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).

Efforts focused on 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 identified specific areas where habitat connectivity efforts should be focused at 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 nine 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 transportation and wildlife agencies, NGO's and landowners, a 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 intended to include 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 funding for a wildlife overpass and 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. During reconstruction the two wildlife crossing structures were built presenting a unique opportunity to evaluate conservation measures that 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 are becoming 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 both an urban and Sonoran Desert environment. 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 stress the importance of a monitoring program to evaluate the effectiveness of the crossing structures and fencing 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 is be conducted primarily by Arizona Game & Fish (AGFD) with support from ADOT Environmental Planning Group, the Coalition for Sonoran Desert Protection, Sky Island Alliance, and Tucson Audubon Society. Monitoring activities include camera documentation of wildlife use of the passage structures, 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. In addition, 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.

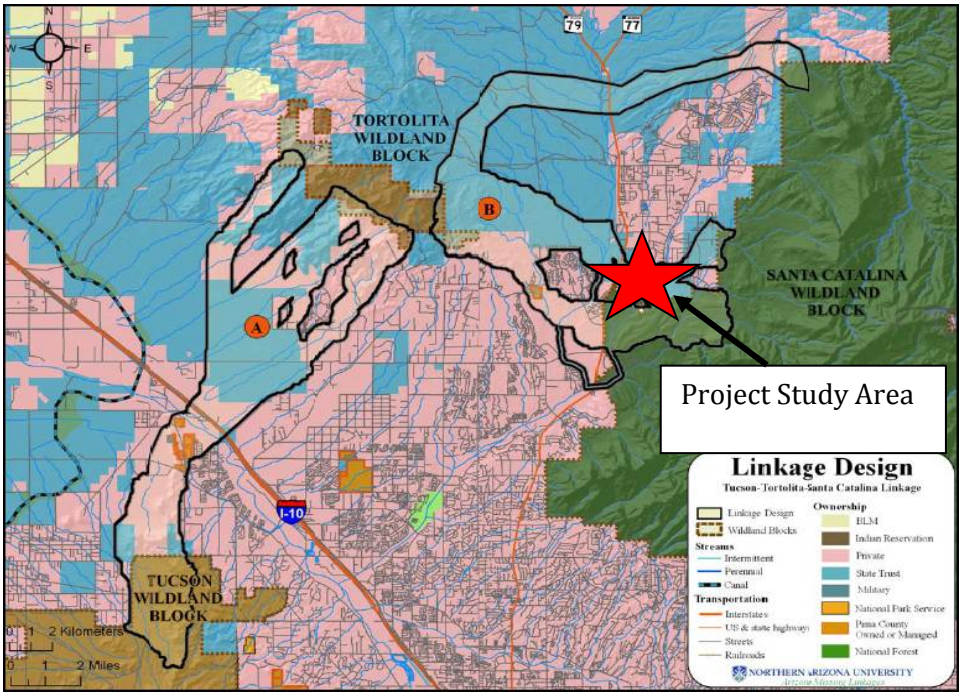


Figure 1. Least-cost linkage design for the Tucson, Tortolita, and Santa Catalina mountains and location of study area. Map from Beier et al. 2006.

RESEARCH OBJECTIVES

The intent of this project id to evaluate the effectiveness of the overpass, underpass and associated funnel fencing. The specific objectives and associated procedures include efforts to:

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

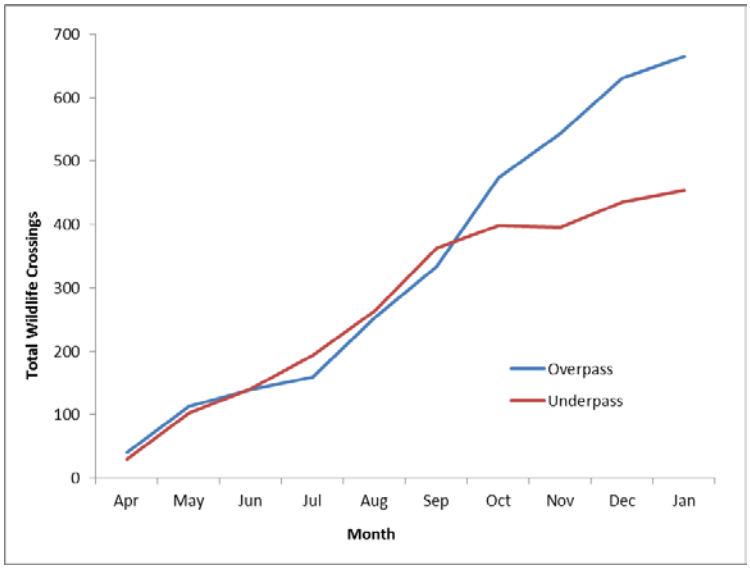
objective, we are using 8-camera video (overpass) and rapid-still frame cameras (e.g., Reconyx®, underpass). Video and still cameras provide detailed documentation of wildlife use and behavior in and near the newly constructed wildlife crossings along SR. We also installed backup Reconyx® cameras on 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.

- **We have documented 1182 crossings and 13 wildlife species at the overpass and underpass (Table 1, Figures 3 and 4)**
- **All cameras were stolen from the underpass in late 2016 but have been replaced and mounted in vandal-resistant boxes to the ceiling of the underpass**
- **Overall use of the overpass is relatively similar to the underpass, however mule deer use of the overpass (545 crossings) is significantly higher than the underpass (20 crossings; Table 1, Figure 3)**
- **We documented 236 overpass crossings by cattle in late 2016. AGFD approached the owners of the cattle and access for cattle was addressed in early 2017 (Figure 4)**
- **We documented human use events on 37 and 183 occasions at the overpass and underpass, respectively (Figure 4)**

Table 1. Number of crossings by species collected through camera surveillance

	Overpass		Underpass		Totals	
Species	**Total Crossings**	**Crossing Events**	**Total Crossings**	**Crossing Events**	**Total Crossings**	**Crossing Events**
Mule Deer	545	298	20	14	565	312
Javelina	8	3	242	82	250	85
Coyote	112	69	191	148	303	217
Bobcat	4	4	53	53	57	57
Other	6	6	1	1	7	7
Totals	**675**	**380**	**507**	**298**	**1182**	**678**



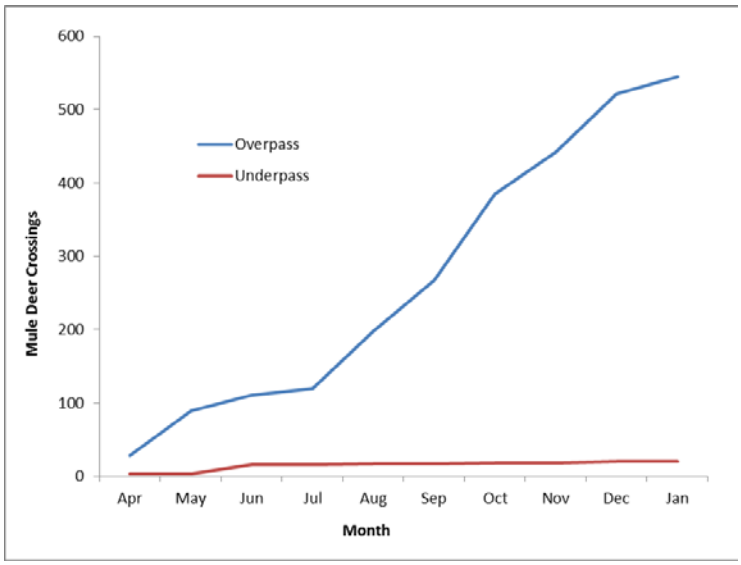


Figure 3. Total wildlife (top) and mule deer (bottom) use of the SR 77 overpass and underpass located on SR 77.

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 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.

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 directed 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.

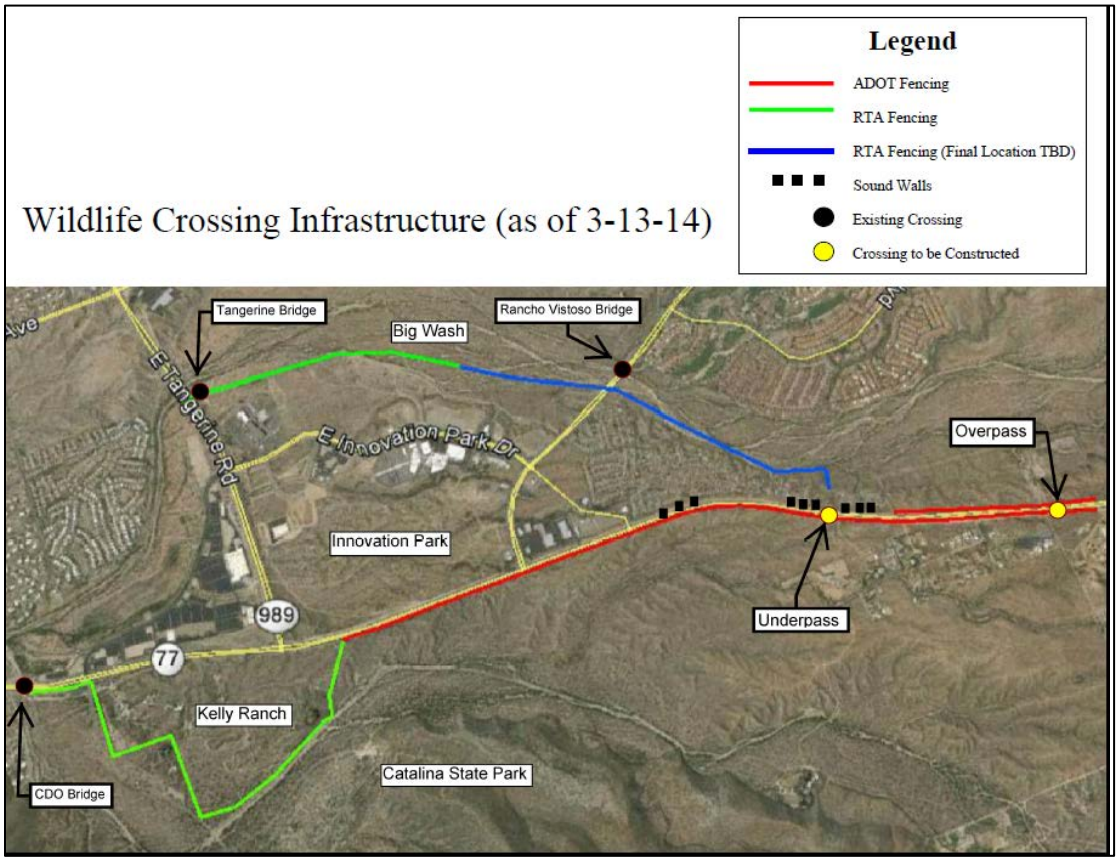


Figure 5. Map showing alignment of wildlife funnel-fencing and the complexities that will need to be accounted for (e.g. fencing distance from road) during road kill analysis. Map courtesy Coalition for Sonoran Desert Protection.

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.

- **Focused roadkill surveys will begin May 1, 2017 and will continue through May 26 followed by 2-3 weeks during monsoons in summer 2017.**
- **Another round of spring and summer roadkill surveys are planned for 2018.**

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 6).

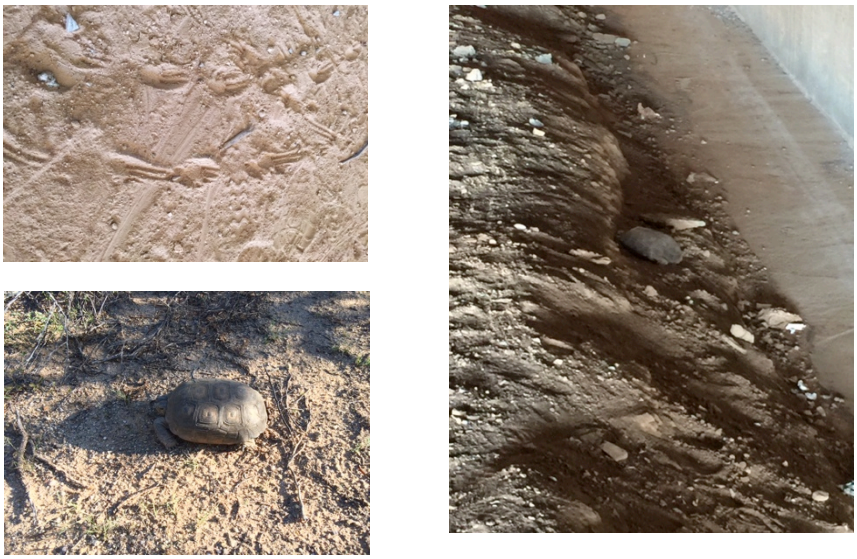


Figure 6. Sonoran desert tortoise found in the wildlife underpass during construction, tracks in underpass that alerted contractor (upper left), leading to location of tortoise in underpass (right) for safe removal from the site (lower left).

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.

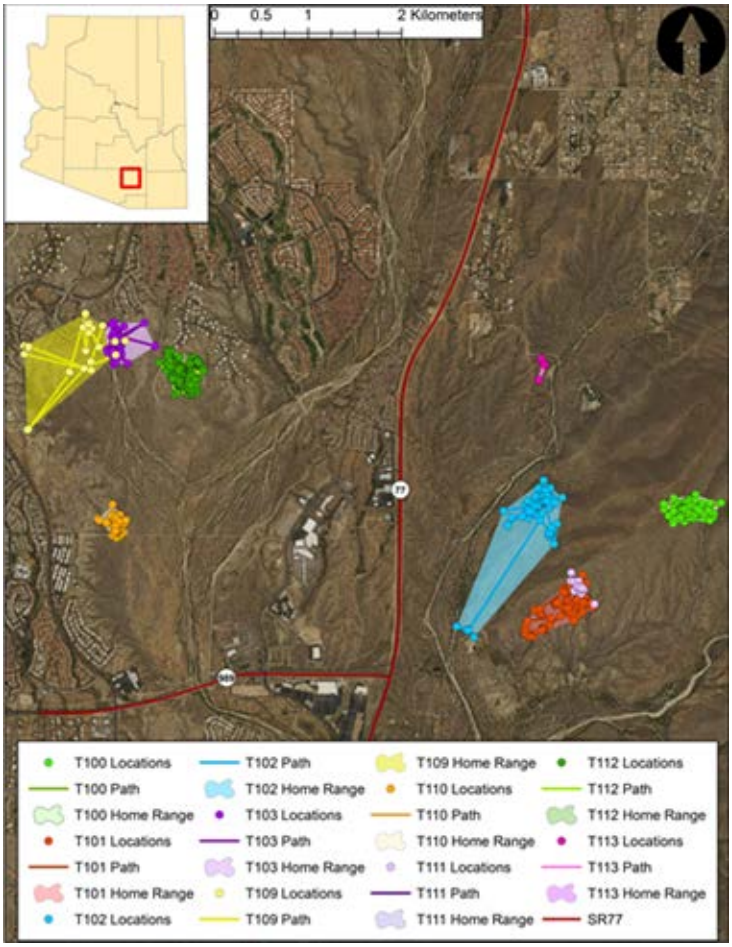


Figure 7. Sonoran Desert Tortoise with a VHF unit attached to front right and GPS unit attached on vertebral scutes (top). GPS position data from a Sonoran Desert Tortoise along SR 77 (bottom).

- **13 individuals detected of which 9 individuals were outfitted with transmitters (5 east of 77, 4 west)**
- **1 outfitted individual deceased (1 of 5 eastern individuals)**
- **2,230 GPS locations have been collected to date (Figure 7)**
- **GPS transmitters removed from 5 individuals in October ahead of winter dormancy and remaining 3 individuals were too deep in winter shelters to retrieve units**
- **All 8 individuals retained VHF transmitters to allow relocation and outfitting with GPS transmitters in April/May 2017**
- **We intend to outfit an additional 12 individuals with transmitters in spring/summer 2017 for a total of 20**

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, AGFD with support and assistance from multiple stakeholders/volunteers began a three year evaluation of wildlife crossing use and desert tortoise movements funded by RTA, AGFD, and AODT. 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.

Project Deliverable	**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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Arizona Game and Fish Department will oversee implementation of mitigation monitoring with the following team members:

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