San Pasqual Valley Wildlife Connectivity Survey

Data Summary

Prepared for:

San Diego Association of Governments

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

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Introduction

As part of a continuing effort to better understand and enhance wildlife movement within San Diego County, the U.S. Geological Survey-San Diego Field Station (USGS), in cooperation with the San Diego Management and Monitoring Program (SDMMP) and the San Diego Association of Governments (SanDAG), has been evaluating wildlife linkages between core conserved areas within San Diego County, California, USA. The SDMMP identified 16 linkages connecting core conserved lands in the document "Connectivity Monitoring Strategic Plan for the San Diego Preserve System-2011" (SDMMP, 2011) which were based on an original assessment made by Ogden (1996). Considerable construction and urbanization have occurred subsequent to the original identification of these linkage areas, along with considerable build out of the reserve system. These changes within the conservation landscape across San Diego County warranted a reevaluation of the potential wildlife linkages within the region.

In coordination with the SDMMP, USGS evaluated each of the 16 linkages with a multi-step process (Rochester and Fisher, 2013 and 2014). Geographic information system (GIS) and imagery tools were used to identify points within each linkage where wildlife potentially may move between the core conserved lands. This included identifying landscape factors available as spatial data as well as taking behavioral responses to the environment into account to hypothesize the likelihood that focal wildlife taxa would be able to move from one core area to the next. Recommendations were made as to potential management actions that might increase the success of wildlife movement or prevent or discourage wildlife from entering roadways. The next phase of this evaluation addressed herein was to further develop and test efficient and effective monitoring techniques and to test a linkage hypothesized to be functional.

Based on the GIS review of these 16 linkages, the San Pasqual Valley was identified as an important route connecting protected lands east of highway I-15 to those on the west side of this major road. Along the linkage between Lake Hodges/Del Dios (Core Area 11) and Ramona Grassland/Boden Canyon (Core Area 12), the I-15 bridge was identified as a critical point for wildlife movement between these core areas, sometimes acting as a potential barrier – sometimes benefitting wildlife movement (Rochester and Fisher, 2013). In coordination with SDMMP, this linkage was chosen as the highest priority site to test for its level of functionality.

When evaluation of the 16 linkages began in 2012, reservoir levels at Lake Hodges were at their highest, filling the area under the I-15 bridge from berm to berm. The only potential routes for wildlife were along the north and south shoulders under the bridge. The north shoulder is a public access area with high use: pedestrians, joggers, cyclists, and pets. The south shoulder was built specifically to serve as a wildlife path. During high water levels, it seemed unlikely that wildlife would move along either of these routes and the entire linkage from Core Area 11 and Core Area 12 was hypothesized to be non-functional.

As the evaluation of the 16 linkages continued in 2014, water levels at Lake Hodges dropped, drastically changing the suitability of the I-15 bridge for wildlife movement. By 2014, the area under the bridge had dried down and began producing a riparian shrub community, providing habitat and cover for potential wildlife. The low water levels in the reservoir at the time of the study provided an opportunity to investigate wildlife movement along a route that may not exist every year.

Along the San Pasqual Valley linkage, three bridge structures were identified as possible barriers to wildlife movement between the core areas and were selected as survey locations suitable for monitoring with wildlife motion cameras: I-15 bridge over Lake Hodges, SR-78 bridge over San Pasqual Creek, and SR-78 bridge over Santa Ysabel Creek (fig. 1). Camera traps have become a useful tool in recording the activity of various wildlife species (Griffiths & Van Schaik, 1993; O'Connell, et. al., 2011; Karanth & Nichols, 1998). Cameras provide a minimally intrusive and relatively low-maintenance means to survey wildlife populations. Visitations to the camera units are only made to change the memory storage device, collect photos and change the batteries as needed. Camera traps have been shown to be effective for monitoring the focal taxa in this study, including both common and rare species (O'Connell et. al., 2011).

Methods

Timing

Once the linkage through San Pasqual Valley had been selected as the priority for testing wildlife connectivity, site reconnaissance began in summer 2014 to identify potential wildlife movement paths and suitable camera locations from which to document each. Near the end of July, the specific locations for individual camera stations were selected (table 1) and we began testing the camera set up and configurations to ensure all equipment were functioning as expected and capturing images of the desired movement path. After a few small adjustments during the camera set up and testing period, all 12 cameras were installed and running by early August. The wildlife motion cameras were in the field for 12 sample periods, consisting of 6-8 days each, from August 6, 2014 through October 29, 2014 (table 2). While this study was intended to take place from July through September, due to logistics, permitting, equipment installation and adjustments, sampling was delayed slightly, but did capture mid-summer to early fall activity.

Sites

Three bridge structures, identified as possible barriers to wildlife movement between Core Area 11 and Core Area 12, were selected as survey locations suitable for monitoring with wildlife motion cameras:1) I-15 bridge over Lake Hodges, 2) SR-78 bridge over San Pasqual Creek, and 3) SR-78 bridge over Santa Ysabel Creek (fig. 1).

I-15 Bridge at Lake Hodges

The I-15 bridge over Lake Hodges is one of the few points along this transportation corridor where there is a potential for wildlife movement. The I-15 bridge at Lake Hodges was evaluated as part of the linkages evaluation process as point 1112_01 (Rochester and Fisher, 2013). It was hypothesized that the connectivity value of this point was largely dependent on water levels in the reservoir. During high water years, it was hypothesized that perhaps only coyote (*Canis latrans*) would regularly cross the I-15 at this point. During low water years, it was hypothesized that all of the focal species should be able to use this point to move between the habitats on either side of the highway. The I-15 bridge at Lake Hodges was identified in Ogden (1996) as "L-2 Lake Hodges/San Pasqual Valley" and had been measured as part of a previous effort by SanDAG where it is described as being 10 meters high X 70 meters long X 205 meters wide, concrete with a dirt/water substrate (Samarin and Roeland, 2010).

During the recent (2003-2009) renovation and expansion of the bridge, a shoulder was added along the south end of the bridge to allow wildlife a path past the reservoir during high water levels. During low water levels, wildlife is likely to travel through the dry lakebed. In order to test this hypothesis, in early August 2014 we installed six cameras under the I-15 bridge where it crosses over Lake Hodges. Two cameras were installed along the pedestrian path on the north shoulder, two cameras were installed along the south shoulder (referred to here as 'wildlife path', and two cameras were installed in the dry lakebed directly under the bridge (fig. 2).

Pedestrian Path

A pedestrian path runs along the north shoulder under the I-15 bridge. Two cameras were installed along this route (fig. 2). Station 01 was on the east side of the bridge and Station 02 was on the west side. The location for each of these cameras was chosen based on the potential that any wildlife movement would likely be funneled past the selected points. Although wildlife movement was expected to be very low in this area due to human activity, we included these two stations to provide a baseline reference for wildlife movement during a low water period against which to compare potential future studies done during high water levels.

During the preliminary surveys of the pedestrian path, there was little sign that any wildlife moved through this portion of the habitat. Near where Station 01 would be installed, there was potential bobcat (*Felis rufus*) sign. Near where Station 02 would be installed, vegetative cover continued up to the path from the lakebed below and there was a gap in the chain-link fence which would seem to provide wildlife the necessary cover and opportunity to move through this area back and forth under the bridge.

The habitat along the pedestrian path was mostly geared towards human use. A portion of the area on the north shoulder has a concrete path wide enough to drive a vehicle on. Under the bridge there is also a wide section of bare ground. Under the bridge, the path and section of bare ground are approximately 20 meters wide between the bridge abutment and the top of the rip-rap berm. From east to west, the pedestrian path is 70 meters long. A chain-link fence separates the level paved path from the rip-rap slope which is 8 to 10 meters wide. There was no vegetation along the pedestrian path under the bridge; the only vegetation in this area was to the east and west of the bridge abutment.

Lakebed

Directly under the I-15 bridge, we installed two camera stations, Stations 03 and 04 (fig. 2). Station 03 was placed at the north end of the lakebed, near the base of the rip-rap berm. Station 04 was placed towards the south end. The specific locations for these cameras were selected due to the presence of extremely high levels of mule deer (*Odocoileus hemionus*), raccoon (*Procyon lotor*), and coyote tracks. The dry lakebed represented the most natural habitat at this potential choke point. During low water periods, the lakebed should provide a wide area over which wildlife could choose its own route. During high water periods, this option would not be available to most species.

The open area under the bridge was extremely large, roughly 170 meters along the north-south axis and 75 meters long on the east-west axis. The substrate was a mix of cobble, gravel and sand. Vegetation was sparse in this heavily shaded area. There was extensive riparian vegetation on both the east and west sides of the bridge. The area was relatively open except for the four rows of bridge support columns, with eight columns in each row.

Wildlife Path

Along the south end of the I-15 bridge at Lake Hodges, two camera stations were installed along the wildlife path, Stations 05 and 06 (fig. 2). Station 05 was installed on the west side of the bridge near the top of the rip-rap berm, pointed towards the wall. Station 06 was installed on the east side of the bridge near the corner of the abutment pointed to the northeast. Although the portion of the wildlife path directly under the bridge looks very similar to the pedestrian path, there was very little evidence of human activity at this end of the bridge.

During the preliminary surveys of the wildlife path, there were signs that some animals were using the area. Raccoon prints were the most obvious indication of animal activity in the area. No mule deer prints were detected at this time.

The south shoulder was narrower than the north one. The section of level ground along the south shoulder was approximately 8 meters wide from the bridge abutment to the top of the rip-rap berm and 70 meters long. Outside of the bridge, the wildlife path wrapped back parallel to I-15. The rip-rap berm was approximately 8 to 10 meters wide. Little vegetation grew on this path which was mostly bare ground.

San Pasqual Creek

The SR-78 bridge over San Pasqual Creek may provide a northern route into and out of San Pasqual Valley, connecting to the Lake Wohlford area and Valley Center (fig. 3). This bridge was the smallest of the three that were sampled. Riparian habitats north and south of the bridge provide cover for wildlife to approach the bridge. North of the bridge, the riparian habitat gives way to heavily grazed fields. During our study, San Pasqual Creek and the pond to the north-east of the bridge were dry.

The San Pasqual Creek Bridge, identified as 1112_06, had been hypothesized to be a functional connection for all of the focal species in Rochester and Fisher (2013). Based on the surrounding habitat and the nature of the structure itself, it seemed likely that wildlife would be able to move successfully past this bridge. It had been measured as part of the SanDAG master culvert file and described as 3 meters high X 13 meters long X 71 meters wide, concrete with a dirt substrate (Samarin and Roeland, 2010). Although the previous reports indicated that there was 3 meters of vertical clearance under the bridge, clearances during this study were less than 2 meters for most of the bridge. The lack of fencing at this location was noted as a potential short-fall. Without constraints, wildlife approaching the San Pasqual Creek Bridge may choose to attempt an at-grade crossing of SR-78.

Streambed

Two wildlife motion trigger cameras were installed in the streambed under the San Pasqual Creek Bridge (fig. 3). Station 07 was located at the west end of the bridge and was aimed to the southwest, at the corner of the bridge abutment. Station 08 was installed next to the post that M. Jennings had previously used to monitor the site in 2011-2012 (Jennings and Lewison, 2013). Both of these locations had wildlife trails indicating movement through the area. The stream was completely dry during our survey exposing a sand and silt substrate.

Latrine

Station 09 was on the east end of the bridge and aimed at a location with a large accumulation of wildlife scat along the ledge of the abutment (fig. 3). The 'latrine' area appeared to be a focal point for wildlife activity under the bridge. The latrine was located near the top of the rip-rap berm adjacent to the narrow concrete ledge that ran along the bridge abutment. During any periods of high water, the ledge and latrine area may serve as a dry route for wildlife movement under the roadway.

Santa Ysabel Creek

At the east end of San Pasqual Valley, we installed three cameras near the SR-78 bridge over Santa Ysabel Creek (fig. 4). This riparian zone may represent an east-west movement route between Core Area 11 and Core Area 12 (fig. 1). There are extensive vehicle tracks in the streambed all along Santa Ysabel Creek on both sides of the bridge.

The Santa Ysabel Creek Bridge, identified as point 1112_03, had been hypothesized to be a functional connection for all of the focal wildlife species in Rochester and Fisher (2013). It was noted that the vegetative cover in the area may be insufficient for mountain lions (*Felis concolor*) and mule deer. The bridge had been measured as part of the SanDAG master culverts file and described as 5 meters high X 13 meters long X 92 meters wide, concrete with a sand substrate (Samarin and Roeland, 2010). The area under the bridge was divided into three sections by the two support columns.

Center Span

Two wildlife motion cameras were installed in the widest of the three subdivisions under the bridge (fig. 4). The cameras were located on opposite sides of the center span and were roughly aimed at each other. The distance across the center span was wider than the motion sensor range of a single camera, so we used two cameras to cover the area. Near the bases of the support columns there was sparse vegetation, consisting mostly of giant reed (*Arundo donax*) and cocklebur (*Xanthium* spp.). The substrate within the center span was mostly loose sand. Station 10 was installed on the north side, pointing south. Station 11 was installed on the south side, pointing northwest, near the same location previously used by M. Jennings to monitor the site in 2011 and 2012 (Jennings and Lewison, 2013).

Wildlife Span

The southern division under the bridge, between the south support column and the rip-rap berm, appeared to be the most likely route for wildlife movement (fig. 4). There was more vegetation along the south edge of the river channel leading to the bridge on both sides. There was also a single-lane dirt road through this section of the underpass. In addition to the giant reed and cocklebur, there was more riparian vegetation along this path. Station 12 was installed on the north side of the road, pointed south.

Cameras

Make and Model

We used two models of Reconyx HyperFire™ cameras for the field portion of our study: four HC500 and eight PC800 (table 3). These models were chosen because they are compatible with photo processing tools previously developed by USGS (Tracey et al., 2014). Both models have a 1/5 second response time between the motion sensor detecting movement and the first photo (Reconyx, 2013). The only difference between these two models, with respect to this study, is that the PC800 has an infrared illumination range up to 70 feet and the range of the HC500 is 50 feet.

Settings

All 12 cameras were configured the same in an attempt to standardize the equipment parameters and detection probabilities. The following settings were used:

1. Motion Sensor: **On**
2. Sensitivity: **High**
3. Picture Interval: **RapidFire™**
4. Quiet Period: **No**
5. Resolution: **3.1M**
6. Pic Per Trigger: **5**
7. Night Mode: **Balanced**
8. Illuminator: **On**

Rotation

During a previous study using some of the same Reconyx cameras, it was suggested that there was some variability in the performance of each. Certain cameras appeared to be more sensitive to movement, while others seemed to take more pictures once something was in front of the camera. In an attempt to compensate for these potential slight differences, we rotated the cameras through the 12 sample locations. Each camera was at each station for one week-long sample period. Any difference whether under-performance or over performance of any single camera should then be equally distributed among the 12 stations. If there are differences in the cameras, leaving one at the same station for the duration of the study could impact detection rates, in either direction.

Photo Processing

The photos collected during this study were processed and reviewed using the "USGS Image Processor" program developed by J. Tracey for the Underpass Enhancement Study (Tracey et al., 2014). The image processor program is able to extract metadata from each image file created by the Reconyx cameras and populate a spreadsheet with that information. The image processor program also renames each photo in the process to create a unique name to help manage large sets of photographs. Using the photo review tools within the "USGS Image Processor" program, each photo was looked at to determine if any wildlife was in the field of view of the camera at the time. The species was added to the record, along with the number of individuals, and the direction of travel. After the photo review process was completed, the records generated by the image processor were exported as a Comma Separated Values (CSV) file , formatted in Microsoft Excel to perform some preliminary calculations, and then imported into a Microsoft Access database for the purposes of data summaries and reductions.

During the photo review process we only attempted to identify the species of wildlife present and not differentiate between individuals within the same species. Many of the wildlife images were at night and depended upon the infrared flash. These images were often not of sufficient quality to pick out distinguishing features at the individual level. Although unintentional, some individuals did become recognizable during the review process including joggers, daily dog walkers, a few mule deer with unique features, domestic dogs (*Canis familiaris*) , and domestic cats (*Felis silvestris*).

Species identification went through a two-step process; initial review and identification by the field technician and a secondary review by the lead author. As described above, the field technician used the

"USGS Image Processor" program. All photos of wildlife species were reviewed by the lead author to confirm the identification using a Microsoft Access database viewer. Not all wildlife photos could be identified to the species level. Such photos were grouped into one of five unknown "species" categories; unknown birds, unknown canine, owl, rabbit, and unknown. All of the owl observations were likely barn owns (*Tyto alba*) but this was difficult to confirm because of the quality of the images. The rabbit observations are potentially two species, brush rabbit (*Sylvilagus bachmani*) or desert cottontail (*Sylvilagus audubonii*), both of which occur in the study area but are complicated to distinguish from one another. Photos of unknown birds (n = 19), unknown canine (n = 7), and complete unknown species (n = 123) were dropped from any further discussion.

Data reduction

Number of Photos and Species Events

We chose to summarize the results of the photo survey based on the number of times that a species was in front of the camera station in addition to the number of raw photos of the species. The number of photos of a species could potentially be influenced by the behaviors of the species and not the density of individuals in the area. California ground squirrels (*Spermophilus beecheyi*), for example, sometimes will spend several minutes in front of a camera station, resulting in dozens of photographs of the same animal. A bobcat, on the other hand, passes in front of a camera and typically continues on, resulting in just a few photos of the individual. We have used the term "event" to identify when a species is detected by the camera station.

Because of the behavior of some species, we further defined an event based on the possible time in between photos. We defined an event as all of the photographs of the same species within a 5-minute floating window at each camera station. If a species was detected within the field of view of a camera station, any photo of the same species within 5-minutes of the previous detection of that species was grouped with the prior detection as an event. This new photo then becomes the standard against which to measure the next 5-minute window. Any new photos of the same species within this second window would also be added to the same event that was initiated by the first photo, even if that first photo was more than 5 minutes earlier. This 5-minute floating window means that a single event for a species could last for more than 5 minutes but that there was never more than a 5 minute gap between photos of the species. This same 5-minute floating window was used for both wildlife species and the human related categories of observations.

Index of Relative Abundance

To obtain an index of relative abundance, we divided the number of species events by the total sampling effort for that camera. This index was calculated using the equation

$$\mathbf{I_j = [v_j/n_j]}$$

where, I_j = index of relative abundance at camera j, v_j = number of species events at camera j by a particular species, and n_j = number of nights that camera j was active. The sampling effort was relatively consistent among camera stations with 10 out of 12 sample periods being of equal length. In many wildlife camera studies, the effort at each camera varies based on the number of images that can be recorded or on the battery power of the camera. With the equipment that we used during this effort, no camera ever completely filled its memory capacity or depleted its batteries during the week long sample period. This abundance index does not provide data on the absolute number of individuals. Instead, the index compares the relative abundance of species across space and time.

As part of the characterization of each species' activity, we determined the duration of time that each species was at a camera station during a species event. Using the time stamp on each photo, we calculated the average length of time a species event lasted, the minimum duration and the maximum. To further summarize the detection results, we used the number of species events to calculate the Shannon Diversity Index for each of the camera stations and determine the number of species observed.

Protocol Optimization

In an effort to increase efficiency for future efforts, we looked at the results from our study to try and identify components that could be modified to reduce effort and time needed to document the presence of wildlife using motion trigger cameras. For each of the wildlife species, we calculated the average number of sample days before the first detection of the species across all camera stations, the minimum number of sample days, and the maximum. We also determined how long was required for each camera station to detect its full suite of species, however many species that might be.

One area where there are potentials for reducing the amount of effort is in the reduction of the number of photos that need to be reviewed and documented. In an effort to try and refine this, we have looked at the number of photos in each motion trigger event, the quiet period, and the usefulness of multiple camera stations at a site.

One of the pieces of metadata that the Reconyx cameras embed in each photo is the photo position in the sequence of pictures taken each time the motion sensor is triggered. Using this information we calculated how often each position in the sequence of five photos did not detect a species within the field of view. We calculated the cumulative percentage of species events that were first identified in each position of the sequence to try and determine if the five photo sequence was necessary or if each sequence could be reduced to three photos per motion trigger event.

The Reconyx cameras have the option to turn on or off the quiet period between motion triggered events. The quiet period is the ability to delay the next photo series for a set length of time since the previous motion triggered event. We turned off the quiet period so that the cameras would take pictures any time that motion was detected, regardless of how recently the previous picture was taken. Using MS Excel, we artificially imposed a 5-minute quiet period on the full dataset. Any photos taken within 5-minutes of the previous one were removed from the calculations to investigate any changes in what would have been the results if we had used the maximum length (5 minutes) of quiet period possible with the cameras we used.

At each of the three study sites, there were multiple cameras, each with the potential to detect a species moving through the site. We compared the frequency with which a given species event was detected by multiple cameras or not. This may highlight either the limitations of single camera surveys or the redundancy of multiple cameras. If the majority of species events at a study site are picked up by multiple cameras, it would indicate that the amount of extra observations documented by the extra cameras was of potentially limited value. If the majority of species events are only detected by one of many cameras, there may be the suggestion that any single camera will miss a portion of the movement events through the vicinity.

Camera Performance

In many wildlife camera research projects, it is generally assumed that all of the cameras perform to a certain standard, each functioning like the next. We looked at the resulting files from each camera used in our study to investigate if this was the case. We reviewed the photos to evaluate whether any of the cameras used were over- or under-active based on the number of photos taken where no species was detected. We called these "false trigger" events. The rate of false triggers could be impacted by several potential factors. For example, the sensitivity of the camera may be inaccurate, detecting motion when none was present or when there was movement in nearby vegetation. The lack of species detection could also be the result of a fast moving animal which triggers the camera but the camera does not respond quickly enough to document the animal's presence. There may be little that can be done in most studies to accommodate inconsistencies in equipment performance, but reviewing the results can help identify and possibly explain patterns in the observations that are the results of the survey method and not the behavior of the wildlife.

Results

Species Detection Rates

Wildlife Species

During the 12 weeks of surveying in San Pasqual Valley, we documented 1,209 wildlife events across the 12 sample stations. At Lake Hodges we recorded 816 events, at San Pasqual Creek there were 202 unique species observations and 191 at Santa Ysabel Creek (table 4). There were 10,492 raw photos of wildlife species during the 12 data collection weeks of surveys: 8,205 from Lake Hodges, 811 from San Pasqual Creek and 1,476 from Santa Ysabel Creek (table 5). Results are summarized for each sample period in appendix 1.

At least thirteen wildlife species were detected, including bobcats, California quail (*Callipepla californica*), coyote, mule deer, opossum (*Didelphis marsupialis*), grey fox (*Urocyon cinereoargenteus*), greater roadrunner (*Geococcyx californianus*), striped skunk (*Mephitis mephitis*), owls (Order: Strigiformes), raccoon, California ground squirrel, black-tailed jackrabbit (*Lepus californicus*), and rabbits (*Sylvilagus* spp.; figs. 5-16). Based on unique events (table 4), the mule deer was the most commonly detected species at Lake Hodges (n=459) and across all camera stations (n=459), the coyote was the most commonly detected species at San Pasqual Creek (n=155), and rabbits were the most common at Santa Ysabel (n=99). The least frequently documented species was the black-tailed jackrabbit which was only detected once, in two photos at Station 12, and the grey fox which was only detected once by two cameras in 21 combined photos. For the grey fox, the same event was recorded at two stations at San Pasqual Creek. Only two events were detected for the California quail, but these were separate events, occurring on different days. Based on the number of raw photos (table 5), the most frequently detected species remained the same: mule deer (n=5,850) at Lake Hodges and across all camera stations (n=5,850), coyote at San Pasqual (n=544), and rabbits at Santa Ysabel Creek (n=1,147). The black-tailed jackrabbit at Santa Ysabel Creek was the least photographed species, only two photos. The owls at Lake Hodges were the second least photographed animal across the whole study (n=15), followed by California quail (n=18) and the grey fox (n=21).

The distribution of each species varied within each site and across sites. Across all camera stations, the coyote, greater roadrunner, and raccoon were the most wide-spread species, each occurring at 10 out of 12 stations (table 4). The owls and the black-tailed jackrabbit had the narrowest distribution and were only detected at one camera station each, the owls at Station 06 and the black-tailed jackrabbit at Station 12. Within the six stations at Lake Hodges, the greater roadrunner and raccoon were documented at all camera stations. At San Pasqual Creek, only the striped skunk and raccoon were recorded at all three camera stations. At Santa Ysabel Creek, coyote, greater roadrunner, and rabbits were found at all three stations.

The number of species detected at any single camera station ranged between two and nine. At the site level, the number of species detected ranged between 7 and 10 (tables 4 and 5). Station 12 detected nine species. Stations 05 and 06 had the second highest number detected with eight species each. Station 09 was the lowest with only two species detected, striped skunks and raccoons. The greatest number of species (10) was detected at Lake Hodges; however, no single station detected all 10 species at this site. The second highest number of species (9) was found at Santa Ysabel Creek and all were detected by Station 12. San Pasqual Creek had the lowest number of species detected (7) and all were detected by Station 07.

The Shannon Diversity Index was calculated for the wildlife species at each of the 12 cameras stations and each of the three sites. Based on the number of species events, the site level species diversity was similar across two of the sites and lower at the third (table 4). Station 02 along the pedestrian path at Lake Hodges had the highest wildlife species diversity, H'=1.695. We detected the lowest wildlife species diversity at Station 04, in the lakebed under I-15 at Lake Hodges, H'=0.5821. At the site level, Lake Hodges (H'=1.448) and Santa Ysabel Creek (H'=1.446) had similar diversity indices and were higher than that measured at San Pasqual Creek (H'=0.872). Although Lake Hodges and Santa Ysabel had similar diversity measures, this was not reflective of the differences between the communities at the two sites. The observations at Lake Hodges were dominated by mule deer, raccoon, coyote, California ground squirrel, and bobcat, in that order. The community at Santa Ysabel Creek was largely comprised of rabbits, coyote, opossum, and striped skunk. Although the Shannon Diversity Index was also calculated based on the number of raw photo of each species (table 5), we considered the diversity index based on the number of species events to more accurately reflect the wildlife communities at each camera station. The photo based diversity index has been included for the purposes of comparison (tables 4 and 5).

Human Related Categories

During the 12 weeks of surveying in San Pasqual Valley, we documented 6,949 human related events across the 12 sample stations. At Lake Hodges we recorded 6,721 events, at San Pasqual Creek there were 5 unique human observations and 223 at Santa Ysabel Creek (table 6). There were 41,965 raw photos of human related categories during the 12 data collection weeks of surveys: 39,213 from Lake Hodges, 70 from San Pasqual Creek, and 2,682 from Santa Ysabel Creek (table 7). Results are summarized for each sample period in appendix 1.

We grouped the human related species into eight categories. The human related categories included humans, humans on bicycles, domestic dogs, humans on horseback, domestic cats, humans on OHV, humans with dogs, and humans in automobiles (figs. 17-24). Based on unique events (table 6), human was the most commonly detected category at all three study sites and over the entire study: Lake

Hodges (n=4,074), San Pasqual Creek (n=5), Santa Ysabel Creek (n=100) and across all camera stations (n=4,179). The least frequently documented category was the domestic cat: it was only detected 16 times. Based on the number of raw photos (table 7), the most frequently detected category remained the same: humans (n=27,422). The domestic cats at Santa Ysabel Creek were the least photographed species within the human related categories (n=89).

The human related categories were not equally represented at all sites or camera stations. Across all camera stations, "humans" were the most wide-spread species, occurring at 12 out of 12 stations. "Humans on bikes" was the narrowest category and was only detected at two camera stations, Stations 01 and 02 at Lake Hodges (tables 6 and 7). Within the six stations at Lake Hodges, the "humans" category was the only one documented at all camera stations. At San Pasqual Creek, "humans" was the only human related category and it was recorded at all three camera stations. At Santa Ysabel Creek, all three stations detected some level of human related activity.

The number of human related categories detected at any single camera station ranged between one and seven. At the site level, the number of categories detected also ranged between one and seven. No single camera station detected all eight human related categories. Stations 01, 02, and 11 each documented seven human categories. Stations 03, 04, 07, 08, and 09 only detected one category, "humans". Based on the number of unique events, 96.0% of all human related activities were detected at Stations 01 and 02 at Lake Hodges. Based on the number of raw photos, 92.1% of all human activities across the study were at Stations 01 and 02.

Species Accumulation

Across the entire study, we documented 13 wildlife species but no single camera station detected all species. Not all species were detected as quickly as others within a camera station, across a study site, or across the study as a whole. Within each species there was variability across camera stations as to how long before the species was first detected at that station.

The minimum number of sample days for each camera station to detect all of the species observed at the station ranged between 14 and 75 days (table 8). Station 09 documented its last new species only 14 days into the study. After that, Station 09 only detected more occurrences of the same two species, striped skunks and raccoons. Station 10 also plateaued relatively early in the study, it reached its maximum number of species detected after 18 days. Stations 05 and 06 required the longest time to detect the last species at each station. On sample day 75, the same group of mule deer moved past these two stations. Averaged across all of the camera stations, it took 53 sample days to detect 100% of the species at that station. At the site level, Lake Hodges reached its maximum number of species after 19 sample days when an owl was recorded at Station 06. Seven out of the ten species at Lake Hodges were detected within the first week of sampling, one new species in week two, and the last two species were first observed in week three. At San Pasqual Creek all species would have been detected within the first three weeks except for the last species, the grey fox, that showed up for the first and only time on day 57 of sampling, in the 8th week of data collection. Santa Ysabel Creek would also have peaked in number of species detected after three weeks except for the one and only observation of a raccoon at this bridge on day 47 (7th week of sampling).

The minimum number of sample days before each species was detected by a given camera station ranged between 1 and 75 days (table 8). The California ground squirrel was the quickest to be detected at an average of three days until the first detection at a camera station (range=2 to 5 days, n=3).

Coyotes were the second most quickly detected species, at an average of 12 days until first observation (range=1 to 48 days, n=10). The species that took the longest to detect was the grey fox, it was recorded on day 57. For species that were detected at more than one camera station at a site, mule deer had the greatest window between first detections and the California ground squirrel had the shortest window between first detections. At Lake Hodges, mule deer were first recorded on the first sample day at Station 04, but were not observed until day 75 at both Stations 05 and 06. Also at Lake Hodges, California ground squirrels were first observed on the second sample day at Station 05 and on the third sample day at Station 02.

Across Camera Detections

As animals moved through each of the study sites there was the potential that the same animal would be detected by more than one motion sensor camera. Based on the 5-minute floating window standard, seven different species were observed to travel between one or more cameras within the same study site (table 9). There was only one instance where a species appears to have traveled between three camera stations. On September 28, 2014, one coyote was detected at Station 02 at 5:57 AM, then at Station 01 at 5:58 AM (102 meters away from the first camera), and lastly at Station 06 at 6:03 AM (254 meters away from the second camera). Of the 1,182 observations of wildlife species, 30 were documented by two cameras (2.5%), and only one was across three cameras (<1%).

Movement between camera stations was not the same across wildlife species or study sites. Coyote was the species most frequently observed to move between cameras, accounting for 12 of 31 detected movements. Of the species that were detected moving from one camera to another, the grey fox was the least frequently detected, one movement was detected between Station 07 and 08.

Multiple Camera Installation

Multiple cameras were installed at each of the three study sites to document wildlife movement through the area, but there was some variability in the number of observations, the number of species detected, and indices of relative abundance measured within a species across each site. Some stations produced the highest number of species observations within a site but also detected the fewest number of species of any of the cameras at the given site.

At Lake Hodges where there were six cameras, the percent of the total species events recorded at the site observed by any single camera ranged between 2.3% and 62.5% (table 10). Station 04 was the highest, recording 62.5% of the total species events at Lake Hodges and Station 01 with the lowest percentage of detections, only recorded 2.3% (table 10). While Station 04 documented nearly 3 out of every 5 species events, it failed to detect five of the 10 species known to be at the site based on the results of all six cameras. Stations 05 and 06 detected the most species with eight each. No station at Lake Hodges detected all 10 species from the site. Station 04 produced most of the results for mule deer, coyote, and bobcat, but infrequently detected the other seven species which were picked up by the remaining five cameras.

At San Pasqual Creek where we had installed three wildlife motion detection cameras, one camera dominated the species detections and documented all of the seven species known from the site (table 10). Station 07 produced 87.6% of all of the observed species events at San Pasqual Creek, followed by Station 08 (7.4%) and Station 09 (5.0%). Station 08 failed to detect greater roadrunners and Station 09 only detected two out of the seven species observed at the site. Of the three stations at San Pasqual

Creek, Station 09 had the highest detection rate for raccoon and the second highest rate for striped skunk.

As with San Pasqual Creek, one camera station dominated the detections at Santa Ysabel Creek: Station 12 (table 10). Two-thirds of the species events at Santa Ysabel were documented by cameras at Station 12 which also included all 9 species reported from the site. Station 12 also had the highest detection frequency for each species, with the exception of California quail and striped skunk, for which it tied with Station 10.

The indices of relative abundance for each species varied from station to station within each site. The overall indices of relative abundance at the three study sites were never mirrored by any single station within the study site (table 11). Using the greater roadrunner as an example, we see how the differences between stations may be presented. At the level of the three study sites, Lake Hodges had the highest index for greater roadrunners, 0.046, followed by Santa Ysabel at 0.044, and then San Pasqual Creek with 0.008. Although Lake Hodges as a whole had the highest average index, many of the individual stations had indexes lower than those measured at the individual stations at Santa Ysabel Creek.

Species Event Duration

Because the cameras were set to continually take pictures whenever motion was detected and there is a time stamp on each photo, we were able to calculate the length of time that each species was present in front of the camera station and the number of pictures taken of the event. Of the 13 wildlife species detected during the study, the black-tailed jackrabbit event was the shortest; the one and only event lasted two seconds and two photos (table 12). Owls spent the second least amount of time in front of the camera. An owl event only lasted for 2 seconds on average, during which three photos were taken. Bobcats spent the next shortest amount of time with an average of 5 seconds per occurrence at a camera station and 5.75 photos per event. Rabbits spent the longest time in front of the cameras. On average rabbit events lasted 1 minute and 2 seconds with 10.8 photos per event. For most species, the shortest length of an event was just one photo; the animal was photographed once and then was gone. The longest events for any species were for mule deer, based both on duration and the number of photos. On August 16, 2014, mule deer were detected in front of Station 04 from 8:16:38 PM until 8:25:33 PM; 8 minutes and 56 seconds during which 39 photos were taken (9 consecutive motion trigger events). On August 11, 2014, mule deer were detected in front of Station 04 for 85 images, between 10:17:21 AM and 10:22:32 AM (17 consecutive motion trigger events).

For the human related categories, the event durations were calculated using the same parameters, but produced very different results, especially at the upper range. Of the eight human related categories detected during the study, domestic cats spent the least amount of time in front of the camera, 4 seconds and 5.6 photos per event (table 13). Domestic dogs spent the second shortest amount of time with an average of 8 seconds and 3.0 photos. On average, “humans” spent the longest time in front of the camera, averaging 1 minute and 58 seconds with 6.6 photos per event. “Human” and “Human on Bicycle” produced the longest events. On October 11, 2014, there were bicyclists in front of Station 02 from 9:30:39 AM until 10:36:34 AM (1 hour 5 minutes), producing 285 photos.

Protocol optimization

Length of Photo Series

Based on the 107,044 photos captured during these field efforts, we calculated the results of the sequence number of photos taken during each motion trigger event. The Reconyx HC500 and PC800 cameras used can be programmed to take 1, 2, 3, 5, or 10 photos each time the motion sensor is activated. We used the 5 photo setting. For the wildlife species, 99.84% of the species were identified within the first three photographs out of the series of five photos that were taken (table 14). Only 0.16% of species were first identified in either photo four or five in the series. For the human related observations, 99.71% of species determinations were made within the first three photos of a five photo sequence (table 15). Only 0.29% of human related observations were first reported in either photo four or five in the series. No species were reported in 55.27% of the photos in the "4 of 5" position and 61.45% in the "5 of 5". No species were reported 20.81% of the time for the first photo in the motion trigger event (fig. 25).

If the results of our study were limited to the first three photos in each series, there would have been minimal differences in the number of events detected for each species. Four coyote events out of 293 would have gone undetected, two at Station 07 and two at Station 12. One mule deer event out of 429 at Station 04 would have been missed. At Station 12, one out of 66 rabbit events would have gone undocumented.

Quiet Period

The Reconyx HC500 and PC800 cameras used can be programmed to pause in between motion trigger events, called the "Quiet Period". During the "Quiet Period", no additional photos will be taken even if the motion sensor is triggered. The Reconyx cameras have the following options for the duration of the "Quiet Period": no, 15 seconds, 30 seconds, 1 minute, 3 minutes, or 5 minutes. We used the "no" option, setting the camera to take pictures every time the motion sensor was triggered, regardless of the length of time since the last motion triggered event.

An artificial 5 minute quiet period was overlaid upon the data to assess what the impact would be on the observation results. For the wildlife species, a 5 minute quiet period would have reduced the number of photos from 10,492 down to 4,838 (table 16), reducing the number of photos taken to 46% of that recorded without the quite period. The impact to the number of wildlife events would have been minimal. Only 34 wildlife events would have been missed based on the artificial 5-minute quiet period (table 16). Across all 13 wildlife species, 97% of the events still would have been documented. For the 20 coyote events that would have been missed if we had used a quiet period, 18 were likely the result of the coyote triggering the motion sensor while outside of the range of the image. In each of these cases, there was a series of empty photos immediately prior to the photos of the coyote. The other two coyote events that would have been missed were likely predator-prey events where a rabbit (August 17, 2014 at Station 12) and a mule deer (August 18, 2014 at Station 04) immediately precede the photo of the coyote. For coyotes, the quiet period would have changed the number of days per camera station during which coyotes were detected. For coyote, a quiet period would have omitted one day out of eight at Station 02, two days out of 33 at Station 04, two days out of 71 at Station 07, and three days out of 22 at Station 12. The other coyote detections that would have been omitted by the quiet period occurred on dates when there were multiple detections of the species at the given camera station. For the six mule deer events that would have been missed if we had used a quiet period, five were likely the result of the mule deer triggering the motion sensor while outside of the range of the image. On August 12, 2014, the mule deer that passed in front of the camera at Station 04 within 5 minutes of us checking the camera would have been missed. For mule deer, the quiet period would not have changed the number of days per camera station during which mule deer were detected. The two greater roadrunner events that a quiet period would have missed would have changed the number of detection days for this species. The greater roadrunner detection on October 3, 2014 was the only detection of this species at Station 01 on that date and the detection on October 10, 2014 at Station 02 was the only detection on that date. A quiet period would have missed these observations of the greater roadrunner due to the previous detection of human activity at each camera station within 5 minutes prior to the greater roadrunner's activity. Five of the six rabbit events that would have been omitted by a quiet period were likely the result of the rabbits' activity outside of the field of view; the last would have been omitted due to human activity just prior to the rabbit. One day out of seven would have been omitted by a quiet period at Station 11 for rabbits.

For the human related categories, it is more complicated to estimate what the impacts of a quiet period would have been. The change in the number of photos was straight forward. Without the quiet period, there were 41,965 photos, with a 5-minute quiet period there would have only been 17,542 photos (43% of total: table 17). Where this translates into the number of events is the complicated part. Under the current set up, photos separated by less than the 5-minute floating window are counted as a single event. With the theoretical 5-minute quiet period, the single bicyclist event that lasted 1 hour and 5 minutes (see above) would have been divided into seven events. Where some events may have been missed during a quiet period, events longer than 5-minutes would be divided into multiple events, confounding any change in the overall number. This complication seems less likely to impact the results from the wildlife species, few wildlife events lasted 5-minutes or more.

Camera Performance

Of the 12 Reconyx cameras used as part of this study, we detected inconsistencies in the performance of at least two individual cameras that could have potential impacts in the interpretation of camera study results. Cameras 05 and 10 appear to have functioned slightly differently than the other 10 cameras used during the study. Each of these cameras presented a different anomaly.

Camera 10

Although all of the cameras were programmed to only take pictures during motion triggered events, Camera 10 would also record a photo series at timed intervals. During samples 001, 002, 003, 005, 006, and 010, Camera 10 took five pictures at half hour intervals; most of these photo series detected no animals within the field of view. Within the week long sample periods, with no modifications to the settings of the camera, this process would start and stop several times. The fact that this was happening was not detected until the time stamps on the pictures were reviewed during sample 007, five weeks into the data collection phase of the project. Reviewing the photos showed that there was a disproportionate number of photos taken at the same two minutes of the hour within each sample period, always separated by half an hour (fig. 26). During these events, the five photos were always taken within the first four seconds of the minute; the photos that were not part of this anomaly were evenly distributed across all seconds within a minute. During sample 003 for example, 38% of the photos from Camera 10 were recorded at 18 minutes after the hour and 32% were at 48 minutes after the hour. The remaining 30% of the photos were evenly distributed across the other 58 minutes of the hours. Even though Camera 10 was taking these photos at timed intervals, each photo was still being tagged by the camera as having been taken during a motion sensor event. The Reconyx cameras do have a setting to take a single picture at a user specified time interval, but this was turned off. When the time series option is active, the camera will capture one photo at the specified time. Camera 10 was taking five photos at the half hour intervals. Since the Reconyx cameras that we used for this study have no setting to account for this pattern of photos, we could not deactivate this feature. We continued to use this camera for the duration of the study and continued moving Camera 10 through the rotation from one camera station to the next.

Camera 05

During the photo review process for Sample 011, it appeared that Camera 05 may be faster than the other cameras even though all of the cameras were using the same settings. Camera 05 was at Station 01 during Sample 011. The apparent quickness of Camera 05 was noticed based on the increased frequency with which bicycles were detected. Typically at Station 01 there are many motion trigger events where nothing appears in any of the five photos. During Sample 011, Camera 05 frequently showed just the back tire of a bicycle leaving the field of view (fig. 27). During Sample 011, bicycles were detected nearly five times more often when compared to the other 11 samples from this station (mean=115 vs Sample 011=613). When Camera 05 was moved to Station 02 during Sample 012, a similar observation was made (mean=495 vs Sample 012=1,766). Human on bicycle was the only species category where this pattern was observed clearly and bicycles were only observed at Stations 01 and 02. The time in between photos within a series of five was the same as far as the time stamps are able to tell us; what appeared to be quicker with Camera 05 was either a) the sensor detected movement more quickly or b) the time between the motion sensor being triggered and the first photo was shorter. Without any documentation of when the motion sensor was triggered it is impossible to say how much Camera 05 differed from the other cameras. The other samples at Station 02 with high numbers of human on bicycle photos were not attributed to the camera at the station during that sample; there was not the corresponding increase in cyclist detections at Station 01 the preceding sample (fig. 28).

False Triggers

The frequencies of "false triggers" were calculated for each camera, station, and the whole field effort. Across the 12 cameras, Camera 10 had the highest rate of "false triggers" with 1,147 out of 1,939 motion trigger events detecting no species in any of the five photos (59.2%: this includes the anomalous time series photos described above). Camera 09 showed the lowest rate of "false triggers" at 14.7% but also produced the fewest motion trigger events overall (n=886). The remaining 10 cameras ranged between 15 and 27% of motion trigger events being "false triggers" across the entire length of the study. Across the 12 stations, Station 10 had the highest rate of "false triggers" with 470 out of 752 motion trigger events resulting in no species detection (62.5%). The lowest "false trigger" rate was at Station 03, only 8.8%. The other ten stations ranged between 15 and 54% "false trigger" rates. Across the whole field effort, the "false trigger" rate was 22.1%, 4,246 motion sensor events out of 19,222 detected no species in any of the five photos in each series. At five photos per motion sensor event, this translates into 21,230 photos that were collected, processed, and reviewed that produced no species specific data. Of the 4,246 "false trigger" events, 1,800 were at Station 01 and 906 were at Station 02, 42% and 21%, respectively. The other ten camera stations ranged between >1% and 11% of the "false trigger" events.

Discussion

Linkage Evaluation Versus Camera Study Results

One purpose for conducting this work was to do a field level assessment of each of these three bridge structures. All had been identified as potential barriers to wildlife movement between the core conserved lands (Rochester and Fisher, 2013) and had been hypothesized to be functional or non-functional based on the available information. The initial linkage evaluation process was strictly a GIS exercise based on a combination of expert opinion, aerial imagery, and available habitat data layers. Such exercises must be reviewed and compared to empirical data, such as those generated by this camera study.

The I-15 bridge at Lake Hodges had been hypothesized to be non-functional for wildlife movement during high water periods and functional for all focal taxa during low water levels. Our results during this effort concur with the evaluation of Lake Hodges I-15 bridge functionality during low water levels. The only expected focal species that we did not detect was the mountain lion (Rochester and Fisher, 2013). Mule deer, coyote, bobcat, and small terrestrial vertebrates were routinely observed moving past this potential barrier. Even though no mountain lions were observed, we suspect that there is a high likelihood that if one did approach this structure it would be able to successfully cross from one side of this major transportation corridor to the other. Despite the high level of human activity on the north shoulder and the lack of cover, there was wildlife movement along this path suggesting that even during high water wildlife may be willing to travel along this route. Although detection rates for wildlife species were low along the north shoulder compared to those measured in the lakebed, this indicates that some wildlife may be able to move past the I-15 bridge at Lake Hodges regardless of water level. All of the wildlife species detected at Lake Hodges were also documented using the south shoulder. The south shoulder was designed to provide movement options for wildlife but there are concerns regarding the total length of this path between habitat patches during high water. Mule deer used the south shoulder but were only detected after 75 sample days, suggesting that the species is willing to use it but that it is not the preferred option given the dry streambed that is available during low water levels. According to the City of San Diego Public Utilities Watershed and Resource Protection Department (N. McGinnis, pers. comm.), the reservoir levels present during our study are the new target and will only increase based on naturally occurring water flow. As long as this is the case, we expect that the I-15 bridge at Lake Hodges will continue to provide connectivity between Core Area 11 to the west and Core Area 12 and beyond to the east. Should there be a change in policy and the level of the reservoir is increased, flooding the lakebed between the north and south shoulders under the bridge, additional research would be needed to determine the impacts to wildlife with the much reduced pathways under the bridge.

The SR-78 bridge at San Pasqual Creek was hypothesized to be functional for all of the focal taxa evaluated (Rochester and Fisher, 2013). Based on the findings of our field efforts, it appears this bridge may act as a barrier to mule deer or mountain lion attempting to move past this point; any movement by these two species may be at-grade rather than through the underpass. Coyote, bobcat, and small terrestrial vertebrates did move through the area on a regular basis. Mule deer activity at this site may have been limited by the interior height under the bridge even though there was suitable vegetative cover on both sides with ample visibility. Although previous measurements of this structure reported the height as 3 meters, it was less than 2 meters in most places. The lack of any mule deer or mountain lion detections at this site may be reflective of the surrounding landscape and the absence of any roadside barriers preventing animals from attempting to cross at-grade. The slopes and soil contours on both sides of the bridge allow wildlife to approach and enter the roadway as easily as they might pass under the bridge. The high level of coyote activity at the site may also deter mule deer movement.

With no wildlife cameras outside of the structure monitoring the surrounding habitat, we are unable to determine if mule deer and mountain lion were present during the study in the surrounding area and avoided the structure or were absent from the entire area.

Based on the GIS review of the SR-78 bridge at Santa Ysabel Creek, it was hypothesized to be functional for all of the focal taxa. The results of the current study have shown that this area does support coyote, bobcat, and small terrestrial vertebrate movement, but did not detect any mule deer or mountain lion activity. Mule deer habitat may have been a limiting factor. Much of the area under and adjacent to the bridge is a sandy stream channel with sparse vegetation that may not be suitable to mule deer activity. Additionally, human activity at the site may be deterring mule deer and mountain lion movement. Agricultural equipment, OHV activity, and street legal vehicles were frequently documented passing under the bridge. On one occasion, the center span was used as a soccer field by a large group of people and another time it was used for a horse training session. Additionally, there is little preventing any animal from entering the roadway and attempting to cross at-grade.

Wildlife Species

The list of wildlife species detected at each of the three study sites was in-line with what was expected, with just a few exceptions. Based on the GIS analysis and general familiarity with the sites and species behaviors, we had expected to see mule deer at San Pasqual Creek and Santa Ysabel Creek, but none were detected. In addition, mountain lion was not detected at any of the three study sites. The three month sample period may have been too short to expect a wide ranging carnivore like a mountain lion to be detected. But based on the results from Lake Hodges, mule deer are readily detected by our survey method and were definitely active at the time of our survey. The lack of mule deer at San Pasqual Creek and Santa Ysabel Creek would seem to indicate that the species is not passing through these structures, is at a very low detection rate at these sites compared to Lake Hodges, or that they are passing these points at-grade rather than under the bridges. The lack of mountain lion detections may be more a reflection of the protocol and timing than on the suitability of these structures to provide connectivity for the species. Based on the amount of mule deer movement under the I-15 bridge at Lake Hodges, it seems likely that a mountain lion would be able to pass through the area also. There is at least one known mountain lion that has traversed the San Pasqual Valley area within the year prior to our study (W. Vickers, pers. comm.). Since no mountain lion or mule deer were detected at the two eastern points of this survey, it may be necessary to conduct additional surveys to identify where and if these two species are able to safely move into and out of San Pasqual Valley. Two possible routes are along Bandy Canyon Road or somewhere along SR-78. There are few restrictions along either of these two roadways to deter wildlife from attempting to cross either road at-grade.

There were several other species that were not detected or were detected very rarely. Grey fox was detected one time at San Pasqual Creek, which may be the only one of the three sites with suitable habitat for the grey fox. Both Lake Hodges and Santa Ysabel Creek are more riparian in nature with little upland habitat in the immediate vicinity. Although San Pasqual Creek does have a strong riparian component, there are coastal sage scrub hillsides with rocky outcrops just to the north of the site that may support grey fox. Previous observations of grey fox in San Diego County (Tracey et al., 2014) suggested that when a structure is part of the home range of a grey fox, the grey fox will move through the structure on a regular basis, passing through in one direction, later returning in the opposite direction. The grey fox detections at San Pasqual did not indicate this pattern of activity, suggesting that the one individual observed at this location did not routinely use this structure to move from one part of its range to another. This one event could represent a long range movement, indicating that the San

Pasqual Creek bridge may provide for at least some level of connectivity for grey fox. Or it may have been a single venture by a neighboring animal to the edge of its territory.

Similar to the grey fox, the black-tailed jackrabbit was detected rarely during our study along San Pasqual Valley. The riparian habitats that dominated much of the landscape around our camera sites may have limited use by black-tailed jackrabbits. With few barriers along the roadways in the area, especially near San Pasqual Creek and Santa Ysabel Creek, both of these species may be crossing the roads at-grade instead of using the areas under the bridges. Road-kill surveys would be needed to determine if this is happening unsuccessfully and identify potential management actions to improve connectivity.

There were several target species for which there were low expectations of detecting or for which the protocol may not have been suitable. Recent surveys for American badgers (*Taxidea taxus*) in the Ramona Grassland confirmed that the species does occasionally visit the area. As a broad ranging species, there was a very slight possibility that an American badger might have moved from the Ramona area past one of these three points, however no American badgers were detected. Spotted skunks (*Spilogale putorius*) and long-tailed weasels (*Mustela frenata*) were also not detected, but the placement of our cameras may have been incompatible with these smaller species.

The Shannon Diversity Index at the cameras showed some unexpected patterns at the level of the individual camera stations. Looking at the diversity index, the results from the lowest and highest camera stations were the opposite of what was expected. Based on the visual inspection when setting up each camera station, Station 02 was considered to be poor wildlife habitat with high human activity and thus likely to support little diversity and Station 04 was considered higher quality habitat with little human activity, native but sparse vegetation, and few obstructions. But more species were detected at Station 02 (n=7) than at Station 04 (n=5). The species at Station 02 were also more evenly represented in the total observations. At Station 04, mule deer dominated the detections, accounting for 84% of the species events observed. Since the Shannon Diversity Index accounts for the number of species and the evenness within those species, it is reasonable that Station 02 scored higher than Station 04.

Protocol Recommendations

Pictures per Trigger

Based on the results of this study, there are several refinements that we recommend for future studies. When monitoring medium to large terrestrial vertebrates is the main objective of a study, it should be sufficient to program the wildlife cameras to take three photos per motion trigger event. In our study, the fourth and fifth photos seldom produced any additional species detections different than those identified in the first three photos. Eliminating the fourth and fifth pictures would reduce the number of photos generated by 40%, which, in the case of our study, would have resulted in the loss of as little as 1% of the species observations. For studies attempting to document smaller wildlife species or human activities at a site, the five photo series per motion sensor trigger event may still be warranted. From our observations, humans moved through these areas differently than the wildlife species. The bicycle riders at our study sites typically moved very quickly past a camera and what may have been most frequently detected was a second rider in the group and not the bicycle that initially triggered the camera. It is possible that the number of bicycle riders have been under-documented. If, in addition to documenting wildlife use of an area, documenting human activity and its potential impacts on wildlife is a goal, the extra images captured during the fourth and fifth photos may be necessary to determine what triggered the camera.

Quiet Period

Wildlife typically moved past our cameras and kept going with other members of the species as a group or with nobody else following closely behind. The individual or group was photographed followed by a long period before the next time the camera detected any motion. If the motion sensor was triggered multiple times, most often it simply resulted in more photos of the same species event or just background vegetation. From this we recommend, for medium to large vertebrate studies, to use a 5-minute quiet period between photos. Using our data as an example, the quiet period would have reduced the number of photos generated by almost 50% with the loss of only 3% of the observations. With the artificial quiet period applied to the results of our survey, there would have been no change in the species list detected by each camera station. There may have been fewer observations of certain species, but all species observed at each camera station would have remained the same. All of the rare species events, like the grey fox and black-tailed jackrabbit, would have been documented. If the objective of the study is to look at human activity at the site, the quiet period may not be advised. The level of omission increased with the artificial quiet period that we tested when looking at human activities. While the number of photos that would have been taken with a quiet period would have dropped to 43% of that produced without a quiet period, the number of detections dropped to 80%, a potentially unacceptable trade off.

Camera Rotation

Our review of camera performance indicated that not all of our cameras functioned in a consistent manner, either within its own deployment or when compared to the other cameras used during the study. The problem with Camera 10 generated many images of nothing and this may not be a problem other than needing to store and review all of these files. However, this would impact an analysis comparing the number of photos of a species to the total number of images or if some percentage of these blank photos is interpreted as a species event. We found these photos from Camera 10 resulted from a glitch in the electronics, not from the camera being triggered, but too slow to capture an image of the stimulus, as may have been the case with the cyclists and Station 01 and 02.

The idiosyncrasies of Camera 05 had the potential to drastically alter the data. If Camera 05 had been at Stations 01 or 02 for the entire length of the survey, the number of cyclist events detected may have been very different from our current results. If Camera 05 operates with less lag time between the trigger and a photo being taken, detecting quick moving targets better than the other 11 cameras, the results of Camera 05 remaining at a single station during the whole survey would have been incomparable to any other results that might involve bicycle activity. The results of Camera 05 staying at Stations 01 or 02 may have given a more realistic estimate of bike activity at either of these locations, but we would not be able to say with any confidence that the difference was real or simply a result of the observer/camera at that site.

By rotating our cameras every week, we minimized the potential that any unique features of a particular camera would accumulate in the results of a single monitoring station. For future studies, a camera rotation policy may be warranted if no other efforts are going to be made to calibrate the equipment. In many scientific studies the equipment used to measure and document the phenomena of interest are calibrated and adjusted before, during, and after to ensure a consistent, reliable performance. We recommend these same steps when using cameras for wildlife monitoring.

Interpreting and reducing the frequency of "false trigger" events may be complicated. Adjusting the sensitivity of the motion sensor on the camera may be one way to reduce the frequency of "false trigger" but may also translate into a higher omission rate, not detecting a species when there really was something present. We didn't test any combinations of this camera feature that would allow us to estimate the impacts of a lower sensitivity setting on our results. All of the cameras used during our study were set to the highest sensitivity. Based on the distribution of the "false trigger" events, the majority are probably not really false triggers, but cases where the stimuli moved past the camera before it could capture an image. There may be no way to reduce the number of "false triggers" without compromising the results and may be an unavoidable element of camera studies.

Across Camera Detection

There were very few instances where we could say with confidence that a wildlife species moved past one camera station and then another. One interpretation of this is that there were many potential routes through each of the study sites that were not covered by any camera, where animals would go undetected. All three study sites were large enough that the combined area within the range of the motion sensors was only a small fraction of the whole site. The results from camera surveys in areas that are only partially confined likely under sample the wildlife activity in the area. At locations where animals have fewer options, motion cameras should have a higher likelihood of detecting more of the activity and provide more evidence that target species move back and forth between areas. Although we were able to document the movement of a few animals from one camera station to another, these results only provide a very small window into the larger home-range sizes and movement patterns of these species. If home-range size and movement patterns are a goal of a study, techniques more suited to those data, like radio or GPS telemetry, should be applied.

Multiple Camera Installation

Our results provide further support that multiple cameras should be installed when sampling large areas like the bridges studied here. Most of the wildlife events at each of the bridges were only detected by one of the multiple cameras present, especially at Lake Hodges. At San Pasqual Creek and Santa Ysabel Creek, one camera dominated the wildlife detections, but this could only be identified after collecting data. Station 07 at San Pasqual Creek detected 88% of the wildlife events at this bridge and Station 12 produced 62% of Santa Ysabel Creek's results. If only one camera had been installed at each bridge, there is a chance that it would have been one of the lower producing sites. Expertise and careful observations of wildlife signs (e.g., tracks or scat) in the area may increase the likelihood of picking the best location within a site to install a camera, but the features within a site that made for a good movement route in the past may shift over time, changing animal's movement patterns. The best observation point to place cameras may not be static over long periods of time. Multiple cameras increases the actual area being sampled but also must be balanced against the extra work required to process and manage the additional image files.

Species Accumulation

From the wildlife species observations documented during this project, there are several possible protocol recommendations that can be made based on the rate of species accumulation during the study. At the level of the individual camera station, it took from 14 to 75 days to detect all of the species documented per camera. If sampling had stopped after 10 weeks, the number of species detected at 10 out of 12 stations would have been the same as measured over the full 12 weeks. Only the mule deer moving past Stations 05 and 06 would have been missed. Averaged across all 12 stations, 97.9% of all species known to occur at the station would have been detected with only 83.3% of the effort required for the full study. At the site level, across the multiple cameras at each site, it took from 19 to 57 days to detect all of the species at the site. If sampling had stopped after 8 weeks, the number of species detected at two out of the three sites would have been the same as measured over the full 12 weeks. Only the grey fox at San Pasqual Creek would have been missed. Averaged across the three study sites, 95.2% of all species known to occur at each site would have been detected with only 66.6% of the effort required for the full study.

Conclusion

Wildlife motion camera surveys at the bridges at Lake Hodges, San Pasqual Creek, and Santa Ysabel Creek confirmed the presence of 13 wildlife species moving in the vicinities of these potential barriers. This study confirmed that the I-15 bridge at Lake Hodges supports the movement and connectivity of the focal species as predicted by Rochester and Fisher (2013 and 2014). All but mountain lions were documented in areas adjacent to the bridge. We suspect that the I-15 bridge would also be suitable for mountain lions to move past the highway if any were present in the surrounding landscapes. The SR-78 bridges at San Pasqual Creek and Santa Ysabel Creek provided connectivity for coyote, bobcats, and small terrestrial vertebrates but may be a barrier to mule deer. No mule deer were detected at either site during the 12 week study during which time mule deer were abundant at the I-15 bridge. Two potentially limiting factors at San Pasqual Creek may be the height of the bridge, less than 2-meters high, and the high levels of coyote activity at the site. The SR-78 Bridge at Santa Ysabel Creek may have too much disturbance to be suitable for mule deer. Off-road activity, agricultural activity, and general human use of the area may deter mule deer movement, as well as sparse cover along the riparian corridor. Rochester and Fisher (2013) hypothesized that the bridges at San Pasqual Creek and Santa Ysabel Creek could provide connectivity for mule deer and mountain lions, but this study did not confirm that. Although no mule deer or mountain lions were detected using the areas under these bridges, there may be movement by both species using at-grade crossings to connect from San Pasqual Valley into neighboring habitats.

Recommendations for future research include road surveys to try and determine where and if mule deer and mountain lions are successfully moving through San Pasqual Valley. Mule deer movement in the immediate vicinity of the I-15 bridge may only represent limited connectivity if the animals are not moving into the areas further to the east of the bridge. This study also resulted in recommendations for future camera studies targeting wildlife: 1) use a 5-minute quiet period between motion trigger events to reduce redundant and blank photos (though this could limit detections of human activity that could be reducing wildlife use of an area), 2) use a three photo series option when the motion sensor is activated, 3) test cameras in a controlled setting before deployment, 4) cycle the wildlife cameras between stations to distribute any anomalous camera behavior across locations, and 5) use multiple cameras where possible to increase the probability of detection. Where a species list is the main objective of a wildlife study, it may be beneficial to limit the length of the field effort to 10 weeks if the cameras are going to be considered independently or eight weeks if multiple cameras are used at the same site. If detecting extremely rare species and movement events are the goal of the study, longer field surveys and more cameras per site may be required.

The San Pasqual Valley and the I-15 bridge at Lake Hodges are currently the best potential to provide connectivity between the conserved lands east of the highway and those to the west. There are few other options providing wildlife the ability to move east and west past this major transportation corridor. The recent decision by the City of San Diego Public Utilities Watershed and Resource Protection Department to manage Lake Hodges for the low water levels that existed during this study will greatly increase the ability of this area to serve as a functional linkage. The efforts of Caltrans to include a path along the south shoulder under the bridge has also increased the functional connectivity through the landscape and will likely provide the only movement route during any future high water events. There were signs that the linkage through San Pasqual Valley is functional, but there is additional information needed to fully understand and improve the functionality of this linkage and its contribution to the countywide conservation efforts.

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Figure 1. Three sites were selected along San Pasqual Valley to monitor using wildlife motion detection cameras, the I-15 at Lake Hodges, the SR-78 at San Pasqual Creek and the SR-78 at Santa Ysabel Creek.

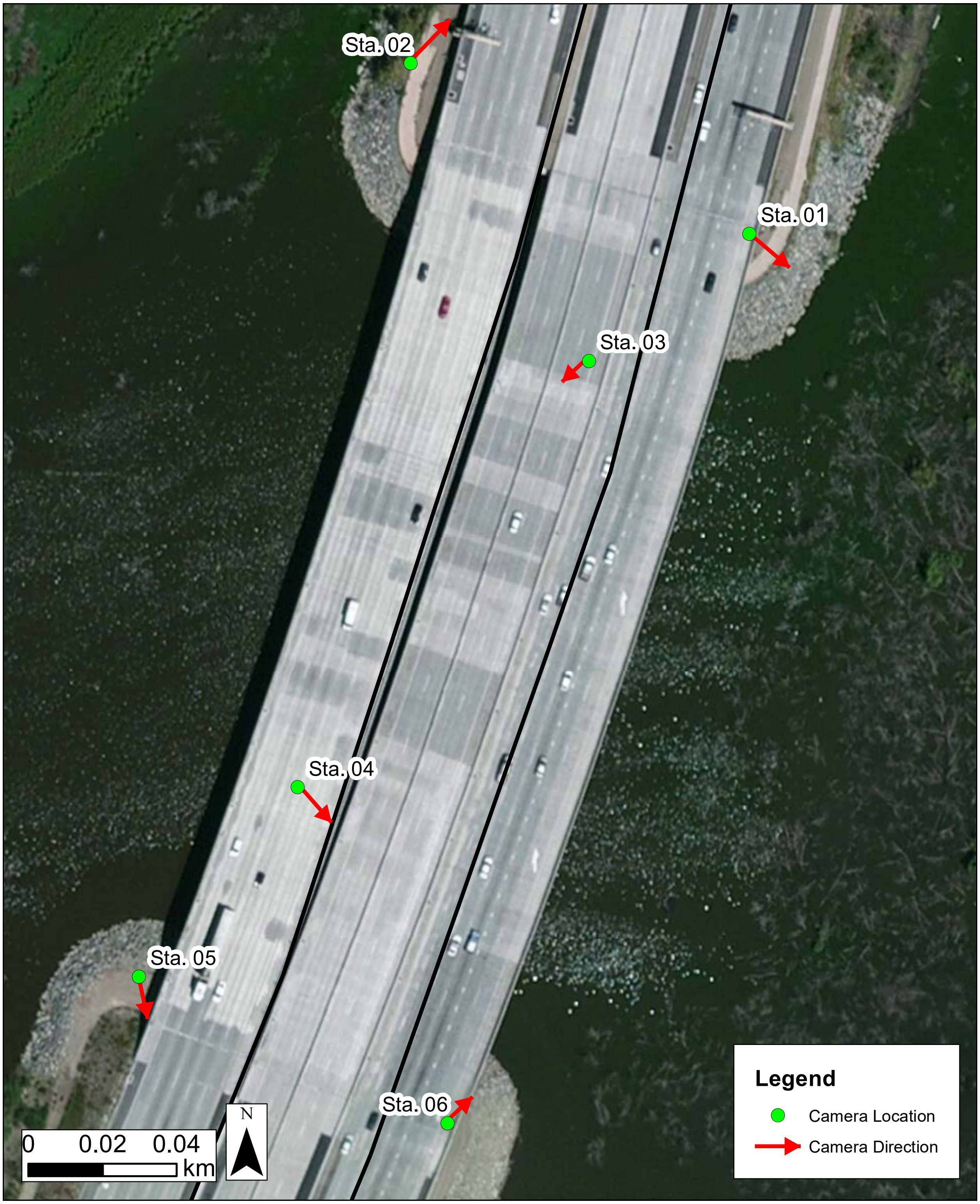

Figure 2. Wildlife motion cameras were installed and monitored at six locations under the I-15 bridge at Lake Hodges. Stations (Sta.) 01 and 02 were on the pedestrian path on the north shoulder, Sta. 03 and 04 were in the lakebed, and Sta. 05 and 06 were on the wildlife path on the south shoulder.

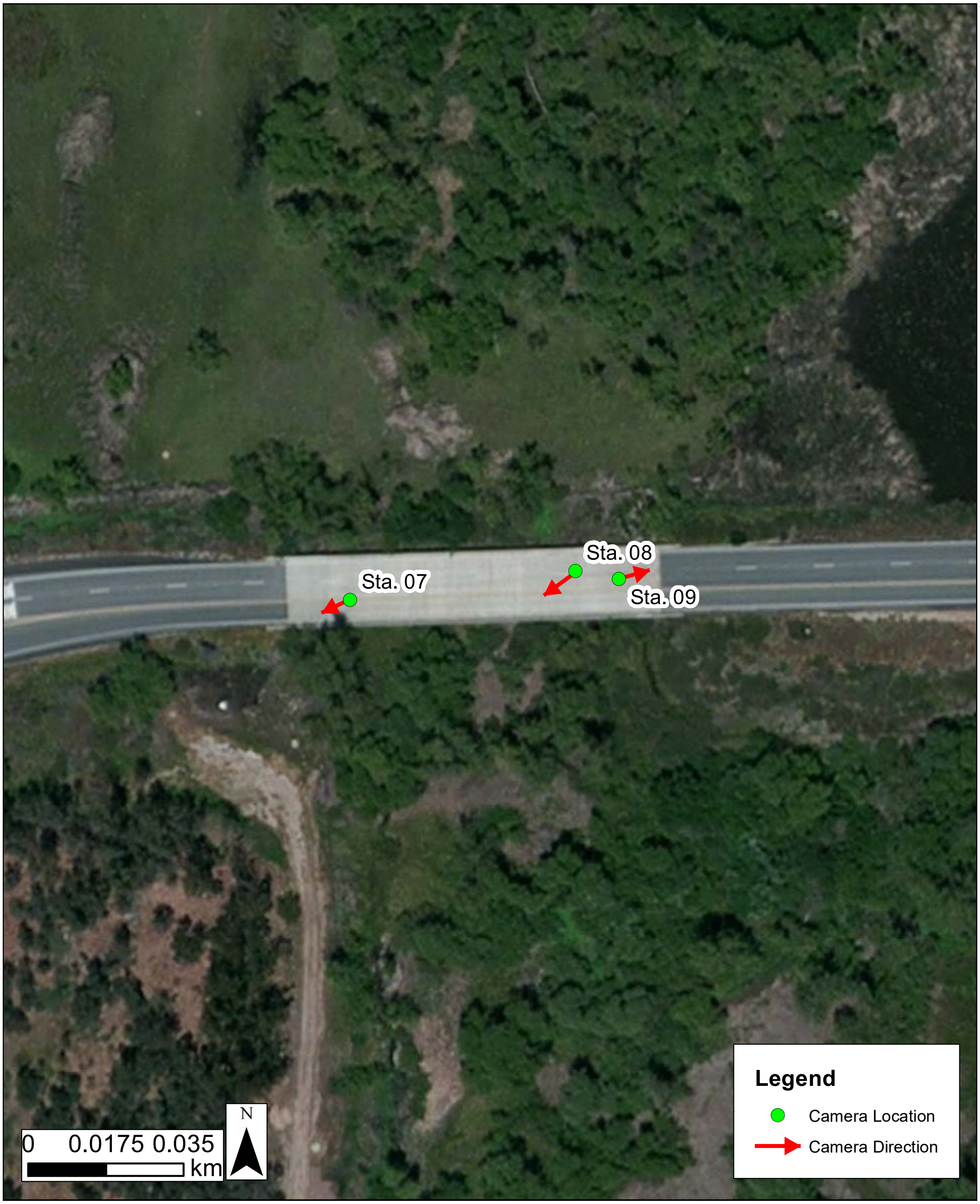

Figure 3. Three cameras were installed and monitored at the SR-78 bridge over San Pasqual Creek. Sta. 07 and 08 were in the streambed and Sta. 09 was aimed at a wildlife latrine at the east end of the bridge.

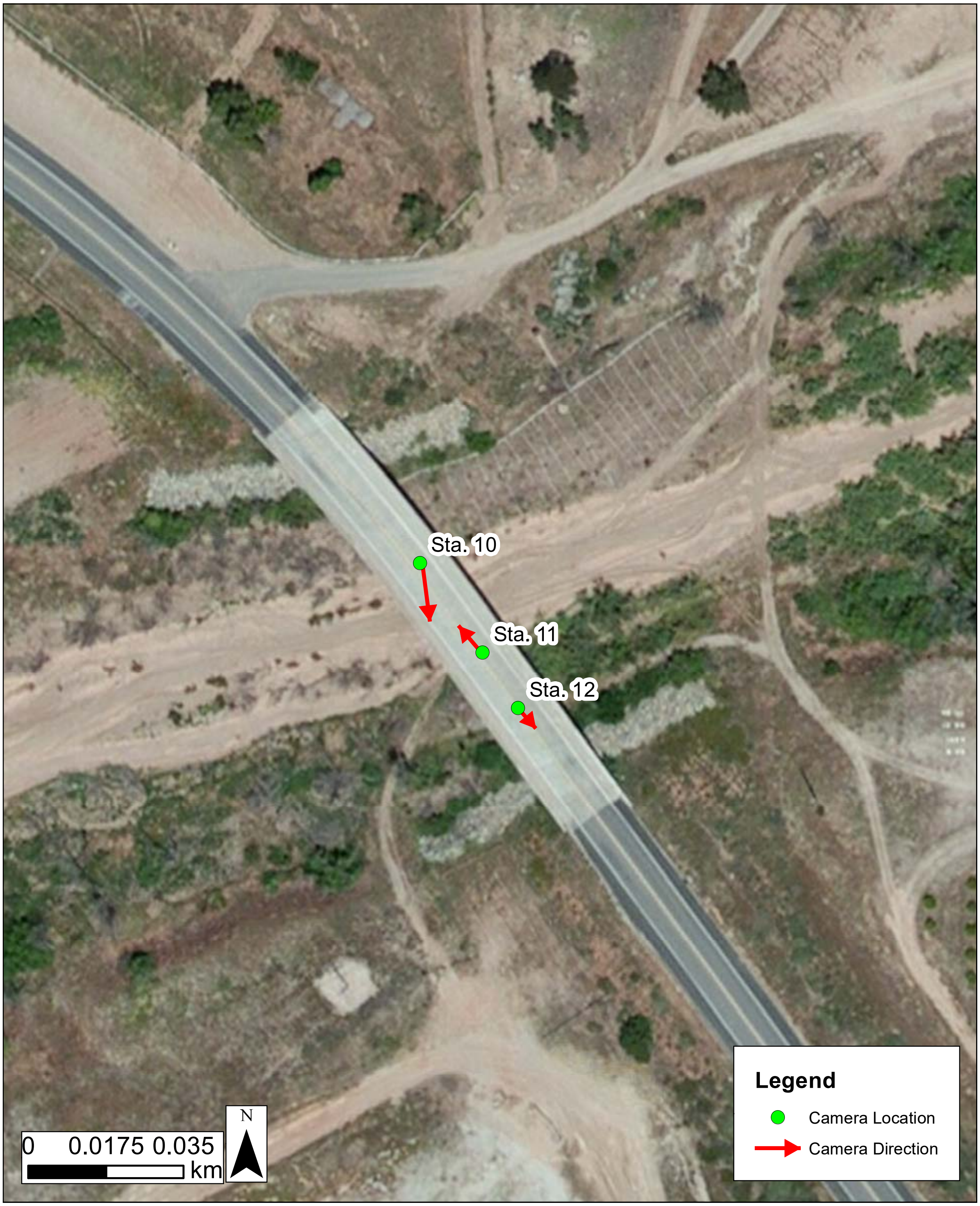

Figure 4. Three wildlife motion detection cameras were installed and monitored at the SR-78 bridge over Santa Ysabel Creek near the east end of San Pasqual Valley. Sta. 10 and 11 faced each other from opposite sides of the center span and Sta. 12 was on the north side of the wildlife span.

Table 1. Coordinates for the 12 camera stations used to monitor wildlife connectivity in San Pasqual Valley (WGS84).

Site	Section	Station	Latitude	Longitide	Installation Method
Lake Hodges	Pedestrian Path	01	33.05984	-117.06928	Telespar post
		02	33.06018	-117.07010	Telespar post
	Lakebed	03	33.05958	-117.06967	Telespar post with cable lock around bridge column
		04	33.05871	-117.07037	Telespar post
	Wildlife Path	05	33.05832	-117.07076	Telespar post
		06	33.05802	-117.07001	Telespar post
San Pasqual Creek	Streambed	07	33.09884	-117.01802	Telespar post
		08	33.09889	-117.01757	Telespar post
	Latrine	09	33.09888	-117.01748	Cable lock around bridge column
Santa Ysabel Creek	Center Span	10	33.09338	-116.95567	Telespar post
		11	33.09322	-116.95554	Telespar post
	Wildlife Span	12	33.09313	-116.95547	Telespar post

Table 2. Sample period details.

Sample Number	Start Date	End Date	Number of Sample Days	Sample Notes
001	Jul 31, 2014	Aug 4, 2014	4	testing period, cameras not installed at station 02, 03, or 09
002	Aug 4, 2014	Aug 6, 2014	2	testing period, cameras not installed at station 03 or 09
003	Aug 6, 2014	Aug 14, 2014	8	first sample with all 12 cameras
004	Aug 14, 2014	Aug 20, 2014	6	
005	Aug 20, 2014	Aug 27, 2014	7	
006	Aug 27, 2014	Sep 3, 2014	7	
007	Sep 3, 2014	Sep 10, 2014	7	
008	Sep 10, 2014	Sep 17, 2014	7	
009	Sep 17, 2014	Sep 24, 2014	7	
010	Sep 24, 2014	Oct 1, 2014	7	
011	Oct 1, 2014	Oct 8, 2014	7	
012	Oct 8, 2014	Oct 15, 2014	7	
013	Oct 15, 2014	Oct 22, 2014	7	
014	Oct 22, 2014	Oct 29, 2014	7	

Table 3. Models and specification for the 12 cameras used during the study.

Camera	Make	Model	Serial Number	Notes
01	Reconyx	HC500	06211772	
02	Reconyx	HC500	06211782	
03	Reconyx	PC800	01146854	
04	Reconyx	PC800	05154860	
05	Reconyx	PC800	01146907	May be faster than other cameras
06	Reconyx	PC800	01146883	
07	Reconyx	HC500	06211902	
08	Reconyx	PC800	01146909	
09	Reconyx	PC800	05154891	
10	Reconyx	HC500	06211874	Randomly takes time series photos
11	Reconyx	PC800	01146638	
12	Reconyx	PC800	01146915	

Table 4. Wildlife species events across the 12 sample stations during the 12 weeks of monitoring. Species events were defined by a 5-minute floating window (see text for full description).

	Site and Camera Station																		
	Lake Hodges							San Pasqual Creek				Santa Ysabel Creek							
Species	01	02	03	04	05	06	Total	07	08	09	Total	10	11	12	Total	Total Events	# of Stations	Total Events Rank	# of Stations Rank
Bobcat		1	1	28	1	15	46	4	2		6			5	5	57	8	5	4
California Quail												1		1	2	2	2	11	10
Coyote	6	8	22	47		16	99	150	5		155	5	12	22	39	293	10	2	1
Mule Deer	1		23	429	3	3	459									459	5	1	7
Opossum		1			6	1	8						3	14	17	25	5	9	7
Grey Fox								1	1		2					2	2	11	10
Greater Roadrunner	3	7	1	1	8	3	23	2			2	1	2	8	11	36	10	8	1
Black-Tailed Jackrabbit														1	1	1	1	13	12
Striped Skunk		2	2		1		5	12	5	7	24	8		8	16	45	8	7	4
Owl						5	5									5	1	10	12
Raccoon	4	5	14	5	10	69	107	1	1	3	5			1	1	113	10	4	1
California Ground Squirrel		9			41	5	55									55	3	6	9
Rabbit	5		1		3		9	7	1		8	1	33	65	99	116	8	3	4
Total Events	19	33	64	510	73	117	816	177	15	10	202	16	50	125	191	1,209			
Species Count	5	7	7	5	8	8	10	7	6	2	7	5	4	9	9	13			
Shannon Diversity	1.490	1.695	1.371	0.582	1.424	1.345	1.448	0.645	1.543	0.611	0.872	1.230	0.914	1.481	1.446				
Total Events Rank	9	8	6	1	5	4		2	11	12		10	7	3					
Species Count Rank	8	4	4	8	2	2		4	7	12		8	11	1					
Shannon Diversity Rank	3	1	6	12	5	7		10	2	11		8	9	4					

Table 5. The raw number of pictures of wildlife species across the 12 sample stations during the 12 weeks of monitoring.

	Site and Camera Station																		
	Lake Hodges							San Pasqual Creek				Santa Ysabel Creek							
Species	01	02	03	04	05	06	Total	07	08	09	Total	10	11	12	Total	Total Detections	# of Stations	Total Detections Rank	# of Stations Rank
Bobcat		8	1	162	1	94	266	29	12		41			21	21	328	8	5	4
California Quail												8		10	18	18	2	11	10
Coyote	34	58	100	286		101	579	515	29		544	17	25	37	79	1,202	10	3	1
Mule Deer	1		219	5,423	116	91	5,850									5,850	5	1	7
Opossum		5			34	5	44						11	83	94	138	5	9	7
Grey Fox								14	7		21					21	2	10	10
Greater Roadrunner	12	54	2	2	40	22	132	5			5	6	6	34	46	183	10	8	1
Black-Tailed Jackrabbit														2	2	2	1	13	12
Striped Skunk		6	3		2		11	59	9	65	133	38		21	59	203	8	7	4
Owl						15	15									15	1	12	12
Raccoon	47	40	97	62	96	603	945	5	9	17	31			10	10	986	10	4	1
California Ground Squirrel		24			246	18	288									288	3	6	9
Rabbit	55		5		15		75	31	5		36	6	617	524	1,147	1,258	8	2	4
Total Photos	149	195	427	5,935	550	949	8,205	658	71	82	811	75	659	742	1,476	10,492			
Species Count	5	7	7	5	8	8	10	7	6	2	7	5	4	9	9	13			
Shannon Diversity	1.305	1.631	1.145	0.377	1.486	1.236	1.197	0.846	1.605	0.51	0.987	1.324	0.297	1.098	0.906				
Total Photos Rank	9	8	7	1	6	2		5	12	10		11	4	3					
Species Count Rank	8	4	4	8	2	2		4	7	12		8	11	1					
Shannon Diversity Rank	5	1	7	11	3	6		9	2	10		4	12	8					

Table 6. Human related events across the 12 sample stations during the 12 weeks of monitoring. Species events were defined by a 5-minute floating window (see text for full description).

	Site and Camera Station															Total Detections	# of Stations	Total Detections Rank	# of Stations Rank
	Lake Hodges							San Pasqual Creek				Santa Ysabel Creek							
Native Species	01	02	03	04	05	06	Total	07	08	09	Total	10	11	12	Total				
Human on Bicycle	595	896					1,491									1,491	2	2	8
Domestic dog	28	11					39					9	10	16	35	74	5	5	3
Human on Horse	7	5					12					3	4		7	19	4	7	5
Domestic Cat												2	6	8	16	16	3	8	6
Human on OHV	4	1					5					28	28	2	58	63	5	6	3
Human	2,427	1,601	18	7	9	12	4,074	1	3	1	5	38	50	12	100	4,179	12	1	1
Human with Dog	541	385					926						1		1	927	3	3	6
Human in Automobile	78	93			1	2	174					3	3		6	180	6	4	2
Total Events	3,680	2,992	18	7	10	14	6,721	1	3	1	5	83	102	38	223	6,949			
Species Count	7	7	1	1	2	2	7	1	1	1	1	6	7	4	7	8			
Total Events Rank	1	2	6	9	8	7		11	10	11		4	3	5					
Species Count Rank	1	1	8	8	6	6		8	8	8		4	1	5					

Table 7. The raw number of pictures of human related categories across the 12 sample stations during the 12 weeks of monitoring.

	Site and Camera Station																		
	Lake Hodges							San Pasqual Creek				Santa Ysabel Creek							
Native Species	01	02	03	04	05	06	Total	07	08	09	Total	10	11	12	Total	Total Detections	# of Stations	Total Detections Rank	# of Stations Rank
Human on Bicycle	1,877	5,934					7,811									7,811	2	2	8
Domestic dog	57	32					89					47	39	45	131	220	5	6	3
Human on Horse	17	24					41					495	67		562	603	4	4	5
Domestic Cat												10	21	58	89	89	3	8	6
Human on OHV	8	5					13					91	92	5	188	201	5	7	3
Human	13,047	12,109	245	110	111	68	25,690	23	44	3	70	999	544	119	1,662	27,422	12	1	1
Human with Dog	2,351	2,716					5,067						5		5	5,072	3	3	6
Human in Automobile	153	324			14	11	502					16	29		45	547	6	5	2
Total Photos	17,510	21,144	245	110	125	79	39,213	23	44	3	70	1,658	797	227	2,682	41,965			
Species Count	7	7	1	1	2	2	7	1	1	1	1	6	7	4	7	8			
Total Photos Rank	2	1	5	8	7	9		11	10	12		3	4	6					
Species Count Rank	1	1	8	8	6	6		8	8	8		4	1	5					

Table 8. Wildlife species accumulation rates at the 12 sample stations during the 12 weeks (84 days) of monitoring. The values in the body of the table are the number of days before the first detection of each species at the given camera station. The earliest detection of each species at the site level (Site Min.) is shown in gray for each species.

	Site and Camera Station															Study		
	Lake Hodges						Site	San Pasqual Creek			Site	Santa Ysabel Creek			Site	Avg. 1st	Earliest 1st	Latest 1st
Wildlife Species	01	02	03	04	05	06	Min.	07	08	09	Min.	10	11	12	Min.	Detection	Detection	Detectio
Bobcat		23	16	3	67	7	3	8	15		8			20	20	20	3	67
California Quail												18		51	18	35	18	51
Coyote	48	19	3	1		16	1	1	2		1	18	4	4	4	12	1	48
Mule Deer	51		6	1	75	75	1									42	1	75
Opossum		14			2	13	2						61	13	13	21	2	61
Grey Fox								57	57		57					57	57	57
Greater Roadrunner	14	55	24	38	16	18	14	17			17	18	21	4	4	23	4	55
Black-Tailed Jackrabbit														3	3	3	3	3
Striped Skunk		16	54		67		16	11	27	12	11	2		2	2	24	2	67
Owl						19	19									19	19	19
Raccoon	17	46	5	62	16	3	3	51	68	14	14			47	47	33	3	68
California Ground Squirrel		3			2	5	2									3	2	5
Rabbit	10		23		1		1	10	37		10	5	4	5	4	12	1	37
Avg. 1st Detection	28	25	19	21	31	20	6	22	34	13	17	12	23	17	13	22		
Earliest 1st Detection	10	3	3	1	1	3	1	1	2	12	1	2	4	2	2		1	
Latest 1st Detection	51	55	54	62	75	75	19	57	68	14	57	18	61	51	47			75

Table 9. Wildlife species movements between camera stations. The values in the body of the table are the number of times that the given species was documented by the given number of cameras within each study site based on the 5-minute floating window.

	Site and Number of Camera Stations								
	Lake Hodges			San Pasqual Creek			Santa Ysabel Creek		
Species	1	2	3	1	2	3	1	2	3
Bobcat	42	2		6			5		
California Quail							2		
Coyote	80	8	1	149	3		39		
Mule Deer	449	5							
Opossum	8						11	3	
Grey Fox					1				
Greater Roadrunner	23			2			11		
Black-Tailed Jackrabbit							1		
Striped Skunk	5			20	2		12	2	
Owl	5								
Raccoon	99	4		5			1		
California Ground Squirrel	55								
Rabbit	9			8			99		
Total	775	19	1	190	6		181	5	

Table 10. Within each of the three study sites, the individual camera stations varied as to the percent of species events that each detected.

	Site and Camera Station											
	Lake Hodges						San Pasqual Creek			Santa Ysabel Creek		
Species	01	02	03	04	05	06	07	08	09	10	11	12
Bobcat	0.0%	2.2%	2.2%	60.9%	2.2%	32.6%	66.7%	33.3%	0.0%	0.0%	0.0%	100.0%
California Quail										50.0%	0.0%	50.0%
Coyote	6.1%	8.1%	22.2%	47.5%	0.0%	16.2%	96.8%	3.2%	0.0%	12.8%	30.8%	56.4%
Mule Deer	0.2%	0.0%	5.0%	93.5%	0.7%	0.7%						
Opossum	0.0%	12.5%	0.0%	0.0%	75.0%	12.5%				0.0%	17.6%	82.4%
Grey Fox							50.0%	50.0%	0.0%			
Greater Roadrunner	13.0%	30.4%	4.3%	4.3%	34.8%	13.0%	100.0%	0.0%	0.0%	9.1%	18.2%	72.7%
Black-Tailed Jackrabbit										0.0%	0.0%	100.0%
Striped Skunk	0.0%	40.0%	40.0%	0.0%	20.0%	0.0%	50.0%	20.8%	29.2%	50.0%	0.0%	50.0%
Owl	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%						
Raccoon	3.7%	4.7%	13.1%	4.7%	9.3%	64.5%	20.0%	20.0%	60.0%	0.0%	0.0%	100.0%
California Ground Squirrel	0.0%	16.4%	0.0%	0.0%	74.5%	9.1%						
Rabbit	55.6%	0.0%	11.1%	0.0%	33.3%	0.0%	87.5%	12.5%	0.0%	1.0%	33.3%	65.7%
Total Within Site %	2.3%	4.0%	7.8%	62.5%	8.9%	14.3%	87.6%	7.4%	5.0%	8.4%	26.2%	65.4%
Count of Species	5	7	7	5	8	8	7	6	2	5	4	9

Table 11. Indices of relative activity for wildlife species at the 12 sample stations during the 12 weeks of monitoring.

	Site and Camera Station														
	Lake Hodges							San Pasqual Creek				Santa Ysabel Creek			
Species	01	02	03	04	05	06	Total	07	08	09	Total	10	11	12	Total
Bobcat	0.000	0.012	0.012	0.333	0.012	0.179	0.091	0.048	0.024	0.000	0.024	0.000	0.000	0.060	0.020
California Quail												0.012	0.000	0.012	0.008
Coyote	0.071	0.095	0.262	0.560	0.000	0.190	0.196	1.786	0.060	0.000	0.615	0.060	0.143	0.262	0.155
Mule Deer	0.012	0.000	0.274	5.107	0.036	0.036	0.911								
Opossum	0.000	0.012	0.000	0.000	0.071	0.012	0.016					0.000	0.036	0.167	0.067
Grey Fox								0.012	0.012	0.000	0.008				
Greater Roadrunner	0.036	0.083	0.012	0.012	0.095	0.036	0.046	0.024	0.000	0.000	0.008	0.012	0.024	0.095	0.044
Black-Tailed Jackrabbit												0.000	0.000	0.012	0.004
Striped Skunk	0.000	0.024	0.024	0.000	0.012	0.000	0.010	0.143	0.060	0.083	0.095	0.095	0.000	0.095	0.063
Owl	0.000	0.000	0.000	0.000	0.000	0.060	0.010								
Raccoon	0.048	0.060	0.167	0.060	0.119	0.821	0.212	0.012	0.012	0.036	0.020	0.000	0.000	0.012	0.004
California Ground Squirrel	0.000	0.107	0.000	0.000	0.488	0.060	0.109								
Rabbit	0.060	0.000	0.012	0.000	0.036	0.000	0.018	0.083	0.012	0.000	0.032	0.012	0.393	0.774	0.393
Total	0.226	0.393	0.762	6.071	0.869	1.393	1.619	2.107	0.179	0.119	0.802	0.190	0.595	1.488	0.758

Table 12. The length of time and number of photos that each wildlife species was detected in front of the motion detection cameras was calculated based on the timestamp associated with the photos taken during the event.

Species	Average Event Duration (hh:mm:ss)	Average Event # of Photos	Shortest Event Duration (hh:mm:ss)	Shortest Event # of Photos	Longest Event Duration (hh:mm:ss)	Longest Event # of Photos	Count of Events
Bobcat	0:00:05	5.75	0:00:01	1	0:00:25	15	57
California Quail	0:00:21	9.00	0:00:12	8	0:00:29	10	2
Coyote	0:00:13	4.10	0:00:01	1	0:03:37	36	293
Mule Deer	0:00:35	12.75	0:00:01	1	0:08:56	85	459
Opossum	0:00:13	5.52	0:00:01	1	0:03:27	17	25
Grey Fox	0:00:13	10.50	0:00:06	7	0:00:21	14	2
Greater Roadrunner	0:00:07	5.08	0:00:01	1	0:01:34	14	36
Black-Tailed Jackrabbit	0:00:02	2.00	0:00:02	2	0:00:02	2	1
Striped Skunk	0:00:06	4.51	0:00:01	1	0:01:09	14	45
Owl	0:00:02	3.00	0:00:01	1	0:00:04	5	5
Raccoon	0:00:18	8.73	0:00:01	1	0:04:43	45	113
California Ground Squirrel	0:00:13	5.24	0:00:01	1	0:03:15	26	55
Rabbit	0:01:02	10.84	0:00:01	1	0:08:01	70	116
Total	0:00:26	8.68	0:00:01	1	0:08:56	85	1209

Table 13. The length of time and number of photos that each human related category was detected in front of the motion detection cameras was calculated based on the timestamp associated with the photos taken during the event.

Human Related Category	Average Event Duration (hh:mm:ss)	Average Event # of Photos	Shortest Event Duration (hh:mm:ss)	Shortest Event # of Photos	Longest Event Duration (hh:mm:ss)	Longest Event # of Photos	Count of Events
Human on Bicycle	0:01:05	5.24	0:00:00	1	1:05:55	285	1,491
Domestic dog	0:00:08	2.97	0:00:00	1	0:04:21	12	74
Human on Horse	0:02:29	31.74	0:00:00	1	0:24:50	470	19
Domestic Cat	0:00:04	5.56	0:00:01	2	0:00:13	14	16
Human on OHV	0:00:19	3.19	0:00:00	1	0:04:44	15	63
Human	0:01:58	6.56	0:00:00	1	1:01:54	475	4,179
Human with Dog	0:00:23	5.47	0:00:00	1	0:10:51	93	927
Human in Automobile	0:00:06	3.04	0:00:00	1	0:03:45	29	180
Total	0:01:29	6.04	0:00:00	1	1:05:55	475	6,949

Table 14. The cumulative percentage of wildlife species events where the species was first identified in the sequence of photographs taken during the motion trigger event.

	Photo Sequence				
Species	1 of 5	2 of 5	3 of 5	4 of 5	5 of 5
Bobcat	100.00%	-	-	-	-
California Quail	100.00%	-	-	-	-
Coyote	99.17%	99.17%	99.50%	99.83%	100.00%
Mule Deer	99.81%	99.83%	99.90%	99.97%	100.00%
Opossum	99.28%	99.28%	100.00%	-	-
Grey Fox	95.24%	100.00%	-	-	-
Greater Roadrunner	98.91%	100.00%	-	-	-
Black-Tailed Jackrabbit	100.00%	-	-	-	-
Striped Skunk	100.00%	-	-	-	-
Owl	100.00%	-	-	-	-
Raccoon	99.59%	99.80%	99.80%	99.90%	100.00%
California Ground Squirrel	99.31%	99.65%	100.00%	-	-
Rabbit	99.44%	99.76%	99.76%	99.84%	100.00%
Grand Total	99.64%	99.74%	99.84%	99.93%	100.00%

Table 15. The cumulative percentage of human related events where the category was first identified in the sequence of photographs taken during the motion trigger event.

	Photo Sequence				
Category	1 of 5	2 of 5	3 of 5	4 of 5	5 of 5
Human on Bicycle	94.19%	98.35%	99.17%	99.48%	100.00%
Domestic dog	96.36%	98.18%	98.64%	99.55%	100.00%
Human on Horse	81.76%	99.00%	99.67%	99.83%	100.00%
Domestic Cat	98.88%	100.00%	-	-	-
Human on OHV	99.00%	100.00%	-	-	-
Human	97.17%	99.65%	99.85%	99.94%	100.00%
Human with Dog	91.64%	98.62%	99.80%	99.88%	100.00%
Human in Automobile	98.90%	99.82%	99.82%	99.82%	100.00%
Grand Total	95.75%	99.27%	99.71%	99.84%	100.00%

Table 16. If a 5-minute "Quiet Period" (QP) had been used between motion triggered events, the number of raw photos of wildlife species would have been greatly reduced while the number of species events would have been minimally impacted.

	Photographs				Events			
Species	without QP	with QP	Diff.	% Diff.	without QP	with QP	Diff.	% Diff.
Bobcat	328	253	75	77%	57	57	0	100%
California Quail	18	8	10	44%	2	2	0	100%
Coyote	1,202	825	377	69%	293	273	20	93%
Mule Deer	5,850	2,117	3,733	36%	459	453	6	99%
Opossum	138	102	36	74%	25	25	0	100%
Grey Fox	21	9	12	43%	2	2	0	100%
Greater Roadrunner	183	126	57	69%	36	34	2	94%
Black-Tailed Jackrabbit	2	2	0	100%	1	1	0	100%
Striped Skunk	203	155	48	76%	45	45	0	100%
Owl	15	15	0	100%	5	5	0	100%
Raccoon	986	516	470	52%	113	113	0	100%
California Ground Squirrel	288	229	59	80%	55	55	0	100%
Rabbit	1,258	533	725	42%	116	110	6	95%
Total	10,492	4,890	5,602	47%	1,209	1,175	34	97%

Table 17. If a 5-minute “Quiet Period” (QP) had been used between motion triggered events, the number of raw photos of human related categories would have been greatly reduced. The number of human related events that were documented may also have been reduced if a 5-minute “Quiet Period” had been used.

	Photographs				Events			
Categories	without QP	with QP	Diff.	% Diff.	without QP	with QP	Diff.	% Diff.
Human on Bicycle	7,811	3,098	4,713	40%	1,491	1,030	461	69%
Domestic dog	220	140	80	64%	74	59	15	80%
Human on Horse	603	61	542	10%	19	18	1	95%
Domestic Cat	89	63	26	71%	16	16	0	100%
Human on OHV	201	146	55	73%	63	59	4	94%
Human	27,422	12,333	15,089	45%	4,179	3,622	557	87%
Human with Dog	5,072	2,023	3,049	40%	927	599	328	65%
Human in Automobile	547	340	207	62%	180	139	41	77%
Total	41,965	18,204	23,761	43%	6,949	5,542	1,407	80%

Figure 5. Coyote at Station 01 on October 6, 2014.

Figure 6. Greater roadrunner at Station 02 on October 28, 2014.

Figure 7. Mule deer at Station 04 on September 1, 2014.

Figure 8. Raccoon at Station 03 on September 4, 2014.

Figure 9. Owl at Station 06 on September 18, 2014.

Figure 10. California ground squirrel at Station 05 on August 11, 2014.

Figure 11. Grey fox at Station 08 on October 1, 2014.

Figure 12. Bobcat at Station 07 on August 13, 2014.

Figure 13. Striped skunk at Station 09 on September 5, 2014.

Figure 14. California quail at Station 10 on August 23, 2014.

Figure 15. Opossum at Station 11 on October 6, 2014.

Figure 16. Black-tailed jackrabbit at Station 12 on August 8, 2014.

Figure 17. Human with dog at Station 01 on August 2, 2014.

Figure 18. Human on bicycle at Station 02 on July 31, 2014.

Figure 19. Domestic cat at Station 11 on August 10, 2014.

Figure 20. Domestic dog at Station 12 on August 18, 2014.

Figure 21. Human on OHV at Station 10 on August 4, 2014.

Figure 22. Human at Station 07 on September 5, 2014.

Figure 23. Human on horse at Station 02 on 3 September 3, 2014.

Figure 24. Human in automobile at Station 10 on August 23, 2014.

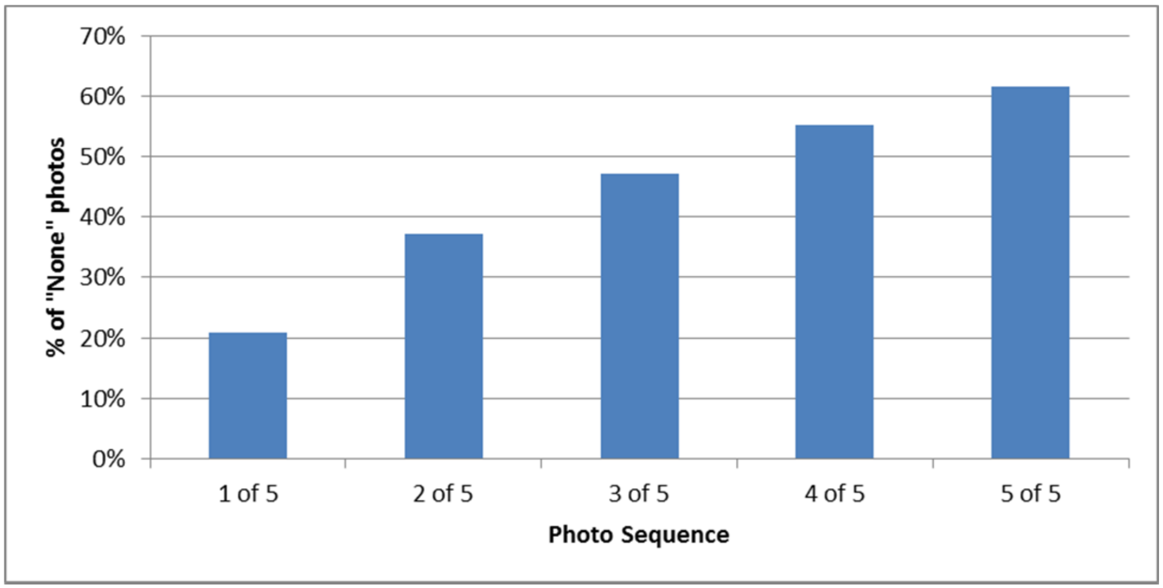

Figure 25. The percent of photos within each of the five positions in the photo sequence where no species was visible.

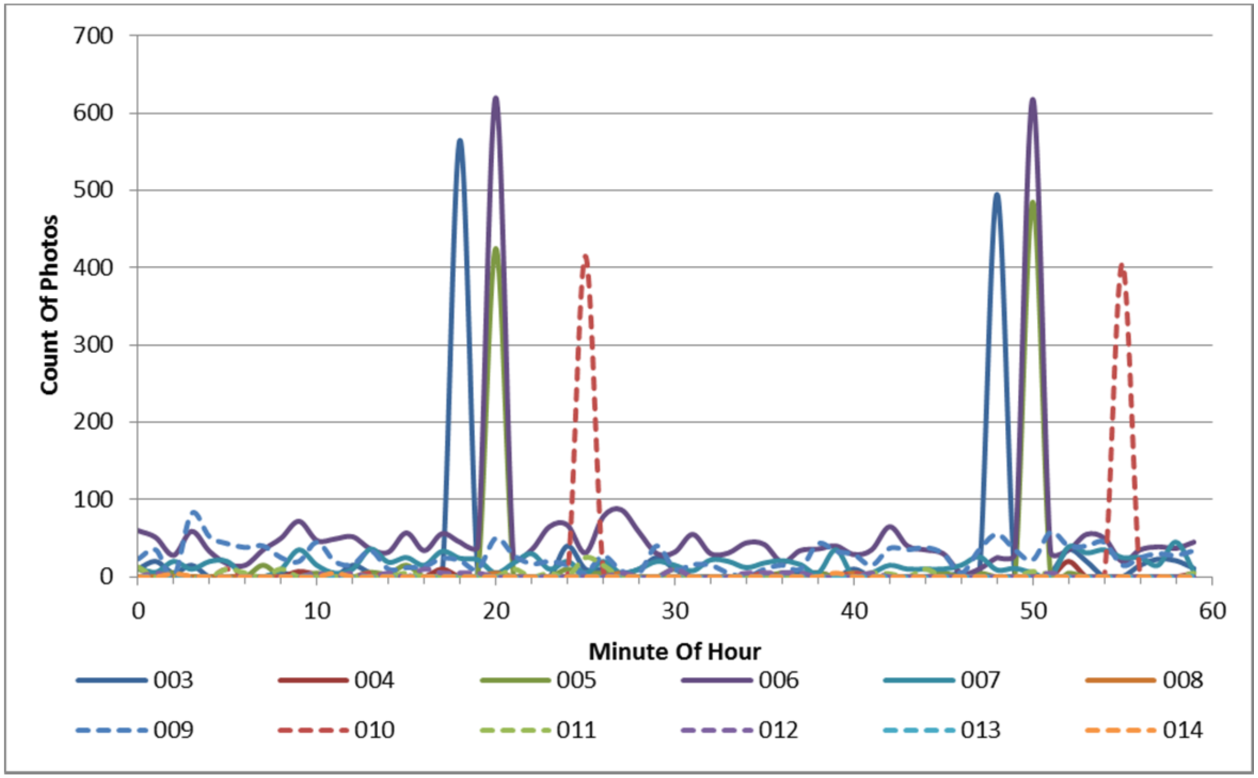

Figure 26. Camera 10 periodically malfunctioned and recorded a photo series every half hour as seen in sample period 003, 005, 006, and 010 where unusually high numbers of photos were taken at the same time every hour, spaced out at half hour intervals.

Figure 27. Camera 05 appears to function slightly faster than the other wildlife motion cameras used during the study. At Stations 01 and 02, more humans on bikes were detected when Camera 05 was at each station.

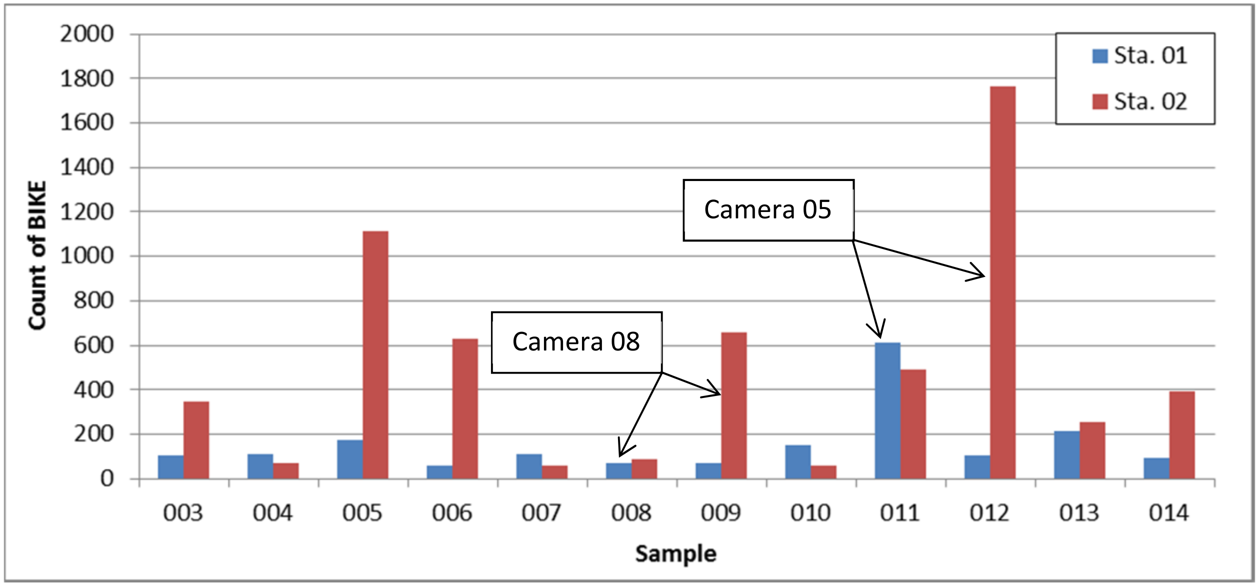

Figure 28. Humans on bicycle (BIKE) photos at Stations (Sta.) 01 and 02 over the entire study. Camera 05 captured more images of BIKEs than any other cameras at these stations.

Appendix 1. Sample period summaries

Summary results for each sample period separated into two tables: wildlife (top) and human related categories (bottom). Sample periods 001 and 002 were test and set up periods only; the photos from these periods have not been included in any of the results presented.

A. Sample 003

Sample:	003	Start Date:		Aug 6, 2014			End Date:		Aug 14, 2014					
						Station:								
	01	02	03	04	05	06	07	08	09	10	11	12		
						Camera:							Total	# of
Species	01	02	03	04	05	06	07	08	09	10	11	12	Events	Stations
Bobcat				2		1	1						4	3
California Quail													0	0
Coyote			1	4			16	3			1	3	28	6
Mule Deer			2	57									59	2
Opossum					2								2	1
Grey Fox													0	0
Greater Roadrunner												1	1	1
Black-Tailed Jackrabbit												1	1	1
Striped Skunk										1		1	2	2
Owl													0	0
Raccoon			2			3							5	2
California Ground Squirrel		2			5	1							8	3
Rabbit					3					1	3	5	12	4
Total Events	0	2	5	63	10	5	17	3	0	2	4	11	122	
Species Count	0	1	3	3	3	3	2	1	0	2	2	5	10	

Sample:	003	Start Date:		Aug 6, 2014			End Date:		Aug 14, 2014					
						Station:								
	01	02	03	04	05	06	07	08	09	10	11	12		
						Camera:							Total	# of
Category	01	02	03	04	05	06	07	08	09	10	11	12	Events	Stations
Human on Bicycle	24	67											91	2
Domestic dog	3	1								2	2	2	10	5
Human on Horse													0	0
Domestic Cat											1	1	2	2
Human on OHV										9	10		19	2
Human	254	132	1	2	5	1				4	10		409	8
Human with Dog	65	32											97	2
Human in Automobile	11	8								1	1		21	4
Total Events	357	240	1	2	5	1	0	0	0	16	24	3	649	
Species Count	5	5	1	1	1	1	0	0	0	4	5	2	7	

B. Sample 004

Sample: 004 Start Date: Aug 14, 2014 End Date: Aug 20, 2014

	Station: 01	02	03	04	05	06	07	08	09	10	11	12		
Species	Camera: 12	01	02	03	04	05	06	07	08	09	10	11	Total Events	# of Stations
Bobcat				2									2	1
California Quail													0	0
Coyote				2			8					1	11	3
Mule Deer			1	41									42	2
Opossum		1			1	1						1	4	4
Grey Fox													0	0
Greater Roadrunner	1											2	3	2
Black-Tailed Jackrabbit													0	0
Striped Skunk							3		1	3		1	8	4
Owl													0	0
Raccoon			1			5			1				7	3
California Ground Squirrel					4	3							7	2
Rabbit	3						3					6	12	3
Total Events	4	1	2	45	5	9	14	0	2	3	0	11	96	
Species Count	2	1	2	3	2	3	3	0	2	1	0	5	9	

Sample: 004 Start Date: Aug 14, 2014 End Date: Aug 20, 2014

	Station: 01	02	03	04	05	06	07	08	09	10	11	12		
Category	Camera: 12	01	02	03	04	05	06	07	08	09	10	11	Total Events	# of Stations
Human on Bicycle	33	22											55	2
Domestic dog												2	2	1
Human on Horse													0	0
Domestic Cat										1		1	2	2
Human on OHV													0	0
Human	189	65	1		2	1					3		261	6
Human with Dog	39	16											55	2
Human in Automobile	7	4								1	2		14	4
Total Events	268	107	1	0	2	1	0	0	0	2	5	3	389	
Species Count	4	4	1	0	1	1	0	0	0	2	2	2	6	

C. Sample 005

Sample: 005 Start Date: Aug 20, 2014 End Date: Aug 27, 2014

	Station:													
	01	02	03	04	05	06	07	08	09	10	11	12		
	Camera:												Total	# of
Species	11	12	01	02	03	04	05	06	07	08	09	10	Events	Stations
Bobcat			1	2		1		1				1	6	5
California Quail										1			1	1
Coyote		1		3		1	14			2	1	2	24	7
Mule Deer			2	58									60	2
Opossum												1	1	1
Grey Fox													0	0
Greater Roadrunner					3	1	2			1	1		8	5
Black-Tailed Jackrabbit													0	0
Striped Skunk		1					3			2		2	8	4
Owl						1							1	1
Raccoon	1		1		2	6							10	4
California Ground Squirrel		1			1								2	2
Rabbit							1				4	3	8	3
Total Events	1	3	4	63	6	10	20	1	0	6	6	9	129	
Species Count	1	3	3	3	3	5	4	1	0	4	3	5	11	

Sample: 005 Start Date: Aug 20, 2014 End Date: Aug 27, 2014

	Station:													
	01	02	03	04	05	06	07	08	09	10	11	12		
	Camera:												Total	# of
Category	11	12	01	02	03	04	05	06	07	08	09	10	Events	Stations
Human on Bicycle	55	158											213	2
Domestic dog	7	2											9	2
Human on Horse													0	0
Domestic Cat										1		3	4	2
Human on OHV										1	1		2	2
Human	234	222								5	3	1	465	5
Human with Dog	56	56											112	2
Human in Automobile	11	16								1	1		29	4
Total Events	363	454	0	0	0	0	0	0	0	8	5	4	834	
Species Count	5	5	0	0	0	0	0	0	0	4	3	2	7	

D. Sample 006

Sample: 006 Start Date: Aug 27, 2014 End Date: Sep 3, 2014

	Station: 01	02	03	04	05	06	07	08	09	10	11	12		
Species	Camera: 10	11	12	01	02	03	04	05	06	07	08	09	Total Events	# of Stations
Bobcat		1		2			1					1	5	4
California Quail													0	0
Coyote			1				11					1	13	3
Mule Deer			2	49									51	2
Opossum												1	1	1
Grey Fox													0	0
Greater Roadrunner			1		1	1						2	5	4
Black-Tailed Jackrabbit													0	0
Striped Skunk							2	2		1			5	3
Owl						2							2	1
Raccoon			2		1	7							10	3
California Ground Squirrel		2			1								3	2
Rabbit			1								4	4	9	3
Total Events	0	3	7	51	3	10	14	2	0	1	4	9	104	
Species Count	0	2	5	2	3	3	3	1	0	1	1	5	10	

Sample: 006 Start Date: Aug 27, 2014 End Date: Sep 3, 2014

	Station: 01	02	03	04	05	06	07	08	09	10	11	12		
Category	Camera: 10	11	12	01	02	03	04	05	06	07	08	09	Total Events	# of Stations
Human on Bicycle	20	122											142	2
Domestic dog	2	3											5	2
Human on Horse													0	0
Domestic Cat											1	1	2	2
Human on OHV										1	2		3	2
Human	190	162	3	2	1				1	1	7		367	8
Human with Dog	43	26											69	2
Human in Automobile	4	5											9	2
Total Events	259	318	3	2	1	0	0	0	1	2	10	1	597	
Species Count	5	5	1	1	1	0	0	0	1	2	3	1	7	

E. Sample 007

Sample: 007 Start Date: Sep 3, 2014 End Date: Sep 10, 2014

Station:	01	02	03	04	05	06	07	08	09	10	11	12	Total	# of
Species / Camera:	09	10	11	12	01	02	03	04	05	06	07	08	Events	Stations
Bobcat						1							1	1
California Quail													0	0
Coyote			1	2			14						17	3
Mule Deer			2	48									50	2
Opossum													0	0
Grey Fox													0	0
Greater Roadrunner												1	1	1
Black-Tailed Jackrabbit													0	0
Striped Skunk							2	2	1	1			6	4
Owl													0	0
Raccoon			1			1							2	2
California Ground Squirrel		1				1							2	2
Rabbit							2				3	8	13	3
Total Events	0	1	4	50	0	3	18	2	1	1	3	9	92	
Species Count	0	1	3	2	0	3	3	1	1	1	1	2	8	

Sample: 007 Start Date: Sep 3, 2014 End Date: Sep 10, 2014

Station:	01	02	03	04	05	06	07	08	09	10	11	12	Total	# of
Category / Camera:	09	10	11	12	01	02	03	04	05	06	07	08	Events	Stations
Human on Bicycle	21	17											38	2
Domestic dog	3	1										1	5	3
Human on Horse	1	1											2	2
Domestic Cat												1	1	1
Human on OHV													0	0
Human	184	76	2		1		1	1		6	2	8	281	9
Human with Dog	31	21											52	2
Human in Automobile	6	3											9	2
Total Events	246	119	2	0	1	0	1	1	0	6	2	10	388	
Species Count	6	6	1	0	1	0	1	1	0	1	1	3	7	

F. Sample 008

Sample: 008 Start Date: Sep 10, 2014 End Date: Sep 17, 2014

Station:	01	02	03	04	05	06	07	08	09	10	11	12		
Species / Camera:	08	09	10	11	12	01	02	03	04	05	06	07	Total Events	# of Stations
Bobcat				3		1							4	2
California Quail													0	0
Coyote			1				9	1			2		13	4
Mule Deer				44									44	1
Opossum													0	0
Grey Fox													0	0
Greater Roadrunner				1	3								4	2
Black-Tailed Jackrabbit													0	0
Striped Skunk													0	0
Owl						1							1	1
Raccoon			2		2	5							9	3
California Ground Squirrel		2			11								13	2
Rabbit								1			5	11	17	3
Total Events	0	2	3	48	16	7	9	2	0	0	7	11	105	
Species Count	0	1	2	3	3	3	1	2	0	0	2	1	8	

Sample: 008 Start Date: Sep 10, 2014 End Date: Sep 17, 2014

Station:	01	02	03	04	05	06	07	08	09	10	11	12		
Category / Camera:	08	09	10	11	12	01	02	03	04	05	06	07	Total Events	# of Stations
Human on Bicycle	22	23											45	2
Domestic dog	4											1	5	2
Human on Horse													0	0
Domestic Cat											2		2	1
Human on OHV										5	3		8	2
Human	150	75				1		1					227	4
Human with Dog	20	14											34	2
Human in Automobile	3	6											9	2
Total Events	199	118	0	0	0	1	0	1	0	5	5	1	330	
Species Count	5	4	0	0	0	1	0	1	0	1	2	1	7	

G. Sample 009

Sample: 009 Start Date: Sep 17, 2014 End Date: Sep 24, 2014

	Station:													
	01	02	03	04	05	06	07	08	09	10	11	12		
	Camera:												Total	# of
Species	07	08	09	10	11	12	01	02	03	04	05	06	Events	Stations
Bobcat						2						1	3	2
California Quail													0	0
Coyote	1	2		2		2	10				4	2	23	7
Mule Deer			1	32									33	2
Opossum												1	1	1
Grey Fox													0	0
Greater Roadrunner						1							1	1
Black-Tailed Jackrabbit													0	0
Striped Skunk		1					1					1	3	3
Owl						1							1	1
Raccoon	1	1				5			1			1	9	5
California Ground Squirrel					6								6	1
Rabbit											4	7	11	2
Total Events	2	4	1	34	6	11	11	0	1	0	8	13	91	
Species Count	2	3	1	2	1	5	2	0	1	0	2	6	10	

Sample: 009 Start Date: Sep 17, 2014 End Date: Sep 24, 2014

	Station:													
	01	02	03	04	05	06	07	08	09	10	11	12		
	Camera:												Total	# of
Category	07	08	09	10	11	12	01	02	03	04	05	06	Events	Stations
Human on Bicycle	22	91											113	2
Domestic dog	2	1										1	4	3
Human on Horse	2												2	1
Domestic Cat											1		1	1
Human on OHV										1	2		3	2
Human	193	131	1	1						7	7	2	342	7
Human with Dog	42	29									1		72	3
Human in Automobile	6	12											18	2
Total Events	267	264	1	1	0	0	0	0	0	8	11	3	555	
Species Count	6	5	1	1	0	0	0	0	0	2	4	2	8	

H. Sample 010

Sample: 010 Start Date: Sep 24, 2014 End Date: Oct 1, 2014

	Station:													
	01	02	03	04	05	06	07	08	09	10	11	12		
	Camera:												Total	# of
Species	06	07	08	09	10	11	12	01	02	03	04	05	Events	Stations
Bobcat				3		2							5	2
California Quail												1	1	1
Coyote	2	2	2	5		1	14					7	33	7
Mule Deer	1		1	31									33	3
Opossum												2	2	1
Grey Fox							1	1					2	2
Greater Roadrunner		1			1							1	3	3
Black-Tailed Jackrabbit													0	0
Striped Skunk			2						1			1	4	3
Owl													0	0
Raccoon	1	1			1	4	1						8	5
California Ground Squirrel					2								2	1
Rabbit	1										1	5	7	3
Total Events	5	4	5	39	4	7	16	1	1	0	1	17	100	
Species Count	4	3	3	3	3	3	3	1	1	0	1	6	11	

Sample: 010 Start Date: Sep 24, 2014 End Date: Oct 1, 2014

	Station:													
	01	02	03	04	05	06	07	08	09	10	11	12		
	Camera:												Total	# of
Category	06	07	08	09	10	11	12	01	02	03	04	05	Events	Stations
Human on Bicycle	51	18											69	2
Domestic dog	3											2	5	2
Human on Horse													0	0
Domestic Cat													0	0
Human on OHV	1	1								3	4		9	4
Human	236	89	1			2		1		2	2		333	7
Human with Dog	60	21											81	2
Human in Automobile	10	4											14	2
Total Events	361	133	1	0	0	2	0	1	0	5	6	2	511	
Species Count	6	5	1	0	0	1	0	1	0	2	2	1	6	

I. Sample 011

Sample: 011 Start Date: Oct 1, 2014 End Date: Oct 8, 2014

	Station: 01	02	03	04	05	06	07	08	09	10	11	12		
Species	Camera: 05	06	07	08	09	10	11	12	01	02	03	04	Total Events	# of Stations
Bobcat				3		1							4	2
California Quail													0	0
Coyote	2	2	7	12		7	11				1		42	7
Mule Deer			1	26									27	2
Opossum					1						3	6	10	3
Grey Fox													0	0
Greater Roadrunner	2	1											3	2
Black-Tailed Jackrabbit													0	0
Striped Skunk									1				1	1
Owl													0	0
Raccoon			1	3		5							9	3
California Ground Squirrel					5								5	1
Rabbit	1										3	2	6	3
Total Events	5	3	9	44	6	13	11	0	1	0	7	8	107	
Species Count	3	2	3	4	2	3	1	0	1	0	3	2	9	

Sample: 011 Start Date: Oct 1, 2014 End Date: Oct 8, 2014

	Station: 01	02	03	04	05	06	07	08	09	10	11	12		
Category	Camera: 05	06	07	08	09	10	11	12	01	02	03	04	Total Events	# of Stations
Human on Bicycle	232	90											322	2
Domestic dog	3										2		5	2
Human on Horse										3	6		9	2
Domestic Cat													0	0
Human on OHV	2									4	4		10	3
Human	253	216	1							5	7		482	5
Human with Dog	45	38											83	2
Human in Automobile	7	9				1							17	3
Total Events	542	353	1	0	0	1	0	0	0	12	19	0	928	
Species Count	6	4	1	0	0	1	0	0	0	3	4	0	7	

J. Sample 012

Sample: 012 Start Date: Oct 8, 2014 End Date: Oct 15, 2014

Station:	01	02	03	04	05	06	07	08	09	10	11	12		
Camera:													**Total**	**# of**
Species	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**01**	**02**	**03**	**Events**	**Stations**
Bobcat				2	1	1	1						5	4
California Quail													0	0
Coyote			6	6		1	9				1	4	27	6
Mule Deer			7	19									26	2
Opossum					1							2	3	2
Grey Fox													0	0
Greater Roadrunner		2										1	3	2
Black-Tailed Jackrabbit													0	0
Striped Skunk					1			1					2	2
Owl													0	0
Raccoon		1	1		2	8		1					13	5
California Ground Squirrel		1			1								2	2
Rabbit												6	6	1
Total Events	0	4	14	27	6	10	10	2	0	0	1	13	87	
Species Count	0	3	3	3	5	3	2	2	0	0	1	4	9	

Sample: 012 Start Date: Oct 8, 2014 End Date: Oct 15, 2014

Station:	01	02	03	04	05	06	07	08	09	10	11	12		
Camera:													**Total**	**# of**
Category	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**01**	**02**	**03**	**Events**	**Stations**
Human on Bicycle	43	180											223	2
Domestic dog		2								2	2	6	12	4
Human on Horse	2	2											4	2
Domestic Cat											1	1	2	2
Human on OHV	1										1		2	2
Human	233	240	2							3	2	1	481	6
Human with Dog	50	65											115	2
Human in Automobile	4	7											11	2
Total Events	333	496	2	0	0	0	0	0	0	5	6	8	850	
Species Count	6	6	1	0	0	0	0	0	0	2	4	3	8	

K. Sample 013

Sample: 013 Start Date: Oct 15, 2014 End Date: Oct 22, 2014

	Station: 01	02	03	04	05	06	07	08	09	10	11	12		
Species	Camera: 03	04	05	06	07	08	09	10	11	12	01	02	Total Events	# of Stations
Bobcat				4		3	1						8	3
California Quail													0	0
Coyote			2	5		1	17			2		1	28	6
Mule Deer			2	7	2	2							13	4
Opossum					1								1	1
Grey Fox													0	0
Greater Roadrunner		2											2	1
Black-Tailed Jackrabbit													0	0
Striped Skunk							1		3			1	5	3
Owl													0	0
Raccoon	1	1	3	2	1	11							19	6
California Ground Squirrel					2								2	1
Rabbit												7	7	1
Total Events	1	3	7	18	6	17	19	0	3	2	0	9	85	
Species Count	1	2	3	4	4	4	3	0	1	1	0	3	9	

Sample: 013 Start Date: Oct 15, 2014 End Date: Oct 22, 2014

	Station: 01	02	03	04	05	06	07	08	09	10	11	12		
Category	Camera: 03	04	05	06	07	08	09	10	11	12	01	02	Total Events	# of Stations
Human on Bicycle	62	45											107	2
Domestic dog	1									3	3		7	3
Human on Horse													0	0
Domestic Cat													0	0
Human on OHV										1	1	2	4	3
Human	409	132	2			4				4	1		552	6
Human with Dog	50	23											73	2
Human in Automobile	6	7											13	2
Total Events	528	207	2	0	0	4	0	0	0	8	5	2	756	
Species Count	5	4	1	0	0	1	0	0	0	3	3	1	6	

L. Sample 014

Sample: 014 Start Date: Oct 22, 2014 End Date: Oct 29, 2014

	Station:													
	01	02	03	04	05	06	07	08	09	10	11	12		
	Camera:												Total	# of
Species	02	03	04	05	06	07	08	09	10	11	12	01	Events	Stations
Bobcat				5		2		1				2	10	4
California Quail													0	0
Coyote	1	2	1	7		4	18	1		1	2	1	38	10
Mule Deer			2	18	1	1							22	4
Opossum													0	0
Grey Fox													0	0
Greater Roadrunner		1									1		2	2
Black-Tailed Jackrabbit													0	0
Striped Skunk												1	1	1
Owl													0	0
Raccoon		1		1	1	9			1				13	5
California Ground Squirrel					3								3	1
Rabbit							1				2	1	4	3
Total Events	1	4	3	31	5	16	19	2	1	1	5	5	93	
Species Count	1	3	2	4	3	4	2	2	1	1	3	4	8	

Sample: 014 Start Date: Oct 22, 2014 End Date: Oct 29, 2014

	Station:													
	01	02	03	04	05	06	07	08	09	10	11	12		
	Camera:												Total	# of
Category	02	03	04	05	06	07	08	09	10	11	12	01	Events	Stations
Human on Bicycle	22	81											103	2
Domestic dog	1	1								2	2	1	7	5
Human on Horse	2	2											4	2
Domestic Cat													0	0
Human on OHV										3	2		5	2
Human	331	204	4	2		3				5	7		556	7
Human with Dog	50	53											103	2
Human in Automobile	3	12			1	1							17	4
Total Events	409	353	4	2	1	4	0	0	0	10	11	1	795	
Species Count	6	6	1	1	1	2	0	0	0	3	3	1	7	