Coyote Valley Linkage Assessment Study
Final Report

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SANTA CLARA VALLEY OPEN SPACE AUTHORITY

GUADALUPE-COYOTE RESOURCE CONSERVATION DISTRICT

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Lastly, we would like to thank our research partners, Adina Merelender and Morgan Gray at UC Berkeley for all their great work on the genetic analysis, occupancy modeling, and research design on the project.

Bobcat in Fisher Creek at the Laguna Bridge.

Executive Summary

Coyote Valley has been identified as providing important habitat for wildlife movement between the Santa Cruz Mountains and the Diablo Range. Previous studies involving computer modeling have identified Coyote Valley as an important habitat linkage for wildlife movement (Critical Linkages: Bay Area & Beyond 2013). Other studies have also found that wildlife travel through various culverts and bridges along Highway 101 to safely cross underneath the highway (Safe Passage for Coyote Valley Phillips, J. et al 2012). However, there is very little data on wildlife movement across the valley floor and what habitats wildlife are using as pathways. Another important aspect of wildlife corridor studies is to identify if genetic flow is occurring between local wildlife populations to determine if the habitat is facilitating movement between subpopulations. Genetic work has not been previously conducted in Coyote Valley.

This research project is working on: 1) identifying important pathways and habitats that wildlife are using to travel across the valley floor through field camera surveys and occupancy modeling; and 2) determining if genetic flow or isolation is occurring. With the current rate of habitat fragmentation and loss of habitat due to human development, it is important to identify wildlife linkages that species are using to ensure the long term viability and health of our local wildlife populations, which could be at risk of local extinctions due to habitat loss (Soulé & Terborgh 1999).

In the past year we identified several pathways that various animals are using to travel across the valley floor through a variety of habitats and road infrastructure. One of the main pathways we identified is along Fisher Creek, in which animals are traveling from the west Santa Cruz Mountain foothills at the Coyote Valley Open Space Preserve, across the valley floor along the creek bed, and over to Coyote Creek County Park on the east side of the Valley through the Monterey Road Fisher Creek culvert (see Figure 5 and 10).

Wildlife, including bobcat, grey fox, coyote, deer and other small and medium-sized mammals have been documented traveling from Coyote Ridge and Coyote Creek County Park on the east side of Coyote Valley by using the Coyote Creek Golf Course Drive Underpass to safely cross underneath Highway 101.

Our study also found that juvenile coyote, deer, and bobcat are using these pathways, thereby showing that Coyote Valley is providing food and water resources, breeding and natal den habitat, and juvenile dispersal habitat.

Our research also identified barriers to wildlife movement through our camera data and road kill analysis. Based on these findings we have created a prioritized list of barriers that can be improved to better facilitate animal movement.

We collected and processed twenty-six ground squirrel genetic samples and the data was inputted into the occupancy model developed by Morgan Grey at UC Berkeley as part of her dissertation work. The results of the genetic work and occupancy model will be published once the analysis is complete. Future research needs include identifying additional pathways animals are using and implementing a radio collar study on a focal species such as bobcats. This study detected a high number of individual bobcats using Coyote Valley and a radio collar study would provide a better understanding of wildlife movement and habitat use in Coyote Valley.

Report Sections

1.0 Introduction

1.1 Location

Coyote Valley is located in Santa Clara County between the cities of San Jose and Morgan Hill (Figure 1). It consists of mixed land use including protected lands, agricultural fields, and residential homes. Coyote Valley is significant because it is the northernmost non-urbanized area that provides wildlife the ability to move between the Santa Cruz Mountains and Diablo Range (Figures 1 and 2).

The Santa Cruz Mountains and the Diablo Range have large undeveloped tracts of land that provide habitat for mammals such as mountain lions, deer, bobcats, and coyotes which can have relatively large home ranges (Wilmers 2013, Riley 2006, & Figure 1). Coyote Valley provides habitat for these types of species to move between the two mountain ranges, which is important to maintain healthy wildlife populations (Beier 1995).

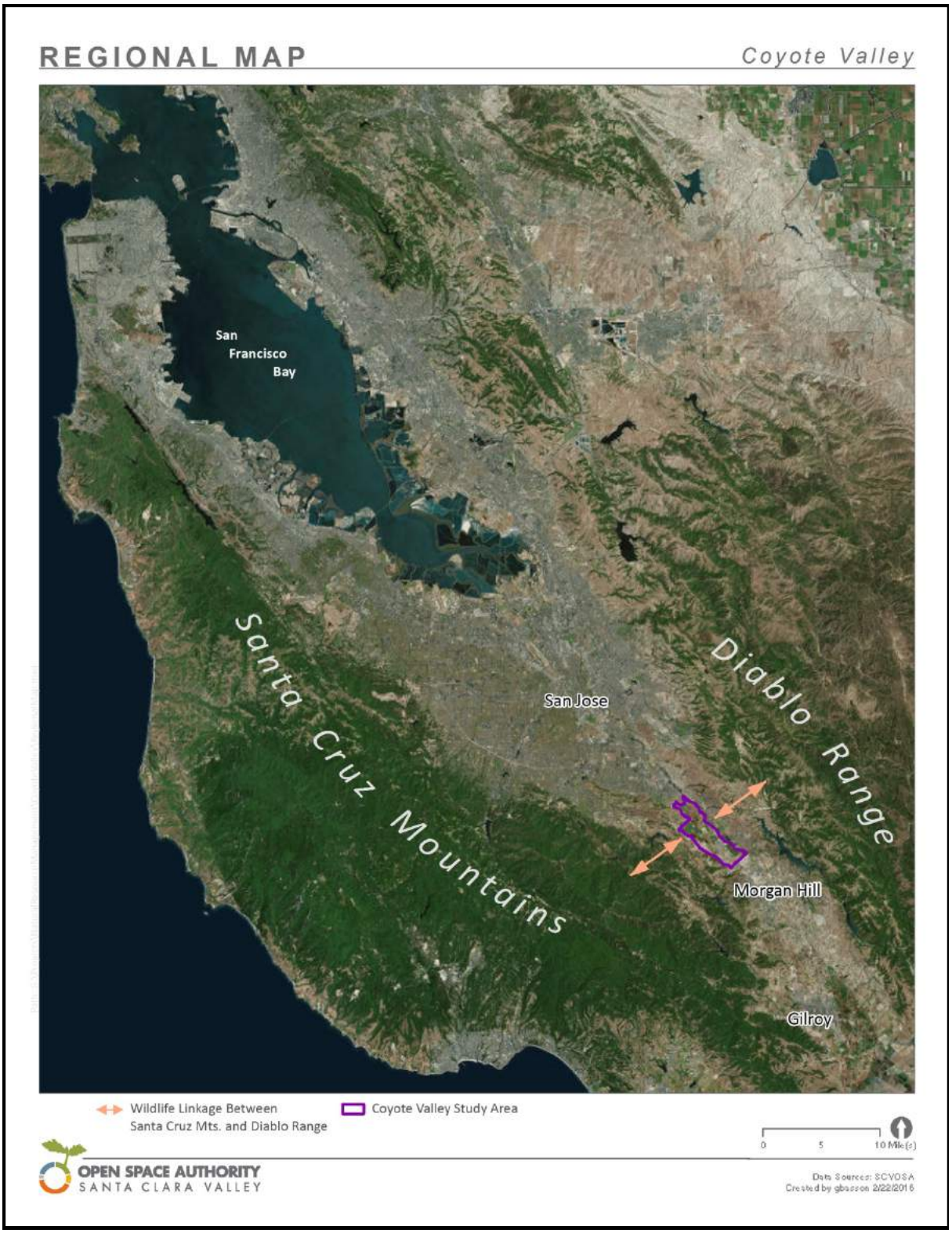

Figure 1: Regional View of the Coyote Valley Study Area.

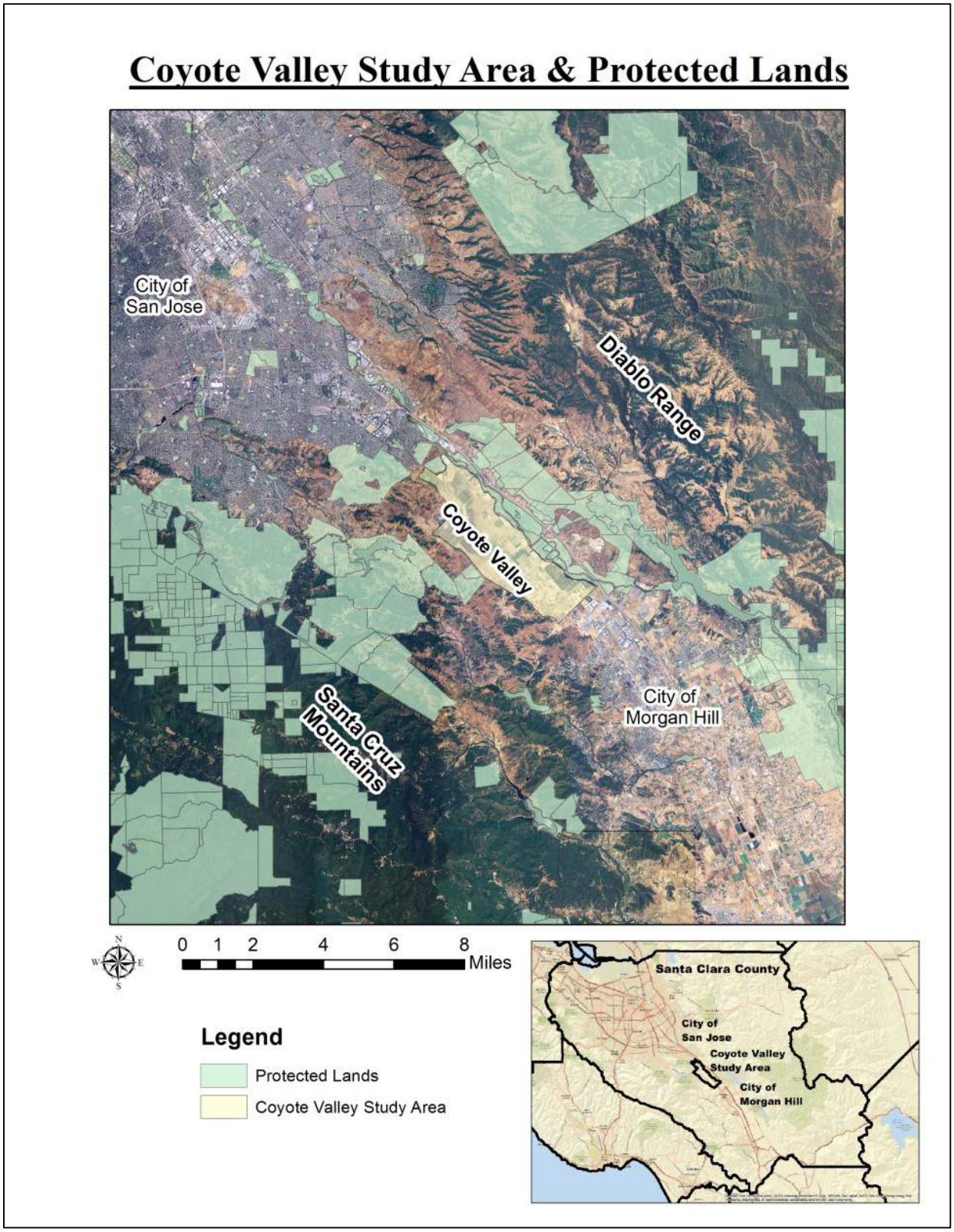

Figure 2: Coyote Valley Study Area.

1.2 Corridor Ecology & Landscape Connectivity

As the Bay Area becomes increasingly fragmented due to human development, the remaining habitat and linkages connecting them are necessary to identify to conserve animal populations and prevent local extinctions (Soulé & Terborgh 1999). Identifying linkages that connect habitats is critical as they provide a means for species to access necessary resources (Soulé & Gilpin 1991), provide access for juvenile dispersal (Beier 1995), and facilitate movement between habitat patches for wildlife to find viable mates (Hilty *et al* 2006).

Urban development reduces available habitat to sustain wildlife populations (Soule & Terborgh 1999). Smaller habitat size can mean fewer individuals, which can lead to negative genetic effects, such as inbreeding (Corridor Ecology 2006). Roads can be barriers to movement for animals and a significant source of mortality for wildlife populations due to high rates of animal-vehicle collisions (Urban Carnivores 2010). When roads are significant barriers to movement, this can also lead to negative genetic effects, such as genetic isolation between populations separated by roads (Safe Passages 2010). With reduced gene flow between populations, low genetic diversity often occurs, which reduces the health of wildlife populations and ability to withstand disease (Road Ecology 2003).

There have been several studies conducted in California which have found significant negative genetic effects on mountain lion, bobcat, and coyote populations due to highways creating a barrier effect to animal movement and genetic flow within populations (Seth P. D. Riley et al. 2006, Ernest H.B. et al. 2003, & Wilmers, C. et al. 2013).

On either side of Coyote Valley there is an extensive network of protected lands owned by various conservation organizations and agencies (Figure 2). Many species need to be able to travel throughout a large landscape to maintain healthy populations. For species with large home ranges such as mountain lions, badgers, and bobcats, this often means traveling across habitats that are fragmented by roads and human developments (Bier 1995). How species move through these fragmented landscapes, and specifically the Coyote Valley, has been to focus of past studies.

1.3 Past Studies

There have been several projects that have identified Coyote Valley as an important linkage that provides habitat for species movement between the Santa Cruz Mountains to the Diablo Range. In 2011, The Conservation Lands Network and Bay Area Open Space Council, completed the Bay Area Critical Linkages Project. Through the Bay Area Critical Linkages Design analysis, various segments of Coyote Valley have been designated as a critical linkage for animal movement between the Santa Cruz Mountains and the Diablo Range. Another project, the Santa Cruz Mountains Linkages Conceptual Area Protection Plan also identified Coyote Valley as an important linkage for wildlife movement between the Santa Cruz Mountains and the Diablo Range. These models and analyses need to be validated by wildlife surveys to determine if wildlife species are traveling through the valley floor.

The Safe Passage for Coyote Valley Report, produced by De Anza College, documented animals species using various bridges and culverts to travel underneath Highway 101 in Coyote Valley. However, there is little data documenting pathways and routes that animals are using to move across the valley floor between the Santa Cruz Mountain Range and the Diablo Range. There have also been no studies conducted to determine if genetic flow is occurring for species between these two ranges.

2.0 Objectives and Methods

This study was developed to better understand animal movement and habitat permeability in Coyote Valley, and if genetic flow was occurring for focal species populations between the Santa Cruz Mountains and the Diablo Range. The study investigated animal movement, habitat permeability, and gene flow across Coyote Valley with the use of: (1) camera traps to identify key locations for wildlife movement and habitat use across the valley floor; and (2) genetic data collection and analysis for two focal animal species (bobcat and California ground squirrel) to determine the extent of gene flow.

2.1 Research Questions

1) Camera Study & Occupancy Modeling Research Questions

Research Question 1: What pathways are animals using to move through and across Coyote Valley?

Research Question 2: What landscape features correlate with animal presence and are critical for wildlife movement?

2) Genetic Data Collection

Research Question 3: Is gene flow occurring across Coyote Valley for focal species California ground squirrel (*Otospermophilus beecheyi)* and bobcat (*Lynx rufus*)? Are there cases of genetic differentiation or isolation among animal metapopulations in Coyote Valley?

2.2 Methods

1. Bobcat Habitat Suitability Mapping & Linkage Mapper Analysis.

To determine the best locations in which to set up camera arrays, a habitat suitability map for bobcats was created which categorized habitat from best available habitat to the most poor habitat. The connectivity analysis tool Linkage Mapper was then run on the suitability layer to identify potential routes suitable for bobcats to travel along based on their best available habitat.

2. Camera Stations.

Twelve camera stations were set up throughout the valley floor along various routes delineated by the Linkage Mapper analysis. Each camera station set to determine multiple objectives: 1) pathways animals are using across the valley floor; 2) how animal were accessing and leaving sites; and 3) the use of bridges and culverts that animals are using to safely cross underneath roads (Figure 3).

i. Camera Data & Occupancy Modeling: The specific objective was to identify pathways that various classes of wildlife were using to cross the valley floor. One of the focal species for the camera research is bobcats. Since bobcats can be identified by their unique stripe and spot patterns, photographs from camera traps can be used to estimate their population size and follow individual bobcat movement.

To evaluate habitat use by bobcats across Coyote Valley, Morgan Gray at UC Berkeley, is currently working on an occupancy model for the region using camera trap detections, existing vegetation maps, digital elevation models, road types, and hydrology. The model will be extrapolated across the valley floor to estimate key areas of land use by bobcats. Using these three sources of data and existing maps of regional

land use, a community assemblage-based landscape permeability map will be created for Coyote Valley. Preliminary findings are in Appendix B and full results are expected when analysis is complete.

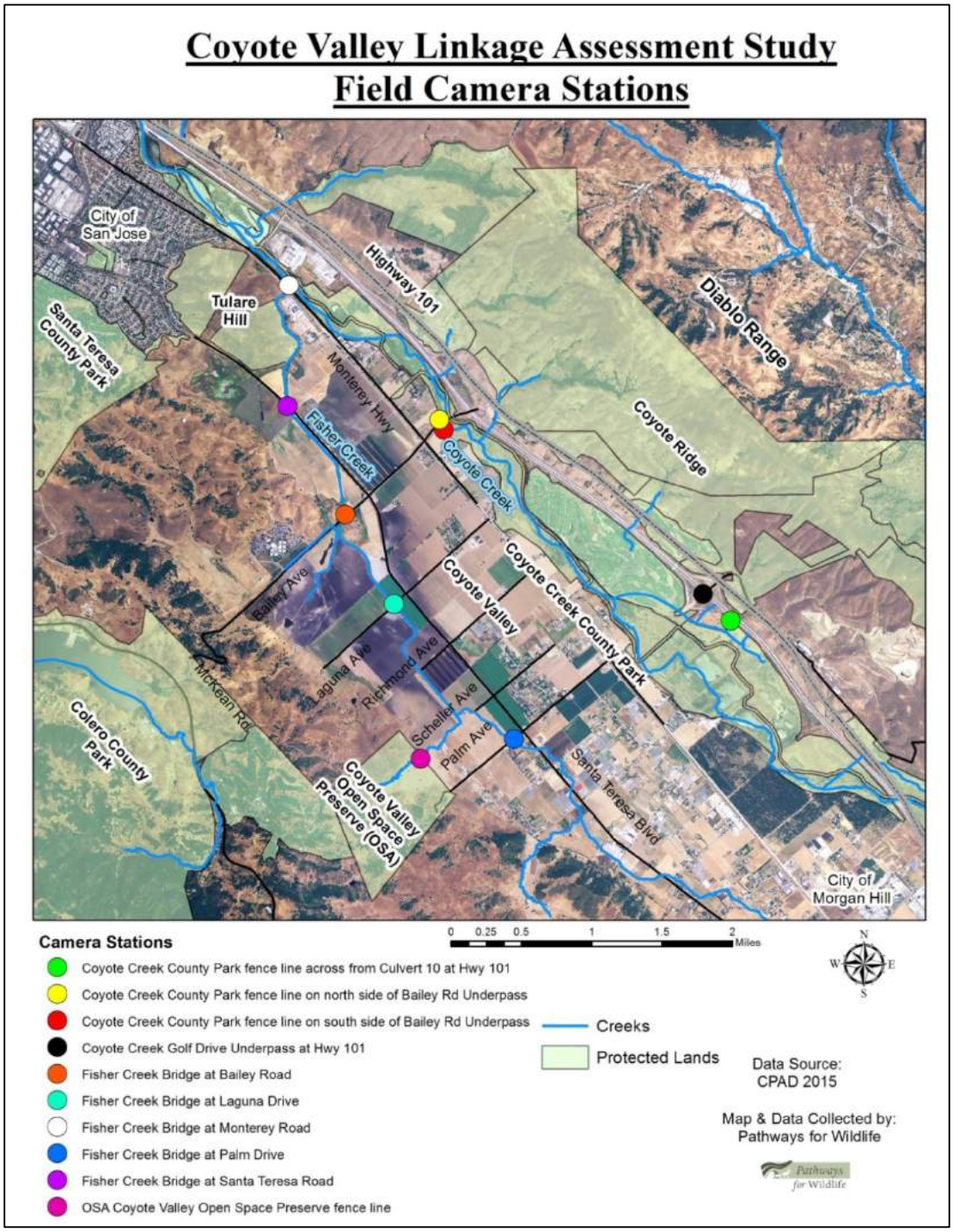

Figure 3: Field Camera Locations.

3. Genetic Sampling

Twenty three transects were set up throughout the valley floor for scat and hair sample collection. These transects included: roadsides; trails systems; and protected habitats throughout the study site. Scat and hair samples were frozen and sent to Morgan Gray at UC Berkeley for analysis.

i. Genetic Data Collection and Analysis: Two focal species were used; California ground squirrel and bobcat to determine the extent of gene flow. Ground squirrels were chosen as a focal species because they have small home ranges, restricted mobility, and may be more fully isolated due to habitat fragmentation. Bobcats were used as a focal species because they are more mobile, have relatively large home ranges, and are often a focal species for conservation. Using molecular markers unique to ground squirrels and bobcats we will determine the genetic diversity of the population and if genetic distance or differentiation is occurring within populations

3. Roadkill Surveys

Roadkill surveys were conducted every two weeks per month. The surveys were conducted along Highway 101 and Monterey Highway. Other roads were also surveyed throughout the valley while traveling between camera stations and while conducting scat transect surveys.

For each roadkill data point, a picture was taken, the location GPS'd and entered into a database for analysis. Data analysis included a roadkill Hot Spot analysis, ran in ArcView 10.2, to determine locations along roads in which the majority of animals were most often routinely hit.

3.0 Results

3.1 Camera Data

3.1.1 Total Number of Detections

A total of 1,301 animals were detected at all the camera stations (Table 1). The highest percentage of species detections includes: deer (34%); coyote (14%); and bobcat (14%) (Chart 1). The animals most often recorded traveling in the valley floor were midsized to large mammals.

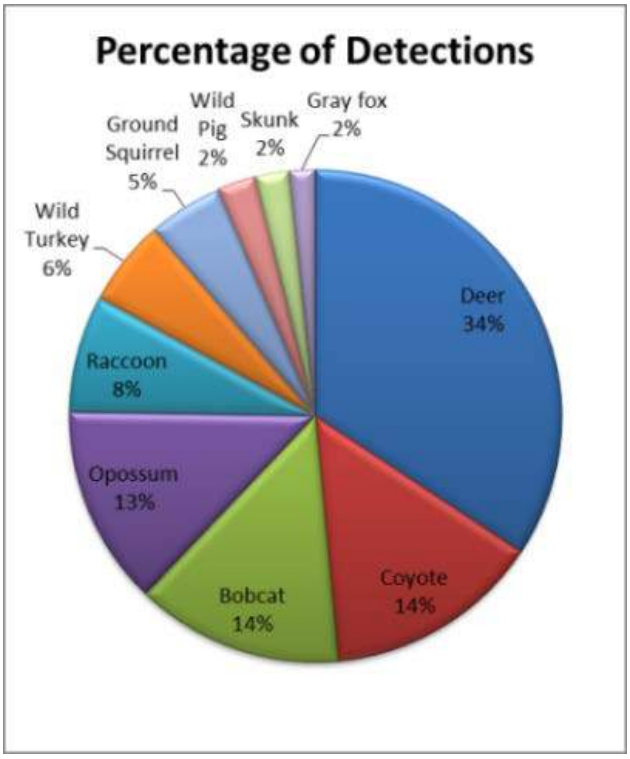

Chart 1: Percentage of Animal Detections.

Table 1 shows the number of animal detections by species for each camera site. The bridges along Fisher Creek at Palm Ave, Laguna Ave, Santa Teresa Rd. and underpasses along Coyote Creek at Highway 101 are facilitating a high amount of animal passages throughout the year. Detailed information with the findings from each camera station are found in Appendix A.

Camera ID	Camera Site	Bobcat	Coyote	Deer	Gray fox	Ground Squirrel	Opossum	Raccoon	Skunk	Wild Pig	Wild Tur-key	Total Animals Recorded at Each Camera Station
1	**Fisher Creek at Palm Road**	55	17		4	25	88	23	2			**214**
2	**Fisher Creek at Laguna Road**	31	8			1	30	20				**90**
3	**Fisher Creek at Bailey Road**	6	0	2				2	1			**11**
4	**Fisher Creek at Santa Teresa Road**	18	78	4		3	5	12	0			**120**
5	**Fisher Creek at Monterey Road**	44	0	14	1	24	46	27	24			**180**
6	**Coyote Creek Park at Bailey Underpass Cam 1**	1	40	83	1	2				10	30	**167**
7	**Coyote Creek Park at Bailey Underpass Cam 2**	1	6	28		4		4		7	40	**90**
8	**Coyote Creek Park near Coyote Golf Course Underpass Cam 3**		8	24				2		10		**44**
9	**Coyote Creek Open Space Preserve (OSA)**	8	20	170		4				6	3	**211**

Camera ID	Camera Site	Bobcat	Coyote	Deer	Gray fox	Ground Squirrel	Opossum	Raccoon	Skunk	Wild Pig	Wild Tur-key	Total Animals Recorded at Each Camera Station
10	**Hwy 101 Golf Course Drive Underpass**		4	19		1	1	5	1			**31**
11	**Hwy 101 Coyote Creek Bridge**	13	4	10 2	16		1	5	1		1	**143**
12	**Coyote Ridge-VTA Property**											
	Grand Total	**177**	**185**	**446**	**22**	**64**	**171**	**100**	**29**	**33**	**74**	**1301**

Table 1: Total number of animal detections at all camera stations.

3.1.2 Camera Data: Number of Detections of Animals per 100 Trap Nights.

The camera stations were not set up for the same duration of time based on the ability to set up cameras at different sites (Table 2). To normalize the data so that the camera results from each station could be compared to each other, detections of each species per 100 trap nights was tabulated using the equation (X detections *100/ Y Trap Nights) (Table 2).

The camera stations at Coyote Creek County Park and OSA's Preserve recorded the highest number of detections per 100 trap nights, which means they were consistently recording the highest number of animal detections overall throughout the study period (Chart 2). Three out of the five camera stations along Fisher Creek recorded similar amounts of detections compared to Coyote Creek County Park and Coyote Valley Open Space Preserve. This is an important finding in that, **Fisher Creek is facilitating similar numbers of animal detections as found in protected habitats (Chart 2).**

Camera Site	Monitoring Period	Total Detections Recorded at Each Camera Station	Trap Nights	Detections per 100 Trap Nights
Coyote Creek County Park Fence line by the Bailey Underpass Cam 2	3 months	90	90	**100**
Coyote Creek Open Space Preserve (OSA)	7 months	211	210	**100**
Coyote Creek County Park Fence line at Bailey Underpass Cam 1	6 months	167	180	**93**
Hwy 101 Coyote Creek Bridge	6 months	143	180	**80**
Fisher Creek at Monterey Road	8 months	180	240	75
Fisher Creek at Palm Road	10 months	214	300	71
Fisher Creek at Santa Teresa Road	8 months	120	240	**50**
Coyote Creek County Park Fence line across from Hwy 101 Culvert 10 near the Coyote Golf Course Underpass Cam 3	4 months	44	120	**37**
Fisher Creek at Laguna Road	10 months	90	300	**30**
Hwy 101 Golf Course Drive Underpass	5 months	31	150	**21**
Fisher Creek at Bailey Road	8 months	11	240	**5**

Table 2: Detections per 100 Trap Nights

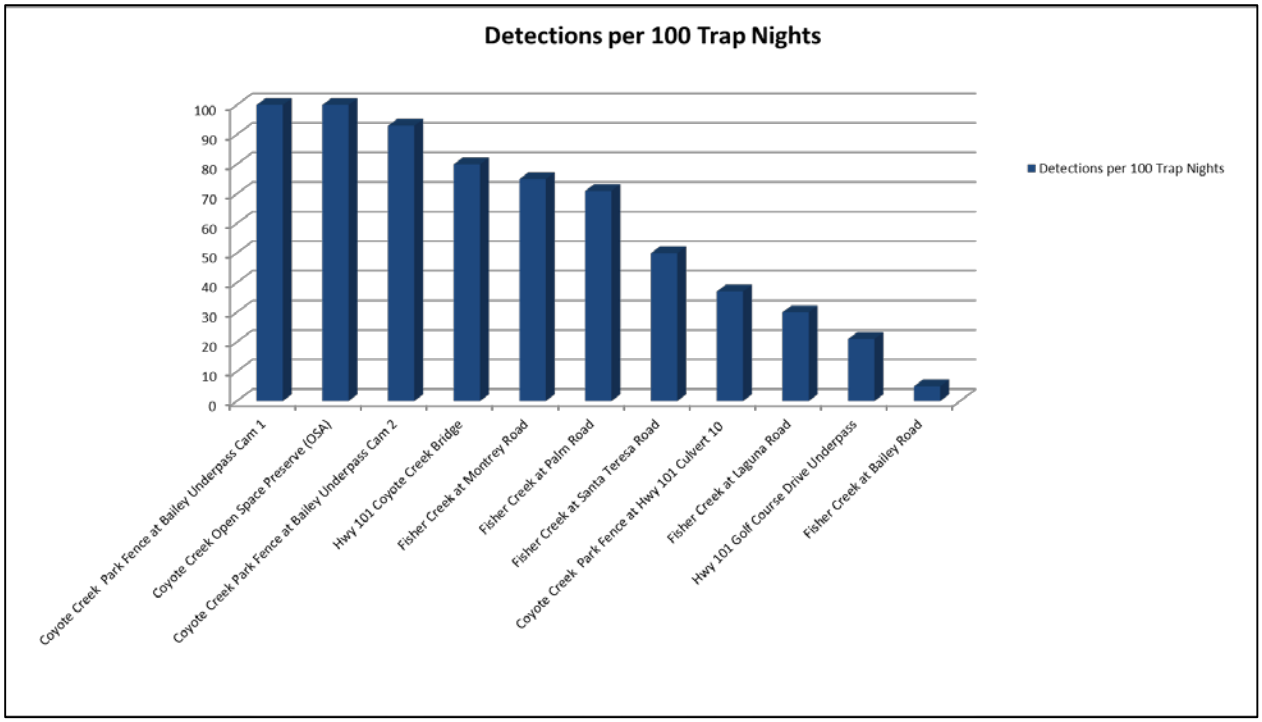

Chart 2: Total Number of Animal Detections per 100 Trap Nights.

3.1.3 Juvenile Detections

A total of 114 juveniles were recorded traveling with their parents at eight different camera stations (Table 3). The camera site with the highest number of juvenile detections was at the Coyote Valley Open Space Preserve with 51 records of deer (Chart 3). The second highest number of detections was 43 records of coyote juveniles at Fisher Creek at Santa Teresa Road (Table 3). These 43 detections included two coyote puppies that were frequently traveling through the creek bed

Camera Site	Number of Juvenile Detections
Coyote Preserve OSA	51
Fisher Creek at Santa Teresa	43
Fisher Creek at Monterey Ave	7
Hwy 101 Golf Dr Underpass	6
County Park Fence Cam 1	4
Fisher Creek at Bailey Ave	1
County Park Fence Cam 1	1
Hwy 101 Coyote Creek Underpass	1

Table 3: Number of Juvenile at Recorded at Camera Stations.

3.2 Roadkill Survey

From the roadkill surveys it was found that more animals are being hit along Monterey Road than Highway 101 (Figure 4). This could be due to Highway 101 having several bridges and culverts that animals are using to safely cross under the highway, while Monterey Road has only one dual box culvert available for wildlife to travel through.

There were several hot spots in which animals are routinely being hit along several roads. Data sets from previous animal-vehicle collision data collected from 2007-2014 by T. Diamond was incorporated into this dataset.

Hot Spot 1: At Highway 101 at the Bailey exit, a mountain lion, bobcats, North America badgers, and coyotes have been recorded hit at this location or in the vicinity of it. At this site there is a large culvert that used to have documented animal movement through it in 2007. However, in 2008 it became no longer passable when it became full of soil and large branch debris from a flooding event.

Hot Spot 2: At the Bailey Road Bridge, where Fisher Creek runs though, there have been several animals hit at this location, including a coyote and gray fox. On the south side of the culvert, there is an exclusionary fence set up that restricts the ability for wildlife to move through the culvert. The Bailey bridge has significantly less animals moving through this area compared to the other bridges animals are moving through along Fisher Creek.

Hot Spot 3: At the Monterey Road dual box culvert, which Fisher Creek runs through, there have been multiple species hit at this location including, North American badgers, coyotes, raccoon, and ground squirrels. On the east side of the culvert there are large cement slabs that restrict the ability for wildlife movement through the culvert, which may be resulting in animals attempting to cross the road and getting hit by vehicles. Monterey Road consists of a 5-foot high cement median with a 3-foot high wire fence on top of the median at many locations along the road. The median and fence makes it difficult for animals to safely cross the road. Through the road kill surveys, there have been many documented cases of animals that had got trapped at the median and hit by vehicles.

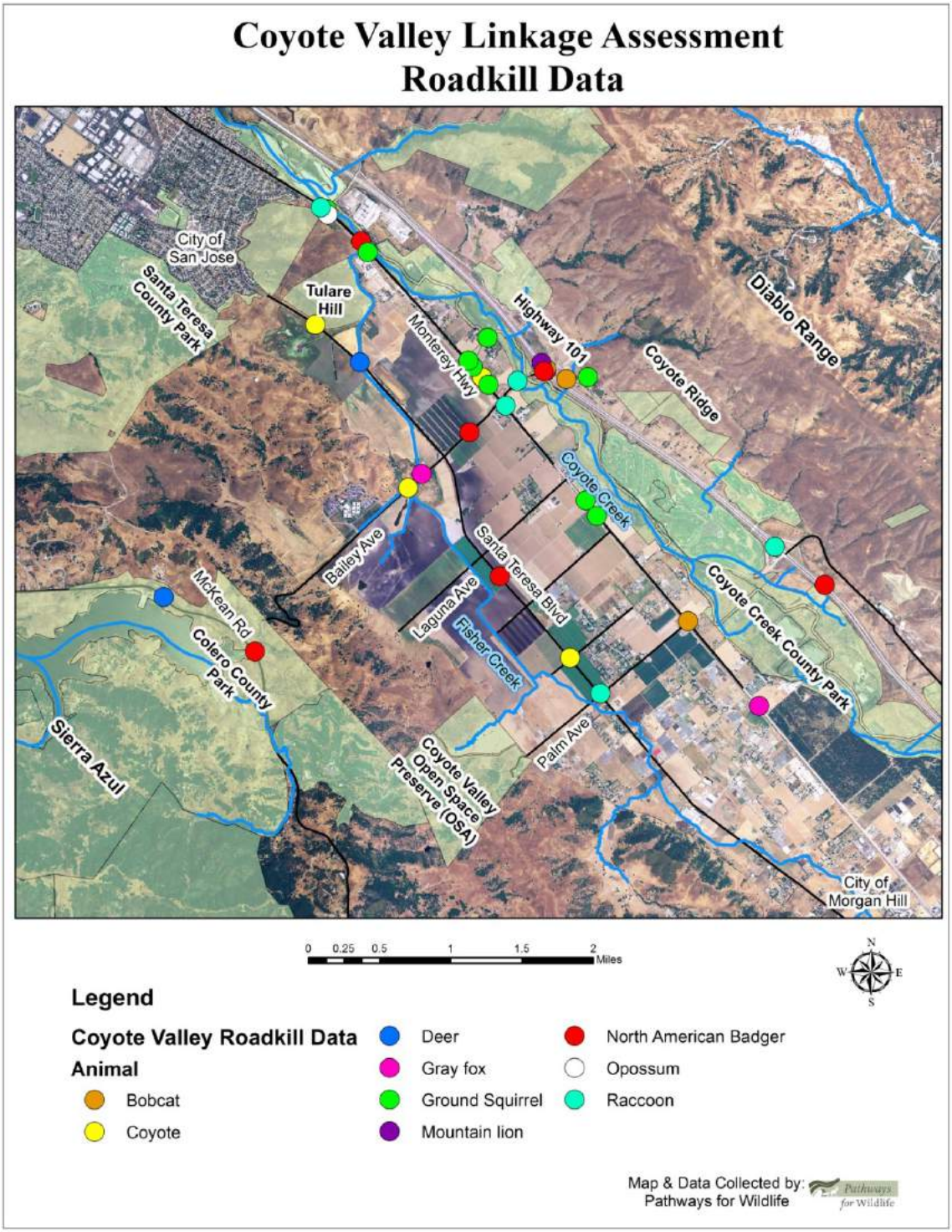

Figure 4: Roadkill Survey Results.

3.3 Genetic Results

Please see Appendix B for preliminary results.

4.0 Discussion

4.1 Wildlife Movement in Coyote Valley

There are several documented pathways that animals are using to travel across the valley floor. These routes enable animals to travel from the Santa Cruz Mountain foothills on the west side of the valley to Coyote Ridge and the Diablo Range on the east side.

4.1.1 Fisher Creek and Coyote Creek County Park

Based on the results there is evidence that Fisher Creek and Coyote Creek are being used by a variety of wildlife for movement along the creek systems. These animals include both large and small mammals, such as bobcat, deer, coyote, grey fox, raccoon, and ground squirrels. These pathways are facilitating a large variety of wildlife movement, despite the different species' ecology that move through the habitat, indicating the importance and functionality of Fisher Creek and Coyote Creek as a linkage.

1. Cross Valley Floor Bobcat Pathway: Midsection-North Section.

Bobcats have been recorded at each camera station in Fisher Creek from Palm Avenue in the mid-section of Coyote Valley up to Monterey Road in the most northern section. There is a confluence in which animals can travel from Fisher Creek into Coyote Creek at this point (Figure 5). Furthermore, the only culvert underneath Monterey Road for animals to safely travel underneath the road is at this confluence. Once animals are in Coyote Creek County Park, there are several Highway 101 culverts large enough for medium size animals to travel from the park into Coyote Ridge (Figure 5).

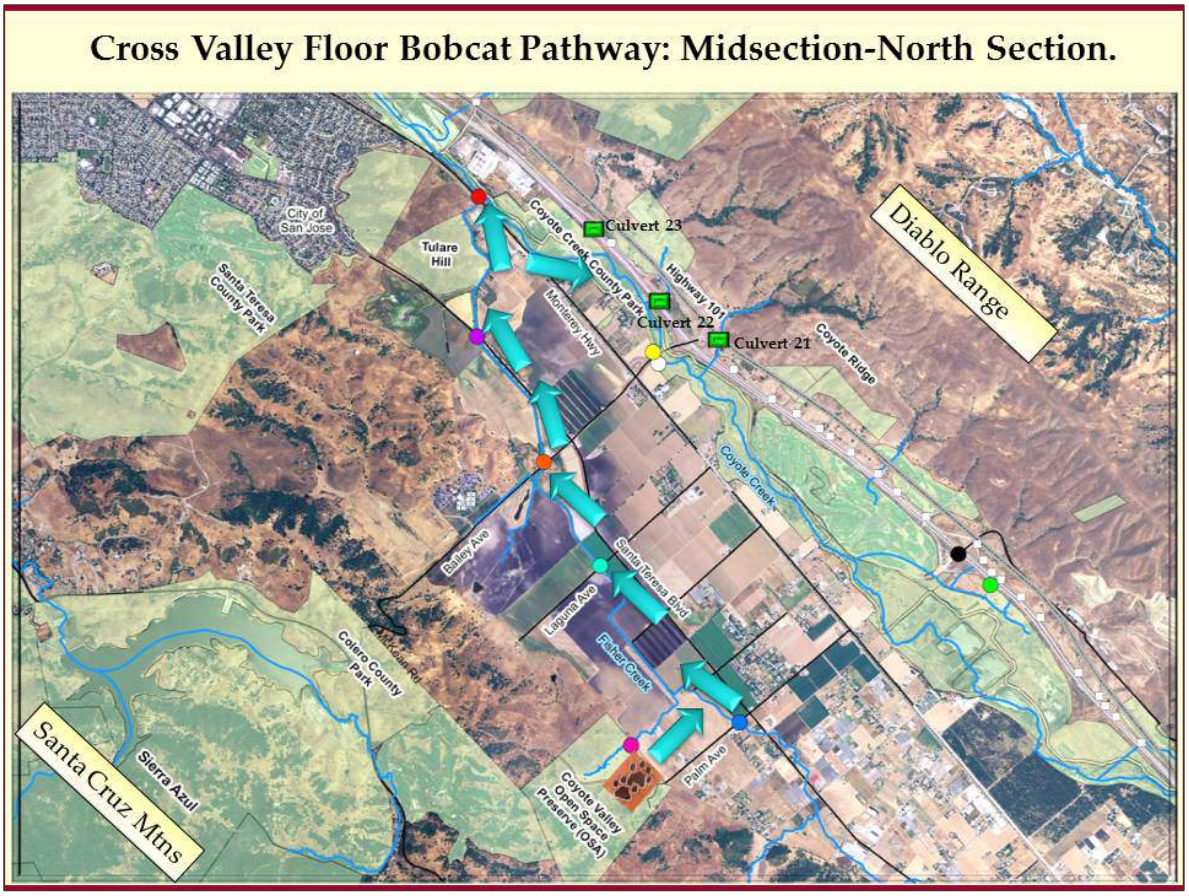

Figure 5: Cross Valley Floor Bobcat Pathway: Midsection-North Section.

Each month throughout the study period, several bobcats were recorded traveling at various camera stations in Fisher Creek. For example, in the month of September, there were several detections of different bobcat individuals at each camera station along Fisher Creek from the midsection of Coyote Valley to the North Section (Figures 6,7,8, & 9).

Figure 6: Bobcat in Fisher Creek at Palm Ave 9-13-2015.

Figure 7: Bobcat in Fisher Creek at Bailey Ave 9-26-2015.

Figure 8: Bobcat in Fisher Creek at Santa Teresa Ave 9-8-2015.

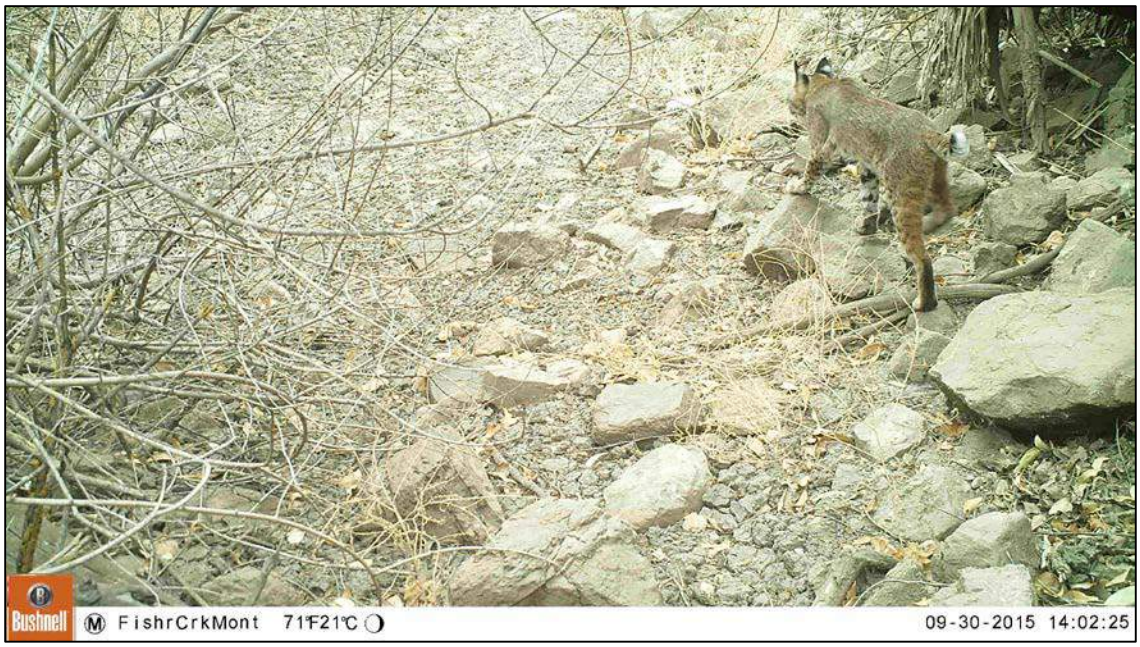

Figure 9: Bobcat in Fisher Creek at Monterey Road 9-30-2015.

2. Cross Valley Floor Deer Pathway: Midsection-North Section.

A route that deer are using to cross the valley floor has also been identified. Deer are traveling along Fisher Creek at the Bailey Bridge, then continuing east along the Creek underneath Santa Teresa Road, and then to the east side of the valley at Monterey Road (Figure 10). Once deer are in the Coyote Creek County Park, there are several Highway 101 culverts and a bridge in the midsection of the valley large enough to facilitate large mammal movement through them (Figure 10). This is an important finding in that this route could also potentially facilitate mountain lion movement across the valley floor.

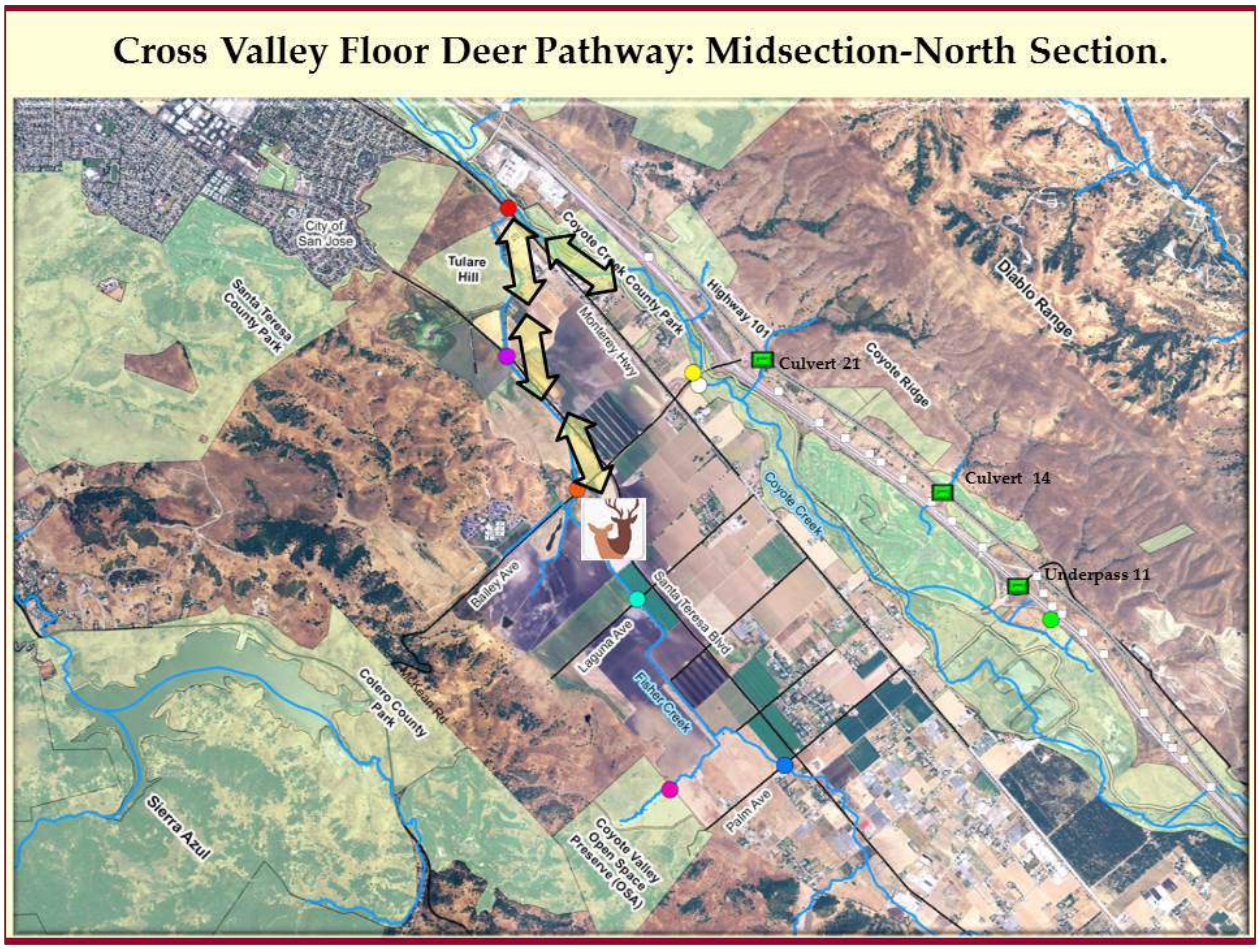

Figure 10: Cross Valley Floor Deer Pathway: Midsection-North Section.

4.1.2 Following Individual Animals

Individual bobcats can be identified by their leg and tail stripe/spot patterns (Figure 11). Using this technique we identified eleven different bobcats traveling at the camera stations in Fisher Creek and Coyote Creek throughout the study period.

Figure 11: Two different individual bobcats in Fisher Creek at Monterey Rd.

Male bobcats can have home ranges up to 5.2 square kilometers (3.2 square miles) (Riley et al 2003). Female bobcat home ranges are generally 2.3 square kilometers (1.5 square miles). Coyote Valley is 5.9 km (3.7 miles) wide, so one could expect that there would no more than two bobcat residents within the valley floor.

With having detected eleven bobcats, Coyote Valley maybe serving as habitat for both resident and dispersing bobcats moving through the linkage. One male and one female

resident have been consistently identified in Fisher Creek at Monterey Highway. In October 2015, the female had two kittens traveling with her (Figure 14).

We were also able to identify a male individual deer that was traveling along Fisher Creek from the Bailey Bridge, Santa Teresa Road, and Monterey Road (Figures 12 & 13). These detections of this individual deer spanned between a four month time frame from May to August 2015.

Figure 12: Male deer with 1 tine in antler in Fisher Creek at Bailey on 6-28-2015.

Figure 13: Male deer with 1 tine in antler in Fisher Creek at Monterey Road on 6-29-2015.

4.1.3 Juvenile Detections

Having recorded juveniles traveling with their parents is significant in that it increases the conservation value of the habitat at these locations three fold in that the habitat is providing: 1) resources such as food and water; 2) breeding and natal den habitat; and

3) habitat for juveniles to disperse though to establish their own home range. **These three functions of the habitat indicate this is an important wildlife linkage** (Hilty *et al* 2006)**.** Furthermore, there were juveniles recorded at over half of the camera stations throughout the entire study area (Chart 3).

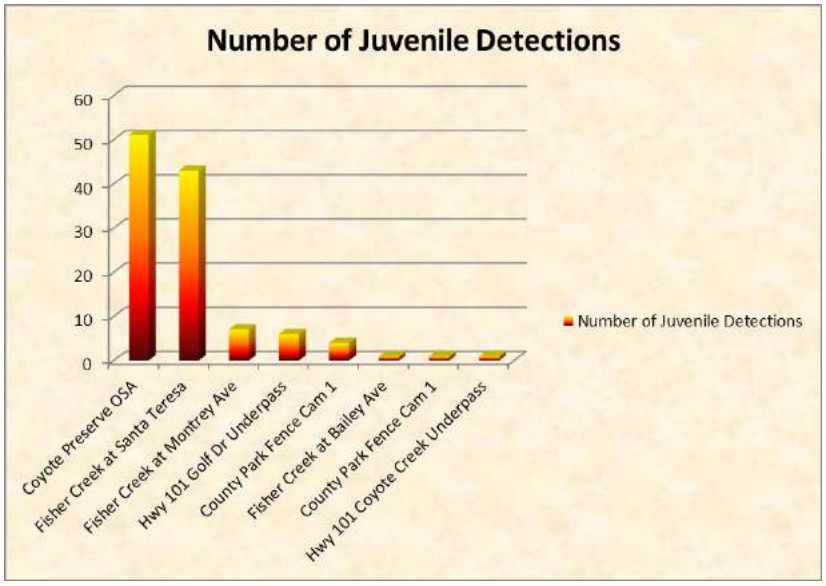

Chart 3: Number of Juvenile Detections at Camera Stations.

Interestingly, the detections by species included large and midsized animals, which were deer, coyote, and bobcat. The highest percentage of juveniles recorded were of deer (52%) and coyotes (41%) (Chart 4). These three different species have defined home ranges in which the juveniles most often disperse out of their parental home range to establish their own (Safe Passage 2010).

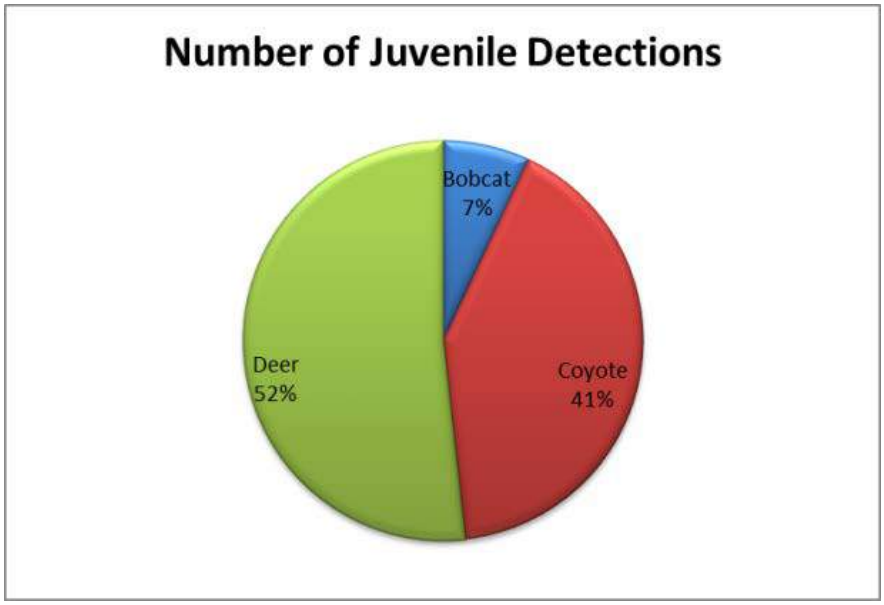

Chart 4: Percentages of Juvenile Detections.

Figure 14: Female bobcat with 2 kittens in Fisher Creek at Monterey Road.

Figure 15: Two coyote puppies in Fisher Creek at Monterey Road.

4.1.4 Limitations of Data

Limitations of data include only having the ability to follow individuals such as bobcats or deer with a distinguishing characteristic. We also do not have information on how animals are moving through other locations in the landscape, such as agricultural habitats. This first phase of the study was based on finding routes animals were using along riparian habitats and creek systems. The other habitats within Coyote Valley have not yet been monitored.

4.2 Known Barriers to Wildlife Movement

There are six sites within the study area that have barriers to wildlife movement (Table 4). Along Fisher Creek at Palm Avenue and Bailey Road, exclusionary fencing has been set up, which restricts animal movement (Figures 16 and 17). There are several culverts along Highway 101, in which wildlife use to travel through but are now blocked by either fencing or are full of debris (Figures 18 and 19).

ID	Location	Wildlife Movement Barrier
1	Hwy 101 Culvert by Coyote Ranch , Culvert #23	Box Cement Culvert with Fence put up in front of it on southbound side.
2	Hwy 101 Bailey Culvert, Culvert #21	Round Cement Culvert full of Debris.
3	Fisher Creek Bridge at Palm Drive	Bridge has an exclusionary fence set up on the north side.

ID	Location	Wildlife Movement Barrier
4	Fisher Creek Bridge at Bailey Road	Bridge has an exclusionary fence set up on the south side.
5	Fisher Creek Bridge at Monterey Road	Dual Box Culvert has large cement rip rap on the east side.
6	Monterey Road Median Barrier	Median Barrier along Monterey Road, except at intersections.

Table 4: Known Barrier to Wildlife Movement.

Figure 16: Fencing on north side of Palm Bridge.

Figure 17: Fencing on south side of Bailey Bridge.

Figure 18: Hwy 101 Culvert 23 blocked by fence.

Figure 19: Hwy 101 Culvert 21 full of debris.

Monterey Road is particularly impermeable to wildlife movement as there is a cement median that spans the majority of the road, in which animals often are trapped at and hit by cars (Figure 20). However, there is one culvert available for animals traveling along Fisher Creek that animals can use to travel underneath the road. At this location

there is a confluence with Fisher Creek and Coyote Creek in which animals can access Coyote Creek County Park. However, in terms of barriers, on the east side of the culvert there are large cement slabs which restrict animal movement such as deer through the culvert (Figure 21).

Figure 20: Monterey Road median barrier.

Figure 21: Debris at Monterey Road Culvert.

5.0 Recommendations and Next Steps

5.1 Continuation of Existing Research

5.1.1 Camera Monitoring

As mentioned in the Limitations section, the first phase of the study was to identify if animals were moving along creeks and riparian systems throughout Coyote Valley. However, the majority of habitats have not yet been monitored in the study area. Next steps would include adding additional camera stations in a variety on habitats, ranging from agricultural lands, habitats adjacent to the creeks, wetlands, and mixed land use areas. When identified barriers at crossing structures have been removed, we can also monitor those sites to document animal passage and rate the success of the barrier removal.

Having data from a variety of habitat types is also important to include into the Occupancy Modeling being performed by Morgan gray at UC Berkeley. The analyses will be more robust in informing and predicting the different types of habitats that wildlife are using.

5.1.2. Genetic Research

While enough ground squirrel genetic samples have been collected in the valley floor, the amount of genetic samples needed to complete the analysis is incomplete for the east side of Highway 101 at Coyote Ridge. With new access to private lands in Coyote Ridge granted by our project partners, Santa Clara Valley Transportation Authority and newly protected lands by Santa Clara Valley Open Space Authority, sufficient samples can now be collected during a future phase of the study to complete the analysis.

5.1.3. Roadkill Surveys

Through this past year's roadkill surveys, several hot spots have been identified in which animals are routinely being hit by cars. These locations correlate with culverts and bridges that have barriers, such as exclusionary fencing or are blocked with debris. Roadkill data is important to continue to collect as barriers at different crossing structures are removed to evaluate the effectiveness in increasing the ability for wildlife to safely move across the landscape.

5.2 Additional Research Needs

Based on the high number of individual bobcat detections throughout the valley floor, we propose including a radio collar study with bobcats into the next phase of the project. The data from this study would reveal how bobcats are utilizing the landscape and a variety of habitats in terms of where they are traveling, hunting, breeding, and dispersing. This would result in a robust landscape analysis of bobcat movement through the valley floor.

Chris Wilmers, who heads the UCSC Puma Project, has a new Postdoc student that has extensive experience in radio collaring bobcats and data analysis from research conducted in Southern California. If funding was available, they have agreed to collaborate on the project and conduct the bobcat radio collar study. This is fortunate timing in that there are few organizations capable of conducting this study in the Bay Area.

5.3 Planning and Land Use Needs

5.3.1 Barrier Removal Recommendations

A Wildlife Connectivity Design with Permeability Improvements was created to identify locations for barrier removal to increase the ability for wildlife to move safely

through the landscape (Figure 22). This map also prioritizes barrier removal based on the impacts they are causing such as roadkill rates correlated at sites with blocked or inhibited crossing structures, in which animals have no choice but to cross over the road. Rankings were also based on high use areas by wildlife to lower use. High & Secondary Priority Recommendations, colored coded as orange (high priority) and yellow (secondary priority) in Figure 21:

i. Fisher Creek: Removing existing exclusionary fences along Fisher Creek at Palm Ave and Bailey Road by replacing them with wildlife friendly fencing and fish passage designs (Figures 16 & 17). When Fisher creek floods there needs to be enough available habitat along the banks of the creek for wildlife to travel along. Implementing a restoration plan that increases the current riparian habitat along the creek would be beneficial for wildlife movement along it.

ii. Highway 101: Highway 101, Culverts 21 is full of debris and needs to be cleared out along with putting up directional fencing to guide animals to it (Figure 19). At Culvert 23, there is an exclusionary fence that needs to be removed, along with putting up directional fencing to guide animals to it (Figure 18).

iii. Monterey Road: The culvert at Fisher Creek at Monterey Road has large cement slabs that need to be removed on the east side so that mammals such as deer can cross through it (Figure 21).This location would also benefit from directional fencing to keep wildlife within the creek and people out as there is a high degree of trespassing and vandalism.

iiii. Fenceline at Camera 3: Replacing the small lift in the fence with a wildlife friendly design.

Low Priority Recommendations include, colored coded as purple, in Figure 21:

i. Fisher Creek Laguna Avenue bridge: Installing directional fencing along the Fisher Creek Laguna Avenue bridge to keep wildlife species within the creek bed and domestic animals out to avoid human-wildlife conflicts, such as depredation of farm animals by wildlife.

ii. Highway 101 Culvert 10: The culvert is filling up with sediment and needs to be cleared out before it is completely blocked. There is less available space for medium size animals, such as bobcat and coyotes, to travel through it.

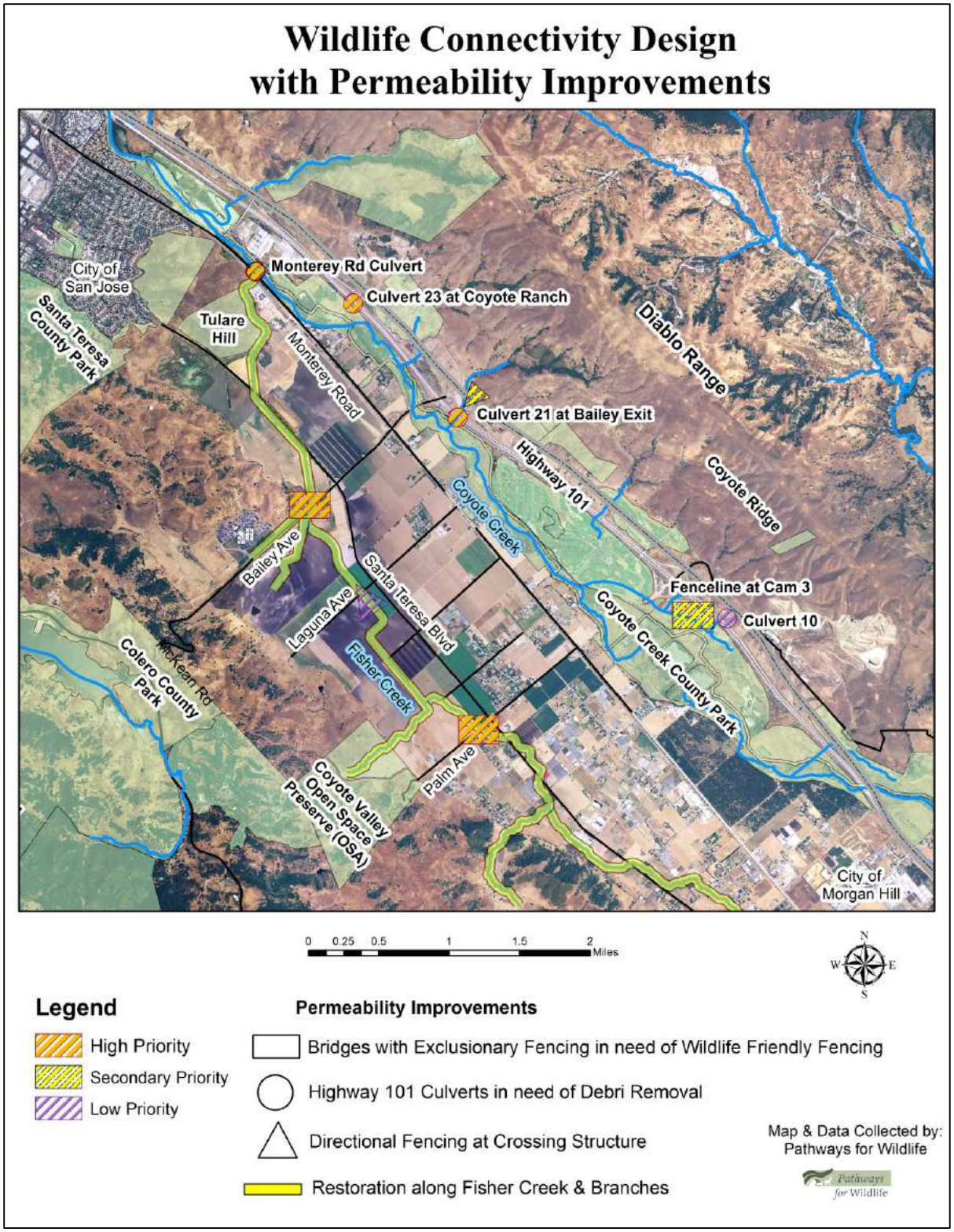

Figure 22: Improvements for Wildlife Movement at Known Barriers.

5.3.2 Partnerships

Given the significance of the findings that Coyote Valley has been identified as a critical linkage in regional planning, and that this study has illustrated that different species of wildlife are traveling through the valley floor, it is important to work on setting up various conservation planning strategies to maintain this wildlife linkage.

The landscape is complex with multiple stakeholders and there is various transportation infrastructure in need of barrier removals along with setting up long-term maintenance plans for them as wildlife crossing structures. To work on these types of next steps and tasks, it is important to share this information and engage with multiple stakeholders.

Part of the work this year included bringing together multiple stakeholders for a workshop which included a presentation of the data collected and a field trip of the study area. These stakeholders included: California Department of Fish & Wildlife, Santa Clara Valley Open Space Authority, Guadalupe-Coyote Resource Conservation District, Santa Clara County Parks, Santa Clara Valley Transportation Authority, Caltrans, Peninsula Open Space Trust, the Gordon and Betty Moore Foundation, Silicon Valley Land Conservancy, Stuart Weiss, and Midpeninsula Regional Open Space District. One result of the meeting included discussions on how to collaborate with various groups on project goals and recommendations emerging from the findings of the project. This included a discussion about the need for a Wildlife Corridor Restoration and Enhancement Plan, described below.

5.3.3 Wildlife Corridor Restoration and Enhancement Plan

Fisher Creek, and the larger Coyote Valley, has been found to be an important travel route for a variety of wildlife species, ranging from small to large mammals. However, there are still a number of barriers and land uses that restrict wildlife movement and no comprehensive plan for how to manage and enhance wildlife movement within this corridor.

A Wildlife Corridor Restoration and Enhancement Plan would serve as the foundation for coordinated management of critical passage infrastructure, developing priority corridor enhancement projects, and providing best management practices for private land owners to implement on their lands to reduce conflicts with wildlife. Coyote

Valley's importance as a regionally significant wildlife corridor and dependence on surrounding open space and agricultural lands justifies development of a Plan that coordinates efforts between transportation agencies, resource management agencies, and private land owners. This work could be used to inform larger restoration or development planning.

We hope that this report will lead to working with the various stakeholders on recommendations made to enhance wildlife movement at various locations and conserving important habitats that facilitate connectivity within the landscape. As we move forward with the project, we also hope to engage with new stakeholders to build on the work that has been done this past year.

Female Bobcat with Kittens in Fisher Creek at Monterey Road.

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Appendix A – Results of all camera data

3.1.3) Results from Individual Camera Stations

Camera Station 1: Santa Clara Valley Open Space Authority: Coyote Valley Open Space Preserve

This camera was set up along the fence line adjacent to a tributary that feeds into Fisher Creek. The objective was to determine what wildlife species were traveling in and out of the property at this location.

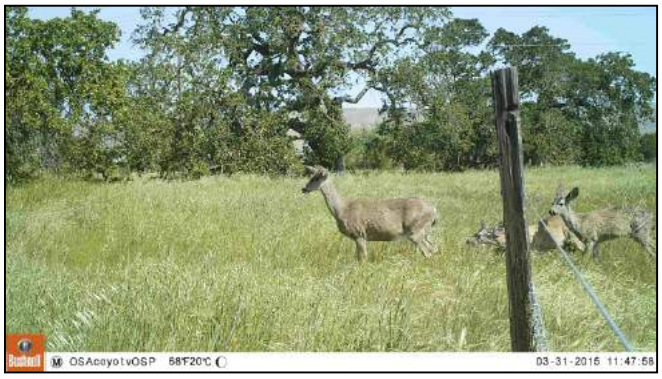


Figure 23: Deer traveling north into the Tributary from Coyote Valley Open Space Preserve.

Figure 24: Coyote traveling north into the Tributary from Coyote Valley Open Space Preserve.

The highest number of detections recorded was of deer (170), coyote (20) and bobcat (8), with a total of 211 detections (Table 5 & Chart 5). There were several individual male deer recorded along with females with fawns (Figure 23). The majority of the animals were traveling in and out of the property, traveling north and south through the fence line (Figures 23 & 24).

Species	Number of Detections	Sex	Number of Juvenile Detections
Bobcat	8		
Coyote	20		
Deer	170	21 males, 54 females	51
Ground Squirrel	4		
Wild Pig	6		
Wild Turkey	3		
Total	**211**		**51**

Table 5: Number of Detections Recorded

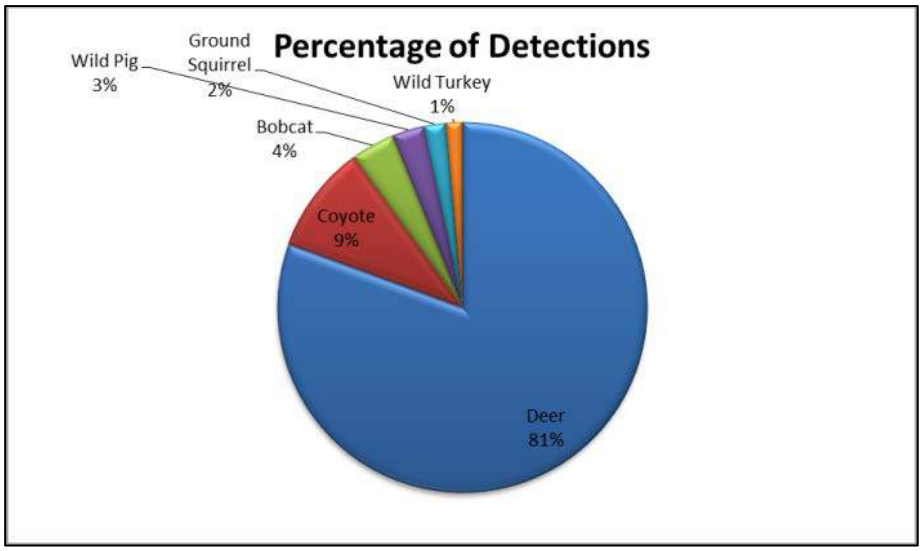


Chart 5: Percentage of Species Recorded.

Camera Station 2: Palm Ave Bridge at Fisher Creek

The highest number of detections was of opossum (88) and bobcat (55), which traveled through this site consistently throughout the year (Table 6, Chart 6, & Figure 25). The total number of detections was 214 (Table 4). Coyotes were also recorded using the bridge, however there were no detections of deer at this site. A gray fox began using the bridge in September, six months after the camera was set up. This may have been a juvenile that established a new home range, as there were several detections of gray fox in the following months (Figure 26).

Figure 25: Bobcat at the Fisher Creek Palm Avenue Bridge.

Figure 26: Gray fox at the Fisher Creek Palm Avenue Bridge.

Species	Number of Detections
Bobcat	55
Coyote	17
Deer	0
Gray fox	4
Ground Squirrel	25
Opossum	88
Raccoon	23
Skunk	2
Total	**214**

Table 6: Number of Detections Recorded.

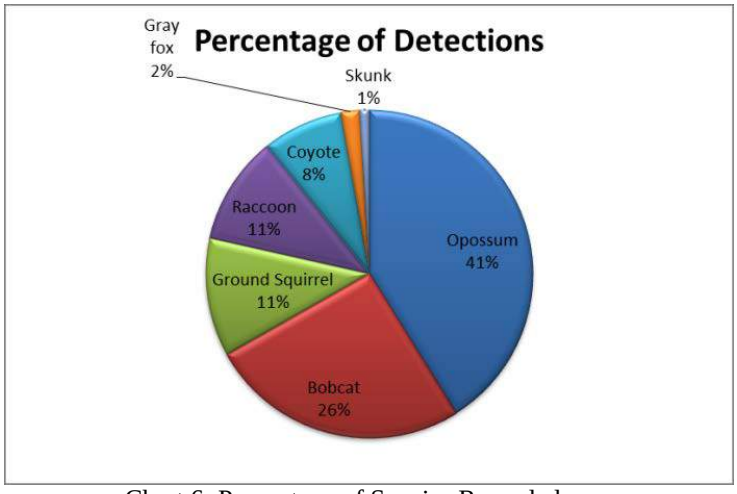


Chart 6: Percentage of Species Recorded.

Camera Station 3: Laguna Road Bridge at Fisher Creek

The highest number of detections was bobcat (31), which traveled through this site consistently throughout the year (Table 7 and Chart 7). The total number of detections was 90 (Table 7). There were several records of coyotes and bobcats using the bridge consistently. For example, as seen in the above pictures both bobcat and coyotes were using Fisher Creek to travel through during the day (Figures 27 & 28).

Species	Number of Detections
Bobcat	31
Coyote	8

Ground Squirrel	1
Opossum	30
Raccoon	20
Total	**90**

Table 7: Number of Detections Recorded.

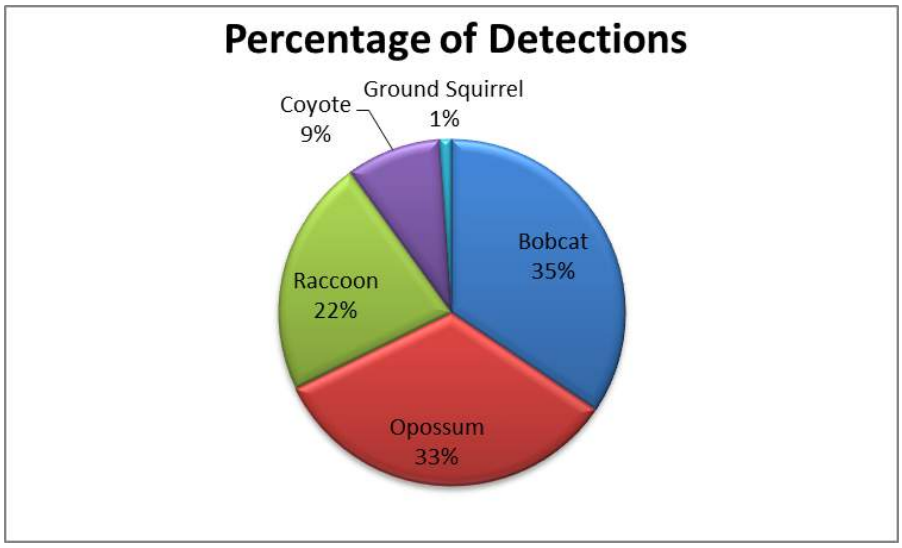


Chart 7: Percentage of Species Recorded.

Figure 27: Coyote at the Fisher Creek Laguna Avenue Bridge.

Figure 28: Bobcat at the Fisher Creek Laguna Avenue Bridge.

There were also many records of domestic animals such as dogs, cow, and chickens using the underpass (Figures 29 & 30). This location would benefit from directional fencing to keep out domestic animals and keep wildlife species within the creek bed to avoid human-wildlife conflicts, such as depredation of farm animals by carnivore wildlife species.

Figure 29: Domestic dogs at the Fisher Creek Laguna Avenue Bridge.

Figure 30: Cow at the Fisher Creek Laguna Avenue Bridge.

Camera Station 4: Bailey Road Bridge at Fisher Creek

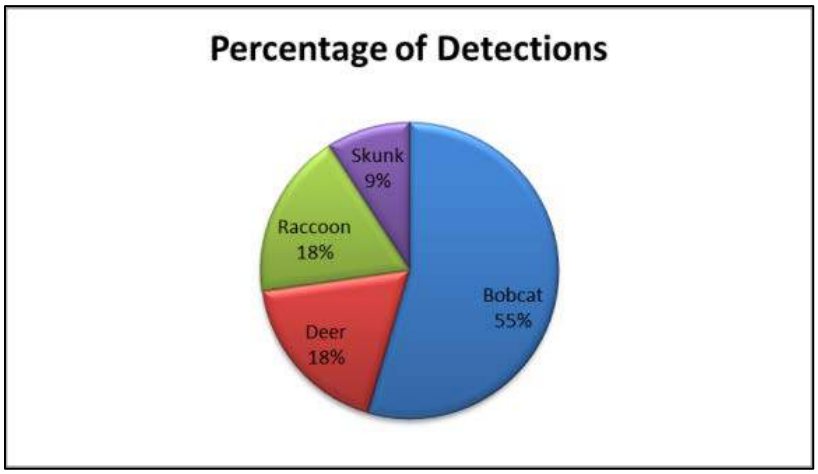
The highest number of detections was bobcat (6) (Table 8, Chart 8, & Figure 30). Overall, the total number of detections, 11, is low compared to the other camera stations along Fisher Creek. This is most likely due to an exclusionary fence that has been put up on the south end of the culvert, see Figure 33.

Figure 31: Bobcat at the Fisher Creek Bailey Avenue Bridge.

Figure 32: Deer at the Fisher Creek Bailey Avenue Bridge.

Species	Number of Detections	Sex	Number of Juvenile Detections
Bobcat	6		1
Deer	2	1 male, 1 female	
Raccoon	2		
Skunk	1		
Total	**11**		**1**

Table 8: Number of Detections Recorded



. Chart 8: Percentage of Species Recorded.

Figure 33: Exclusionary Fencing on south side of the Bailey bridge in Fisher Creek.

Camera Station 5: Santa Teresa Road Bridge at Fisher Creek

The highest number of detections was of coyote (78) and bobcat (18), which traveled through this site consistently throughout the year (Table 9, Chart 9, Figure 34). The total number of detections was 120 (Table 9). This site recorded the highest amount of detections of coyotes. This is due to a pair of coyotes, which were frequently documented traveling together at this location. In July, the pair had two puppies, which were also recorded traveling with their parents and on their own in late fall (Figure 35).

Figure 34: Bobcat at the Fisher Creek by Santa Teresa Road.

Figure 34: Coyote Puppy at the Fisher Creek by Santa Teresa Road.

Documenting breeding and juveniles traveling with their parents in the valley floor is an important finding in that the habitat is not just serving for wildlife movement to find food and water but is also providing breeding habitat.

There were also four detections of deer, which included a female and male (Table 9). This is the second location a deer was recorded traveling along Fisher Creek, the other being at the Bailey bridge. Deer have only been recorded traveling in the north section of Coyote Valley along Fisher Creek.

Species	Number of Detections	Sex	Number of Juvenile Detections
Bobcat	18		
Coyote	78	1 male, 1 female	43
Deer	4	1 male, 1 female	
Ground Squirrel	3		
Opossum	5		
Raccoon	12		
Total	**120**		**43**

Table 9: Number of Detections Recorded.

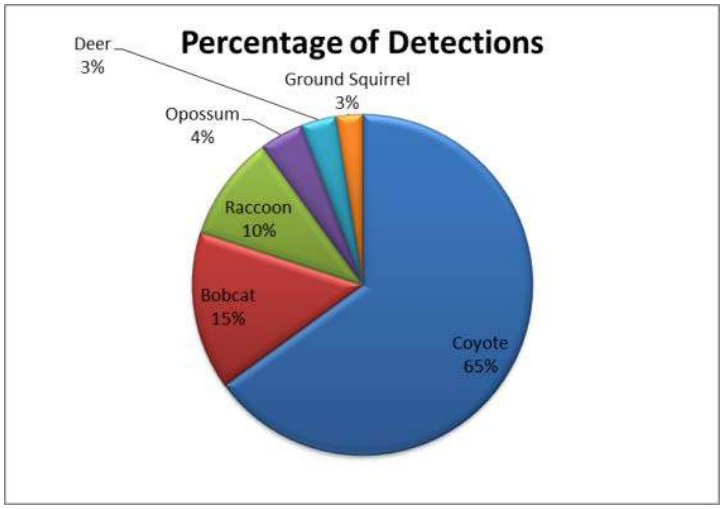


Chart 9: Percentage of Species Recorded.

Camera Station 6: Monterey Road at Fisher Creek

The highest number of detections was bobcat (44) and opossum (46), which traveled through this site consistently throughout the year (Table 10, Chart 10, & Figure 36). The total number of detections was 180 (Table 10).

Species	Number of Detections	Sex
Bobcat	44	1 male, 1 female
Coyote	0	
Deer	14	1 male
Gray fox	1	
Ground Squirrel	24	
Opossum	46	
Raccoon	27	
Skunk	24	
Total	**180**	

Table 10: Number of Detections Recorded

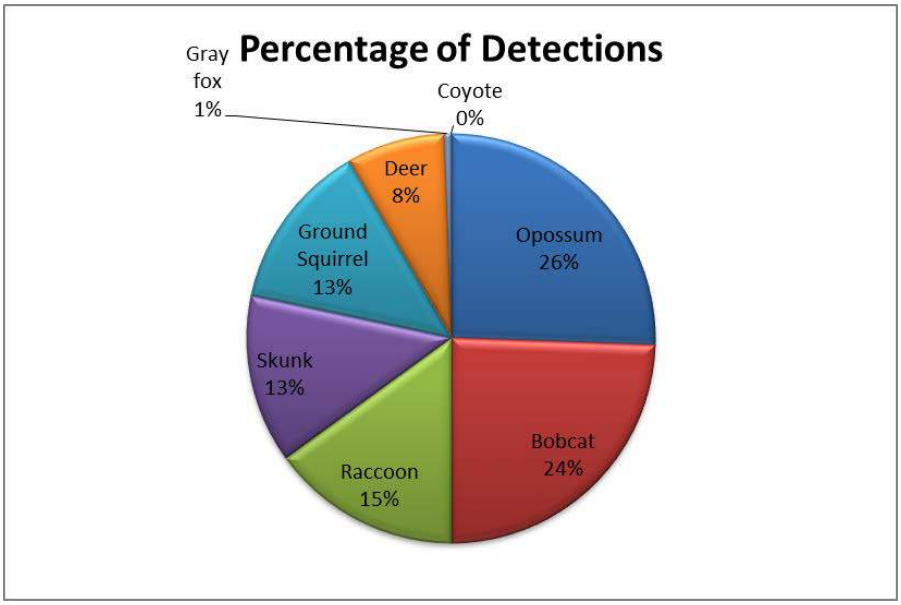


Chart 10: Percentage of Species Recorded.

There was a female and male bobcat traveling both east and west throughout the year. In late October, a female bobcat was recorded with two bobcat kittens (Figure 36). Vocalizations of the kittens were also recorded via video by the camera station. The kittens were traveling with their mother throughout late October and November, and then again in January. She may have moved them to a safer location in December. This is the second location along Fisher Creek in which a carnivore species has been found to be traveling with their young.

Figure 36: Bobcat at the Fisher Creek by Monterey Road.

Figure 37: Female bobcat with 2 kittens.

In July, a first detection of a gray fox was recorded at this location (Figure 38). This camera station was the fourth site a gray fox had been detected in the overall study area. The other three sites are in the most southern part of the study area; Palm Ave, Highway 101 Coyote Creek Bridge, and in Coyote Creek County Park by the Bailey Underpass. In December, a pair of gray foxes were recorded traveling together at this site (Figure 39).

Figure 38: Gray fox in Fisher Creek at Monterey Road.

Figure 39: Pair of gray foxes in Fisher Creek at Monterey Road.

A male deer, with a set of one large antler with one tine, was recorded throughout a four month period starting in May, traveling both east and west at the camera site. On June 29 2015, the male was recorded traveling with another deer (Figure 40).

Figure 40: Male deer in Fisher Creek at Monterey Road.

Camera Station 7: Coyote Ridge on the Santa Clara Valley Transportation Authority (VTA) Property

A camera was set up on Coyote Ridge on a trail that runs adjacent to the highway. A North American badger burrow was documented close to the trail (Figure 41). This camera was set up late in the study, data will from this location will be included in a future report.

Figure 41: North American Badger burrow on Coyote Ridge.

Camera Station 8: Highway 101 Golf Course Drive Underpass

Figure 42: Highway 101 Golf Course Drive Underpass.

This underpass is directly across from camera station 7 at Coyote Ridge on the Santa Clara Valley Transportation Authority (VTA) Property. This location was chosen to document if animals at Coyote Ridge are traveling under the highway to Coyote Creek County Park, which is on the other side of the highway.

The highest number of detections was deer (19), which traveled through this site consistently throughout the year (Table 11, Chart 11, Figures 43 & 44). The total number of detections was 31 (Table 9). There were also detections of female deer traveling with their fawns (Figure 44). This is important information as there are a limited amount of available culverts and bridges large enough for large animals to move under Highway 101.

Species	Number of Detections	Sex	Number of Juvenile Detections
Coyote	4		
Deer	19	3 males, 4 females	6
Ground Squirrel	1		
Opossum	1		
Raccoon	5		
Skunk	1		
Total	**31**		**6**

Table 11: Number of Detections Recorded

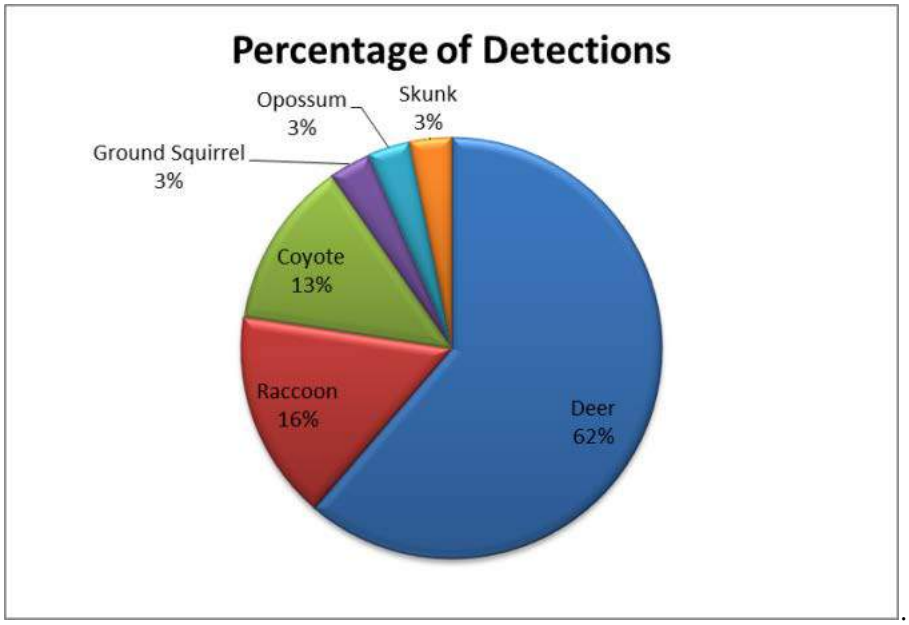


Chart 12: Percentage of Species Recorded.

Figure 43: Male Deer under the Underpass.

Figure 44: Deer w/ fawns under the Underpass.

Camera Station 9: Coyote Creek County Park Fence line Camera 3

On the west side of the Highway 101 Golf Course Drive Underpass, there is a fence line that runs adjacent to the highway (Figure 45). There is a lift in the fence, approximately three high, across from the Highway 101 Culvert 10, which has documented use by coyotes and bobcats (Figure 46).

Figure 45: Coyote Creek County Park Fence line

Figure 46: Highway 101 Culvert 10

The camera was set up at the lift at the fence to document if animals that traveled under the Highway 101 Golf Course Drive Underpass or through Culvert 10, are then traveling through the opening in the fence line to access Coyote Creek County Park.

We documented 24 detections of deer traveling both west and east under the fence line, along with 8 coyotes (Table 13, Figures 47 & 48). The total number of detections was 44

(Table 13). Surprisingly, the majority of detections were of deer (Chart 13), as the opening of the fence is only three feet of the ground (Figure 47 & 48).

Species	Number of Detections	Sex
Coyote	8	
Deer	24	2 males, 9 females
Raccoon	2	
Wild Turkey	10	
Total	**44**	

Table 13: Number of Detections Recorded.

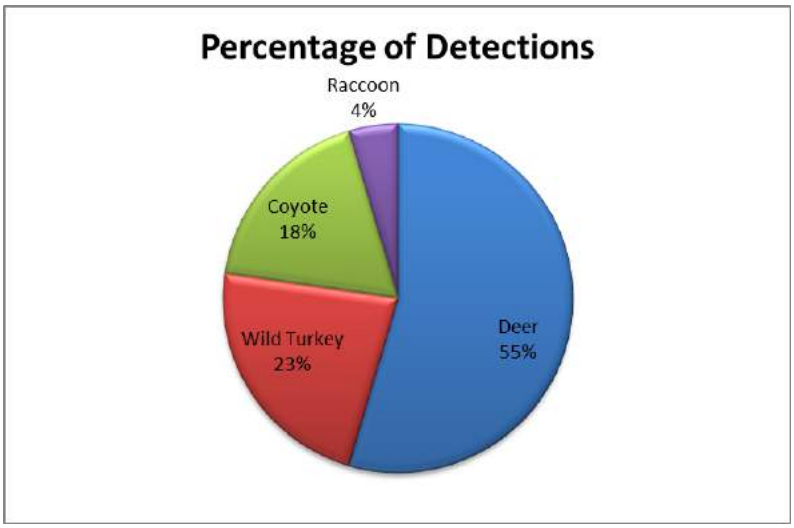


Chart 13: Percentage of Species Recorded.

Figure 47: Deer traveling under the fence line

Figure 48: Coyote traveling under the fence line

Camera Station 10: Hwy 101 Coyote Creek Underpass at Coyote Creek County Park

Figure 49: Highway 101 Coyote Creek Underpass.

The highest number of detections was deer (102), which traveled through this site consistently throughout the year (Table 14, Chart 14, Figures 49 & 50). Of the 102 total detections, there were 30 records of male deer, and 16 females. Of the 30 records of male deer, were able to determine that there were 5 different individual male deer routinely using the underpass throughout the study period. The total number of detections was 143 (Table 14). The second highest detection was of a gray fox (16), which also used the underpass throughout the year (Figure 50).

Species	Number of Detections	Sex	Number of Juvenile Detections
Bobcat	13		
Coyote	4		
Deer	102	30 males, 16 females	1
Gray fox	16		
Opossum	1		
Raccoon	5		
Skunk	1		

Wild Turkey	1	Male	
Total	**143**		**1**

Table 14: Number of Detections Recorded.

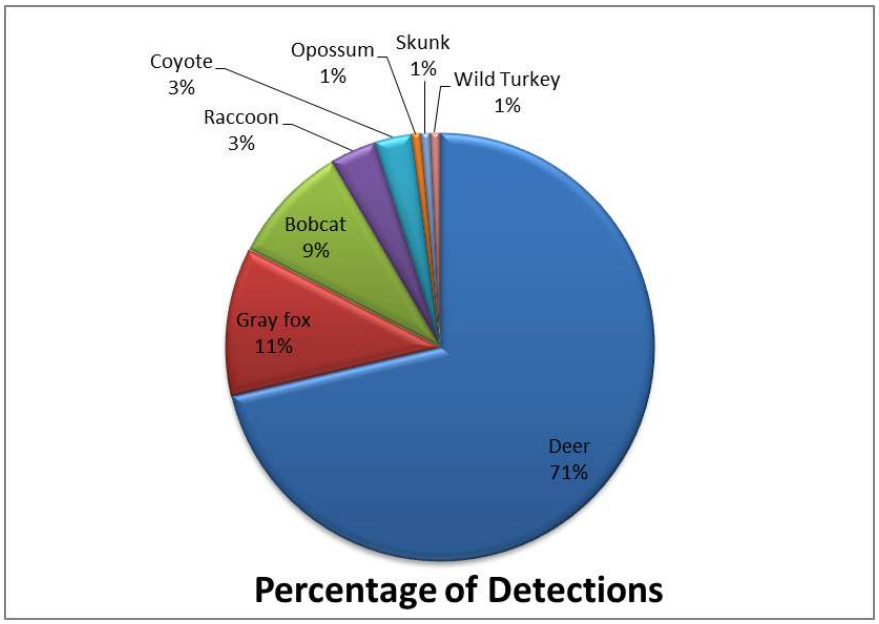


Chart 14: Percentage of Species Recorded.

Figure 50: Gray fox at Highway 101 Coyote Creek Underpass.

Figure 51: Deer at Highway 101 Coyote Creek Underpass.

Camera Stations 11 & 12: Coyote Creek County Park Fence line Camera 1 and Camera 2.

These cameras were set up to determine to locations animals were traveling in and out of the Coyote Creek County Park on both the south and north side of the Bailey Underpass.

Camera Stations 11: Coyote Creek County Park Fence line Camera 1.

Figure 52: Coyote Creek County Park Fence line Cam 1.

This camera is set up on the north side of the Bailey Underpass, where the chain link fence is down (Figure 52). On the north side of the fence is an orchard and to the west is Monterey Road.

The highest number of detections was deer (83) and coyote (40), which traveled both east and west through the underpass throughout the year (Table 15 & Figure 53). The total number of detections was 167 (Table 15). In June 2015, a pair of coyotes were recorded traveling with two coyote puppies (Figure 54). The puppies traveled throughout the summer with their parents both north and south through the underpass.

Species	Number of Detections	Sex	Number of Juvenile Detections
Coyote	8		2
Deer	24	2 males, 9 females	
Raccoon	2		
Wild Turkey	10		
Total	**44**		

Table 15: Number of Detections Recorded.

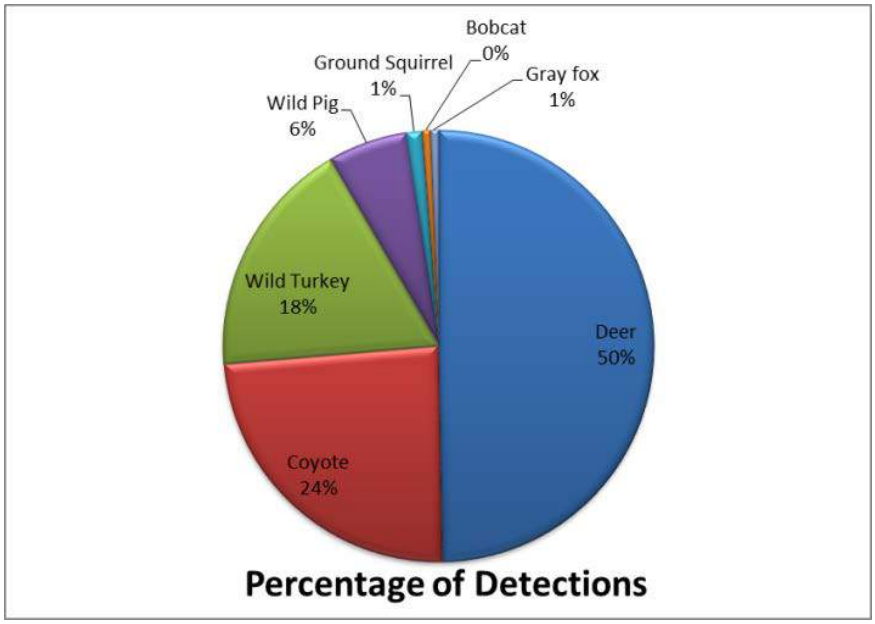


Chart 15: Percentage of Species Recorded.

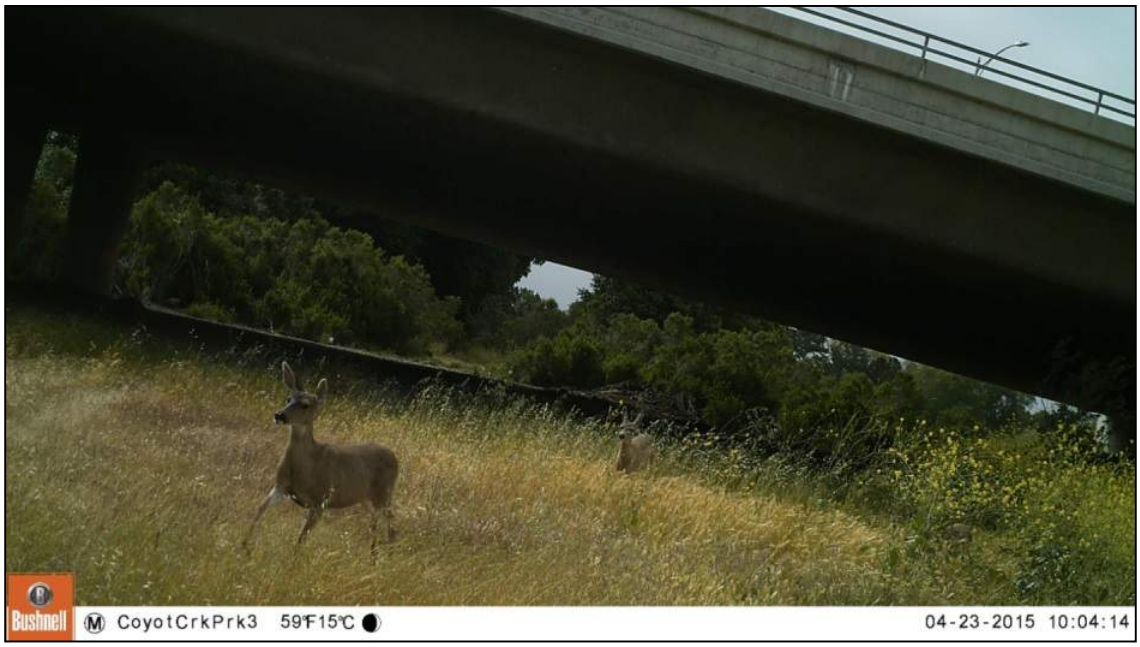


Figure 53: Deer traveling under the Bailey Overpass.

Figure 54: Coyote puppies traveling with parents through the underpass.

Camera Stations 12: Coyote Creek County Park Fence line Camera 2.

Figure 55: Coyote Creek County Park Fence line Cam 2.

The highest number of detections was wild turkey (40) and deer (28), which traveled through the fence line, both in and out of the park, consistently throughout the year (Table 16, Chart 16, and Figures 56 & 57). The total number of detections was 90 (Table 16).

Species	Number of Detections	Sex
Bobcat	1	
Coyote	6	
Deer	28	3 males, 7 females
Ground Squirrel	4	
Raccoon	4	
Wild Pig	7	
Wild Turkey	40	5 males, 4 females
Total	90	

Table 16: Number of Detections Recorded.

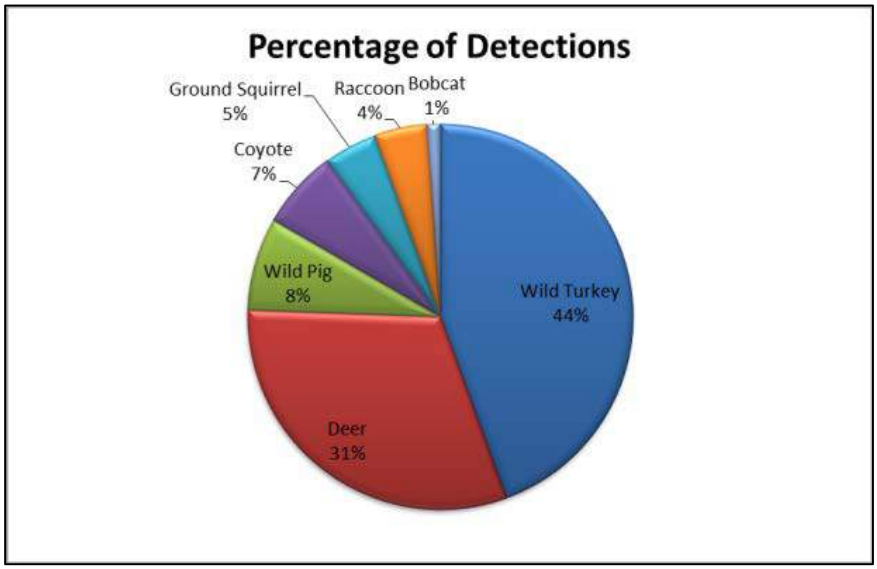


Chart 16: Percentage of Species Recorded.

Figure 56: Coyote at Fence line Cam 2.

Figure 57: Deer at Fence line Cam 2.

Appendix B – Preliminary Genetic and Occupancy Modeling Results by Morgan Gray and Adina Merelender at UC Berkeley.

Analysis of Coyote Valley, California for maintaining

landscape permeability, gene flow, and pathways for wildlife

February 1, 2015

Prepared for:

The Department of Fish & Wildlife & the Santa Clara Valley Open Space Authority

Prepared by:

Morgan Gray, PhD Candidate[1]

Table of contents

Introduction

Coyote Valley is a critical linkage that allows for animal movement between the Santa Cruz Mountains and the Diablo Range. Of the several barriers that affect the east-west movement of terrestrial wildlife across Coyote Valley, Highway 101 is the most significant due to heavy traffic (up to 8 lanes), as well as a 20-foot wide median and

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steep slope between the two directions. Highway 101 is permeable to wildlife movement at some locations, but little is known about gene flow across the valley floor between the two ranges.

What features are barriers to animal movement across Coyote Valley? To investigate this question we are investigating habitat permeability across Coyote Valley and nearby highways. We are incorporating three things into this analysis: (1) landscape permeability, (2) gene flow, and (3) animal movement pathways, specifically in relation to Highway 101. We are evaluating ground squirrels (*Otospermophilus beecheyi*), which have small home ranges and restricted mobility and may be more fully isolated due to habitat fragmentation, and bobcats (*Lynx rufous*), which are more mobile and often a focal species for conservation.

Landscape permeability

Methods

The landscape permeability models were derived from an estimated linear relationship between specific landscape features related to human land use (e.g. traffic volume, housing density) and bird and mesocarnivore detection levels from empirical field studies (Figure 1). These models were designed to make a general, community-level habitat quality assessment based on linear regression models derived from species assemblages in northern California (Forman 2000; Reed 2007; Merenlender et al. 2009). Gray et al. (2016) compared these biologically informed, structural permeability models with animal field observations and showed that the model estimates do reflect animal habitat use on the ground. Thus, habitat permeability models constructed using information about animal response to human land use activities can be an informative component for land management and conservation planning in fragmented landscapes even when species data are unavailable.

Figure 1. Photographs showing examples of landscape permeability that can be found in Coyote Valley, CA.

Results

The landscape permeability estimate covered a region centered on Coyote Valley of 242.6 km^2, and was comprised of 269,522 grid cells (900 m^2). The distribution of permeability values ranged between 0.14 and 0.71 (Figure 2), with an average of 0.47 (standard deviation = 0.14). Wildlife use of roads varies based on many factors such as animal type, body size, and mobility; and road width, composition, traffic volume, and traffic speed. Thus, a seemingly low permeability value of 0.144 as seen along Highway 101, Highway 101, or Santa Theresa may not indicate that the road is a complete barrier to all varieties of birds or terrestrial animals.

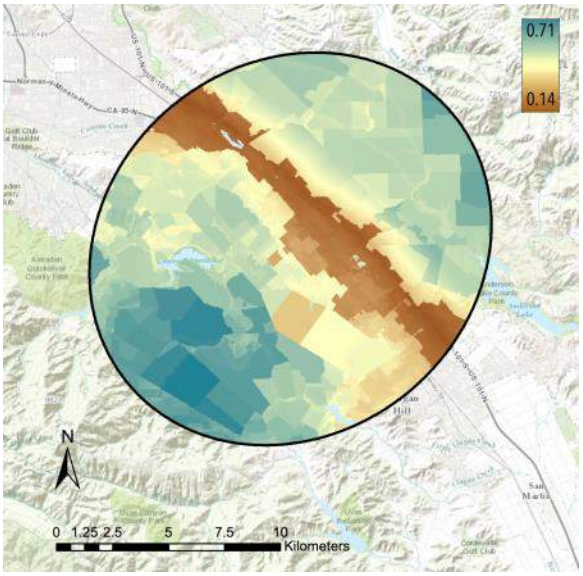


Figure 2. Landscape permeability model extrapolated across the region centered on Coyote Valley, CA.

Our results showed Coyote Valley has a broad range of permeability values, with much of the region with relatively high permeability. Specifically, 66% of land in Coyote Valley has a permeability value between 0.45-0.75 (Figure 3), a habitat permeability range that is preferentially used by wildlife, as demonstrated for pumas (*Puma concolor*) by Gray et al. (2016). This distribution indicated that there is land of relatively high permeability within Coyote Valley, and such habitat is not rare.

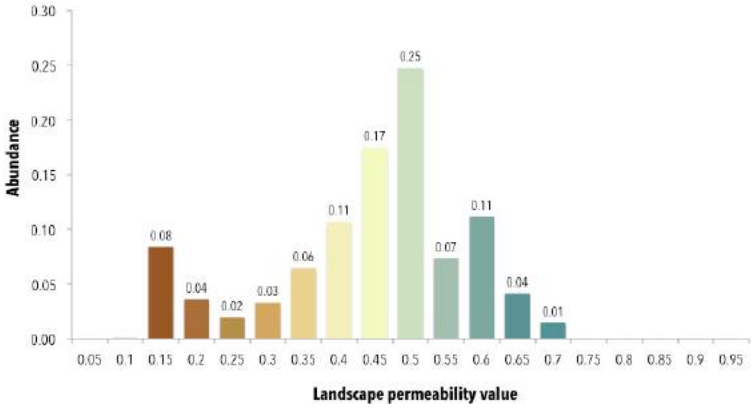


Figure 3. Distribution of landscape permeability values for Coyote Valley, grouped into 0.05 unit increments.

By measuring landscape permeability associated with human development, this analysis offers a spatially explicit method to identify and prioritize habitat corridors for improved wildlife movement through Coyote Valley. Permeability at the boundaries of this analysis would be affected by neighboring landscapes and their use. For example, the presence of roads and residential development to the north of Coyote Valley would likely reduce landscape permeability, whereas the open habitat to the west would not. Expanding this landscape permeability analysis to include the wider planning area would help us better understand the matrix within which the study area is situated.

Gene flow

We used ground squirrels as a focal species to compare genetic variation across a land use gradient in Coyote Valley to evaluate the extent of gene flow across both sides of Highway 101, and identify the genetic relatedness among ground squirrel metapopulations (Figure 4). Ground squirrels are widespread throughout almost all habitats across California, and can commonly be found along roadsides and in croplands, making them an easy species to sample. Because the average ground squirrel home range size is approximately 135m around a burrow, numerous individuals can be sampled within the study region. They are also ecologically relevant, as they are an important prey source for larger animals.

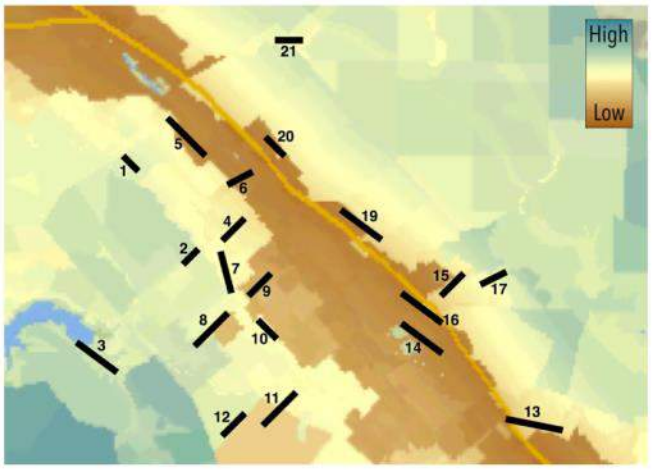
Figure 4. A. We used the ground squirrel (*Otospermophilus beecheyi)* as the focal species for the genetic analysis. B. A typical burrow opening where scats are deposited by ground squirrels. C. Ground squirrel scats collected for DNA extraction and analysis.

When populations are separated, they can accumulate genetic differences. Genetic differences can be quantified and compared to determine length of time since

separation. To test whether roads are a barrier to ground squirrels in Coyote Valley, we designed a series of 21 transects for scat detection surveys based on our permeability model results (Figure 5). We conducted scat transects along a permeability gradient throughout Coyote Valley. We extrapolated our permeability model across Coyote Valley to identify areas of predicted high and low permeability, and used these locations to inform the location of scat surveys.

Methods

Transects were walked on multiple separate occasions between the dates August 14, 2015 and September 7, 2015. For each sampling event, all available ground squirrel scats were collected outside burrows using sterile tweezers and placed in a 2 ml screw-cap tube containing DET solution (20% DMSO, 0.25 m EDTA, 100 mm Tris, pH 7.5 and NaCl to saturation) per Seutin et al. Tubes were kept frozen at -20°C until processing.



Transect #	Scats
1	2
2	1
3	4
5	2
6	2
8	1
11	2
12	4
13	3
22	1
23	4
Grand Total	**26**

Figure 5. Map of transect locations and count of scats collected at each transect across Coyote Valley, CA.

We extracted ground squirrel DNA from scat samples using Qiagen's QIAamp DNA Stool Mini Kit, a commercially available kit. The resultant DNA was amplified and sequenced using the previously published primers (MVZ6: CGAAGCTTGATATGAAAAACCATCGTT and MVZ15: AAATAGGAARTATCAYTCTGGTTTRAT) and amplification protocol for the cytochrome b mitochondrial gene designed for ground squirrels per Phuong et al. 2014.

Cytochrome b is commonly used as a region of mitochondrial DNA for determining phylogenetic relationships between organisms, due to its internal sequence variability. While the primer regions of the cytochrome b locus are broadly conserved across vertebrates, the coding region within the gene varying considerably between taxa. Thus cytb has been extensively used in intra- and inter-specific molecular systematic studies.

Preliminary Results

For this analysis, 26 samples were processed, with a 70% success rate for amplification (n=18).

Animal movement pathways: occupancy models for bobcats

We used bobcats as a focal species to document mid-sized animal movement across the landscape. About bobcats: distribution, home range, diet, and relationship to land use. We collected bobcat detections using camera trap arrays (Figure 6). To evaluate habitat use by bobcats, we created an occupancy model for the region using camera trap detections and existing maps of relevant environmental variables.

Camera	Location
1	Fisher Creek @ Palm
2	Fisher Creek @ Laguna
3	Fisher Creek @ Bailey
4	Fisher Creek @ Santa Theresa
5	Fisher Creek @ Monterery
6	Coyote Point Fence 1
7	Coyote Point Fence 2
8	Coyote Point Fence 3
9	OSA
10	Highway 101 @ Golf Drive
11	Highway 101 @ Coyote Creek

Figure 6. Map of camera locations and placement descriptions across Coyote Valley, CA.

Species distribution models relate animal presence with habitat characteristics, but do not always account for imperfect detections. Failing to account for these "non-detections" in a survey will result in an underestimate of population size. Occupancy

models estimate the probability of detecting a species, given imperfect detection (MacKenzie et al. 2002) using a combination of detection and non-detection data, with the assumption that an observed "absence" may be a true absence or a non-detection. To estimate detection probability, occupancy models require repeated surveys at a site.

Methods

For occupancy analysis, the survey window used was 1 day (n=304 days). For each site, we coded each day with 1 to indicate bobcat detection (presence), 0 to indicate lack of bobcat detection (absence), or (–) when no data was collected on that day. We ran occupancy model in program PRESENCE (citation) using the following site-specific variables:

Preliminary Results

A total of 136 individual bobcat detections were collected during the 304 day study period (Figure 7). Bobcats were more commonly detected at cameras placed at crossing structures along Fisher Creek (e.g. at Palm Avenue, Monterey Highway, and Laguna Avenue). Surprisingly, few bobcats were detected in the more open habitats of Coyote Creek County Park and the Coyote Creek Open Space Preserve, which showed high detections for other species like deer.

Given this preliminary data, we can begin building an occupancy model for bobcats that includes variables related to camera location, like crossing structure type, distance to road, and landscape permeability value. To better understand how the surrounding habitat matrix influences bobcat movement, we will set up additional cameras across a land use gradient (Figure 8).

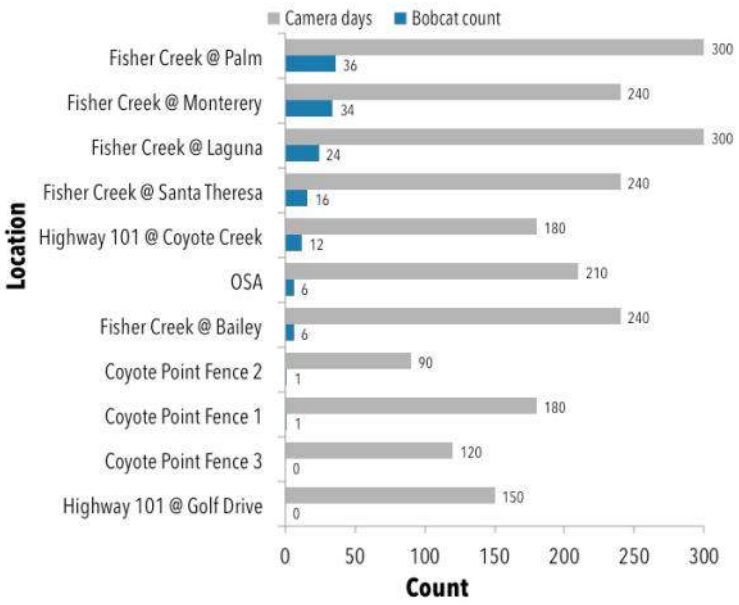


Figure 7. Bobcat detections by camera location.

Next steps

To continue the genetic analysis for ground squirrels, we will place emphasis on collecting scats at transects east of Highway 101 (e.g., transects 15, 17, 19, 20, 21). We will continue the molecular laboratory work and genetic sequence analysis for these samples to report genetic comparisons (e.g., F_{ST}) across the study area. In particular, the genetic comparison between sites on the east and west of Highway 101, as well as those for the north and south of Coyote Valley, will be used to explore the impact of roads as a barrier to wildlife movement for ground squirrels.

To examine how roads and land use influence the movement for larger-bodied wildlife, we have expanded our genetic analysis to include bobcats. We have collected 7 bobcat scats at our existing transects. To increase our bobcat DNA collection, we will install baited hair snares across from cameras at locations used by bobcats across the Valley floor, as well as at new locations on the east side of Highway 101. The scats and hair samples will be used for molecular analysis.

We will continue our exploration of animal movement pathways across Coyote Valley, we will refine our occupancy models to evaluate variables such as crossing structure type, median road effect value (within a 50m radius around camera), median landscape

permeability value (within a 50m radius around camera), and distance to agricultural lands. To identify the occupancy models that best explain the data, we will evaluate model performance using WINBUGS and report the credible interval for the highest performing models.

To better understand how bobcats use a variety of landscape features beyond crossing structures, we will set up cameras to collect detection data at locations along agricultural and permeability gradients (Figure 8). This data will allow a comparison between bobcat detections at culverts and crossing structures to occurrence elsewhere in Coyote Valley. Specifically we will look at how the agricultural matrix across the Valley floor relates with bobcat movement to identify of impact land use and barriers to movement.

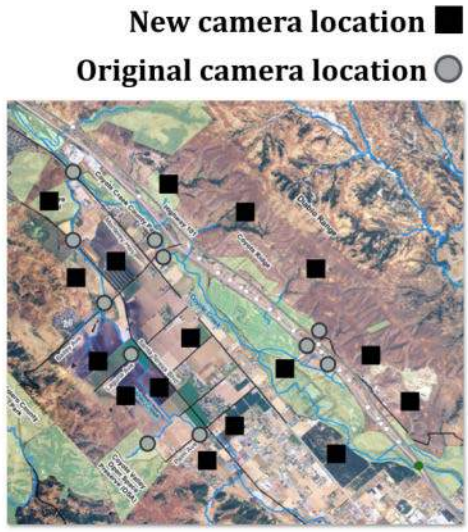


Figure 8. Map of current and proposed camera locations for Coyote Valley, CA.