverse comparable habitat as seen from the aerial photographs, so we refer back to the CPF to provide added insight. The CPF shows that all of these options have roughly the same economic cost. Similarly the ecological costs do not vary much. However option 6 does represent the best economic path, and has the lowest ecological cost of options 5 – 8. Therefore, our final recommendation for area A1 is option 6.

The paths within area A2 (options 10-13) are more dynamic in terms of the cost tradeoffs. Options 10 and 13 represent the two extremes of ecological and economic cost. Of the four A2 alternatives, option 10 represents the best ecological option, and option 13 represents the best economic option. This tradeoff provides an interesting opportunity to explore the impacts of prioritizing budget constraints against higher habitat suitability. When choosing option 10 one gets the best ecological path within area A2, but at the highest economic cost of all paths leading to Destination A. Option 13 is the path with the lowest economic cost, yet it is also contains the highest ecological cost of all Destination A paths. This result makes sense logically, as high quality land will usually command higher market prices, and vice versa.

Given the ambiguous result of attempting to optimize ecological or economic characteristics, the next step is to examine a path such as options 11 and 12 that produce more moderate CPF results. The economic cost of option 12 is 40% lower than that of option 11, but it has a higher ecological cost. This means that option 12 may be easier to implement, but at the expense of traveling through less suitable ecological habitat. Given the potential to undervalue a particular path, the use of land value merely as a proxy for ease of implementation and the nonnegotiable biological requirements of wildlife that more accurately determine the 'suitability' of a corridor we decided to place higher priority on ecological characteristics over that of land value. Therefore we placed our emphasis on options 10 and 11, which have higher economic costs, but lower ecological costs. Options 12 and 13 were removed from consideration for their failure to provide optimal ecological conditions. Traveling through approximately 2300 meters of preserved lands lowered the economic costs of these two paths; yet the longer, more circuitous routes require species to navigate more complex paths of lesser quality habitat.

After referring to the GIS data and aerial photography, there are no obvious disadvantages to options 10 or 11. However option 11 does have a few beneficial features that make it a slightly better path than option 10. Option 11 is closer to an existing culvert that will allow for easier access to the south side of Highway 126. There is riparian habitat leading into and out of the culvert that provides vegetation cover for species movement. In addition, option 11 has 18% less economic cost than option 10 indicating that it may be slightly easier to implement the corridor using this path. Although there is an ecological tradeoff, almost 3%, between option 10 and 11, the benefits of a culvert and riparian cover in that region outweigh this small increase in ecological cost.

Our final recommendation for area A2 is option 11, maintaining our prioritization of ecology over economics. It is important to note here that option 11 represents a compromise in the ecological/economic trade-off, and could potentially be a final recommendation if a compromise is considered the optimal approach.

<u>Destination B</u>

Figure 4.6.3 is the CPF graph of paths to Destination B, including the 12 implementation options previously described in detail (black dots). Figure 4.6.4 decreases the range of both the ecological cost and economic cost, showing the implementation options at a more informative scale. As described above, all options to Destination B either fell into the category of B1 or B2 areas of evaluation. Area B1 includes options 1-8, while area B2 includes options 9-12.

The linkage area leading to Destination B is different from that of Destination A for various reasons. Unlike area A, two growing urban areas do not enclose area B. It is ecologically better because it generally consists of more suitable habitat, which allows for shorter, less roundabout paths from source to destination areas, and from feasibility perspective contains more preserved lands and larger parcels. This is verified by the CPF data in which all Destination B ecological and economic costs are lower than those for Destination A.

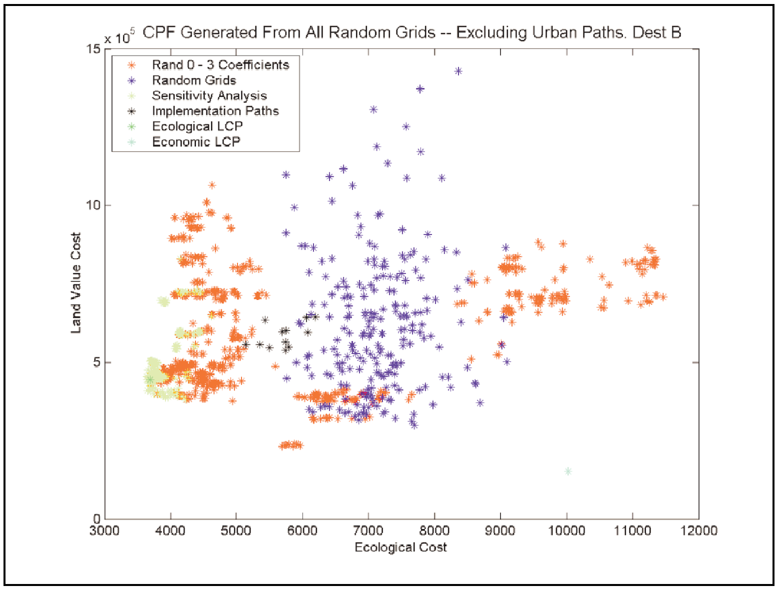


Figure 4.6.3 – CPF for Paths to Destination B

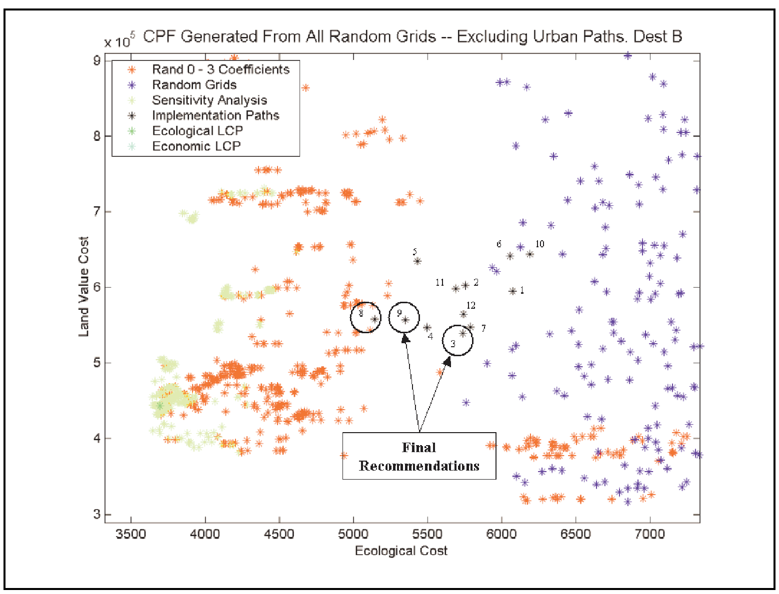


Figure 4.6.4 – CPF for Paths to Destination B (Enlarged View)

As mentioned above, the B1 area presents less ecological and implementation challenges than the area A. For these reasons there were less decisions that needed to be made within this area. For area B1 (options 1-8) the two extreme options, circled in Figure 4.6.4, are options 3 and 8. Option 8 represents the best ecological option, while option 3 represents the most feasible option. The only difference between these two paths occurs in the upper zone, which consists mainly of federally owned land. Option 3 utilizes more preserved land, which explains its low economic cost. In this case, we prioritized the use of the preserved status of Los Padres National Forest and Bureau of Land Management land. This tradeoff is made because we feel that the difference in ecological cost that exists between these two paths most likely occurs in federally owned land, and it will be easier to conduct restoration activities on this land versus trying to preserve private land.

Our final recommendation for area B1 is option 3, allowing for the tradeoff between more feasible paths over better ecological areas because there is a viable management option of restoration.

Area B2 (options 9-12) shows a unique distribution of options. Option 9, circled in Figure 4.6.4, is clearly both the best ecological option and the best economic option. In this case there is no trade-off between ecological cost and economic cost. Consultation of the GIS data and aerial photographs verifies these conclusions. Therefore, the obvious final recommendation for area B2 is option 9. All other options have a higher ecological and economic cost.

4.6.3 Prioritize Recommendations

There are four final corridor recommendations for the study area. The recommendations for Destination A are options 6 and 11, and for Destination B are options 3 and 9. While all of these options represent the best corridors based upon ecological and feasibility constraints, we prioritize the options in order to assist The Nature Conservancy in creating a more effective linkage implementation plan. We ranked the four final recommendation options using the same feasibility criteria that were used to adjust the ecological corridors, in addition to other regional knowledge that is not represented within the planning documents, the GIS layers or the land value data.

Figure 4.6.5 shows the recommended options to Destination A, options 3 and 9. Each option has positive and negative points that allow for a more useful analysis of the paths to Destination A. Option 3 has better ecological landscape than option 9, yet travels very close to the Santa Paula CURB boundary. The use of a riparian area may increase its ecological suitability, however in order to realistically access the lower portion of this area, the individual must come very close to and cross into the Santa Paula CURB boundary. Also in anticipation that a minimum width will be applied to the corridor to accommodate the large roaming distance of WRCs, it will be necessary to access this urban area. The urban edge effects, such as increased light and noise, that will exist when Santa Paula is built out to the edge of the CURB will negatively affect the individual, and may cause it to avoid the area all together. Largely due to the close proximity of option 3 to the CURB boundary, option 11 is better corridor.

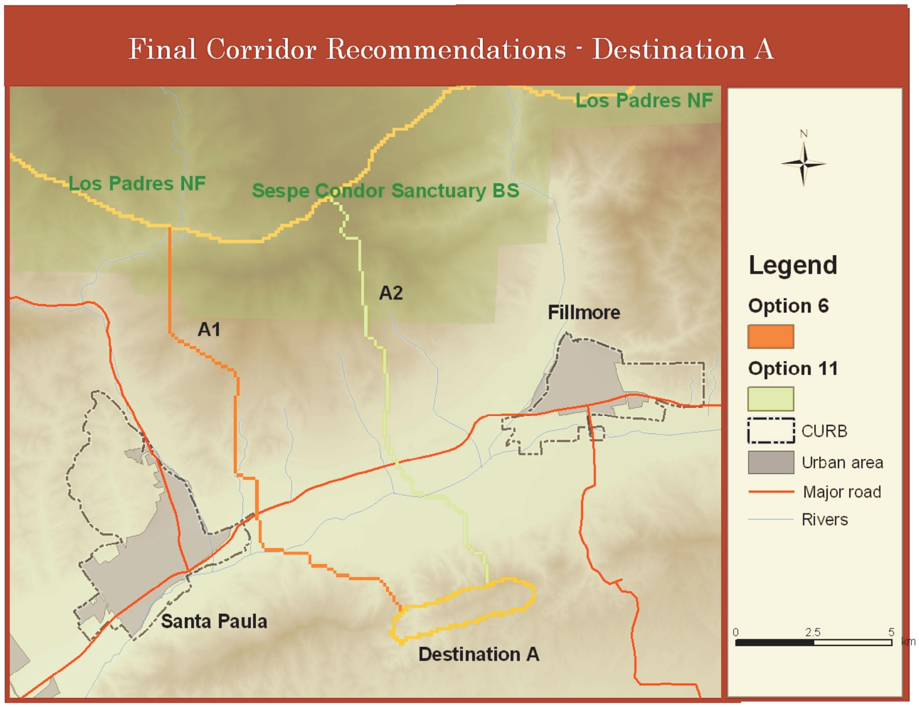


Figure 4.6.5 – Final Corridor Recommendation for Destination A

The recommended options to Destination B, options 3 and 9 (see Figure 4.6.6), face the same issue that exists within linkage area A. Option 3 passes very close to the Fillmore CURB boundary and will exhibit the same negative effects that are mentioned above. For these same reasons, option 9 is a better option.

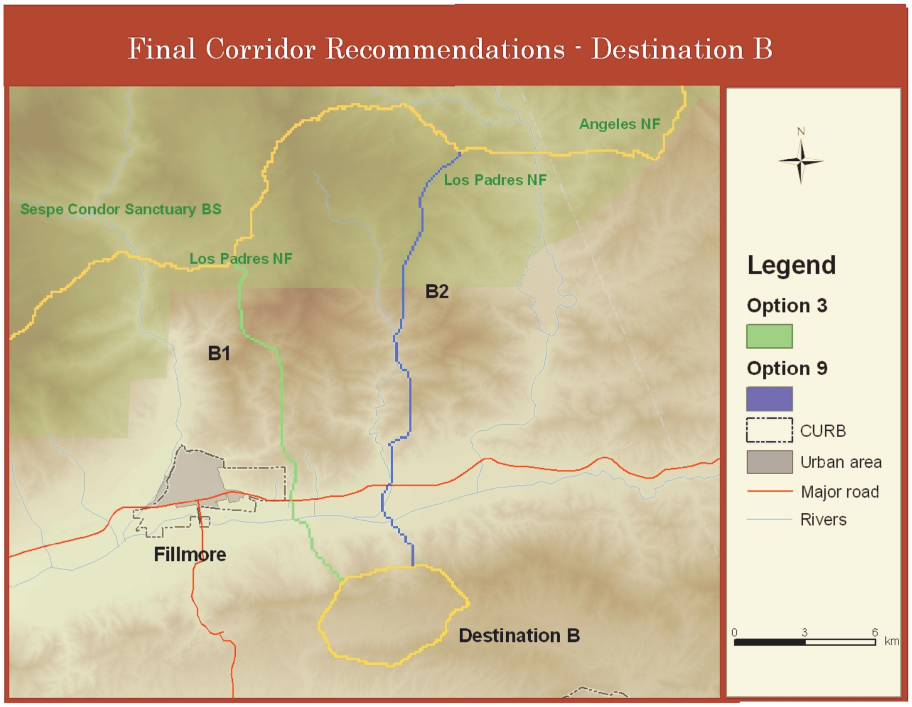


Figure 4.6.6 – Final Corridor Recommendation for Destination B

4.6.4 Comparison of Final Corridor Recommendations to Ecological LCP's

The final recommendations enhance and make the best ecological corridors more feasible using regional socioeconomic factors and policy tools to guide the adjustments. Overall these recommendations will be more successful because they integrate the human landscape into the WRC species landscape. At this point, we want to examine the final recommended options against the best ecological paths created in the ecological modeling phase of the project.

Figure 4.6.7 shows the final four recommendations with the ecological least cost paths. It is interesting that the two least cost paths are almost identical to options 6 and 3, the lowest priority, and yet least feasible options. This illustrates the common tradeoff made in conservation between ecological suitability and social reality. This situation highlights the main reason why various conservation programs fail to achieve their goals - they consider only ecological factors in their decision-making process. Had feasibility not been incorporated into the analysis of these corridors, and the ecological least cost paths were chosen it is likely that these areas would not maintain connectivity in the linkage area because WRC species would not use them.

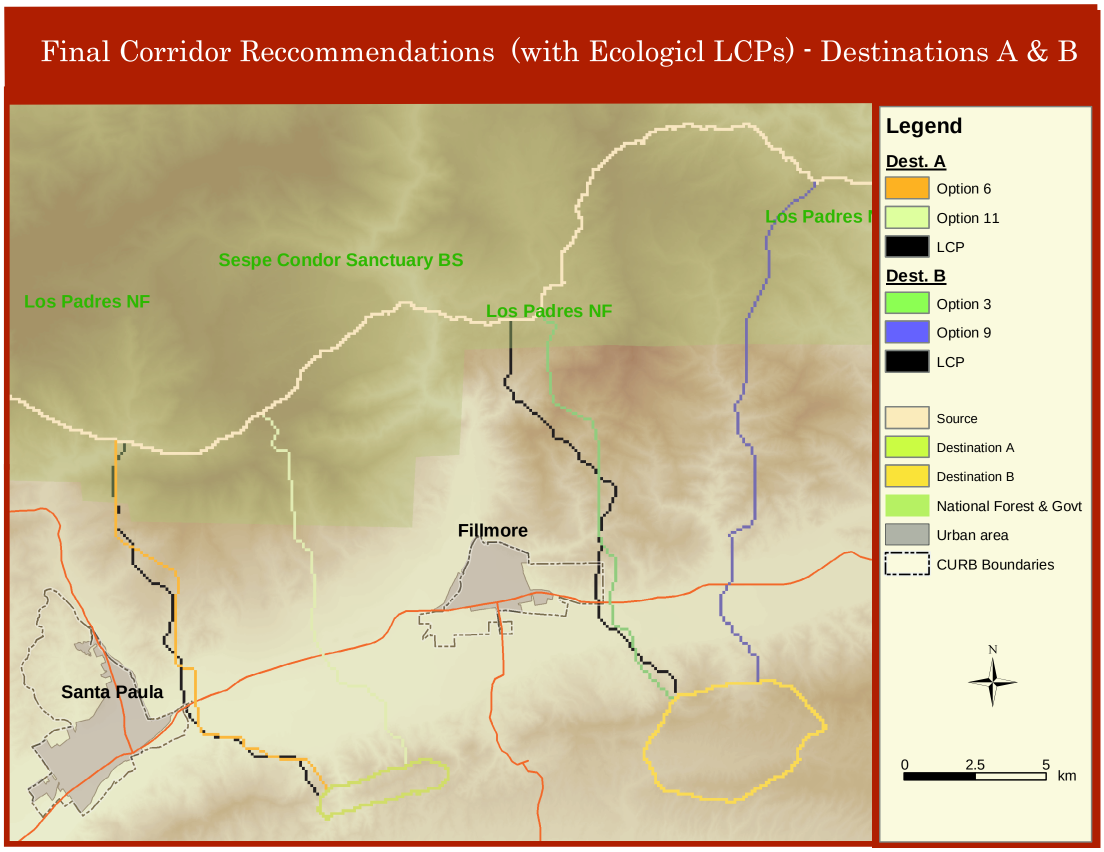


Figure 4.6.7 – Final Corridor Recommendation for Destinations A and B

4.7 Critique and Evaluation of Feasibility Analysis

***Stakeholder Involvement*:** The feasibility analysis does not incorporate stakeholder participation in the corridor design and implementation process. According to Sanderson (2002) a stakeholder in a conservation area is any person or organization that uses, administers or has an interest in some part of the conservation area or program. Stakeholder involvement is an important part of any conservation initiative because it leads to the design of policies that are better able to achieve the conservation goals, and are more successful in the long run (Lawrence and Daniels 1996). Utilization of local knowledge and resources allows for the acquisition of relevant information and concerns, efficient use of resources, and public buy-in for the sustainability of the project (Borrini-Feyerabend 1997). Due to lack of time and resources, as well as sensitivity to potential negative issues associated with wildlife corridors we did contact many local stakeholders. However we were able to meet with various officials from Ventura County government agencies, such as the Resource Management Agency, the Planning Department, the GIS Department and the Assessor's Office. Most of these meetings were for general information gathering, and data collection, however we were able to get a feel for some of the important social, economic and political issues that would affect our project.

Other projects should consider incorporating public feedback (see list below) into the process at various levels, preferably beginning at the project outset. This will allow for consideration of local needs and concerns, and help to ensure more effective achievement of conservation goals.

Potential Stakeholders to Involve:

- Landowners
- Developers
- Agricultural Organizations
- Environmental Advocates
- Local Citizens and Neighbors
- Government Agencies (Federal, State, Local)
- County Commissioners
- Planners

***Land Value*:** Various assumptions (see Section 4.4 and Table 4.4.1) were made within the feasibility analysis section. These assumptions established the relationship between the socioeconomic land disposition and the feasibility of implementing a wildlife corridor on that land. The assumptions for the feasibility criteria (see Table 4.4.1) were made to help evaluate the benefits of various states of each criterion. However the key assumption that we made was that there is a direct relationship between land value and the ease of protecting that land, which allowed the group to use land value as a proxy for feasibility of corridor implementation. This means that high value land would be more difficult to conserve or protect. This assumption was made by asserting that land acquisition is the most expensive conservation technique, and therefore can be used as the most conservation estimate of feasibility of conservation. This is an assumption that we cannot prove because in reality many factors contribute to the costs of conservation programs, which differ between geographic regions, political environments and land dispositions. Therefore further research into the validity of the land value-feasibility relationship should be conducted.

***Feasibility Criteria*:** The analysis used a set of socioeconomic criteria (preserved lands, number of parcels, contiguous ownership, zoning, land use, CURB) to measure the feasibility of implementing a corridor in our study area. These criteria were selected to assess the degree of human use and management of the land that ultimately affects the ability to implement a wildlife corridor. These criteria were specific to our study area; a region that experiences high-density agriculture, suburban sprawl and a short-term restriction on development in open space areas. While the criteria we used are basic aspects of social land planning, other projects should utilize data that are pertinent to the specific area being studied. These could include the presence of existing utility and sewer infrastructure or easements, the quality of agricultural lands (to predict conversion rates), areas of resource extraction, political boundaries and unique land uses and values, such as recreation, viewsheds, and cultural/historic areas, not represented in planning documents.

Preserved Lands**:** The presence of currently preserved land is an important criterion in the feasibility analysis. The assumption underlying this designation is that a path going through already preserved land is easier to implement than one that travels through unpreserved land. Within our analysis preserved lands include land owned by the federal government, the state of California, The Nature Conservancy and The Friends of the Santa Clara River. The aforementioned assumption is based upon two sub-assumptions: 1) that the preserved land is in good ecological condition, and 2) that the use or management of this land does not conflict with, and is willing to incorporate the presence a wildlife corridor.

The land owned by The Nature Conservancy and The Friends of the Santa Clara River both contain good quality habitat, or are in various stages of restoration. After examining aerial photographs most of the other preserved properties appear to have moderate to good habitat. However given no conflicting uses, we also assume that federal and state governments would be willing to work with The Nature Conservancy to conduct a restoration program if necessary. Similar to the quality of habitat, the management of TNC and FSCR property is conducive to including a wildlife corridor. While we were unable to determine the specific uses for all of the federal and state owned lands, we assume that they would not be detrimental to the wildlife corridor. In addition we re-examined many of these preserved areas against the ecological cost surface to determine the ecological cost.

Development Potential: Threat of development can be an extremely important factor, which can help us prioritize and implement landscape linkage and linkage efforts. As mentioned in section 4.2 we intended to use data from a development projection model for California created by John D. Landis and Michael Reilly (Landis and Reilly unpublished 2003) in our analysis. However, the data from this model indicated that little development would occur in our study area of Ventura County over the next century (Landis personal communication). In contrast, results of models from the Ventura County Planning Department, which predict housing and populations for Santa Paula and Fillmore through 2020 (See Appendix A-Figure A.10) predict a steady increase in development potential. Due to the conflicting results we decided not to use development potential model in our feasibility analysis.

Given the time and resources an adequate development potential layer could be constructed from GIS layers including: water, sewer, utility, and proximity to roads, and population and dwelling forecasts. These layers can be obtained by the County's GIS Department. We recommend that future projects strive to incorporate a development potential layer in the feasibility analysis if possible.

***Implementation Strategies*:** This project has a robust method for evaluating the applicability and implementability of conservation strategies in our study area. However, our process was constrained because stakeholder involvement was outside the scope of our project. We believe that this process would be greatly aided by involving stakeholders. Valuable information about existing social and political climates in the study area can be gleaned from community and stakeholder involvement. This information can aid in determining the evaluating which conservation strategies would be successful within the study area.

Evaluation and Monitoring: Creation of monitoring and evaluation schemes to assess the success of the designated corridors was outside the scope of our project. However, it is well documented that monitoring and evaluation is critical to improving the effectiveness and efficiency of conservation programs (Klieman et al., Margoluis and Salafsky 1998, Meffe et al. 1998). This is particularly true for programs such as this that involve living and changing systems, and take over a decade implement and reach their conservation goals. Thus, we strongly urge the organizations responsible for implementing these corridors to create a monitoring and evaluation program to assist them.

In particular, continuous monitoring and periodic evolutions followed by program alteration can result in adaptive conservation management programs that continually improve prospects for success. According to Klieman et al. (2000), in order to be comprehensive, evolutions should address not only whether the primary biological goals were met, but also:

- How well science is employed
- How efficiently resources are used
- The degree to which public support is garnered for the program
- How well the program is organized and functions to address the conservation challenge
- The degree to which the program is characterized by innovative problem solving and individual and organizational learning
- To what extent economic, biological and social considerations were distinguished when goals and objective were established.

5 CONCLUSIONS

Our approach to creating wildlife corridors is innovative in several ways. First, connectivity is addressed across multiple-scales and multiple-species. Second, implementation is considered in the design process in addition to biological considerations. Conventional methods often consider only biological factors in the design of wildlife corridors and leave implementation up to practitioners.

The result of this approach, which includes a robust ecological modeling and feasibility analysis, are two corridors recommended for implementation in the project area. In addition, a toolbox of conservation strategies, relevant to land disposition of the study area, was recommended to aid practitioners in corridor implementation.

This project is relevant beyond our project area in Southern Ventura County. It provides a framework that can be used for creating and implementing wildlife corridors within the South Coast Ecoregion as well California's six other ecoregions.

The framework provides a foundation that can be built upon and adapted to other study areas within the State. Hopefully, monitoring and evaluation of corridors will allow for learning, change and improvement of the existing process. In addition, understanding of connectivity issues and the socioeconomic and political forces that are at the root of them will improve over time and can be incorporated to strengthen the process.

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APPENDICES

Appendix A – Background Information

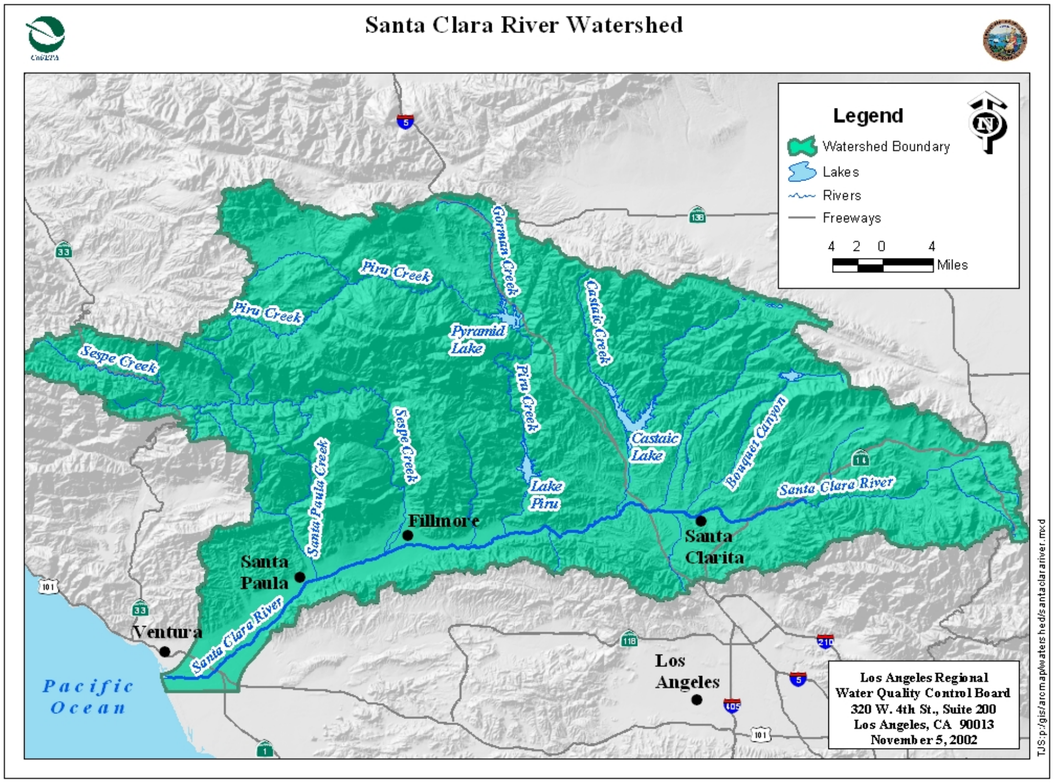

Figure A.1 – Map of the Santa Clara River Watershed

Mammalia	Yuma Mountain Lion	Puma (=Felis) concolor browni	Species of Special Concern	None
Mammalia	American Badger	Taxidea taxus	None	None
Mammalia	Mohave Ground Squirrel	Spermophilus mohavensis	Threatened	None
Mammalia	San Bernardino Kangaroo Rat	Dipodomys merriami parvus	Species of Special Concern	Endangered, 1998
Mammalia	Los Angeles Pocket Mouse	Perognathus longimembris brevinasus	Species of Special Concern	None
Mammalia	Bobcat	Lynx rufus	None	None
Mammalia	Black Bear	Ursus americanus	None	Threatened
Mammalia	Bighorn sheep	Ovis canadensis	Threatened, 1971; Endangered, 1999	Endangered, 2000
Mammalia	Gray fox	Urocyon cinereoargenteus	None	None
Mammalia	Coyote	Canis latrans	None	None
Aves	California Least Tern	Sterna antillarum browni	Endangered, 1971; Fully Protected	Endangered, 1970
Aves	Snowy Plover	Charadrius alexandrinus nivosus	Species of Special Concern	Threatened, 1993
Aves	Southwestern Willow Flycatcher	Empidonax traillii extimus	Endangered, 1991	Endangered, 1995
Aves	Coastal California gnatcatcher	Polioptila californica californica	Species of Special Concern	Threatened, 1993
Aves	Least Bell's Vireo	Vireo bellii pusillus	Endangered, 1980	Endangered, 1986
Aves	Le Conte's Thrasher	Toxostoma lecontei	Species of Special Concern	None
Aves	Golden Eagle	Aquila chrysaetos	Species of Special Concern; Fully Protected	None
Pisces	Santa Ana Sucker	Catostomus santaanae	Species of Special Concern	Threatened May 2000
Pisces	Steelhead - Southern California	Oncorhynchus mykiss irideus	Species of Special Concern	Endangered, 1997
Pisces	Three spined stickle back	Gasterosteus aculeatus	Endangered, June 1971. Fully Protected.	Endangered, October 1970
Reptilia	Desert Tortoise	Gopherus agassizii	Threatened, 1989	Threatened, 1990
Reptilia	Southwestern Pond Turtle	Clemmys marmorata pallida	Species of Special Concern	None
Amphibia	Arroyo southwestern toad	Bufo microscaphus californicus	Species of Special Concern	Endangered, 1995
Amphibia	Western spadefoot toad	Scaphiopus hammondii	Species of Special Concern	None
Insecta	Quino Checkerspot butterfly	Euphydryas editha quino	None	Endangered

Figure A.2 – Key Species Identified for the South Coast Ecoregion in the "Missing Linkages" Initiative

Class/Group	***Common name***	***Scientific name***	***Cal.State Status***	***Fed. Status***
Mammalia	Yuma Mountain Lion	Puma (=Felis) concolor browni	Species of Special Concern	
Mammalia	American Badger	Taxidea taxus		
Mammalia	Mule deer	Odocoileus hemionus		
Mammalia	Desert woodrat	Neotoma lepida	Species of Special concern	
Mammalia	Brush rabbit	Sylvilagus bachmani		
Aves	Loggerhead shrike	Lanius ludovicianus	Species of Special concern	
Aves	California thrasher	Toxostoma redivivum		
Aves	Acorn woodpecker	Melanerpes formicivorus		
Reptilia	Whiptail lizard	Cnemidophorus tigris		
Reptilia	Common kingsnake	Lampropeltis getula		
Amphibia	Western toad	Bufo boreas		
Pisces	Steelhead - Southern California	Oncorhynchus mykiss irideus	Species of Special Concern	Endangered, 1997
Insecta	Damselflies	Odonata-Zygoptera spp.		
Insecta	Desert harvester ant	Pogonomyrmes rugosus		
Insecta	Scorpion	Anuroctonus phaiodactylus		
Insecta	Variable Checkerspot	Euphydryas chalcedona		
Plant	Walnut	Juglans californica		
Plant	Valley oak	Quercus lobata		
Plant	Bigberry manzanita	Arctostaphylos glauca		

Figure A.3 – Key Species Identified at the July, 2002 South Coast Wildlands Project Workshop

Figure A.4 - Species Matrix

TAXONOMIC GROUP		CWHR ID	Characteristics that may make species in this group vulnerable to Habitat Fragmentation(source:original TNC matrix)
MAMMALS		__	Local distribution in uncommon habitats. Small population sizes. Small home range and short dispersal distances. Large home range and movement requirements.
Badger	Taxidea taxus	M160	__
Brush Rabbit	Sylvilagus bachmani	M045	__
Desert Woodrat	Neotoma lepida	M126	__

	Reason why this species was selected (source:workshop)	Habitat Types/ Requirements (source: Cal Fish & Game Notes) Blue=Audobon	Best Habitats that occur in the project area (According to CWHR, high habitat suitability,)
MAMMALS	_____	_____	___
Badger	Moderately area sensitive, occurs at low density, would suffer inbreeding in small areas, being a grassland specialist would serve as umbrella for other species needing grassland in a linkage.	Drier open stages of most shrub, forest, and herbaceous habitats.Open plains/praries, farmland, and sometimes edges of woods	ANNUAL GRASS, DESERT SCRUB, BARREN
Brush Rabbit	Patchily distributed, specialist for dense shrubland vegetation, would serve as umbrella for species needing brushy vegetation in a linkage	Wide variety of grasses and forbes, thickets, riparian areas, and abundant edge forbs (clovers, foxtails, bromes, thistles) in grasslands, meadows, and riparian areas - always within or near dense, brushy cover.Thick brushy areas, especially where some brush has been cut	URBAN, CHAMISE-REDSHANK CHAPARRAL,COASTAL SCRUB, MIXED CHAPARRAL, MONTANE CHAPARRAL, ANNUAL GRASS
Desert Woodrat	Patchily distributed, specilist for shrub vegetation and riparian areas. Possibly redundant to brush rabbit, but may have a shorter dispersal distance and thus may require closely-spaced habitat patches in a linkage	Joshua tree, pinyon-juniper, mixed and chamise-redshank chaparral, sagebrush, and most desert habitats	CHAMISE-REDSHANK CHAPARRAL,COASTAL SCRUB, DESERT WASH, MIXED CHAPARRAL,PINYON-JUNIPER, SAGEBRUSH

	Areas in Region that are Important for Species	Minimun Patch Size Needed to Support an Indvl / Popln (from CWHR & workshop) Blue=Audobon	Barriers and Threats in the Area (specific info. from workshop, general info. may also be from CAL F&G) Green=workshop	Goals for genetic, individual and population connectivity
MAMMALS	__	__	__	__
Badger	May be occuring in the Santa Susannas	(a.) Home range Approx: 1.37 - 3.04 sq km for 5 females (Utah). 1.6. km for 7 females and 2.4 sq. km for 3 males.(Idaho);(b.) Population density:One badger(or 10 dens) per 2.58 sq. km .Varies from 2.5 to 17 km2. Home range of the male is larger, and encompasses the range of several females.	No info. from workshop. Highway 126- if badgers do not use underpasses. Ag. Lands and urban development.Habitat loss.Possibly the use of rodenticides by farmers in the area?	Allow metapopulation dynamics between patches of habitats
Brush Rabbit	NO info	Avg-Home ranges: Males: 0.015, Females:0.005.sq.km. Home ranges often conform to shape and sizes of patches. Homing ability extends up to 0.35 km. Territory: Males not territorial, home ranges overlap,Females may protect areas Territories : 12- 173 m in diameter.	No Info.from workshop. It can be assumed that the rabbit is vulnerable to urbanization, hunting, and loss of large, contiguous habitat patches. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf) Ag lands?	Demographic persistence and gene dispersal
Desert Woodrat	NO info	In CSS:Home range-0.0004-0.02 sq. km. Avg density:- In CSS: 3.5 to 12.3/0.01sq.km. Cactus: 38, Sagebrush juniper: 2.8.	No Info.from workshop. General loss of coastal sage scrub habitat to agricultural and urban development. Also, discing of vacant land for farming and weed abatement and cattle and sheep grazing may destroy or degrade woodrat habitat. A potential long-term threat to the species is isolation and fragmentation of habitat. This species is patchily distributed among rock outcrops and dense patches of vegetation and loss of habitat between these microhabitats may prevent woodrats from dispersing or colonizing suitable habitats when a resident woodrat dies.Isolation may also result in loss of genetic diversity because of impediments to dispersal and genetic exchange. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)	Genetic dispersal

	Areas in Region that are Important for Species	Minimun Patch Size Needed to Support an Indvl / Popln (from CWHR & workshop) Blue=Audobon	Barriers and Threats in the Area (specific info. from workshop, general info. may also be from CAL F&G) Green=workshop	Goals for genetic, individual and population connectivity
MAMMALS	__	__	__	__
Badger	May be occuring in the Santa Susannas	(a.) Home range Approx: 1.37 - 3.04 sq km for 5 females (Utah). 1.6. km for 7 females and 2.4 sq. km for 3 males.(Idaho);(b.) Population density:One badger(or 10 dens) per 2.58 sq. km .Varies from 2.5 to 17 km2. Home range of the male is larger, and encompasses the range of several females.	No info. from workshop. Highway 126- if badgers do not use underpasses. Ag. Lands and urban development.Habitat loss.Possibly the use of rodenticides by farmers in the area?	Allow metapopulation dynamics between patches of habitats
Brush Rabbit	NO info	Avg-Home ranges: Males: 0.015, Females:0.005.sq.km. Home ranges often conform to shape and sizes of patches. Homing ability extends up to 0.35 km. Territory: Males not territorial, home ranges overlap,Females may protect areas Territories : 12- 173 m in diameter.	No Info.from workshop. It can be assumed that the rabbit is vulnerable to urbanization, hunting, and loss of large, contiguous habitat patches. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf) Ag lands?	Demographic persistence and gene dispersal
Desert Woodrat	NO info	In CSS:Home range-0.0004-0.02 sq. km. Avg density:- In CSS: 3.5 to 12.3/0.01sq.km. Cactus: 38, Sagebrush juniper: 2.8.	No Info.from workshop. General loss of coastal sage scrub habitat to agricultural and urban development. Also, discing of vacant land for farming and weed abatement and cattle and sheep grazing may destroy or degrade woodrat habitat. A potential long-term threat to the species is isolation and fragmentation of habitat. This species is patchily distributed among rock outcrops and dense patches of vegetation and loss of habitat between these microhabitats may prevent woodrats from dispersing or colonizing suitable habitats when a resident woodrat dies.Isolation may also result in loss of genetic diversity because of impediments to dispersal and genetic exchange. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)	Genetic dispersal

	Current Distribution and Popln Status (Proj.area) (workshopmaps and notes, mostly. Also from CDFG notes) Green=Workshop	Current Distribution and Popln Status (Region /state/ beyond) (CWHR range maps)	Dispersal Distance (km) ,daily movements, other movements (mostlyWorkshop & Cal Fish and Game) Blue=Audobon Green=Workshop
MAMMALS	__	__	__
Badger	Santa Susanas	Distribution all throughout the state except northwestern CA. Populations declining in coastal Southern CA.	Max=48 km acc. to a study (USGS) Need to confirm and get details.
Brush Rabbit	No maps.	8 subspecies found in California, of which only the riparian subspeices occuring in central valley is endangered.	Brush rabbits appear to be sedentary, but very little specific dispersal data were found for this species. Based on radiotelemetry data for brush rabbits near Corvallis, Oregon, Chapman (1971) concluded that dispersal movements were relatively small.the distances over which brush rabbits were able to successfully home were shorter than other species of Sylvilagus and many other mammals.When crossing between clumps, rabbits invariably chose the shortest distance between clumps. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)
Desert Woodrat	No info.- no map	Present mostly in Southern California."Species of Special concern" in CA.	No dispersal distance as of now. Mark-recapture will be done by NPS. Relatively sedentary and may not be capable of dispersing long distances between suitable habitat patches.(http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf) Linear Movement:In sagebrush juniper: 0.08m/night for males;0.045m/night for females. In CSS: 0.014m/night

	Other useful info. (various sources) Blue=Audobon Green=Workshop	Management/ Stewardship needs (misc. sources)	Monitoring needs (misc. sources)	Recomendations for Conservation Design (various sources) Green=Workshop
MAMMALS	__	__	__	__
Badger	Cultivable land is not very useful to badgers as habitat. Badger burrows often considered threat to livestock, but badgers also condidered valuable for rodent control (Aud)	Maintaining grasslands.	Determine population sizes and distribution in the project region	Maintaining grasslands is important esp. between the cores
Brush Rabbit	Brush rabbits are wary and secretive animals. They use runways, tunnels, and burrows--although not as extensively as other members of their genus. When pursued, brush rabbits climb trees and scrubs.To protect themselves from predators, brush rabbits can sit perfectly still for long periods of time. When threatened they run in a zig-zag manner at about 20 to 25 miles an hour. (http://animaldiversity.ummz.umich.edu/accounts/sylvilagus/s._bachmani$narrative.html) Rabbits' homing movements were impeded by human activity and vehicles and they were reluctant to cross roads. Chapman also demonstrated that brush rabbits show little natural dispersal and tend to stay in the clumps in which they were first trapped regardless of age. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)	Maitaining brushy cover	Determine population sizes and distribution in the project region	Brush rabbits probably will require continuous suitable habitat because they appear unlikely to move long distances through unsuitable habitat. Small, isolated patches of habitat probably are unlikely to support viable populations of brush rabbits. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)
Desert Woodrat	Woodrat populations probably only are limited by the availability of suitable microhabitat features such as rock outcrops, cactus patches and dense shrub vegetation. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)	___	Determine population sizes and distribution in the project region.Also need to determine its dispersal distance	Conserve large habitat blocks and linkages that are suitable for occupation by the desert woodrat. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)

TAXONOMIC GROUP		CWHR ID	Characteristics that may make species in this group vulnerable to Habitat Fragmentation (source:original TNC matrix)
MAMMALS		__	Local distribution in uncommon habitats. Small population sizes. Small home range and short dispersal distances. Large home range and movement requirements.
Mountain Lion	Puma concolor	M165	__
Mule Deer	Odocoileus hemionus	M181	__
Bobcat	Lynx rufus	M166	__
Gray Fox	Urocyon cinereoargenteus	M149	__

	Reason why this species was selected (source:workshop)	Habitat Types/ Requirements (source: Cal Fish & Game Notes) Blue=Audobon	Best Habitats that occur in the project area (According to CWHR, high habitat suitability,)
MAMMALS	_____	_____	___
Mountain Lion	Area sensitive species, habitat generalist, can travel far in 1 day and can use relatively narrow long corridors	Nearly all except xeric habitats and croplands. Requires riparian vegetation and brushy stages of different habitats. Caves and thickets in brush and timber.Originally varied; now generally mountainous, semi-arid terrain, forests	SIERRAN MIXED CONIFER, MONTANE HARDWOOD-CONIFER,MONTANE RIPARIAN, MONTANE HARDWOOD, MIXED CHAPARRAL, BLUE OAK-FOOTHILL PINE
Mule Deer	Aversion to use of long dark culverts, thus an umbrella for species that are similarly difficult to move underneath a road	Widespread distribution throughout most of California, except in deserts and intensively farmed areas without cover. Early to intermediate successional stages of most forest, woodland, and brush habitats. A mosaic of vegetation, providing an interspersion of herbaceous openings, dense brush or tree. Mixed habitats - forest edges, mountains, and foothills	BLUE OAK WOODLAND, COASTAL OAK WOODLAND, VALLEY OAK WOODLAND, BLUE OAK FOOTHILL PINE, COASTAL SCRUB, MONTANE CHAPARRAL, VALLEY FOOTHILL RIPARIAN, MONTANE RIPARIAN, MONTANE HARDWOOD
Bobcat	NOT CHOSEN	Nearly all habitats and successional stages. Optimal habitats are brushy stages of low and mid-elevation conifer oak, riparian, and pinyon-juniper forests, and all stages of chaparral.Primarily scrubby country or broken forests - hardwood, coniferous, or mixed; Also swamps, farmland, and rocky or brushy arid lands.	COASTAL SCRUB ,MIXED CHAPARRAL,MONTANE CHAPPRAL, CHAMISE REDSHANK CHAPARRAL, MONTANE HARDWOOD, JUNIPER, BLUE OAK-FOOTHILL PINE, PINYON-JUNIPER, VALLEY OAK WOODLAND, COASTAL OAK WOODLAND, JEFFREY PINE, BLUE OAK WOODLAND, SIERRAN MIXED CONIFER, MONTANE RIPARIAN, MONTANE HARDWOOD CONIFER, SAGEBRUSH
Gray Fox	NOT CHOSEN	Shrublands, valley foothill riparian, montane riparian, and brush stages of many deciduous and conifer forest and woodland habitats. Meadows and cropland areas.	CHAMISE-REDSHANK CHAPARRAL,COASTAL SCRUB,MIXED CHAPARRAL,MONTANE CHAPARRAL

	Relavent Life History Characteristics (mostly from Cal Fish and Game and CWHR life history notes) Blue=Audobon	Prey/food (mostly from Cal Fish and Game and CWHR Life history notes) Blue=Audobon	Predators and Competitors (mostly from Cal. Fish and Game and CWHR Life History notes)
MAMMALS	_____	___	___
Mountain Lion	Active yearlong; mostly nocturnal and crepuscular,Seasonal movements within a fixed range in response to prey movements.Carnivorous. Tend to mutually avoid each other.Abundant in riparian areas, and brushy stages of most habitats.capable of existing for long periods without drinking water.No fixed mating season; 1-6 young usually born in midsummer every other year	Mule deer 70-80%,rabbits and hares, bighorn sheep,rodents, porcupines, skunks,coyotes,occasionally , domestic stock. Rarely: Grouse, turkey, fish, insects, grass, and berries. Also:beavers, mice, marmots, hares, raccoons, birds, and even grasshoppers	Predators:Humans.Large hawks, eagles, and bears may take young.Competitors: (based on dietary overlap) bobcats,coyotes, bears, and wolverine.
Mule deer	Crepescular, may be resident or migratory. Herbivore. Adult does may defend areas for newborns. Prefers open habitats but needs brushy areas for escape areas.1-2 young born in June/Aug	Browse and graze, prefer new growth of shrubs, many forbs, and few grasses. Also dig subterranean mushrooms.Acorns where available.summer brouse: mainly herbaceous plants, also berries and salal. winter brouse: twigs of douglas fir, cedar, yew, aspen, willow, dogwood, dogwood, juniper, sage, acorns	Predators:Humans, Mountain lions, coyotes,wolves bobcats, blackbears, domestic dogs, golden eagles. Compete with cattle and sheep, wild horses wild pigs and black bears for food.
Bobcat	Active yearlong, mostly nocturnal crepescular, some diurnal activity. Non migratory. Not very territorial, breed in winter usually. Mates Feb-March, usually has 1 litter (occasionally 2) of 1-7 young (usually 2-3), born in late April or early May	Carnivorous- Lagomorphs, rodents, deer(mostly fawns), birds, reptiles, amphibians, inverts. Domestic cats,porcupines,skunks, chickens, fox, occasionally carrion	Predators:Great horned owls may kill young bobcats. Adults occasionally taken by mountain lion and domestic dogs. Competitor: coyote.
Gray Fox	Yearlong active, crepescular, and nocturnal, non migratory.Territorial. Requires permananent water source near den. 1 litter of 1-7 young, born in March/May	Omnivore. Rabbits, mice, gophers, woodrats and squirrels are the princial foods. Also eats large amounts of fruits, nuts, grains, grasshppers, crickets, beetles, moths and butterflies, carrion, small amounts of herbage. Voles	Large hawks, golden eagles, great horned owls, domestic dogs, bobcats- may prey on pups.

	Areas in Region that are Important for Species	Minimun Patch Size Needed to Support an Indvl / Popln (from CWHR & workshop) Blue=Audobon	Barriers and Threats in the Area (specific info. from workshop, general info. may also be from CAL F&G) Green=workshop	Goals for genetic, individual and population connectivity
MAMMALS	—	—	—	—
Mountain Lion	NO info	Home ranges: Males- Min.40 km².). Female - usually 8-32 km².Home ranges of females may overlap completely with those of other females, or with males.Males have large homeranges that do not overlap with other males, females have smaller homeranges that may overlap with those of other females and may be enclosed by that of a male	The primary threats to the mountain lion are habitat fragmentation, loss of large areas of undeveloped land, road kills, and loss of natural prey base. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf) Workshop:Developed areas(lot areas <40 acres), row crops,- impediments, highway 126(not adept at crossing roads and avoid roads) Lighting(?) Loss of habitat.	Genetic dispersal
Mule deer	—	Home ranges:-Doe and fawn groups 1-3 sq.km typically. Avg: 0.5-5sq.km. Less than 1.6 km in diameter.	Highway 126- (massive roadkills?) and culverts.(Aversion towards long dark culverts.) Loss of habitat due to urbanisation.	Genetic diversity. Attract mountain lions.
Bobcat	No info.	Home ranges: Acc. to NPS, Males:3.11 sq. km, females1.55 sq. km. Home range varies in size with sex, season, and prey distrubution and abundance	Urbanisation, do not cross areas that is not natural	Genetic diversity
Gray Fox	No info.	Home ranges: avg for 4 females: 1.2 sq. km	—	Genetic diversity

	Current Distribution and Popln Status (Proj.area) (workshopmaps and notes, mostly. Also from CDFG notes) Green=Workshop	Current Distribution and Popln Status (Region /state/ beyond) (CWHR range maps)	Dispersal Distance (km) ,daily movements, other movements (mostlyWorkshop & Cal Fish and Game) Blue=Audobon Green=Workshop
MAMMALS	__	__	__
Mountain Lion	No info.	Statewide distribution.Cal. Species of Special concern.	Travels 5 miles per night,disperses 40 km from natal area.(Santa Ana) (In New Mexico-100 km.) -Paul Beier (acc. to Audobon- up to 25 miles per night) While juveniles are capable of dispersing long distances (Sweanor et al. [1996b] determined an average dispersal of 7.7 miles for females and 62.8 miles for males), they require sufficient cover to move safely (see Beier 1996). (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)
Mule deer	No info. (ask NPS)	No special status but in general populations generally decline due to habitat fragmentation.Statewide distribution	
Bobcat	_	Statewide	Travels: 2.6 km in 24 hours- (adult female). 4.8 km (adult male). Bobcats make daily movements of approximately 0.6 mile to 6.2 miles per day (Larivière and Walton 1997) While young are capable of dispersing long distances (at least 182 km [113 miles]), they require sufficient cover to move safely.Young bobcats start traveling alone by six months of age, but stay close to their natal den. Yearlings permanently disperse before the next litter is born and are capable of moving very long distances. For example, two young males dispersed 182 and 158 km, respectively (Larivière and Walton 1997)(http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)
Gray Fox	_	Statewide	__

	Other useful info. (various sources) Blue=Audobon Green=Workshop	Management/ Stewardship needs (misc. sources)	Monitoring needs (misc. sources)	Recomendations for Conservation Design (various sources) Green=Workshop
MAMMALS	__	__	__	__
Mountain Lion	In areas of dense veg.movement is facilitated by presence of dirt roads. Will not cross roads but will use bridged underpassses, large open culverts and overcrossings.Able to leap more than 20 feet (~6m)Using a simulation model, Beier (1993) estimated that lions were at a low extinction risk in areas at least 2,200 sq. km. in size (about 544,000 acres). Beier (1996) also observed dispersing individuals using corridors along well covered travel routes, an underpass, areas lacking artificial lighting, and areas with low residential densities (<1 dwelling unit/16 hectares). (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)	Need to ensure widespread distribtution of mule deer as a source of food in the vicinity of linkages.	Need to get info. on population sizes in the proj area.Review studies.	Open bridges are the preferred undercrossing. New undercrossings should meet minimum requirements of 10 to 20 feet in width, depending on length, with fencing and vegetative cover to funnel mountain lions into the crossing and away from the roadway. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)
Mule deer	Aversion to use of long dark culverts.Have been known to damage crops and timber (Aud).	Maintaining open areas with low cover.	Info on movement across highway 126 and posssible roadkills.	Linkage can be riparian (woody cover needed). Broad open underpass or a vegetated overpasss.
Bobcat	Bobcat adult females rarely use alternate area. Mainly remain inside natural areas. Males tend to move out. But mainly use modified natural habitat areas. Will use crossing only where natural habitat on both sides.	Maintenance of undisturbed habitat patches for breeding, preferably with rock outcrops and boulders, is important for conserving and managing this species.(http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)	Population in Proj. area	Open bridges are the preferred undercrossing. New undercrossings should meet minimum requirements of 10 to 20 feet in width, depending on length, with fencing and vegetative cover to funnel bobcats into the crossing and away from the roadway. Riparian habitat and dense and rocky chaparral or coastal sage scrub along longer movement corridors (e.g., longer than six miles) would be ideal.Crossings used by mule deer will be sufficient for bobcats; e.g., culverts measuring 10-20 feet in width and providing for unobstructed visual contact from end to end. In addition,fencing along roadways near movement linkages to funnel bobcats into the wildlife crossing andreduce vehicular collisions should be used. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_6.0.pdf)
Gray Fox	Also found in meadows and cropland areas.Only american canid with true clining ability; sometimes forages and takes refuge in trees	__	Population in Proj. area	__

TAXONOMIC GROUP		CWHR ID	Characteristics that may make species in this group vulnerable to Habitat Fragmentation (source:original TNC matrix)
BIRDS	—	—	Vagility. Habitat specificity/restriction. Need for cover. Social facilitation.
Acorn Woodpecker	Melanerpes formicivorus	B296	—
California Thrasher	Toxostoma redivivum	B398	—
Loggerhead Shrike	Lanius ludovicianus	B410	—
AMPHIBIANS	—	—	Pond breeding species have localized distributions with short dispersal distances. Aquatic breeders are sensitive to degradation in water quality. Aquatic breeders require localized habitat continuity among a variety of habitat types (streams or ponds, chaparral, oak woodland and coastal sage scrub)
Western Toad	Bufo boreas	A032	—
Arroyo Toad	Bufo microscaphus californicus	A035	_

	Reason why this species was selected (source:workshop)	Habitat Types/ Requirements (source: Cal Fish & Game Notes) Blue=Audobon	Best Habitats that occur in the project area (According to CWHR, high habitat suitability,)
BIRDS	_____	___	__
Acorn Woodpecker	Oak woodlands specialist(upland species), Complex social system (communal breeder) mostly sedentary, keystone species.	Hardwood and hardwood-conifer habitats. Requires stands with large oaks and snags. Low-density stands of large oaks with sparse canopy and snags.	URBAN, COASTAL OAK WOODLAND,BLUE FOOT HILL PINE, BLUE OAK WOODLAND, VALLEY OAK WOODLAND, MONTANE HARDWOOD-CONIFER
California Thrasher	Very weak flying ability, poor dispersal ability, avoids open and urbanized areas, has a history of diappearing from fragmented habitats(Baldwin Hills), extremely sedentary.	moderate to dense chaparral habitats and, less commonly, extensive thickets in young or open valley foothill riparian habitat. In southern California, occurs in montane chaparral up to 1500-2000 m (5000-6600 ft). Avoids dense tree canopy. Dense shrubs in parks or gardens?	MIXED CHAPARRAL, COASTAL SCRUB, CHAMISE REDSHANK CHAPPRAL, URBAN
Loggerhead Shrike	Once widespread, now scarce in linkage region, prey base issues of survival: herps, small mammals, large insects, open habitat specialist, absent from heavily urbanized areas, breeding populations are in rapid decline, mostly sedentary.	open habitats with scattered shrubs, trees, posts, fences, utility lines, or other perches. Highest density occurs in open-canopied valley foothill hardwood, valley foothill hardwood-conifer, valley foothill riparian, pinyon-juniper, juniper, desert riparian, and Joshua tree habitats	COASTAL OAK WOODLAND,VALLEY OAK WOODLAND, BLUE OAK WOODLAND, BLUE FOOTHILL PINE, PINYON JUNIPER, JUNIPER
AMPHIBIANS	____	___	
Western Toad	Historically widely dispersed and occurred in all ranges, not as habitat specific as others. Riparian species.	everywhere except the deserts and highest mountains. Standing water	ANNUAL GRASS
Arroyo Toad	NOT CHOSEN	Valley-foothill and desert riparian as well as a variety of more arid habitats ncluding desert wash, palm oasis, and Joshua tree mixed chaparral and sagebrush.,	VALLEY FOOTHILL RIPARIAN

	Relavent Life History Characteristics (mostly from Cal Fish and Game and CWHR life history notes) Blue=Audobon	Prey/food (mostly from Cal Fish and Game and CWHR Life history notes) Blue=Audobon	Predators and Competitors (mostly from Cal. Fish and Game and CWHR Life History notes)
BIRDS			
Acorn Woodpecker	Oak specialist, keystone species, lives in group of 2-6. Yearlong diurnal activity,resident. 4 or 5 white eggs in hole in tree, they nest in colonies, mostly in dead oak branches	Acorns, flying insects and sap. In urban/agricultural areas almonds and walnuts also	Predator: Hawks. Competitors: Lewis' woodpecker,band tailed pigeon, scrub jay and American crow.
California Thrasher	Yearlong, diurnal activity. Sedentary resident mostly, may be some local movement in non breeding season. Nesting in large shrub or tree usually 0.6 to 1.5 m above ground.	Insects, spiders, terrestrial invertebrates,fruits, acorns,forbs seeds.Feeds amongst leaf litter on the ground - under the shelter of bushes	Sharp shinned hawks, feral and domestic cats. Nest Predators: skunks cats, lizards, racers, scrub jays. Competes with northern mocking birds for nesting sites.
Loggerhead Shrike	Common resident and winter visitor in lowlands and foothills throughout California. Often found in open cropland.Searches for prey atleast 0.6 m above the ground.Yearlong diurnal activity.Territory defended by solitary individuals.	Large insects, small birds, mammals, amphibians, reptiles, fish carrion, inverts.	Predation by magpies(In Colorado) prevented nesting
AMPHIBIANS			
Western Toad	Terrestrial individuals are primarily nocturnal but also active diurnally during spring. Inactive during extreme weather.Pronounced movements to hiberate in case of severe winter. No extensive seasonal movements in case of mild winters. Males defend small areas around themselves during breeding season.	Terrestrial insects, small arthropods, earthworms, snails, slugs. Tadpoles eat:plant materials, plankton, detritus	Predators: Aquatic invertebrates,garter snakes, birds.
Arroyo Toad	Adult toads are primarily nocturnal, but may be diurnal during breeding season. Newly metamorphosed toads are active during the daylight hours and can tolerate much higher temperatures than can adults Probably migrates short distances to breeding sites.	snails, Jerusalem crickets, beetles, ants, caterpillars, moths, and occasionally they cannibalize newly metamorphosed individuals	Predators:Fish (crayfish, catfish, sunfish) Bullfrogs

	Areas in Region that are Important for Species	Minimun Patch Size Needed to Support an Indvl / Popln (from CWHR & workshop) Blue=Audobon	Barriers and Threats in the Area (specific info. from workshop, general info. may also be from CAL F&G) Green=workshop	Goals for genetic, individual and population connectivity
BIRDS				
Acorn Woodpecker	Oak locations	Lives in communal groups of 2-16, consisting of atleast 2 breeding adults. Territory ranges from 0.009-0.03 sq. km amd avg. is 0.024sq. Km	No info from workshop.	Gene dispersal
California Thrasher	Continuous or semi open scrub, riparian corridors, can breed in or disperse across modified habitats at urban/wildland interface.	In CSS:Home range-0.0004-0.02 sq. km. Avg density:- In CSS: 3.5 to 12.3/0.01sq.km. Cactus: 38, Sagebrush juniper: 2.8.	Weak flyers- may not cross wide freeways.	Demographic persistance
Loggerhead Shrike	No info available from workshop .Shrubs for nesting, elevated perch sites.	Avg home range: 0.076sq.km. Varying from 0.045 to 0.46km (In Kern County). From workshop:- Adult terrotiral range is 100's of meters to 1+ km in diameter.	Avoids continous dense woodland chapparal, urbanized areas.Pesticide senstive, may not survive in many ag. Areas.	Demographic persistance
AMPHIBIANS				
Western Toad	Presence of pools with exotic fish and herps. Breeding ponds or pools in streams with low flow.	Individual variation in home range size. At low elevation, individuals are occasionally encountered up to 1 km away from potential breeding sites.	Roads are used by toads in general and result in mortality. Toads have poor jumping ability- man made barriers- i.e. curbs, fences etc will impede movement.	No info.to establish goals
Arroyo Toad	No info.	—	Development and alterstion of streamside flats (by changing the natural hydrologic regime) have led to extirpation of historic populations.Excessive human use-camping grounds, mining, Road crossings,Suction dredging on Piru Creek. Natural disturbances like forest fires and drought (in the late eighties)	Demographic persistance

	Current Distribution and Popln Status (Proj.area) (workshopmaps and notes, mostly. Also from CDFG notes) Green=Workshop	Current Distribution and Popln Status (Region /state/ beyond) (CWHR range maps)	Dispersal Distance (km) ,daily movements, other movements (mostlyWorkshop & Cal Fish and Game) Blue=Audobon Green=Workshop
BIRDS			
Acorn Woodpecker	Along the Los Padres ranging from Santa Paula to Fillmore. In the Santa Susannas ranging from Happy Canyon to Santa Clarita.(info from workshop map)	No special status	Adult movements in 100s of meters. Will disperse large distances.
California Thrasher	All places in the linkage area except 2 places where it is ABSENT:-Santa Clarita(beyond interstate 5),urban areas of Santa Paula(info from workshop map)	No special status	Juvenile dispersal: few data, probably < 5km and usually < 2-3 km
Loggerhead Shrike	Not mapped. Absent from all urban areas, most or all intensive agricultural areas, densely wooded areas, continuous chapparal,CSS, north slope of mountain ranges. Now absent from large areas of seemingly suitable habitat. Strongholds: Maybe Santa Clara river valley.	mearnsi subpecies is Federally endangered, anthonyi subspecies is Cal. Species of Special Concern. Neither of them occur in the proj. area as these are island subspecies	Juvenile dispersal - no data, probably many kms.Juvenile dispersal has been measured at around 12 to 14.7 km from the natal site with adults dispersing a mean distance of 2.7 km (Yosef 1996; Collister and De Smet 1997). Movement patterns of the shrike indicate that they disperse preferentially along connecting corridors of vegetation rather than between equally sized isolated patches of habitat (Haas 1995). (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_2.0.pdf)
AMPHIBIANS			
Western Toad	Piru Creek, Hopper Canyon.(info from workshop map)	Wide distribution throughout the state.	2 km regularly;upland habitat and reproductivehabitat within 100 meters for long term survival. Moves on average 6.7 meters/day. Extreme dispersal (unpub) 5 km over inhospitable habitats.
Arroyo Toad	Occurs in the Los Padres Nation forest. Specifically in the Sespe and Piru creeks vicinity.	Cal Species of Special Concern. Also Federally endangered	Sweet (1993) found that many sub-adults and some males moved along streams >0.8 km in distance and 1.0 km in some cases. More recent studies have found linear movement along drainages to range between 1 and 2 kilometers.Sweet's study in the Los Padres National Forest (1993), generally concluded that most arroyo toads disperse from their natal pools about a year after metamorphosis. The females become more sedentary as they mature, while many, but not all males maintain a tendency to move up or down the drainage during the breeding season. Sweet (1993) also found a lack of movement between August and late March.(http://www.rcip.org/Documents/draft_mshcp_vol_2/b_1.0.pdf)

	Other useful info. (various sources) Blue=Audobon Green=Workshop	Management/ Stewardship needs (misc. sources)	Monitoring needs (misc. sources)	Recomendations for Conservation Design (various sources) Green=Workshop
BIRDS				
Acorn Woodpecker	Able to move across urban or inappropritate natural habitats. Not very linkage dependant.	—	GIS-creating an overlay of oak locations this will indicate where the woodpeckers are found.	—
California Thrasher	Probably rarely successful in large areas of open or urban habitats	—	Need to monitor the population project area.	—
Loggerhead Shrike	Is a strong flier and easily crosses freeways. The loggerhead shrike is known to forage over open ground within areas of short vegetation, pastures with fence rows, old orchards, mowed roadsides, cemeteries, golf courses, riparian areas, open woodland, agricultural fields, desert washes, desert scrub, grassland, broken chaparral and beach with scattered shrubs (Unitt 1984; Yosef 1996). Individuals like to perch on posts, utility lines and often use the edges of denser habitats (Zeiner, et al. 1990). In some parts of its range, pasture lands have been shown to be a major habitat type for this species, especially during the winter season (Yosef 1996) (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_2.0.pdf)	Management for resident shrikes should include a patchwork of grassy habitats and sparsely vegetated bare areas at the scale of individual shrike territories (Gawlik and Bildstein 1993). (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_2.0.pdf)	Need to monitor the population and occurance in the project area.	Open spaces. Movement patterns of the shrike concluded that they disperse preferentially along connecting corridors of vegetation than between equally sized isolated patches of habitat (Haas 1995). (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_2.0.pdf)
AMPHIBIANS				
Western Toad	—	—	More info. needed on the population status and distribution in the project area	Culverts to allow easy passage.Prevent and restore habitat integrity. Requires movement between ponds and upland habitat.
Arroyo Toad	This species requires access to permanent water during the breeding season and unrestricted corridors for movement from water sources to adjacent upland stream terrace habitat where much of the remaining active season is spent. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_1.0.pdf)	Protection of overflow pools and streamside flats. Prevent development in vicinity of habitats. Avoid silation of streams. Isolate toad populations form exotic aquatic fauna.	Surveys to determine population size	Adults: overflow pools adjacent to the inflow channel of 3rd to greater order streams,(free of predatory fish) for breeding.Exposed pools (i.e., with little marginal woody vegetation) that are shallow, sand- or gravel-based and have a low current velocity.). Pools with a minimum of silt are necessary for arroyo toad larvae to feed and grow rapidly.Stable, sandy terraces should possess a moderately well-developed, but scattered shrub and tree vegetation overstory (Sweet 1991), and typically have mulefat (Baccharis viminea), California sycamore (Platanus racemosa), Fremont's cottonwood (Populus fremontii), or coast live oak present

TAXONOMIC GROUP		CWHR ID	Characteristics that may make species in this group vulnerable to Habitat Fragmentation (source:original TNC matrix)
Spadefoot Toad	Scaphiopus(OR Spea) hammondii	A028	__
REPTILES	__	__	Localized distribtutions. Long range dispersal.
Southwestern Pond Turtle	Clemmys marmorata pallida	R004	__
REPTILES	__	__	Localized distribtutions. Long range dispersal.
Common Kingsnake	Lampropeltis getula	R058	__
Whiptail Lizard	Cnemidophorus tigris	R039	__

	Reason why this species was selected (source:workshop)	Habitat Types/ Requirements (source: Cal Fish & Game Notes) Blue=Audobon	Best Habitats that occur in the project area (According to CWHR, high habitat suitability,)
Spadefoot Toad	NOT CHOSEN	valley-foothill and desert riparian as well as a variety of more arid habitats including desert wash, palm oasis, and Joshua tree, mixed chaparral and sagebrush.	ANNUAL GRASS
REPTILES	___	___	
Southwestern Pond Turtle	NOT CHOSEN	Permanent or nearly permanent water in a wide variety of habitat types below 1830 m	VALLEY FOOTHILL RIPARIAN, BLUE OAK-FOOTHILL PINE, VALLEY OAK WOODLAND, BLUE OAK WOODLAND, COASTAL OAK WOODLAND, ANNUAL GRASS, MONTANE RIPARIAN
REPTILES	___	___	
Common Kingsnake	Wide ranging, can move through variety of habitats. Feeds on small lizards	valley-foothill hardwood, and hardwood-conifer, mixed and montane chaparral, valley-foothill riparian, coniferous forests, and wet meadows.	VALLEY FOOTHILL RIPARIAN, COASTAL SCRUB, CHAMISE-CHAPARRAL, MIXED CHAPARRAL, EUCALYPTUS, VALLEY OAK WOODLAND, COASTAL OAK WOODLAND, DESERT SCRUB, SAGEBRUSH, PINYON-JUNIPER, BLUE OAK WOODLAND, ANNUAL GRASS, BLUE OAK FOOTHILL PINE
Whiptail Lizard	Wide ranging and wide spread.Varying habitat types	including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, mixed conifer, pine-juniper, chamise-redshank chaparral, mixed chaparral, desert scrub, desert wash, alkali scrub, and annual grass types.	DESERT WASH, DESERT SCRUB, SAGEBRUSH, CHAMISE REDSHANK CHAPARRAL

	Relavent Life History Characteristics (mostly from Cal Fish and Game and CWHR life history notes) Blue=Audobon	Prey/food (mostly from Cal Fish and Game and CWHR Life history notes) Blue=Audobon	Predators and Competitors (mostly from Cal. Fish and Game and CWHR Life History notes)
Spadefoot Toad	Almost completely terrestrial, entering water only to breed spadefoots become surface active following relatively warm (10.0-12.8OC) rains in late winter-spring and fall, emerging from burrows in loose soil to a depth of at least 1 m.Active on the surface nocturnally during rains or periods of high humidity. Remain active in underground burrows during most of the year, not territorial during most of the year	Insects-butterfly moth larvae, ants termites, worms, other inverts,planktonic organisms and algae, dead aquatic larvae of amphibians, including their own species	Tadpoles may compete for food or space with other amphibian larvae. Because of their secretive behavior during most of the year, adults probably avoid predators. Dense populations of tadpoles may be heavily preyed upon by wading birds, or certain species of mammals.Bull frogs and crayfish-predators.
REPTILES			
Southwestern Pond Turtle	Usually leaves the aquatic site to reproduce, to aestivate, and to overwinter.Along the central and southern coast of California, western pond turtles may be active year-round.Seem to avoid water at temperatures of > 39-40 deg.C Water bask by lying in the warmer surface water layer with their heads out of water .Most activity is diurnal but some crepuscular and nocturnal activity too,active all year where climates are warm.During the spring or early summer, females move overland for up to 100 m (325 ft) to find suitable sites for egg-laying. Other long distance movements may be in response to drying of local bodies of water or other factors	omnivorous. Aquatic plant material, including pond lilies, beetles and a variety of aquatic invertebrates as well as fishes, frogs, and carrion	Hatchlings and juveniles are preyed upon by certain fishes, bullfrogs, garter snakes, wading birds, and some mammals
REPTILES			
Common Kingsnake	Habitat generalist. In California, most abundant near streams, rivers and in vicinity of irrigated agriculture. Active during favorable temperatures (midday in cooler periods, early morning and evening in summer). Inactive in winter. No migration reported.Often found in vicinity of rock outcrops and clumps of vegetation. Clutch sizes range from 2 -12.	Lizards, snakes, small rodents, birds, bird eggs, their own shed skins	Predators: Mammals, prey birds,esp. hawks, other snakes. Competitors: With other species, nature unknown.
Whiptail Lizard	Primarily diurnal,active mostly in the morning, no migration observed. Often found associated with sand areas along gravelly arroyos or washes. More?	Inverts:Grasshoppers, beetles, ants, termites, insect, larvae, spiders	Diurnal predators: Snakes, larger lizards, predaceous birds, roadrunners. Competitor: May have slight competetion with the zebra tailed lizard.

	Areas in Region that are Important for Species	Minimun Patch Size Needed to Support an Indvl / Popln (from CWHR & workshop) Blue=Audobon	Barriers and Threats in the Area (specific info. from workshop, general info. may also be from CAL F&G) Green=workshop	Goals for genetic, individual and population connectivity
Spadefoot Toad	No info.	Will travel up to several meters on rainy nights. Movements to and from breeding ponds are rarely extensive.	In southern California (from the Santa Clara River Valley, Los Angeles and Ventura counties, southward), > 80% of habitat once known to be occupied by S. hammondii has been developed or converted to uses that are undoubtedly incompatible with its successful reproduction and recruitment).Fragenmentsion of habitat poses a threat to metapopulations. Emigration of juvenile and adult bullfrogs into rainpool breeding sites may also pose a threat to some populations	Demographic persistance
REPTILES				
Southwestern Pond Turtle	No info.	home range is normally quite restricted	Drought (had occured from 1986-1990)- habitat alteration,changes in land and water use, and abusive grazing practices.. Many localities that harbor turtles populations seem to be affected because the nesting habitat is being impacted or altered during the incubation interval on an annual basis by some type of agriculture or the activity of livestock.some introduced exotic aquatic predators or competitors. Increases in local raccoon activity because of local human disturbances or translocations by animal control agencies, introduced red foxes (Vulpes vulpes spp.), and translocated black bear (Ursus americanus) populations may have all contributed to increased predation on nests or post-hatching stages over historic background levels	Demographic persistance and gene dispersal
REPTILES				
Common Kingsnake	Habitat generalist. No area specified.	Home range not known. No evidence for territorial denfese (though males may probably fight during the breeding season.)	Can cross roads but mortality occurs. Snakes pause to thermoregulate on warm roads in cold nights. Being nocturnal avoids areas with light pollution	No info.to establish goals
Whiptail Lizard	Common in and around dense vegetation	Home range: Avg- 0.001sq.km.Av densites 13-36/0.01sq.km (In Arizona) Lack of male territoriality probably since home anges overlap.	Suspectible to habitat fragmentation, roads, highways, extremely impervious environments. Habitat loss due to development, , off-road vehicle use? (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_8.0.pdf)	No info.to establish goals

	Current Distribution and Popln Status (Proj.area) (workshopmaps and notes, mostly. Also from CDFG notes) Green=Workshop	Current Distribution and Popln Status (Region /state/ beyond) (CWHR range maps)	Dispersal Distance (km) ,daily movements, other movements (mostlyWorkshop & Cal Fish and Game) Blue=Audobon Green=Workshop
Spadefoot Toad	Santa Clara river area. Exact population not known but in general numbers are low.	Cal Species of Special Concern	There is no information , however, it is known that juveniles disperse shortly after metamorphose and breeding toads stay near breeding ponds (Zeiner et al. 1988). (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_1.0.pdf)
REPTILES			
Southwestern Pond Turtle	25 in Ventura County.(http://www.rcip.org/Documents/draft_mshcp_vol_2/b_8.0.pdf) (Santa Clara river area.	Cal Species of Special Concern	? No info on dispersal distance. While moving between pools within the stream system, average distances were 354 m for males, 169 m for females, and 142 meters for juveniles. Greater than 81% of males moved over 200 m, while only 37% of females and 23% of juveniles traveled that distance. (http://www.rcip.org/Documents/draft_mshcp_vol_2/b_2.0.pdf)
REPTILES			
Common Kingsnake	NOT SHOWN ON MAP. All protected areas can be considered to be core areas since the species is a habitat generalist.	Wide distribution throughout the state.	Not known
Whiptail Lizard	NOT clear from Map (?)	Wide distribution almost throughout the state.	Not known

	Other useful info. (various sources) Blue=Audobon Green=Workshop	Management/ Stewardship needs (misc. sources)	Monitoring needs (misc. sources)	Recomendations for Conservation Design (various sources) Green=Workshop
Spadefoot Toad	—	Protect significant areas of rainpool habitat from alteration	Population in the proj. area	Temporary rainpools with water temperatures of 9OC and < 30OC. Rainpools free of crayfish and bullfrogs
REPTILES				
Southwestern Pond Turtle	Mats of submergent vegetation, such as pondweed (Potamogeton spp.) and ditch grass (Ruppia maritima), are favored water basking locations because these mats trap surface water thus maintaining even higher surface water temperatures, and turtles require less energy to maintain their position in the surface layer when such a vegetation structure is present (Holland 1985a; pers. observ.).	Protection of suitable nesting habitat associated with the sites where those populations exist, and reduction of mortality in the younger age (size) groups of turtles	Movement responses to habitat change, the pattern of movements in the absence of change, and recolonization ability in structurally different habitats	Corridors broad enough not to impede either the movement of adult females to and from the nesting location nor the movement of hatchlings from the nest to the aquatic site should be fenced in a manner to allow turtle movement and to ensure that nests will not be trampled during incubation.Isolate such systems from the exotic aquatic fauna that may prey on or compete with western pond turtles, and in particular, discourage human translocation of such organisms within the state.
REPTILES				
Common Kingsnake	Corridor boundaries assume no problem to snakes to move through steep gradients and variety of habitat. Can move through orchards.	—	Population estimate, movement and distribution in project area. Need to find out whether or not they follow drainages.	Will probably do better in large blocks connected by short wide corridors rather than narrower larger connections.
Whiptail Lizard	Most common in and around dense vegetation, spend little time in open areas but will cross barren spaces in order to reach shrubs.May seek refuge in burrows to avoid predators.	—	Distribution and population in the project area.	Maintaining dense covers in areas of scanty vegetation

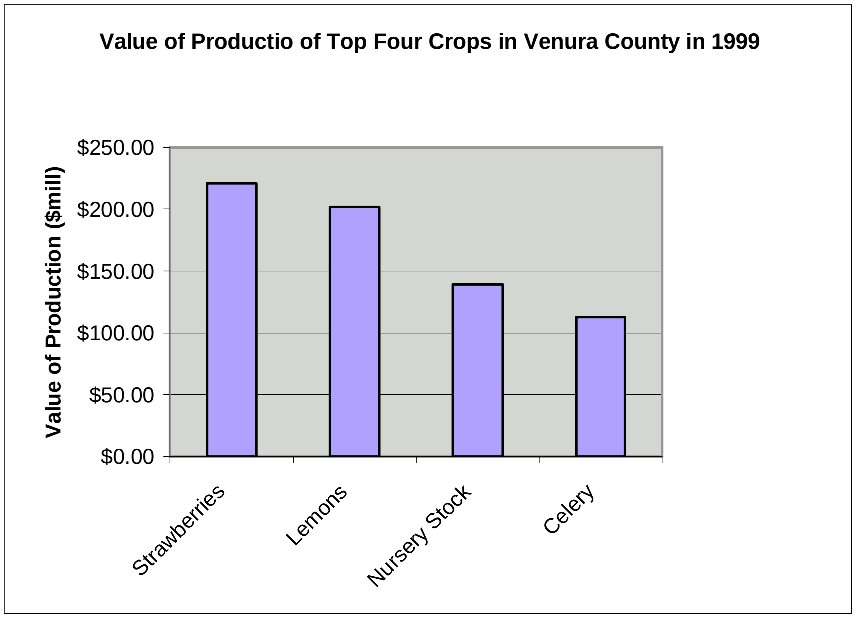

Figure A.5 – Value of Production of Top Four Crops in Ventura County in 1999

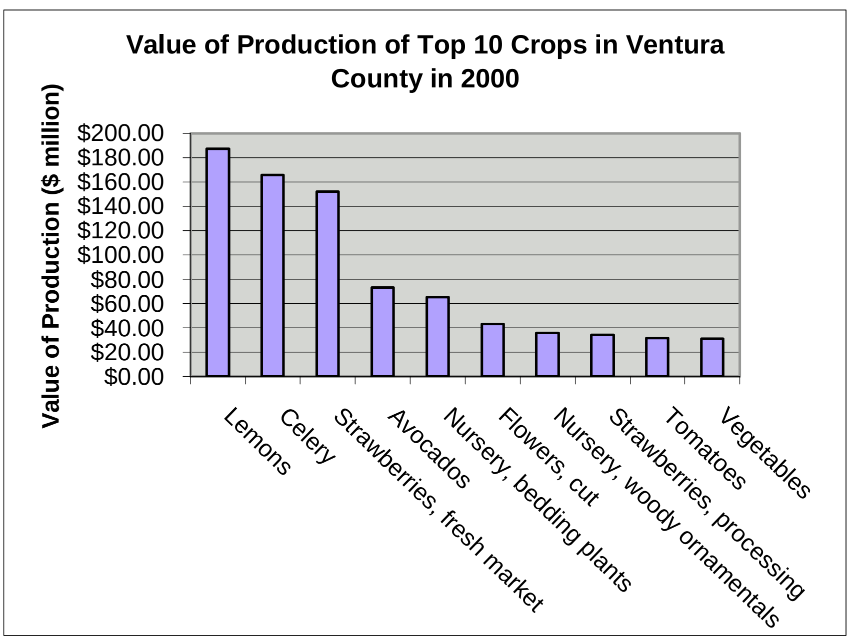

Figure A.6– Value of Production of Top 10 Crops in Ventura County in 2000

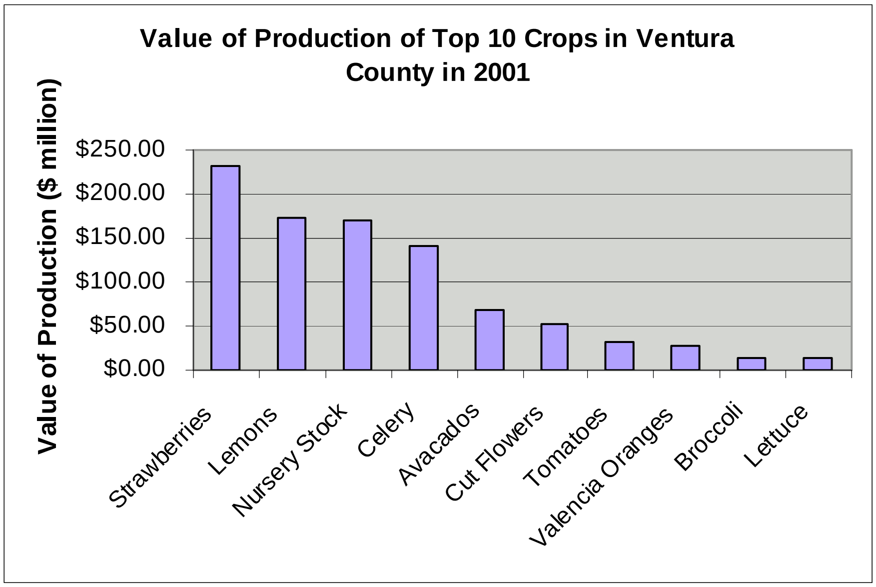

Figure A.7 – Value of Production of Top 10 Crops in Ventura County in 2001

AGRICULTURE			
Number of farms, 1997	2,214	**Leading commodities with value of production, 2000**	$ mill.
Acreage in farms, 1997	346,279		
% of land area	*29.3*		
		Lemons	$187.17
Agricultural employment, 2000	19,600	Celery	$165.54
		Strawberries, fresh market	$152.08
Value of production, 2000 ($ mill.)	1,047.1	Avocados	$73.07
Percent of California	*3.6*	Nursery, bedding plants	$65.24
County Rank	10	Flowers, cut	$43.06
Field crops	$8.44	Nursery, woody ornamentals	$35.69
Seed crops	$0.00	Strawberries, processing	$34.52
Vegetables	$353.30	Tomatoes	$31.80
Fruits and nuts	$473.68	Vegetables	$31.21
Nursery, flowers, and foliage	$204.83		
Apiary products	$0.85		
Livestock and livestock products	$5.27		
Poultry and poultry products	$0.70		

Figure A.8 – Agricultural Information for Ventura County in 2002

City	Total Population	White	Hispanic	Black	American Indian	Asian	Pacific Islander
Santa Paula	28,598	7,551	20,360	69	129	180	27
Fillmore	13,643	4,178	9,090	26	69	97	11

City	Other	Two or more races	Median Household Income	Square Miles	Acres	Housing Units
Santa Paula	39	243	$41,651	4.61	2,949	8,365
Fillmore	24	148	$45,510	2.73	1,748	4,062

Figure A.9 – Demographic Information on Ethnic Diversity in Santa Paula and Fillmore in 2002

	1960	1970	1980	1990	2000	2010	2020
Population							
Santa Paula	13,279	18,001	20,552	25,062	28,598	32,730	37,920
Fillmore	4,808	6,285	9,602	11,992	13,643	16,187	20,964
Dwelling Units							
Santa Paula	4,263	5,769	7,172	8,062	8,341	10,452	12,068
Fillmore	4,808	6,285	9,602	11,992	13,643	16,187	20,964

Figure A.10 – Population and Dwelling Unit Data for Santa Paula and Fillmore from 1960 to Present and Projected through 2020

Appendix B – Modeling Scripts

```
/* species_cost_surface.aml
/* Links Group Project
/* Donald Bren School of Environmental School and Management
/* 03/12/03
/* This script is written for Arc/Info 8.X but will most likely work for earlier
/* versions.
/* Author: Eric H. Fegraus
/*****************************************************************
/* This script creates an ecological cost surface based upon several input layers.
/* These input layers should be scrutinized for their accuracy before using this
/* script.  The choice of cost surface inputs is left to the researcher but should be
/* topics that can be scientifically demonsrated to affect species movement across a
/* landscape. A least-cost path is then conducted with the cost surface. We create
/* cost surfaces (linear and exponential).  See text for explanation.  This script
/* is written to create a least cost path for a wide ranging carnivore.  The outputs
/* are as follows:

        /* carnivore_lc        - linear weights cost surface
        /* carnivore_exp       - exponential weights cost surface
```

```
        /* lcp_crn_lc_bz        - LCP using linear cost surface w/ LCP by-zone option
        /* lcp_crn_lc_bc        - LCP using linear cost surface w/ LCP by-cell option
        /* lcp_crn_ec_bz        - LCP using exponential cost surface w/ by-zone option
        /* lcp_crn_ec_bc        - LCP using exponential cost surface w/ by-cell option

/* Required Raster layers
        /* Input layers - 3 used here but can be easily adjusted.
        /* Destination  - Raster usually containing the border of one core area
        /* source       - Raster usually containing the border of the other core area

                /* Note: If more than one destination core area repeat analysis
                /* or copy and paste adjusting the destination raster.

/*****************************************************************
/* Determine the weights to give your inputs to expand the
/* cost surface values. See text for determining weights.
/* Habitat Suitability = 2 Road Effects = 2.66 Slope = 1.66

/* Create a linear cost surface from inputs
temp_hs = ma_carnivore * 2          /*ma = moving average
temp_re = road_effects * 2.66
temp_s  = slope * 1.66

/* Add the layers together
carnivore_lc = temp_hs + temp_vs + temp_s

kill temp_hs
kill temp_vs
kill temp_s

/* Create an exponential cost surface from inputs
temp_hs = pow(ma_carnivore,2)
temp_vs = pow(road_effects, 2.66)
temp_s  = pow(slope, 1.66)

/* Add the layers together
carnivore_exp = temp_hs + temp_vs + temp_s

kill temp_hs
kill temp_vs
kill temp_s

/* Creat Linear LCPs
outcost_lc = costdistance(dest_crnvr,carnivore_lc,out_dir_lc)
```

```
lcp_crn_lc_bc = costpath(source_crnvr,outcost_lc,out_dir_lc)        /* By-cell LCP
lcp_crn_lc_bz = costpath(source_crnvr,outcost_lc,out_dir_lc,byzone)
/* By-zone LCP

/* Creat Linear LCPs
outcost_ec = costdistance(dest_crnvr,carnivore_exp,out_dir_ec)
lcp_crn_ec_bc = costpath(source_crnvr,outcost_ec,out_dir_ec)        /* By-cell LCP
lcp_crn_ec_bz = costpath(source_crnvr,outcost_ec,out_dir_ec,byzone)
/* By-zone LCP

/* Clean up
kill outcost_lc
kill out_dir_lc
kill outcost_ec
kill out_dir_ec
```

/* lcp_sensitivity_analysis.aml

```
/* Links Group Project
/* Donald Bren School of Environmental School and Management
/* 03/12/03
/* This script is written for Arc/Info 8.X but will most likely work for earlier
/* versions.
/* Author: Eric H. Fegraus
/*****************************************************************
/* This script conducts a sensitivity analysis of a least cost path (LCP).  It should
/* be run from the Arc prompt.  This will run a Monte Carlo simulation with 1000
/* iterations each creating a LCP from a cost surface which has inputs varying
/* +- 0.5.  The goal of this type of sensitivity analysis is twofold:
        /* 1. Gain understanding regarding your LCP analysis model, inputs and cost
                /* surfaces.
        /* 2. Create a probabilistic LCP layer that might highlight new areas for a


/* corridor or re-inforce currently proposed corridors.
/* The outputs are as follows:

        /* lcp_final####        - 1000 (or however many) LCPs
        /* lcp_sa_####          - a raster where all lcp_final#### layers have been
/* added together.  Each grid cell value represents the
/* number of times it was included in a lcp_final####
/* layer.
        /* lcp_crn_lc_bz        - LCP using linear cost surface w/ LCP by-zone option
        /* lcp_crn_lc_bc        - LCP using linear cost surface w/ LCP by-cell option
        /* lcp_crn_ec_bz        - LCP using exponential cost surface w/ by-zone option
```

```
        /* lcp_crn_ec_bc        - LCP using exponential cost surface w/ by-cell option

/* Required Raster layers
        /* Input layers - 3 used here but can be easily adjusted.
        /* Destination  - Raster usually containing the border of one core area
        /* source       - Raster usually containing the border of the other core area
/* lcp_blank    - A raster of the appropriate area with al values = 0
        /* con function an easy way to make it
        /* lcp_sa_dir   - A directory to store files.
/*****************************************************************

grid
/* Set all cells in lcp_final equal to zero.
lcp_sa_dir/lcp_final0 = lcp_sa_dir/lcp_blank

/* Set variables
&setvar i = 2           /* Start one number higher.
&setvar j = 1000

&DO &UNTIL %i% eq %j%
&setvar k = %i% - 1

/* Generate random total cost surface
/* Add the input layers together
/* hs = 2 re = 2.66 s = 1.66
&sv rand_var_hs = [random 15 25] / 10       /*  Have to round due to inability to use
/* floating pts.
&sv rand_var_vs = [random 21 31] / 10
&sv rand_var_s =  [random 11 21] / 10
lcp_sa_dir/temp_hs = pow(ma_carnivore, %rand_var_hs%)
lcp_sa_dir/temp_re = pow(road_effects, %rand_var_vs%)
lcp_sa_dir/temp_s  = pow(slope, %rand_var_s%)

lcp_sa_dir/temp_cost    =    lcp_sa_dir/temp_hs    +    lcp_sa_dir/temp_re    +
lcp_sa_dir/temp_s

/* Kill temp vars
kill lcp_sa_dir/temp_hs
kill lcp_sa_dir/temp_re
kill lcp_sa_dir/temp_s


/* Create Simulated LCP w/ by-zone option
```

```
lcp_sa_dir/outcost_a =
costdistance(dest_crnvr,lcp_sa_dir/temp_cost,lcp_sa_dir/out_dir_a)
lcp_sa_dir/lcp_crn_%i% =

costpath(source_crnvr,lcp_sa_dir/outcost_a,lcp_sa_dir/out_dir_a,byzone)

/* Kill temp vars
kill lcp_sa_dir/out_dir_a
kill lcp_sa_dir/outcost_a
kill lcp_sa_dir/temp_aost

/* Get total cost values from real cost surface for all simulated LCPs.
lcp_sa_dir/lcp_one%i% = con(lcp_sa_dir/lcp_crn_%i% == 3, 1, 0)
lcp_sa_dir/lcp_temp%i% =
con(isnull(lcp_sa_dir/lcp_one%i%),0,lcp_sa_dir/lcp_one%i%)
lcp_sa_dir/lcp_final%i% = lcp_sa_dir/lcp_temp%i% + lcp_sa_dir/lcp_final%k%

/* Final cleanup
kill lcp_sa_dir/lcp_one%i%
kill lcp_sa_dir/lcp_temp%i%
kill lcp_sa_dir/lcp_final%k%
/*kill lcp_sa_dir/lcp_crn_%i%        /* Uncomment to keep only latest LCP file.
/* Will cut down on storage space needed but
/* nice to see what path looks like and required /* to run  cpf.aml.

/* Create a probabilistic or final LCP sensitivity analysis layer.
        lcp_sa_dir/temp_one%i% = con(lcp_sa_dir/final%i% == 3,1,0)
        lcp_sa_dir/temp%i% =
con(isnull(lcp_sa_dir/temp_one%i%),0,lcp_sa_dir/temp_one%i%)
        lcp_sa_dir/lcp_sa_%i% = lcp_sa_dir/temp%i% + lcp_sa_dir/final_%k%
        kill lcp_sa_dir/final_%k%
        kill lcp_sa_dir/temp_one%i%
        kill lcp_sa_dir/temp%i%


&setvar i = %i% + 1
&end
quit /* Quit grid and go onto something else
```

```
/* cpf.aml
/* Links Group Project
/* Donald Bren School of Environmental School and Management
/* 03/12/03
/* This script is written for Arc/Info 8.X but will most likely work for earlier
/* versions.
/* Author: Eric H. Fegraus
/*********************************************************************
/* This script creates a graph titled the Conservation Possibilties Frontier (CPF).
/* See text for explanation.  This graph will use create 3 sets of LCPS.
        /* Sensitivity Analysis paths  -- use lcp_sensitivity.aml to create them
        /* Random grid paths            -- uses the GRID random grid function
        /* Random Coefficients                   -- Varies the cost surface from 0-3
        /*                                  and generates an LCP

/* These LCPS are then used to clip out the values of ecological and land value
/* grids.  These values represent the ecological and economic costs of
/* that path.  These value are then exported as text files which can then
/* be imported by other software products to aggregate cell values and hence the
/* total values of the path. I'm sure this could be easily done in Arc/Info but
/* haven't had time to look into it.

/* The outputs are the paths created by the Random grid GRID function and the
/* random
/* coefficients.


/* Required Raster layers
        /* Input layers - 3 used here but can be easily adjusted.
        /* Destination  - Raster usually containing the border of one core area
        /* source       - Raster usually containing the border of the other core area
        /* Sensitivity Paths located in lcp_sa_dir
        /* lcp_cf_dir   - a directory to store random coefficient paths
        /* lcp_eco_dir - dir to store ecological paths w/ costs
        /* lcp_econ_dir - dir to store economic paths w/ costs
        /* carnivore_exp - the cost surface created in species_cost_surfaces_lcps.aml
        /* parcel_g     - a parcel layer with $/ha in every cell.
        /* eco_data     - dir to store .txt files with LCP cost surface values
        /* econ_data    - dir to store .txt files with LCP cost surface values
/* Note: If more than one destination core area repeat analysis or copy
/* and paste adjusting the destination raster.
/* This code will run much faster if it is broken up into manageable segments.
/*********************************************************************
```

```
grid
/* Set variables
&setvar i = 1
&setvar j = 1001

&DO &UNTIL %i% eq %j%
/* Generate random total cost surface
/* Add the input layers together
/* hs = 2 re = 2.66 s = 1.66
&sv rand_var_hs = [random 0 30] / 10
&sv rand_var_vs = [random 0 30] / 10
&sv rand_var_s =  [random 0 30] / 10
lcp_cf_dir/temp_hs = pow(ma_carnivore, %rand_var_hs%)
lcp_cf_dir/temp_re = pow(road_effects, %rand_var_vs%)
lcp_cf_dir/temp_s  = pow(slope, %rand_var_s%)

lcp_cf_dir/temp_cost = lcp_cf_dir/temp_hs + lcp_cf_dir/temp_re + lcp_cf_dir/temp_s

/* Kill temp vars
kill lcp_cf_dir/temp_hs
kill lcp_cf_dir/temp_re
kill lcp_cf_dir/temp_s

/* Create Simulated Random Coefficient LCP
lcp_cf_dir/outcost_a                                                              =
costdistance(dest_crnvr,lcp_cf_dir/temp_cost,lcp_cf_dir/out_dir_a)
lcp_cf_dir/lcp_cf_%i%                                                             =
costpath(source_crnvr,outcost_a,lcp_cf_dir/out_dir_a,byzone)

kill lcp_cf_dir/out_dir_a
kill lcp_cf_dir/outcost_a
kill lcp_cf_dir/temp_cost

/* Create Random grid paths
lcp_rc_dir/cost_surf = rand()
/* Create Simulated LCP
lcp_rc_dir/outcost_a                                                              =
costdistance(dest_crnvr,lcp_rc_dir/cost_surf,lcp_rc_dir/out_dir_a)
lcp_rc_dir/lcp_crnvr_%i%                                                          =
costpath(source_crnvr,lcp_rc_diroutcost_a,lcp_rc_dir/out_dir_a,byzone)

kill lcp_rc_dir/cost_surf
kill lcp_rc_dir/out_dir_a
```

```
kill lcp_rc_dir/outcost_a


/* Get total cost values from real cost surfaces for all simulated LCPS.
/* Eco cost
        lcp_eco_dir/eco_cf_%i% = con(lcp_cf_dir/lcp_cd_%i% == 3, carnivore_exp,
0)
        lcp_eco_dir/eco_rc_%i% = con(lcp_rc_dir/lcp_rc_%i% == 3, carnivore_exp,
0)
        lcp_eco_dir/eco_sa_%i% = con(lcp_sa_dir/lcp_crn_%i% == 3, carnivore_exp,
0)
/* Feas. Cost
        lcp_econ_dir/ecn_cf_%i% = con(lcp_cf_dir/lcp_cf_%i% == 3, parcel_g, 0)
        lcp_econ_dir/ecn_rc_%i% = con(lcp_rc_dir/lcp_rc_%i% == 3, parcel_g, 0)
        lcp_econ_dir/ecn_sa_%i% = con(lcp_sa_dir/lcp_crn_%i% == 3, parcel_g, 0)

/* Convert to integers to make a VAT. These are the paths with the correct cost
surface values.
lcp_eco_dir/eco_cfint%i% = int(lcp_eco/eco_cf_%i%
lcp_eco_dir/eco_rcint%i% = int(lcp_eco/eco_rc_%i%
lcp_eco_dir/eco_saint%i% = int(lcp_eco/eco_sa_%i%

lcp_econ_dir/ecn_cfint%i% = int(lcp_econ/ecn_cf_%i%
lcp_econ_dir/ecn_rcint%i% = int(lcp_econ/ecn_rc_%i%
lcp_econ_dir/ecn_saint%i% = int(lcp_econ/ecn_sa_%i%

/* Clean up
kill lcp_eco_dir/eco_cf_%i%
kill lcp_eco_dir/eco_rc_%i%
kill lcp_eco_dir/eco_sa_%i%

kill lcp_econ_dir/econ_cf_%i%
kill lcp_econ_dir/econ_rc_%i%
kill lcp_econ_dir/econ_sa_%i%

&setvar i = %i% + 1
&end

quit /* Quit and go onto exporting the data from paths

/* Export the data files for lcp_econ_dir
&workspace lcp_econ_dir/
Tables
&setvar i = 1
```

```
&setvar j = 1001

&DO &UNTIL %i% eq %j%
sel ecn_cfint%i%.vat
unload econ_data/ecn_cfint%i%.txt
sel ecn_rcint%i%.vat
unload econ_data/ecn_rcint%i%.txt
sel ecn_saint%i%.vat
unload econ_data/ecn_saint%i%.txt
&setvar i = %i% + 1
&end

&workspace ../lcp_eco_dir/
Tables
&setvar i = 1
&setvar j = 1001
sel eco_cfint%i%.vat
unload eco_data/eco_cfint%i%.txt
sel eco_rcint%i%.vat
unload eco_data/eco_rcint%i%.txt
sel eco_saint%i%.vat
unload eco_data/eco_saint%i%.txt
&setvar i = %i% + 1
&end
&workspace ..
q
&workspace ..
```

Appendix C – Ventura County GIS Base Data Layers

(Updated July, 2002)

Layer	Description
Street Centerlines	Street Centerlines with Street Names, Zip Codes and Address Ranges (new centerline file available August, 2002).
Parcels	Parcel lines, with APN attributes.
Tract Boundary Lines	Subdivisions along tract lot lines and R/W’s, not within R/W’s

Lot Dimensions*	text appropriate for 200' scale maps (very limited coverage)
Parcel Map Boundaries	Parcel map lines along lot lines and R/W's, not within R/W's
Mobile Home Park Lots*	Lot boundary lines
Easements*	Ingress and egress; flood control; utility; guy wires; public utility; pole easement; slope easement
Acreage*	text appropriate for 200' scale maps
Freeway Over/Underpass	text included
Abandoned roads	text included
Parks and Golf Courses*	
Mean High Tide Line	text included
Geographical Place Names*	Canyons, points, etc
Bench Marks	
R/W width dimensions*	text appropriate for 200 scale mapping
Railroad R/W	sidelines, track locations
Railroad text	e.g. Pacific Railroad
Street names	outside of R/W, text appropriate for 500' scale mapping
Street names	inside of R/W, text appropriate for 500' scale mapping
Tract Numbers/Names	text appropriate for 500' scale mapping, includes record reference
Parcel Map text	text appropriate for 500' scale mapping
Hydrologic Features	Oceans, rivers, lakes, streams, harbors, includes text
Records of Survey	500' scale Records of Survey references
Section Corners	500' scale section corners, section numbers, township and range numbers, township and range lines
Section lines	
National Forest/Park	Boundaries, with text; Los Padres Forest and Santa Monica Mts

Old R/W	lines
Dirt Roads	includes roads of 40’ width or more, includes road names
Private R/W’s	includes those with deeded access
Private Road Centerlines	
Administrative Boundaries	cities, special districts, supervisory districts, spheres of influence School districts, college trustee districts, election precincts

* These data layers are not complete for the entire County.   Source: Ventura County GIS Division

Appendix D – Implementation Strategies

Mitigation

General Background

Mitigation strategies are used to alleviate or compensate for activities, which are negatively impacting the habitat of native flora and fauna such as development of houses or roads. Mitigation strategies include: development permits, mitigation fees, wildlife crossings, land exchanges, and transferable development rights. These strategies will be discussed in greater detail below. Many of these strategies are contingent on the habitat corridor being designated as an overlay zone by the county.

Mitigation Strategies

Development Permit

Landowners involved in a development permit program are required to dedicate environmentally sensitive lands as a condition of receiving entitlements. The most common example of the development permit is a requirement of The California Planning, Zoning and Development Laws, known as the Quimby Act, (Government Code § 66477) which permits local agencies to require dedication of parklands as a condition of development approval. Dedication requirements are mandatory because development entitlements are conditioned on satisfying mitigation needs.

This is a useful strategy used by most jurisdictions. However, development permit projects are difficult to implement in an inter-jurisdictional setting. This is because a developer is generally required to secure separate development permits from each applicable jurisdiction. Another drawback of this strategy is that it fluctuates the economic momentum of the private sector. Thus it is hard to predict and manipulate when this strategy is implemented. (Glickfeld 2000).

Feasibility in Ventura County

Development permits could be used in Ventura to help preserve land within urban areas for use in a corridor. Ventura County has a Parks Department that has the ability to manage and oversee such parklands. The designation of a corridor would allow the Parks Department to place parks established by development permits strategically throughout the corridor to allow for movement of species. Currently, there is no coordination by the parks department to place parks in a systematic manner as to allow movement of species throughout the landscape.

Development or Mitigation Fees

The California Planning, Zoning and Development Laws, known as the Quimby Act, Government (Government Code § 66477) allows a city to collect mitigation fees from developers in specified impact or benefit areas in exchange for the rights to develop a property. Mitigation fee programs require a developer to pay a fee for every acre or unit developed. Revenue is used for conservation purposes such as to purchase new land to protect open space and habitat areas. Typically, the habitat or open space is obtained by an acquisition agency that also manages the land and conservation easements for the city.

Development fee programs are typically successful particularly when a city has the preexisting infrastructure to deal with the administrative demands. The drawback of this strategy is that it is development driven thus; it is best suited to be used in urban areas where development is prominent. Also, since the strategy is development driven it is subject to fluctuations in the housing market.

Feasibility in Ventura County

Ventura County already includes development fees in its discretionary permitting process. One of the development fees imposed on new residential dwellings in Ventura County is applied towards local parks providing money to the local park district or the County General Services Agency (GSA) which houses the Parks Department for the improvement of existing parks and/or the purchase of new parks.

Development fees could be expanded to include funding for the improvement of acquisition of lands for open space or for greenbelt agreements. Greenbelt agreements are agreements between a county and its cities to limit annexations and development within specified areas that typically encompass land that is outside of the cities' Sphere of Influence and SOAR boundaries (VC General Plan, land use appendix). There are currently seven existing greenbelts in the County that affect approximately 155,300 acres of unincorporated agriculture and open space lands. Three of these greenbelt agreements lie within our study area.

Wildlife Crossings

Background

The Transportation Equity Act for the 21st Century (TEA-21), implemented through the US Environmental Protection Agency (EPA), authorizes over $200 billion to improve the Nation's transportation infrastructure, enhance economic growth and protect the environment (TEA 1998). The Act, among other things, creates new opportunities to improve water quality, restore wetlands and natural habitat, and rejuvenate urban areas through transportation redevelopment, increased transit and sustainable alternatives to urban sprawl.

Transportation project planning and funding processes are locally and State-driven. As part of its long-term transportation plan, each State and metropolitan area develops transportation improvement programs (TIPs), which prioritize projects and funding. Only projects in an approved TIP are eligible for Federal funding. Through additions to both the Surface Transportation Program (STP) and the National Highway System (NHS), TEA-21 creates flexibility to fund environmental enhancement opportunities.

Programs under TEA-21

Environmental Streamlining: TEA-21 requires that Federal Agencies work together to streamline environmental review of transportation projects. The goal of this provision is to integrate the review process and allow State and Federal Agencies to better address important considerations such as analysis of alternatives and cumulative environmental impacts of transportation projects.

Transportation-Environment Cooperative Research Program: This provision funds research into the relationship between highway density and ecosystem integrity. It also requires the establishment of an Advisory Board that makes recommendations about environmental research, conservation and technology transfer.

Metropolitan and Statewide Planning: TEA-21 consolidates the metropolitan and statewide planning criteria established in 1991. This program provides state and local agencies an opportunity to look at "sprawl" and to better integrate consideration of watershed plans, wetlands, habitat and open space.

Critter Crossings: The U.S. Department of Transportation's Federal Highway Administration has a program called Critter Crossings. The purpose of this program is to address issues of roadkill, habitat fragmentation, and habitat loss due to public roads. The program provides solutions such as freeway under and overpasses for wildlife and humans. The program also provides funding for programs as well as information on partnership building to achieve program goals.

Wetlands Mitigation Banking: TEA-21 establishes a preference for mitigation banks in STP or NHS projects that involve natural habitat or wetlands mitigation. Impacts would have to occur within the service area of the mitigation bank (e.g. watershed), and the bank would have to be approved in accordance the Federal Mitigation Banking guidance and other applicable federal laws and regulations.

Feasibility in Ventura County

The creation of a designated corridor area recognized by the county would allow the county to create transportation improvement programs (TIPs) along the 126 freeway. Thus, the programs and funding discussed above under the Transportation Equity Act would be available to the county. This would provide the county with an infrastructure and funding to implement and maintain the corridor in our study area.

Land Exchange

Land exchanges occur when a large public or private agency, that owns land with habitat or open space value for purposes other than resource protection, specifically designates such land for resource protection through legal commitment, or donates that land to a land trust. Alternatively, land owned by a large public or private landowner, which is not suitable or needed for open space conservation, is made available for exchange for private lands needed for conservation.

Private landowners can receive tax benefits by donating conservation land to a public or nonprofit entity. Conducting a land exchange secures development permits and may be quicker and more cost effective than seeking individual private landowners willing to sell mitigation land. Land exchanges are covered by Section 1031 of the IRS code. Exchanges or donation in return for development entitlements are not eligible for tax benefits.

Transferable Development Rights

Background

A Transfer of development rights program allows landowners to transfer the right to develop one parcel of land to a different parcel of land. Generally, TDR programs are established by local zoning ordinances. The parcel of land where the rights originate is called the "sending" parcel. When the rights are transferred from a sending parcel, the land is restricted with a permanent conservation easement. The parcel of land to which the rights are transferred is called the "receiving" parcel. Buying these rights generally allows the owner to build at a higher density than ordinarily permitted by the base zoning. TDR is sometimes known as transfer of development credits (TDC) in California (http://www.farmlandinfo.org/fic/tas/tafs-tdr.html).

TDR programs are based on the concept that property owners have a bundle of different rights, including the right to develop, and some or all of those rights can be transferred or sold to another person. When a landowner sells property generally all the rights are transferred to the buyer. TDR programs enable landowners to separate and sell the right to develop land from their other property rights (http://www.farmlandinfo.org/fic/tas/tafs-tdr.html).

TDR is most suitable in places where large blocks of land remain in open space or agricultural use, and that land is under encroachment by development. Jurisdictions also must be able to identify receiving areas that can accommodate the development to be transferred out of the open space or agricultural area. The receiving areas must have the physical capacity to absorb new units, and residents of those areas must be willing to accept higher density development. Often, residents of potential receiving areas must be persuaded that the benefits of protecting open space or agricultural resources outweigh the costs of living in a more compact neighborhood. TDR programs are distinct from purchase of agricultural conservation easement (PACE) programs because they involve the private market. Most TDR transactions are between private landowners and developers. This is an important benefit in Ventura County, where purchasing conservation easements is almost impossible for Land Trusts and Conservancies due to SOAR.

A few jurisdictions have experimented with public purchase and "banking" of development rights. A TDR bank buys development rights and sells the rights to private landowners. These programs have been extremely successful due to their ability to maintain market flow when the economic climate fluctuates (http://www.farmlandinfo.org/fic/tas/tafs-tdr.html).

The success of a TDR program relies on the creation of the proper market. There are ten factors that assist in creating an ideal TDR program market. The program must: 1) Plan comprehensively, 2) Motivate sending site owner to sell their development rights, 3) Motivate receiving site developers to buy development rights, 4) Make TDR approvals fast, easy, and certain, 5) Treat development rights as a commodity, 6) Form a TDR bank or revolving fund, 7) Provide other incentives to receiving site developers such as fees exemptions or relaxed code requirements, 8) Provide staff and resources for implementation, 9) Monitor program performance, 10) Refine the program as needed (Pruetz 1997).

TDR Relevance in Ventura County

Ventura County is in a tremendous position to initiate a TDR program. An assessment of the ten factors for creating a market for TDRs in Ventura County indicates that while the precise infrastructure is not yet in place for a TDR program, many of the necessary components of these factors are established or are being established.

Ventura is currently looking at TDR programs as a way to permanently preserve agricultural landscapes and open space. The proposed Open Space District will strive to conserve open space through strategies other than acquisition. A tremendous amount of time and energy is currently being used to design where the OSD will target their conservation projects. When incorporating a TDR program, that kind of effort will be necessary to examine the location of sending and receiving sites.

Ventura County currently has development restrictions on properties outside of the SOAR boundaries. This should provide an incentive for sending site landowners to participate in a TDR program. Currently the receiving site motivation may be low. Development within the SOAR boundaries often does not reach its full density limit. However, as SOAR is taking effect, this trend may change due to the growth within SOAR boundaries and the emergence of metropolitan characteristics in cities.

A TDR bank could be formed from one of a variety of organizations within Ventura County. Organizations such as the Ventura Agricultural Land Trust, Ojai Valley Land Conservancy or The Nature Conservancy could purchase the TDR credits and sell them to developers to be used at receiving sites.

There are many organizations, such as the Ventura County Farm Bureau and the Ventura Agricultural Land Trust, that seek to obtain permanent conservation of agricultural resources. Their involvement in the process could provide the education, marketing and facilitation resources that are necessary in a successful TDR program.

These are some examples of the characteristics that Ventura County possesses, indicating that a TDR program could be quite successful. Eventually, the implementation of such a project will depend on the willingness of the county planning department to actively participate in such a program.

Alterations to TDR Programs

In-Lieu Fees

At times a TDR can become complicated. To avoid this, In-Lieu fees can be paid by developers of receiving sites. These developers are not actually buying TDRs, however the money generated from the fees is put into a revolving fund that can then be used to purchase the maximum amount to development rights. The fee needs to be set at a price that encourages the developers to pay them and still run a profit, as well as be high enough such that the revenue gained is enough to purchase development rights. A revolving fund or TDR bank is necessary for this transaction to occur. An example of this is the Malibu Coastal Program, which was funded by the California Coastal Conservancy.

Mandatory TDR Programs

These programs require a developer to purchase a TDR from a willing sender or a revolving fund in order to develop a "receiving" site. However, the developer does not gain any advantage by buying the TDRs. In Morgan Hill, CA a developer must purchase 1 TDR for every 25 units proposed to be developed. The sending sites are located on a designated area of hills that would normally not be very developable, providing incentive for the sending site owner to sell their development rights. Those sending sites are areas of open space valued by the population in that region.

Clustering TDR Programs

This is a voluntary process that allows transfers on a single parcel. As a matter of right, the landowner may develop a certain number of units on the property in accordance with the zoning. For example, an owner may be able to develop their 100-arce agricultural parcel, building 5 units on five 20-acre lots. The landowner may be allowed to cluster the development (all 5 units) onto adjacent 1-acre lots by providing an easement for the remaining 95% of the property. Sometimes, just the incentive of the ability to build the units in close proximity to one another is enough, however if more incentive is needed the landowner may be allowed to build at a higher density. One problem with this program is that there might be development near sensitive habitat (linkage) areas. An example of this program is Boulder, CO.

Planning and Zoning

General Plan

A general plan is a jurisdiction's long-term strategy for future growth within its boundaries. It includes a set of broad policies generated from the community's goals that direct future development. The general plan guidelines only provide a framework from which local land use decisions can be evaluated; it does not include implementation strategies. Section 65302 of the Planning and Zoning Law (The California Government Code) requires that the general plan contain seven elements that address specific issues influencing land use and development. The mandated elements include land use, circulation (transportation), housing, conservation, open space, noise and safety, however these elements can be added to depending on the needs of a jurisdiction.

The main purpose of the general plan is to provide a framework for informed decision-making regarding the direction of development, however one aspect of this plan must include the foresight to preserve natural resources for safeguarding of the economy, future use and enjoyment. The conservation and open space elements are the most obvious locations for addressing the conservation issue such as the preservation of threatened and unique habitats, wildlife, open space and other natural resources. The conservation element focuses on the preservation, development and use of natural resources including water, forests, soils, minerals, wildlife and others. The open space element is a long-term plan for the conservation of open space in the community recognizing that open space is a limited and valuable natural resource.

The legal authority for local jurisdictional conservation efforts stems from various federal and state regulations, including the following:

Federal Regulations

- The Endangered Species Act (ESA) (7 U.S.C. 136;16 U.S.C. 460 et seq.) – Creates a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found.
- National Environmental Policy Act (NEPA) (Public Law, Section 90 – 109, 42 U.S.C. 4321-4347) – Requires all federal agencies to identify, evaluate the significant environmental impacts and methods in which these can be prevented or mitigated.
- Fish and Wildlife Conservation Act (Nongame Act; 16 U.S.C. 2901-2911; 94 Stat. 1322) – Offers support to states to develop and implement conservation programs for non-game fish and wildlife.

State Regulations

- California Constitution, Article XI, section 7 – State delegates regulatory power to local jurisdictions (counties and cities).
- California Environmental Quality Act (CEQA) (CA Public Resources Code Section 2100.) – Requires California public agencies to identify significant environmental effects, and to avoid or mitigate those effects when feasible for projects that require their approval through the creation of an Environmental Impact Report (EIR). Unlike the federal statute, CEQA requires that negative effects due to growth being evaluated.
- Planning and Zoning Law (California Government Code, Title 7, Chapter 3, Article 10.5, Section 65560) – State requires that local jurisdictions prepare and implement a plan to protect local open space.
- Planning and Zoning Law (California Government Code, Title 7, Chapter 3, Article 5, Section 65302) – State requires that each local jurisdiction prepare and implement a plan for the conservation and sustainable development of natural resources.
- California Endangered Species Act (CESA) (California State Fish & Game Code Section 2050) – Parallels the federal version, The Endangered Species Act.
- The Wildlife Conservation Law (California Fish and Game Code, Sections 1300 – 1301) – California policy on the conservation, protection and restoration of wildlife and high-quality habitat.
- The Native Species Conservation and Enhancement Act (California Fish and Game Code, Sections 1750 – 1756) – Directs state policy to preserve and protect viable populations of wildlife and plants and their habitats for their use, ecological and existence values.
- The Wildlife Habitat Enhancement Act (California Fish and Game Code, Sections 2600 – 2602) – Provisions to provide funding for habitat restoration in the most severely degraded ecosystems in California.

All of these regulations must also adhere to the 5th amendment of the United States Constitution that prohibits the 'taking' of private property without equal compensation. This amendment protects individual's private property rights from eminent domain issues.

Relevance in Ventura County

The Ventura County Board of Supervisors adopted *Ventura County General Plan: Goals, Policies and Programs* in 1988. The County has divided their general plan into four chapters entitled Resources, Hazards, Land Use and Public Facilities and Services. Policies for the seven mandated elements are incorporated into these sections where applicable (Figure D.1). Each chapter also includes an appendix that provides background information and data that support County development policies. The current general plan presents policy options for growth to 2010. There is no schedule for the next overall general plan revision, however the housing element was updated in 2001.

State Requirements	Ventura County General Plan Chapter and Appendix Location			
	Resources	Hazards	Land Use	Public Facilities & Services
Land Use Element				
Housing			X	
Business			X	
Industry			X	
Open Space	X	X	X	X
Agriculture	X			
Scenic Beauty	X			
Education				X
Public Buildings & Grounds				X
Solid & Liquid Wastes		X		X
Population Density/Building Intensity			X	
Flooding		X		X
Timberland Production	X		X	
Circulation Element				
Major Thoroughfares				X
Transportation Routes				X
Terminals				X
Utilities				X
Housing Element			X	
Conservation Element				
Water	X			X
Hydraulic Force		X		X
Forests	X			
Soils	X			
Rivers	X	X		X
Harbors				X
Fisheries	X			
Wildlife	X			
Minerals	X			
Open Space Element	X		X	
Noise Element		X		
Safety Element		X		X

Figure D.1 – Ventura County Chapter Summary

The information and policies that affect the implementation of wildlife corridors in southern Ventura County exist in the conservation and open space elements of the Ventura County General Plan document. These elements are spread throughout the document, however the Resources chapter of the Ventura County General Plan most heavily addresses these issues. Therefore this section will focus on describing the data and policies presented in the Resources section only.

Resource Chapter

The resource section develops policy and programs to address the conservation and usage of nonrenewable resources defined as air, water, minerals, biological organisms, farmland, scenic and cultural assets, energy and coastal property.

The County has a threefold goal for resource management that consists of:

1. Inventory and monitoring of resources
2. Appropriate protection, use and access to all resources within Ventura County
3. Collaboration with all organizations that deal with the County's resources

These goals are supported by a broad policy stating that county directives including General Plan amendments, zone changes and discretionary development projects should be evaluated using CEQA guidelines. The remainder of the policy directs the use of mitigation to prevent potential negative impacts that the previous changes may have on the status of resources within Ventura County. The specific implementation actions that the county recommends consist only of an annual review of the programs specified in each individual resource section.

Biological and farmland resources are the two most relevant sections to our project. Our study area is particularly unique because it consists almost entirely of agricultural land. Therefore agricultural preservation issues are addressed just as heavily as purely biological conservation.

Biological Resources

The main goal of the biological resources section of the Ventura County General Plan is to protect 'significant biological resources' in the County from conflicting land uses and development. These resources are generally defined as plant or animal species, their habitats and the surrounding ecosystems. These resources include threatened, rare or locally important species, their habitats and migration corridors. While the California Department of Fish and Game is responsible for fish and wildlife resources in the state, Ventura County maintains the ecosystem components that support these resources. This is reflected in the County's emphasis on vegetation and habitats, rather than individual species.

The County's policies focus primarily on the proper evaluation and consideration of discretionary development projects (Ventura County General Plan).[4] The basic restrictions include the consultation of a qualified biological consultant and various federal, state and non-profit agencies to assess impacts when biological resources may be affected, and the incorporation of all feasible mitigation measures. More specific guidelines are provided for discretionary development that occurs near significant wetland habitat.

The County biological resource programs include the identification of endangered species, maintenance of a list of biological consultants, the use of prescribed burning to enhance habitat and biological resource protection area for wetland habitats.

Farmland Resources

The agricultural resource section of the Ventura County General Plan addresses farmland preservation specifically for its importance as a significant part of the local economy. The County's primary objective is to protect farmland as a resource that produces food and other products. In support of this objective, Ventura County also promotes the development of auxiliary agricultural businesses that enhance and support farms. Farmland preservation is based upon the inventory of existing agricultural resources. The main tool used is the Federal Important Farmland Inventory (IFI) that assess agricultural land based on it productive capacity (Ventura County General Plan). Given the objective of farmland as an economic asset, a majority of the County's policies and programs are directed towards sustaining and enhancing the economic viability of farms.

The County's farmland preservation policies are based on making farms more viable from an economical and operational perspective. Most of the policies exist to address the economic reasons why farmland is converted to other uses. Discretionary development on land zoned agricultural must be designed to minimize the removal of land from farming and the negative impacts on soil. Expanding the use of greenbelts and disallowing the conflicting land uses near farms are other county policies. In addition the use of Land Conservation Act (LCA) contracts on agricultural land provides economic incentives.

The existing County programs that support farmland resources are: updates to the Land Conservation Act and the Important Farmland Inventory, development of standards for development occurring adjacent to farmland and the creation of an annual report reviewing the status of LCA contracts in the county.

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[4] Discretionary development is any development proposal, project or permit which requires the exercise of judgment, deliberation, or decision on the part of the decision-making authority in the process of approving or disapproving a particular activity, as distinguished from situations where the decision-making authority merely has to determine whether there has been conformity with applicable statutes, ordinances, or regulations.

Discretionary Development
As required by CEQA, an Initial Study must be completed for each discretionary project in Ventura County unless an Environmental Impact Report has been completed. The assessment considers the individual and cumulative impacts to Resources, Land Use, Hazards and Public Facilities and Services.

The biological resources section considers impacts to endangered/threatened species, wetland and coastal habitat, locally important species/communities and migration corridors. This section will focus on impacts to endangered species and migration corridors, which are defined as areas that experience recurrent fish or wildlife movement, and are important to species movement. The guidelines state that significant impacts to endangered species would result if the project effects reduced species population or habitat, or reduced their capacity to breed, and for migration corridors are those that would substantially interfere with the use of the area by fish or wildlife. Interference of the use of the area could occur through elimination of native vegetation, erection of physical barriers, or intimidation of fish or wildlife through the introduction of noise, light, development or increased human presence (Ventura County Initial Study Assessment Guidelines).

A qualified biologist must complete the assessment if the project area is not:

1. Developed/under cultivation/devoid of vegetation
2. Not adjacent to native vegetation areas
3. At least 300 feet from wetland habitat
4. At least 500 feet from coastal or intertidal areas in the defined Coastal Zone

The agricultural resources section addresses the impacts to farms in terms of air quality, soil, water quality and availability, pests/diseases and incompatible uses.

Recommendations
Following are broad recommendations that create a positive climate for conservation by increasing the importance placed on wildlife preservation, habitat restoration, and sustainable use of all natural resources. The recommendations are as follows:

- The County should **establish a separate chapter in the General Plan** to address conservation problems and policies. The conservation of animals, plants, other natural resources and whole ecosystems are interrelated on an ecological and policy levels. This section synthesizes the data and policies for a more effective presentation and result. This section should include the following:
    - Equal importance on conservation goals for future use purposes and for preservation of biodiversity and natural ecosystems, and for enjoyment and appreciation of conserved individuals or systems.
    - Encourage restoration as a conservation tool.

- More effectively **emphasize the importance of natural resource conservation** for the improved health of ecosystems, preservation of the natural 'wildness' and beauty, and maintenance of the land characteristics that attract people to the study area.

- Amend the General Plan to include more **specific references to wildlife and migration corridors** with reference to their ecological importance and the necessity to protect them.
    - Produce a system of mapped wildlife corridors, a detailed documentation of the negative impacts that development projects could have on their success, or a plan to protect these habitat corridors.
    - Preparation for creation of a special biological resources protection area for wildlife migration corridors that applies special regulatory measures.

- Amend the General Plan to **recognize that farmland has multiple values** in addition to being an important component of the region's economy and a food producer. Other values include providing buffers between urban and natural areas, community growth management tools, scenic views, open space areas, air and water protection and habitat for wildlife. The following steps should be included:
    - Formal identification of additional farmland values.
    - Establish additional programs that recognize these values, and provide incentives for their protection and enhancement.

- Amending the **Initial Study Assessment Guidelines** to include more specific corridor data, each project would have to be evaluated to project the presence and severity of development effects on the existing environment.

Use of the General Plan to assist in conservation efforts is a valuable supplement to other implementation strategies, however it should be noted that the general plan is not permanent in nature. The flexibility of the document allows for revisions based on the changing priorities and objectives of a community, yet there is also less stability in the proposed conservation goals. In addition the process to change the General Plan, or propose an amendment is variable in terms of time and complexity.

Zoning

Zoning divides a jurisdiction into separate districts and prescribes what land uses can occur within them. In California zoning is typically the tool that implements the general plan because California law requires that there is 'consistency' between a county's general plan and the zoning ordinances. Fulton (1999) states, "The goals and principles of the plan are supposed to be translated into parcel-specific regulations by the zoning ordinance." The zoning ordinances are laws that divide land into 'zones' with specific permitted land uses and required standards. The California Government Code Section 65850 authorizes zoning ordinances, and provides them with their legal basis – local jurisdiction's regulatory power.

The zoning ordinance usually consists of three aspects: use, bulk and 'impact' that dictate usage requirements (Fulton 1999). The use aspect is the most fundamental parameter within the zoning ordinance. It defines use districts, or zones in which the type of development is restricted to certain uses such as agricultural, residential or commercial. Each zone has additional restrictions placed on it in the form of specific development standards. These standards set a structural 'envelope' into which buildings must fit. Lot area, percent coverage of buildings, paving and other structures, setbacks, height limits are some of the specific provisions defined within the bulk aspect. The third aspect consists of guidelines to mitigate the negative impacts that may be caused by a particular usage or structures. Some common examples include the creation of additional parking with new building construction, or required landscaping for certain development projects.

Relevance in Ventura County

The *Ventura County Non-Coastal Zoning Ordinance* was initially enacted in March 1947 through Ordinance 412. The main goal of the first code was to amend the Uniform Building Code, however it also established the initial zoning of the land. The current stated purpose of the Zoning Ordinance is "…to provide the environmental, economic and social advantages which result form an orderly, planned use of resources; to establish the most beneficial and convenient relationships among land uses and to implement Ventura County's General Plan (Ventura County Non-Coastal Zoning Ordinance)." The Zoning Ordinance has been amended several times during the past 55 years, however major revisions occurred in 1968, 1983 and 1995, and it was last amended in 1999.

The County Zoning Ordinance designates sixteen separate zoning districts, or base zones (Figure D.2). In order to regulate these zones, each is given a unique abbreviation and minimum lot area.[5] In addition to these provisions, the purpose, allowable uses, 'envelope' requirements or development standards, and specific use and zone type standards are defined. The purposes are divided into general zone categories that include: open space/agricultural, rural residential, urban residential, commercial, industrial, special purpose and overlay. The 'permitted uses by zone' section uses a matrix to define the type of permit required for hundreds of specific uses, such as animal husbandry, cemeteries, filming activities and sewage treatment facilities, allowed with each zone.

[5] A minimum lot area is the minimum required gross or net area of a lot for subdivisions, uses of land and/or structures, and for other specified activities (Ventura County Non-Coastal Zoning Ordinance).

Zoning District Base Zones	Abbreviation	Minimum Lot Area*
Open Space	O-S	10 Acres
Agricultural Exclusive	A-E	40 Acres
Rural Agricultural	R-A	1 Acre
Rural Exclusive	R-E	10,000 square feet
Single-Family Estate	R-O	20,000 square feet
Single-Family Residential	R-1	6,000 square feet
Two-Family Residential	R-2	7,000 square feet
Residential Planned Development	R-P-D	As specified by permit
Commercial Office	C-O	No Requirement
Neighborhood Commercial	C-1	No Requirement
Commercial Planned Development	C-P-D	No Requirement
Industrial Park	M-1	10,000 square feet
Limited Industrial	M-2	10,000 square feet
General Industrial	M-3	10,000 square feet
Timberland Preserve	T-P	160 Acres
Specific Plan	S-P	Established by Plan
Overlay Zones		
Scenic Resource Protection	/SRP	Not Applicable
Mineral Resource Protection	/MRP	Not Applicable
Scenic Highway Protection	/SHP	Not Applicable
Community Business District	/CBD	Not Applicable

* See sections 8103-1.1 and 8103-1.2 of the Ventura County Non-Coastal Zoning Ordinance for exceptions.

Figure D.2 – Ventura County Zoning Ordinance (Base Zones)

The type of permits are defined by the following levels:

- Not Allowed
- Allowed, but exempt from obtaining a Zoning Clearance
- Zoning Clearance, or other ministerially approved permit unless specifically exempted.[6]
- Zoning Clearance or other ministerially approved permit with signed waivers
- Planning-Director-approved Planned Development Permit
- Planning Commission-approved Planned Development Permit
- Board of Supervisors-approved Planned Development Permit
- Planning Director-approved Conditional Use Permit[7]
- Planning Commission-approved Conditional Use Permit
- Board of Supervisors-approved Conditional Use Permit
- Given the large amount of agriculture and the short-term development restriction due to SOAR in the study area, the remainder of this analysis focuses on the open space, agricultural and residential zones

The setback, building and other development standards vary among the designated zones. The minimum required setbacks for open space and agricultural exclusive zones are 20 feet, 10 feet, 20 feet and 15 feet for the front, side (interior/corner lots),

[6] A ministerial act is one in which the local government has no discretion; it usually involves the mandatory issuance of a permit if certain conditions are met (Fulton 1999).

[7] A conditional use permit is "a mechanism that allows a local government the ability to permit specific uses not otherwise allowed, as long as the landowner or business owner meets certain conditions (Fulton 1999)."

side (reverse corner lots) and rear respectively. In addition to the minimum lot area, the setback/height standards and the specific standards for particular permitted usages, the majority of the remaining regulation is applied in general standards for each zone.

The general standards for these zones are described in Section 8109-1 of the Ventura County Zoning Ordinance. The standards state that there should not be more than one principal residential structure on any lot, and not more than two dwellings on any lot in the R-2 zone. There are additional comprehensive guidelines specifically for the Residential Planned Development (R-P-D) zone. Section 8109-1.2.4 contains the open space requirements for the R-P-D zone; the salient points of this section are:

- At least 20% of the net area of the site should be private or common open space such as parks, recreational facilities, greenbelts and bike and pedestrian paths.
- This space should be suitably improved for its intended purpose.
- 75% of golf courses, lakes and reservoirs can be used to the above allotment of open space.
- These minimum open space standards can be modified by the decision-making authority if alternative, but comparable, value amenities are provided.

Agricultural and Residential

As expressed in the General Plan, Ventura County recognizes that agriculture plays an important part in the local economy, and has taken steps to protect and nurture this industry. The County has adopted various programs to facilitate agricultural preservation including agricultural land use zone designations.

Ventura County has four agricultural-related zones: Agricultural Exclusive (A-E), Rural Agricultural (R-A), Rural Exclusive (R-E) and Single-Family Estate (R-O). (Figure D.3) The A-E zone falls within a larger zone entitled Open Space/Agricultural Zones, while the other three zones make up the Rural Residential Zones. The A-E zone is the only zone that is strictly agriculture related, while the others incorporate residential uses as well. The purpose of the A-E zone is to "preserve and protect commercial agricultural lands as a limited resource…". The R-A, R-E and R-O zones increasingly move from agricultural-focused uses to purely residential uses respectively while allowing a complementary portion of the other use. Therefore there is only one zone that protects agriculture as a major industry against non-farming uses.

Base Zones	Minimum Lot Area
Agricultural Exclusive (A-E)	40 Acres
Rural Agricultural (R-A)	1 Acre
Rural Exclusive (R-E)	10,000 sq. ft.
Single-Family Estate (R-O)	20,000 sq. ft.

Figure D.3 – Ventura County Zoning Ordinance (Agricultural Zones)

The remaining three zones provide residential options in a rural setting with varying degrees of other permitted uses. In fact, the least strict rural residential zone, R-O, provides of 'residential estates' where only rural 'atmosphere' is maintained through the allowance of horticultural activities and animals for recreational purposes.

Open Space

The defined purpose of the open space zones is "to provide for the conservation of renewable and nonrenewable resources, to preserve and enhance environmental quality and to provide for the retention of the maximum number of future land options while allowing reasonable and compatible uses on open lands in the County which have not been altered to any great extent by human activities (Ventura County Non-Coast Zoning Ordinance)." There are no additional specific standards guiding development in these areas beyond the general standards for the open space zone.

Recommendations

- Amend the purpose of the open space zone (Section 8104-1.1) of the Ventura County Zoning Ordinance to reflect a higher importance on the protection of specified 'resources', rather than the current approach which places higher emphasis on current and future economic use of the resources.
- Incorporate wildlife corridors into the concept of 'resource' in the zoning ordinance. (Also accomplished in the General Plan recommendations.)
- Amend the County Zoning Ordinance to create a special overlay zone for wildlife corridors that place additional restrictions on the area within the zone. (see Overlay Zone below for additional details)
- Amend the County Zoning Ordinance to create a special agricultural cluster zone. (see Cluster Development section below for additional details)

Overlay Zone

An overlay zone is a mapped area, or zone, onto which additional restrictions are placed. It is designed to preserve, protect and enhance the natural resources within the County, in this case biological resources. This could be a strong tool for corridor implementation that is easily incorporated into the County's current zoning techniques. The county currently uses overlay zones to protect areas such as scenic resource areas but it has never been used for corridors. In order to designate an overlay zone the County's Zoning Ordinance would need to be amended.

Below are some additional restrictions that would be beneficial to a corridor overlay zone:

- Increase minimum lot area.
- Require cluster development. (See Cluster Development section)
- Apply more strict discretionary evaluation criteria.

- Develop a more detailed plan to protect the corridor biological resources
- Mitigation for development with the overlay zone must be performed in the same location/area.
- Mitigation must be comparable to damage inflicted.
- Allow development outside the overlay zone to satisfy their mitigation requirements within corridor overlay zone (i.e. Using TDR or banking scheme).
- Strict noise standards.
- Revise standards for residential development projects that provide more open space.
- Increase setbacks.
- Require the construction of conservation buffers. (See Buffer section below)
- Increase level of discretionary permit needed.
- Infrastructure improvements, particularly for transportation (culverts, overpasses, bridges, leading fences, etc.)

Buffers
Conservation buffers are physical barriers between conflicting land uses, typically separating development from residential, agriculture or sensitive ecological habitat areas. Buffers usually are small areas or strips of land in permanent vegetation, designed to prevent water runoff, provide shelter and stabilize degraded areas. Specific buffers used with agriculture include contour buffer strips, field borders, filter strips, grassed waterways, living snow fences, riparian buffers, windbreaks, and wetlands.

Buffers can also be used to enhance wildlife habitat and preserve biodiversity. These buffers typically consist of a strip of land up to 300 feet in width that provides open space or more suitable habitat for native species. The addition of buffers to a zoning requirement would provide another tool that would enhance the habitat suitability within the designated corridors. However these buffers could also be regulatory in nature, acting as a land use barriers imposed through zoning ordinances. A beneficial zone change would call for limited use and restricted building types, densities and sizes. Funding for design and construction of these buffers is offered through various state and federal program such as the Wildlife Habitat Incentives Program (WHIP), Wetland Reserve Program (WRP) and Environmental Quality Incentives Program (EQIP) within the Farm Bill.

Cluster Development/Zoning
Most farmland today is on the urban-rural fringe, and faces increased threats such as loss due to sprawl, increased pollution and erosion, due to the encroaching suburbs. Additional problems as experienced by the residential aspect include noise pollution, unpleasant odors, dusty conditions and potential exposure to harmful chemicals. However changes to the local zoning ordinances can provide some relief to these

problems by providing a geographic and protectionist buffer between these two incompatible land uses. Agricultural zoning is usually the first line of defense to protect farmland by separating agriculture from other non-farm uses (Daniels 1999). There are various zoning techniques that can be used to preserve agricultural land; some include exclusive agricultural zoning, sliding scale zoning, quarter zoning, large lot zoning, agricultural buffers and cluster zoning.

Cluster development, specifically agricultural cluster zoning, is a tool that can be utilized to preserve farmland for use as a wildlife corridor. Agricultural cluster zoning is a zoning ordinance that requires the grouping of houses or other structures to a specific portion of the land, leaving the remainder of the parcel as open space, particularly for continued farming. In contrast to the other agricultural zoning techniques, cluster development does not focus on limiting the type of land use, or production capability, but rather on making more efficient use of the available space (Marquette County Information System). The main objective of this tool is to create high-density development that limits the disturbance caused by development to a smaller area while keeping the number development units constant.

The cluster-zoning ordinance dictates the allowable development or residential densities in the agricultural cluster zone. Some local ordinances may also include design and review guidelines, right-to-farm provisions and authorization for commercial farming enterprises. All of these factors are meant to support farm preservation through increased profitability and operation facilitation.

Ventura County already has some strong agricultural aspects in their zoning ordinances into which they can incorporate cluster zoning. The A-E zone minimum lot areas are set relatively high providing ample opportunity for viable farming to continue. This minimum area is on the high side to support “ranchette” style residential/agricultural entities. Currently the County allows only one principal residential structure on any lot, except in certain circumstances within the open space, agricultural and residential zones listed above. While this is a low density, the impacts of these structures on the existence and maintenance of a corridor could be lessened by requiring cluster development. Cluster zoning would be an excellent complement to all of Ventura County’s existing agricultural-related zones (See Figure D.3 above). This zone would decrease the amount of habitat affected by structures and position it to one portion of the lot, or group all the structures of many lots in one area.

A major disadvantage of agricultural cluster zoning is that the goal is farmland preservation, and not corridor implementation. Yet while preservation of farmland is not the goal of the project, it is an indirect method to conserving land for wildlife corridors. But it should be noted that this tool reflects the notion that species will use agriculture land as a movement corridor. Many of the perceived advantages to farmland preservation actually provide no benefit (and may actually harm) the corridor function. Some of these include maintenance of a rural farming community thereby potentially increasing citizen outcry to wildlife corridors being placed through their property, reduced costs to developers and those measures that increase agricultural profitability. However if it is taken as truth that species will use agricultural land as a movement corridor given no better alternatives, then preservation of this land is another viable option to enact the corridor.

Research states that within economically strong farming communities the best techniques include delineation of city growth boundaries and agricultural areas, a maximum building density of 1 per minimum lots of 25 or 50 acres, favorable agricultural taxation, right-to-farm laws and establishment of easement or TDR programs (Daniels 1999). However the capacity of taxation, farm rights and conservation programs to be effective decreases without strong agricultural zoning. The most practical technique to use is cluster zoning because it allows for the protection of large plots of land at low costs. These large areas are then able to foster and support the regional farming community and the ancillary businesses.

There are differing opinions on the efficacy of agricultural cluster development in the rural-urban fringe to protect farmland, rather than merely rationalizing development projects. The main pro-cluster development arguments are: it provides landowners alternatives to selling all their land to large-scale developers, and it protects farming and open space better than conventional zoning ordinances. The opponents of cluster zoning cite the fact that they actually allow more people to live in rural areas where incompatible agriculture and residential uses will clash. In addition this type of zoning is often used as a quick planning fix, places much more emphasis on site planning rather than regional planning, may result in clusters of sprawl/development with no viable working farming in between and can indirectly cause farmers to reduce investment in their property in anticipation of future/eventual conversion to development.

Farm Bill

The Farm Security and Rural Investment Act of 2002 (Farm Bill) is legislation which responds to and provides funding for a broad range of emerging natural resource challenges faced by farmers and ranchers, including soil erosion, wetlands, wildlife habitat, and farmland protection. The 2002 Farm Bill places a strong emphasis on the conservation of working lands, ensuring that land remains both healthy and productive. Implemented through the United States Department of Agriculture (USDA) the Farm Bills provides landowners with various programs each with its own objectives and incentives. These programs include:

- Conservation of Private Grazing Land (CPGL)
- Conservation Reserve Program (CRP)
- Agriculture Management Assistance (AMA)
- Conservation Corridor Program

- Conservation Security Program (CSP)
- Desert Terminal Lakes
- Environmental Quality Incentives Program (EQIP)
- Grasslands Reserve Program (GPR)
- Grassroots Source Water Protection Program
- Great Lakes Basin Program for Soil Erosion and Sediment Control
- Ground and Surface Water Conservation
- Partnerships and Cooperation
- Farmland Protection Program (FPP)
- Resource Conservation and Development Program (RC&D)
- Small Watershed Rehabilitation
- Wetlands Reserve Program (WRP)
- Wildlife Habitat Incentives Program (WHIP)

We determined that the following Farm Bill programs would be appropriate for implementation within our study area.

Conservation Corridor Program: The Conservation Corridor Program is a demonstration program in Delaware, Maryland, and Virginia that set up conservation corridors. This program could be the template upon which Ventura County could submit a plan to create a corridor program in the Santa Clara Valley. This would provide an educational example to the public of the importance of corridors both environmentally and economically.

The Farmland Protection Program (FPP): The Farmland Protection Program (FPP) is a voluntary program that helps farmers and ranchers keep their land in agriculture. The program provides matching funds to State, Tribal, or local governments and non-governmental organizations with existing farmland protection programs to purchase conservation easements or other interests in land. FPP is reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill). The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) manages the program.

This program is important to our study site in Ventura County. Since the study area is predominantly agricultural land that is threatened by urban sprawl it is important to help preserve agricultural land in the area and keep it in agriculture. However, it is also important to educate landowners on the conservation issues that exist on their lands and provide partnerships that will help them deal with these land use dilemmas.

The Wetlands Reserve Program (WRP): The Wetlands Reserve Program (WRP) is a voluntary program that provides technical and financial assistance to eligible landowners to address wetland, wildlife habitat, soil, water, and related natural resource concerns on private lands in an environmentally beneficial and cost-effective manner. The program provides an opportunity for landowners to receive financial incentives to enhance wetlands in exchange for retiring marginal land from agriculture. The program provides landowners with conservation options including: permanent easements, 30-year easements or restoration cost-sharing agreements. The Natural Resources Conservation Service (NRCS) administers the program while funding for WRP comes from the Commodity Credit Corporation.

This program could be instrumental to improving habitat quality along the Santa Clara River. This river provides habitat for many native species including several threatened and endangered species. This program provides financial incentives to aid agricultural landowners in making responsible, conservation-minded land use decisions.

Wildlife Habitat Incentives Program (WHIP): The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed.

WHIP has proven to be a highly effective and widely accepted program across the country (NRSC 2002). By targeting priority habitat types such as riparian area and stream corridors, endangered species habitat, wetlands, and farmland compatible habitat wildlife, WHIP provides assistance to conservation minded landowners who are unable to meet the specific eligibility requirements of other USDA conservation programs.

The first step in implementing the WHIP program is for local conservation districts to identify local wildlife habitat priorities. Our project already identifies these priorities and Ventura County could further promote them. Much of the work is already done and can thus be promoted by the county to the State Technical Committee that ranks criteria for the State WHIP plan.

Preferential Taxation

One of the current problems with conservation planning is the perceived notion that the economic costs outweigh the benefits in many people's opinion. One method that has been successfully used to make conservation (programs) more attractive to potential decision-makers, landowners, and citizens is the offering of incentives. Incentives can take many forms such as financial aid, technical assistance, education, relaxation of regulations and recognition programs. Economic incentives, in particular, can be a significant factor in the conservation process, acting as a catalyst to moving conservation programs from the planning stages to reality. Economic incentives typically are direct payments such as grants, green payments, low or no-interest loans, purchase of land rights or preferential taxation programs. Some of the more common programs that provide tax relief are differential assessment, tax credits, suspension of income or inheritance tax.

Preferential taxation is primarily used to sustain the economic viability of agriculture. There are two methods for which preferential taxation could be used to help implement the corridor plan – through direct protection of land for a wildlife corridor or through indirect measures that preserve farmland. Some of the current programs are explained below.

Differential Assessment

Programs

The Land Conservation Act/Open Space Subvention Program (Williamson Act of 1965)

The Land Conservation Act (LCA), also known as the Williamson Act is a California state regulation that was passed in 1965 in response to disappearing agricultural and open space lands as they were converted to development. The act defines 'agricultural preserves' as areas in which local governments can enter into contracts with landowners to restrict land use to agricultural, recreational or open space. The program applies a differential assessment to eligible lands that is based upon its agricultural, open space or recreational values, and not on potential market value. The lower assessed value allows landowners to decrease their property taxes, and hopefully reinvest the capital in their farming operations.

The LCA contract consists of a ten-year term that is automatically renewed for one year on the anniversary date of the contract. However the contract does not have to be renewed after the first year of participation, and can be cancelled with a minor penalty charge, approval of the county Board of Supervisors and substantial evidence that the future use will be in the public interest and compatible with the general plan. Generally the Board of Supervisors does not approve cancellations, unless there is extreme hardship. The minimum area for an agricultural preserve is 100 acres; this requirement can be met with land from one landowner or by combining two or more parcels given that they are contiguous or have common ownership.

Only land within an agricultural preserve is eligible for LCA contracts, and therefore must conform to the stipulated land uses. While the agricultural and recreational uses are self-explanatory, the open space use is defined as the "use or maintenance of land in a manner that preserves its natural characteristic, beauty, or openness for the benefit and enjoyment of the public, to provide essential habitat for wildlife, or for the solar evaporation of seawater…" given that the land is in various defined areas such as a scenic highway corridor, a wildlife habitat, or a managed wetland area (Land Conservation Act, 1965). Further the 'wildlife habitat area' must be defined as such by a local board with agreement from the California Department of Fish and Game.

Farmland Security Zone

The California Division of Land Resource Protection administers the Farmland Security Zone program through a 1998 amendment to the Williamson Act. The state program is a voluntary one that provides additional tax reduction above that provided by the basic Williamson Act. The program requirements are similar to those for the Williamson Act, however eligibility for these 'Super Williamson Act' contracts require landowners to remain in the program for at least 20 years or longer. In exchange for longer participation the landowner is given an added 35% tax reduction above the initial Williamson Act assessed value, or Proposition 13 valuation whichever is lower.

Property Tax Benefits for Conservation/Open Space Easements

Conservation easements are voluntary deed restrictions placed on land that restrict any uses that interfere with conservation or agricultural. The easement can be donated by the landowner, or purchased by a designated non-profit organization or local government agency usually for the difference between its market value and the value of its current use. The landowner retains access and current use rights to the land, and in exchange for giving up the development rights receives either a payment or tax benefit. According to California Revenue and Tax Code §421 – 430.5, landowners who enter into a conservation easement for at least ten years can have their assessed property value reduced to reflect their land's restricted uses.

Property Tax Benefits for Wildlife Habitat and Native Pasture Conservation

This tax assistance is a similar in structure to the Williamson Act, but for the benefit of wildlife conservation. California Revenue and Tax Code §421 states that landowners with 150 acres or more can enter into a wildlife habitat contract with various federal and state agencies. The contract limits the land uses within the subjected area to habitat for native or migratory wildlife and native pasture for at least ten years. According to the tax code, "Land subject to a wildlife habitat contract is valued by using the average current per acre value based on recent sales including the sale of an undivided interest therein, of lands subject to a wildlife habitat contract within the same county (CA Revenue and Tax Code §421). This decreased valuation translates into a lower property tax.

Relevance to Ventura County

Differential assessment is a common method used to preserve farmland by increasing the economic viability of the agricultural industry by reducing the financial burden of taxation. However this tool does not incorporate the potential to improve the land, it merely 'maintains' the current status of the land. The conservation potential of this tool is limited unless the current use and habitat suitability is sufficient for species movement. For this analysis it is assumed that farmland is a viable option for corridor placement given the lack of other choices or the option of worse choices such as urban land.

There is definite value in the farmland conservation abilities of the Williamson Act. As of 2001 Ventura County currently had 124,920 acres under LCA contracts (Figure D.5). The positive impacts of the Williamson Act can be seen its ability to help ensure economic viability for the agricultural community and protect the land used for non-urban uses albeit temporarily.

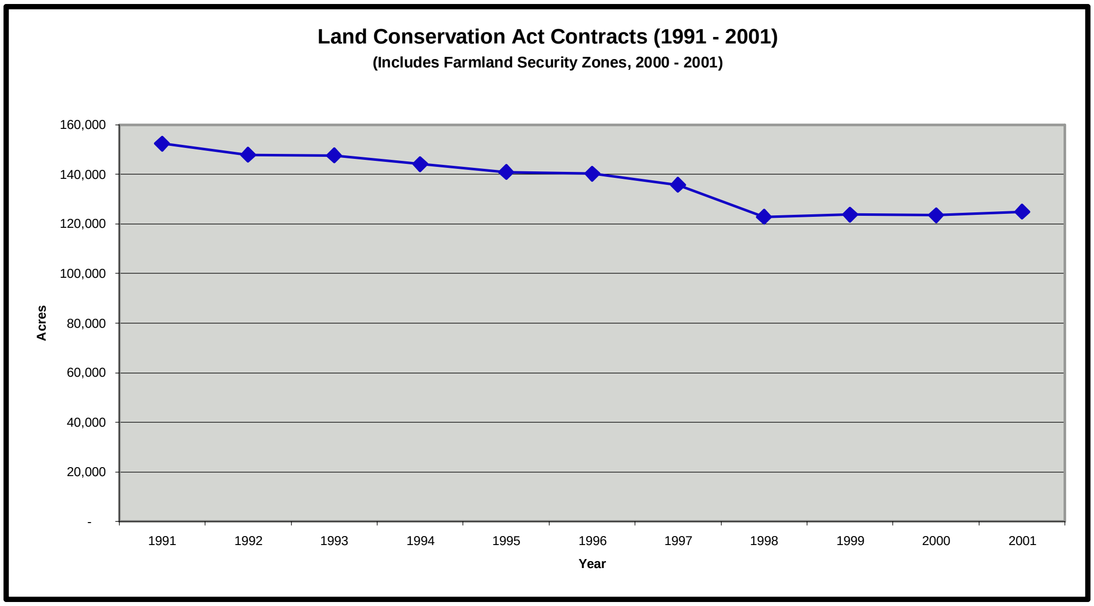


Figure D.5 – Ventura County Land Conservation Act Contracts (1991-2001)

However, the impermanence of the program can lend itself to abuse and unintended results. Some landowners sign a LCA contract in order to become eligible for reduced property taxes while they are waiting for the market to increase at which point they sell their land. The temporary nature of the program also essentially results in the leasing or renting of land for only short-term protection of farmland. Valuable financial resources are being poured into this program with diminishing returns on that investment.

Research shows that it is difficult to protect farmland at the urban-rural fringe through LCA contracts because the tax reductions are not enough to offset the true difference between the agricultural and development values. However even when LCA contracts are able to prevent farmland conversion the farmland still may not be suitable as species habitat. Therefore a tax incentive that encourages restoration of portions of farmland to more suitable habitat would be a more effective tax tool.

The local governments bare the majority of the cost of the Williamson Act because it reduces revenue to local government through reduced property tax revenue. This is supposed to be rectified through the Open Space Subvention portion of the act, however it usually does not happen. Local governments receive an annual subvention of forgone property tax revenues from the state via the Open Space Subvention Act (1971).

The Ventura County General Plan states that the LCA has been the foundation for farmland preservation within the county. Given the voluntary and temporary nature of the Williamson Act, it is important that the county supplement this program with other initiatives to strengthen farmland preservation. The County recognizes that agricultural preservation hinges on the economic viability of the industry, and while it does not have complete control over this aspect it can develop land use policies that foster a strong agricultural economy. Some of the policies that Ventura County supports are water conservation programs, right-to-farm ordinances, long-range transportation planning and zoning that encourages high minimum agricultural parcel sizes, adequate setback buffers and infrastructure restrictions. All of these polices are currently being implemented in the county to supplement the Williamson Act.

The current LCA statistics do not show an optimistic future for the program. In order provide the necessary support for farmland preservation Ventura County must revise its LCA contracts to address the current inadequacies. The Resources Appendix to the General Plan states that the County should make its LCA contracts consistent with the current agricultural protection policies. Additional issues that need to be addressed are the removal of the ambiguities and inconsistencies. Have not established an Advisory Committee to produce a comprehensive annual report on the status of agricultural land in the county.

Tax Deductions

Income Tax Benefits for Open Space Conservation

The California state Revenue and Tax Code §24357.7 states that a donation of qualified real property interest to a qualified organization exclusively for conservation purposes is allowed to take a deduction from their gross income on the California state income tax. A donation is not 'exclusive' unless it is donated in perpetuity. The definition of 'conservation purpose' is:

1. The preservation of land areas for outdoor recreation by, or the education of, the general public.

2. The protection of a relatively natural habitat of fish, wildlife, or plants, or similar ecosystem.

3. The preservation of open space (including farm land and forest land) where that preservation is for any of the following:
   - For the scenic enjoyment of the general public.
   - Pursuant to a clearly delineated federal, state, or local governmental conservation policy, and will yield a significant public benefit.
   - The preservation of a historically important land area or a certified historic structure.
   - Certified historic structures

This tool, while simple, is an added benefit to those who choose to donate land for conservation purposes. It can be used as a supplement to other incentive-based conservation programs. It acts to reduce the landowner's tax payment by applying a deduction to their pre-tax income.

Tax Credits

The Natural Heritage Preservation Tax Credit Program

The Natural Heritage Preservation Tax Credit Act of 2000 is meant to incorporate economic development into the natural resource conservation process. It introduced legislation that allows private landowners to permanently donate land or water rights through fee or easements to selected local agencies or nonprofit organizations for strict conservation purposes. In exchange for a donation, the landowner receives a California state tax credit equal to 55% of the appraised fair market value of the donated land. Eligible donations must meet one or more of the following criteria:

- The property will meet the goals of a conservation plan designed to benefit native species of plants and animals.
- The property will provide corridors or reserves for native plants and wildlife.
- The property interest is a perpetual easement or donation of agricultural land that is threatened by development and is located in an unincorporated area certified by the secretary to be zoned for agricultural use by the county.

Tax credits provide greater financial benefits compared to other favorable tax programs such as tax deductions or differential assessments because a credit is subtracted from the amount of tax that a landowner must pay. However this program is temporary as funding is secured only through December 30, 2005, or until all the $100,000,000 in credits are used. This program is unique because it is designed to foster public-private partnerships that are currently deficient in conservation planning. Unlike most conservation programs, it supports habitat stewardship and rewards landowners who place a positive value on species' habitat.

The Wildlife Conservation Board (WCB) is the entity that has approval power for projects (See Appendix for flow chart). In August 2002, after only 17 months of operation the WCB distributed approximately $33,500,000 in tax credits securing just over 7,061 acres of open space, agricultural lands, wildlife habitat, water and public parks. There has been only one approved project in Ventura County – the Joel McCrea Conservation Area. This project consists of 58 acres of donated land northwest of Thousand Oaks that was given to the Conejo Recreation and Park District in order to protect open space and provide the public with access to park space.

Suspension of Inheritance Tax

The suspension of the inheritance, or estate tax, for landowners that pass their land onto family or other persons that will keep it in its current use is another tax-based incentive tool. This method does not currently exist, however many groups have considered it for use in conservation programs. This method provides similar motivation to conserve as other preferential tax tools – it increases the economic viability of the landowner by allowing them to pay less taxes. The suspension of the inheritance tax would be particularly valuable for farmland preservation as farms are commonly passed onto the next generation. As a means of survival, those that inherit the land cannot afford the keep it in operation and must sell it on the market, usually to developers. The current California estate tax rate is set at 37% at $675,000, rising gradually to 55% for estates of $3 million or more. By waiving this tax, it is more likely that agricultural land will stay 'in the family' and also in farming. It would require strong advocacy and support on the state or federal level to implement this regulation, but it would provide a much-needed benefit to farming families.

All of the methods discussed above provide incentives of varying ranges to conserve agricultural or open space land. In most cases these cannot be used alone, but rather will be used in conjunction with other incentive programs. Most complement any other conservation programs very well, and support comprehensive regional planning. Given the agricultural nature of the project study area, it is likely that the agricultural based programs would receive more support within the community and among the local government. However there is no mention of any of these programs in the Ventura County General Plan or other planning documents.

Restoration

Background

Restoration encompasses a wide variety of activities aimed at returning disturbed habitat to a more native state. Restoration projects can include removing exotic invasive plant species and replacing them with native vegetation or reintroducing native fauna such as steelhead trout. Restoration projects are typically funded and implemented by non-governmental organizations or collaboration between government and NGOs (site). There are a large number of restoration projects currently in progress within Ventura County such as riparian and steelhead restoration projects along both the Ventura and Santa Clara Rivers and the removal of Matilija Dam. Currently, restoration activates are undertaken in a disjointed manner. Restoration strategies would be most effective when used in conjunction with other strategies, which permanently conserve large areas of land that make restoration efforts more effective than those randomly dispersed thought the county.

Feasibility in Ventura County
The Nature Conservancy is implementing several programs within the study area. First, they have a program aimed at restoring natural aquatic and riparian habitats along the Santa Clara River. One of the benefits of this program is that native plants will lessen pollution in the river by filtering pollutants out of the water and will stabilize banks to decrease sedimentation caused by erosion. Second, TNC plans on restoring the river to a natural state, which allows steelhead trout to migrate in and out of the river. The Friends of the Santa Clara River, a non-profit, have also taken on restoration activities along the riparian areas of the Santa Clara River.

Appendix E – Strategy Characterization Matrix Assumptions

Acquisition
Acquisition is optimally used for the conservation of land that is inexpensive given budget constraints. All things being equal, with a budget constraint, acquisition could preserve more inexpensive land, thus having a larger impact on corridor conservation.

Zoning
Overlay Zone
Overlay Zones can have an equal impact on Ag or Open Space zoned property, with a higher impact on areas of high land value due to the threat of land use change or development. It will have the highest impact (setbacks, permitting, etc.) on areas with agricultural land use practices due to land use threat to corridor functionality.

Cluster Development
Cluster Development can be used where landowners want to develop larger parcels of land. That can occur equally on Ag or Open Space zoned properties, and is particularly relevant in areas of high land value due to the threat of development. It can only be used in areas that allow development.

Transferable Development Rights (TDR)
TDR programs can be optimally used in areas of a high land value due to the threat of development, as well as areas currently used as native vegetation. Any other land use may require restoration to accompany the TDR program. Sending sites will optimally exist outside CURB boundaries.

Mitigation

Development Fees

Revenue from this program is used for conservation of open space and sensitive habitat areas, thus Open Space zoning and Native Vegetation land use are optimal for this strategy. Low land value for target land will give the program more land/$. Target sites will optimally be outside the CURB boundaries.

Development Permits

Development permits require the dedication of environmentally sensitive lands, thus Open Space zoning and Native Vegetation land use are optimal for this strategy. Low land value for target land will give the program more land/$. Target sites will optimally be outside the CURB boundaries.

Land Exchange

Land exchange is similar to TDRs, although land to be protected must have habitat or open space value. This program would be used optimally in Open Space zoning, Native Vegetation land use, and outside the CURB boundaries. A lower land value will mean that less land value will be needed to trade and execute the transaction.

Farm Bill

Farmland Protection Program

The FPP must be used for land zoned Ag and having a land use other than Native Vegetation. It can be optimally used in a low land value environment because the program purchases conservation easements and engages in other such conservation activity. Low land value gives the program the highest land/$.

Wetlands Reserve Program

The WRP must be used for land zoned Ag and having a land use other than Native Vegetation. Since the incentive mechanism is based on tax relief, a higher land value will provide a higher incentive.

Wildlife Habitat Incentives Program

The WHIP must be used for land zoned Ag and having a land use other than Native Vegetation. A property with a high land value will probably have a landowner that is capable of paying the remaining 25%, or higher, costs associated with habitat restoration.

Preferential Taxation

Williamson Act/ Farmland Security Zone

Both of these two strategies can only occur on agricultural land, thus it is only relevant on property zoned Ag and a land use other than native vegetation. They are optimally relevant in areas of high land value because the incentives involved with these programs are based on property value. Therefore, the greater the property value the larger the incentive to participate in the program.

Tax Relief for Conservation/Agricultural Easement

Conservation and Agricultural easements are equally relevant on Ag or Open Space zoned property. They will have a larger impact on land that is currently suitable habitat for corridors, which likely occurs in a land use designation of native vegetation. Since the incentives in this program are based on property value, the greater the property value the larger the incentive to participate.

Wildlife Habitat Contract

This strategy is optimally relevant on Ag or Open Space zoned properties, as long as Ag zoned properties do not have agricultural use. A land use designation of native vegetation may provide optimal wildlife habitat. Since the incentives in this program are based on property value, the greater the property value the larger the incentive to participate.

Appendix F – Additional Ecological Analysis of LCP-C

The initial ecological analysis for this region was made using destination-C (see Figure F.1). This original destination zone is almost completely blocked off by what will soon to become the City of Newhall Ranch. After presenting our findings, we were urged by stakeholders to conduct additional analysis using a slightly modified target zone for Destination-C. This additional target zone is referred to as Destination-Z, and is created according to the same standards as Destination-C (with the exception that the top 3 habitat classes are used instead of only using the top 2). The intent of this additional analysis is to determine whether suitable corridors might exist adjacent to Newhall Ranch, in acknowledgement of the fact that any corridor passing through the city will soon become unusable.

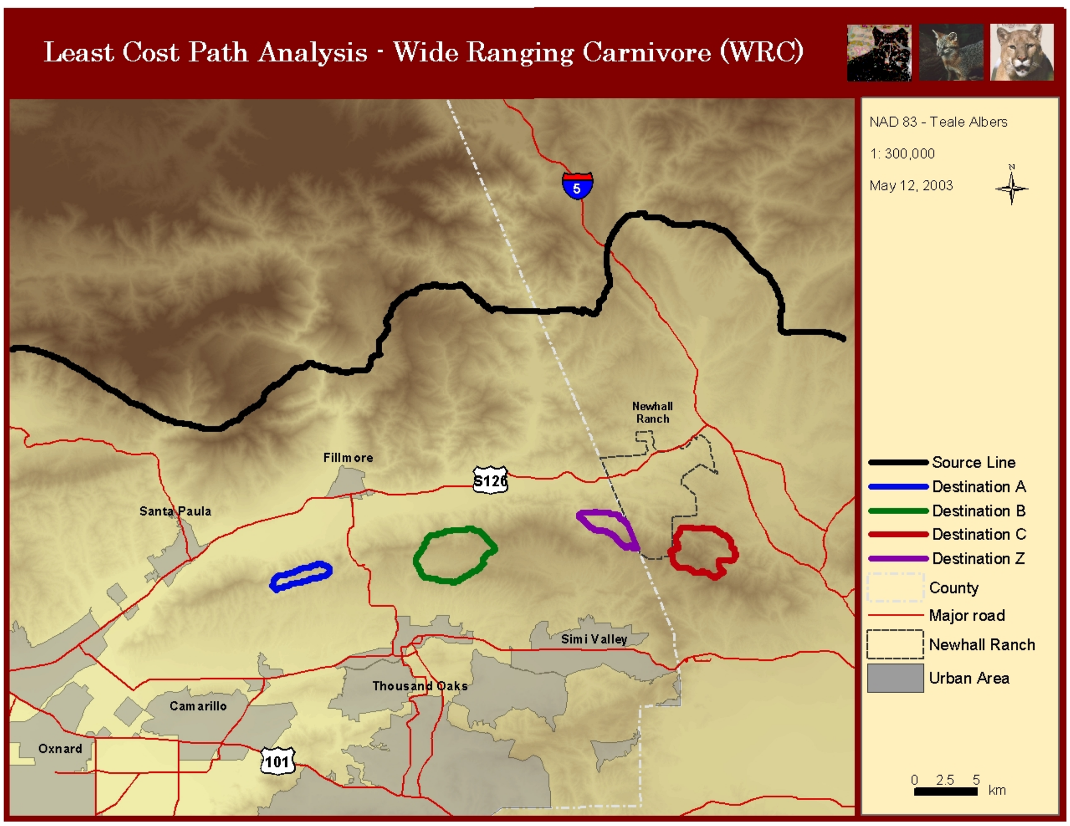


Figure F.1 - Project Area, showing Destination-Z in purple

As in all the earlier modeling iterations, by-zone, by-cell, and sensitivity analysis paths are created for this additional destination zone. The resulting outputs of the model are shown below.

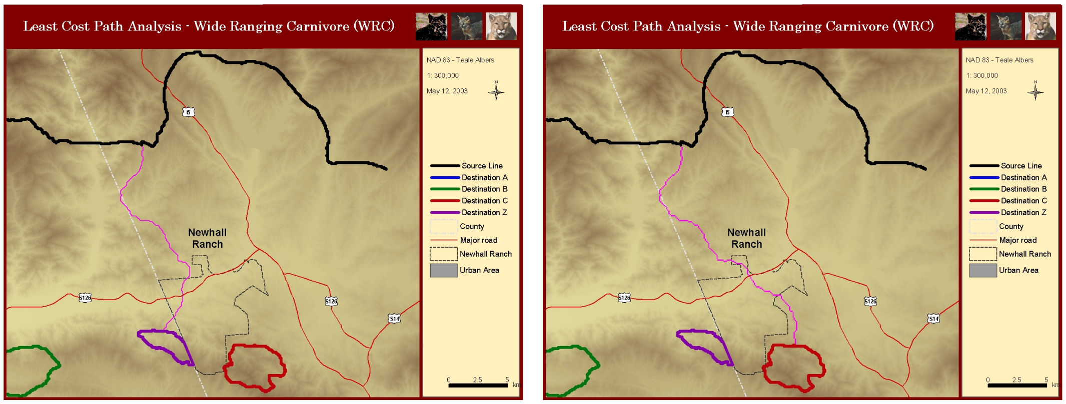


Figure F.2 - ByZone paths for Dest-Z (left) and Dest-C (right)

The by-zone paths follow the same route until just north of Hwy 126, then split off noticeably. Even though these two paths diverge, both routes pass through the proposed city limits of Newhall Ranch.

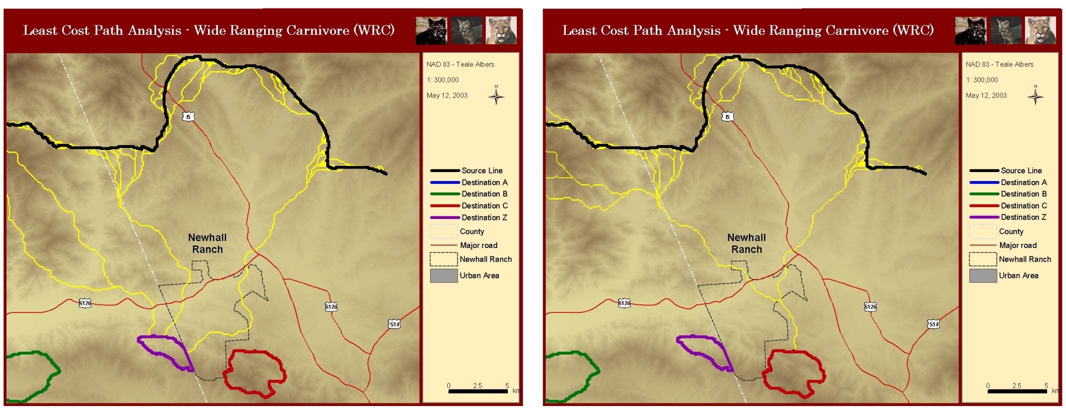


Figure F.3 - ByCell paths for Dest-Z (left) and Dest-C (right)

The paths that result from by-cell analysis differ significantly for Dest-C and Dest-Z. All the paths for Dest-C merge just below Hwy 126, and travel predominantly through Los Angeles County. There are at least three distinct paths for Dest-Z that never merge, and one of them resides exclusively in Ventura County.

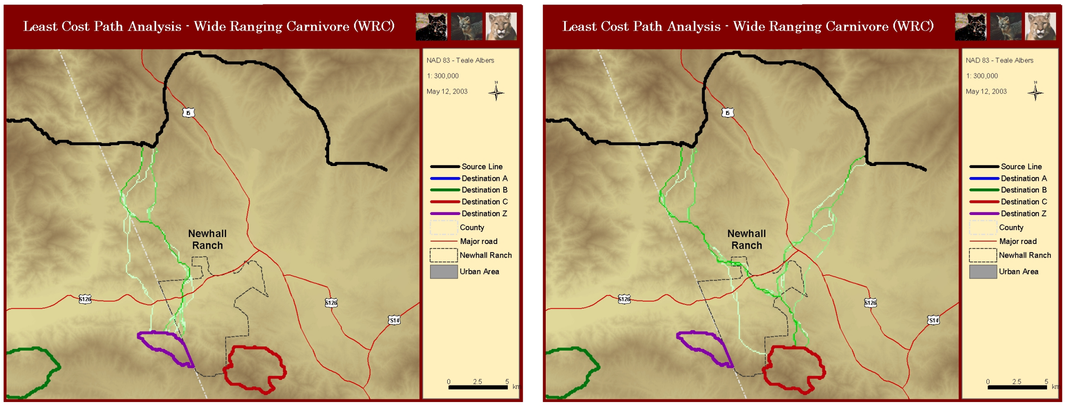
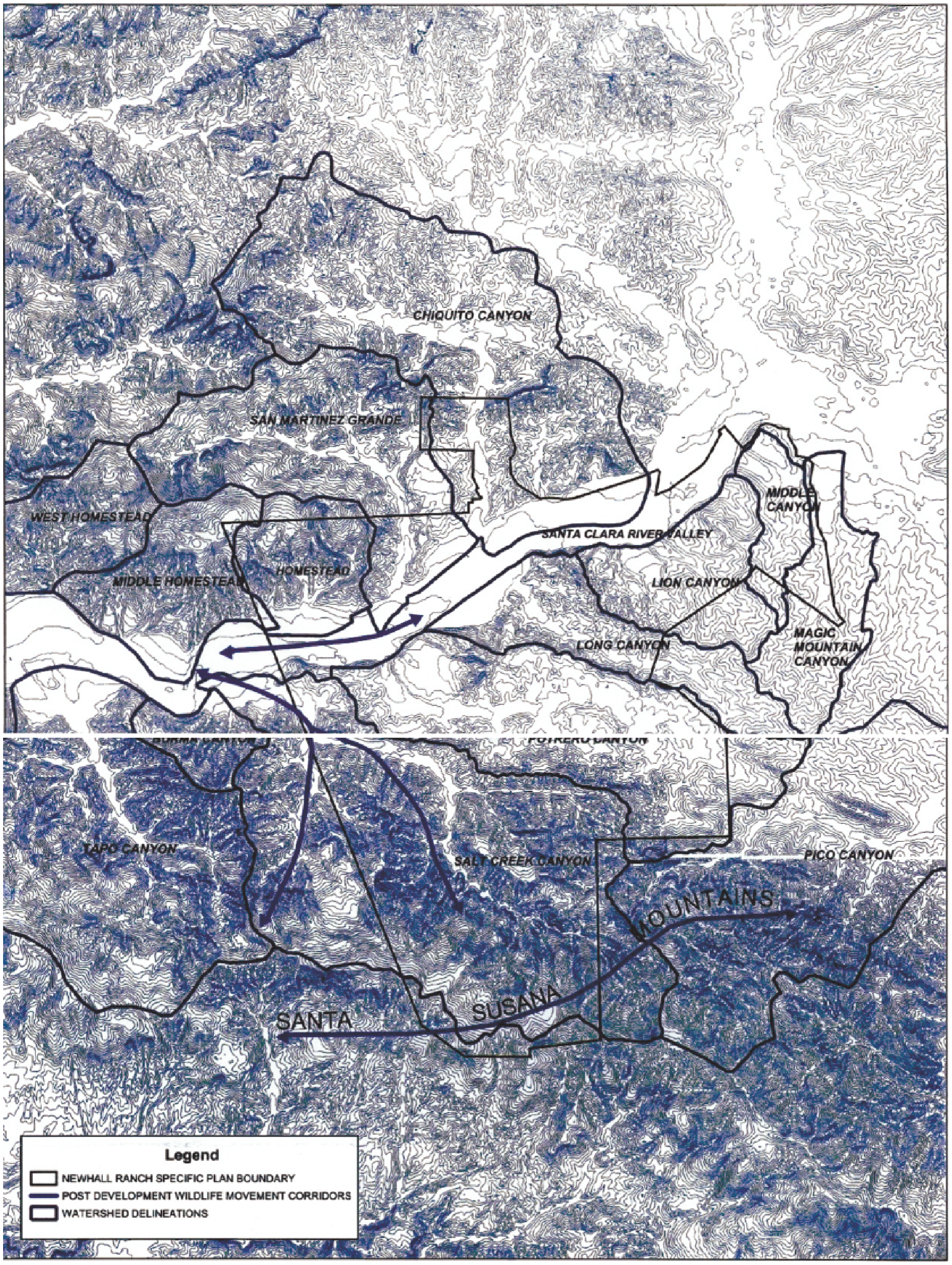


Figure F.4 - Sensitivity Analysis for Dest-Z (left) and Dest-C (right)

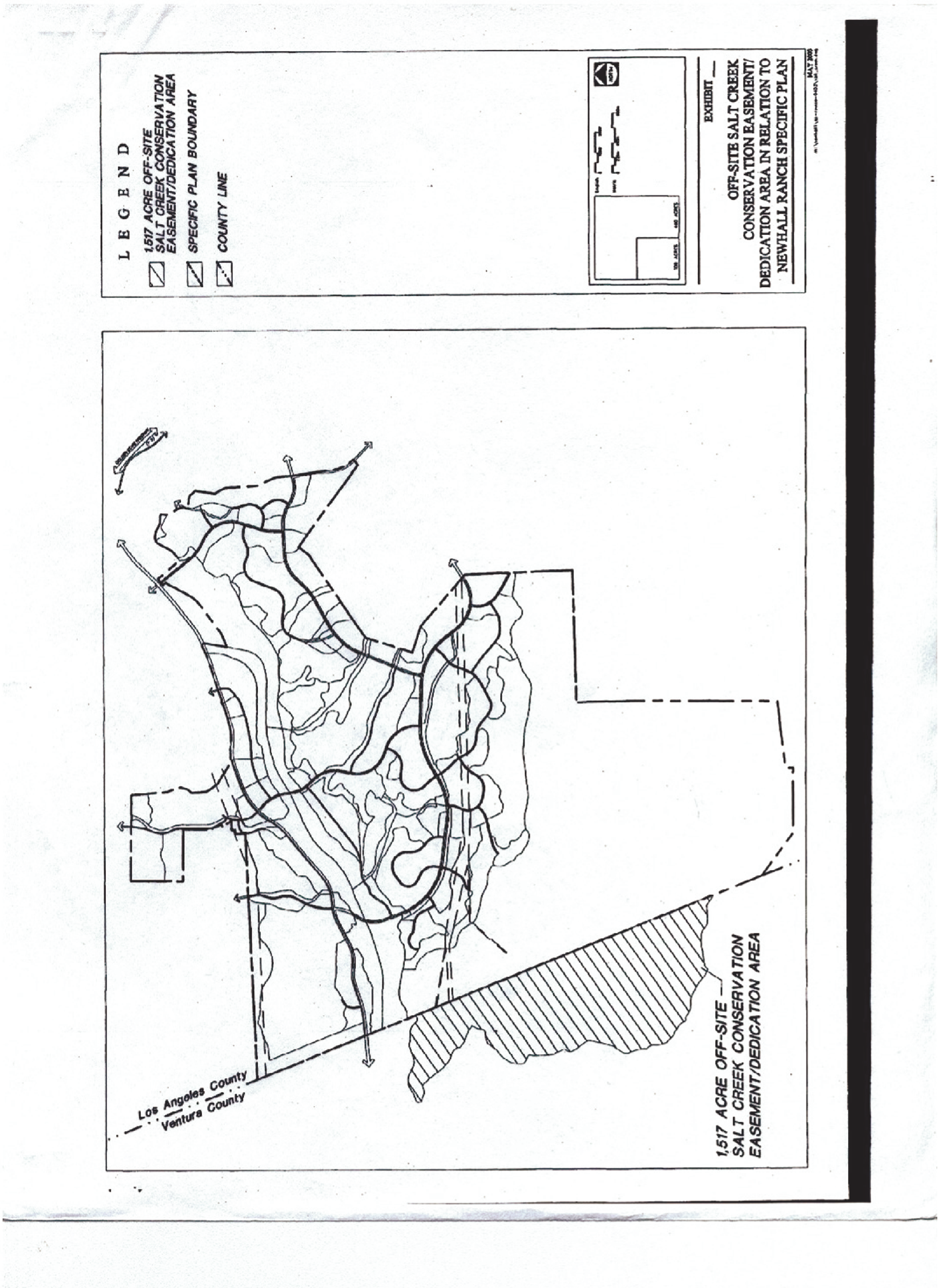
Sensitivity analysis yields results that are almost the opposite of those produced from by-cell analysis. The paths for Dest-Z are rather consistent and those for Dest-C are more scattered. Here again, the westernmost paths for Dest-Z lie almost completely within Ventura County, but all others pass through Los Angeles County and Newhall Ranch.

It seems possible that the model may have ruled out paths running parallel with Piru Creek (or even inside the dry streambed). Piru Creek has a very wide streambed and very wide culverts passing under Hwy 126, which would seem to make it quite suitable for a corridor. Yet, none of our modeling results identified this as a low-cost corridor. This could result from the fact that a road runs next to the creek, so that the benefits of a riparian corridor were mathematically cancelled out by road proximity. Anyone considering the viability of a corridor in the easternmost portion of Ventura County might want to consider this issue further.



NEWHALL RANCH
Newhall Ranch Company

FIGURE 2.2-2
NEWHALL RANCH WATERSHEDS


LEGEND
1,517 ACRE OFF-SITE SALT CREEK CONSERVATION EASEMENT/DEDICATION AREA
SPECIFIC PLAN BOUNDARY
COUNTY LINE
EXHIBIT __
OFF-SITE SALT CREEK CONSERVATION EASEMENT/ DEDICATION AREA IN RELATION TO NEWHALL RANCH SPECIFIC PLAN
Los Angeles County
Ventura County
1,517 ACRE OFF-SITE SALT CREEK CONSERVATION EASEMENT/DEDICATION AREA

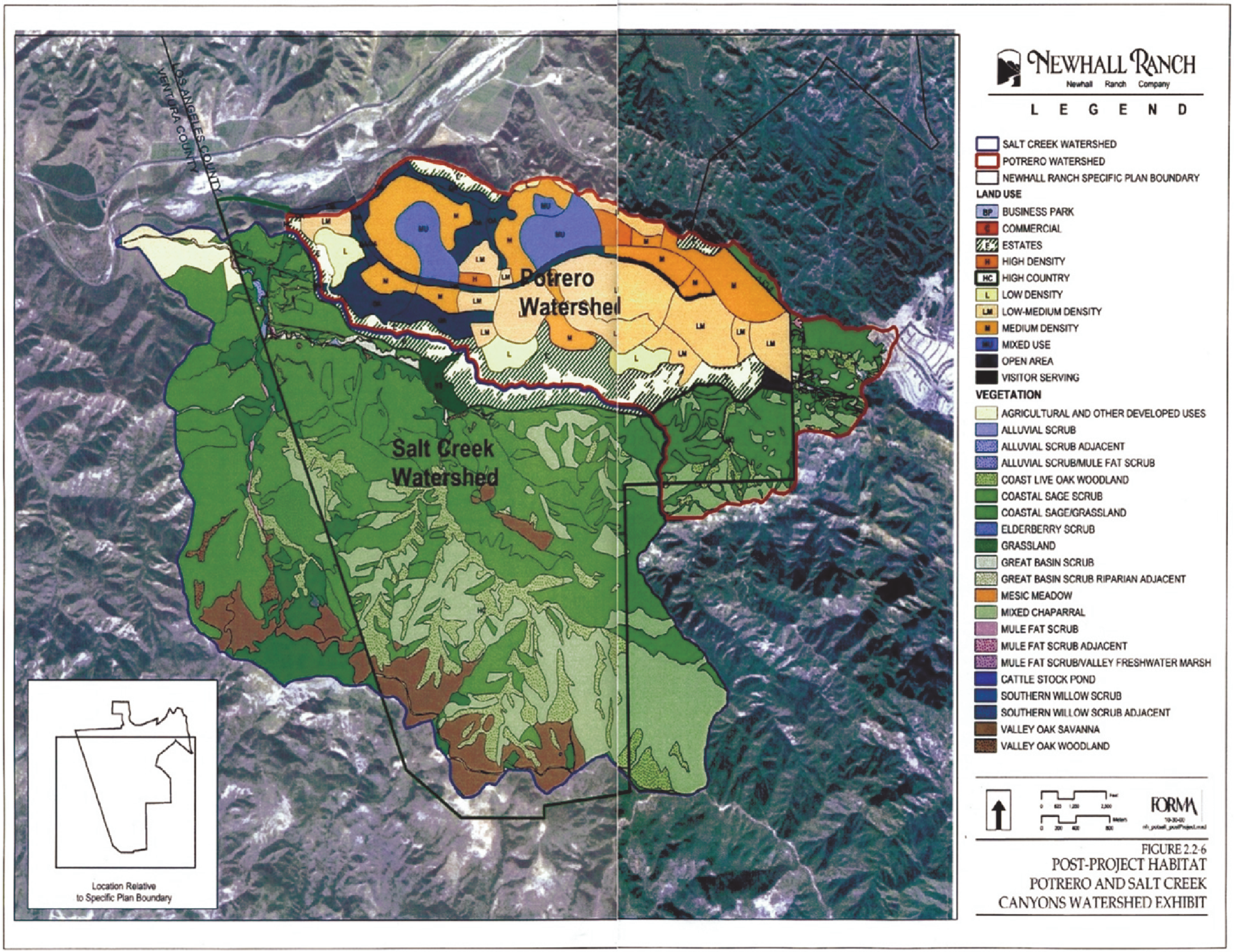


FIGURE 2.2-6
POST-PROJECT HABITAT
POTRERO AND SALT CREEK
CANYONS WATERSHED EXHIBIT