

Progress Report

**Evaluation of Measures to Reduce
Wildlife-Vehicle Collisions and
Promote Connectivity in a Sonoran
Desert Environment – State Route
77**

Santa Catalina – Tortolita Mountain Corridor

Presented to the: Regional Transportation Authority



Submitted by the:
Arizona Game and Fish Department
Wildlife Contracts Branch



Collaborators Include:



INTRODUCTION

With continued human population growth and ongoing investment in transportation infrastructure, there is growing interest in excluding wildlife from roadways for safety reasons, in addition to maintaining landscape connectivity for wildlife populations (Bissonette and Adair 2008, Huijser et al. 2008). This concern has generated an interest in safe crossing structures for wildlife by both transportation and resource management agencies as a tool for mitigating the negative interactions between roadways and wildlife (Forman et al. 2003, Huijser et al. 2008).

Work toward habitat conservation has been a priority for Pima County since the inception of the Sonoran Desert Conservation Plan in 1999. In 2001, a team of biologists identified biologically-important lands. Part of this analysis included six “Critical Landscape Connections,” or lands that have been shown to have landscape barriers between protected areas. The Santa Catalina Mountains – Tortolita Mountains linkage is one of these Critical Landscape Connections.

Although connection of the unique sky island ecosystems in southern Arizona has long been a priority for many, in 2004 local stakeholders had the opportunity to identify specific areas where habitat connectivity efforts should be focused through a statewide workshop hosted by the Arizona Wildlife Linkages Workgroup (AWLW, Nordhaugen et al. 2006). This workshop identified 152 potential linkage zones across the state. Linkage #81 identified the importance of the connection between the Santa Catalina and Tortolita Mountains for various wildlife species, with State Route (SR) 77 as the primary barrier to wildlife movements (Figure 1). With the imminent widening of SR 77, it was essential to determine where efforts to provide connectivity should be focused. Through least-cost modelling efforts that included information for 9 different species and thorough linkage zone evaluations, three main corridors across SR 77 were identified (Beier et al. 2006). Ultimately, through coordination between multiple entities, that included natural resource and transportation and wildlife agencies, NGO’s and landowners, the main southernmost corridor was selected for wildlife crossing opportunities. In May 2006, Pima County residents voted for the half-cent excise tax to fund the Regional Transportation Plan, a comprehensive transportation plan including 2.1 billion dollars for transportation planning throughout Pima County. A portion of this funding is reserved to address wildlife connectivity and linkage plans associated with roadway development and improvement within Pima County. With financial support from Pima County’s Regional Transportation Authority (RTA), implementation of wildlife crossings became a reality when the RTA approved a total of \$11 million for a large wildlife overpass and a large wildlife underpass across SR 77 in 2009.

In 2014, the Arizona Department of Transportation (ADOT) began upgrading key sections of SR 77 within the identified corridor. As SR 77 is expanded and the two wildlife crossing structures are built, we are presented with a unique opportunity to evaluate conservation measures that will allow for the safe passage of wildlife across this roadway, while simultaneously increasing motorist safety. These wildlife crossing structures are located in a zone of high wildlife mortality (Ostergaard 2006, Sky Island Alliance, unpublished data) and – along with wildlife funnel fencing – are designed to reduce wildlife-vehicle collisions (WVCs).

Though wildlife crossing structures have recently become more common in North America as a means to enhance permeability and reduce wildlife-vehicle collisions for a range of wildlife species, there is limited information on the efficacy of crossing structures in promoting permeability in the Sonoran Desert. While examples of successful crossing structures for large animals exist in other ecosystems (Clevenger and Waltho 2000, Gagnon et al. 2011, Sawyer et al. 2012), this is the first time that an overpass will be constructed in the Sonoran Desert. It is within the context of the Sonoran Desert's unique habitat and species assemblages that we propose to implement a monitoring program to evaluate the effectiveness of the crossing structures in an effort to document the multiple species benefits that the structures are designed to provide.

Given the commitment by ADOT and RTA to ensure motorist safety and mitigate the effects of the newly constructed SR 77 on local wildlife populations, as well as its status as one of the first comprehensive efforts to promote wildlife connectivity within the Sonoran Desert, evaluation of the crossing structures on SR 77 is necessary to determine their success. Effectiveness monitoring will be conducted by the AGFD Wildlife Contracts Branch in cooperation with ADOT Environmental Planning Group, the Coalition for Sonoran Desert Protection, and Sky Island Alliance. Monitoring activities will include camera documentation of wildlife use of the passage structures and tracking of WVC incidence, and desert tortoise movement monitoring. ADOT Environmental Planning Group, in cooperation with AGFD, have already invested substantial resources into the incorporation of a wildlife video surveillance system at the overpass along with still cameras at the underpass. The Coalition for Sonoran Desert Protection has invested substantial resources into documenting wildlife occurrence in the vicinity of the project with their volunteer-supported Remote Wildlife Camera Project that they started in 2012. The Coalition has over 30 volunteers monitoring 18 motion-activated wildlife cameras in the project area. The Coalition has also been instrumental in garnering public support for the project. Sky Island Alliance conducts wildlife tracking workshops in the area, has a group of volunteers that regularly monitor transects for wildlife tracks, and has recently launched an iNaturalist project in the area (iNaturalist is an online platform that enables citizens to record wildlife sightings).

Information gathered from this monitoring effort will inform the design and management of future wildlife crossing projects for the benefit of multiple species across multiple ecosystems. The insights we gain from this project will be extremely valuable for finding solutions to wildlife-highway conflicts in southern Arizona and fill a significant information gap.

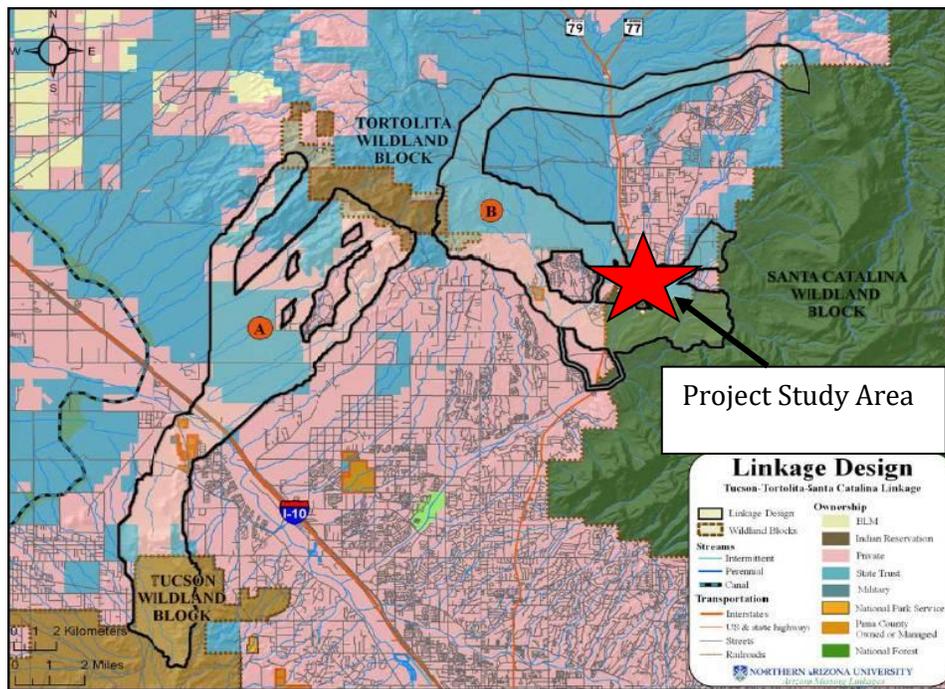


Figure 1. Least-cost linkage design for the Tucson, Tortolita, and Santa Catalina mountains and location of study area. Map from Beier et al. 2006.

RESEARCH OBJECTIVES

This project will utilize a staged approach to allow documentation of WVC and wildlife use of the overpass, underpass and associated funnel fencing. The specific objectives and associated procedures of our proposed SR 77 research project include:

1. Assess wildlife use and passage rates of the wildlife crossings using integrated video and still camera surveillance.
2. Investigate wildlife-vehicle collision patterns along SR 77.
3. Monitor movements of Sonoran Desert tortoise and activity centers in relation to SR 77.
4. Provide recommendations for the adaptive-management/maintenance of the structures and fencing as well as recommendations to guide future projects in southern Arizona.

Objective 1: Assess wildlife use and passage rates of the wildlife crossings using integrated video and still camera surveillance

Given the tremendous commitment by ADOT and RTA to provide wildlife crossing structures to reduce motorist collisions with wildlife and mitigate the impact of highway barrier effects, it is essential to evaluate their level of acceptance by Sonoran Desert wildlife. This is the primary objective of the post-construction monitoring study. To accomplish this objective,

we are using 8-camera video (overpass) and rapid-still frame cameras (e.g., Reconyx®, underpass). Video and still cameras provide detailed documentation of wildlife use and behavior in and near the newly constructed wildlife crossings along SR. We also installed backup Reconyx® cameras on the overpass to ensure no loss of data, in the event of short term video system failures. Long-term evaluation of the wildlife crossings is essential for a proper evaluation and future recommendations (Gagnon et al. 2011). All surveillance equipment was installed by AGFD and ADOT during the highway construction.



Figure 2. Structure surveillance system components: video camera with infra-red lights (left) with still camera (right) as backup documentation at the overpass and to capture wildlife use at the underpass.

- **Image data has been analyzed to June 21st, 2018**
- **We have documented 4418 crossings and 22 wildlife species at the overpass and underpass.**
- **We have documented 2477 and 1941 total crossings at the overpass and underpass respectively.**
- **2057 Mule Deer crossings have been recorded at the overpass against 220 crossings at the underpass.**
- **56 Javelina crossings have been documented at the overpass against 1006 crossings at the underpass.**
- **322 Coyote crossings have been observed at the overpass against 581 crossings at the underpass.**
- **There have been no further interruptions at the underpass since stolen cameras were replaced by ceiling mounted cameras in vandal resistant boxes in late 2016.**

- Trail cameras at the underpass were reinstalled in their original configuration in July 2017 due to observed usage trend anomalies since installation of ceiling mounted cameras.
- There has been no further cattle encroachment observed at the overpass since December 2017.
- We documented human use events on 121 and 396 occasions at the overpass and underpass, respectively

Table 1. Number of crossings by species collected through camera surveillance to June 21st, 2018.

6/21/2018	Number of Crossings		
Species	Overpass	Underpass	Combined
Mule Deer	2057	220	2277
Javelina	56	1006	1062
Coyote	322	581	903
Bobcat	19	110	129
Other	23	24	47
Totals	2477	1941	4418

Observed crossing trends at the overpass can be seen to be relatively consistent for all wildlife, and for Mule Deer specifically since the 4th month of monitoring (Figure 3). Trends at the underpass have been more difficult to track given the disruption to monitoring caused by theft of the original trail cameras. However, crossings accumulated at a similar rate at the underpass prior to theft in October 2016 and after reinstallation of the original orientation in July 2017. Crossing accumulation rates at both structures exhibited an accelerating trend from December 2017 into early 2018.

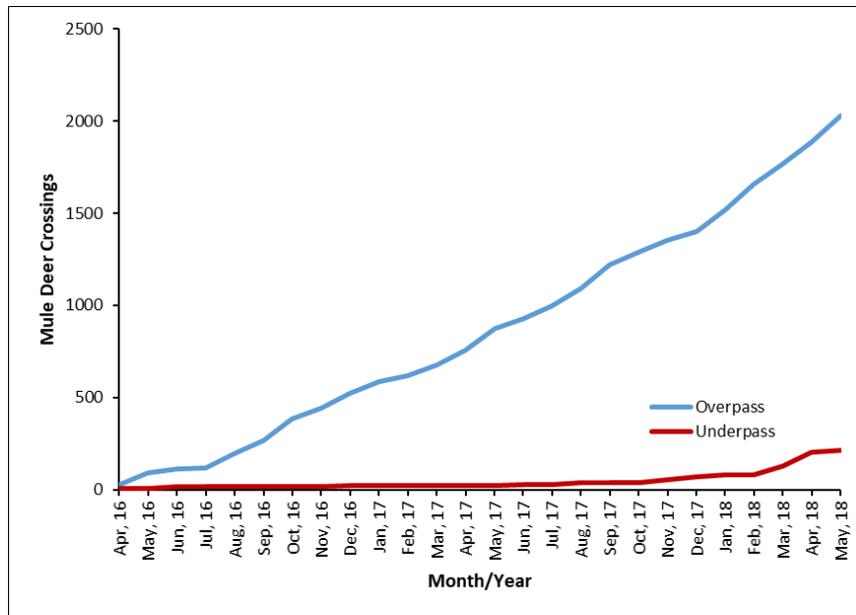
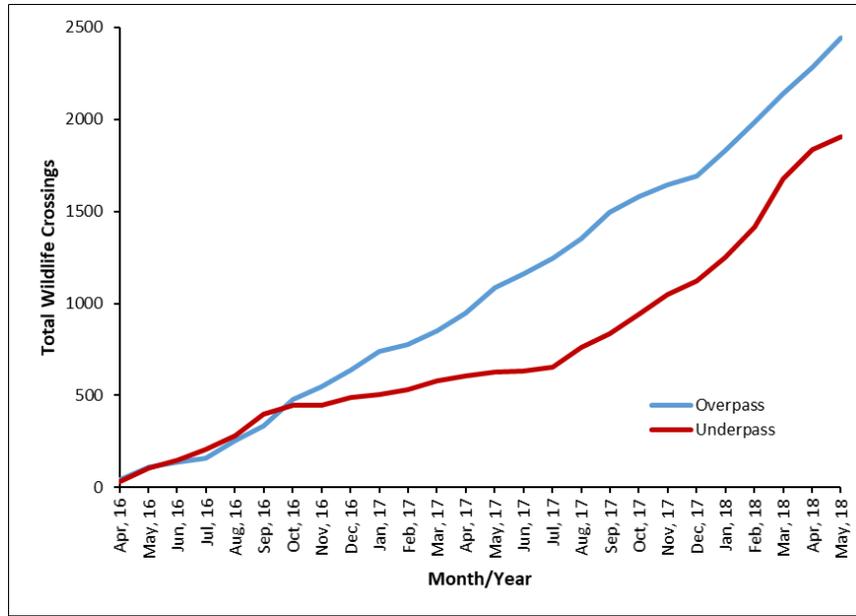


Figure 3. Total wildlife (top) and mule deer (bottom) use of the SR 77 overpass and underpass located on SR 77.



Figure 4. Examples of wildlife and non-wildlife events documented at the SR 77 overpass and underpass.

Objective 2: Investigate wildlife-vehicle collision patterns along SR 77

Determining the number and composition of roadkill following completion of the two wildlife crossings and funnel-fencing along the newly improved stretch of SR 77 will allow for understanding their combined effectiveness in reducing collisions for various species types (mammal, reptile, amphibian, bird). It is essential to thoroughly collect data on larger wildlife, which is a higher safety concern to motorists, and equally important to document road kill trends for smaller species important to the Sonoran Desert ecosystem. Studies conducted elsewhere in Pima County documented a large portion of game species along with other birds, mammals, reptiles and amphibians were killed on local roads. Although, pre-construction road kill data along SR 77 was “opportunistic” and emphasis was placed on large mammals, it nevertheless provided a sample of species found prior to construction (Ostergaard 2006). Additional intensive roadkill studies will be important to determine the effectiveness of the fencing in excluding both large and smaller animals from SR 77 and guiding them to wildlife crossings and culverts.

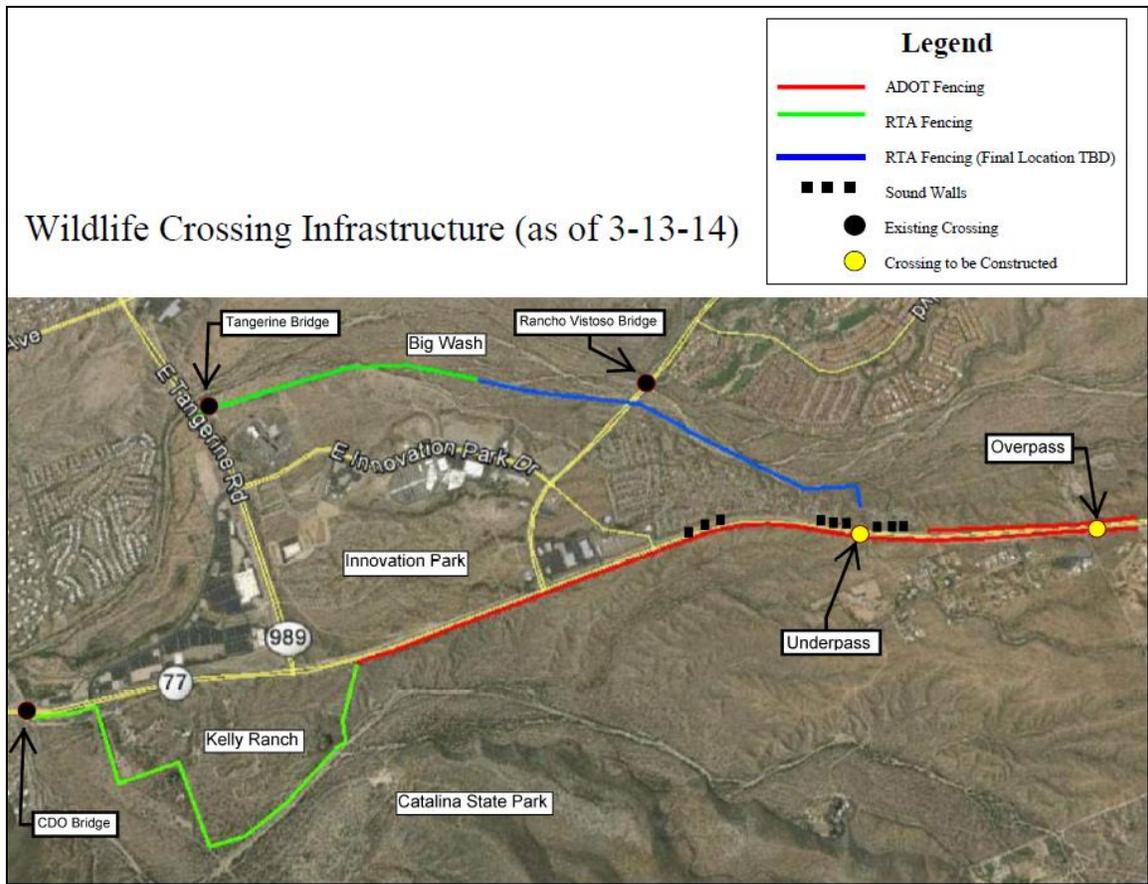


Figure 5. Map showing alignment of wildlife funnel-fencing and the complexities that will need to be accounted for (e.g. fencing distance from road) during road kill analysis. Map courtesy Coalition for Sonoran Desert Protection.

Funnel-fencing associated with most highway projects is generally placed along the right-of-way on each side of the road. Along the SR 77 project, designers have been forced to deviate

from this traditional alignment and take the fencing away from the road to avoid local communities/business (Figure 5). This orientation provides a unique opportunity to evaluate the effectiveness of fencing as it is pulled away from the road and encompasses additional habitat. These differences will be accounted for during road kill analysis and we will compare their relative effectiveness.

Roadway Walking Surveys

To accomplish this objective we will conduct road-kill surveys between MP 80.8 (CDO Bridge) and MP 86.0 (Hawser St) focusing on peak roadkill times identified through nearby mortality studies on Tangerine Road (Lowery et al. 2011). Road kill surveys will begin ½ hour before sunrise in order to minimize the loss of wildlife mortalities due to scavenger activity. We will document all road-killed wildlife by species and location. The complete road right-of-way will be surveyed (i.e., the area between the two right-of-way boundary fences). In areas where the wildlife funnel-fencing has been pulled back from the road we will still only evaluate the area associated with the ADOT right-of-way. All individual mortalities will be marked or removed from the roadway once they are recorded. We will compare the frequency of road mortalities for several taxonomic groups (i.e., amphibians, lizards, snakes, small mammals, carnivores, and ungulates) with the expectation that the frequency of road mortality should be lower on the segment of road where wildlife fencing has been installed on both sides of SR 77 versus area where only one side is fenced adjacent to SR 77, or fence ends.

Roadway Driving Surveys

Daily walking surveys will complement daily driving surveys along the remainder of the project area (approximately 4 miles). A single surveyor will drive along the edge of the paved roadway at 25 – 30 mph and scanned for larger-sized mortalities (i.e., rabbit and larger) or unusual (e.g. snakes, Gila monsters, desert tortoises, etc.) wildlife that otherwise might go undetected between alternating survey segments which were not scheduled to be intensively walked until the following days. This strategy will minimize loss of detections due to scavenger removal of animal remains across the project area. In addition, this method will allow for the collection of data points which would be removed by passers-by, degraded by repeated friction by passing vehicles, and extreme environmental conditions. Detections during the driving segments will be recorded on physical data forms and exact coordinates will be documented using the AGFD Roadkill App. Roadway driving survey data will then be added to the overall road mortality database prior to analysis.

Additionally, the project team will coordinate with AGFD, ADOT, Pima County, DPS, Coalition for Sonoran Desert Protection, Tucson Audubon Society, Sky Island Alliance, and local volunteers to document and compile a comprehensive list of road kill throughout the duration of the study.

- **Spring 2017 roadkill surveys consisted of 4 complete survey cycles conducted from Monday thru Thursday during 4 consecutive weeks between May 1 and May 26.**

- Summer 2017 roadkill surveys consisted of 3 complete survey cycles conducted from Monday thru Thursday during 3 consecutive weeks between July 31 and August 17.
- Spring 2018 roadkill surveys consisted of 4 complete survey cycles conducted from Monday thru Thursday during 4 consecutive weeks between April 30 and May 24.
- Summer 2018 roadkill surveys repeated the 2017 survey pattern, surveys began on July 30 and will conclude on August 16.
- Road mortality data has been compiled through the conclusion of the Spring 2018 survey session.
- 1330 vertebrate mortalities have been recorded within the ROW.
- 206 fewer vertebrate mortalities were recorded in Spring 2018 than Spring 2017, with 323 and 529 records respectively.
- There have been 7 Coyote records: 2 mortalities, 2 live records and 3 records of scat.
- 1 Javelina mortality has been recorded.
- Small Mammals and Lizards accounted for 480 and 381 records respectively.
- The most commonly encountered species were Merriam’s Kangaroo Rat (238 records) and Regal Horned Lizard (133 records).
- Notable records include; Gila Monster, Barn Owl, Bobcat, Kit Fox.
- Mortalities from 70 vertebrate species were recorded during surveys.

Table 2. Number of mortalities detected through the 2018 spring roadkill survey session by group.

Group	Count
Reptile	539
Mammal	531
Bird	134
Amphibian	122
Unknown	4
Total	1330

The status of installed wildlife fencing along the surveyed extent of SR77 allows us to compare the effectiveness of wildlife fencing in several configurations with respect to the ROW. There is evidence to suggest that installed wildlife fencing is proving effective throughout the surveyed extent. A single ungulate mortality has been recorded and very few carnivores were detected within the ROW. Where wildlife fence directly fronted the ROW on both sides mortality detections were found to be significantly lower than sections where fencing fronted only one or neither side (Figure 6). Mortality detections were significantly higher where wildlife fencing directly fronted one side of the ROW but was retracted or absent on the opposing side and lightly developed on that side. As installation of wildlife fencing is completed and

development within the fenced area occurs it is expected that currently observed hotspots will no longer be significant.



Figure 6. Optimized Hot Spot Analysis for all vertebrate mortalities through the Spring 2018 roadkill surveys with mileposts and installed wildlife fencing (white lines).

Objective 3: Monitor movement of Sonoran Desert Tortoise in relation to SR 77

As with most wildlife species, roads are a nearly impermeable barrier to Sonoran Desert tortoises (SDT). Tortoises rarely cross roads due to their lack of mobility and they suffer high rates of mortality when they do attempt to cross. There is speculation that wildlife crossings can facilitate movement of desert tortoise across roads, however opportunities to evaluate the effectiveness of wildlife crossings for this species have been limited to date (Leavitt and Hoffman 2014). During the early stages of construction, project personnel removed several tortoises from the construction site, including one that attempted crossing through the underpass in October 2015 (Figure 7).



Figure 7. Sonoran desert tortoise found in the wildlife underpass during construction, tracks in underpass that alerted contractor (upper left), leading to location of tortoise in underpass (right) for safe removal from the site (lower left).

The tortoise population in the vicinity of the SR 77 wildlife crossings provides a unique opportunity to determine the combined effectiveness of an overpass, underpass, and multiple culverts linked with funnel fencing in minimizing road mortality while allowing for habitat connectivity for SDT. This knowledge is essential for long-term population persistence of desert tortoise and coexistence with humans as populations increase and additional infrastructure is required to accommodate this growth.

Tortoises are infrequently detected on wildlife cameras even where they are abundant (Leavitt and Hoffman 2014). However, GPS telemetry has proven an effective method to determining permeability of wildlife species across roadways and is an appropriate approach for Sonoran desert tortoise (Dodd et al. 2007a, Dodd and Gagnon 2011, Gagnon et al. 2013).

To evaluate SDT movements along SR 77 we conducted visual surveys for the presence of SDTs and their sign adjacent to SR 77. These surveys were conducted on foot by qualified AGFD biologists where rights-of-entry have been granted. Upon detecting a live SDT, we fit the tortoises with a VHF radio-transmitter (Holohil RI-2B) and a GPS tracking unit. GPS tracking units are replaced monthly and data will be downloaded into ArcGIS so that we may estimate home range size, activity patterns, and movement corridors for each individual.



Figure 8. Sonoran Desert Tortoise with a VHF unit attached to front right and GPS unit attached on vertebral scutes.

- **35 individuals detected of which 22 individuals have been outfitted with transmitters (12 east of 77, 10 west).**
- **4 outfitted individuals deceased (2 east and 2 west).**
- **17 individuals are currently outfitted with transmitters.**
- **GPS transmitters were redeployed for the 2018 season in April.**
- **Up to 2 additional transmitters will be deployed west of SR77 during the 2018 season.**
- **VHF transmitters will be replaced on most outfitted individuals during 2018.**

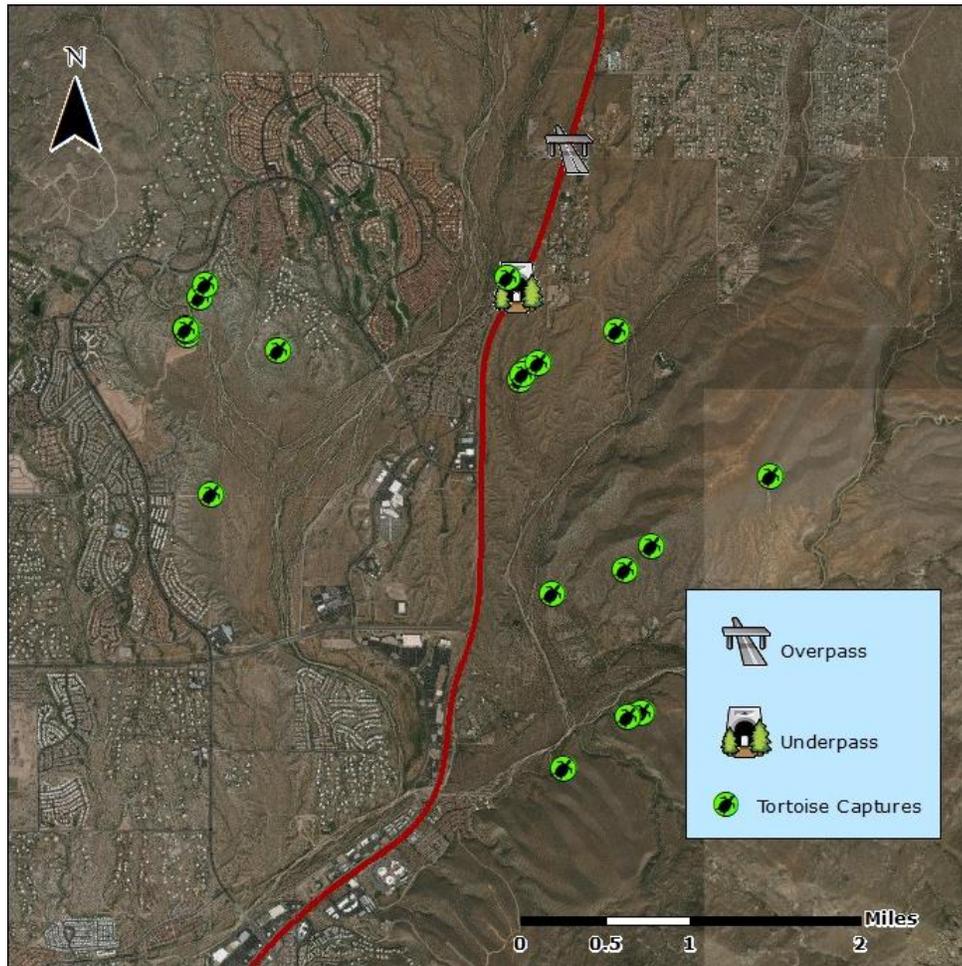


Figure 9. Distribution of Sonoran Desert Tortoise VHF and GPS transmitter deployments.

Objective 4: Provide recommendations for the adaptive-management of the structures as well as recommendations to guide future projects in southern Arizona.

Using lessons learned from the implementation of the SR 77 structures and fencing, combined with current literature and research findings, we will provide general recommendations regarding the applicability of these measures for use in other scenarios throughout southern Arizona and the southwest.

- **Ongoing**

PROJECT SCHEDULE AND DELIVERABLES

Upon completion of the wildlife crossings and fencing in 2016, along with installation of camera systems by AGFD and ADOT, AGFD with support and assistance from multiple stakeholders/volunteers AGFD began a three year evaluation of wildlife crossing use and desert tortoise movements funded by RTA and AGFD. It is estimated that this project will be initiated in May 2016 and will not exceed 4 years to final report completion followed by 6 months of reviews and revisions.

<i>Project Deliverable</i>	Completion date(s)
Project status reports	Twice per year
Final Project Report	NTE 4 years following completion of construct.
Scientific journal manuscripts	Various during and after the project
Professional/scientific symposia presentations	Various during and after the project

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