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***Designing Road Crossings for Safe
Wildlife Passage:***

Ventura County Guidelines

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Problem: Roads & Wildlife

According to the U.S. Department of Transportation's Federal Highway Administration, there are more than 3.9 million miles of public roads that span the United States. Each day, an estimated 1 million animals are killed on roads, making roadkill the greatest human-caused source of wildlife mortality in the United States (1). Road avoidance by animals has an even greater ecological impact, impeding movement and restricting habitat connectivity. The resulting habitat fragmentation and isolation leads to problems such as genetic drift, inbreeding, resource depletion, reduction of biodiversity, and even extinction of wild populations (2).

Solution: Crossing Structures & Wildlife Usage

Efforts to mitigate the negative impacts of roads increasingly incorporate the use of modified crossing structures, such as pipes, culverts, and bridges. Most of these structures are engineered to route water under the roadway. However, with proper refinements and design modifications these structures may also facilitate wildlife movement and promote habitat connectivity, decreasing wildlife mortality from vehicle collisions and enhancing species viability.

The utility of wildlife crossing structures has been researched and discussed since the mid 1970's. Over this 30-year history, studies have consistently documented wildlife use of these structures to safely traverse road networks. Many European countries have developed formal transportation policies to incorporate wildlife crossing structures with specific design characteristics believed to positively influence species' use of these structures. Though the United States is quickly learning from the European example, much remains to be done to synthesize and incorporate the current knowledge into formal policy.



Figure 1: Bear attempting to cross highway. US DOT Federal Highway Administration – Critter Crossings

Project Goal: Ventura County Mitigation Guidelines

The *Ventura County General Plan* (Goal 1.5.1) takes into consideration the preservation and protection of wildlife movement corridors. This policy provides direction for the Ventura County Planning Division staff to review discretionary land use permits for road impacts to wildlife movement corridors, though guidelines to accomplish this goal are lacking. Movement corridors are defined as a patch of wildlife habitat which joins two or more larger areas of wildlife habitat. Situated between the highly developed areas of Los Angeles and Santa Barbara, Ventura County has both large areas of intact wildlands along with increasing development pressure and highly trafficked roads. Landscape level wildlife movement corridors in Ventura County have been identified (3, 4). Sponsored by and in consultation with the Ventura County Planning Division, we developed road crossing structure design standards that best accommodate wildlife usage, evaluated wildlife use of existing structures in Ventura County, and observed roadkill rates to determine where movement corridors may exist.



Figure 2: Bear utilizing crossing structure. ICOET Proceedings, 2003

Research Approach: Literature Review

A literature review was conducted from April 2004 through January 2005. We assessed and compiled information from over 100 articles and documents relating to road impacts and ecology, wildlife corridor assessment, and wildlife crossing structure use and effectiveness. Most current knowledge on effective structure design has been gained from informal observations and through trial and error in the field, as opposed to formal experiments or detailed quantitative surveys. Many efforts involve building wildlife crossing structures and observing what works. Much of the available information is in the gray literature: conference proceedings, public reports, and websites.



Figure 3: Various wildlife crossing structures.

Approximately 70 documents specifically addressed structure design characteristics and effectiveness. To easily store, sort, retrieve, and update this information, these documents were selected for detailed review and summary into a Microsoft Access database. This database stores relevant information about each crossing structure design element in terms of evidence to support a positive versus negative effect on structure use by wildlife.

Research Approach: Field Observations

In addition to compiling research from independent sources, we conducted field observations within unincorporated Ventura County to examine:

- Locations where wildlife crossings are a problem based on roadkill data
- The effectiveness of existing crossing structures in facilitating wildlife movement

Roadkill data for Ventura County was collected for the period June 2004 to January 2005. The California Department of Transportation, the Ventura County Animal Regulation, and volunteers from the Ventura County



Figure 4: Dead coyote found on Cañada Larga Rd., Ventura Co.

Planning Division also recorded roadkill sightings throughout the County during this time period. Roadkill locations were digitally mapped and plotted using ArcGIS. The GIS data was analyzed to determine roadkill frequency and distribution throughout Ventura County.

Figure 5: Observed roadkill rates.

Animal	Roadkill Number	% of Total Roadkill
Opossum	859	41.66%
Bird	224	10.86%
Squirrel	205	9.94%
Rabbit	178	8.63%
Raccoon	139	6.74%
Coyote	129	6.26%
TOTAL	1734	84.09%

The highest concentrations of roadkill occur on the outskirts of cities, notably Ventura, Camarillo, and Simi Valley. This is probably due in part to greater citizen reporting in these areas. However, high

concentration of roadkill in these areas may also be due to the close proximity of these cities to wilderness areas where wildlife is naturally occurring and on the move. The Santa Clara River, a recognized wildlife movement corridor, flows through the cities of Ventura and Santa Paula. Similarly, Camarillo and Simi Valley are both in the vicinity of the Santa Monica Mountains National Recreation Area.

Though many crossing structures exist along State and County roads within our study area, these structures do not appear to adequately facilitate wildlife movement. Roadkill is widespread in Ventura County and is especially high in areas of known wildlife movement corridors and on the outskirts of cities. For example, results of the roadkill survey confirmed the presence of a wildlife movement corridor in the area of Foster Park on highway 33. This movement corridor had previously been identified by the South Coast Wildlands Project (3).

To evaluate wildlife use of existing crossing structures, 14 structures with varying attributes were monitored from September 2004 to January 2005. The structures monitored encompassed a large array of road conditions and land uses, including natural open space, urban, and agricultural areas. Each structure was equipped with tracking plates filled with gypsum powder to capture animal tracks and detect wildlife use of the structure. Animal sightings of structure use were also recorded.



Figure 6: Animal tracks in gypsum powder.

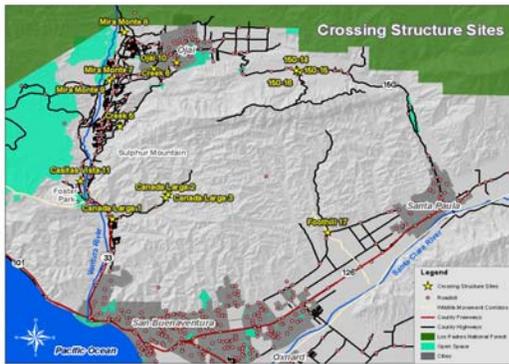
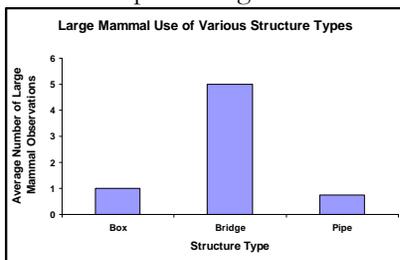


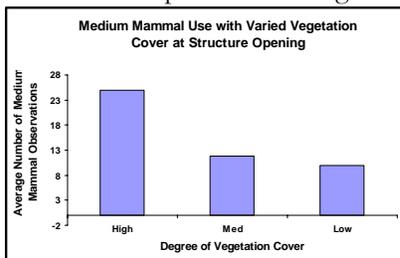
Figure 7: Study area and crossing structure sites.

Overall, the findings of wildlife crossing structure use patterns were consistent with the findings in the literature review:

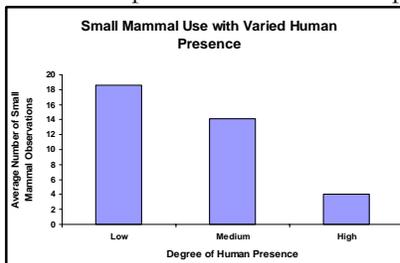
- Large mammals prefer larger structures



- Medium mammals prefer cover vegetation



- Small mammals prefer minimal human presence



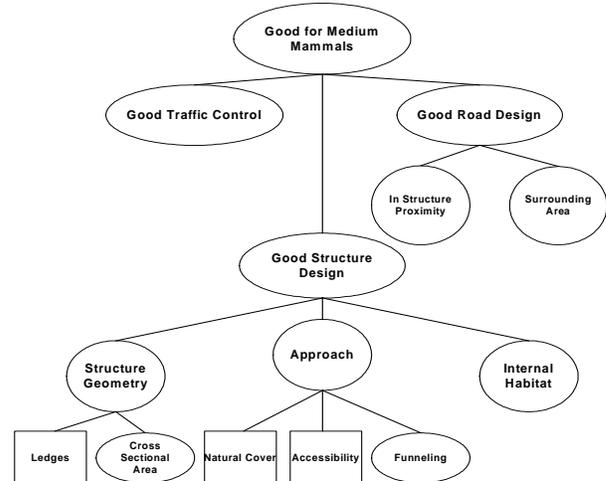
Reptiles and amphibians were also observed in and around the structures though the data was insufficient to conduct a formal analysis. These species are particularly difficult to detect using the gypsum powder tracking plate method. In addition, our study did not account for

seasonal movement of these species: amphibians in the rainy season and reptiles in the summer.

Knowledge Synthesis & Mitigation Guidelines

Using the knowledge synthesis of effective wildlife crossing structure design elements, a knowledge base expert system using Boolean logic was developed. This knowledge base organizes design elements into a framework which allows interactive manipulation and provides a formal system to evaluate crossing structure designs. This system assists planners in the assessment of current and proposed mitigations, highlighting areas for improvement in a given structure design.

Figure 8: Crossing Structure Design Elements Knowledge Base.



Mitigating the negative road impacts that a project may have on wildlife movement corridors requires consideration of several fundamental parameters:

- Placement near traditional wildlife movement routes
- Presence of suitable habitat
- Minimal human activity
- Presence of funneling/fencing mechanisms
- Accessibility into and through structure
- Maintenance & monitoring
- Traffic control measures

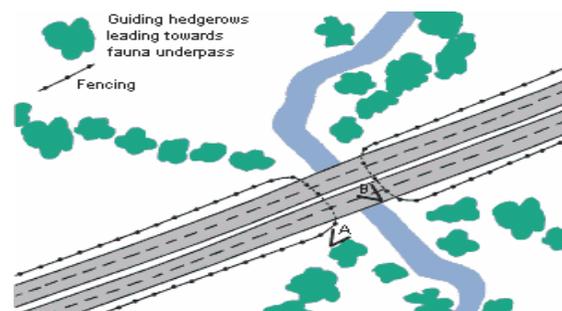


Figure 9: Effective crossing scenario.



- Appropriate road design elements
- Appropriate structure size, shape, & internal habitat

The *Designing Road Crossings for Safe Wildlife Passage Guidelines* provided to the Ventura County Planning Division is an in-depth narrative and photographic description of effective wildlife crossing structure design elements. **Proper placement** of wildlife crossing structures is one of the most important considerations for successful mitigation. Studies conducted in Florida determined that structures placed without regard to traditional movement paths failed (5). **Suitable habitat** surrounding and leading up to the structure entrance provides continuity and encourages animals to approach and utilize crossing structures. Biologists have reported that crossing structures may be ineffective if **human activity** is not controlled (6). Wildlife **funneling/fencing** is particularly necessary for effective crossing structures. Fencing guides animals towards a structure entrance and deters them from approaching the roadway. Roadkill can be dramatically reduced on roadways that have both fencing and crossing structures. Along Interstate 80 in Wyoming, roadkills of mule deer have been reduced by 90%, while there has been a 97% decrease in the number of elk killed in Banff National Park, Canada (5). A crossing structure will only be effective if it is **accessible** to the species that will potentially utilize it. A pipe that becomes perched due to erosion and standing water are just a few examples that create conditions of inaccessibility. **Maintenance** of a crossing structure should include clearing debris or other impediments to movement through the structure, maintaining the surrounding fencing, vegetation, and habitat, as well as ensuring overall structural integrity. Ultimately, the success of a crossing structure can only be assessed through consistent **monitoring** (7).

Traffic control via speed limit signs and/or speed bumps can greatly reduce wildlife mortality from vehicle collisions. As do wildlife crossing signs which inform the public of the potential presence of sensitive, slow moving species on the roadway. Appropriate **road design** elements ensure that the crossing structure appears dark and quiet, while the road in the surrounding area appears bright and noisy, particularly when vehicles are present. The goal is to make the option of using the crossing structure more appealing to an animal than the option of crossing the road. **Structure design** elements are often specific to the type of animal expected to utilize it. In particular,

Figure 10: Wildlife crossing sign.



physical characteristics such as size, shape, and substrate will be very important to some species, but irrelevant to others. For example, a moist substrate is essential for amphibian use, while large mammals are generally indifferent to the substrate surface. On the other hand, the openness ratio, a function of structure length ((height x width)/length) is important for larger animals. Overall, many species benefit from elevated concrete ledges lining interior walls, which allow wildlife to pass through when water flow is high, and an internal habitat which mirrors ambient light, noise, and temperature.

Next Steps: Policy Implementation

The *Ventura County Initial Study Assessment Guidelines* Biological Resources section is now under County review. As part of this process, Ventura County is standardizing how planners and consulting biologists determine project and cumulative impacts to biological resources, including movement corridors. Concurrently, they are reviewing the *Designing Road Crossings for Safe Wildlife Passage Guidelines*. When the revision and review processes are completed, these documents will be forwarded to the Ventura County Board of Supervisors for adoption.

Subsequent to adoption, the *Designing Road Crossings for Safe Wildlife Passage Guidelines* will serve as a tool for planners and consulting biologists to mitigate the negative impacts of roads on wildlife movement corridors within Ventura County.

Acknowledgements

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