SAVING LIVES AND TRAINING THE NEXT GENERATION: STATE ROUTE 101 WILDLIFE CORRIDOR SAFETY PROJECT

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ABSTRACT

State Route (SR) 101 north of San Luis Obispo, California is a major regional traffic corridor with peak weekday traffic volumes of approximately 4,000 vehicles per hour. State Route 101 also bisects a major wildlife corridor in and near the Los Padres National Forest in the central coast region of California. Animal-vehicle collisions (AVCs) with large mammals including mule deer (*Odocoileus hemionus*), black bear (*Ursus americanus*), mountain lion (*Puma concolor*), and feral pig (*Sus scrofula*) are a safety issue. Data provided by California Department of Fish and Wildlife indicates this section of highway may have a higher than normal AVC rate for black bear compared to other areas in the State.

To develop solutions, Caltrans initiated an ongoing collaboration with California Polytechnic State University (Calpoly) in San Luis Obispo. Starting in 2009, students used automatic camera stations, trackplates and daily drive transects to document wildlife roadkills, roadside activity and use of existing underpasses for a wildlife connectivity study associated with a proposed median barrier project. Results from this study helped guide design decisions for a wildlife exclusion fence in a roadkill hotspot located in the same area. The project includes 2.5 miles of wildlife exclusion fence installed on both sides of SR 101, four jump-outs constructed at strategic locations to allow wildlife that become trapped along the roadway to escape from the highway corridor, and four electric mats installed as wildlife guards to discourage wildlife (bears in particular) from entering the highway corridor at unfenced roadways that intersect SR 101. The fencing project was funded through the Federal Highway Administration's Transportation Enhancement Program in 2009 and was completed in April 2012.

Currently, Calpoly students are monitoring the fence's effectiveness at reducing roadkills while maintaining regional wildlife connectivity. Post-construction surveys began in summer 2012 and will continue for at least 12 months to allow for direct comparison with the 2009 pre-construction data. Students are conducting roadkill surveys to determine whether AVC rates have been reduced within the project area. Automatic camera stations have been deployed at the electric mats, jump-outs and undercrossings to quantify species-specific responses to these features. Initial results have documented the electric mats deterring bears from entering the road corridor, but suggest the design should be modified to better exclude deer. Results have also indicated that multiple species are using the undercrossings and deer are using the jump-outs.

On-going monitoring and collaboration with partners has allowed Caltrans to integrate concerns about AVC rates and the preservation of wildlife habitat connectivity into the transportation planning process. The project received the Caltrans "Excellence in Transportation Award" in 2012 and the California Transportation Foundation 2013 Safety Project of the Year Award.

INTRODUCTION

State Route 101 (SR 101) between the Cities of San Luis Obispo and Atascadero bisects a rural area of San Luis Obispo County in the central coast region of California. The highway is a major regional traffic corridor with peak weekday traffic volumes that reach about 4,000 vehicles per hour. SR 101 also bisects an area that has been identified as a regionally important wildlife corridor in and adjacent to the Los Padres National Forest. Animal-vehicle collisions (AVCs) with large mammals including mule deer (*Odocoileus hemionus*), black bear (*Ursus americanus*), mountain lion (*Puma concolor*), and feral pig (*Sus scrofula*) are a safety issue. Data provided by California Department of Fish and Wildlife indicates this section of highway may have a higher than normal AVC rate for black bear compared to other areas in the State.

AVC events can cause severe, injury or even death to both wildlife and humans. To improve safety while maintaining connectivity for large mammals a wildlife exclusion fence project was initiated by the California Department of Transportation (Caltrans) District 5, San Luis Obispo, California. The project was funded by the Federal Highway Administration's Transportation Enhancement Program in 2009 and completed in 2012. The project has received local and statewide recognition, receiving the Caltrans Excellence in Transportation Award in 2012 and the California Transportation Foundation Safety Project of the Year Award in 2013.

PROJECT DESCRIPTION

The project (Figure 1) includes 2.5 miles of wildlife exclusion fence installed on both sides of SR 101, four jump-outs constructed at strategic locations to allow wildlife that become trapped along the roadway to escape from the highway corridor, and four electric mats installed as wildlife guards to discourage wildlife (bears in particular) from entering the highway corridor at unfenced roadways that intersect SR 101. Two highway bridges within the project limits serve as the end points for the fence since they provide large undercrossings that allow safe passage for wildlife. The southern end point is the overhead crossing for the railroad at the top of Cuesta Grade north of the City of San Luis Obispo and the northern end point is the Santa Margarita Creek Bridge just north of the SR 101 and State Route 58 Interchange near the town of Santa Margarita. There are also two culverts (> 4 feet) within the project limits that are large enough to pass medium to large mammal species and nine smaller culverts (< 3 feet) that are large enough to pass small mammals.

Independent of the fencing project, Caltrans also initiated a two-pronged wildlife connectivity study associated with a median barrier project proposed for the same stretch of highway. In 2009, Caltrans began an ongoing collaboration with California Polytechnic State University (Calpoly) in San Luis Obispo to conduct field studies to document roadkills, roadside activity and use of existing underpasses by wildlife (Perrine et al. 2011). In addition to the field studies, Caltrans also contracted with the Information Center for the Environment at U.C. Davis to model the suitability of the wildlife connections across SR 101 for habitats in the vicinity of the project (Thorne et al. 2011). Results from these studies helped guide design decisions for the installation of the wildlife exclusion fence. The fence was installed in a roadkill hotspot for black bear identified by the Calpoly study, and in an area identified by the UC Davis model as having high potential for connectivity for both black bear and mule deer (Figure 2 and 3).

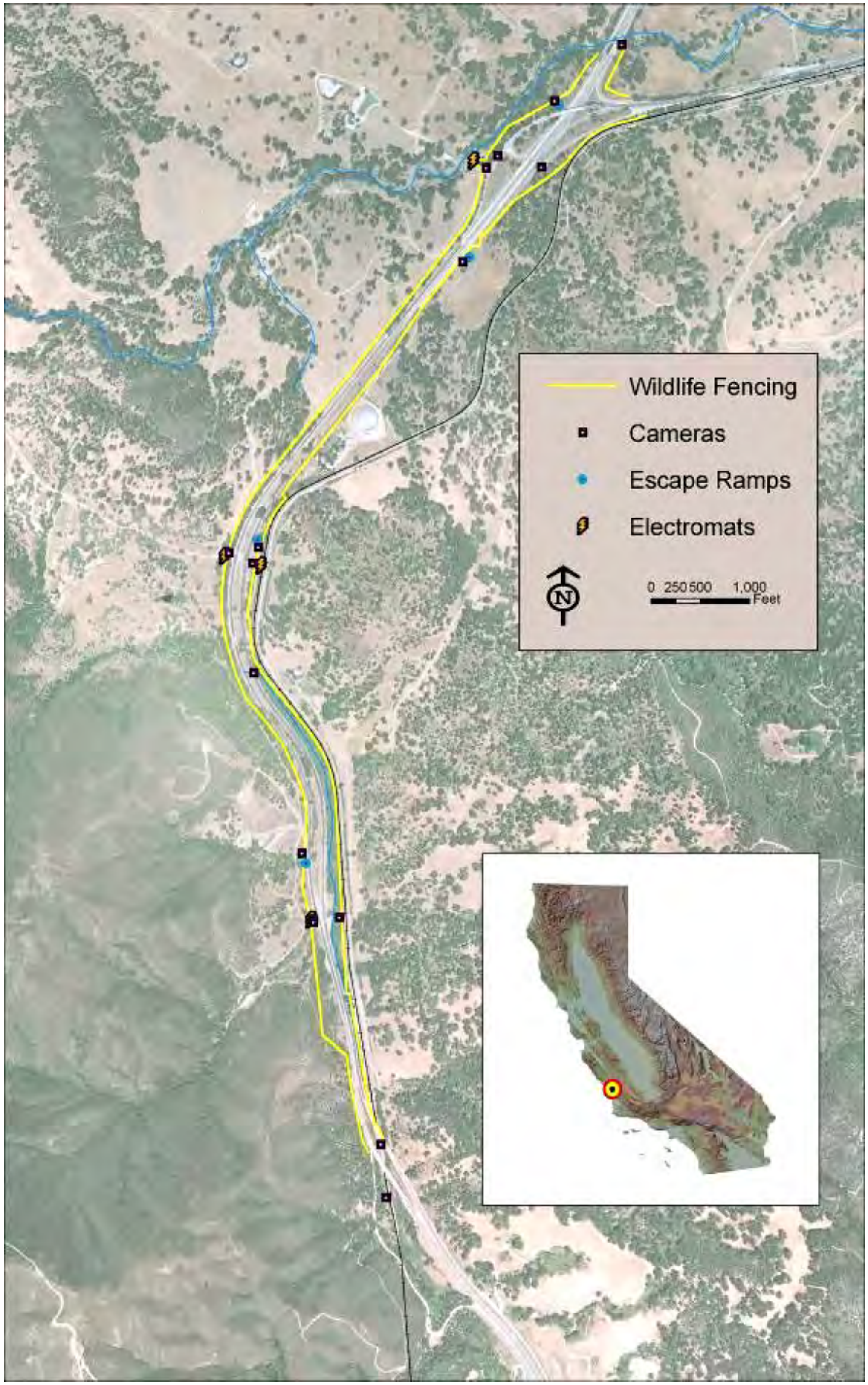

FIGURE 1 Location map with project features.

FIGURE 2 Wildlife connectivity study area.

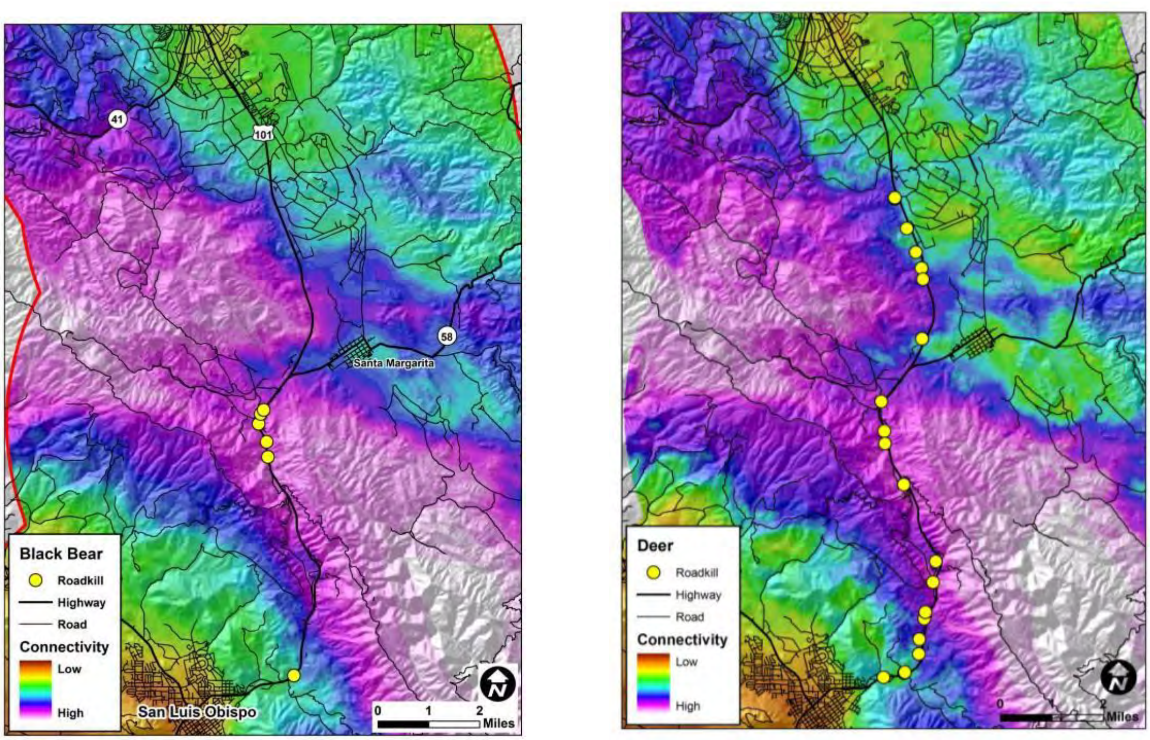

FIGURE 3 Model for black bear and mule deer connectivity study with roadkill overlay.

CONSTRUCTION

The California Conservation Corps (CCC) Los Padres Center began installing 2.5 miles of wildlife exclusion fence November 2010 and completed the installation April 2012. Electrobraid Inc. was hired as a subcontractor by the CCC to install the jump-outs and the electric mats prior to installation of the fence. The total cost for the project was about $600,000 dollars.

Construction constraints

Resources that needed to be avoided during construction included archeological sites and perennial streams with sensitive amphibian and fish species. This required that the installation of the fence and brush clearing be done using hand tools. Because of the natural landscape along the SR 101 corridor, maintaining the high visual quality in the area was also taken into consideration when choosing construction materials for the fence. In addition, the high pressure gas line that parallels the fence for most of the length of the project dictated where portions of the fence could be constructed.

Materials/cost/maintenance

Fencing materials included 8-foot high graduated wire mesh fencing, 10-foot high steel T-post and 10-foot high wooden treated post set in concrete. The jump-outs were constructed using recycled tongue and groove plastic boards, used 3 inch steel pipe, the 8-foot high wire mesh fencing material and local dirt to form the earthen ramps on the jump-outs (Figure 4). The vertical height of the jump-outs on the drop off is about 6.5 feet to accommodate coastal mule deer. The fence is being maintained by the California Conservation Corps and Caltrans maintenance; the jump-outs and electric mats are being maintained by Caltrans maintenance.

FIGURE 4 Fencing and jump-out.

The electric mats (Figure 5) are constructed with recycled plastic and contain electrodes that run perpendicular to the road. The mats deliver a 7,000- 9,000 volt shock to animals attempting to cross it and they are powered by a solar panel that charges a 12 volt battery. The mats are posted with warning signs in English and Spanish. The width of each mat is 48 inches and the length ranges from 24 feet to 32 feet.

FIGURE 5 Electric mat and solar panel.

MONITORING METHODS

Currently, Calpoly students are monitoring the effectiveness of the fence at reducing roadkill while maintaining regional wildlife connectivity. Students are conducting roadkill surveys to determine whether AVC rates have been reduced within the project area. In addition, they are reviewing images from automatic camera stations deployed at the electric mats, jump-outs and undercrossings to quantify species-specific responses to these features.

Post-construction surveys began in summer 2012 and will continue for at least 12 months to allow for direct comparison with the 2009-2010 pre-construction data collected for the median barrier project. In order to directly compare the data, the same survey methods are being used with the exception that funding allowed for an increase in the number of cameras deployed. To capture a regional perspective, the post-construction study area extends beyond the project limits with the southern boundary beginning at San Luis Obispo (northern city limits) and the northern boundary ending at Atascadero (the southern city limit).

Roadkill surveys

The roadkill surveys are conducted every weekday morning with some variation on start time. The survey team typicall includes a driver and data recorder. The SR 101 northbound survey begins at the northern city limit for San Luis Obispo and ends at the southern city limit for Atascadero. The surveys for southbound SR 101 is the reverse. Although the objective is to document the location of the four target species (deer, bear, mountain lion, and feral pig), non-target species encountered in the survey area are also recorded. A hand-held Garmin Trex Summit GPS unit is used to record the location of each target species encountered as roadkill. For non-target species the vehicle’s trip odometer is used to record the approximate location of each roadkill.

Camera stations

Twenty four cameras are monitoring wildlife activity between San Luis Obispo and Atascadero. To date, no camera theft has occurred.

Camera station selection criteria

Approximately 142 culverts exist along SR 101 between San Luis Obispo (northern city limits) and Atascadero (southern city limits). The majority of the culverts are small drainage culverts with a diameter of less than 2.5 feet Since these are likely impassable by deer, bear, mountain lion, and feral pig, the focus has been on culverts with a diameter or width equal to or greater than 4 feet.

Potential culverts were visited to determine if they were passable by the four target species; those that were fully submerged, choked with vegetation or with vertical drops >4 feet were discarded. Cameras are deployed at all passable culverts (greater than or equal to 4 ft) within the project limits, and at selected culverts in the broader study area. Some of these culverts are designed for storm drainage, but others are for human or vehicle/livestock access under the freeway.

Camera deployment

A single Reconyx HC600 Hyperfire with IR flash was deployed at each of the four jump-outs and at each of the four electric mats in July 2012. The cameras have been monitored continuously since then, with minor exceptions for dead batteries and cameras that were temporarily knocked off-target. An additional camera was installed at an access gate for the railroad and utility lines located on the eastside of the highway across from the electric mat and jump-out at the southern end of the project.

Eleven cameras were deployed at culverts and large underpasses in August-September 2012 and four more were deployed in Jan-Feb 2013. These cameras are a mix of Reconyx HC600s and Bushnell Trophycam HDs (also with IR flash). The first priority was to deploy cameras within the limits of the fencing project, and then secondarily within the larger study area for the roadkill surveys. The cameras have been monitored continuously since their deployment.

The cameras take AA lithium batteries (Reconyx = 12, Bushnell = 4 or 8) and an 8 Gb data storage card. The long-lasting batteries and large data cards allow the cameras to be checked less frequently with low risk of dead batteries or card saturation. However, occasionally data nights are lost at some stations for these reasons, or by the camera being knocked off position, generally by human passersby. Most of the cameras are monitored every 2-3 weeks by a 2-person student crew who retrieve the data cards and replace batteries as needed. Due to the locations for a couple of the cameras, they are monitored every 4-6 weeks.

All the cameras are mounted to structures, such as metal or wood support posts or trees (Figure 6 and 7). In culverts, the cameras are mounted with epoxy to prevent having screws penetrate the culvert wall. All cameras are mounted using ball joints intended for home stereo speakers; the ball joint allows the camera to be aimed very precisely. The cameras are protected in metal security boxes and secured with various combinations of padlocks, chain and cable locks (Master Python lock).

FIGURE 6 Calpoly students checking cameras mounted on trees at undercrossings

FIGURE 7 Cameras mounted on jump-out and electric mat

PRELILMINARY RESULTS

To document the long-term effectiveness of the wildlife fencing including the electric mats, jump-outs and undercrossings, post-construction monitoring is on going through June 2014. The monitoring is also designed to capture any changes in wildlife movement that may occur after the median barrier project is completed summer of 2014.

Roadkill surveys

Sixty-five post-construction roadkill surveys were conducted July 2012 through September 2012. Surveys were suspended temporarily when the contract agreement between Caltrans and the California State University system expired. The surveys will be re-initiated once the new contract agreement is in place. Once surveys resume and the data from the post-construction monitoring are available they will be compared to the pre-construction roadkill surveys conducted for the median barrier project May 2009 to June 2010. As a reference, the pre-construction survey results for the four target species are discussed below.

Deer roadkills (18) were spread throughout the study area, both spatially and temporally. Two feral pig roadkill events (one involving 4 pigs) were in the same location north of the wildlife fencing project in the southbound lane near the Atascadero city limits. The California Department of Fish and Wildlife data documented 6 bears struck by vehicles within the project area during the 2009-2010 survey period (personal communication). Five of these occurred in a 1-mile area just north of the top of Cuesta Grade, strongly suggesting a “roadkill hotspot.” There were no mountain lion roadkills observed during the survey period (Perrine et al. 2011). However, two mountain lion roadkill were observed in the project limits prior to completion of the fencing project in 2012.

Camera stations

The number of photos captured by the cameras has varied widely. Some cameras at the electric mats generated more than a thousand photographs per day, mostly by passing vehicles, whereas cameras in the smaller underpasses only generated a few photographs per week.

Electric mats and jump-outs

The initial results have documented that black bear and mule deer are being repelled by the electric mats and deer are using the jump-outs to escape the highway corridor. However, the results are mixed and summarized below. There are no detections of either mountain lion or feral pig at the electric mats or jump-outs. To date there are no observations where any wildlife have used the jump-outs to climb or jump into the highway corridor.

Black bear (Figure 8) detections at the electric mats and jump-outs have been sparse. Preliminary data documented that a bear was repelled by the electric mat on the east side of the highway at the southern end of the project. In a single incident, a black bear gained access to the highway corridor (from where is unknown) and walked across the southern electric mat on the west side of SR 101. The photo clearly shows that the bear got shocked and leaped off the mat and out of the road corridor. Within the same time frame a bear approached the top of the jump-out just to the north of the electric mat then turned back into the highway corridor rather than jumping off. It is possible this was the same bear that later crossed the mat to exit the highway corridor. This is the only incident where a bear was observed on a jump-out. There were two events that documented a bear crossing the electric mat located on the west side of the highway at the northern end of the project, however, it was later determined that the mat was not turned on at the time. Once the mat was turned on, bear were not observed crossing the mat.

FIGURE 8 Black bear approaches electric mat to enter highway corridor, later retreats.

Mule deer (both does and bucks) have been documented using the jump-outs (Figure 9). In five out of 36 events, deer were observed using the jump-out to escape the highway corridor. For the remaining 31 events, the deer chose not to use the jump-out to leave the highway corridor. Many times the deer walked up the ramp, looked around and browsed a bit, then walked back down the jump-out. Since the deer are not tagged, it is unclear how many individuals are actually involved in the events. It is possible the cameras are detecting just a few animals and individual behavior is playing a role in whether an individual uses the jump-out. In 39 events where deer were detected at or near the base of the jump-out, they never jumped into the highway corridor.

FIGURE 9 Doe and Buck using jump-out to escape the highway corridor.

Preliminary data have documented the electric mats successfully repelling mule deer in 9 out of 63 events. For the remaining 54 events, deer were documented crossing the mats (Figure 10). This includes deer passing in both directions, whether in the highway corridor coming out or outside of the highway corridor going into the roadway. A doe with a fawn or a doe with a trailing buck were counted as 1 event. Again, the deer are not tagged so individuals cannot be identified and it is possible that the same individual may visit on multiple occasions. For example out of the remaining 54 events, it is likely that 44 events involved a single doe with two fawns that repeatedly crossed the electric mat on the east side of the highway at the southern end of the project. This is the same electric mat that successfully prevented a black bear from entering the highway corridor.

FIGURE 10 Buck crossing mat to enter highway corridor and doe crossing mat to exit.

Other wildlife detected both crossing and being repelled by the electric mats includes the occasional fox (gray and red), coyote, bobcat, opossum, raccoon and gray squirrel.

Undercrossings

In addition to the two large undercrossings at each end of the fencing project, there are two culverts in between these two points that are large enough to pass the four target species. All of the target species except mountain lion have been documented using one or more of the undercrossings within the limits of the project.

One culvert located about 1 mile north of the railroad overhead crossing is a 4-foot by 8-foot (4x8) reinforced concrete box culvert that is 170 feet in length. The largest culvert located about 0.5 miles further north is a 10-foot by 11-foot (10x11ft.) reinforced box culvert with a 10-foot corrugated metal arch at the inlet. Both of these culverts have the potential to pass wildlife from one side of the highway to the other since each is a single culvert. A third drainage culvert is a segmented 4-foot by 4-foot (4x4 ft.) reinforced concrete box culvert and a portion of it daylights in the median at the SR 101/SR 58 Interchange. This culvert is not connected to the wildlife fence, however, it is being monitored for wildlife that may enter the highway corridor and use it to pass through the interchange area.

Black bear (Figure 11) have been documented using both of the large underpasses and all three culverts within the limits of the fencing project. It is likely that the bear documented using the 4x4 foot culvert at the interchange is breaching the fence near the outlet to the culvert and then moving through at least the first segment of the culvert where it daylights in the median.

FIGURE 11 Black bear using 4x8 ft. (left) and 4x4 ft. (right) box culvert.

Mule deer (Figure 12) have been documented using both of the large underpasses and the 4x8 foot culvert located near the southern end of the project. Although passable by deer, they have not been documented using the 10x11foot culvert. This culvert is dark and located in a perennial stream channel. As the culvert daylights at the outlet it narrows into a vertical concrete walled open culvert that makes a 90 degree angle turn.

FIGURE 12 Mule deer using 4x8 ft. box culvert and Santa Margarita Creek undercrossing.

Feral pigs (Figure 13) are only using the Santa Margarita Creek undercrossing at the northern end of the project. They have not been documented using any of the other undercrossings.

FIGURE 13 Feral pig using the undercrossing at Santa Margarita Creek undercrossing.

Other wildlife that are using the undercrossings on a more regular basis than the target species include opossum, raccoon, gray fox, bobcat, squirrel, rabbit, striped skunk, and American badger.

Within the larger study area, the cameras deployed in the two large culverts south of the limits of the fencing project have documented black bear, mountain lion and mule deer (Figure 14). The cameras deployed in the three large drive-through culverts in the larger study area north of the limits of the fencing project have not detected any of the four target species. These cameras have only recorded smaller mammals such as striped skunk, American badger, and ground squirrels.

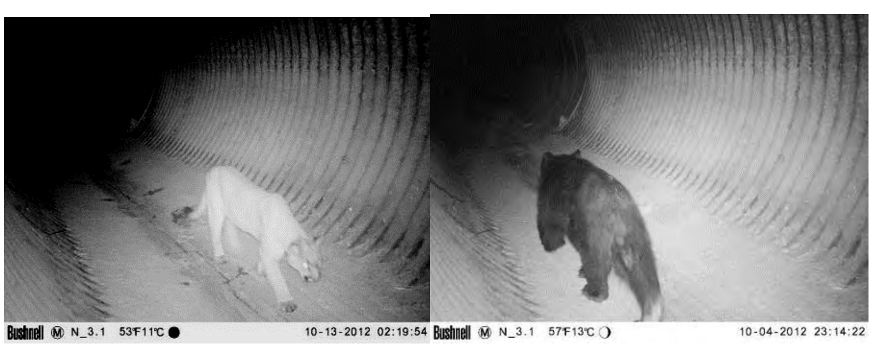

FIGURE 14 Mountain lion and black bear 10x10 ft. corrugated metal culvert.

CONCLUSIONS/RECOMMENDATIONS

Fencing

The wildlife fencing is working to guide three (mule deer, black bear and feral pig) of the four target species to the existing undercrossing within the project limits. Although the roadkill surveys are not completed, Caltrans maintenance crew responsible for removing carcasses have reported a reduction in roadkill within the limits of the project.

Electric mats

Based on camera station documentation, there is evidence that the electric mats are more effective at repelling black bear than mule deer. The majority of the observations for mule deer documented crossing events where deer crossed the mats to either enter the highway corridor or exit it. The first recommendation for improving the effectiveness of the mats at deterring deer is to set the energizer for the mat at the appropriate speed (pulse rate per second) for the target species.

The energizer for the electric mats can be set at slow-day speed (2.5 pulses per second) and fast-night speed (1.5 pulses per second) for wildlife active during the night. For wildlife active during the day the speed can be set at fast-day speed (1.5 pulses per second) and slow-night speed (2.5 pulses per second) speed to conserve the battery (User Manual). Caltrans maintenance electricians currently have the speed set for diurnal species because the batteries were draining overnight when set to the speed used for nocturnal species. To improve the operation of the mats, Caltrans biologists are currently working with maintenance staff to trim the vegetation that shades the solar panels at three of the four locations. This may improve the ability of the solar panel to keep the batteries charged and allow the energizer to be reset to slow-day/fast-night speed for wildlife more active at night.

Additional recommendations include eliminating the gap between the post and the electric mat that currently allow some wildlife to skirt the mat. Also the effectiveness of the electric mats could be improved by making them wider and reducing the width of the spaces between the electrodes.

Jump-outs

The camera stations have document mule deer are using the jump-outs, but most observations document the deer approaching the edge and turning around. The first step that’s been taken by Caltrans biologist to improve the use of the jump-outs, is the removal of a board that was placed on the edge of each jump-out (See Figure 9) as an experiment to deter wildlife from climbing or jumping into the highway corridor. If the removal of the boards does not resolve the issue, the next recommendation by the author’s is to lower the height of the jump-out.

In addition, annual weed removal could help make the jump-outs more visible and less attractive for browsing by mule deer. As a side note, the steel posts used to construct the jump-outs should be capped to prevent attracting birds and small rodents from building nests inside the pipes.

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BIOGRAPHICAL SKETCHES

Nancy R. Siepel has worked for the California Department of Transportation District 5 as an Associate Environmental Planner (Natural Resources), a.k.a. wildlife biologist, since 1999. For the past seven years she has worked in the Environmental Stewardship Branch as a mitigation and wildlife connectivity specialist promoting advanced mitigation strategies for transportation projects. She is currently collaborating on a Regional Wildlife and Habitat Connectivity Plan for District 5. Nancy has an additional 20 years of experience working as a biologist on research studies related to threatened and endangered species as well as marine fisheries. She received her Bachelor of Science from Northern Arizona University.

John D. Perrine is a professor in the Biological Sciences Department of California State Polytechnic University (CalPoly) in San Luis Obispo, CA. He has broad interests in wildlife ecology and conservation, especially in regard to using non-invasive automatic cameras to document activity patterns and resource use by mammalian carnivores. He is currently working with a suite of state and federal agencies to document the distribution and basic ecology of the Sierra Nevada red fox, one of California's rarest and least-studied carnivore species. Dr. Perrine received his Ph.D. from the University of California in Berkeley, CA.

Lisa K. Schicker worked for the California Department of Transportation District 5 as an Associate Environmental Planner (Natural Resources) from 1990 to December 2012. Her experience as a biologist included environmental planning, arboriculture, biological studies and permit compliance. She is currently a biology instructor at Cuesta College and the owner of Pacific Habitats Environmental Consulting. Lisa received her Master of Liberal Arts in

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