

**Wildlife Presence Adjacent to I-580**  
**Alameda Landfill Open Space Committee**  
**Phase II Report**

***Alameda County***

***Resource Conservation District***

3585 Greenville Road, Suite 2

Livermore, Ca 94550

*Katherine Boxer, Chief Executive Officer*

*Courtney Coon, Biologist*

**&**

***Road Ecology Center***

Institute of Transportation Studies

University of California, Davis CA 95616

*Fraser Shilling, Director*

*David Waetjen, Analyst*

*Julianne Mackey, Madison Burnam, Selena Cao, Michelle See, Christina Cruz Andrade, Student Assistant*

**January 10, 2024**

Alameda County



**RESOURCE**  
CONSERVATION DISTRICT

## Table of Contents

<b>Executive Summary</b> .....	2
<b>Introduction</b> .....	3
Background .....	3
Habitat and Study Area .....	3
Research Purpose and Objectives.....	4
Task 1: Landowner Communication.....	4
Task 2: Field Sites and Data Collection.....	5
Task 3: Data Management and Analysis .....	5
<b>Methods</b> .....	5
Outreach methods .....	5
Camera methods.....	6
Data analysis .....	6
<b>Results &amp; Discussion</b> .....	7
Camera Positions, Camera Days and Mammal Species .....	7
Locations, Camera Days and Mammal Species.....	10
Species Detected at Locations Relative to Distance from I-580 .....	11
Species Detected in Castro Valley/Dublin Compared to Diablo Range .....	13
<b>Comparison of Camera Trap, Roadkill, and Modeled Species Distribution</b> .....	14
<b>Frequency of Species Occurrence Among Locations and Positions</b> .....	15
<b>Comparison with UCB Parcel-Based DSS</b> .....	16
<b>Recommendations</b> .....	18
<b>Conclusions</b> .....	18
<b>Next Steps</b> .....	19
<b>Literature Cited</b> .....	20

## Executive Summary

I-580 is an important barrier to wildlife movement across both the East Bay Hills and northern Diablo Range. This barrier effect could impede the benefits of conservation acquisitions in Alameda County by reducing connectivity and thus the ecological value of properties close to or far from the highway. For example, all lands north of this potential barrier may have now, or eventually have lower species diversity or population sizes of certain wildlife that have limited mobility across I-580.

Wildlife connectivity is usually defined as a measure of how much wildlife can move through landscapes. Connectivity is a valuable ecological attribute that varies continuously across landscapes. This means that for a given species, some areas may have relatively high connectivity, others relatively low connectivity, and the remaining some intermediate value of connectivity. Highways are typically semi-permeable barriers, meaning some wildlife may be able to connect from one side of the highway to another, depending on available structures under the right-of-way, or low traffic volumes allowing surface crossing. Interstates, such as I-580, may have sufficiently high traffic volumes such that any permeability will be via under-crossings (bridges and culverts).

The Alameda County Resource Conservation District (ACRCD) and UC Davis Road Ecology Center (UCD) used camera traps to monitor wildlife use of under-crossings and nearby habitat areas in the East Bay Hills and Diablo Range portions of I-580. We found varying species diversity across structures among different parts of I-580 (Figure ES1). Structures under the far western portion of I-580 had the greatest species diversity through the East Bay Hills, while structures closer to Dublin (that contained a street) had lower species diversity. Certain structures and nearby habitat areas had high species diversity depending on protected status (e.g., Brushy Peak) and low-intensity grazing (e.g., Stop Waste). The bridge near Greenville Road and the rail alignment near the Altamont Pass had the *highest diversity* among both structures and any area along I-580. Different species used each structure depending on proximity to their habitat and no one structure provided connectivity for all native mammals detected. Our recommendations for improving conservation decisions along and near I-580 were based on these findings.

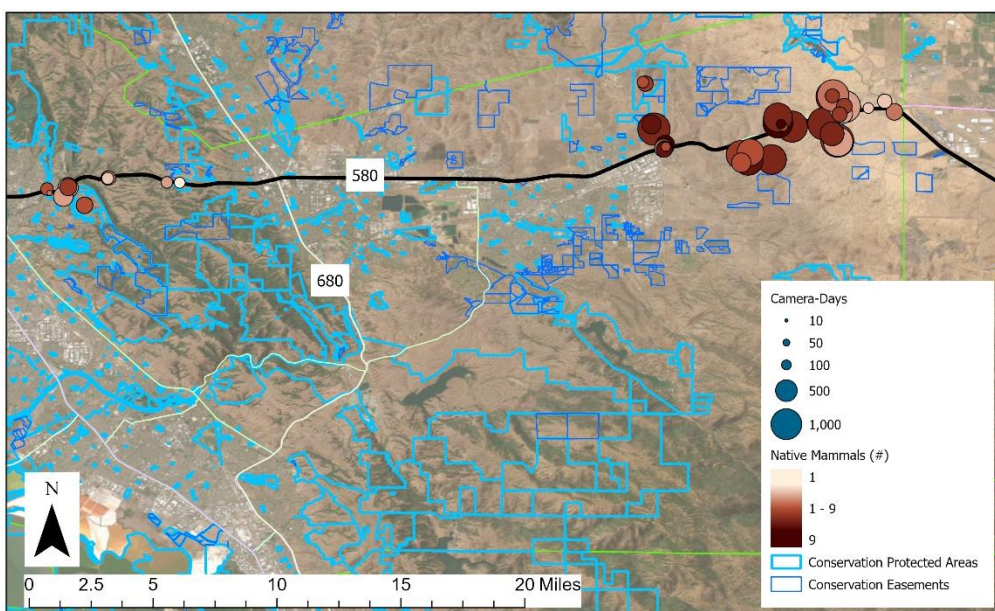


Figure ES1. Number of native mammals detected among structure and wildlife trails through the East Bay Hills and Altamont Pass areas.

## Introduction

### Background

Prioritizing land acquisition based on wildlife presence and activity along with habitat connectivity is recognized as essential to the protection of biodiversity. With this interest in mind, the Alameda County Resource Conservation District (ACRCD) actively initiated discussion with potential stakeholders and began partnering with the Road Ecology Center at the University of California, Davis (UCD) to explore wildlife occurrence and movement in proximity to major transportation corridors surrounding the Livermore Valley in early 2017. When the Altamont Landfill Open Space Committee (ALOSC) members learned about the ACRCD's interest in conducting transportation corridor wildlife research, the ALOSC inquired as to whether the research could also support the ALOSC's land acquisition goals by identifying land parcels where species were most frequently sighted.

As a result of these discussions, the ACRCD received a generous grant from the ALOSC, administered through a contract with the City of Livermore (COL), and subcontracted with UCD to collaborate on a wildlife research study on behalf of the ALOSC. Given the long-term goal of the ALOSC – to prioritize parcels for acquisition or purchase as conservation easements - it was understood that multiple phases of research would be needed to identify areas with greatest potential as habitat connectivity for wildlife in eastern Alameda County. In line with the interests of ACRCD and UCD, it also was understood that the prioritization study would aim to highlight optimal wildlife crossing sites along I-580.

This report presents Phase II of a multi-phase, multi-year investigation, as defined in Professional Services Agreement 22-228, executed 6 June 2022, between the ACRCD and the City of Livermore on behalf of the ALOSC. The ACRCD subcontracted with UCD to carry out wildlife field research and data analysis. Together, ACRCD and UCD are providing data that informs the ALOSC of locations that exhibit the most frequent and diverse wildlife sightings within the designated study area so that they may include evidence of wildlife in their future land acquisition and/or conservation easement decisions.

Phase I of this project involved initial field investigation of species occurrence including camera trapping and track/sign collection and analysis of other wildlife databases such as UC Davis's California Roadkill Observation System and the US Geological Survey's Biodiversity Information Serving our Nation.

In Phase II, camera trapping and animal sign detection work was expanded to include additional locations in the Altamont Pass and Castro Valley area.

### Habitat and Study Area

The focus of this research was within and immediately adjacent to ALOSC's areas of concern (Figure 1) in land within 2 miles of I-580. The eastern part of the study area is primarily open grasslands (often grazed by cattle) whereas western parts of the study area are often classified as mixed oak woodland or a mix of grassland and suburban housing.



Canyons Open Space (EBRPD), Brushy Peak Regional Park (EBRPD), Rowell Ranch Rodeo (HARD), and the underpasses at Palo Verde/Eden Canyon Rd and Schaefer Ranch Rd (Caltrans).

ACRCD also reached out to private landowners in Eastern Alameda County using email and letters. In total, approximately 100 individuals were contacted through these methods; an additional landowner was contacted online. However, of the 100 private landowners contacted only two responded. Cameras were placed at both sites, one in October and the other in December 2022. ACRCD CEO, Katherine Boxer, also reached out to Cattleman's Association but did not receive a response. Elizabeth McElligott, Assistant Director of County Planning kindly provided the ACRCD with the Alameda County parcel map and corresponding names and addresses.

### Task 2: Field Sites and Data Collection

Data collection primarily involved camera trapping at sites in 3 regions of the study area: Castro Valley/Dublin Grade, the West slope of the Diablo range, and the East slope of the Diablo range. Camera locations within sites were chosen based on water access, openness, human traffic, and obvious wildlife sign such as scat, tracks, or trails. As was the case for this project, this type of spatially-biased sampling is appropriate when the goal is determining species occupancy within the sampled area (it is not appropriate for determining population size).

### Task 3: Data Management and Analysis

All camera trap data associated with this project were managed using the UCD's processing and database system (<https://wildlifeovserver.net>) and cataloged by individuals trained to identify local wildlife species. Once data were collected and cataloged through 1 August 2023, data were analyzed by first dividing each camera-specific species count by the number of trap nights (the number of days that a camera was active during the study period). Then descriptive statistics, namely species lists and relative number of detections by species were analyzed:

- at each camera position
- at each property/location (e.g., Brushy Peak Regional Park)
- at sites at the highway, within ½ mile of highways and between ½ and 2 miles from I-580, and
- at cameras in Castro Valley, the west-slope Diablo Range and on the east-slope Diablo Range

## Methods

### Outreach methods

ACRCD used two different methods to contact landowners adjacent to I-580 in East Alameda County. Public municipalities, including but not limited to Caltrans, Alameda County Waste Management Authority, Contra Costa Water District, County of Alameda, Caltrans, State of California Water Resources, and Union Pacific Railroad, were contacted by the ACRCD via phone call. For private landowners, the ACRCD utilized parcel maps to determine property owners along I-580. Once determined, private landowners were contacted via physical letters and, in the case of a single landowner, online contact was made. The ACRCD attempted to contact the Cattleman's Association to utilize their mailing list; however, no response was received. In total, approximately 25 private landowners were contacted. The ACRCD received responses from all municipalities; however, of the private landowners contacted only three responded.

## Camera methods

Phase II cameras were placed or re-placed by Fraser Shilling (UCD) and/or Courtney Coon (ACRCD), both of whom have extensive experience with camera trapping. Optimal camera locations were chosen within sites to maximize wildlife detection. Cameras were placed in the Castro Valley area by UCD independently of this project, but the results were included here for information purposes.

Cameras in the study were checked and maintained by UCD interns under the mentorship of Fraser Shilling or maintained by ACRCD staff. Cameras were checked every 6 to 12 weeks, depending on accessibility, weather, human activity at the location, and other factors. Cameras away from I-580 were baited, part-time with a scent-lure (Caven's Gusto Lure).

All cameras were Browning Dark Opps cameras. Each camera was outfitted with lithium batteries and 16GB SD cards and placed in bear boxes and locked with Python cable locks for security. Cameras were set at heights and angles that best suited the location (based on trail or feature angle, sun light exposure, etc.) in ways that maximized detection of medium to large wild mammals.

SD cards from checked cameras were uploaded to UCD's database and cataloging system (<https://wildlifeobserver.net>). This database uses AI to process camera data and remove 'blank' photos (photos without humans or wildlife) and then facilitates species identification, data management and image storage. All species identification was completed by trained UCD interns and occasional spot checked by secondary individuals. In addition to species identification, data was collected on the number of animals and their movement type and direction.

## Data analysis

Variables of interest for this analysis were outlined by the ALOSC in the scope of work and included (1) camera position (where individual cameras were placed), (2) camera location (the properties where the cameras were placed, e.g., EBRPD's Brushy Peak), (3) distance to I-580 (at the highway, within 0.5 miles, or between 0.5 and 2 miles), and (4) region (Castro Valley/Dublin Grade, the West slope of the Diablo range, and the East slope of the Diablo range).

Cameras at each location were active for different amounts of time, and each variable category (site, distance from I-580, and region) had different numbers of cameras. This is because some cameras were up starting in Phase I, while others were only active during Phase II. Alternatively, some cameras experienced malfunctions, were tampered with, stolen, or their view was moved/obstructed during monitoring (e.g., by cows knocking into the camera, spiders building webs over the lens, or vegetation growing in front of the camera view). To make species detection data comparable between camera locations, sites, or regions given these differences in camera 'effort,' the number of detections need to be relativized by dividing by the number of days each camera was actually active, also known as "camera-days." Camera days were calculated by screening the photo catalog database for lapses in detection of any species that were > 4 weeks. In the absence of a lapse, the camera was assumed to be working correctly and continuously monitoring the area and camera days were calculated by determining the number of days between earliest and latest photo date. If a lapse was detected in the photo catalog database, the start and end dates of continuous monitoring period(s) were recorded and added together to determine the total number of camera days for that camera.

Species lists were developed by finding all the unique species detected at each camera location, site, or other categorical variable. Frequency of occurrence of each species was calculated by dividing the

number of occurrences of the species at a camera position or location by the number of camera days at that position or location. Species diversity was calculated using the Shannon Diversity Index, which is a way of representing species diversity while accounting for the variability of the frequency in observation or number of individuals of each species.

## Results & Discussion

### Camera Positions, Camera Days and Mammal Species

Forty-three camera positions were successfully populated with cameras for between 29 to 1,163 days (Table 1, Figure 2). Fourteen of the cameras were at I-580 underpasses and 29 were on adjacent properties. The camera codes in the table correspond to the codes on the maps in Figure 2.

**Table 1.** Camera position identifying codes, locations, types, and number of days deployed.

Position	Location	Position Type	Camera Days
ACE1	Alameda County East (ACE)	Wildlife Trail	1032
ACE2	Alameda County East (ACE)	Wildlife Trail	95
ACE3	Alameda County East (ACE)	Wildlife Trail	95
ACE4	Alameda County East (ACE)	Underpass	879
ACE5	Alameda County East (ACE)	Wildlife Trail	934
BPN_1	Brushy Peak Regional Park	Wildlife Trail	140
BPN_2	Brushy Peak Regional Park	Wildlife Trail	251
BPS_1	Brushy Peak Regional Park	Wildlife Trail	1118
BPS_2	Brushy Peak Regional Park	Wildlife Trail	395
CC_1	Don Castro Regional Recreation Area	Wildlife Trail	164
CCWDE_1	Contra Costa Water District East	Underpass	237
CCWDE_2	Contra Costa Water District East	Underpass	384
CCWDN_1	Contra Costa Water District North	Wildlife Trail	1152
CCWDN_2	Contra Costa Water District North	Wildlife Trail	1062
CCWDN_3	Contra Costa Water District North	Wildlife Trail	1095
CCWDN_4	Contra Costa Water District North	Wildlife Trail	258
CCWDN_5	Contra Costa Water District North	Wildlife Trail	215
CCWDS_1	Contra Costa Water District South	Wildlife Trail	1163
CCWDS_2	Contra Costa Water District South	Wildlife Trail	924
CCWDS_3	Contra Costa Water District South	Wildlife Trail	597
CCWDS_4	Contra Costa Water District South	Wildlife Trail	1099
DCE_1	Don Castro Regional Recreation Area	Wildlife Trail	29
DCN_1	Don Castro Regional Recreation Area	Wildlife Trail	421
DCS_3	Don Castro Regional Recreation Area	Underpass	438
DCS_4	Don Castro Regional Recreation Area	Underpass	319
FC_1	Five Canyons Open Space Park	Wildlife Trail	297
Greenville1	Greenville	Underpass	268
Greenville2	Greenville	Underpass	356
Greenville3	Greenville	Underpass	263
Greenville4	Greenville	Underpass	94
Greenville5	Greenville	Underpass	382
Midway1 (Nitiri & Mano)	Private properties in the Altamont	Wildlife Trail	224
PVR_east	Palo Verde / Eden Canyon Rd	Underpass	236
PVR_west	Palo Verde / Eden Canyon Rd	Underpass	148
Rodeo1	Rowell Ranch Rodeo	Wildlife Trail	147
Shuff1	Private properties in the Altamont	Underpass	122
SRR_west	Schaefer Ranch Road underpass	Underpass	127
SW1	StopWaste	Wildlife Trail	922
SW2	StopWaste	Wildlife Trail	400
SW3	StopWaste	Wildlife Trail	919
SW4	StopWaste	Wildlife Trail	759
SW5	StopWaste	Wildlife Trail	838
Zoox1	Private properties in the Altamont	Wildlife Trail	292

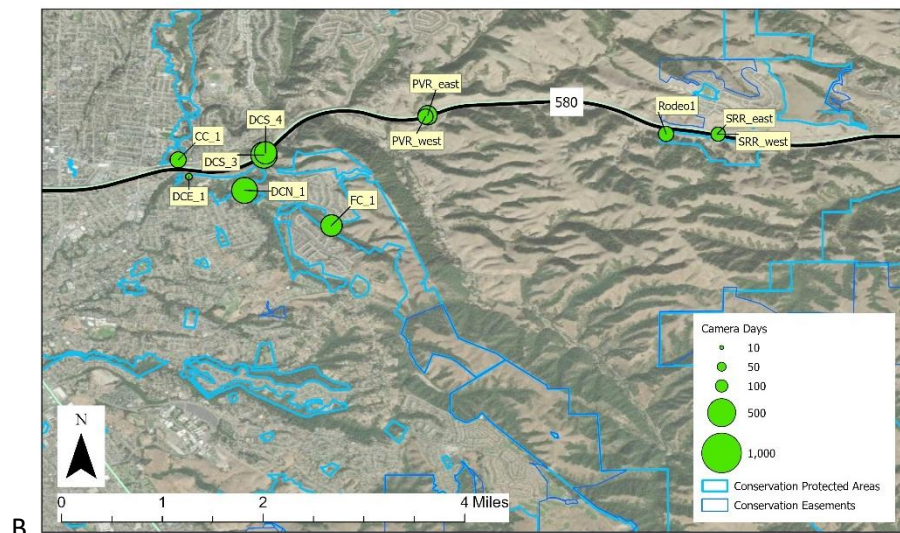
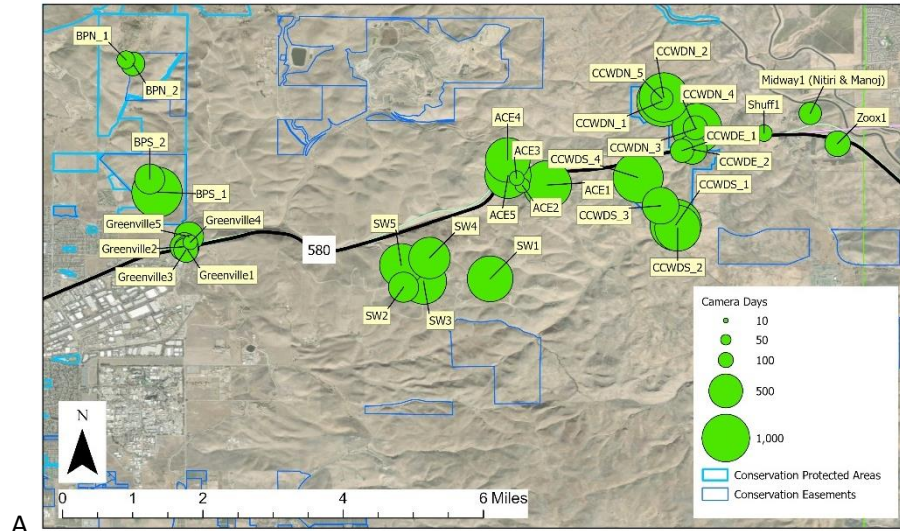


Figure 2: Locations of camera positions in the Altamont Pass area (A) and the East Bay Hills (B), and the number of days the cameras were active (taking pictures). The size of the symbol corresponds to the number of days. Conserved areas are shown.

Between 1 and 9 native mammal species were detected across all camera positions (Table 2, Figure 3). Non-native mammal species were also detected at most sites, but were in the minority of all species detected. In addition, there was no relationship between length of time (camera days) and number of species detected, suggesting that cameras were deployed for long enough to detect species that were present.

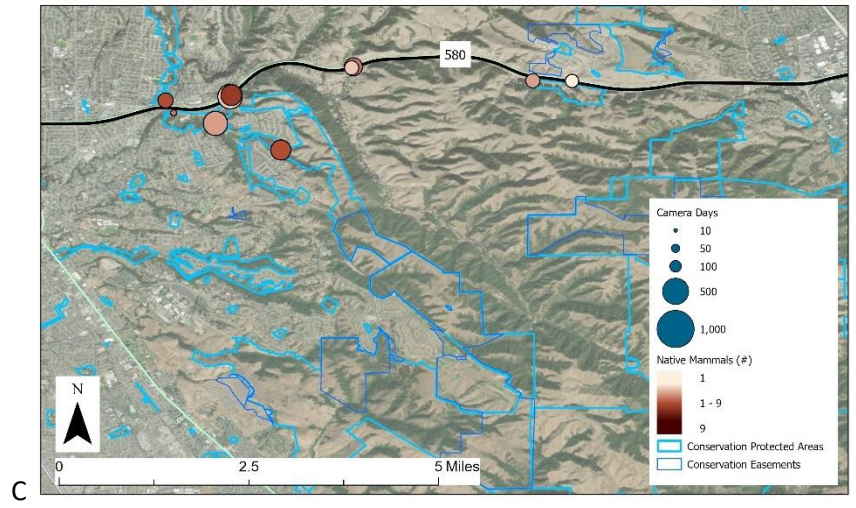
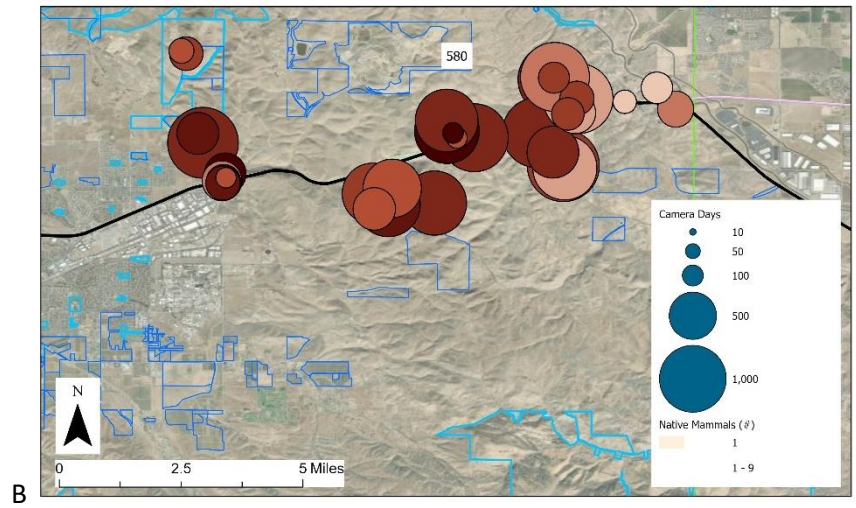
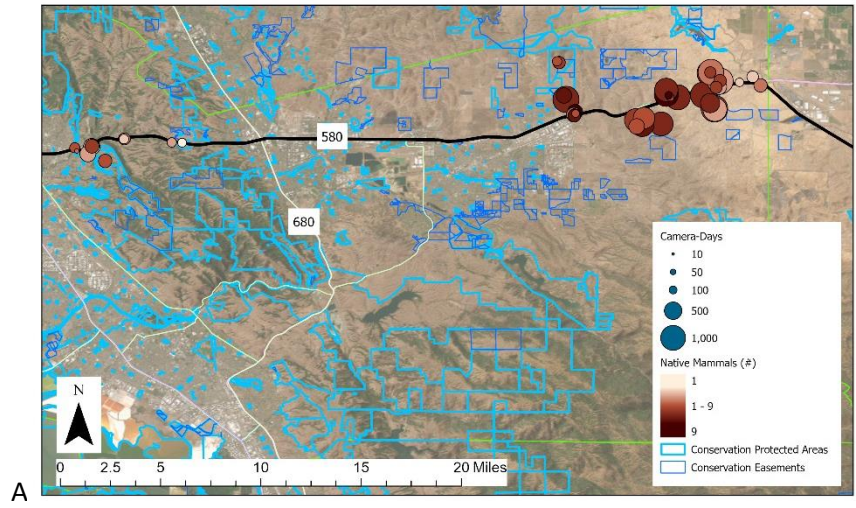


Figure 3: Number of native mammal species and number of camera days for each monitored position. A) all camera positions, B) positions in the Diablo Range and C) positions in the East Bay Hills.

**Table 2.** Camera position identifying codes, locations, types, number of days deployed, and number of native and non-native mammal species detected.

Position	Location	Position Type	Camera Days	Distance from I-580 (m)	Number Wild Mammal Species	Number Native Mammal Species	Number Non-Native Mammal Species
ACE1	Alameda County East (ACE)	Wildlife Trail	1032	277	10	7	3
ACE2	Alameda County East (ACE)	Wildlife Trail	95	240	5	5	0
ACE3	Alameda County East (ACE)	Wildlife Trail	95	47	10	8	1
ACE4	Alameda County East (ACE)	Underpass	879	50	7	7	0
ACE5	Alameda County East (ACE)	Wildlife Trail	934	257	10	9	1
BPN_1	Brushy Peak Regional Park	Wildlife Trail	140	4405	5	5	0
BPN_2	Brushy Peak Regional Park	Wildlife Trail	251	4250	8	6	2
BPS_1	Brushy Peak Regional Park	Wildlife Trail	1118	1312	9	7	2
BPS_2	Brushy Peak Regional Park	Wildlife Trail	395	1620	8	8	0
CC_1	Don Castro Regional Recreation Area	Wildlife Trail	164	50	8	5	3
CCWDE_1	Contra Costa Water District East	Underpass	237	0	7	6	1
CCWDE_2	Contra Costa Water District East	Underpass	384	0	3	3	0
CCWDN_1	Contra Costa Water District North	Wildlife Trail	1152	1160	8	7	1
CCWDN_2	Contra Costa Water District North	Wildlife Trail	1062	1240	4	4	0
CCWDN_3	Contra Costa Water District North	Wildlife Trail	1095	350	4	3	1
CCWDN_4	Contra Costa Water District North	Wildlife Trail	258	370	7	6	1
CCWDN_5	Contra Costa Water District North	Wildlife Trail	215	1220	6	6	0
CCWDS_1	Contra Costa Water District South	Wildlife Trail	1163	1630	8	6	2
CCWDS_2	Contra Costa Water District South	Wildlife Trail	924	1670	4	3	1
CCWDS_3	Contra Costa Water District South	Wildlife Trail	597	1120	9	7	2
CCWDS_4	Contra Costa Water District South	Wildlife Trail	1099	350	8	7	1
DCE_1	Don Castro Regional Recreation Area	Wildlife Trail	29	80	5	4	1
DCN_1	Don Castro Regional Recreation Area	Wildlife Trail	421	340	4	3	1
DCS_3	Don Castro Regional Recreation Area	Underpass	438	0	3	2	1
DCS_4	Don Castro Regional Recreation Area	Underpass	319	0	7	6	1
FC_1	Five Canyons Open Space Park	Wildlife Trail	297	1390	5	5	0
Greenville1	Greenville	Underpass	268	0	11	8	3
Greenville2	Greenville	Underpass	356	0	5	4	1
Greenville3	Greenville	Underpass	263	0	10	8	2
Greenville4	Greenville	Underpass	94	0	7	5	2
Greenville5	Greenville	Underpass	382	154	12	9	3
Midway1 (Nitiri & Mano)	Private properties in the Altamont	Wildlife Trail	224	260	3	2	1
PVR_east	Palo Verde / Eden Canyon Rd	Underpass	236	0	4	4	0
PVR_west	Palo Verde / Eden Canyon Rd	Underpass	148	0	2	2	0
Rodeo1	Rowell Ranch Rodeo	Wildlife Trail	147	40	3	3	0
Shuff1	Private properties in the Altamont	Underpass	122	0	2	2	0
SRR_east	Schaefer Ranch Road underpass	Underpass	7	0	1	1	0
SRR_west	Schaefer Ranch Road underpass	Underpass	127	0	1	1	0
SW1	StopWaste	Wildlife Trail	922	1580	9	7	2
SW2	StopWaste	Wildlife Trail	400	1160	7	5	2
SW3	StopWaste	Wildlife Trail	919	1160	10	8	2
SW4	StopWaste	Wildlife Trail	759	730	6	5	1
SW5	StopWaste	Wildlife Trail	838	690	7	6	1
Zoox1	Private properties in the Altamont	Wildlife Trail	292	90	5	4	1

### Locations, Camera Days and Mammal Species

Between 2 and 11 native mammal species were detected across all locations (Table 3). Non-native mammal species were also detected at most sites, but were in the minority of all species detected. The top five highest Shannon Diversity Index values (dark green fill) were for wildlife trails, except the Greenville underpass. The lowest values (yellow fill) were an even mix of wildlife trails and underpasses.

**Table 3.** Camera location identifying codes, positions, types, number of native and non-native mammal species detected, list of species detected, and Shannon Diversity Index (Shannon, 1948; Hill, 1973). The dark green highlights the five highest Shannon Index values, light green Index values above one, and yellow Index values less than one. Species codes: AB – American Badger, BC – Bobcat, BJR – Black-tailed Jackrabbit, BR – Brush Rabbit, CGS – California Ground Squirrel, CKR – California Kangaroo Rat, Coy – Coyote, DC – Desert Cottontail, EFS – Eastern Fox Squirrel, EGS – Eastern Gray Squirrel, GF – Gray Fox, HKR – Heermann’s Kangaroo Rat, MD – Mule Deer, ML – Mountain Lion, Rac – Raccoon, Rat – Unknown Rat Species, RF – Red Fox, SS – Striped Skunk, VO – Virginia Opossum, WP – Wild Pig

Positions	Location	Location Type	Number Wild Mammal Species	Number Native Mammal Species	Number Non-Native Mammal Species	Species List	Shannon Species Diversity Index
ACE1,2,3,5	Alameda County East	Wildlife Trail	15	11	4	AB, BJR, BC, CGS, CKR, Coy, DC, EGS, GF, HKR, Rac, RF, SS, VO, WP	1.1
ACE4	Alameda County East	Underpass	7	7	0	AB, BC, CGS, Coy, DC, Rac, SS	1.12
BPN,S	Brushy Peak Regional Park	Wildlife Trail	13	9	4	AB, BJR, BC, CGS, Coy, DC, EFS, EGS, MD, Rac, RF, SS, VO	1.72
CCWDE_1,2	Contra Costa Water District	Underpass	7	6	1	BC, CGS, Coy, DC, GF, Rac, RF	0.397
CCWDS_1,2,3,4	Contra Costa Water District	Wildlife Trail	11	8	3	AB, BC, CGS, Coy, DC, EFS, MD, Rac, RF, SS, WP	1.3
CCWDN_1,2,3,4,5	Contra Costa Water District	Wildlife Trail	10	7	3	AB, BC, CGS, Coy, DC, EGS, ML, RF, SS, VO	1.12
CC_1,DCE_1,DCN_1	Don Castro Regional Park	Wildlife Trail	8	5	3	BC, Coy, EFS, EGS, MD, Rac, SS, VO	0.475
DCS_3, DCS_4	Don Castro Regional Park	Underpass	7	6	1	CGS, Coy, DC, EFS, MD, Rac, SS	0.775
FC_1	Five Canyons Open Space Area	Wildlife Trail	7	7	0	BC, Coy, GF, MD, ML, Rac, SS	1.35
Greenville1,2,3,4,5	Greenville Road UC	Underpass	13	10	3	AB, BJR, BC, CGS, Coy, DC, EFS, GF, MD, Rac, RF, SS, VO	1.37
Midway1 (Nitiri & Manoj)	Midway1 (Nitiri & Manoj)	Wildlife Trail	3	2	1	CGS, Rac, RF	0.683
PVR_east,west	Palo Verde Rd UC	Underpass	5	5	0	AB, CGS, Coy, MD, Rac	1.3
Rodeo1	Rodeo	Wildlife Trail	3	3	0	Coy, MD, Rac	0.279
Shuff1	Shuff	Underpass	2	2	0	Coy, MD, Rac	0.796
SRR_east, west	Schaefer Ranch Rd	Underpass	2	2	0	MD, Rac	0.693
SW1,2,3,4,5	Stop Waste	Wildlife Trail	12	9	3	AB, BC, BR, CGS, Coy, DC, Rac, Rat, RF, SS, VO, WP	1.33
Zoox1	Zoox	Wildlife Trail	5	4	1	Coy, GF, Rac, RF, SS	0.598

### Species Detected at Locations Relative to Distance from I-580

More native mammal species were detected on wildlife trails near and far from I-580 than at I-580 developed and undeveloped underpasses (Table 4). This suggests that certain species may be hesitant to approach the interstate (e.g., mountain lion). Several of the species are challenging to identify because they are small, cryptic, or similar to other species (i.e., BR, CKR, HKR). For example, although the HKR and CKR observations are clearly of kangaroo rats, it is possible that only one species is present, rather than two. Similarly, desert cottontail rabbit can be misidentified as brush rabbit, especially with poor lighting, or with certain orientation of the body. Even if the two kangaroo rats were actually one species and brush rabbits were actually desert cottontail rabbits, kangaroo rats, and mountain lion were not detected using underpasses.

**Table 4.** Location type, number of native species and codes for species observed on each location type. Species codes are the same as in Table 3.

Location Type	Number Native Species	Native Species List
Wildlife Trail	14	AB, BJR, BC, <b>BR</b> , CGS, <b>CKR</b> , Coy, DC, GF, <b>HKR</b> , MD, <b>ML</b> , Rac, SS
Underpass	10	AB, BJR, BC, CGS, Coy, DC, GF, MD, Rac, SS

More native wildlife species were generally detected at any distance >0 m from I-580, however the relationship was weak (Figure 4) between position distance from I-580 and number of species. A similar weak, or no relationship was found between number of mammal species detected and categories of distance from I-580 (Table 5).

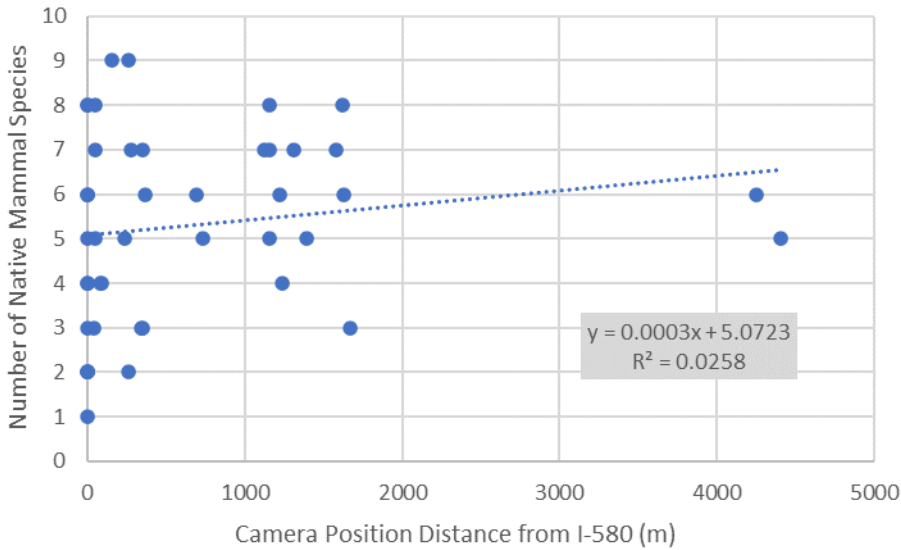


Figure 4: Number of mammal species observed compared to camera position distance from I-580

**Table 5.** Number and types of species at 3 distances from I-580: “0” (at an underpass); “0 – 0.5 mi”, for positions between the highway and 0.5 mi from the highway; and “>0.5 mi”, for camera positions that were greater than 0.5 mi from the highway. Species codes are the same as in Table 3.

Position Distance from I-580	Number Native Species	Native Species List
0	10	AB, BC, BJR, CGS, Coy, DC, GF, MD, Rac, SS
0 - 0.5 mi	12	AB, BC, BJR, CGS, <b>CKR</b> , Coy, DC, GF, <b>HKR</b> , MD, Rac, SS
>0.5 mi	11	AB, BC, BJR, CGS, Coy, DC, GF, MD, <b>ML</b> , Rac, SS

These weak relationships are in contrast to previous findings (Shilling et al., 2018), where stronger differences were observed between underpasses and background/wildlife trail locations (Figure 5).

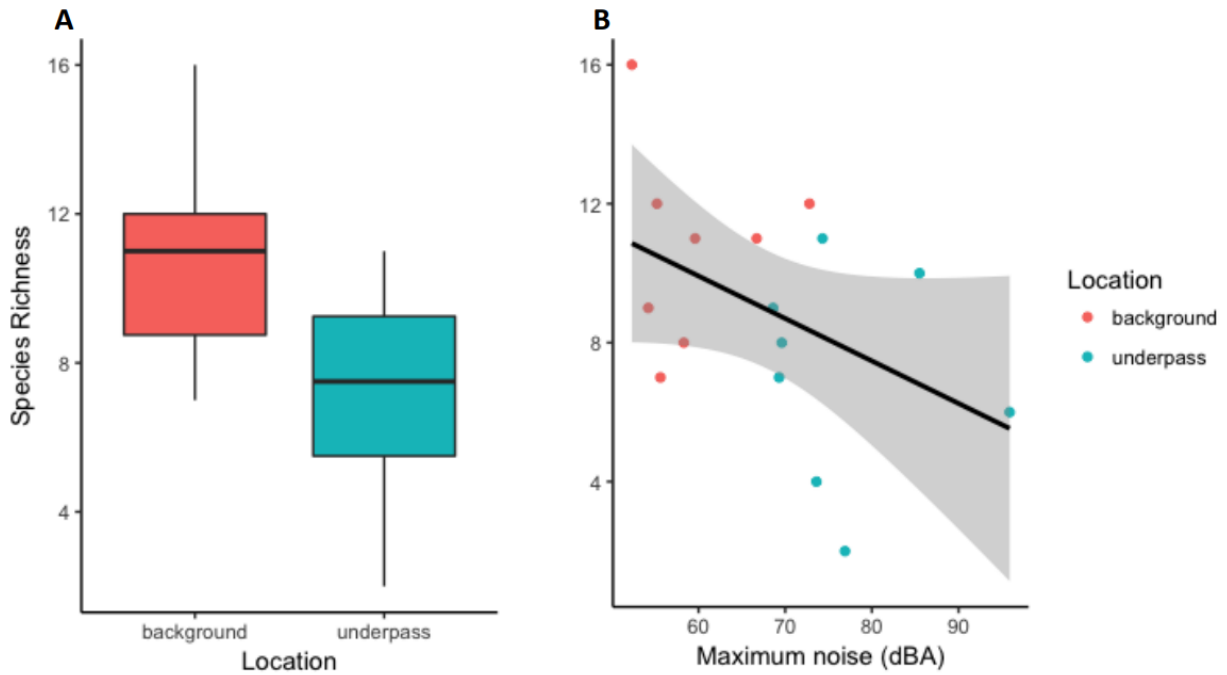


Figure 5: A) Relationship between number of native mammals and background (same as “wildlife trail” in this study) and underpass positions throughout California; B) Relationship between number of native wildlife mammals and maximum traffic noise at underpass and background positions. Graph image from Shilling et al. (2018).

### Species Detected in Castro Valley/Dublin Compared to Diablo Range

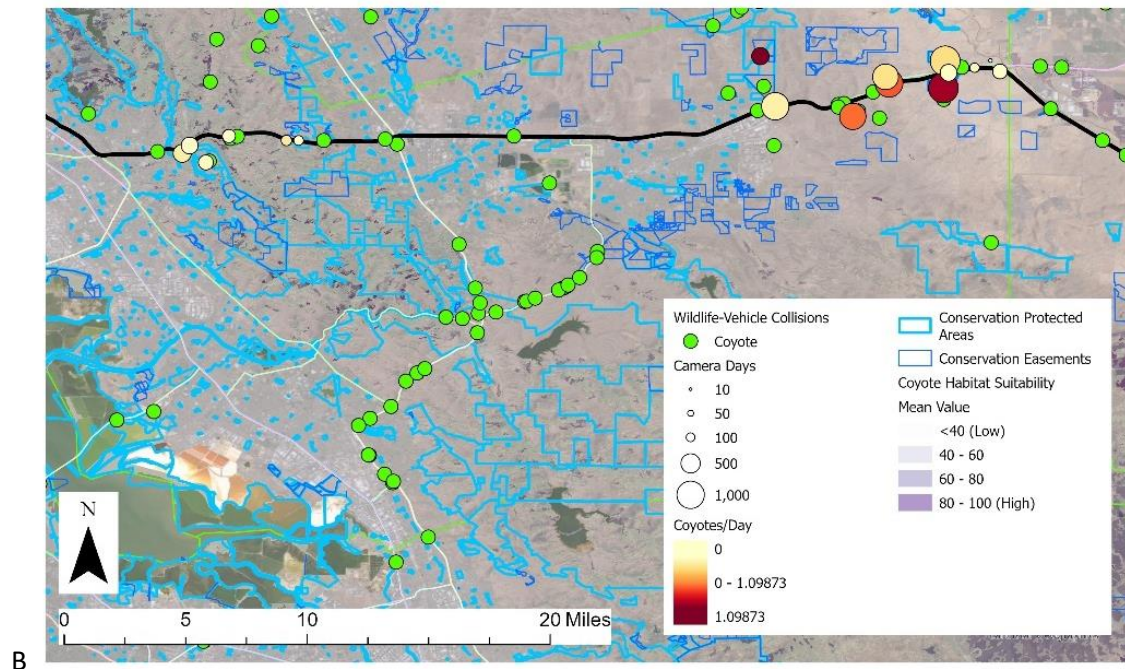
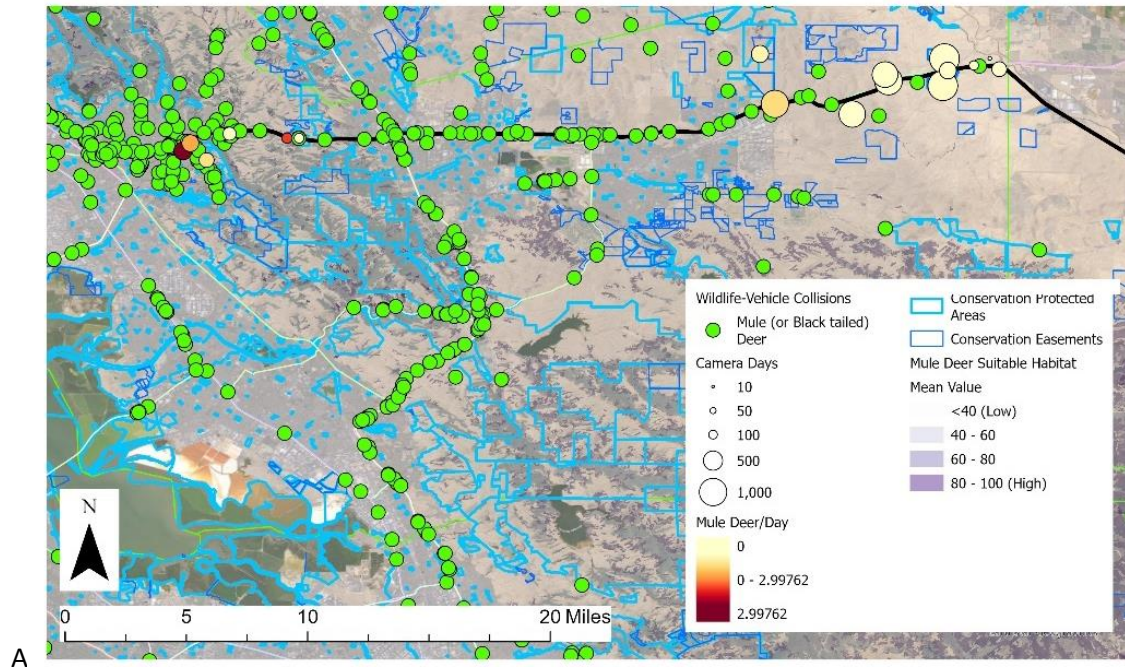
More native mammal species were detected in the Altamont Pass area (14 species) than the East Bay Hills (9 species, Table 6). This is possibly because the Altamont Pass is less developed and has larger areas of habitat than the East Bay Hills. Although a single mountain lion was detected in the Altamont Pass, the confidence was lower for the identification than for the repeated detection of a family of mountain lions in the East Bay Hills. black-tailed jackrabbits, brush rabbits and kangaroo rats were only detected in the Altamont Pass area and not the East Bay Hills.

**Table 6.** Number and type of native mammal species in each major region of the study area: Altamont Pass/Diablo Range and between Castro Valley and Dublin in the East Bay Hills. Species codes are the same as in Table 3.

Location Along I-580 I-580	Number Native Species	Native Species List
Altamont Pass/Diablo Range	14	AB, BJR, BC, BR, CGS, CKR, Coy, DC, GF, HKR, MD, ML, Rac, SS
Castro Valley/Dublin, East Bay Hills	9	AB, BC, CGS, Coy, DC, GF, MD, ML, Rac, SS

## Comparison of Camera Trap, Roadkill, and Modeled Species Distribution

Species generally had similar distributions of roadkill, camera trap detections, and modeled habitat suitability (Figure 6). Generally, where cameras detected a species, that species was more likely to be detected as roadkill and where either camera or roadkill detection of a species occurred, the modeled habitat suitability values were greater. There was variation among species in their preference or tolerance for different underpasses.



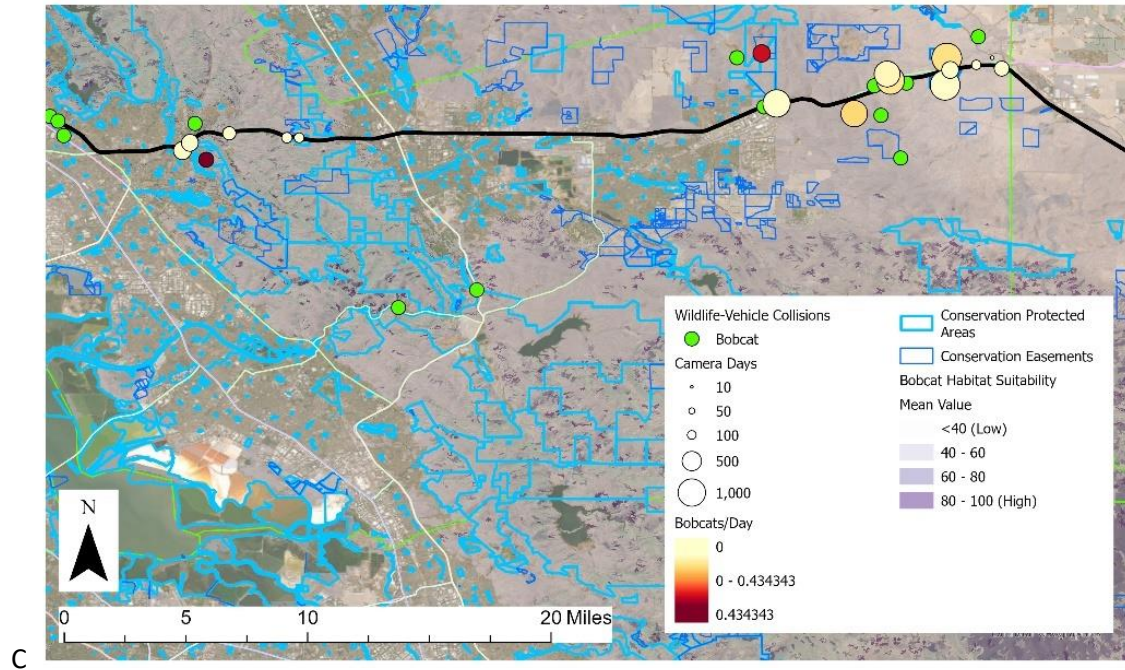


Figure 6: Comparison of camera trap detections, observed roadkill/wildlife-vehicle collisions, and modeled suitable habitat for A) Mule Deer, B) Coyote, and C) Bobcat.

## Frequency of Species Occurrence Among Locations and Positions

The frequency at which different species occurred at underpasses varied among locations (Table 7) and positions and position types (Table 8). Only raccoons used an underpass at every location, American badger, California ground squirrels, coyotes, desert cottontail rabbits, mule deer, and striped skunk used at least one underpass location in each of the East Bay Hills and the Altamont Pass area. Black-tailed jackrabbits, brush rabbits, bobcats, and gray foxes were only detected using underpasses in the Altamont Pass area. Mountain lions and kangaroo rats were observed in certain locations, but were not observed at any underpasses.

**Table 7.** Frequency (# observations/day) of observation of each species in underpasses at each location. Dark green indicates high frequency (>0.1/day), medium green indicates medium frequency (>0.01/day), and light green indicates low frequency (>0.001/day). Species codes are the same as in Table 3.

Location	Positions	AB/d	BJR/d	BC/d	BR/d	CGS/d	CKR/d	Coy/d	DC/d	GF/d	HKR/d	Hum/d	MD/d	ML/d	Rac/d	SS/d
Alameda County East	ACE4	0.0137	0.0000	0.0228	0.0000	0.0034	0.0000	0.2071	0.0569	0.0000	0.0000	0.0978	0.0000	0.0000	0.0148	0.0011
Contra Costa Water District	CCWDE_1,2	0.0000	0.0000	0.0052	0.0000	0.7552	0.0000	0.0234	0.0234	0.0026	0.0000	0.1302	0.0000	0.0000	0.0130	0.0000
Don Castro Regional Park	DCS_3, DCS_4	0.0000	0.0000	0.0000	0.0000	0.4096	0.0000	0.0213	0.0053	0.0000	0.0000	0.0532	1.2074	0.0000	0.0426	0.0080
Greenville Road UC	Greenville1, 2,3,4,5	0.0040	0.0111	0.0020	0.0000	0.1841	0.0000	0.1087	0.1308	0.0020	0.0000	0.0905	0.6680	0.0000	0.0604	0.0171
Palo Verde Rd UC	PVR_east,west	0.0254	0.0000	0.0000	0.0000	0.0678	0.0000	0.0127	0.0000	0.0000	0.0000	0.0339	0.0636	0.0000	0.0042	0.0000
Schaefer Ranch Rd	SRR_east,west	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0315	0.0079	0.0000	0.0079	0.0000

**Table 8.** Frequency (# observations/day) of observation of each species in each underpass or group of wildlife trails within a location. For frequency of wildlife detection, dark green indicates high frequency (>0.1/day), medium green indicates medium frequency (>0.01/day), and light green indicates low frequency (>0.001/day). For humans, dark orange indicates high frequency (>0.1/day), and medium orange to indicate medium frequency (>0.01/day). Species codes are the same as in Table 3.

Positions	Location	Location Type	AB/d	BJR/d	BC/d	BR/d	CGS/d	CKR/d	Coy/d	DC/d	GF/d	HKR/d	Hum/d	MD/d	ML/d	Rac/d	SS/d
ACE1,2,3,5	Alameda County East	Wildlife Trail	0.008	0.001	0.074	0.000	0.138	0.021	0.668	1.719	0.001	0.004	0.089	0.000	0.000	0.011	0.103
ACE4	Alameda County East	Underpass	0.014	0.000	0.023	0.000	0.003	0.000	0.207	0.057	0.000	0.000	0.098	0.000	0.000	0.015	0.001
BPN,S	Brushy Peak Regional Park	Wildlife Trail	0.008	0.071	0.354	0.000	0.919	0.000	1.099	1.357	0.000	0.000	0.471	0.233	0.000	0.053	0.354
CCWDE_1,2	Contra Costa Water District	Underpass	0.000	0.000	0.005	0.000	0.755	0.000	0.023	0.023	0.003	0.000	0.130	0.000	0.000	0.013	0.000
CCWDS_1,2,3,4	Contra Costa Water District	Wildlife Trail	0.003	0.000	0.005	0.000	0.510	0.000	1.021	0.347	0.000	0.000	0.149	0.074	0.000	0.053	0.032
CCWDN_1,2,3,4,5	Contra Costa Water District	Wildlife Trail	0.009	0.000	0.086	0.000	0.687	0.000	0.228	1.084	0.000	0.000	0.146	0.000	0.002	0.000	0.005
CC_1,DCE_1,DCN_1	Don Castro Regional Park	Wildlife Trail	0.000	0.000	0.010	0.000	0.000	0.000	0.121	0.000	0.000	0.000	0.012	2.998	0.000	0.280	0.012
DCS_3, DCS_4	Don Castro Regional Park	Underpass	0.000	0.000	0.000	0.000	0.410	0.000	0.021	0.005	0.000	0.000	0.053	1.207	0.000	0.043	0.008
FC_1	Five Canyons Open Space Area	Wildlife Trail	0.000	0.000	0.434	0.000	0.000	0.000	0.037	0.000	0.007	0.000	3.710	0.616	0.205	0.010	0.098
Greenville1,2,3,4,5	Greenville Road UC	Underpass	0.004	0.011	0.002	0.000	0.184	0.000	0.109	0.131	0.002	0.000	0.091	0.668	0.000	0.060	0.017
Midway1 (Nitiri & Mano)	Midway1 (Nitiri & Mano)	Wildlife Trail	0.000	0.000	0.000	0.000	0.150	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.200	0.000
PVR_east,west	Palo Verde Rd UC	Underpass	0.025	0.000	0.000	0.000	0.068	0.000	0.013	0.000	0.000	0.000	0.034	0.064	0.000	0.004	0.000
Rodeo1	Rodeo	Wildlife Trail	0.000	0.000	0.000	0.000	0.000	0.000	0.156	0.000	0.000	0.000	0.014	2.014	0.000	0.007	0.000
Shuff1	Shuff	Underpass	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.000	0.000	0.000	0.098	0.008	0.000	0.000	0.000
SRR_east, west	Schaefer Ranch Rd	Underpass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.008	0.000	0.008	0.000
SW1,2,3,4,5	Stop Waste	Wildlife Trail	0.011	0.000	0.107	0.024	1.615	0.000	0.621	0.444	0.000	0.000	0.095	0.000	0.000	0.156	0.038
Zoox1	Zoox	Wildlife Trail	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.007	0.000	0.010	0.000	0.000	0.113	0.007

## Comparison with UCB Parcel-Based DSS

Researchers at the University of California Division of Agriculture and Natural Resources, Berkeley office developed a decision-support tool (DSS) for ALOSC based on the theoretical conservation score of parcels in the ALOSC study area. This score was based on a combination of connectivity models and presence of endangered species habitat. Comparison of the number of native mammal species detected using camera traps with the “Overall score” from the DSS revealed some important differences (Figure 6). For example, the landscape around the Greenville cameras has a high Overall Score and the Greenville and Brushy Peak locations had similarly high number of species (Figure 6A). In contrast, the Overall Score is lower near the Altamont Pass, but the number of mammal species detected using cameras was relatively high, both on the landscape and at the ACE underpass (but not the CCWD underpass). On the east side of the pass, there is more agreement between the Overall Score (medium) and the number of native mammals detected (also medium). Both systems suggest that the areas north and south of the Greenville underpass are important for conservation, that the Pass area may also be important and that areas on the east side of the pass may be relatively less important (but not unimportant).

In the western region, the cameras away from I-580 in the Don Castro Regional Park and Five Canyons Open Space Area both had relatively high numbers of native species detections, suggesting that similar areas nearer Dublin may have similar high biodiversity (Figure 6B). This is supported by the Overall Score

for certain large parcels. In contrast, at the Palo Verde Road and Schaefer Ranch Road underpasses, there was low species diversity, suggesting that even though there may be higher biodiversity nearby, most native mammals are not crossing I-580 in this area.

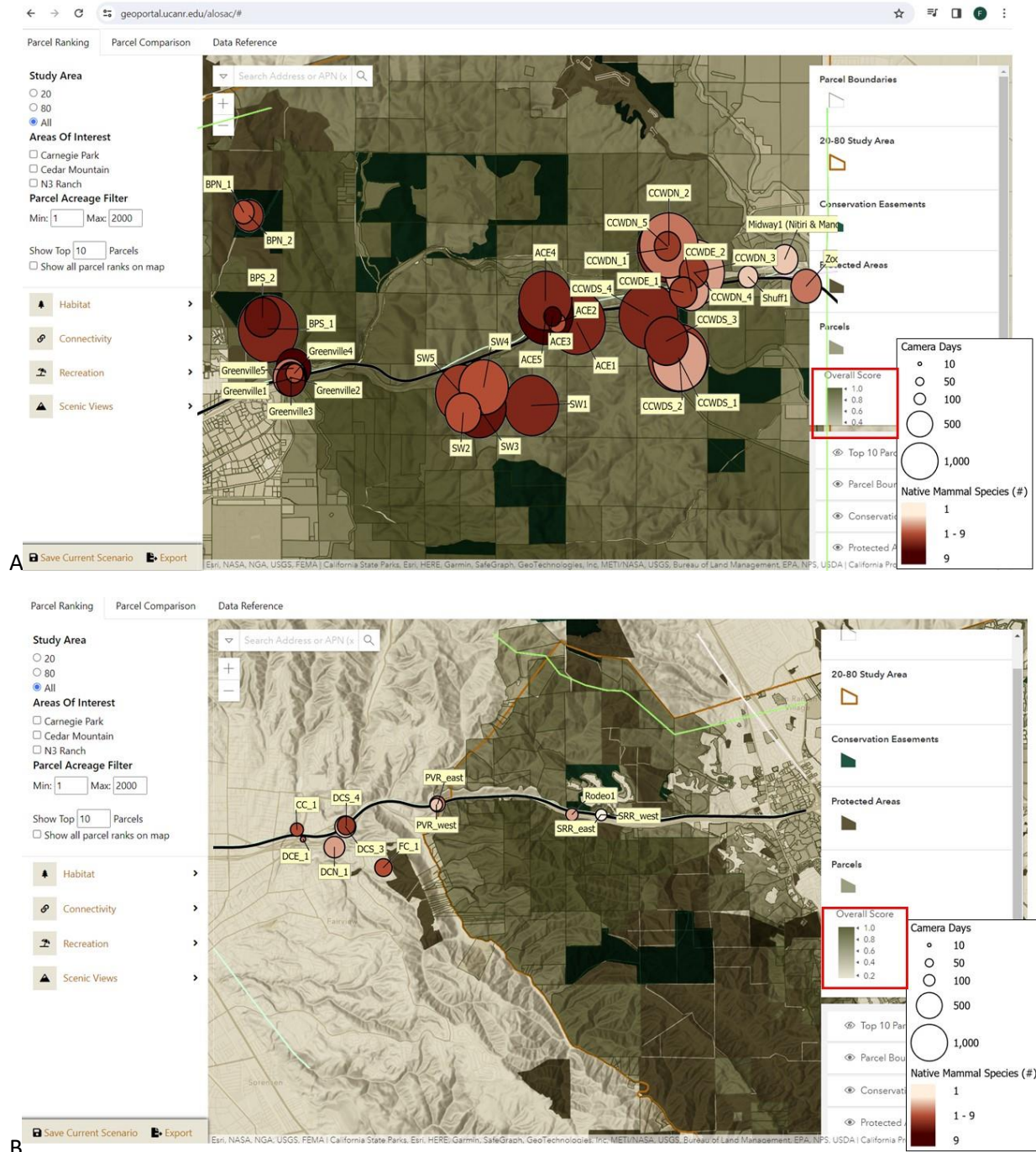


Figure 5: Comparison of number of native mammals detected and “Overall Score” (red box) from the UCANR-UCB decisions support tool (<https://geoportal.ucanr.edu/alosac/>), for A) the Altamont Pass area and B) the East Bay Hills.

## Recommendations

Using the data presented in the report, several primary recommendations were developed vis-à-vis wildlife occurrence and movement, potential conservation acquisition decision-making, and future wildlife crossing planning.

- 1) **Existing Structures:** There are several existing structures (bridges and culverts) that currently provide wildlife passage. They vary in which species use them and the other adjacent and conflicting land uses. The structure with the most activity and species diversity is the undercrossing next to Greenville Road, identified here as “Greenville”. This structure is currently critical to wildlife movement through the Diablo Range across I-580 and lies between Brushy Peak Regional Park and unprotected areas to the south. Protecting the structure and adjacent lands from human disturbance and the approaches to the bridge from traffic disturbance would be a critical wildlife connectivity action. The second highest use was at the railroad underpass near the Alameda County East location (ACE4), at Altamont Pass. Although it experiences occasional rail traffic and is disturbed by I-580 traffic, it is a large open structure that would benefit from conservation of adjacent lands and reduction of human use. The third highest use was at the I-580 bridge in Don Castro Regional Park (DCE3 and DCE4). This is the best underpass in the East Bay Hills region of I-580, but is only protected on the south side. The underpass has a lot of human activity, elimination of which would benefit wildlife connectivity across I-580.
- 2) **New Structures:** A new wildlife crossing planning project has begun for the area, supported by the Wildlife Conservation Board. This project is intended to complement existing opportunities for wildlife connectivity, connecting existing and newly-protected lands using over and undercrossings across I-580, SR84, and I-680. The locations and types of new crossing structures will be decided in the first phase of the project, during 2024.
- 3) **Land Acquisition:** It is possible that new conservation land acquisition, or new management of existing conserved lands will be needed to complement existing and proposed new wildlife crossings. For example, the lands to the south of the Greenville crossing and immediately to the north are not protected, but would be critical to maintaining the continued functioning of this high-diversity crossing. If, for ecological reasons, new wildlife crossings are planned in areas with low levels of land protection, then new land acquisition would help to maintain connectivity to and through the structures.

## Conclusions

After close to 3 years of camera trap monitoring of culverts, bridges, and wildlife trails along the I-580 corridor in Altamont County, it's possible to draw several conclusions about species distributions and movement across I-580. Most native mammal species detected were observed crossing I-580 through an underpass. However, black-tailed jackrabbits, brush rabbits, bobcats, and gray foxes were only detected using underpasses in the Altamont Pass area. Assuming our detection system was adequate, this suggests that either these species are not present near I-580 in the East Bay Hills, or are not approaching structures under I-580 in this area. Mountain lions and kangaroo rats were observed in certain locations, but were not observed at any underpasses. This suggests conditions at the underpasses we monitored are inadequate for movement by these species.

In terms of informing conservation land acquisition decisions, the UCD DSS could be improved by adding either representation of the native mammals we detected in just the areas we monitored, or by adding distribution models for all native mammals expected to be in the area. In a recent publication from UCD, the models that the DSS relies on to represent connectivity were shown to not represent movement or occurrence of most species (Iverson et al., 2023). This suggests that the representation of connectivity in the DSS should be removed.

The findings from this study can be used to help inform siting and type of wildlife crossings structures to aid movement of all native species in the Diablo Range and East Bay Hills. Specifically, where existing structures could be already contributing to wildlife connectivity, adjacent lands should be conserved to protect this important function (e.g., Greenville bridge). This is a logical and cost-effective way to protect wildlife populations. Where wildlife movement “should” be occurring (e.g., in protected areas), but may be inhibited by human presence, then human use could be reduced or eliminated to cost-effectively provide for wildlife movement. This is especially critical for structures like the I-580 bridge over Pacheco Creek/Five Canyons Parkway which is large, and continuous with protected areas, but has a large trail going under it with a lot of human activity.

## Next Steps

**Monitoring:** Because camera trap data are suggestive of higher species diversity near Altamont Pass than the priority values from the UCB DSS model, camera trap monitoring should continue through these and adjacent lands. Monitoring of continued wildlife use of adjacent lands and I-580 structures could potentially be carried out more occasionally and efficiently using environmental DNA (eDNA) sampling. Multiple species can be detected in single samples and sampling could be once or twice per year. In addition, if the distribution of certain species may be fragmented by I-580, then genetic differences between one side of the highway and the other could be detectable.

**DSS:** The priority values of the DSS do not appear to reflect native mammal species diversity, as observed using camera traps. If the DSS does not include species distribution models for native mammals yet, it should, as these models appear to align well with direct observations of species occurrences.

**Acquisitions:** Over the next year using Wildlife Conservation Board support, priority areas will be identified for wildlife crossings to help with connectivity across I-580. If there is not complete, or ideal site control at these locations, the ALOSC could consider targeting its resources to these areas, to assist with wildlife movement through the Altamont Pass and East Bay Hills areas.

**Crossing & Fencing Planning:** The ACRCDC will be working with consultant scientists and engineers to plan and design wildlife crossings across I-580, I-680, and SR 84 in areas where additional connectivity is needed. As importantly, fencing will be planned to reduce overall wildlife mortality on these highways. This combination of reduced mortality and increased connectivity is intended to support the continued persistence of wildlife in both habitat peninsulas -- the East Bay Hills and the Diablo Range.

## Literature Cited

- Benedict, B.D., Castellanos, A.A. and Light, J.E., 2019. Phylogeographic assessment of the Heermann's kangaroo rat (*Dipodomys heermanni*). *Journal of Mammalogy*, 100(1), pp.72-91.
- Hill, M. O. 1973. Diversity and evenness: a unifying notion and its consequences. *Ecology* 54: 427–432.
- Iverson, A.R., Waetjen, D. and Shilling, F., 2024. Functional landscape connectivity for a select few: Linkages do not consistently predict wildlife movement or occupancy. *Landscape and Urban Planning*, 243, p.104953.
- Shannon, C. 1948. A mathematical theory of communication. *Bell Syst. Tech. J.* 27: 379–423, 623–656.
- Shilling, F., Collins, A., Louderback-Valenzuela, A., Farman, P., Guarnieri, M., Longcore, T., Banet, B. and Knapp, H., 2018. Wildlife-Crossing mitigation effectiveness with traffic noise and light.