Sonoma Valley Wildlife Corridor Road Underpass Use Report 2013-2014

Mountain lion at Stuart Creek West

Gray fox pair at Stuart Creek West

Male Deer at Hooker Creek West

Bobcat at Hooker Creek West

Mountain lion at South Sonoma Creek West

Two deer at South Sonoma Creek East

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For the Sonoma Land Trust

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1. Introduction

The Sonoma Valley Wildlife Corridor (SVWC) connects the Sonoma Mountains and the Mayacamas Mountains through the Sonoma Valley floor (Figure 1). The SVWC is part of a larger linkage identified by the Bay Area Critical Linkages Project between the Marin coast and Blue Ridge-Berryessa regions (Penrod et. al. 2013). In 2013 Sonoma Land Trust (SLT) began a multi-year study, funded in part by the Gordon and Betty Moore Foundation, to determine whether mobile wild animals are able to move freely through the designated corridor. As described in the *Sonoma Valley Wildlife Corridor Management and Monitoring Strategy*, the study includes a remote camera grid across the corridor landscape, cameras at bridges and culverts ("underpasses"), and roadkill surveys. The objective in placing cameras at underpasses is to determine if these structures are facilitating wildlife movement under Highway 12 and Arnold Drive within and adjacent to the SVWC. Roads often fragment landscapes. However, they may be permeable to safe wildlife passage where crossing structures are available for animals to travel under the road (Corridor Ecology 2006). This report describes and summarizes data and findings from the first year of data collected at several underpasses within and adjacent to the SVWC.

2. Summary of Findings

A total of 2,986 animal detections were recorded at all camera sites throughout the twelve month monitoring period. The highest total number of animal detections by camera station were recorded at; South Sonoma Creek on the west side, Stuart Creek on the west side, South Sonoma Creek on the east side, and Hooker Creek on the west side.

Deer and gray fox were the most frequently captured species, but most species expected to be in the region were found to use the underpasses to some degree. This reveals that the underpasses are likely improving the safety of the highway for drivers by facilitating deer passages under the road, thus reducing animal-vehicle collisions, and also improving permeability of the landscape across roads to facilitate dispersal and genetic flow in local wildlife populations.

Animals were most frequently captured at the underpasses during the summer months. Underpass use was also high during the fall. During the summer months, many captures included juveniles traveling with their parents, and detections of these juveniles traveling alone increased in the fall. This seasonal variation shows the important role the underpasses are playing as wildlife crossing structures throughout the year as animals search for water in the summer months, viable mates in the winter, and juvenile dispersal avenues out of their parental home ranges in the fall.

The high volume of juveniles traveling with their parents through the underpasses and close proximity of natal areas, as exemplified by the gray fox pair at Stuart Creek, document that well designed structures are not solely used by individuals during dispersal or in searching for resources, but they are also integral to breeding and natal habitat for some species. This is

compelling evidence that well designed underpasses are not avoided as barriers but provide ready passage under roads, and that young are learning to use underpasses from their parents.

In Fall, many of the juveniles were traveling on their own while dispersing out of their parental home range to establish their own. This was documented at several camera stations. For example, gray fox juveniles previously recorded at the Stuart Creek underpass with their parents were later captured traveling alone and young first year bucks were also recorded at camera sites on their own. This indicates that the bridges are not only linking adjoining habitat and home ranges on either side in daily activity but are also being used by dispersing animals.

There are only a few documented cases of mountain lions using underpasses to travel underneath highways in California (Safe Passages 2010, Urban Carnivores 2010). It is significant that a mountain lion is so readily passing through the Stuart Creek underpass. The bridge dimensions and adjacent habitat types may serve as a case to study in determining the type of crossing structures and surrounding habitats that will facilitate mountain lion movement across busy roads.

3. Study Area and Methods

The valley floor of the study area includes a mixed land use of open space, vineyards, agricultural lands, highways, and riparian habitats. The riparian systems are interwoven within the agricultural lands and the different creeks flow from upland habitats in the Mayacamas to the west and Sonoma Mountains to the east, ultimately draining to Sonoma Creek in the valley floor (Figure 1). Animals tend to travel along riparian habitats. These creeks may be facilitating wildlife movement through the valley floor and under the two major roads bisecting the SVWC into upland habitats, much of which is protected as private conservation lands and local and state parks.

SLT mapped all underpasses along four mile and three mile stretches of Highway 12 and Arnold Drive respectively (Figure 2). The first year of data collection focused on four of the larger underpasses in the study area, including Calabazas Creek, Hooker Creek, South Sonoma Creek, and Stuart Creek. Each underpass is a bridge or large concrete box culvert in which a blue-line creek or river runs underneath Highway 12 or Arnold Drive. At each site, cameras were set up on both the east and west sides of the underpass to determine direction of travel and if animals were traveling through the structures.

Surveys were conducted by SLT staff and interns under permit from Caltrans and permission by Sonoma County Transportation and Public Works. Digital infrared (no white flash) Bushnell HD field cameras were established and maintained throughout a nine to twelve month study period. All underpass cameras were placed within steel security boxes to protect from theft and vandalism and labeled with research tags providing project purpose and contact information for the principle investigator. Cameras were positioned outside of underpasses, near apparent animal trails if found, facing into or across the opening to capture animals entering or exiting the

structure. Woody plants were not removed but herbaceous vegetation and small twigs in front of the cameras that might cause false triggers were mowed or trimmed.

SD memory cards were collected and batteries replaced approximately semi-monthly. The data were entered into a database by Pathways for Wildlife, which includes information on identification of individual animals when possible, juveniles traveling with parents, and relevant behavioral information.

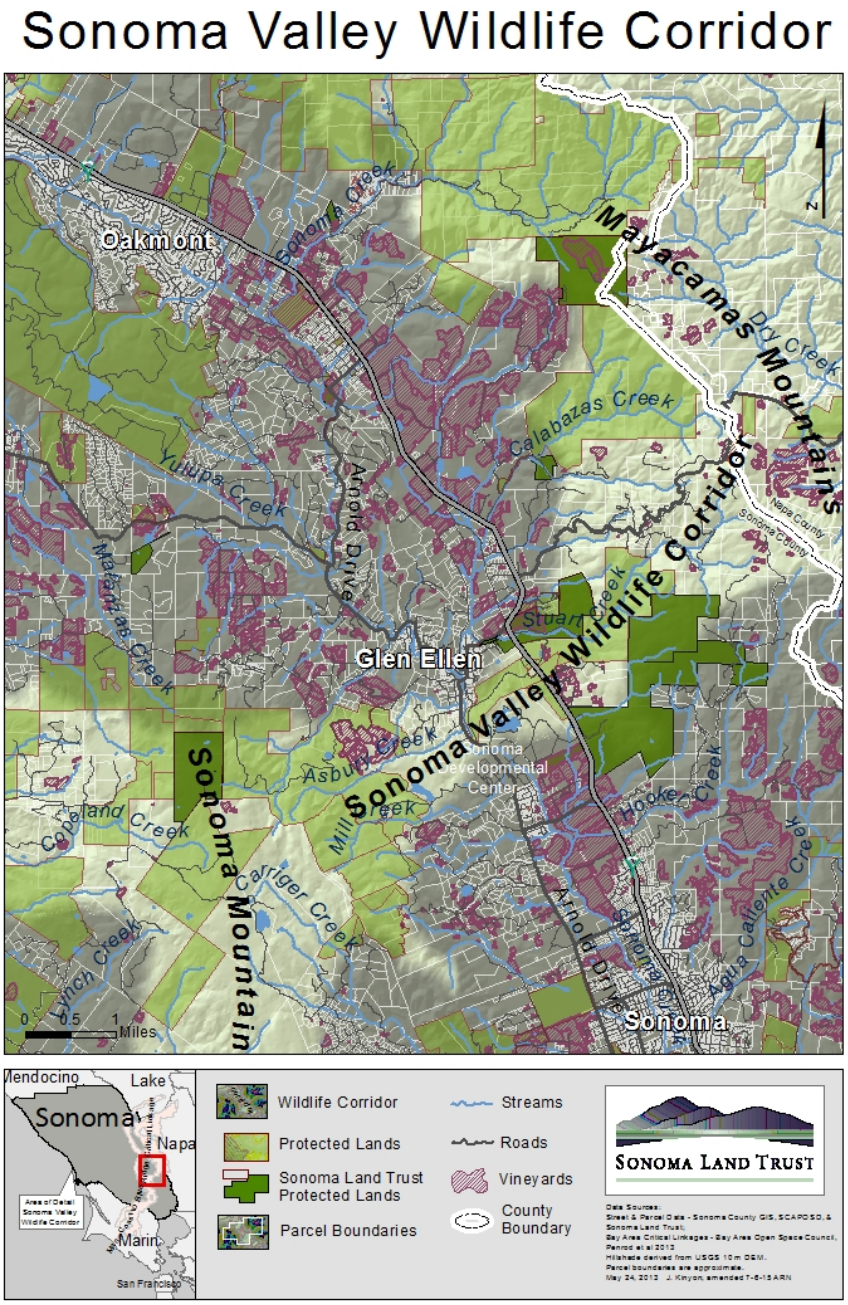


Figure 1: Sonoma Land Trust Wildlife Passage Study Area

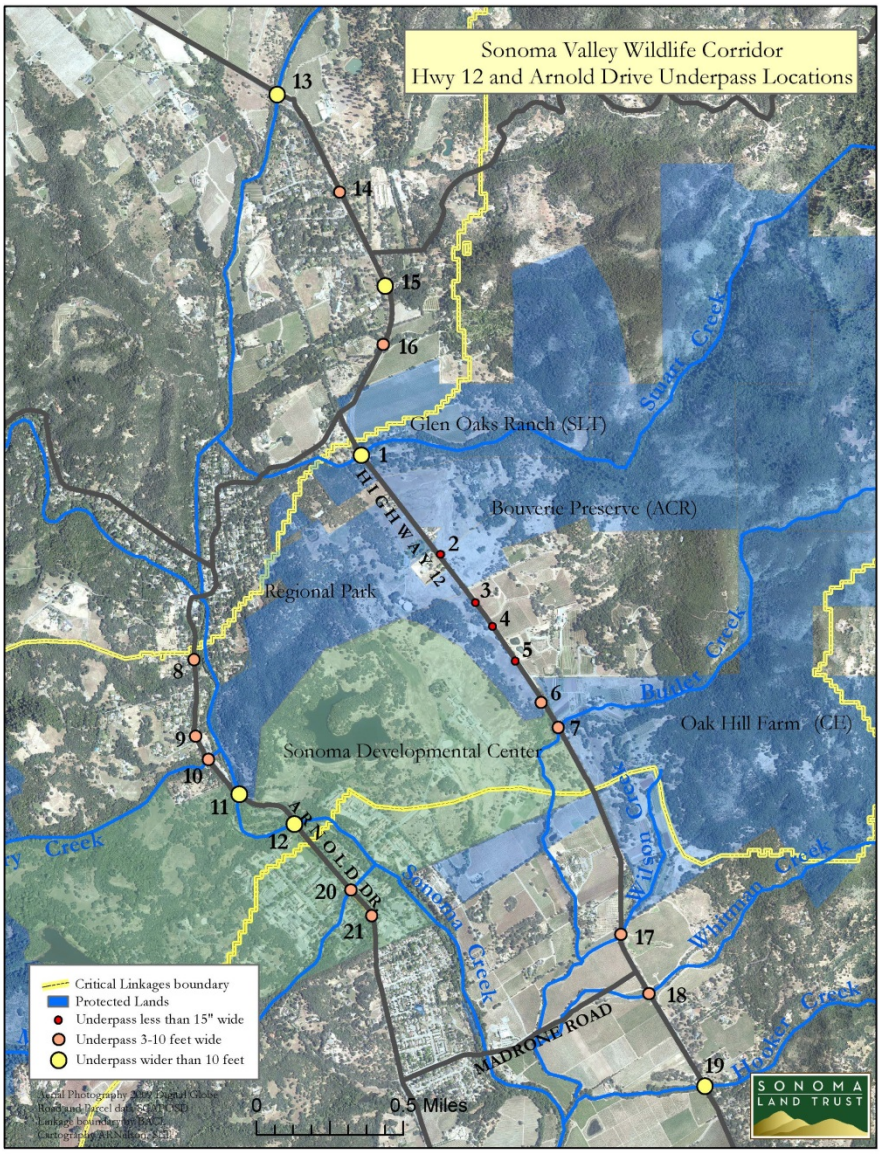


Figure 2: Hwy 12 and Arnold Drive Underpass Locations

4. Results of Study:

i. Total Number of Detections

A total of 2,985 animals were detected at the camera stations. The highest number of detections was recorded at; South Sonoma Creek on the west side, Stuart Creek on the west side, South Sonoma Creek on the east side, and Hooker Creek on the east side, in descending order (Table 1). In comparison to other similar wildlife connectivity studies conducted by Pathways for Wildlife in Santa Clara County and Monterey County, this is a high number of detections (The Nature Conservancy's Pajaro Wildlife Connectivity Study 2012-2013, The Big Sur Land Trust's Central Coast Connectivity Project 2013-2014).

Camera Name	Beaver	Bobcat	Cat	Coyote	Deer	Gray fox	Mountain lion	Oppossum	Porcupine	Raccoon	Skunk	Monitoring Period	Number of Trap Nights	Total Animals Recorded at Each Camera Station
Calabasas Creek East			31		2			2				May 27, 2014-July 17, 2014	52	**35**
Calabasas Creek West			81	2	21	7		89		29	5	May 27, 2014-Nov 4, 2014	161	**234**
Hooker Creek East		22	1		21	151		10		33	26	Nov 11, 2013-Nov 5, 2014	362	**264**
Hooker Creek West		33	6		35	21				35	38	May 15, 2014-Sep 29, 2014	135	**168**
South Sonoma Creek East		15	28		106	39		14		66	7	Nov 8, 2013-Nov 4, 2014	227	**275**
South Sonoma Creek West	1	11	1	1	704	75	2	58		79	25	Nov 9, 2013-Nov 5, 2014	354	**957**
Stuart Creek East			36	4	50	17	3	11		2	50	Nov 8, 2013-Aug 15, 2014	213	**173**
Stuart Creek West		2	75	1	362	264	9	46	1	23	96	Nov 8, 2013-Nov 5, 2014	347	**879**
														2985
Total by Species	**1**	**83**	**259**	**8**	**1301**	**574**	**14**	**230**	**1**	**267**	**247**			

Table 1: Trapping effort and number of animal detections at all camera sites.

Table 1 and Chart 1 show the number of animal detections by species for each camera site. The South Sonoma Creek, Stuart Creek, and Hooker Creek underpasses are facilitating a high amount of deer passage throughout the year. This is a significant finding in that the underpasses are improving road safety by facilitating deer passage under the road, thus reducing animal-vehicle collisions.

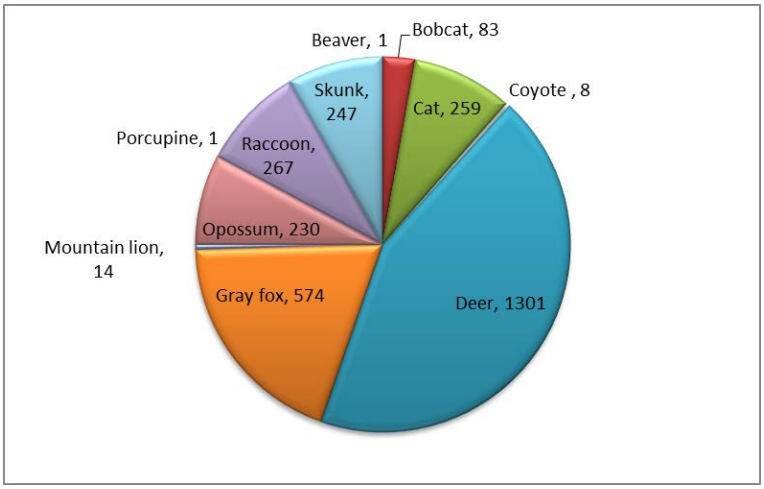


Chart 1: Total Number of Animal Detections.

ii) Number of Detections of Animals per 100 Trap Nights

Because trapping effort varied among camera stations, detections of each species per 100 trap nights was tabulated to compare detection rates between camera stations (Table 1 & Chart 2). Detection rates varied considerably among the camera stations, indicating that the different underpasses are not equally used by, or accessible to, wildlife. For example, deer pass through South Sonoma Creek underpass (396/100TN) significantly more often that than other underpasses. Hooker Creek, Sonoma Creek and Stuart Creek underpasses exhibit the highest detection rates and diversity of use, and are important road crossing structures for deer, mountain lion, gray fox and skunks (Table 1, Chart 2).

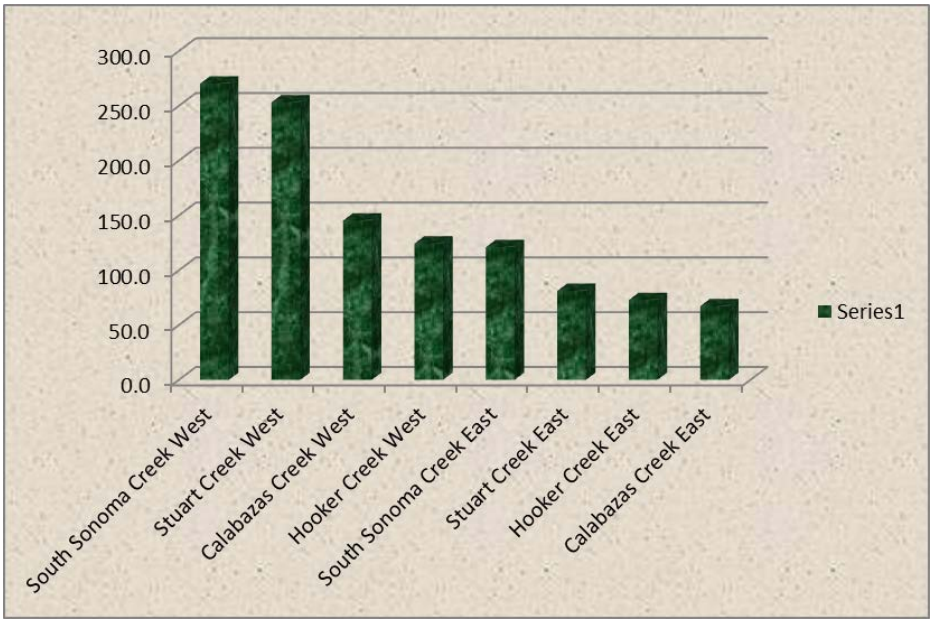


Chart 2: Total Number of Animal Detections per 100 Trap Nights.

5. Bridge and Culvert Data

a) Stuart Creek West

Two male deer 6/3/0214

Mountain lion 7/21/2014

Gray fox pair 8/26/2014

Male Deer 6/3/2014

Stuart Creek runs through Sonoma Land Trust's Glen Oaks Ranch and Audubon Canyon Ranch's Bouverie Preserve, both protected for conservation purposes. Deer, gray fox, and skunk were the most common species detected (Table 2, Chart 3), yet the underpass is facilitating a high diversity of wildlife species in high numbers under Highway 12.

***i.* Deer** A total of 879 animals were detected on the west side of the Stuart Creek underpass traveling through the structure (Table 2). Individual deer can be determined by their antler size, number of tines, and number of females traveling together. There were 149 detections of male deer and 132 detections of female deer. The females were often traveling with juveniles, of which 45 were detected. Deer were consistently traveling under the bridge throughout the year making this an important wildlife crossing structure, facilitating wildlife movement across the valley floor.

***ii.* Gray fox** 264 foxes were detected passing through the underpass. Interestingly, there was a gray fox family consistently using this underpass. In the fall and winter a gray fox pair used the underpass. In spring, the gray fox pair would travel west and often came back east carrying prey items in their mouth. This indicates their den was on the east side of the bridge. During summer the pair showed up with two pups, which also traveled through the underpass as they grew older.

Species	Number of Detections	Number of Detections per 100 Trap Nights	Sex	Number of Juvenile Detections
Bobcat	2	0.6		
Cat	75	22.6		
Coyote	1	0.3		
Deer	362	104.3	149 males, 132 females	45 juveniles
Gray fox	264	76.1	1 male, 1 female	2 juveniles
Mountain lion	9	2.6		
Opossum	46	13.3		
Porcupine	1	0.3		
Raccoon	23	6.6		
Skunk	96	27.7		
Total	**879**			

Table 2: Number of Detections and Detections per 100 Trap Nights at Stuart Creek West.

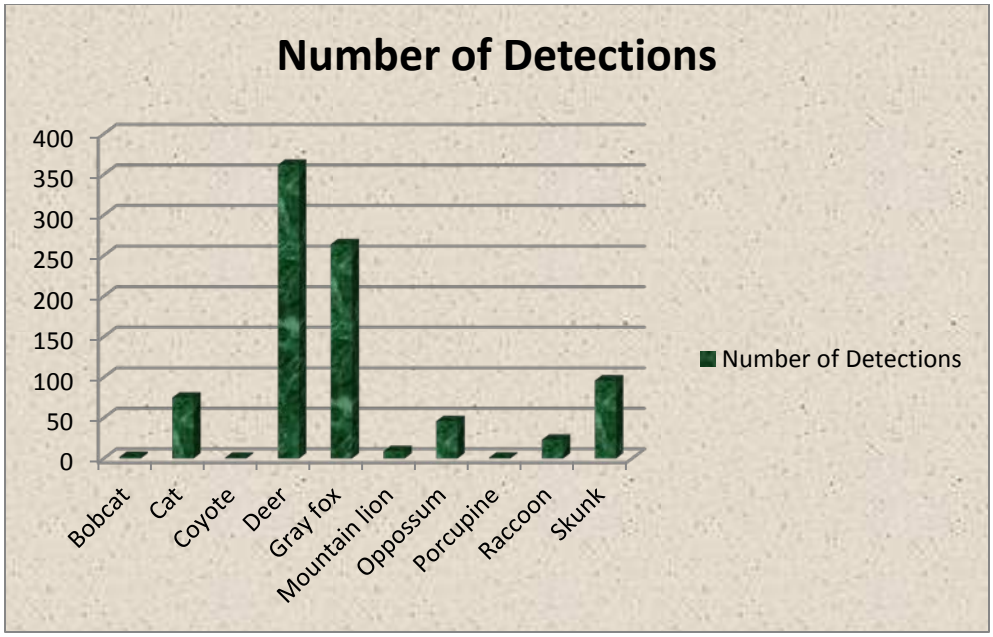


Chart 3: Number of Detections by species at Stuart Creek West

***iii.* Mountain lion** Throughout the study area, there was a total of 14 mountain lion detections (Table 2). Twelve of these detections were at Stuart Creek, and 9 of those were captured on the west side of the underpass. Mountain lions were recorded heading in both east and west directions throughout the year. It appears from the various picture series that these 12 captures were all of the same male lion (Figures 3-6, Pers. com. UCSC Puma Project).

There are only a few documented cases of mountain lions regularly using bridge underpasses to travel underneath highways in California (Safe Passages 2010, Urban Carnivores 2010). This is a significant finding of such high use by a mountain lion. The bridge dimensions and substrates as well as adjacent habitat types may serve as a case study in determining the type of crossing structure and surrounding habitat that will facilitate mountain lion movement underneath busy roads.

Figures 3-6: Mountain lion traveling under Stuart Creek Bridge.

b) Stuart Creek East

Coyote 2/16/2014

Mountain lion 3-29-2014

Three Deer 5/23/2014

Gray fox 1/24/2014

A total of 173 animals were detected on the east side of Stuart Creek (Table 3). The highest rates of detection were of deer and skunk (Chart 4). Both deer and gray fox were recorded traveling with juveniles. There were 30 detections of male deer and 12 detections of female deer. The disparity in captures between the east and west sides are likely due to difficulties in locating the east side camera in a favorable location.

Species	Number of Detections	Number of Detections per 100 Trap Nights	Sex	Number of Juvenile Detections
Cat	36	17		
Coyote	4	1.9		
Deer	50	23.5	30 males, 12 females	1 juvenile
Gray fox	17	8		
Mountain lion	3	1.4		
Opossum	11	5.2		
Raccoon	2	0.9	4 females	8 juveniles
Skunk	50	23.5		
Total	**173**			

Table 3: Number of Detections and Detections per 100 Trap Nights at Stuart Creek East.

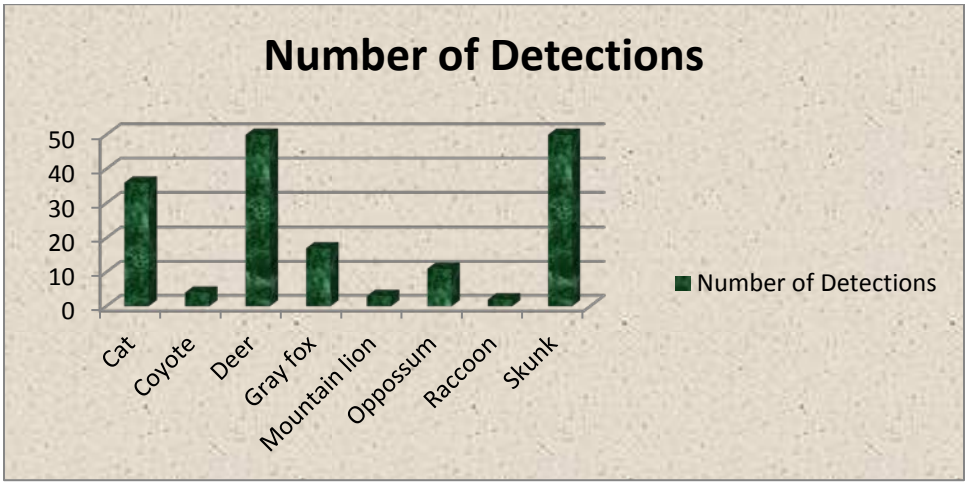


Chart 4: Number of Detections by species at Stuart Creek East.

c) South Sonoma Creek West

Mountain lion 1/20/2014

Gray fox 2/1/2014

Bobcat 1/27/2014

Three deer 11/27/2013

A total of 957 animals were detected on the west side of South Sonoma Creek (Table 4 and Chart 5). The highest rates of detection were of deer and gray fox. Both deer and raccoons were recorded traveling with juveniles. There were 142 detections of male deer and 308 detections of female deer.

Species	Number of Detections	Number of Detections per 100 Trap Nights	Sex	Number of Juvenile Detections
Beaver	1	0.3		
Bobcat	11	3.1		
Cat	1	0.3		
Coyote	1	0.3		
Deer	704	199	142 males, 308 female	124 juveniles
Gray fox	75	21.2		
Mountain lion	2	0.6		
Opossum	58	16.4		
Raccoon	79	2.3	4 females	8 juveniles
Skunk	25	7.1		
Total	**957**			

Table 4: Number of Detections and Detections per 100 Trap Nights at South Sonoma Creek West.

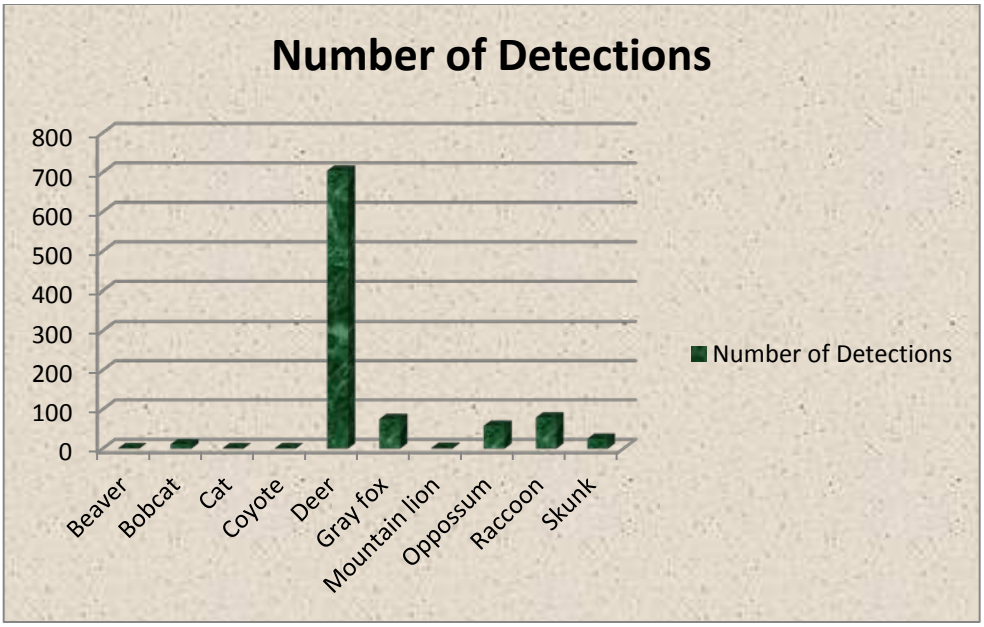


Chart 5: Number of Detections by species at South Sonoma Creek West.

d) South Sonoma Creek East

Two Deer 7/24/2014

Male Deer 10/22/2014

A total of 257 animals were detected on the east side of South Sonoma Creek (Table 5 and Chart 6). The highest rates of detection were of deer, raccoon, and gray fox. Both deer and raccoons were recorded traveling with juveniles. There were 33 detection of male deer and 52 detections of female deer.

Species	Number of Detections	Number of Detections per 100 Trap Nights	Sex	Number of Juvenile Detections
Bobcat	15	6.6		
Cat	28	12.3		
Deer	106	46.7	33 males, 52 females	12 juveniles
Gray fox	39	17.2		
Raccoon	66	29.1	3 females	3 juveniles
Opossum	14	6.2		
Skunk	7	3.1		
Total	**275**			

Table 5: Number of Detections and Detections per 100 Trap Nights at South Sonoma Creek East.

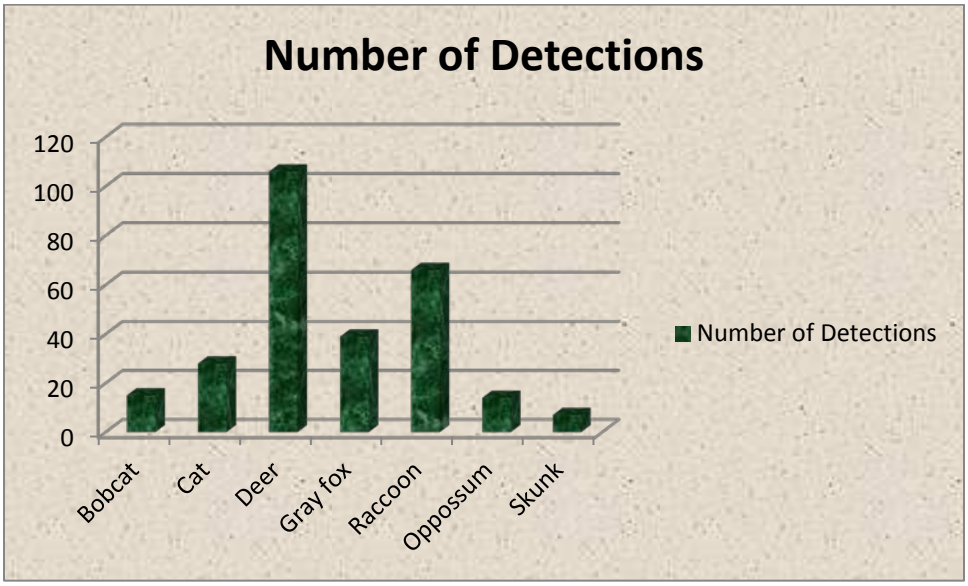


Chart 6: Number of Detections by species at South Sonoma Creek East.

e) Hooker Creek West

Bobcat 8/29/2014

Bobcat 9/27/2014

Male Deer 5/23/2014

Male Deer 6/16/2014

A total of 168 animals were detected on the west side of Hooker Creek (Table 6 and Chart 7). The highest rates of detection were of skunk, deer, raccoon, and bobcat. There were 33 detections of male deer and only 1detection of a female deer.

Species	Number of Detections	Number of Detections per 100 Trap Nights	Sex
Bobcat	33	24.4	
Cat	6	4.4	
Deer	35	26	33 males, 1 female
Gray fox	21	15.6	
Raccoon	35	26	
Skunk	38	28.1	
Total	**168**		

Table 6: Number of Detections and Detections per 100 Trap Nights at Hooker Creek West.

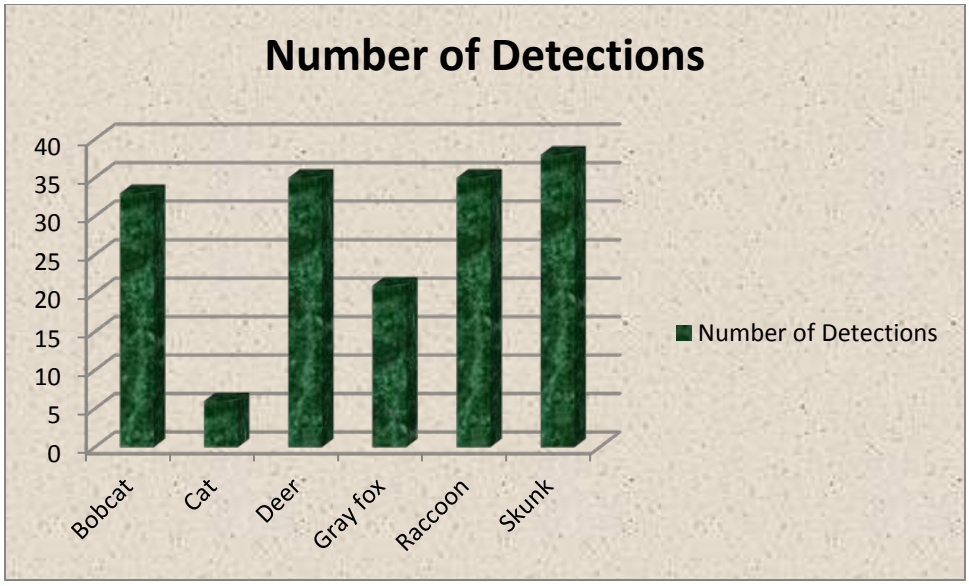


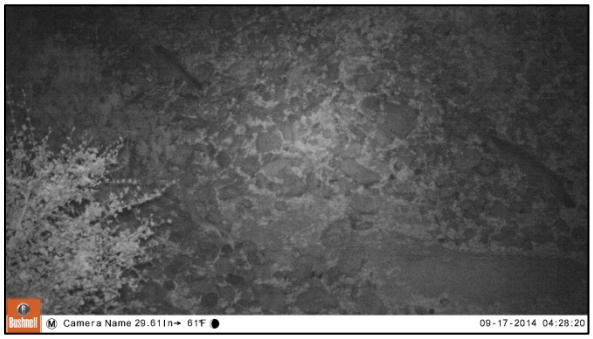
Chart 7: Number of Detections by species at Hooker Creek West.

f) Hooker Creek East

Bobcat 5/7/2014

Bobcat 6/14/2014

Male Deer 8/13/2014



2 Gray fox 9/17/2014

A total of 264 animals were detected on the east side of Hooker Creek (Table 7 and Chart 8). The highest rates of detection were of gray fox, raccoon, skunk, and bobcat. There were 9 detections

of male deer and 1 detection of a female deer. A gray fox pair was also recorded traveling together through the bridge.

Species	Number of Detections	Number of Detections per 100 Trap Nights	Sex	Number of Juvenile Detections
Bobcat	22	6.1		
Cat	1	0.3		
Deer	21	5.8	9 males, 7 females	
Gray fox	151	42.7	1 male, 1 female	
Opossum	10	2.8		
Raccoon	33	9.1		
Skunk	26	7.2		
Total	**264**			

Table 7: Number of Detections and Detections per 100 Trap Nights at Hooker Creek East.

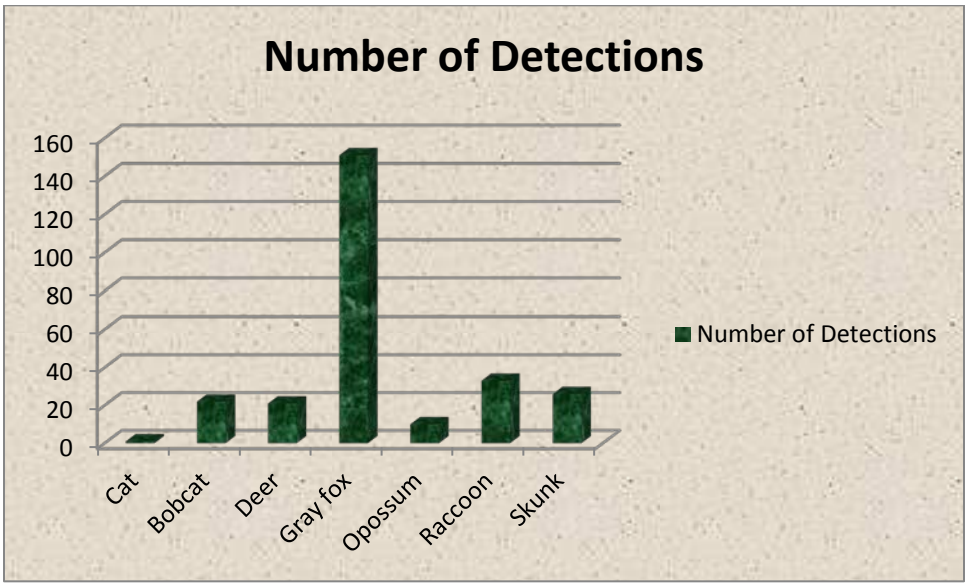


Chart 8: Number of Detections by species at Hooker Creek East.

g) Calabazas Creek West

Raccoon Family 7/20/2014

Female Deer with Fawn 8/4/2014

Gray fox 10/12/2014

Male Deer 6/16/2014

A total of 234 animals were detected on the west side of Calabazas Creek (Table 8 and Chart 9). The highest rates of detection were of opossum, domestic cat, and raccoon. There were 10 detections of male deer and 9 detections of female deer. There were also female raccoons traveling with their juveniles.

Species	Number of Detections	Number of Detections per 100 Trap Nights	Sex	Number of Juvenile Detections
Cat	81	50.3		
Coyote	2	1.2		
Deer	21	13	10 males, 9 females	3
Gray fox	7	4.3		
Opossum	89	55.3		
Raccoon	29	18	3 females	12
Skunk	5	3.1		
Total	**234**			

Table 8: Number of Detections and Detections per 100 Trap Nights at Calabazas Creek West.

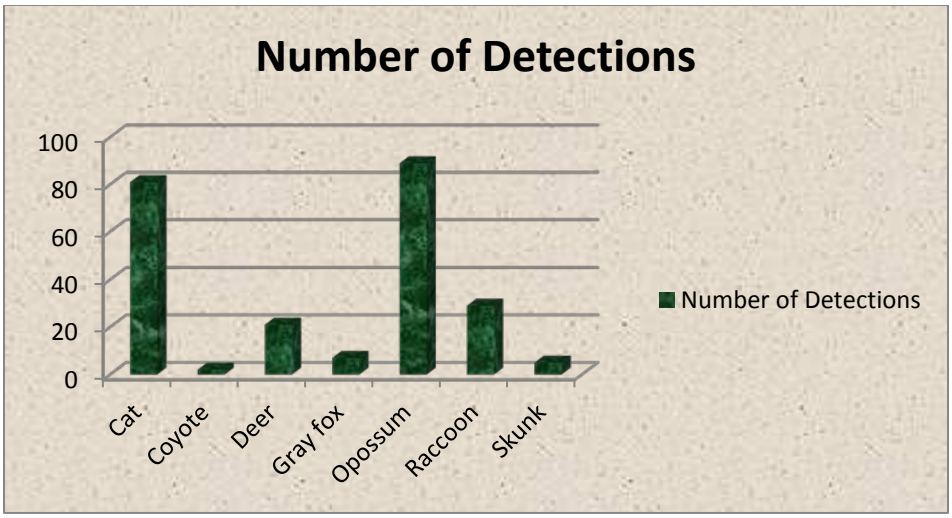


Chart 9: Number of Detections by species at Calabazas Creek West.

h Calabazas Creek East

Male Deer 7/15/2014

Male Deer 7/17/2014

A total of 35 animals were detected on the west side of Calabazas Creek (Table 9). This camera was only set out for 2 months, which partly explains the low overall number of detections. The highest rates of detections were of domestic cat (Chart 10).

Species	Number of Detections	Number of Detections per 100 Trap Nights	Sex
Cat	31	59.6	
Deer	2	3.8	2 Males
Opossum	2	3.8	
Total	**35**		

Table 9: Number of Detections and Detections per 100 Trap Nights at Calabazas Creek East.

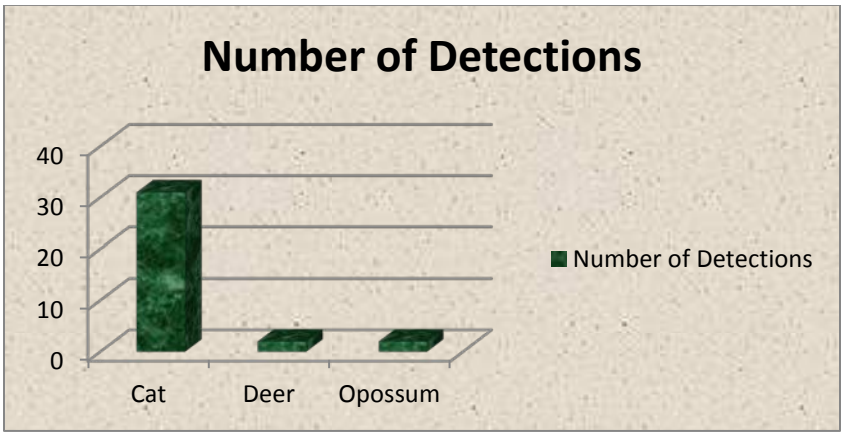


Chart 10: Number of Detections by species at Calabazas Creek East.

6) Seasonal Variation

Animal detections by season were tabulated to determine if there was variation in seasonal patterns of animal movement at each camera station. Detections peaked (870) during the summer months of June, July, and August. There were also a high number of detections (844) during the Fall. These high values reflect animal life stages and behavior. During the summer juveniles are often traveling with their parents, elevating capture rates as documented at many of the camera stations (Table 2,3,4,5,6, and 8). In the Fall, juveniles were traveling on their own and dispersing out of their parental home range to establish their own. This was also documented at several camera stations. For example, gray fox juveniles previously recorded at the Stuart Creek underpass with their parents were later captured traveling alone, and young first year bucks were also recorded at camera sites on their own. This indicates that the bridges are not only linking adjoining habitat and home ranges on either side in daily activity but are also being used by dispersing animals.

Mountain lion use of the Stuart Creek underpass also increased from Winter and Spring through Summer, and Fall (Table 10). This increase could indicate that the mountain lion has incorporated the underpass and surrounding habitat as part of its home range (Cougar 2009, Connectivity Conservation 2006).

The total number of detections by species in each season was also tabulated (in Table 10 & Chart 11). There were low detections of coyote throughout the year. Bobcats, deer, and mountain lion detections increased from Winter to Fall. Of note, a porcupine was recorded in the Fall at Stuart Creek, a beaver was recorded in the Winter at South Sonoma Creek, and a female Wood duck with ten chicks was recorded passing through the Hooker Creek underpass in Spring (Figures 7, 8, & 9).

Species	Winter (Dec, Jan, Feb)	Spring (March, April, May)	Summer (June, July, Aug)	Fall (Sept, Oct, Nov)
Beaver	1			
Bobcat	14	12	31	21
Coyote	2	1	2	2
Deer	227	194	434	285
Gray fox	135	50	120	231
Mountain lion	3	2	3	6
Porcupine				1
Wood duck		11		
Grand Totals	**382**	**270**	**590**	**546**

Table 10: Species Detections by Season

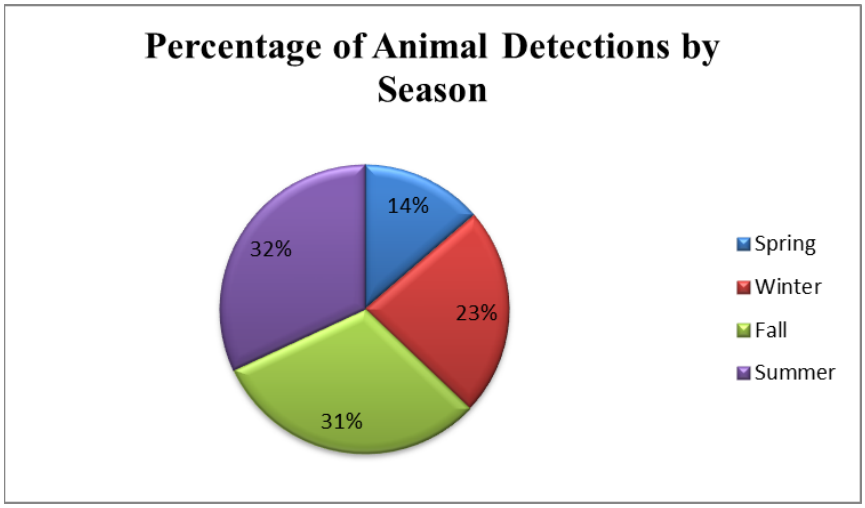


Chart 11: Percentage of Animal Detections by Season

This seasonal variation shows the important role the underpasses are playing as wildlife crossing structures throughout the year as animals travel to find water in the summer months, viable mates in the winter, and provide the ability for juveniles to disperse out of their parental home ranges in the fall.

Figure 7: Porcupine 10/30/2014

Figure 8: Beaver 2/27/2014

Figure 9: Female Wood Duck with Chicks at Hooker Creek East 5/05/2014

7) Human and Domestic Animal Detections

	Calabazas Creek West	Calabazas Creek East	Hooker Creek West	Hooker Creek East	South Sonoma Creek West	South Sonoma Creek East	Stuart Creek West	Stuart Creek East	Totals
Detections of Domestic Cats	81	31	6	1	1	28	75	36	**259**
Detections of Humans	6	16	5	5	52	119	16	8	**227**
Detections of Dogs	0	1	1	3	23	23	1	0	**52**
Grand Totals	**87**	**48**	**12**	**9**	**76**	**170**	**92**	**44**	**538**

Table 11: Number Detections of Domestic Cats, Dogs, and Humans

The total number of detections for domestic cats was 259, while humans and dogs were 227 and 52 (Table 11). Calabazas Creek had the highest detection rates of domestic cat. Calabazas Creek also had the lowest species diversity and detection rates as well, indicating that the presence of domestic animals has a negative effect on wildlife use of the underpass.

8) Recommendations & Next Steps

a) Directional Fencing: If roadkill data indicates that vehicle collisions are problematic, directional fences may help guide more animals to the underpasses and alleviate the problem.

b) Wildlife Friendly fencing: To increase the permeability of the landscape generally and maintain wildlife access to and from the underpasses, fencing in adjacent habitats and especially near underpass entrances should be minimized and be wildlife friendly if needed. Fencing should never be placed across creeks and should be set back from riparian zones as much as feasible to maintain free animal movement in these critical corridors.

c) Protection of lands adjacent to bridges: The majority of the underpasses, with the possible exception of Calabazas, are functioning as wildlife crossing structures. Lands adjacent to these crossing structures, which link into upland habitats, are important in facilitating wildlife movement and genetic flow and maintaining healthy animal populations. Protecting habitat on either side of the underpasses, leading into upland habitats and preserves, is critical to maintaining the wildlife corridor and improving permeability for wildlife movement across the landscape (Figure 1).

d) Human and domestic/feral animal control: Human, dog, and domestic/feral cat detections were relatively high at the South Sonoma Creek East and Calabazas Creek sites, where wildlife detections were low compared to the other locations similar in size and habitat. Previous studies have found that the presence of humans and domestic animals have a negative effect on various wildlife species (Urban Carnivores 2010). Many wildlife species will avoid areas of high use and impact by humans and domestic animals. We recommend minimizing human, dog and cat use of underpasses as they are an important passage location for animals to safely travel underneath the road, hence greatly reducing the number of animal vehicle collisions on the highway.

e) Underpass Maintenance: These findings should be shared with Caltrans and Sonoma County Public Works to encourage improvements that help direct and facilitate wildlife movement through underpasses when replacement or scheduled maintenance occurs. Maintenance and improvement activities that have been found to enhance the ability of wildlife to pass through an underpass include:

i. Clearing out vegetation in front of openings of bridges & culverts to give a clear line of vision through them and enhance the ability of animals to approach and leave the structure. For example, regular mowing of invasive plants such as star thistle, scotch broom, and poison hemlock in front of culverts & bridges and removing overgrown blackberry and poison oak bushes surrounding the structures is very effective as these can often have a barrier effect to animal movement (CA Central Coast Connectivity Project Annual Report 2013-2014, The Nature Conservancy's Pajaro Study 2012-2013).
ii. Clearing debris such as large branches & trash items from entrances and insides of underpasses (Safe Passages 2010).

iii. Adding directional fencing along roads that guide animals to the underpass and reduce animal presence on the road (Safe Passages 2010).

iv. Replace cattle fencing or animal exclusionary fencing in front of underpasses to allow for wildlife passage while maintaining livestock control (Safe Passages 2010).

iv. Retrofit underpasses so there is a clear line of sight through them, with level ground, preferably with soil and gravel substrates and sufficient ground above anticipated high flow levels to maintain winter passage (Safe Passages 2010).

f) Further research: Monitoring animal use of the midsized concrete culverts identified along Highway 12 and Arnold Drive would be helpful in identifying other types of structures that facilitate crossing under the highway.

Genetic analysis would be valuable in verifying if the corridor is facilitating dispersal and genetic flow between Sonoma Mountain and the Mayacamas or if genetic isolation is occurring, and may help identify important restoration efforts or land conservation needs.

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