Courtesy of Coalition for Sonoran Desert Protection

Monitoring Effectiveness of Wildlife Crossing Structures on State Route 77, Pima County, Arizona

Courtesy of Coalition for Sonoran Desert Protection

EXECUTIVE SUMMARY

The landscape linkage between the Tortolita and Santa Catalina Mountains in Pima County has been identified as a critical component in managing for the long-term persistence of regional wildlife populations (Beier et al. 2006). This linkage was designated as one of only six critical landscape connections in the Sonoran Desert Conservation Plan (SDCP; Pima County 2001) and one of 16 high priority linkages out of 152 statewide linkages identified in the Arizona Wildlife Linkages Assessment (Nordhaugen et al. 2006). The major challenge for implementing effective linkage conservation is State Route 77 (SR77), a four-lane commuter road connecting the Town of Oro Valley and Catalina to the greater Tucson metropolitan area. Data collected by the Arizona Game and Fish Department (AGFD; Ostergaard 2006) and the Sky Island Alliance (Janice Przybyl, *personal communication*) have identified SR77 as a wildlife-vehicle collision (WVC) hot-spot. As such, the highway poses a threat to wildlife attempting to travel between the two mountain ranges and a safety hazard for motorists.

While SR77 and other human developments within and adjacent to the linkage have undoubtedly impacted local wildlife populations, there remains suitable habitat on both sides of the highway between mile posts 82 and 86. It is within this road segment that plans are underway to construct three wildlife crossing structures, one overpass and two underpasses. With funds for the structures provided by the Pima County Regional Transportation Authority (RTA), the Arizona Department of Transportation (ADOT) will begin construction on the largest connectivity conservation project ever undertaken in southern Arizona.

The planned crossing structures on SR77 are designed to improve public safety and restore wildlife connectivity between the Tortolita and Santa Catalina Mountains in Pima County. Placement of the structures between mile posts 82 and 86 was based on existing wildlife mortality data, habitat modeling, wildlife movement information, expert opinion, and opportunities to increase the value of the wildlife corridor between the mountain ranges. With adoption of the Arroyo Grande General Plan Amendment in 2008, the Town of Oro Valley incorporated the Tortolita – Santa Catalina Linkage (Beier et al. 2006) into their land use plan in an effort to balance environmental stewardship with the need for community development. The Arroyo Grande General Plan Amendment specifically identifies the approximately one-mile wide wildlife linkage as part of their open space plan, thereby preserving the landscape linkage between the Tortolita and Santa Catalina Mountains (Figure 1). Together, the landscape linkage and the SR77 crossing structures will create a contiguous connection between the mountain ranges and help to ensure that county residents can enjoy the amenity of having robust wildlife communities and safe roads. (For a more thorough compilation of “Sonoran Desert Wildlife Linkage Milestones” that serve as a foundation for this monitoring work, see Figure 2.)

The purpose of the proposed project is to quantify the effectiveness of the three crossing structures, provide a means of informing the long-term management of the wildlife linkage, and generate information that will inform future projects and decisions

around the region. Information gathered during this study will be directly applicable to data-driven decision making regarding adaptive management and maintenance of both the SR77 crossing structures and future ones in southern Arizona to ensure that they are effective in reducing WVCs and enhance wildlife connectivity in the ecologically diverse setting that is the Sonoran Desert. Through collaboration between the RTA, AGFD, and the University of Arizona, we propose to implement a comprehensive monitoring program to document changes in the frequency and spatial pattern of WVC and quantify the use of the SR77 structures by wildlife. **Using nationally recognized standards for conducting pre- and post-construction monitoring developed by AGFD and ADOT, we will obtain information that will guide similar connectivity conservation projects in the region to promote safe passage for humans and Arizona's treasured wildlife resources.**

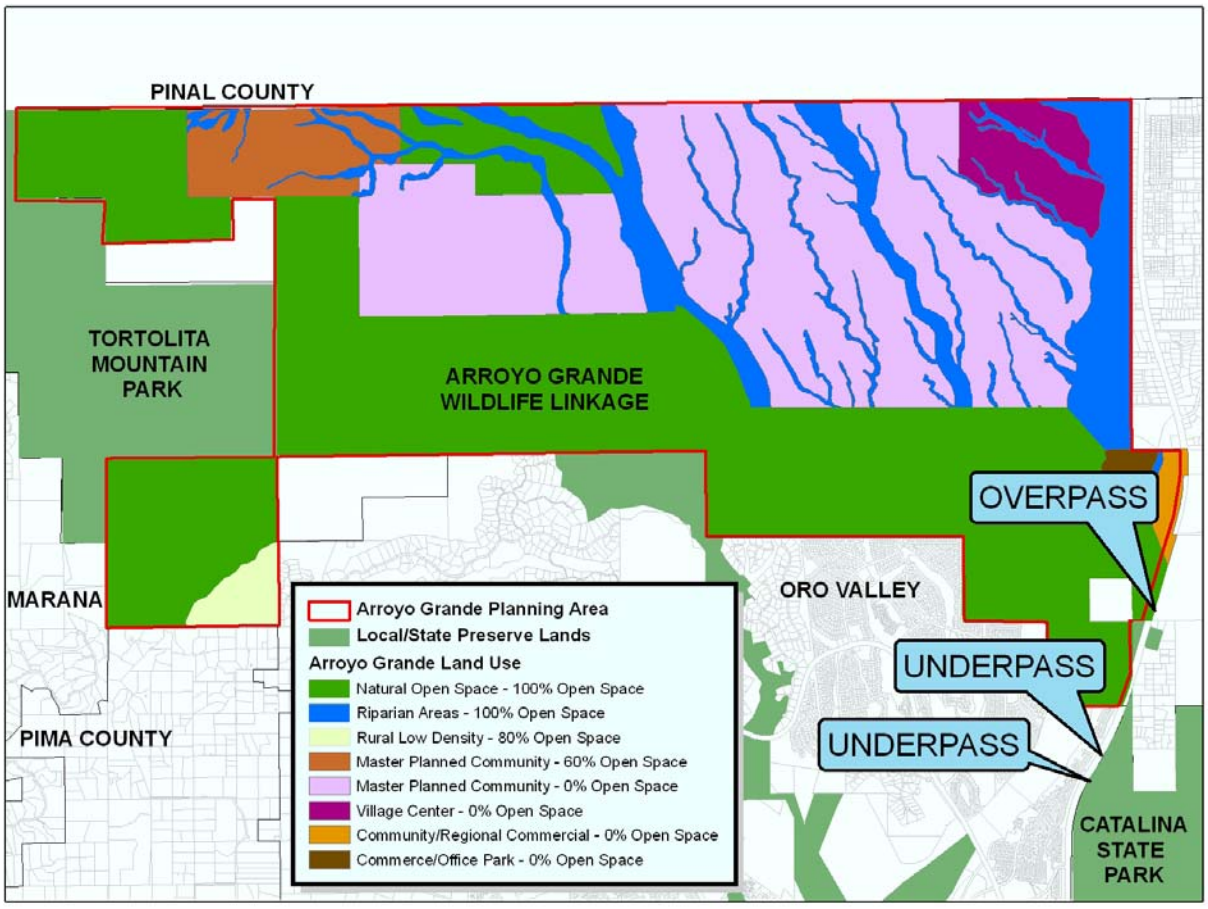

Figure 1. Arroyo Grande (Town of Oro Valley) master plan incorporating a wildlife corridor from the Tortolita Mountains to the Santa Catalina Mountains.

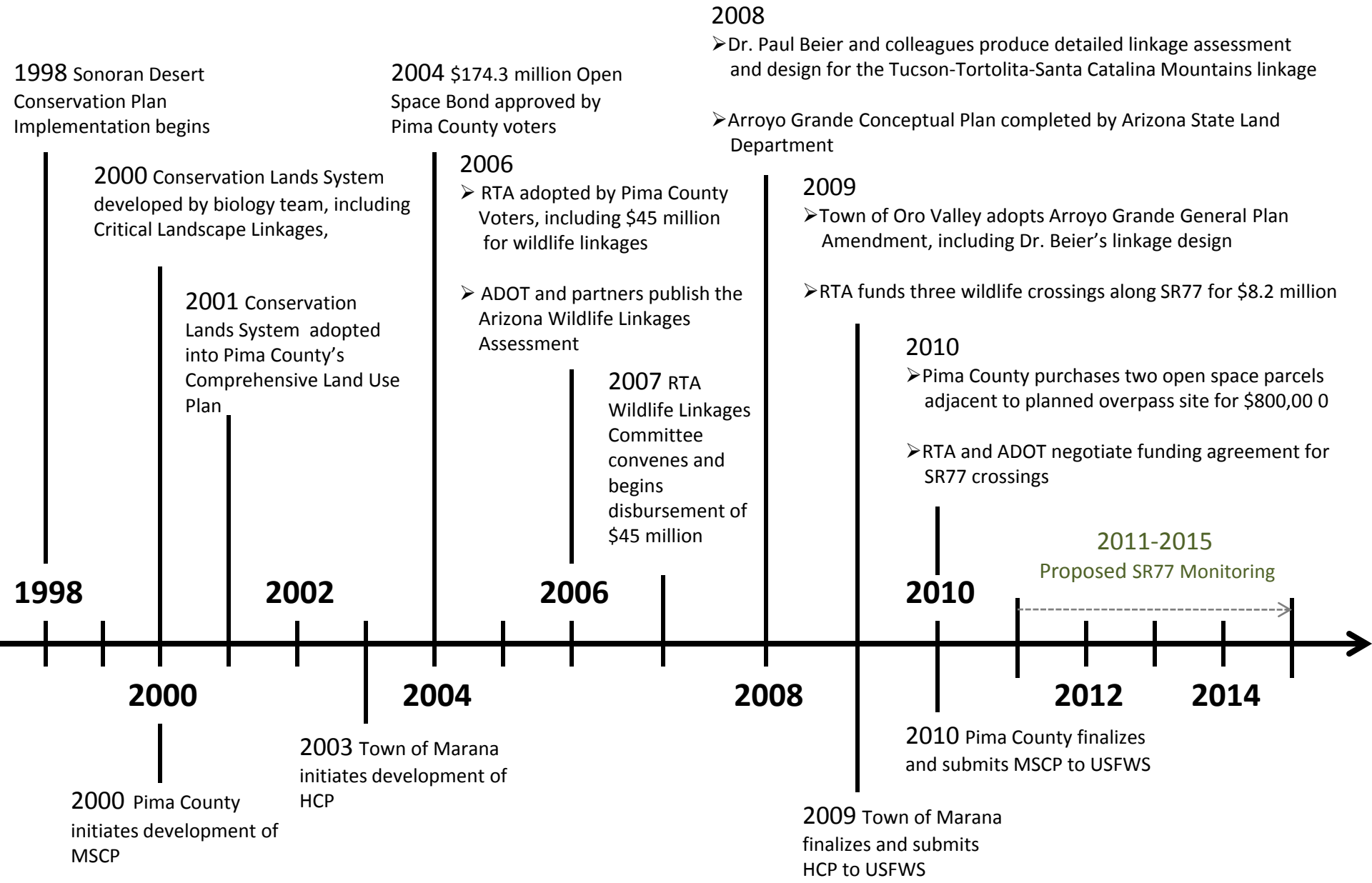

Figure 2: Sonoran Desert Wildlife Linkage Milestones

RTA Wildlife Linkages Project Funding Proposal

1. PROJECT SPONSOR
Arizona Game and Fish Department, Research Branch

2. RESEARCH COOPERATORS
University of Arizona, School of Natural Resources & Environment

3. PROJECT TITLE
Monitoring Effectiveness of Wildlife Crossing Structures on State Route 77, Pima County, Arizona

4. INTRODUCTION

Project Purpose and Overview
The purpose of this project is to evaluate the effectiveness of three wildlife crossing structures on State Route 77 (SR77) in reducing wildlife road mortality and enhancing connectivity between the Santa Catalina and Tortolita Mountains in Pima County, Arizona. Over the 4-year timeframe of the project, we will use a suite of research methods within a scientifically credible monitoring framework to answer three fundamental questions:

1. To what extent are the SR77 crossing structures and associated fencing effective at reducing wildlife-vehicle collisions (WVCs) along SR77?

2. Do the crossing structures facilitate wildlife movement across SR77 (i.e., increase permeability)? If so, what types of wildlife and what types of wildlife movement?

3. Do the three crossing structures vary in effectiveness and species use? If so, why?

Through the investigation of these questions, we will seek to quantify the movement and abundance of small and large mammals, reptiles, and amphibians near and through the three crossing structures; evaluate the frequency of wildlife-vehicle collisions near the crossing structures both pre and post-construction; and investigate the influence other important phenomena such as traffic patterns and environmental variables such as temperature and humidity have on the overall effectiveness of the crossing structures in providing safe passage for wildlife. As a final component to our investigation, we will generate a list of recommendations that will help inform the long-term management of the SR77 crossing structures and that can be utilized by future projects.

Background
In Arizona, efforts to identify critical wildlife corridors have been underway for decades. Most recently, regional, local, and statewide efforts to identify wildlife corridors have included Pima County's Sonoran Desert Conservation Plan (SDCP; Pima County 2001) and the statewide Arizona Wildlife Linkages Assessment (Nordhaugen et al. 2006).

Each of these documents has identified the wildlife linkage between the Santa Catalina and Tortolita Mountains as a top priority for implementation based on multiple characteristics including ecological importance, threats, and opportunities. Subsequent efforts by Beier et al. (2006) described these characteristics and identified the best corridor design using a combination of wildlife habitat modeling procedures and field evaluations to develop an implementation plan for the linkage (Figure 3; Linkage B).

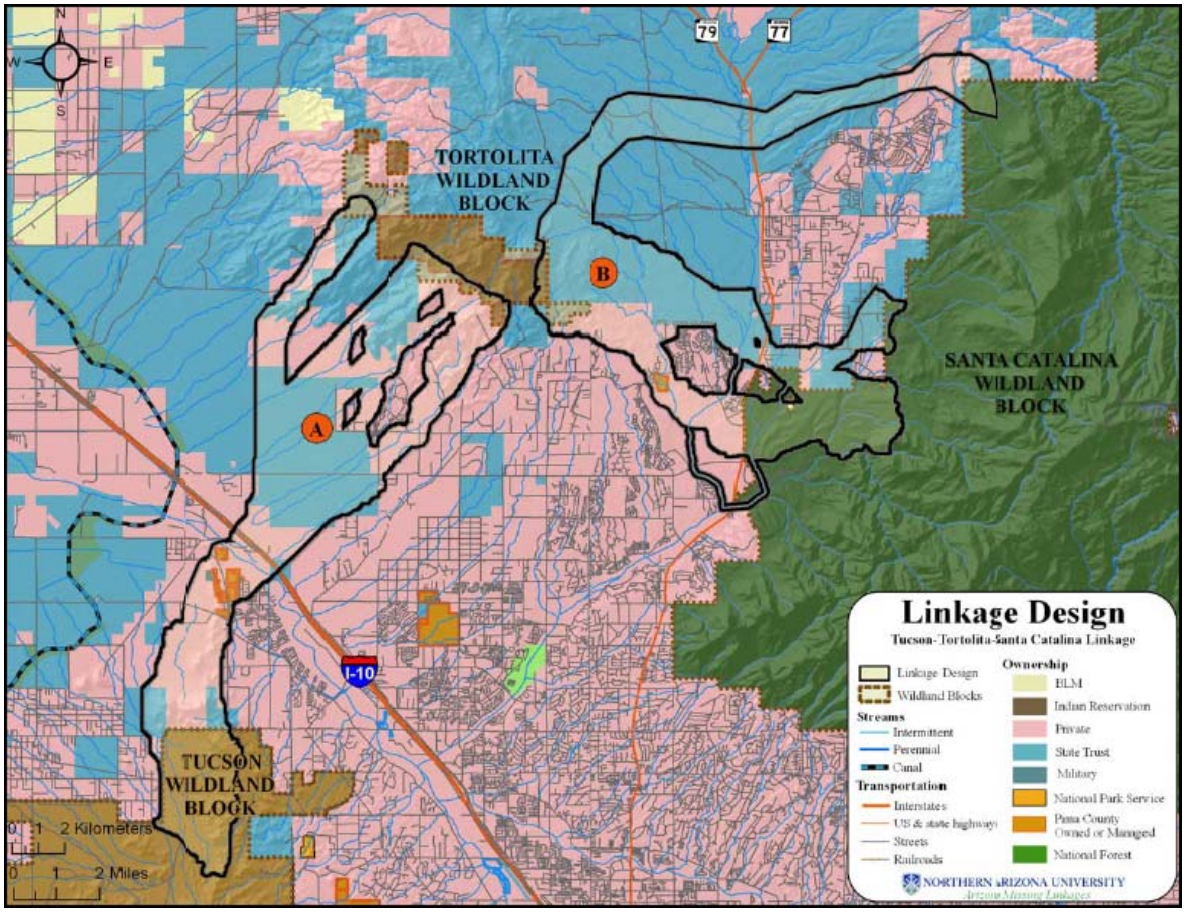

Figure 3. Linkage design for the Tucson, Tortolita, and Santa Catalina Mountains (Beier et al. 2006). Information gathered as part of this monitoring study in Linkage Section B (Tortolita-Santa Catalina Mountains) can be used to inform decisions about and possible structures in Linkage Section A (Tortolita-Tucson Mountains), especially at the long-identified Avra Valley/I-10 abandoned railroad underpass.

An Arizona Game and Fish Department (AGFD) study conducted in 2004 documented 255 road-kill animals between mile posts 81 and 85 (Ostergaard 2006; Figure 4). In addition, mountain lion movement data indicates that lions periodically cross SR77 during movements to access habitat on either side of the roadway (AGFD, unpublished data; Figure 5). Opportunistic road mortality reports collected by AGFD since 1990 identified medium and large sized mammals killed along the same stretch. Analysis of these data suggests that wildlife is attempting to cross SR77 at distinct locations.

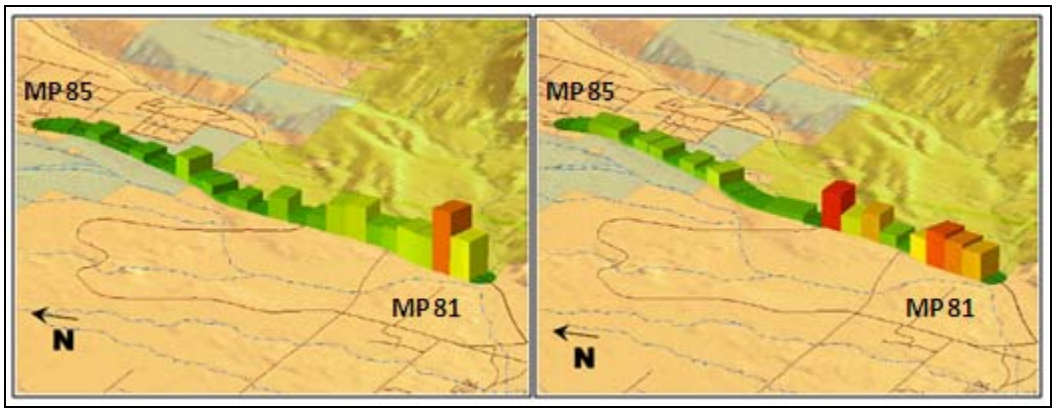

Figure 4. Reptile (left) and mammal (right) road mortality on SR77 between mile posts 81 and 85 (Ostergaard 2006).

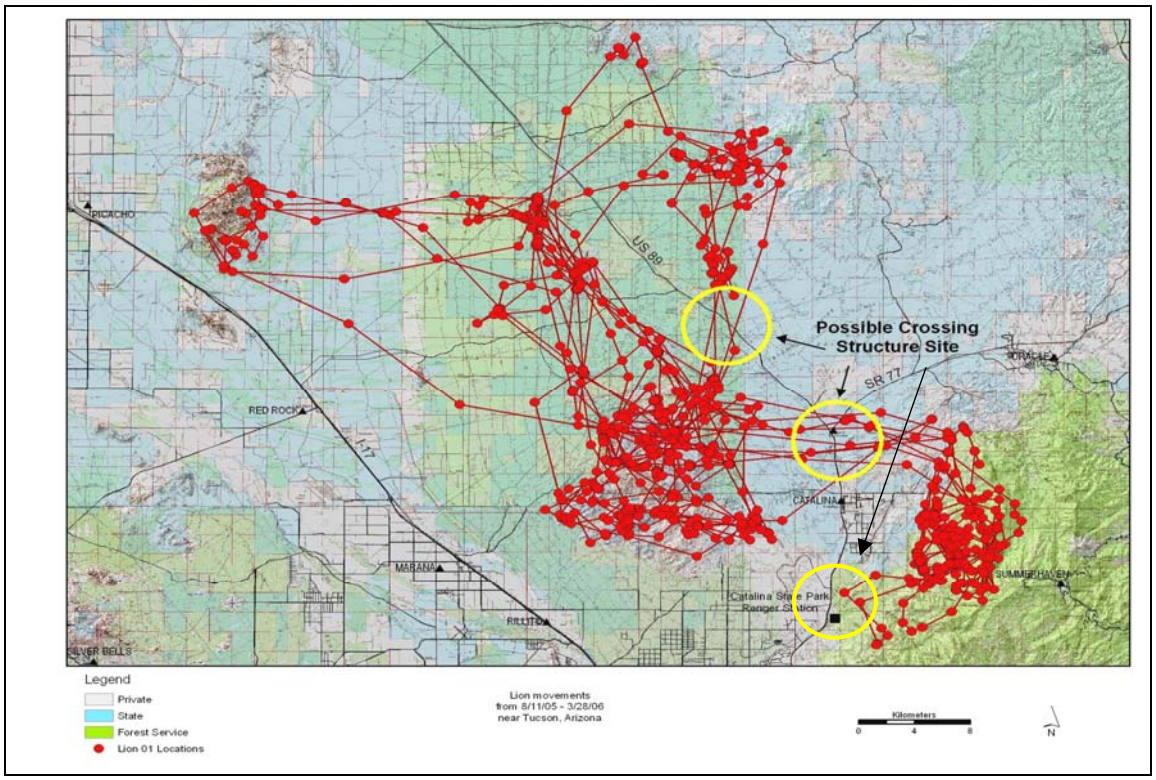

Figure 5. Mountain lion movement patterns between the Picacho, Tortolita, and Santa Catalina Mountains (AGFD, unpublished data).

The Arizona Department of Transportation (ADOT) has begun the process to upgrade and reconstruct key sections of SR77. As SR77 is expanded and improved, we are presented with a unique opportunity to implement conservation measures that will allow for the safe passage of wildlife across this barrier, while simultaneously increasing motorist safety. A recently funded project approved by the Regional Transportation Authority (RTA) identified the location and design for three crossing structures (one overpass and two underpasses with wildlife "funnel" fencing) to increase permeability and maintain connectivity between the Santa Catalina and Tortolita Mountains. These wildlife crossing structures are located in an area of high frequency road kill mortality (Ostergaard 2006, Sky Island Alliance, unpublished data) within a four mile segment of SR77 from milepost 82 to 86.

Wildlife crossing structures have been shown to make roads safer for motorists and wildlife by reducing WVCs and maintaining wildlife connectivity (i.e., the degree to which a landscape facilitates or impedes the movement of organisms among distinct resource patches; Taylor et al. 1993). In general, the most successful projects have a foundation of strong collaboration among governmental agencies, conservation organizations, and other stakeholders. One example, from northern Arizona is the SR260 elk project, which was made successful through cooperation among AGFD, ADOT, the Federal Highway Administration, USDA Forest Service, Arizona Elk Society, and the Rocky Mountain Elk Foundation. In 2000, ADOT upgraded the highway from two to four lanes while incorporating eleven wildlife underpasses with funnel fencing to reduce WVCs and increase permeability. AGFD has documented more than 10,000 animals successfully using the underpasses, while at the same time reducing WVCs by 85-96%. The concept is spreading in Arizona and construction is underway on three wildlife overpasses on US93 near the Hoover Dam to accommodate the safe passage of desert bighorn sheep, the first wildlife overpasses to be constructed in the state.

AGFD is also in the final stages of RTA-funded research on the effectiveness of different fencing types in the Sonoran Desert. This fencing research will inform the type of fencing used to funnel wildlife towards the SR77 crossings, with a goal of minimizing the number of species that are able to breach the fencing and access the SR77 roadway. Final reports on both of these studies are expected by Spring 2011, leaving ample time for their results to be incorporated into final design of the SR77 crossings.

Lastly, this project will be an important building block for restoring wildlife linkages and removing barriers to wildlife movement throughout southern Arizona. Information gathered from this monitoring effort will inform the design and management of future wildlife crossing projects. Potential areas where this information could be applied include the heavily compromised Tucson-Tortolita Mountains wildlife linkage (and specifically enhancing the crossing point across I-10 near Avra Valley Road); the Santa Rita-Sierrita Mountains wildlife linkage (in an area such as Canoa Ranch); and the Santa Rita-Rincon Mountains wildlife linkage (i.e. Davidson Canyon), among others. While this region has thus far taken commendable and important steps to protect our wildlife linkages, the information from this monitoring project will inform the many steps yet to be taken.

Ramifications of No Action

The SR77 crossing structures are the first large crossing structures that will be constructed in the Sonoran Desert. The RTA has approved $8.2 million in funding for their construction, Pima County has invested nearly $1 million in public monies to acquire open space parcels adjacent to the overpass location site, and the Town of Oro Valley invested considerable public resources into the adoption of the Arroyo Grande General Plan Amendment. Without a monitoring plan, we will never know whether these crossing structures are being used by wildlife and are effective at increasing the permeability of the wildlife linkage between the Tortolita and Santa Catalina Mountains. We will also miss a critical opportunity to generate recommendations and produce information that can inform future decisions and wildlife crossing projects in our region.

There will also be no opportunity to change the management of the crossing structures to improve their effectiveness without monitoring results to direct these changes. For example, if this monitoring plan detects changes in vegetation within the crossing structures that seem to relate to a decrease in use by wildlife, we can recommend changes to the vegetation structure or composition that may make the structures more attractive to wildlife again.

The RTA Wildlife Linkages Committee has 15 years and ~$35 million left in funding to disperse to wildlife linkage-related projects. Without a modest investment in monitoring the first large wildlife crossing structures in the Sonoran Desert, the RTA will be lacking in knowledge essential to inform its future considerations of how best to effectively allocate the remaining RTA Wildlife Linkage funds.

5. OBJECTIVES

Crossing structures are known to be effective (Clevenger et al. 2001, Dodd et al. 2007c) and are becoming more common components of transportation construction projects. For example, smaller-scale crossing structures have recently been constructed on the newly opened Twin Peaks Road in the Town of Marana to maintain local wildlife connectivity. However, the SR77 linkage project is the first time that large crossing structures will be implemented to restore a regional wildlife linkage in the Sonoran Desert. It is within the context of the Sonoran Desert's unique habitat and species assemblages that we propose this monitoring plan to evaluate the effectiveness of the three crossing structures planned for SR77. The objectives of this monitoring plan are to:

1. Evaluate the frequency and spatial pattern of WVCs between mile posts 82 and 86 pre- and post-construction;

2. Estimate passage rates as a means to quantify use of the crossing structures by large (e.g., mule deer, mountain lions, bobcats) and small (desert tortoises, Gila monsters, etc.) animals;

3. Identify structural and environmental characteristics that influence passage rates as a means to identify opportunities for increasing structure effectiveness.

Only by monitoring crossing structure use will we be able to determine if additional modifications are needed to achieve the goals set forth in the construction proposal. As such, monitoring is a critical component in the development of successful crossing structures in the Sonoran Desert. Given the fact that these structures are the first of their kind in the Sonoran Desert, and the considerable amount of money being dedicated to their construction, this project presents our first opportunity to evaluate their effectiveness in reducing wildlife road mortality and enhancing connectivity between the Santa Catalina and Tortolita Mountains. This project will also provide important insights and data that will inform future RTA and wildlife crossing projects to increase their effectiveness and viability.

6. METHODS

After careful consideration, we have selected a suite of research methods that will help answer the primary research questions and achieve the project objectives. These methods include:

- Road mortality surveys to determine if the crossing structures and fencing reduce WVCs;

- Camera monitoring to quantify passage rates for large animals (e.g., mule deer, mountain lions, bobcats, etc.);

- Automated PIT-Tag (Microchip) reading systems to quantify passage rates for small animals (e.g., small mammals, snakes, lizards, and amphibians);

- Fluorescent powder tracking to directly quantify movement of animals in their approach to crossing structures and to provide data on behavioral responses to both crossing structures and the road;

- Vegetation surveys, environmental monitoring, and traffic monitoring to examine the influence of these factors on wildlife passage rates; and

Basic details on each of these research methods are included below with more detailed methods available upon request.

Road Mortality Surveys

We will conduct road mortality surveys between mileposts 82 and 86 prior to the construction of the three wildlife crossing structures to provide a baseline dataset for evaluating the effectiveness of the three structures in reducing WVCs. Our effort will build upon existing road mortality data reported in Ostergaard (2006) and compiled by the Sky Island Alliance. Once the construction of the crossing structures is completed,

we will resume the surveys (see '*Timeline*' below). We will then compare patterns of pre- and post-construction road mortality with patterns of traffic flow along this stretch of SR77 (see '*Environmental and Traffic Monitoring*' below). As a metric of success, we expect to see an overall decline in the number of WVCs within the project area.

Assessing Crossing Structure Use

Camera Monitoring

Camera monitoring has been used effectively to monitor wildlife use of crossing structures, allowing for reliable species identification and providing the data required for calculating passage rates (Gagnon et al. 2005, Dodd et al. 2007b, Olsson et al. 2008). We will utilize an integrated multi-camera video surveillance system to quantify wildlife use of the three crossing structures and estimate passage rates for medium and large mammals (e.g., cottontail rabbits, jackrabbits, skunks, coyotes, bobcats, mule deer, coyotes, mountain lions, etc.). Cameras will be instrumented with passive-infrared motion detectors to minimize recording of non-events, which will reduce the amount of time required for reviewing video footage, which is a considerable effort when using continuous recording devices. This camera system will be crucial to the monitoring of the species listed above, and provides a more cost effective means of collecting information than more traditional capture/marking techniques. Cameras will allow us to quantify the passage rates of medium and large mammals and document events such as approaches, unsuccessful crossings, and predation which provide behavioral insight into how animals respond to the crossing structures. Restoring connectivity between the Santa Catalina Mountains and the Tortolita Mountains is a desired result of the crossing structures. Thus, cameras will be extremely useful in assessing the degree of connectivity provided by the crossing structures, as they will document use of the structures by species that move between mountain ranges (i.e., mountain lions, mule deer).

Automated PIT-Tag (Microchip) Reading Systems

Whereas camera systems are designed to quantify passage rates for large animals, automated PIT-tag reading systems are an efficient means of quantifying passage rates for small mammals, reptiles, and amphibians. These systems have been used to successfully monitor culvert use by desert tortoises (Boarman et al. 1998) and snakes (Bellis et al. 2007) and have been used effectively in aquatic applications for similar purposes (Prentice et al. 1990). PIT-tags are tiny microchips about the size of a grain of rice that contain a unique alphanumeric code. PIT-tags are typically inserted just under the skin of an animal to allow for permanent identification of individuals. We will deploy PIT-tags and install a custom-built, automated PIT-tag reading system at each crossing structure to automatically record use by small mammals, reptiles, and amphibians. We will install these systems as soon as construction is completed, leaving them in place for the remainder of the monitoring program.

In order to implement PIT tagging techniques, we need to trap and mark animals. Therefore, a considerable effort must be expended to capture animals. We will mark all individuals that are captured in order to achieve the sample sizes necessary for a reliable estimate on crossing structure use. Inevitably, a proportion of marked individuals will not even approach the PIT tag readers, let alone use the structures. This means that as much effort as the budget allows must be expended to mark a large number of individuals.

PIT tagging techniques will provide us with a list of species that use the crossing structures and the frequency of use – two key elements in determining the value of the crossing structures for small mammals, snakes, amphibians and lizards. PIT tagging also allows us to determine if animals crossed from one side of the structure to the other or if they entered the structure but failed to successfully cross. Without PIT tagging, we might be able to provide a list of animals that used the structures, but we would not know if it was a single individual using the structure repeatedly, or a significant proportion of individuals in the local population using the structures. Similarly, we would not be able to differentiate successful crossings from unsuccessful (i.e., partial) crossings.

Fluorescent Powder Tracking

While PIT-tag readers only record data when animals actually cross through the antennae situated at either side of the structure, powder tracking will allow us to examine an animal's movements in proximity to the crossing structure but in areas not close enough to trigger electronic sensors. Powder tracking will also allow us to evaluate the proportion of animals that approached the crossing; those that approached and didn't cross; and those that approached the crossing, but crossed the road without using the crossing structure. Powder tracking (Leman and Freeman 1985) has been used successfully for documenting wildlife use of crossing structures (McDonald and St. Clair 2004, Ree et al. 2007).

Fluorescent powder tracking involves coating an individual with non-toxic fluorescent powder, allowing the individual to move about its environment, and following the resulting trail with a portable source of UV light (the powder trail is viable for 3-4 days barring any rain). The path can then be recorded on a GPS unit and analyzed. We will opportunistically capture and powder small mammals and reptiles in the vicinity of SR77 and the crossing structures. In doing so, we will document their movements as they approach and move through the structures. We will then analyze each track to determine if there is a change in movement before, during, and after crossing through a structure. All animals captured for powder tracking will also be marked with PIT tags.

Together, camera monitoring, PIT tag reading systems, and powder tracking techniques will allow us to comprehensively assess the level of crossing structure use, provide insight into what might be preventing some animals from using them, and offer insight into ways the crossing structures can be improved to increase crossing rates.

Vegetation Surveys

The vegetation structure adjacent to wildlife underpasses and on wildlife overpasses will have an impact on passage rates by large and small animals. While the specific design features and goals for post-construction re-vegetation have not yet been developed, we will implement a monitoring program that allows us to quantify vegetation features and determine how those features influence animal passage rates. Surveys will be conducted pre- and post- monsoon on an annual basis prior to construction to identify existing conditions and post-construction to monitor changes in vegetation that may impact the effectiveness of the crossing structures. We will establish permanent photo points to visually document changes in vegetation structure. We will also measure vegetation density, species composition, and spatial distribution. These data will be used to guide the maintenance of the structures and inform adaptive management to increase passage rates. As part of this program, we will also monitor the establishment of exotic plants, because their proliferation may be detrimental to the effectiveness of the crossing structures.

Environmental Monitoring

For crossing structures to be effective, environmental variables (e.g., temperature, humidity, etc.) within the structures must be similar to those found in natural surroundings. This is especially true for amphibians and reptiles, because they are ectothermic (i.e., animals that maintain their body temperature by absorbing heat from their environment). If crossing structures alter the thermal environment to the point of avoidance by amphibians and reptiles, then they will not be effective for these organisms. Furthermore, we may fail to understand the underlying mechanism leading to avoidance if we do not monitor the thermal environment in and around crossing structures. To address this, we will deploy automated data loggers to record ambient and surface temperatures within each crossing structure at regular intervals. We will also monitor relative humidity in and around the crossing structures, because many desert animals depend on humid microhabitats to avoid desiccation, and therefore, may be drawn to crossing structures if they provide a more humid environment.

Traffic Monitoring

Traffic patterns are a critical variable when assessing effectiveness of wildlife crossing structures (Forman et al. 2003). Several studies have shown that traffic volume influences road crossing patterns of many mammal species, which prefer to cross roads during times of low traffic volumes (cited in Forman et al. 2003). Traffic volume may have a significant influence on crossing structure use, especially for species that are reluctant to approach roads during periods of high traffic volume. Traffic volume also provides an index of noise associated with crossing structures. To quantify traffic volume, we will use a Diamond Traffic Products inductive loop traffic counter placed at the midpoint of the stretch of SR77 that encompasses the crossing structures. Inductive loop traffic counters use an individual sensor for each lane, which has the advantage of recording two or more vehicles traveling side-by-side. Each sensor determines each

vehicle's speed and classification (i.e., car, light truck, semi-truck) and records them with an associated time stamp. Therefore, we will be able to not only gather data on the number of vehicles traversing the road, but on temporal patterns of traffic flow as well. We will compare patterns of traffic flow with patterns of crossing structure use to determine the extent traffic volume affects wildlife use of the crossing structures.

Linkage Stewardship

Because the SR 77 crossing structures will be located in a place where human activity is not limited to just the road, a well-informed and involved public is crucial to ensuring the long-term success of the structures. In light of this, we will develop and implement a public outreach program to encourage stewardship of the Tortolita-Santa Catalina linkage. The primary goal of our Linkage Stewardship Program will be to provide local residents and the general public with the information they need to coexist safely, responsibly and enjoyably with wildlife at the urban fringe. We will hold periodic workshops where we will provide updates from our monitoring program and discuss topics of importance to the crossing structures and the entire linkage. We will educate the public on issues, such as responsible pet ownership, wildlife feeding, and appropriate trail use. We will inform those involved about the diversity of species in the linkage, as well as debunk myths surrounding animals like rattlesnakes and Gila Monsters. We will provide tips on how to safely make private lands more permeable to wildlife. We will encourage public respect of public and private property. We plan to consult and collaborate with urban wildlife specialists from AGFD Region 5 to make certain we create an environmental education program that makes a noticeable impact on public attitudes and perceptions. We will also pursue the use of signage to heighten the awareness of the public to the importance of the crossing structures in maintaining the health of wildlife populations.

In addition to our outreach program, we will develop a questionnaire to mail to homeowners in the vicinity, inquiring about their use of nearby trails (e.g., frequency, duration, type of activity). This will also provide us with the opportunity to survey their attitudes about the crossing structure project and what criteria they use to assess the structures' success. As this is a taxpayer-funded project, it is vital for the development of future projects to evaluate the public's opinion. No matter how ecologically effective this project may be, public opinion will ultimately have the greatest influence on decisions regarding wildlife crossing structures in the future.

And finally, a crucial component of our monitoring program is our commitment to fostering and maintaining an open dialogue with various stakeholders (e.g., government agencies, non-profit organizations, land and wildlife managers, institutions, developers) involved in the construction of the crossing structures, and the maintenance of the entire linkage. From the outset, we will hold regularly scheduled meetings with stakeholders to present study results, explain methods and discuss outcomes. By regularly presenting our data, and engaging in discussions with the local community, we will minimize potential disconnects between on-the-ground actions and intended results. We also plan to partner with local non-profits such as the Sky Island Alliance

and the Coalition for Sonoran Desert Protection to implement the Linkage Stewardship component of this project.

7. PROJECT SCHEDULE

(Note: Monitoring will only be conducted before and after construction of the SR77 crossings. No monitoring will occur during the construction project itself.)

Task	Time Interval
Road Mortality Surveys	2 times/week, Apr-Oct, 2011-2012, 2014-2015
Camera Monitoring	continuous, year round, 2014-2015
PIT-Tag Systems	continuous, Apr-Oct, 2014-2015
Fluorescent Powder Tracks	opportunistic, Apr-Oct, 2011-2012, 2014-2015
Vegetation Surveys	Twice annually 2011-2012, 2014-2015
Environmental Monitoring	continuous, year round, 2011-2012, 2014-2015
Traffic Monitoring	continuous, year round, 2011-2012, 2014-2015
Linkage Stewardship	continuous, year round, 2011-2015
Reports	annual progress reports 2011-2014, final report 2015

8. FINAL DELIVERABLES

The principal investigators will present annual progress reports to the RTA Wildlife Linkages Committee from 2011-2014 and a final report within 8 months after completion of the final year of post-construction monitoring. The final report will contain detailed project results and conclusions for each of the monitoring methods. The report will also contain a set of recommendations pertaining to management changes that may increase the effectiveness of the SR77 crossings and future crossings throughout the region.

9. PROJECT BUDGET

See Attachment 1 for a summary of the project budget

10. PRINCIPAL INVESTIGATORS

Matt Goode, Research Scientist, University of Arizona, School of Natural Resources and Environment

David Grandmaison, Wildlife Research Biologist, Arizona Game and Fish Department

11. LIST OF COOPERATORS

LOCAL JURISDICTIONS
Pima County
130 W. Congress St.
Tucson, AZ 85701

Town of Oro Valley
11000 N. La Canada Dr.
Oro Valley, AZ 85737

Town of Marana
11555 W. Civic Center Dr.
Marana, AZ 85653

STATE AND FEDERAL AGENCIES
Arizona Department of Transportation
Tucson District
11221 S. 2nd Ave.
Tucson, AZ 85713

U.S. Fish and Wildlife Service
201 N. Bonita Ave.
Tucson, AZ 85745-2999

NON-PROFIT ORGANIZATIONS
Coalition for Sonoran Desert Protection
300 E. University Blvd., Suite 120
Tucson, AZ 85705

Sky Island Alliance
300 E. University Blvd., Suite 270
Tucson, Arizona 85705

12. ATTACHMENTS

Attachment 1 - Project Budget Summary

13. AVAILABLE UPON REQUEST

References
Detailed Budget

ATTACHMENT 1: PROJECT BUDGET SUMMARY

	PreConst	PostConst	Match (Pre)	Match (Post)
PERSONNEL				
Monitoring Research				
Dave Grandmaison (GF)	$39,261.60	$39,261.60		
Tech (GF)	$19,790.40	$19,790.40		
Matt Goode (UofA)	$37,903.68	$37,903.68		
Mickey Parker (UofA)	$16,397.76	$16,397.76		
Work Study (UofA)	$3,474.24	$3,474.24		
Work Study (UofA)	$3,474.24	$3,474.24		
Secretarial / Administrative Support (GF)	$2,447.20	$2,447.20		
Subtotal	**$122,749.12**	**$122,749.12**	**$0.00**	**$0.00**
Linkage Stewardship				
Sky Island Alliance				
Jessica Lamberton (Wildlife Linkages Program Coordinator)			$4,738.50	$4,738.50
Oro Valley tracking transects			$21,375.00	$21,375.00
Oro Valley remote cameras			$3,420.00	$3,420.00
Data Entry			$9,880.00	$9,880.00
		Subtotal	**$39,413.50**	**$39,413.50**
Coalition for Sonoran Desert Protection				
Carolyn Campbell (Executive Director)			$26,677.05	$26,677.05
Kathleen Kennedy (Program Associate)			$5,402.60	$5,402.60
Gabe Wigtil (Admin Associate)			$11,605.23	$11,605.23
TBD (State Land Conservation Organizer)			$3,000.08	$3,000.08
Linkages Brochure Printing			$1,300.00	
		Subtotal	**$47,984.96**	**$46,684.96**
	Linkage Stewardship Subtotal		**$87,398.46**	**$86,098.46**
EQUIPMENT				
Camera Monitoring				
Hi-Temp 8 Channel Air Ventilated DVR		$6,000.00		
Envirocam Camera with 65' Infrared Illuminator		$3,600.00		
New Line Photoelectric Detectors		$2,400.00		
[1]Infrared Illuminators				$2,920.00
[1]Reconyx Surefire Still Camera				$6,000.00
Mileage ($0.55 / mile)		$1,100.00		
Other Miscellaneous Operating Expenses		$6,000.00		
	$0.00	**$19,100.00**	**$0.00**	**$8,920.00**
Road Mortality				
Mileage ($0.55 / mile)	$1,650.00	$1,650.00		
Other Miscellaneous Operating Expenses	$1,250.00	$1,250.00		
Trimble GPS Dataloggers			$3,000.00	
[2]Diamond Traffic Products Inductive Loop Counte	$11,145.00			
	$14,045.00	**$2,900.00**	**$3,000.00**	**$0.00**
Automated PIT-Tag Systems				
RFID Reader		$6,600.00		
PIT-Tags	$6,500.00	$6,500.00		
Pass Through Multi Antennae System		$4,500.00		
Hand-Held PIT-Tag Readers w/ Pole Antennae	$1,960.00			
PIT-Tag Injectors	$50.00	$50.00		
	$8,510.00	**$17,650.00**	**$0.00**	**$0.00**

ATTACHMENT 1: PROJECT BUDGET SUMMARY

	PreConst	PostConst	Match (Pre)	Match (Post)
Funnel Trap and Cover Board Arrays				
Portable Funnel Trap Arrays	$1,800.00			
Cover Board Material	$1,000.00			
[3]Capture and Handling Equipment	$600.00		$300.00	
	$3,400.00	**$0.00**	**$300.00**	**$0.00**
Small Mammal Trapping				
Collapsable Sherman Traps	$6,000.00			
Trapping and Handling Supplies	$200.00			
	$6,200.00	**$0.00**	**$0.00**	**$0.00**
Flourescent Powder Tracking				
Flourescent Powder	$930.00			
Marking Chalk	$30.00			
Maglite Flashlights w/ UV Bulb Retrofit Kit	$220.00			
	$1,180.00	**$0.00**	**$0.00**	**$0.00**
Other Field Equipment				
[4]GPS Units			$3,000.00	
[4]Cameras			$1,800.00	
[4]Binoculars			$1,800.00	
Misc. Supplies	$1,100.00	$1,100.00		
	$1,100.00	**$1,100.00**	**$6,600.00**	**$0.00**
Environmental Monitoring Equipment				
Hobo-Pro Temperature and Humidity Data Logge	$1,440.00			
Housing Software and Cables	$350.00			
Extech Datalogging Light Meters	$2,250.00			
	$4,040.00	**$0.00**	**$0.00**	**$0.00**

	PreConst	PostConst	Match (Pre)	Match (Post)
Total Personnel Budget	**$122,749.12**	**$122,749.12**	**$87,398.46**	**$86,098.46**
Total Equipment Budget	**$38,475.00**	**$40,750.00**	**$9,900.00**	**$8,920.00**
GF Overhead (30.5% of PS)	**$14,103.20**	**$14,103.20**	**$0.00**	**$0.00**
UofA Overhead (26.5% total budget)	**$16,231.23**	**$16,231.23**	**$0.00**	**$0.00**
SUBTOTAL	**$191,558.55**	**$193,833.55**	**$97,298.46**	**$95,018.46**

$191,558.55	**Grand Total (Pre-Construction)**
$193,833.55	**Grand Total (Post-Construction)**
$192,316.92	**Total Matching Funds**
$577,709.02	**Total Project Budget**