VISIONARY CONSERVATION PLANNING AND COMMUNITY SUPPORT BRING $45 MILLION IN ASSURED FUNDING TO WILDLIFE LINKAGE INFRASTRUCTURE IN PIMA COUNTY, ARIZONA

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ABSTRACT

For the past fifteen years, regional conservation planning has been at the forefront of land use decisions in Pima County, Arizona. In 1998, Pima County adopted the groundbreaking Sonoran Desert Conservation Plan; part of this process involved identifying "Critical Landscape Connections," or wildlife linkages, that were particularly threatened by barriers such as highways and development. Then, in 2006, Pima County voters approved the Regional Transportation Authority (RTA) Plan, which is funded by a 20-year ½-cent sales tax and includes $45 million of dedicated monies for wildlife linkage projects. Since 2006, the RTA Wildlife Linkages Working Group, comprised of members representing all the local jurisdictions and two non-governmental organizations, has begun distributing this $45 million to an array of research projects, planning efforts, and the construction of wildlife crossings along major regional roadways.

Research projects have included an investigation of appropriate fencing methods specific to wildlife in the Sonoran Desert and roadkill surveys conducted as a precursor to the siting of wildlife crossings. The Arizona Game and Fish Department also completed a detailed assessment of Pima County's wildlife linkages in 2012. This document and associated maps will help local land-use planners identify specific wildlife linkage challenges and opportunities on local transportation projects.

Thus far, the bulk of the money allocated has been to the construction of wildlife crossings along local roads and highways. These projects reflect a variety of scales, from the addition of small pipe culverts to the first wildlife overpass ever built in the Sonoran Desert. $11 million was allocated for one underpass and one overpass and associated fencing along State Route 77, the largest project funded to date. These crossings will be built by the Arizona Department of Transportation, starting in late 2013, as part of their larger project to widen a section of State Route 77 from four to six lanes. Two underpasses are currently under construction along State Route 86 on the Tohono O'odham Nation, with plans for an additional wildlife overpass approved for the future. A series of wildlife underpasses were approved for two local roadways, Tangerine Road and Silverbell Road, and will be phased into these projects when the roads are widened in coming years. Other smaller projects have rounded out the portfolio of innovative projects funded by the Working Group.

Due to the adoption of the Sonoran Desert Conservation Plan and the creation of the RTA, regional and widespread support now exists for projects that address the re-connection of Sonoran Desert wildlife linkages in transportation projects. Along the way, many challenges have been overcome with local landowners and agencies. Local non-profit organizations have been essential in executing both community outreach efforts and behind-the-scenes negotiations and bridge-building that has proven crucial to the success of these projects. Despite many challenges, local planners, transportation engineers, conservationists, and the larger community are moving forward with the first plan – and an assured local funding mechanism – that addresses wildlife linkage conservation on a regional scale in the Sonoran Desert.

INTRODUCTION

Habitat fragmentation, caused by a growing network of roads and sprawling residential and commercial development, is increasingly threatening wildlife linkages in the Sonoran Desert. In Pima County, on the eastern end of the Sonoran Desert in southern Arizona, regional conservation planning and an innovative local funding source of $45 million for wildlife linkage projects has created robust community support for protecting and re-connecting Sonoran Desert wildlife linkages around the metropolitan area of Tucson.

Regional conservation planning began in earnest in 1998 when Pima County adopted the nationally recognized Sonoran Desert Conservation Plan (SDCP). The biological goal of the SDCP is to "ensure the long-term survival of the full spectrum of plants and animals that are indigenous to Pima County through maintaining or improving the habitat conditions and ecosystem functions necessary for their survival" (Pima County 2012). Throughout the last 15 years, Pima County has implemented this plan through a variety of measures, including revised policies in their comprehensive land use plan, open space purchases, and development of a habitat conservation plan to address endangered species issues. Another important component of the SDCP is the identification of threatened wildlife linkages in Pima County. These wildlife linkages are broadly defined areas that connect preserve areas (such as National Forest lands, National Park lands, or Pima County-owned open space) but also contain existing or potential barriers to wildlife movement (Pima County 2005). These barriers include railroads, agricultural fields, irrigation canals, and most importantly, a network of roads.

Realizing that the critical wildlife linkages surrounding Tucson could soon be severed permanently without appropriate action, in 2006 Pima County voters adopted a 20-year transportation plan and financing tax that included $45 million to fund wildlife crossing infrastructure and related research and monitoring (Regional Transportation Authority 2013). This money is being allocated to local jurisdictions and state agencies for the construction of wildlife crossing structures on specific roadway projects, along with associated research and monitoring.

Pima County also recognizes that there must be connected corridors of open space within wildlife linkages to effectively connect large blocks of protected lands that exist in the sky island mountain ranges surrounding the greater Tucson area. In 2004, Pima County asked voters to approve a $174.3 million habitat-based Open Space Bond that included critical wildlife linkage lands (Pima County 2004). The voters approved the bond measure by a 2-to-1 margin. Since then, Pima County has purchased over 200,000 acres of important open space, including both outright acquisitions and purchase of state grazing leases (Pima County 2011).

This paper describes how Pima County and other local jurisdictions within Pima County are successfully building a broad portfolio of wildlife linkage protection projects, based on a regional conservation plan and utilizing a unique and innovative local funding source. First, a history of regional conservation planning efforts, open space acquisition efforts, and the development of a local funding source for wildlife linkages protection is described. Then, an overview of funded wildlife linkage projects, including wildlife crossings, research, and monitoring, is provided.

GEOGRAPHY AND DEMOGRAPHICS

Pima County is located in southern Arizona and lies at the crossroads of two major ecoregions, the Apache Highlands and the Sonoran Desert (Beier et al., 2008). The Apache Highlands include the mountainous "sky islands," which reach elevations in excess of 2743 meters (9000 feet). The Sonoran Desert lies in the basins between and also extends west and south into Mexico. The Sonoran Desert is characterized by bajadas (a broad area of several blended alluvial fans) sloping down from the mountains and supporting forests of ancient saguaro cacti (*Carnegiea gigantean*), paloverde (*Cercidium sp.*), and ironwood (*Olneya tesota*); creosotebush (*Larrea tridentata*) and bursage (*Ambrosia sp.*) dominate the lower desert (Marshall et al. 2000). More than 200 threatened species call the Sonoran Desert home and more than 500 species of birds use the region at some point in their life cycle, through migration, breeding, or permanent residence (Marshall et al. 2000).

In eastern Pima County, the sky islands, including the Santa Catalina, Tucson, Rincon, and Santa Rita mountains, are separated by the Santa Cruz River valley and its extensive network of tributaries. Sky islands are characterized by a range of biotic communities that allow both vertical and aspect migration (Warshall, undated). The intervening valleys serve as bridges, or wildlife linkages, between the mountain ranges, allowing species to colonize, migrate, breed, and forage in both the mountains and the desert (Warshall, undated). Wildlife crossing projects in the Sonoran Desert are designed for a variety of wildlife species, depending on their size. For wildlife overpasses (bridges) and underpasses (typically pre-cast concrete arches), target species include mountain lion, deer, bobcat, javelina, coyote, and other small mammals. On one planned project in a more rural area of Pima County, a wildlife overpass will be built specifically for desert bighorn sheep. Smaller corrugated metal culverts have been installed to accommodate small mammals, lizards, snakes, etc. The protection of important bat populations is also being addressed by projects that are retrofitting new bridges to include bat habitat.

In 2010, Pima County had a population of almost one million with the majority of people living in eastern Pima County within the Santa Cruz River valley (Pima Association of Governments 2013a). Pima County's population is expected to reach 1.45 million residents by 2041 (Pima Association of Governments 2013a). Residential and commercial development is largely concentrated within the cities of Tucson and South Tucson and surrounding jurisdictions such as the towns of Marana and Oro Valley to the north and northwest, respectively, and the town of Sahaurita to the south (Figure 1). More dispersed development exists in rural areas to the west, east, and southeast of Tucson.

U.S. Interstate 10 runs through eastern Pima County from the northwest to the east, creating a barrier to wildlife moving between the Tucson and Tortolita mountains and the Rincon and Santa Rita mountains (Beier et al. 2008). Annual average daily traffic volumes in 2010 on Interstate 10 in the area of the Tucson-Tortolita Mountains wildlife linkage were estimated to be from 58,000 to 85,000 vehicles per day and in the area of the Rincon-Santa Rita Mountains wildlife linkage from 27,500 to 33,500 vehicles per day (Arizona Department of Transportation 2013). State Route 77 runs north through Oro Valley and bisects the Santa Catalina - Tortolita Mountains wildlife linkage. Traffic volumes on this roadway in the area of the wildlife linkage ranged from 21,500 to 35,000 vehicles per day according to 2010 estimates (Arizona Department of

Transportation 2013). In the southern part of the county, U.S. Interstate 19 creates a barrier between the Santa Rita Mountains and the Sierrita Mountains, with 2010 traffic volumes estimated to be from 16,000 to 22,500 vehicles per day (Arizona Department of Transportation 2013). Additional smaller roadways throughout the county, totaling approximately 4000 miles in 2005, also act as barriers to wildlife movement (Pima Association of Governments 2013b; Campbell and Kennedy 2010).

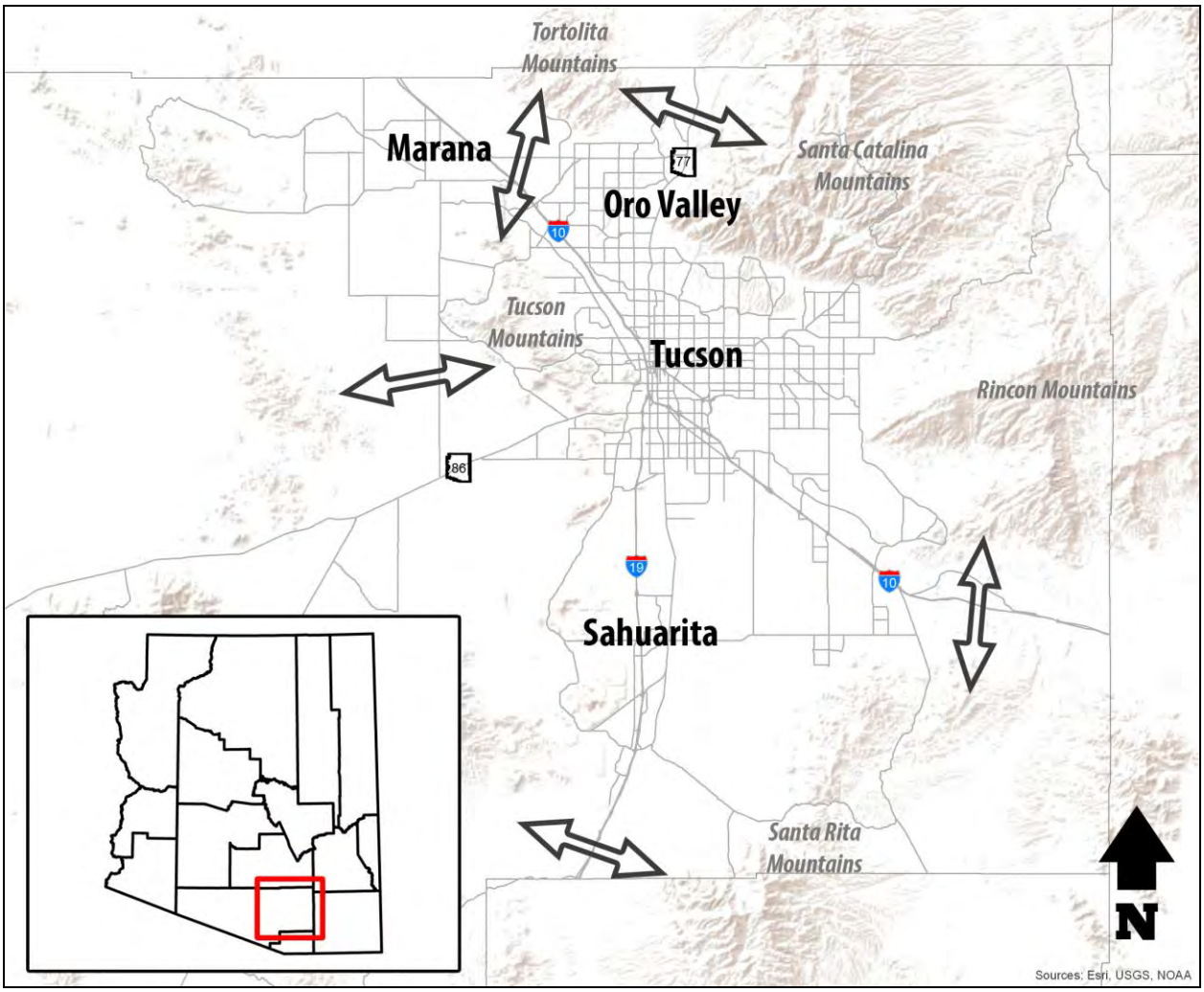

FIGURE 1 Overview map of eastern Pima County, including the major sky island mountain ranges, four incorporated cities/towns (Tucson, Oro Valley, Marana, and Sahuarita), and the major wildlife linkages indicated with arrows. Major roadways are also shown, demonstrating the significant threats to these wildlife linkages from the roadways themselves, along with habitat fragmentation from associated residential and commercial development.

SONORAN DESERT CONSERVATION PLAN

Regional conservation efforts in Pima County began in 1998 when the Pima County Board of Supervisors initiated discussions about how to more effectively merge land-use planning and conservation and make an effort to move away from the growth versus environment debate that had plagued the region for years (Pima County 2013). They also made an important decision to

base future land-use planning on the best available science (Pima County 2013). Another contributing factor to these discussions was the listing of the cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*) as an endangered species under the federal Endangered Species Act in 1997. Pygmy-owl habitat is often located on the types of land best suited for residential and commercial development and the listing of the pygmy-owl as an endangered species prompted passionate public debate about how conservation and economic growth could co-exist (the pygmy-owl was "de-listed" as an endangered species in 2006 after a lawsuit challenged its listing).

After initiating these discussions, Pima County developed and adopted the vision of the Sonoran Desert Conservation Plan (SDCP) in 1998, committing the county to ensuring "the long-term survival of the full spectrum of plants and animals that are indigenous to Pima County through maintaining or improving the habitat conditions and ecosystem functions necessary for their survival" (Pima County 2012). As a first step towards implementation of the SDCP, Pima County convened a Steering Committee in 1999 to produce consensus recommendations to county and federal officials regarding the protection of important Sonoran Desert endangered species.

The Steering Committee included members of the development, conservation, ranching, homebuilding, property rights, and real estate communities, as well as interested members of the public from the region. By most participants' standards, this stakeholder committee was originally considered too large to be effective in reaching consensus. However, in the end, it was precisely this diverse representation that led to broad support for the SDCP among Pima County citizens. The county appointed all citizens who expressed an interest in participating, leading to 84 members on the Steering Committee. Pima County officials held 12 monthly educational workshops for all committee members on various elements of the Endangered Species Act; geographical, demographical, and biological resources of the region; cultural history; and open space reserve design. Subsequently, with the help of a meeting facilitator, three additional years of Steering Committee meetings were held. These meetings were regularly attended by 50-60 stakeholders and were often highly charged and contentious. However, through the work of a smaller, ad hoc committee, the larger group began forging agreements over the course of the final six months of the 4-year long process (Campbell and Kennedy 2010).

In June 2003, the Steering Committee presented elected officials with a series of recommendations on SDCP implementation, development and mitigation standards, and proposed funding options. Key among those recommendations was: 1) acceptance of an open space preserve design developed by a team of local scientists, including an element that identified the most important, and most threatened, Sonoran Desert wildlife linkages, and 2) a call for a county open space bond election to fund habitat acquisition (Campbell and Kennedy 2010).

The Steering Committee also recommended that future open space acquisitions should be based on a subset of biologically-important lands identified by the science team. The subset of lands, or Habitat Protection Priorities, was developed by The Nature Conservancy and Arizona Open Land Trust. This criteria and set of lands was accepted by the Steering Committee as the best available science. Application of these goals and criteria resulted in the identification of the most important lands to protect through acquisition, provided guidance on the sequencing of land

protection efforts, and has been a method for prioritizing goals of an adaptive conservation management program.

LOCAL WILDLIFE LINKAGES FUNDING ESTABLISHED

Multi-Species Conservation Plan Development

In 2000, after adopting the vision of the SDCP and committing to the various pieces of its implementation, Pima County embarked upon a process to obtain a Section 10 incidental take permit from the U.S. Fish and Wildlife Service (referring to Section 10 of the Endangered Species Act). This permit requires the submittal of a Multiple-Species Habitat Conservation Plan (MSCP), essentially a plan to mitigate for the sanctioned but incidental "take" of endangered species granted by the Section 10 permit. The county submitted its permit application with a final draft MSCP in late 2012. Although this process was a direct response to endangered species liability issues countywide, in particular issues with the pygmy-owl, the scientific and community response have ultimately exceeded regulatory compliance. Two important initiatives that came out of the MSCP planning process were 1) the identification of specific wildlife linkages in Pima County that in part served as the rationale for a $174.3 million Open Space Bond in 2004, and 2) the passage of a regional transportation plan that included $45 million for wildlife linkages in 2006 (Campbell and Kennedy 2010).

$174 Million for Open Space Purchases

The SDCP Steering Committee recommended to Pima County in June 2003 that an Open Space Bond election be held as soon as possible. For the environmental community, public financing of conservation lands would bring conservation status of the lands in perpetuity sooner and with more certainty compared to the smaller, piecemeal development set-asides over many years. For the development community, the more mitigation lands acquired with public dollars, the less mitigation would need to be accomplished through regulatory mechanisms. In May 2004, Pima County voters supported a $174.3 million Open Space Bond with 66% of the vote (Campbell and Kennedy 2010).

The success of the Open Space Bond was primarily due to two factors. First, the SDCP received much publicity and was widely viewed by Pima County citizens as a positive framework for regional conservation planning. The planning process also received numerous regional and local awards for its vision and approach to dealing with growth and conservation. Secondly, The Nature Conservancy and the Trust for Public Land brought national resources to the local bond campaign, again because of strong support for the SDCP. Local scientists from The Nature Conservancy were heavily involved in the development of the scientific underpinnings of the Multi-Species Conservation Plan and the organization was convinced that the success of this plan could have national implications (Campbell and Kennedy 2010).

Since the passage of the 2004 Open Space Bond, over 200,000 acres of open space have been purchased for conservation in Pima County. These lands include those purchased outright by the county and the acquisition of grazing leases on state trust lands. Notable purchases include the 2005 purchase of the 14,000-acre Bar V Ranch, located in the wildlife linkage between the Rincon and Santa Rita Mountains and the 2004 purchase of the 40,000-acre A7 Ranch between the Santa Catalina and Rincon Mountains (Coalition for Sonoran Desert Protection 2013).

Although the county has largely spent all of the 2004 open space bond dollars, a new open space bond program is under development with the hopes of purchasing even more parcels from the Habitat Protection Priorities in the future (see Figure 2 for a series of maps that shows open space prior to the SDCP, current open space acquisitions, and parcels targeted for future purchase). The existing open space preserve system, coupled with future purchases, are a critical component of Sonoran Desert wildlife linkage protection, providing essential connected open space between the sky island mountain ranges that surround the Tucson area on all sides.

FIGURE 2 The evolution of open space protection in eastern Pima County. The City of Tucson is the metropolitan area in the center of the maps. Map A shows local, state, and federal protected open space prior to the Sonoran Desert Conservation Plan. Map B shows the additional lands purchased by Pima County with open space bonds approved by voters in 1997 and 2004, totaling over 200,000 acres of new protected open space. Map C shows additional targeted lands for acquisition, the Habitat Protection Priorities, which Pima County hopes to purchase in the future, further connecting and protecting Sonoran Desert wildlife linkages.

Conservation Lands System and Critical Landscape Connections

The SDCP implementation process initiated in 1998 brought together scientists from state and federal agencies, advocates from non-governmental organizations, and local county officials. Planning methodology in the general context of protecting biodiversity included development of a county-wide map identifying and prioritizing biologically-important lands by a science advisory team (Pima County 2005). These lands are called the Conservation Lands System. Categories developed for these lands were: Important Riparian Areas, Biological Core Management Areas, Special Species Management Areas, Multiple-Use Management Areas, and Critical Landscape Connections (or wildlife linkages). Connectivity between existing protected reserves was determined to be of particular importance to a functional landscape, thus the Critical Landscape Connections category became a focus with its own methodology for research and implementation (Campbell and Kennedy 2010).

Critical Landscape Connections were defined as areas that link large reserves or preserve areas, mostly in federal or county ownership (Pima County 2005). These wildlife linkages allow wildlife to move between these large preserve areas and provide for feeding, resting, dispersal of offspring, migration, gene flow, and shifting of a species' range in response to climate change (Beier et al. 2008). To qualify as a Critical Landscape Connection, the identified wildlife linkages had to have either existing or potential future barriers that could isolate major preserves and open space areas (see Figure 1). The barriers include, but are not limited to, railroads, agricultural fields, irrigation

canals, and roads. The linkage definitions, maps, and land use guidelines were included in both the draft Multi-Species Conservation Plan being prepared by Pima County and formally adopted into the County's Comprehensive Land Use Plan.

Pima County adopted the Conservation Lands System map in 2001 by officially codifying the map in a new Environmental Planning Element of their Comprehensive Land Use Plan. This was in response to the passage of the Growing Smarter Act by the Arizona Legislature in 1998 and a huge step in cementing science-based land-use planning in Pima County. The county also adopted natural open space requirements and appropriate land use development configuration guidelines based on the on-site biological resources. This included the Critical Landscape Connections map and land use guidelines. Those guidelines were updated in 2005 to reflect the best available science.

Since the adoption of the Conservation Lands System, Pima County has used the associated map and open space guidelines to guide the configuration of open space set-asides on new development, from small single-family homes that must preserve a small area of riparian habitat to large master-planned communities that have preserved up to 80% of their property as natural undisturbed open space. Retaining connections to open space on adjacent parcels is prioritized as much as possible.

Regional Transportation Authority Plan Approved

While the county was developing the 2004 Open Space bond, local citizens began investigating the feasibility of forming a Regional Transportation Authority (RTA) to address comprehensive transportation funding across the region. Ballot initiatives for transportation plans funded by a sales tax had been put before Pima County voters six times between 1984 and 2003, all unsuccessful. Each election seemed to have voters split into thirds: pro-highway, pro-alternate modes, and anti-tax increase. Following the defeat of a light-rail initiative in November 2003, local officials realized that a new plan was needed that could include a diverse assortment of projects that would have a greater chance of strong voter support. As well, the Pima County region's funding sources were severely lacking to meet transportation needs over the long-term and the options to obtain new funding sources were limited (Campbell and Kennedy 2010).

Recognizing this need, the Pima Association of Governments commissioned a study by the University of Arizona to assess the feasibility of a Regional Transportation Authority (RTA). The University brought together a diverse group of stakeholders and government representatives to approach the State Legislature for statutory authority for this purpose in 2003. The RTA legislation was approved at the end of the legislative session, signed into law by the Governor in April 2004 and becoming effective in August 2004. One of the key components of the legislation for the RTA was eliminating the veto power of the two largest jurisdictions, the City of Tucson and Pima County. This single action required the nine regional jurisdictions to work cooperatively to develop the RTA plan (Campbell and Kennedy 2010).

The nine-member RTA Board, representing the local, state and tribal governments in the region, met for the first time in September 2004 and formed two committees to develop the plan. One was a 35-member Citizens' Advisory Committee representing a diverse group of citizens, including representatives from the chamber of commerce, a car dealership, a light-rail organization, and

members of the real estate, homebuilding, and conservation communities, many of whom had formally opposed each other in prior failed transportation initiatives. The other committee was a Technical/Management Committee with transportation experts and engineers from both the public and private sector. Their role was to advise the Citizens' Advisory Committee on technical components of the plan being developed. Development of the plan lasted ten months, whereby both committees met twice a month and also participated in joint, facilitated meetings, including a weekend retreat. During the final joint session, participants worked and reached consensus on a final recommendation to the RTA Board (Campbell and Kennedy 2010).

During the ten-month process, information about how wildlife is affected by transportation activity was presented to both the Citizens' Advisory and Technical/Management Committees by the Executive Director of the Coalition for Sonoran Desert Protection (Coalition), an alliance of dozens of environmental and community organizations that formed in 1998 in tandem with the adoption of the SDCP. These presentations included information on projects in other communities addressing transportation infrastructure and safe passage for wildlife as well as a rationale for future wildlife linkages infrastructure in Pima County. These presentations were informed by the prior SDCP process and the science-based conclusions reached about threatened wildlife linkages within Pima County (Campbell and Kennedy 2010).

The funding commitment for wildlife linkages within the $2.1 billion RTA plan was initially supported at $10 million, but grew to $45 million after stakeholder education and a presentation of a detailed county-wide project needs list and budget totaling $90 million by the Coalition. Final approval of the proposed plan by the Citizens' Advisory and Technical/Management Committees included $45 million for the Critical Wildlife Linkages funding category in the RTA plan. This was based on a required match within each funding category. For example, development impact fees matched highway and road project funding and farebox revenues matched transit funding. The match for the wildlife linkages category was less prescriptive, however, with proposed funding coming from federal, state and other grants and possible in-kind contributions from local jurisdictions and non-governmental organizations (Campbell and Kennedy 2010).

During an 18-month public outreach process, the RTA conducted 27 open houses, presented to well over 400 neighborhood, business and civic groups and held three major news conferences. The RTA conducted two rounds of meetings with editorial boards at all the major media outlets. All the RTA Board and committee meetings were open to the public. The RTA also had informational exhibits at many public venues (Campbell and Kennedy 2010).

Once the RTA committees received public feedback, they incorporated 14 major changes to the final RTA plan recommended to the RTA Board. The Board unanimously approved the plan, which also received unanimous support from all of the governing bodies of the member jurisdictions. This was a historic first for the region and is a direct reflection of the cooperative spirit of the jurisdictions which was developed as part of the RTA process. In May 2006, Pima County voters approved the RTA plan with 66% of the vote. As was instrumental in the SDCP Steering Committee process, an important part of this process was stakeholder education and commitment to consensus as well external communications and public engagement (see Figure 3 for a summary of important event related to the Sonoran Desert Conservation Plan and the protection of Sonoran Desert wildlife linkages).

1997 * Cactus ferruginous pygmy-owl is listed as endangered under the federal Endangered Species Act.
1998 * Pima County adopts the basic principles of the Sonoran Desert Conservation Plan and commits to implementation in the future.
* Pima County initiates the development of a Multi-Species Conservation Plan as part of a future application for an Incidental Take Permit from the U.S. Fish and Wildlife Service.
2001 * Pima County adopts the Conservation Lands System into their Comprehensive Land Use Plan, establishing a set of land use policies for biologically important areas of the county.
2004 * Pima County voters overwhelmingly approve $174.3 million in bond funding for open space acquisitions.
2006 * Pima County voters approve the Regional Transportation Authority tax which generated $45 million in funding over 20 years for wildlife linkages projects integrated into transportation infrastructure.
2012 * Pima County submits the final draft of their Multi-Species Conservation Plan to the U.S. Fish and Wildlife Service to address endangered species protection and mitigation.

FIGURE 3 Summary of important events related to the implementation of the Sonoran Desert Conservation Plan and the protection of Sonoran Desert wildlife linkages.

$45 MILLION IN LOCAL FUNDING FOR WILDLIFE LINKAGES

Getting Started

After the RTA plan was approved, sub-committees were formed to assist in implementation of the various funding categories (in addition to wildlife linkages, other categories included bike/pedestrian projects, transit projects, and transportation improvement projects). A Wildlife Linkages Working Group was charged with coordinating the disbursement of the $45 million in wildlife linkages funding. Representation on the committee includes representatives from local jurisdictions, state agencies, local tribes, and non-governmental organizations.

The committee's first task was to discuss how funding could be used, leading to general categories of research, both specific to certain roadways and more generally to the Sonoran Desert; the construction of wildlife crossings on new or expanding roads; and retrofitting existing crossings into wildlife crossings on roads and bridges. The next task was to devise a protocol for funding proposals from local jurisdictions and a system for evaluation and decision-making. Lastly, while wildlife linkages were identified on a statewide level in Arizona (Arizona Department of Transportation 2006), a more detailed assessment was needed in Pima County. Only local jurisdictions and state agencies are allowed to apply for wildlife linkages funding from the RTA although they can sub-contract work to private consultants, non-governmental organizations, and other governmental entities. Once the Working Group approves funding for a project, the proposal also must be approved by a series of higher-level committees, culminating with final approval by the RTA Board (made up of an elected representative from each of the participating jurisdictions).

Research Projects

Town of Marana Roadway Extension

Recognizing a need for wildlife linkages research specific to the Sonoran Desert, since much prior research took place in very different ecosystems with different target species, the first projects funded by the RTA Wildlife Linkages Working Group were research projects. The Town of Marana was the first jurisdiction to submit a funding proposal and the town was approved for $20,000 to study wildlife presence and movement along a 3.4-mile stretch of desert sited for a new road (see Figure 4 for a map showing the distribution of projects funded to date by the Working Group). The Town contracted with the Arizona Game and Fish Department to complete the research and a year later this research informed the modification of a planned conspan structure to increase its size for deer passage, three additional pipe culverts to provide more regular spacing of wildlife crossings along the roadway for smaller wildlife species, and wildlife fencing. The RTA Working Group approved $725,659 for the Town of Marana in 2007 to cover the increased construction costs of up-sizing and adding these wildlife crossings to the project.

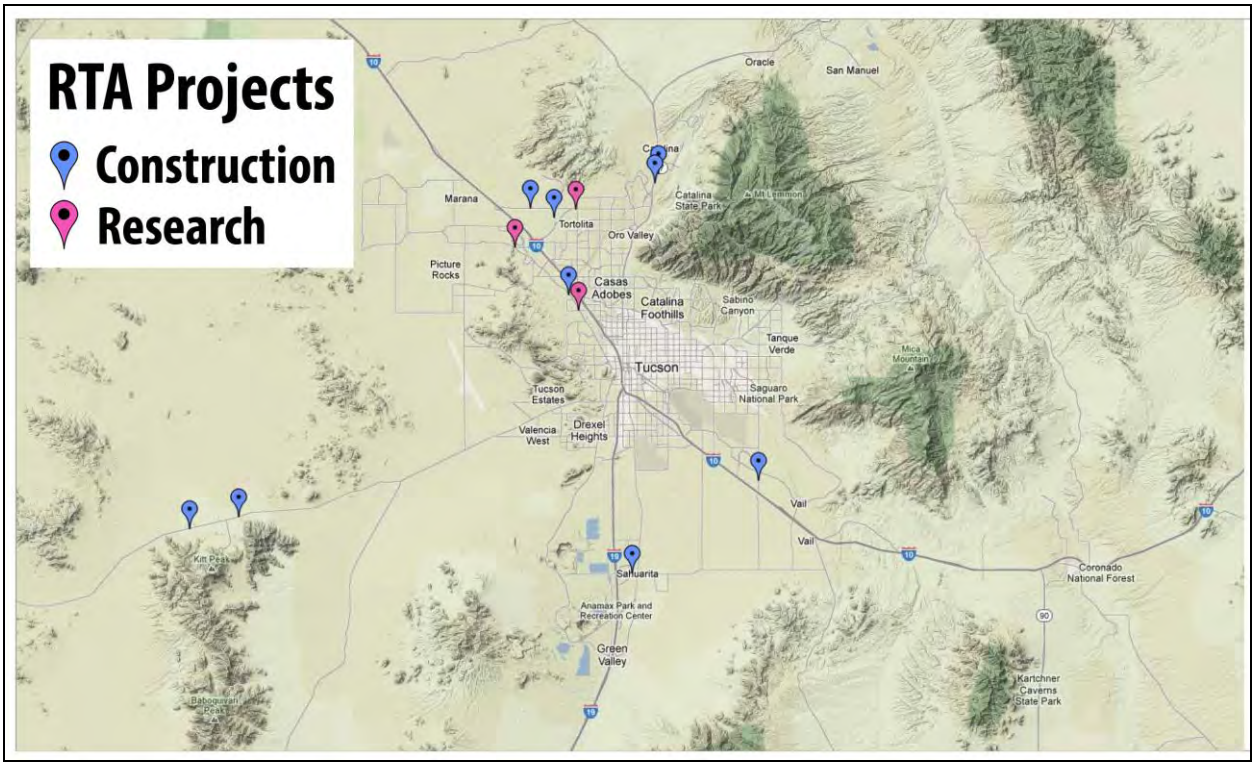

FIGURE 4 Map of eastern Pima County showing the distribution of construction and research projects funded by the RTA Wildlife Linkages Working Group since its inception in 2006. Map data © Google.

Sonoran Desert Culvert and Fencing Design

In 2007, the Working Group also funded two proposals from the Arizona Game and Fish Department to conduct new research on culvert and fencing design specific to Sonoran Desert wildlife species. The culvert design study was funded for $365,060 and the fencing design study for $109,580. Both of these studies generated useful data for local governments on the most appropriate types of culverts and fencing to include in future transportation projects (Grandmaison

2011). Recommendations generated by the studies included general guidelines for effective roadway mitigation such as maintaining natural vegetation near underpass openings and on overpass structures; taxa-specific recommendations such as sufficiently burying barriers to prevent burrowing by Sonoran Desert amphibians and funneling lizards to underpasses using concrete panels with a 4-inch overhang, rusticated steel, and guard rail barriers; and design considerations for multi-species crossing structures (Grandmaison 2011). At the request of the RTA, the study report had a clear list of recommendations at the end to assist transportation planners in the future.

Wildlife Crossing Monitoring Projects

As the RTA Wildlife Linkages program has evolved since its inception in 2006, a consistent challenge for the Working Group has been achieving successful funding for monitoring new wildlife crossings projects. In 2011, a team of researchers from Arizona Game and Fish Department and the University of Arizona submitted a proposal for pre- and post-construction monitoring of the State Route 77 Wildlife Crossing project for $385,381. In addition, the proposal identified $192,316 of matching funds from two local non-governmental organizations, the Sky Island Alliance and Coalition for Sonoran Desert Protection, which had committed to providing significant volunteer time and resources to the project. The proposed 5-year monitoring project would have conducted road mortality surveys prior to and after construction to determine if the crossings reduced wildlife-vehicle collisions; installed cameras on the wildlife crossings after construction to document wildlife passage rates by large animals; deployed automated PIT-Tag (Microchip) reading systems to quantify passage rates by small animals; and completed vegetation surveys, environmental monitoring, and traffic monitoring to evaluate the influence of these factors on wildlife passage rates (Grandmaison et al. 2010). Unfortunately, although the Working Group approved funding for this important monitoring, the RTA Board ultimately rejected the proposal, citing other possible funding sources that should be pursued for monitoring research. To date, an additional funding source has not been procured for this monitoring project.

In April 2012, the Coalition for Sonoran Desert Protection, a local non-profit conservation organization, initiated a volunteer-driven Wildlife Camera Project near the State Route 77 wildlife crossing locations. Thus far, the Coalition has six motion-activated cameras on the landscape to the east and west of State Route 77. The cameras have documented the presence of mountain lion, deer, bobcat, fox, javelina, badger, coyote, and other small mammals, lizards, snakes, and birds (for photos from the project, visit http://www.sonorandesert.org/learning-more/wildlife-linkages/942-2/). Four more cameras will be put on the landscape in 2013. Thus far, this is the only pre-construction monitoring of any type being conducted on the State Route 77 Wildlife Crossing project.

Prior to the unsuccessful proposal for monitoring on State Route 77, the RTA did approve pre- and post-construction monitoring along Sahuarita Road south of Tucson for $135,000. However, no additional monitoring studies have been approved since then.

Pima County Wildlife Linkages Assessment

After the Arizona Game and Fish Department (AGFD) and Arizona Department of Transportation (ADOT) completed a statewide wildlife linkages assessment in 2006, the AGFD began conducting more detailed wildlife linkages assessments on the county scale (Arizona Department of Transportation 2006). These assessments are being completed as funding becomes available. In

2010, the Working Group approved $61,500 to fund the Pima County Wildlife Connectivity Assessment. This funding covered two community forums to gather input from stakeholders and members of the public about wildlife movement corridors and barriers to movement in the county and a temporary yearlong position at AGFD to analyze the data, complete GIS modeling, and write the report. At the community forums, large maps were spread around a large meeting room and attendees were encouraged to identify movement corridors and barriers by writing and drawing on the maps along with filling out detailed data sheets. Over the next year, the AGFD employee digitized and refined these maps using GIS models, along with data from other sources, ultimately producing a 60-page report with detailed information about Pima County's wildlife linkages (Arizona Game and Fish Department 2012).

In the future, the Working Group hopes that this document will assist and inform local and regional transportation planners as they try to incorporate wildlife linkages elements into transportation projects. Opportunities for retrofits are now easier to identify and the entire county has been mapped for healthy and threatened movement corridors, existing bridges that act as *de facto* wildlife crossings, and specific problem areas that need remedying where wildlife movement is particularly constrained or completely severed.

Construction Projects

State Route 77 Wildlife Crossings

The largest construction project funded to date by the RTA is the State Route 77 Wildlife Crossings project. ADOT, in collaboration with other stakeholders, successfully submitted a funding request to the RTA in 2009 for $8.2 million to construct one wildlife bridge (a precast concrete unit consisting of two cells) and two underpasses (prefabricated concrete units) along a stretch of State Route 77 (SR77) in the Santa Catalina-Tortolita Mountains wildlife linkage. Since this six mile section of roadway is scheduled to be widened by ADOT from a four lane highway to a six lane divided highway, the wildlife crossings will be incorporated into the larger construction project, leading to significant cost savings.

The wildlife crossings have been designed to accommodate large mammals such as mountain lion, mule deer, and bear but will be equally as useful for small mammals such as coyote, bobcat, javelina, fox, and badger, as well as even smaller snakes, lizards, and tortoises. Since the original proposal was approved, one of the underpasses was dropped from the project and the RTA approved $3 million in additional funding to cover increased construction costs and additional wildlife fencing.

Planning and Design After the RTA approved the SR77 wildlife crossings in 2009, ADOT convened a Technical Advisory Committee (TAC) to assist them and their design consultants, URS, Inc., with the design of the wildlife crossings, using the best available science and biological data to inform their exact placement and design. Members of the TAC include representatives from the Town of Oro Valley, Pima County, ADOT, AGFD, Tucson Audubon Society, and the Coalition for Sonoran Desert Protection. Since 2009, the TAC has met regularly with ADOT and URS, providing critical input and recommendations on the specific design elements of the wildlife crossings, size and type of associated wildlife fencing, and the size and placement of cattle guards on roadways that create breaks in the wildlife fencing (see Figure 5 for a rendering of the wildlife

bridge). Members of the TAC have facilitated meetings with private landowners in the project area who have concerns about the wildlife crossings or simply want to stay informed as the project develops. They have also served as public ambassadors, keeping interested citizens up-to-date on project developments and changes.

FIGURE 5 Artistic rendering of the wildlife overpass planned for State Route 77 in Pima County, Arizona within the Santa Catalina-Tortolita Mountains wildlife linkage. Courtesy of Arizona Department of Transportation.

Land Ownership Challenges Inevitably, challenges were encountered as the SR77 Wildlife Crossings Project evolved and developed. One of the biggest challenges has been the complex land ownership on either side of the crossing locations. Unlike many wildlife crossing projects where the land on either side of the crossings is publicly owned and protected, the SR77 project is located on the edge of a metropolitan area with a mosaic of public and private lands between the wildlife crossings and larger preserve areas such as the Coronado National Forest in the Santa Catalina Mountains to the east and Pima County-owned Tortolita Mountain Park to the west (Figure 6). This presents an ongoing challenge, both with establishing support for the project from these various landowners and also with finding mechanisms to permanently preserve these lands.

Originally, the SR77 project was designed to have two underpasses and one overpass. However, objections from a private landowner with a parcel on the west side of SR77 adjacent to the outlet of one of the underpasses ultimately led to this underpass being dropped from the project. The landowner was concerned about the aesthetics of the necessary wildlife fencing near the underpass and unfortunately a resolution could not be reached. However, the unwavering commitment of the entire project team led to a creative response to the removal of the underpass, with additional wildlife fencing added to a wash to the west of SR77. This additional fencing will make a few existing bridges more functional, *de facto* wildlife crossings that will connect with the new

underpass and overpass. The project team believes this has created a stronger project that will even better facilitate wildlife movement within this wildlife linkage.

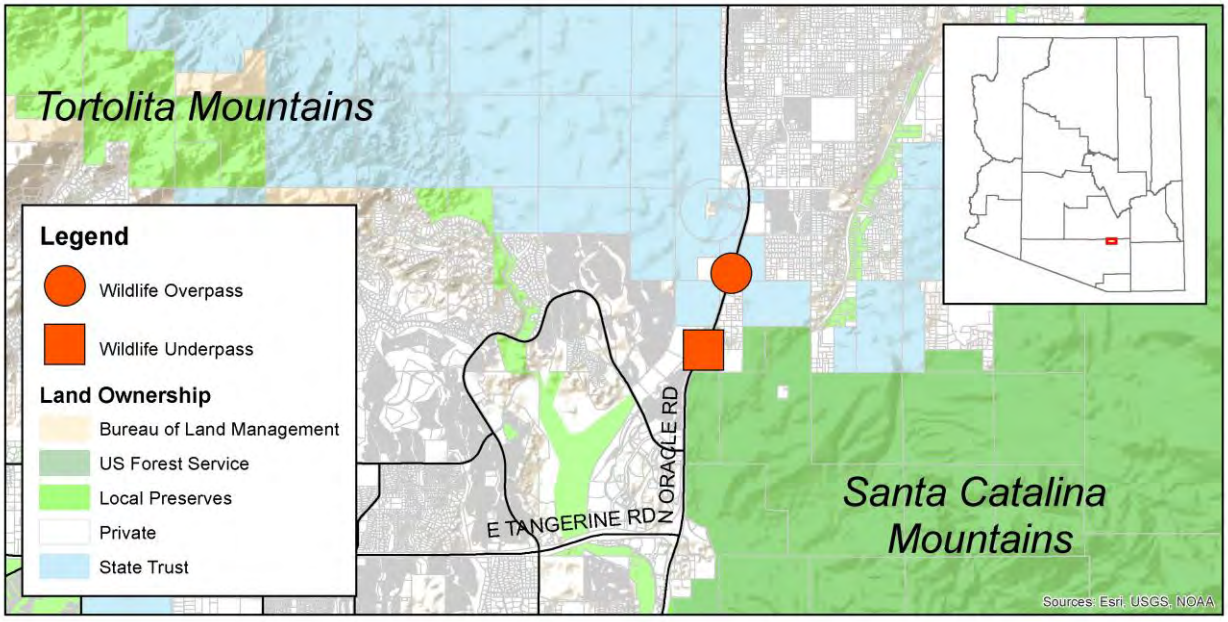

FIGURE 6 Landownership adjacent to and near the SR77 wildlife crossings. A large tract of State Trust Land plus private land and local preserves extends west to the Tortolita Mountains. U.S. Forest Service Land, some of which is managed by Catalina State Park, State Trust Land, and private land extends east into the Santa Catalina Mountains.

On the east side of SR77, landownership is dominated by Catalina State Park (with the park land actually being owned by the U.S. Forest Service) and State Trust Land that connects with the Coronado National Forest of the Santa Catalina Mountains. However, on the west side of SR77, landownership is much more complicated with a mosaic of private, county, and state ownership leading to the Pima County-owned Tortolita Mountain Park in the Tortolita Mountains. Large washes in this area are protected due to their flood conveyance functions. However, a large tract of State Trust Land east of the overpass location still needs permanent protection. In 2009, the Town of Oro Valley identified this land for potential future annexation at the same time that the Arizona State Land Department was drafting a conceptual plan for this area (locally called "Arroyo Grande"). The conceptual plan provides land use information for State Trust Land that is targeted for eventual sale by the State Land Department to both private and public buyers. Due to the vision of the Sonoran Desert Conservation Plan and the biological underpinnings of the Conservation Lands System, a group of stakeholders worked with the State Land Department and Oro Valley to secure a 0.6 mile (1 km) wide wildlife linkage within the conceptual plan for this area. However, until the land is sold, the wildlife linkage is not permanently protected.

Other challenges encountered as the SR77 Wildlife Crossings project has been implemented include finding funding pre- and post-construction monitoring (described above), establishing responsibility for maintenance of the crossings and associated wildlife fencing once the project is completed, and managing the complicated array of partnerships needed to keep the SR77 project moving forward.

Moving Forward Right now, the SR77 wildlife crossings are scheduled to begin construction in late 2013 as part of the larger SR77 widening project. In December 2012, the RTA approved $3 million in additional funding to cover increased costs of construction that were not anticipated in the original proposal and the additional fencing necessitated by the removal of the second underpass. The Coalition for Sonoran Desert Protection will continue to collect wildlife presence data near the crossing locations with their volunteer-led Wildlife Camera Project. The Coalition and other interested stakeholders will also continue to pursue additional funding for monitoring as it becomes available.

State Route 86 Wildlife Crossings Retrofit Project

Another major wildlife crossing project funded by the RTA are two underpasses along State Route 86 (SR86) on the Tohono O'odham Nation west of Tucson. SR86 runs east-west through the Kitt Peak Wildlife Linkage, a linkage identified as one of the "highest priority" for protection in the 2006 Arizona Wildlife Linkages Assessment (Arizona Department of Transportation 2006). These underpasses will consist of pre-cast concrete arch structures and will be installed during a larger widening project that will expand SR86 from its current existence as a two lane roadway with limited shoulders to a two lane roadway with paved 8' (2.4m) shoulders and graded 30' (9.1m) clear zones (Tohono O'odham Nation 2011). They will replace existing, concrete box culverts that are not designed for wildlife movement. The new underpasses are designed to accommodate mule deer, javelina, mountain lion, and other smaller wildlife species. The locations of the two underpasses also correspond well with data about wildlife-vehicle collisions along SR86. Wildlife-vehicle collisions have involved large mammals such as mule deer, mountain lion, javelina, bobcat, coyote, and grey fox (Tohono O'odham Nation 2011). Construction of the SR86 widening projects has already begun, with the underpasses scheduled for completion in 2013.

Other RTA Wildlife Linkage Projects

The RTA Wildlife Linkages Working Group has funded a host of other smaller research and construction projects since 2006 (see Figure 4 for a map showing the distribution of these projects throughout eastern Pima County). In addition to the research projects described above, additional roadkill surveys have been funded to support the placement of wildlife crossings along roadways targeted for future expansion. Other construction projects include wildlife fencing along a roadway east of Tucson; a series of wildlife underpasses along a major roadway in Marana, Pima County, and Oro Valley that will be phased in as the roadway is widened; and, more recently, two projects that will retrofit new bridges to create habitat for bats. Potential future projects include a wildlife bridge over Interstate 10 in the Tucson-Tortolita Mountains Wildlife Linkage and a wildlife bridge across State Route 86 west of the two wildlife underpasses currently under construction.

CONCLUSION

Regional conservation efforts in Pima County over the 15 years have led to successful integration of habitat conservation, transportation, and land use planning on a multi-jurisdictional level. Methodology to design, implement and preserve wildlife connectivity across transportation infrastructure has been multi-faceted, complex, and science-based.

The foundation of these efforts is the Sonoran Desert Conservation Plan (SDCP), a regional vision and commitment to the preservation of biological diversity and an intact Sonoran Desert ecosystem. After an intensive public process that established goals for the SDCP, in 2004 voters

approved an Open Space Bond of $174.3 million that included acquisition of biologically-important lands. Following this success, Pima County voters approved a sales tax for a Regional Transportation Authority (RTA) in 2006 that included $45 million for wildlife linkages funding. The RTA came about from an intensive stakeholder process that sought to bring together previously opposed groups and create a diverse transportation plan that satisfied multiple interests.

Open space bond acquisitions and the RTA funding for wildlife linkages will continue to be implemented in the years ahead. These programs are being integrated not only with each other, but with multi-jurisdictional land use planning decisions, along with on-going research and monitoring. Pima County, Arizona, comprised of a diverse set of local jurisdictions, has much to be proud of as it continues to protect and restore its critical wildlife linkages through the implementation of the visionary Sonoran Desert Conservation Plan. It will only be able to do this with the continued support of its citizens for the conservation of important wildlife habitat, open spaces, and the linkages that bind them together.

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BIOGRAPHICAL SKETCH

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Kathleen Kennedy has managed the program areas and fundraising efforts of the Coalition for Sonoran Desert Protection since 2007. She graduated from Northern Arizona University in 2000 with a B.S. in Geology and from the University of Montana in 2005 with a M.S. in Environmental Studies. Kathleen's responsibilities within the Coalition include researching, writing, and coordinating the Coalition's position statements, along with implementing the Coalition's fundraising plan and development activities. Before joining the Coalition, she worked for the Town of Marana as an Environmental Projects Coordinator and for the USDA-ARS Southwest Watershed Research Center as a Hydrologic Technician.

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