



**Wildlife Conservation Recommendations for I-10 Fencing of
Davidson Canyon Corridor
within the
Rincon – Whetstone – Santa Rita Wildlife Linkage, 2017**



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Introduction

Sky Island Alliance protects and restores the biodiversity and natural heritage of the Sky Islands. We use science, education, and advocacy to connect the binational landscapes, people, and wildlife of the Sky Islands for the benefit of all. With the support of Patagonia Inc. Corporate Grant Program, Sky Island Alliance conducted a wildlife conservation study for Davidson Canyon corridor in 2017. We have focused this research on: 1) reporting wildlife use of this corridor; 2) providing recommendations for fencing that facilitate safe wildlife passage through the section of the corridor traversing Interstate 10; and 3) reporting the corridor's spring resource conditions. This corridor is a key component of a critical regional wildlife linkage, that spans from the Santa Rita Mountains east to the Whetstone Mountains and from the Santa Rita Mountains north to the Rincon Mountains. This wildlife linkage facilitates passage of animals from Sky Islands south of Interstate 10 to the Sky Islands north of Interstate 10, providing connectivity between core montane wildlife habitats. This wildlife corridor and the Davidson/Cienega Creek groundwater system remain threatened by the proposed Rosemont Copper mine which if built would be situated in the northern Santa Rita Mountains.

The two goals of this project are:

- 1) Collect necessary data on wildlife and information on existing barriers to understand requirements for safe wildlife passage within the Davidson Canyon Corridor. Identify fence modifications necessary to achieve a functional wildlife linkage, and make survey-informed corridor stewardship and restoration recommendations to agency partners.
- 2) Gather baseline data on springs within the Davidson Canyon Corridor. Share their importance with agencies and stakeholders and identify strategies to protect water for wildlife, and to monitor impacts to the regional hydrologic system, expressed through springs.

Location and Land Ownership

The Davidson Canyon wildlife corridor is part of the Rincon – Whetstone – Santa Rita Wildlife Linkage (No. 94) identified in Arizona's Wildlife Linkages Assessment (2006) by Arizona Game and Fish Department and Arizona Department of Transportation.¹ This linkage is in the Arizona Department of Transportation (ADOT) Engineering Districts of Safford and Tucson. It is in the ADOT Maintenance divisions of Nogales, St. David, and Tucson North and South. It is also within the ADOT Natural Resources Management Section of Tucson. The linkage occurs within Arizona Game and Fish Department Region 5. The landownership is majority State Trust Land (>65%), followed by private land, Pima County, and Bureau of Land Management.

Ecosystems and Wildlife

The linkage is composed of primarily semi-desert grassland and contains numerous desert wash systems, of which Davidson Canyon and Cienega Creek are the two most prominent and ecologically valuable to wildlife. The large mammals documented using this linkage include: black bear (*Ursus americanus*), mountain lion (*Felis concolor*), and mule deer (*Odocoileus hemionus*). Medium and smaller wildlife using this corridor include: javelina (*Tayassu tajacu*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), and Virginia's (Mexican) opossum (*Didelphis virginiana californica*). Also, occurring are the larger reptiles including: ornate box turtle (*Terrapne ornate*), Sonoran desert tortoise (*Gopherus agassizii*), and the Gila monster (*Heloderma suspectum*) (Sky Island Alliance track surveys 2002-2017). Sky Island Alliance has identified Davidson Canyon and the larger Rincon-Whetstone-Santa Rita landscape linkage (described above), as high priority to conserve wildlife connectivity in the U.S./Mexico Madrean Sky Islands (Figures 1 and 2).

Figure 1. Area map of the Davidson Canyon and Rincon – Whetstone – Santa Rita Wildlife Linkage.

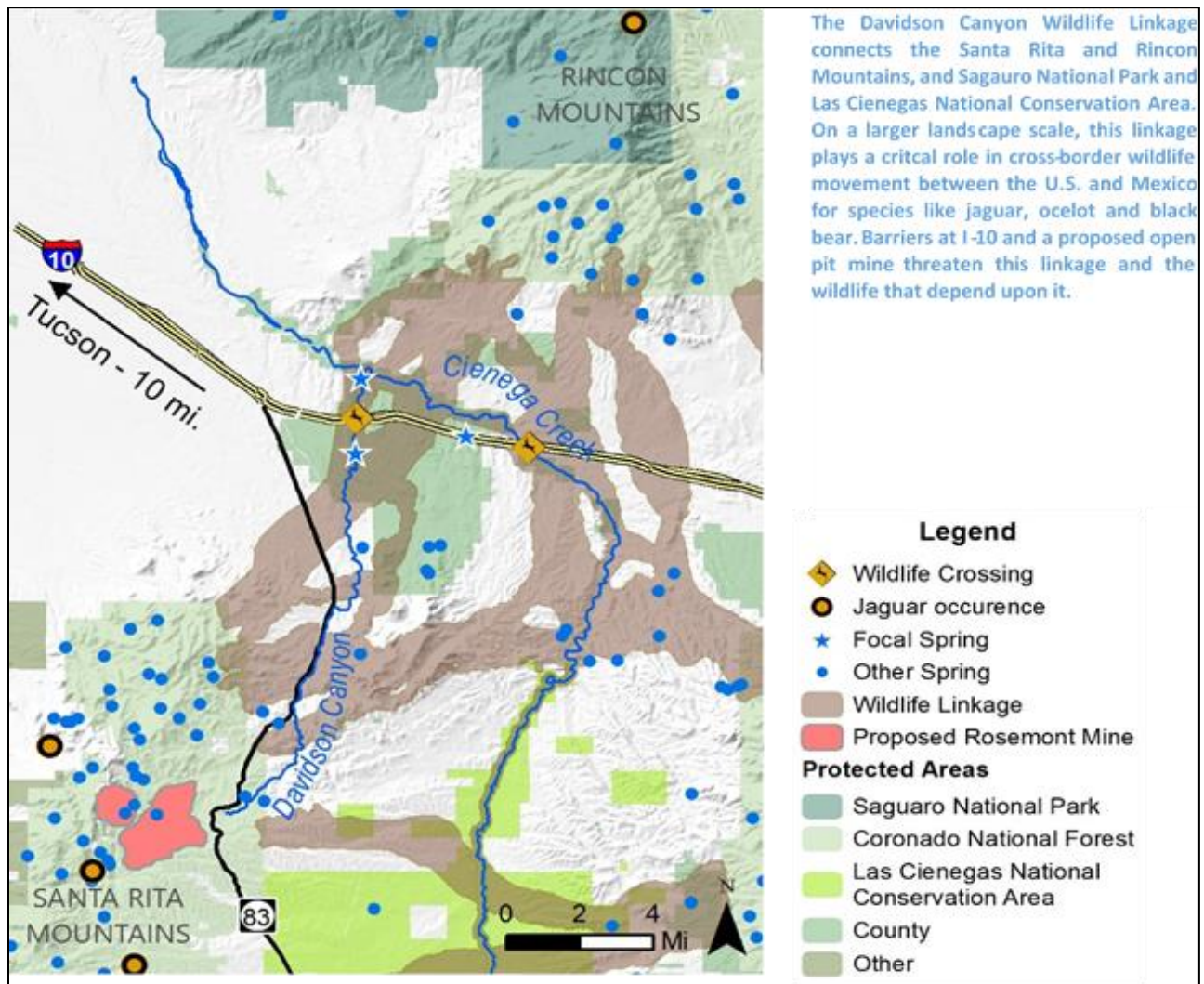


Figure 2. Davidson Canyon, east and west bound bridges, March 2017.



Wildlife Monitoring Report

Conserving or providing safe passage for wildlife across the broader Madrean Archipelago is a goal of Sky Island Alliance. We are particularly focused on providing safe passage for wildlife across the barrier of Interstate 10 because, along with Highway 2 in Mexico, these highways are the major habitat dividing anthropogenic features for wildlife dispersing north-south in their movements within the Sky Island region. Existing and proposed expansion of US-Mexico border fence/wall infrastructure also constitutes another major wildlife barrier we are concerned and focused on mitigating. Existing bridges and culverts across Interstate highways can be a valuable resource for overcoming barriers to regional wildlife movement if they are well positioned in the landscape, properly designed, have proper fencing, and are supported with surrounding land uses that promote their use.

Davidson Canyon and Cienega Creek are two riparian corridors with sufficient cover, water, and food to support wide-ranging wildlife moving between the Santa Mountains and the Rincon Mountains. Additionally, they are ideal corridors for ensuring safe wildlife passage under Interstate 10 because of the highway bridges present in these areas. Additionally, these passageways are within Pima County conservation managed lands, with Pima County's Cienega Creek Natural Preserve to the north, and the Pima County held Bar V grazing allotment of the Arizona State Land Department to the south. Noting the importance of the Davidson Canyon corridor for wildlife movement due to its high bridges and other above factors, in 2002 Sky Island Alliance initiated a wildlife monitoring study for the corridor. We have deployed trained citizen-science volunteers

conducting seasonal track surveys along a 1.5 mile transect from 2002 through 2017 in North Davidson Canyon and from 2006 through 2013 in South Davidson Canyon. We have since added motion-detection wildlife cameras in the summer of 2017 north and south of Interstate 10 at spring sites, and will have more information as to their wildlife documentation in 2018 and on into the future (Figures 3, 4, and 5).

We document here our findings of wildlife monitoring in Davidson Canyon over the last sixteen years. We had two wildlife tracking teams operating in this canyon, one team north of Interstate 10 and one team south of Interstate 10. Tracking teams identified all encountered wildlife track sets to species. We present here the presence/absence and mean detection rate by “focal species” for each year surveyed, as well as the overall mean detection rate of focal species. Focal species are those terrestrial species which have the potential to move longer distances within the Sky Island region, and are capable of being readily identifiable and monitored from prints in the substrate within a tracking transect. Additionally, focal species represent the range of regional wildlife mobility, dispersal distances, home range sizes, corridor occupancy duration, and rarity within the Sky Island region. Focal species include: jaguar, ocelot, Mexican wolf, black bear, mountain lion, bobcat, coati, ornate box turtle, and Virginia’s (Mexican) opossum. To date we have not detected jaguar, ocelot, or Mexican wolf using this wildlife linkage or the Davidson Canyon corridor. Other wildlife, were also recorded, and include local area populations of deer, javelina, raccoon, coyote, gray fox, and skunk.

Figure 3. Bobcat within Davidson Canyon (North) near Interstate 10 crossing, September 2017.



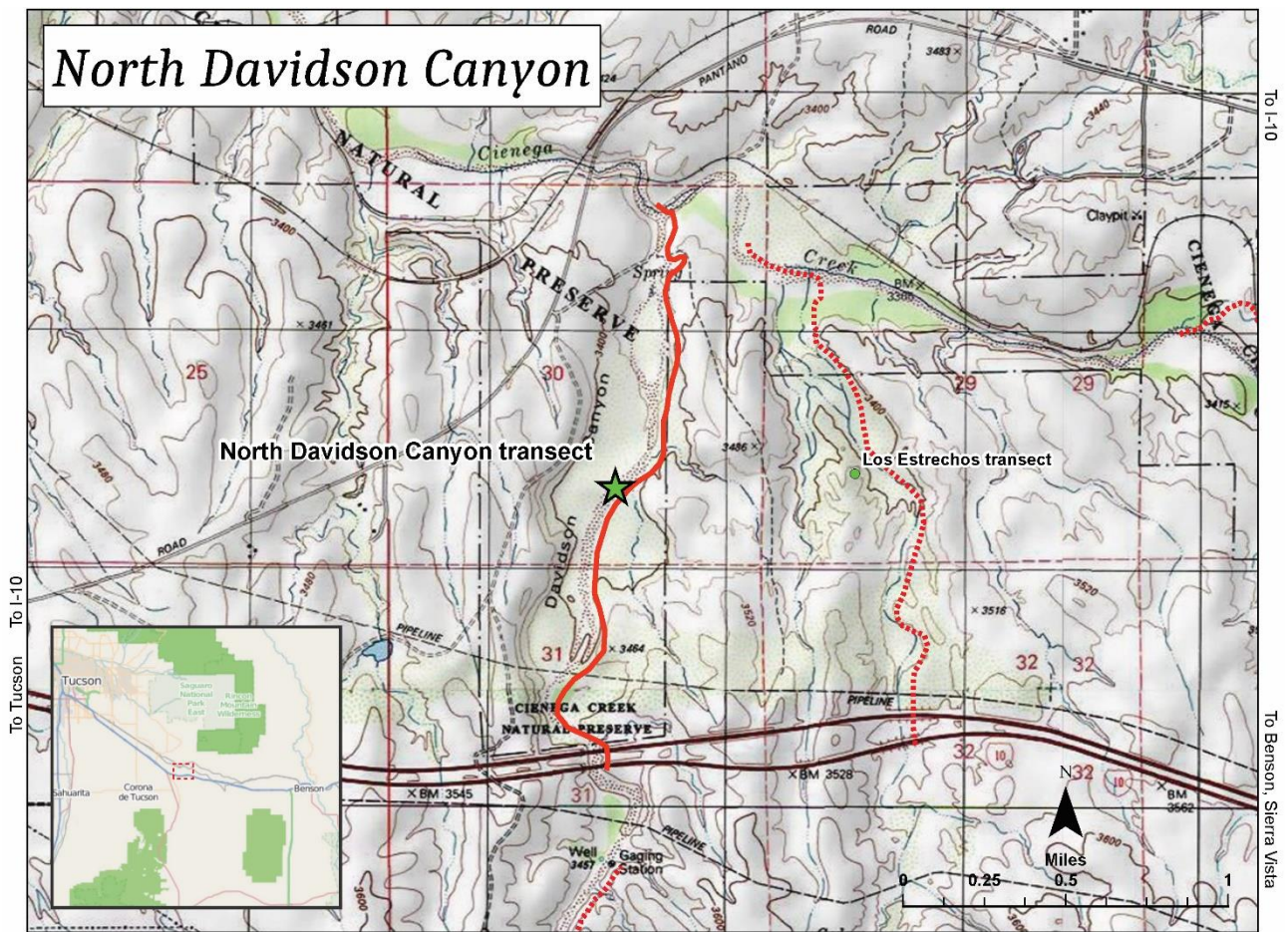
Figure 4. Black bear within Davidson Canyon (North) in route to Interstate 10 crossing, November 2017.



Figure 5. Mule Deer within Davidson Canyon (South) in route to Interstate 10 crossing, July 2017.



North Davidson Transect



North Davidson Canyon Wildlife Detection Summary from Tracking Surveys (this transect remains actively surveyed): Bobcat were the most consistent focal species detected on this transect. We observed a small peak in bobcat numbers for 2-3 years, a dip in numbers, and then another small peak (as evidenced by detection rates). White-nosed coati were also very consistently recorded, and may be becoming more common. The year 2017 had the highest detection rate for coati in the last 16 years. Mountain lions and black bears are present, but in low abundance, as expected. Mexican opossum is a recent arrival in this part of the corridor, and has likely moved northward from Mexico, where the core of the specie’s range is centered (Figure 6, 7, 8, and 9). Overall, bobcats and coati are more mobile than others in their size range, and are regularly present within this corridor, making them notably vulnerable to roadkill if they were to stray from the canyon bottom. Black bears and mountain lion which use the this section of the corridor, probably yearly, are also notably vulnerable to the threat of vehicle-mortality if they were to wander up onto the highway in their passage.

Figure 6. Focal species occurrence from track/sign surveys in North Davidson Canyon (no surveys in 2011).

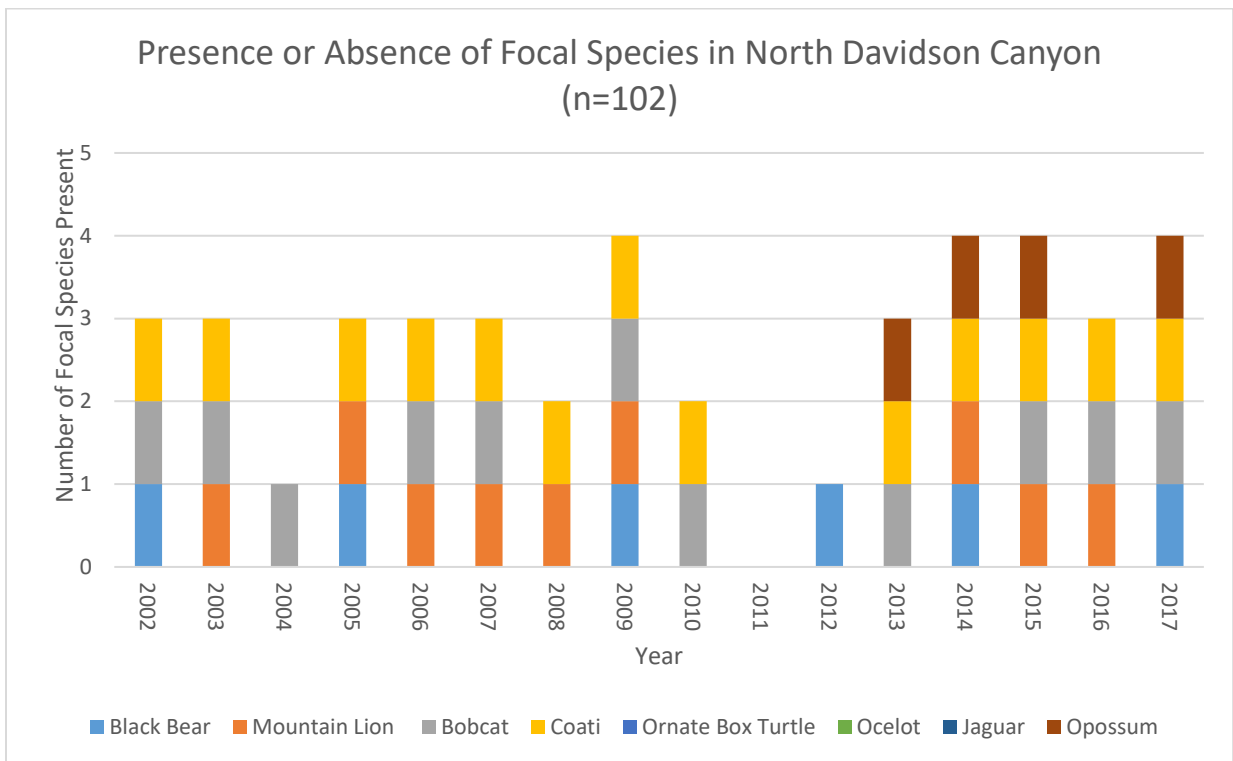


Figure 7. Mean track detection rate for focal species by year within North Davidson Canyon

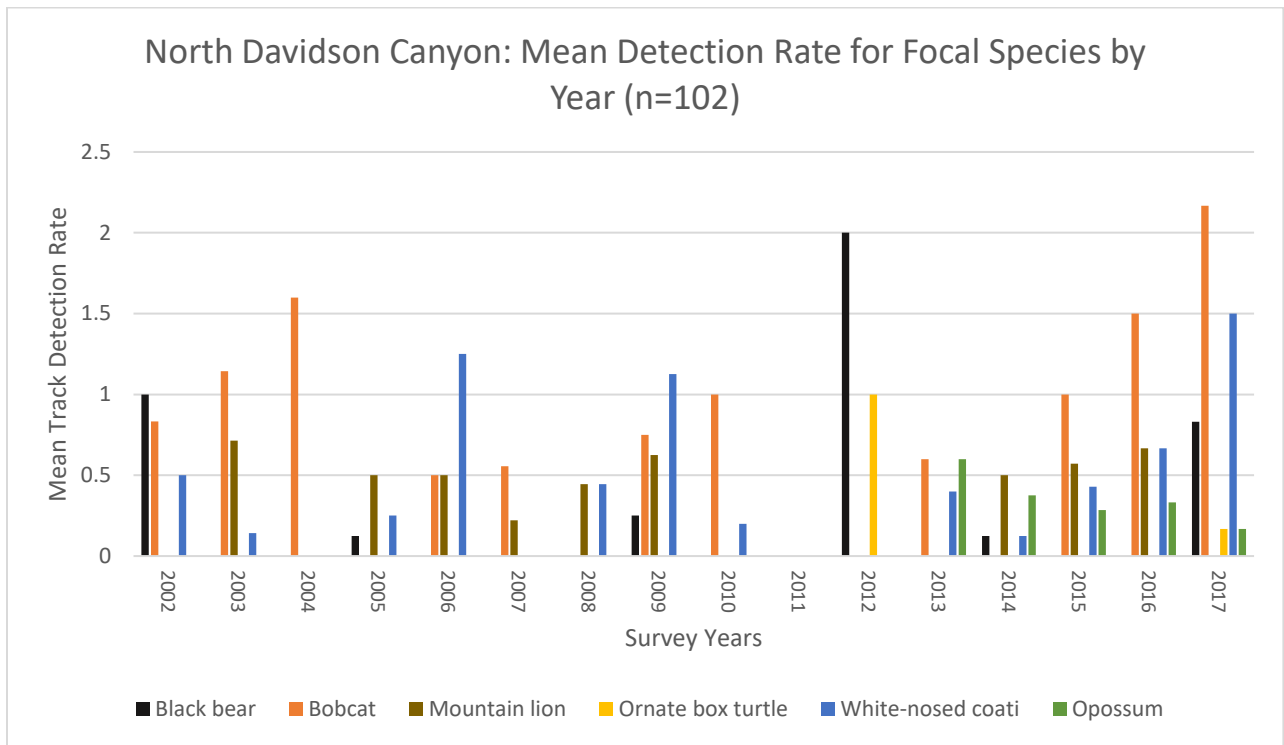


Figure 8. Total mean track detection rate for specific focal species for all years within North Davidson Canyon

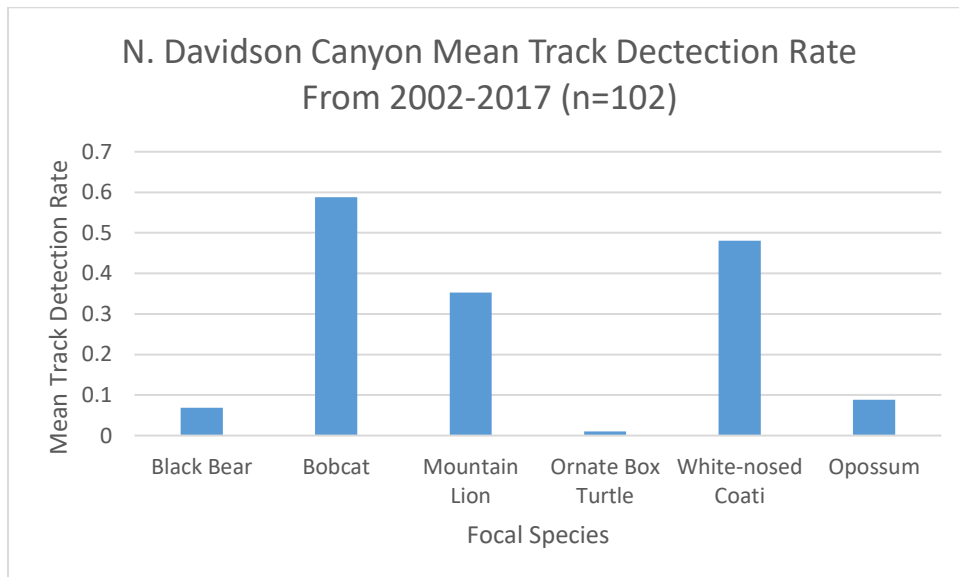
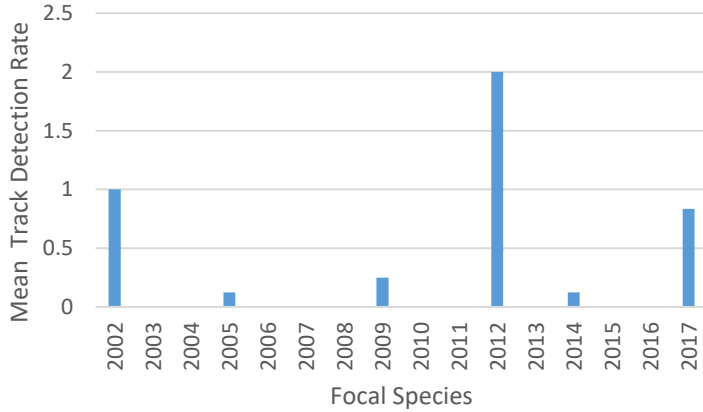
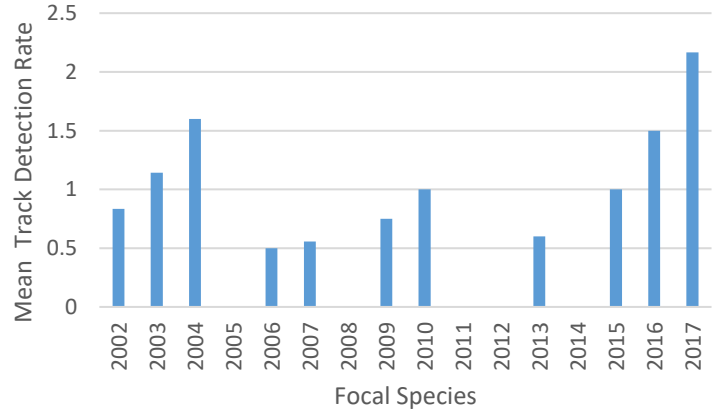


Figure 9. Mean track detection rate for focal species by year within North Davidson Canyon.

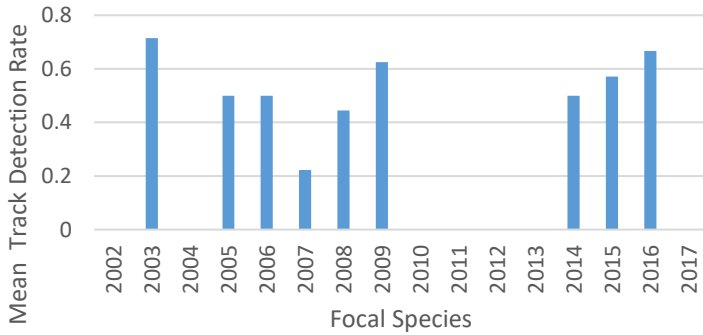
Mean Track Detection Rate for Black Bear from 2002-2017 (n=102)



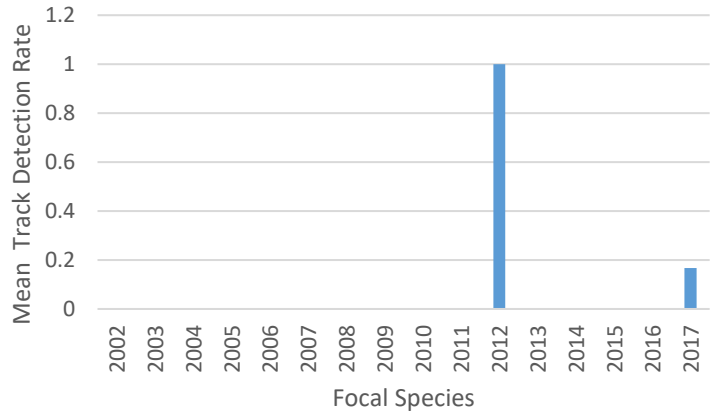
Mean Track Detection Rate for Bobcat from 2002-2017 (n=102)



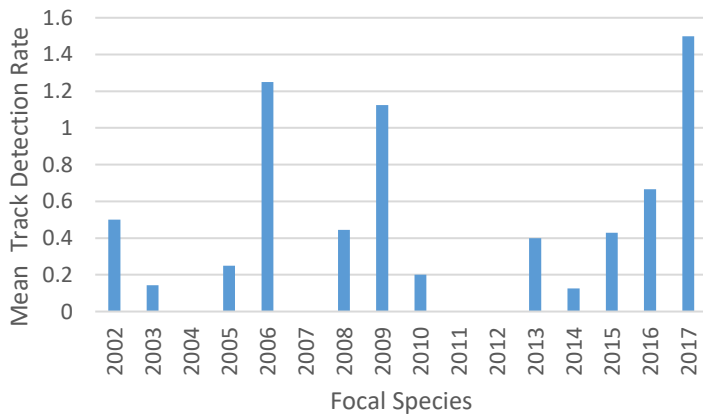
Mean Track Detection Rate for Mountain Lion from 2002-2017 (n=102)



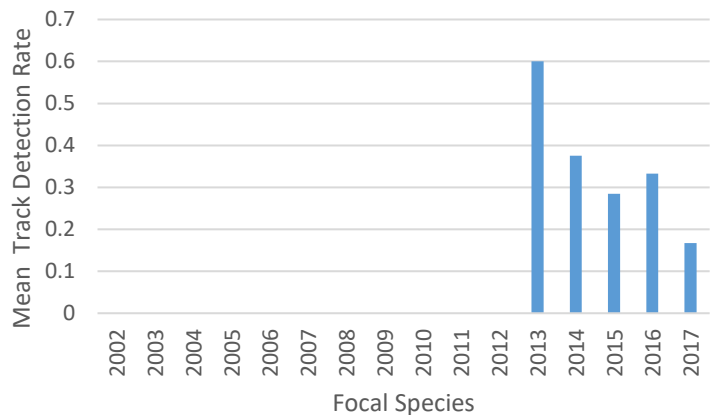
Mean Track Detection Rate for Ornate Box Turtle from 2002-2017 (n=102)



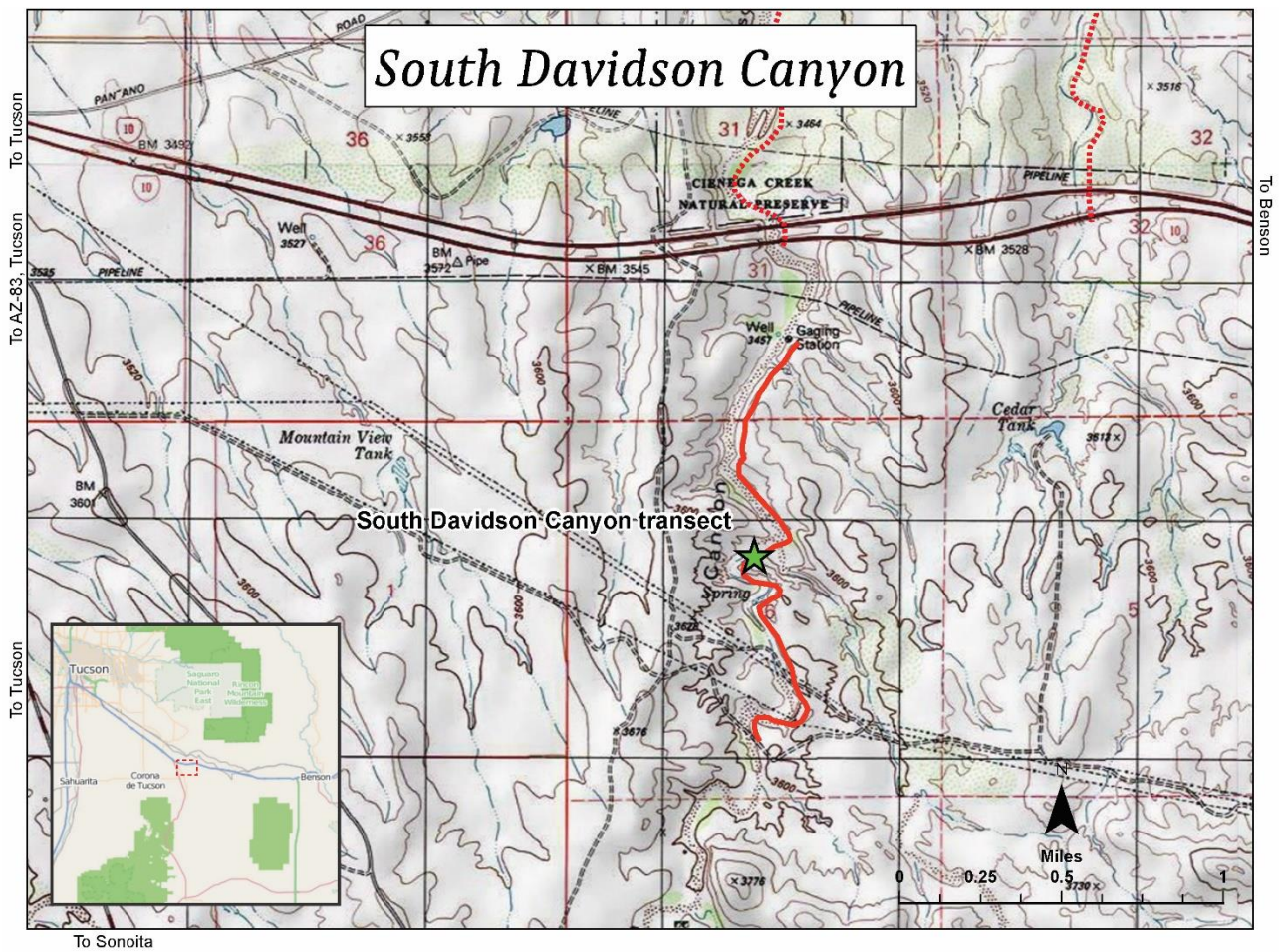
Mean Track Detection Rate for White-nosed Coati from 2002-2017 (n=102)



Mean Track Detection Rate for Opossum from 2002-2017 (n=102)



South Davidson Transect



South Davidson Canyon Wildlife Detection Summary from Tracking Surveys: Mountain lion were the most consistent focal species detected in this portion of the corridor, and were present in 7 of the 8 years surveyed. The detection rate suggests there may be a mated pair within the region. Bobcat abundance may be cyclic, with two small peaks in detection rate observed in the data, but surprisingly not in the same pattern with North Davidson Canyon. Black bear were periodically present in the corridor, and this may represent dispersal of young bears. Interestingly, the Mexican opossum was not detected in the south corridor, which might be due to limitations of particular surveyors (lack of awareness), and/or the more recent arrival of the species (2013 forward) in the corridor (Figures 10, 11, 12, 13). Overall, our documentation of frequent mountain lion and less frequent black bear (bears probably dispersing northward), leads to our heightened concern for both these species, and ensuring their safe passage under the highway.

Figure 10. Focal species occurrence from track/sign surveys within South Davidson Canyon.

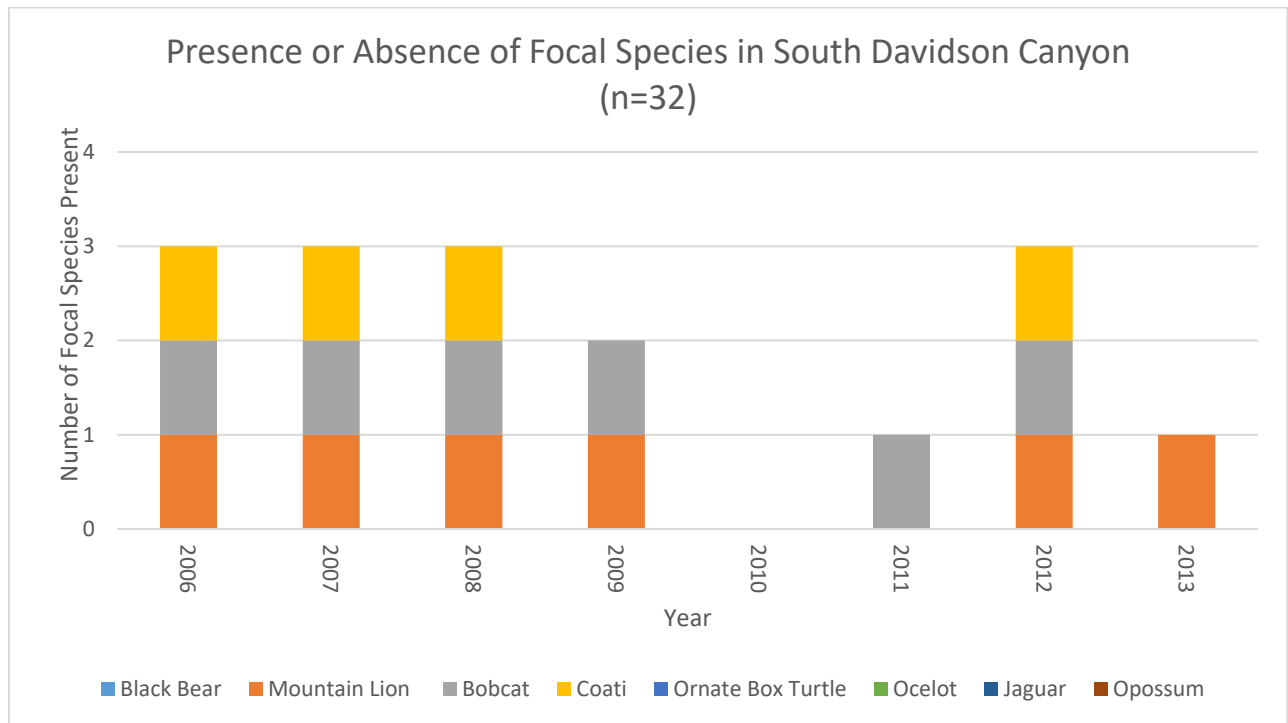


Figure 11. Mean track detection rate for focal species by year within South Davidson Canyon

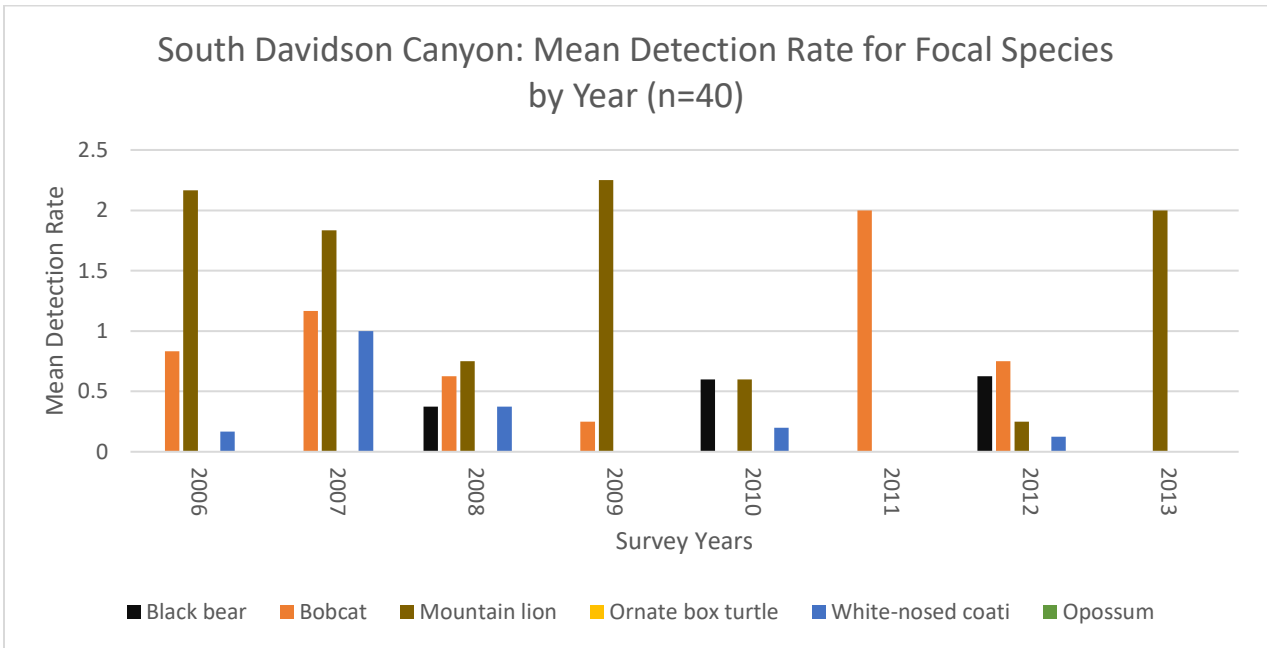


Figure 12. Total Mean Track Detection rate for specific focal species for all years within South Davidson Canyon.

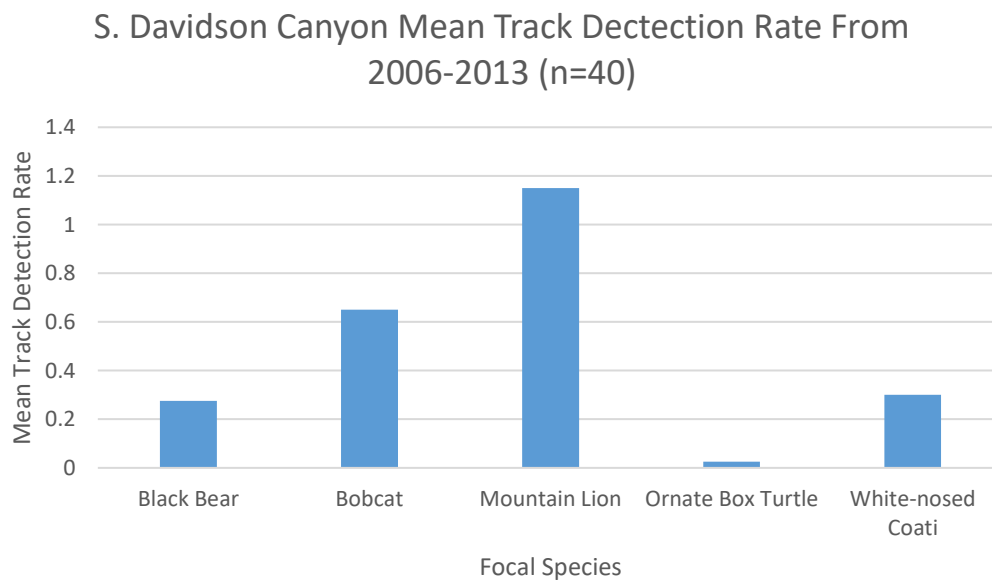
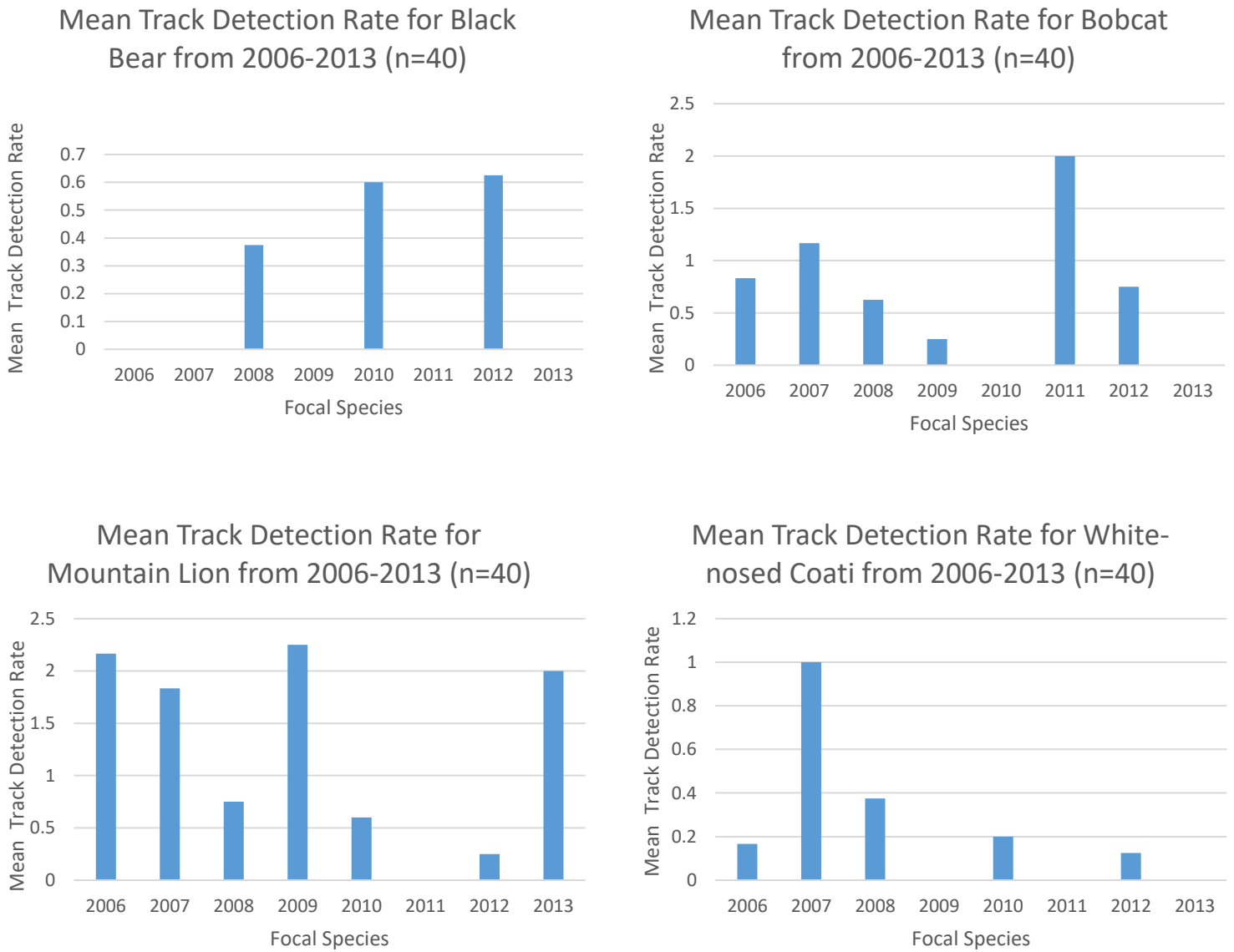


Figure 13. Mean track detection rate for focal species by year within South Davidson Canyon.



Ornate box turtle and opossum were not detected from 2006 to 2013 (n=40 surveys) in South Davidson Canyon.

Wildlife Cameras: Located in both North & South Davidson Canyon

Wildlife camera data is too recent to draw conclusions (~5 months). So far two focal species to date have been detected: bobcat and black bear.

Wildlife Concerns Summary

Davidson Canyon and the larger wildlife linkage are critical habitats for wildlife movement in the Sky Island region. Davidson Canyon is a key pinch point within a nearly continuous habitat connection from Mexico. This habitat connection spans across the international border, where there is currently viable passage, northward (with only ~1-2 paved two-lane road-crossings), through an unfragmented landscape connection to some of the best intact open space habitat north of I-10, within the Rincon, Lower San Pedro, Galiuro wild areas. The Davidson Canyon corridor has been shown to support a suite of wide-ranging large to medium-sized mammals that depend on relatively intact connecting habitat to move between Sky Island mountain ranges to maintain their regional populations. This corridor is particularly important for mountain lion and black bear regional population connectivity. Tracking data showing the use of this corridor by both these species. Mountain lion may be more regular in their occurrence (occurring through all the seasons), with their large home ranges overlapping the corridor, but dispersing individuals may also use the corridor. Black bear are more likely using the corridor in their dispersal movements, likely between the Rincon Mountains/lower San Pedro valley and the Santa Rita Mountains/Las Cienegas valley. Bobcat, mule deer and javelina are often present in the corridor. We are concerned that the current fencing conditions (see below) may allow all these species access to Interstate 10, resulting in animal mortality and dangerous encounters for motorists.

Fence Report & Recommendations

On September 28, 2006, a black bear was killed while attempting to cross I-10 within 1/2 mile of Davidson Canyon bridges (Figure 14)². Proper wildlife fences in the area were not, and are still not, adequately installed to direct animals off the highway and towards potentially safer crossing areas like Davidson Canyon, Cienega Creek, and large culverts. Unfortunately this type of tragic event is all too common, but often goes unreported and unnoticed.

Figure 14. Black bear mortality along Interstate 10 in the vicinity of Davidson Canyon, 2006.



Recent studies have shown that highway crossing structures without associated wildlife fencing have no effect on animal road-kill rates, whereas those with proper fencing guide wildlife to the structures, and keep them off of highways.³ This can result in 83% fewer road-kill incidents for large mammals. Properly designed fencing can also decrease the likelihood of medium and small-sized animals such as bobcat, coati, tortoises, rodents, and snakes, etc., to dying on the road.

We present here fence conditions at Davidson Canyon as they relate to protection of wildlife from mortality on Interstate 10. We also provide fence recommendations for preventing dangerous access by wildlife to the highway and facilitating wildlife movement through Davidson Canyon under the east and west bound bridges (this applies to Cienega Creek corridor as well).

On March 28, 2017 staff from Sky Island Alliance visited the Davidson Canyon I-10 area to investigate its suitability and safety as a highway underpass for wildlife.^{4,5} Our investigation focused primarily on the approach and under bridge fencing conditions of Davidson Canyon (Figure 15). During our investigations we found indications that coyote, mountain lion, and Gila monster had all used various passageways under I-10 in days prior to our visit. The tracks of these animals using Davidson Canyon and nearby culverts to cross under I-10 were certainly good to see and raised our hope that this area could serve as a safe passage for a variety of animal species. Unfortunately, while we determined that the bridge height benefits the potential use by wildlife, we found the fencing around the bridge and along the I-10 corridor near the bridge to be inadequate for keeping wildlife off of the highway and directing it to this and other safe underpasses in the area.

Currently the fencing that exists along I-10 in the vicinity of the bridges consists of 4 and 5-strand barbed wire, which is designed only to keep cattle off the roadway. During our visit, we found some areas of fencing were in such a state of disrepair that they were barely functioning in this capacity, if at all. As can be seen in photographs (Figures 16-map, 17, 18, 19, 20, 21, 22, 23 and images 3376, 3385, 3386, 3387, 3369, 3359, 3399) barbed wire fencing is in such a state of disrepair that there is a good chance that it could be crossed by even livestock with relative ease. Unfortunately, even if these fences were in good shape, they would do nothing to limit the movement of wild animals onto this highway since native wildlife species would easily go over or under these fences.

Figure 15. Looking north at the east and west bound bridges of Davidson Canyon.



Summary of Davidson Canyon Fences (May 2017)

Southeast Parallel I-10 (Turquoise): New 5-strand, not sufficient. Photos: 3391-3392, 3398-3399

Northwest Parallel I-10 (Green): Old 4-strand, very sagging or sunk in spots. Photos: 3374-3376

West Cross I-10 (Purple): Under bridges West; new 4-strand under bridge, not sufficient. Photos: 3368-3371

Southwest Parallel I-10 (Brown): New 5-strand, not sufficient. Photos: 3359-3361

East Cross I-10 (Blue): Under bridges East; old 4-strand, not sufficient. Photo: 3387

Northeast Parallel I-10 (Magenta): Old and new, 4-strand, short, fence down at base of slope. Photos: 3377-3380, 3385-3386

Figure 16. Map of fences and photo numbers at Davidson Canyon Corridor.

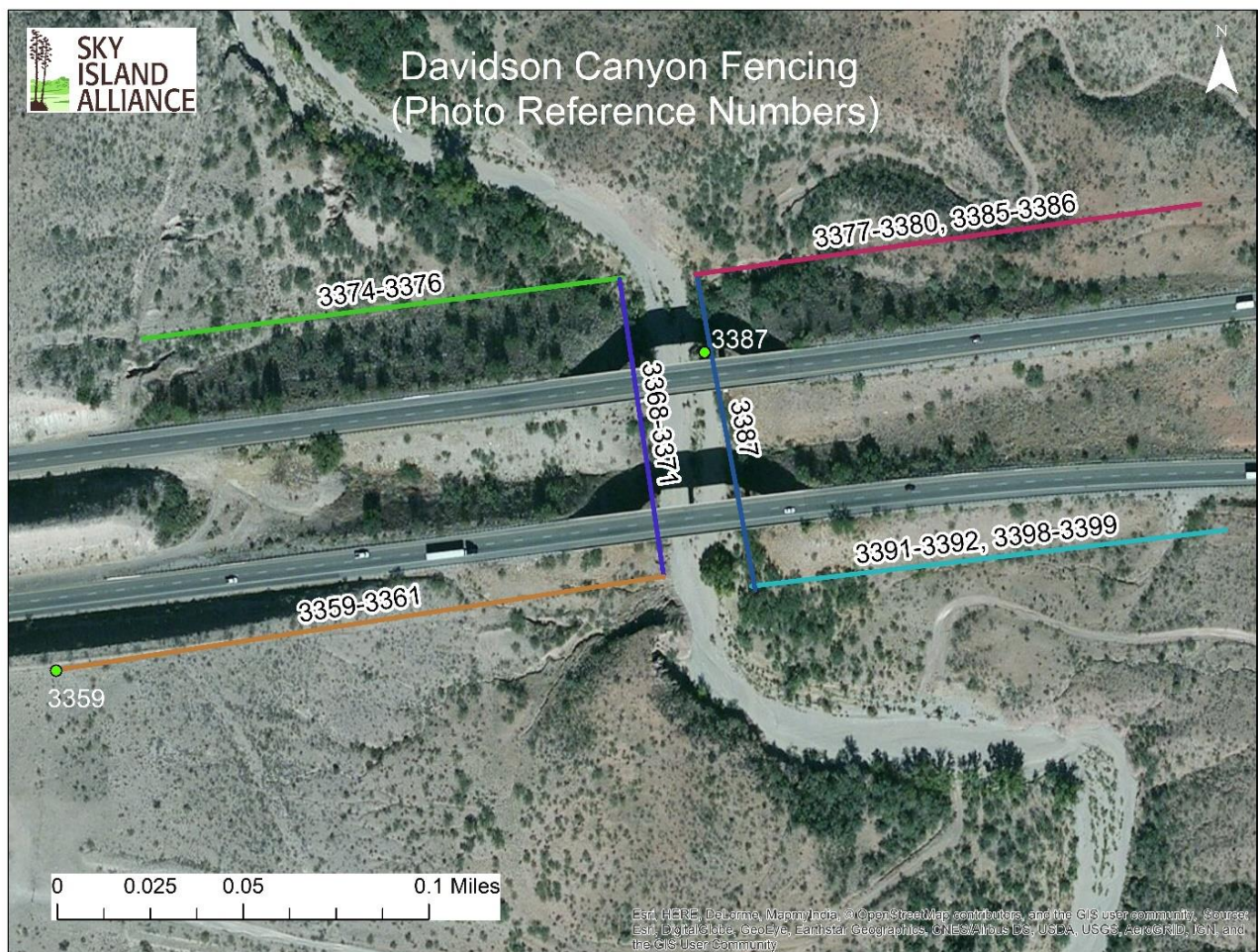


Figure 17. Photo: 3376. Fence saggy and sunk.

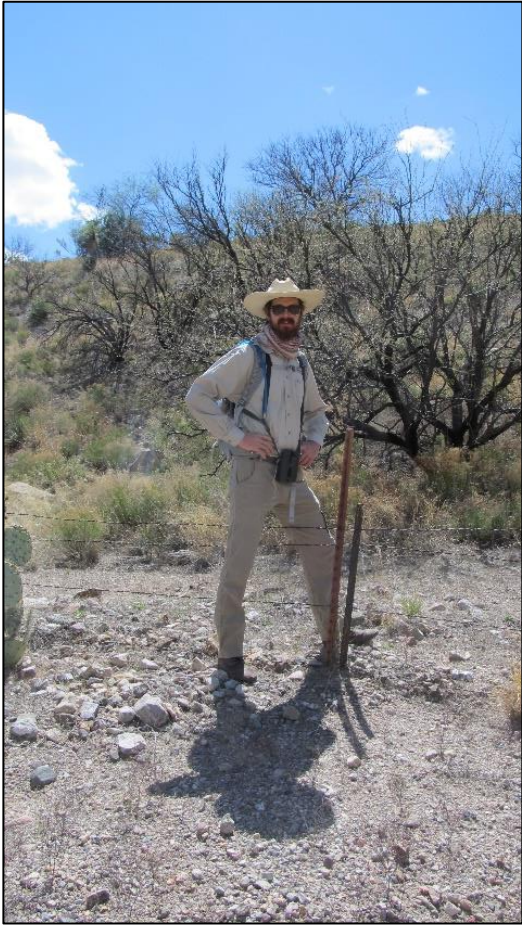


Figure 18. Photo: 3385. Fence down and in disarray.



Figure 19. Photo 3386. Fence down caused by rock slide.



Figure 20. Photo 3387. Insufficient fencing under bridges.



Figure 21. 3369. Insufficient fencing under bridges.



Figure 22. Photo 3359. 4-strand fence meets non-wildlife standard 5-strand highway fence.



Figure 23. Photo 3399. Highway 5-strand fence.



The addition of proper fencing along the highway and under the bridges, and fencing along the approach to certain culverts would ensure more species would be safely funneled under the highway. In order to provide the safe passage for wildlife of all types, wildlife specific fencing is needed with the following minimum measures:

- Woven-wire fencing at least 8 feet tall with additional denser mesh fencing attached to the lower portions of the fence to keep smaller animals from crossing the barrier
- Attachment of a 4-5 feet wide section of galvanized fencing to the bottom of the fence, buried at an angle away from the highway at a depth of about 3 feet below ground level in order to protect against certain animals such as bear, badger, and coyote from digging under the fence to enter the roadway
- Fencing should extend for a significant distance westward (at least 1 mile) from the western edge of Davidson Canyon, placed all through middle area of the linkage, and eastwards a significant distance (at least 1 mile), from the eastern edge of the east linkage strand (Wakefield/Anderson Canyon strand) in this broad area, to ensure that animals are directed to safe crossing points, and prevent animals from walking around the fence and crossing the highway elsewhere in this linkage (the Cornfield Canyon linkage strand should also be evaluated and buffered accordingly)

Further study and analysis would be required to make recommendations about the exact places to begin and end such fencing measures (with local topography considered).

Springs Report

We spent one field day (5/23/17) during the driest time of the year assessing three springs on Pima County land and within an ADOT culvert in the Davidson Canyon area (See Figure 1 “blue stars”, and attached springs reports, Appendices A-C, all are unnamed springs). Conducting the survey during this time of year allowed us to see the minimum flows at these springs. We conducted full assessments at the two springs in Davidson Canyon itself. The north unnamed spring is about a mile north of the Interstate near the canyon’s confluence with Cienega Creek, and the south unnamed spring is approximately a mile south of the Interstate. Full spring assessments consist of recording spring type, flow rate, water chemistry, size and depth of pools, size of wetted area, solar exposure, geology, vegetation, fauna, site conditions, and micro-habitat mapping. We also installed wildlife cameras at each spring, and both springs are now part of our Adopt-a-Spring

program (AAS) at Sky Island Alliance, and will be monitored five times per year following a slightly less intensive survey protocol.

The spring north of the Interstate had no surface water, but we found saturated and damp soils at the site. The site supports diverse and lush riparian vegetation, and we observed 25 vertebrate species, including a number of riparian-dependent species. When AAS volunteers visited the site on 6/6/17, it was still dry, but by 8/5/17 it was flowing at 0.62 L/s (9.8 GPM). The spring south of the Interstate had a significant amount of water present during the dry season. We couldn't measure flow, but estimate that it was at least 0.5 L/s (8 GPM). The site also has healthy riparian vegetation and we observed 20 vertebrate species. When volunteers visited the spring on 8/1/17, the spring was flowing at a rate of approximately 0.92 L/s (14.6 GPM) and they observed tadpoles in the spring. Both of these springs appear to be in good condition, with water present all or much of the year and good cover and diversity of riparian vegetation. There are several invasive vegetation species present at each site, which should be addressed by removal. Our program can provide monitoring after this restoration action and going forward.

The northern spring provides wildlife a water source and an oasis site of meso-riparian habitat, but is only about 100m upstream of a perennial stretch of Cienega Creek, an additional water resource and extensive meso-riparian habitat. As such, the north Davidson spring is an important part of the wildlife corridor in the area, but probably not critical as a wildlife water source, as other surface water is usually very nearby in the creek. This spring has the potential to be over-used by recreationists and visitors to the area. We note many groups take pictures with people standing at the spring site, and our monitoring will document if site conditions worsen due to trampling, erosion, or trash accumulation, and will be valuable to Pima County to devise protective strategies.

The south Davidson spring, provides an important resource "way station" along the southern mostly dry Davidson Canyon wildlife corridor providing water, food, and a cooler moister micro-climate with supported meso-riparian habitat. The next spring to the south within Davidson Canyon is 3 miles or more away, and is on private land. Therefore, this location is particularly important during the driest and hottest time of year. Maintaining the aquifer to maintain the flows at this spring is important for the ecological support this spring provides within this critical corridor of the wildlife linkage. As this area of Arizona on the outskirts of Tucson continues to develop, increased groundwater pumping in the area could threaten this aquifer. Therefore development should be planned to minimize this threat and Pima County Planning and Zoning should be made aware of this spring's regional wildlife value. The proposed Rosemont copper mine is a significant threat to this aquifer as documented in Pima County letters to the Army Corps of Engineers in assessing this mine's potential impacts. We support Pima County in its concern and our spring monitoring data we believe can be useful in further Pima County reports concerning opposition to this proposed mine.

We also conducted a more limited spring assessment at a spring about 3 miles east of Davidson Canyon. This spring is “tapped” by a box ADOT culvert under Interstate 10, where water seeps out of seams in the concrete. While it does not provide riparian habitat, it may actually be quite important as a water source and for wildlife passage underneath the Interstate. The nearest springs are 3 miles away to the north and south, so the water here is probably important for smaller wildlife. We also observed Gila monster tracks that began on the north side and continued to the south side, demonstrating that wildlife do use this culvert. The most important thing to do at this site would be to put in wildlife friendly fencing at the entrances to the culvert – the current fencing is in a state of disrepair and may hinder wildlife use of the culvert.

Conclusions

Sky Island Alliance is committed to long-term conservation of Davidson Canyon and Cienega Creek. They are critical components of a larger wildlife linkage across Interstate 10 (R23 Pima County Riparian Movement Area: Davidson Canyon).⁵ We see the value of the new bridge work completed by the Arizona Department of Transportation over the last year, and recommend additional fencing work to ensure the safe passage of wildlife under these bridges and through existing large culverts. The current situation still allows wandering wildlife to access Interstate 10 and potentially experience collisions with vehicles, and perpetuates dangerous driving conditions for motorists who may be experiencing wildlife within the roadway.

In this report we have noted the current fencing conditions (as of spring/summer 2017). Fences are currently 4 or 5-strand (both old and new) and in places have sunk, sagged, or are damaged, down, and in disarray. We have provided initial recommendations for fence improvements within this report. Sky Island Alliance stands at the ready to work with the ADOT Biological Planning Team and engineers to refine and discuss these recommendations and to help promote and guide a new fencing project for this high value wildlife linkage. Fencing work completed within another wildlife linkage (L11 Pima County Landscape Movement Areas, Kitt Peak), along State Highway 86 between Three Points and Sells at the northern end of the Baboquivari Mountains, offers an example of improved wildlife protection through the facilitation of wildlife movement under this highway by proper wildlife fencing.

We will continue to monitor wildlife through wildlife tracking transects (1-North and soon to be 3 in 2018) and wildlife cameras (3 and soon to be 4 in 2018), within this critical wildlife linkage. We will conduct five surveys per year (winter, spring, dry summer, monsoon, and fall). As such we are constantly acquiring new information on wildlife species usage of this linkage, and within Davidson Canyon and Cienega Creek in particular. We would be happy to share this information at any point. We will also continue monitoring water quantity and quality at springs north and south of Interstate 10 within Davidson Canyon via 4-5 surveys per year. This data can be made available as well, as soon as we enter it into the Spring Stewardship Institute on-line database. We look

forward to continued communication with the Arizona Department of Transportation in 2018 to develop approaches to ensure connectivity and safe roadway passage for wildlife in southern Arizona. We would appreciate your response to this submitted report of wildlife conservation recommendations for Davidson Canyon/ Rincon – Whetstone – Santa Rita Wildlife Linkage in 2017, particularly in regards to the timing for potential fence improvements for the area.

Sincerely,

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References

1. Arizona Wildlife Linkages Workgroup. 2006. Arizona's Wildlife Linkages Assessment. http://www.azdot.gov/inside_adot/OES/AZ_WildLife_Linkages/PDF/assessment/arizona_wildlife_linkages_assessment.pdf.
2. iNaturalist observation. <https://www.inaturalist.org>
3. Rytwinski T., Soanes K., Jaeger JAG, Fahrig L., Findlay C.S., Houlahan J., et al. 2016. How Effective Is Road Mitigation at Reducing Road-Kill? A Meta-Analysis. PLoS ONE 11(11): e0166941. <https://doi.org/10.1371/journal.pone.0166941>
4. Atwood, T.C., Young, J.K., Beckmann, J.P., Breck, S.W., Fike, J., Rhodes Jr., O.E., and K.D. Bristow. 2011. Modeling connectivity of black bears in a desert sky island archipelago. USDA National Wildlife Research Center – Staff Publications. 1013. http://digitalcommons.unl.edu/icwdm_usdanwrc/1013
5. Arizona Game and Fish Department. 2012. The Pima County Wildlife Connectivity Assessment: Report on Stakeholder Input. 55 p.

References

Appendices A-C (See Attached)