

# The Pima County Wildlife Connectivity Assessment: Report on Stakeholder Input

February, 2012



Artist rendering of proposed overpass along State Route 77, courtesy of Coalition for Sonoran Desert Protection

## Arizona Game and Fish Department



Primarily funded by the Regional Transportation Authority of Pima County



In partnership with the Arizona Wildlife Linkages Workgroup  
and the Pima County Wildlife Connectivity Workgroup

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Stakeholder identified species:  
Sonoran desert tortoise  
Photo by A. Owens  
Arizona Game and Fish Department



Stakeholder identified species:  
Sonoran pronghorn  
Photo by G. Andrejko  
Arizona Game and Fish Department



Stakeholder identified species:  
Cactus ferruginous pygmy-owl  
Photo by G. Andrejko  
Arizona Game and Fish Department

## RECOMMENDED CITATION

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## DEFINITIONS

*Note: Terms in this list are highlighted in **bold** where they first appear in the text.*

Arizona Missing Linkage – A subset of wildlife linkage zones identified in the statewide Arizona's Wildlife Linkages Assessment and county-level assessments, developed into detailed modeled corridors based on methods analyzing suitability characteristics of the landscape developed by Beier et al. (2007).

Diffuse movement area – A type of wildlife linkage in which animals move *within* a habitat block across a relatively broad area, rather than *between* habitat blocks through a well-defined linkage.

Habitat block – A relatively large and unfragmented area of land capable of sustaining healthy populations of wildlife into the foreseeable future.

Habitat connectivity – The extent to which an area of the landscape facilitates ecological processes such as unrestricted movement of wildlife. Habitat connectivity is reduced by habitat fragmentation.

Habitat fragmentation – The process through which previously intact areas of wildlife habitat are divided into smaller disconnected areas by roads, urbanization, or other barriers.

Important crossing area – A crossing identified by stakeholders as being important for wildlife movement across barriers, including canals, major roads, and highways.

Landscape movement area – A type of wildlife linkage in which animals move *between* distinct habitat blocks; the area may be relatively broad or through a well-defined linkage.

Riparian movement area – A type of wildlife linkage that includes vegetation, habitats, or ecosystems that are associated with bodies of water (streams or lakes) or are dependent on the existence of perennial or ephemeral surface or subsurface water drainage. Riparian linkages facilitate movement of both terrestrial and aquatic wildlife species. These can also include xeroriparian habitats (washes) that potentially only have surface water for a brief period (i.e. few hours a year) but may contain concentrated vegetation.

Umbrella species – In this report, refers to a group of species that represent the movement needs of all wildlife species within a linkage design or through a crossing structure. May also be known as focal species.

Wildland block – Used interchangeably with habitat block.

Wildlife corridor – This term is often used interchangeably with “wildlife linkage” as we do in this report. Some biologists define the term “corridor” more narrowly to represent features such as canyons, ridgelines, riparian areas, and other landscape features that constrain or “funnel” wildlife movements into more restricted paths.

Wildlife linkage – An area of land used by wildlife to move between or within habitat blocks in order to complete activities necessary for survival and reproduction. Also referred to as a “wildlife movement area” or “wildlife corridor.”

## EXECUTIVE SUMMARY

This report and the accompanying Geographic Information System (GIS) datasets summarize the results of two workshops held in Tucson, Arizona in 2011. At these workshops, stakeholders representing a broad range of organizations and interests identified and mapped the locations of important wildlife linkages across Pima County. Participants included biologists, land managers, planners, and other professionals from federal, state, tribal, private, and non-governmental organizations. The workshops were supported by partnerships between the Arizona Game and Fish Department (AGFD), the Arizona Wildlife Linkages Workgroup, the Pima County Wildlife Connectivity Workgroup, and were funded by the Regional Transportation Authority of Pima County (RTA). This multi-agency, multi-disciplinary effort was undertaken to encourage biologists and non-biologists alike to incorporate information about wildlife linkages and strategies for their conservation into transportation corridor and project planning as well as other community projects including land-use decisions. The workshops provided a forum for stakeholders to learn more about wildlife connectivity, outline the general locations of wildlife linkages on large maps, and provide descriptive information about each linkage on datasheets. The hand-drawn linkages were then digitized with GIS software and refined following an additional opportunity for stakeholder review. The linkages were then further refined to eliminate redundancy for this report.

This report provides background information on the importance and benefits of conserving wildlife linkages for both people and wildlife in Pima County and describes the methods used during stakeholder workshops and in developing the accompanying GIS products. It includes a series of maps generated from the digitized stakeholder data that depict the general locations of wildlife linkages and potential barriers to wildlife movement within Pima County. The maps are followed by tables with descriptive information about the habitat areas each linkage connects, the species each linkage serves, and known threats and potential conservation opportunities associated with each linkage. The information in this report reflects the views and expertise of workshop participants and likely does not represent an exhaustive mapping of all important wildlife linkages across Pima County. It should instead be considered an initial assessment of wildlife movement patterns to be supplemented in the future by further analysis and refinement that includes additional expert input, GIS-based linkage modeling, and research studies of wildlife movement patterns. **The maps and GIS data in this report illustrate approximate locations of wildlife movements on the landscape and should be regarded as the starting point for further consultation with AGFD and other wildlife and land management agencies, preferably during the early stages of project planning.** While the impetus for this report originated from the community's interest in promoting environmentally-sensitive transportation projects, this report and associated GIS data provide a framework for professionals across a range of disciplines to identify and incorporate opportunities for maintaining and enhancing wildlife connectivity within project areas in Pima County. **We hope this report stimulates detailed planning and collaborative on-the-ground actions for conserving wildlife linkages.**

## BACKGROUND

The abundant sunshine and great natural beauty of Arizona draws large numbers of visitors and new residents each year. The state has grown rapidly in recent decades with its human population expected to double from almost 6½ million in 2010 to approximately 13 million by 2050 (Arizona Department of Administration 2006, U.S. Census Bureau 2011). While much of that growth will likely be concentrated throughout the “Sun Corridor” connecting Tucson, Phoenix, and areas of central Yavapai County, communities in other areas of the state are also expected to grow.

From 1980 to 2006, 83% of Arizona’s population growth occurred in Maricopa, Pinal, and Pima counties (Arizona Department of Transportation 2010a). Pima County is currently home to a population of nearly 1 million people (U.S. Census Bureau 2011), with the majority of the population concentrated in and around the Tucson metropolitan area.

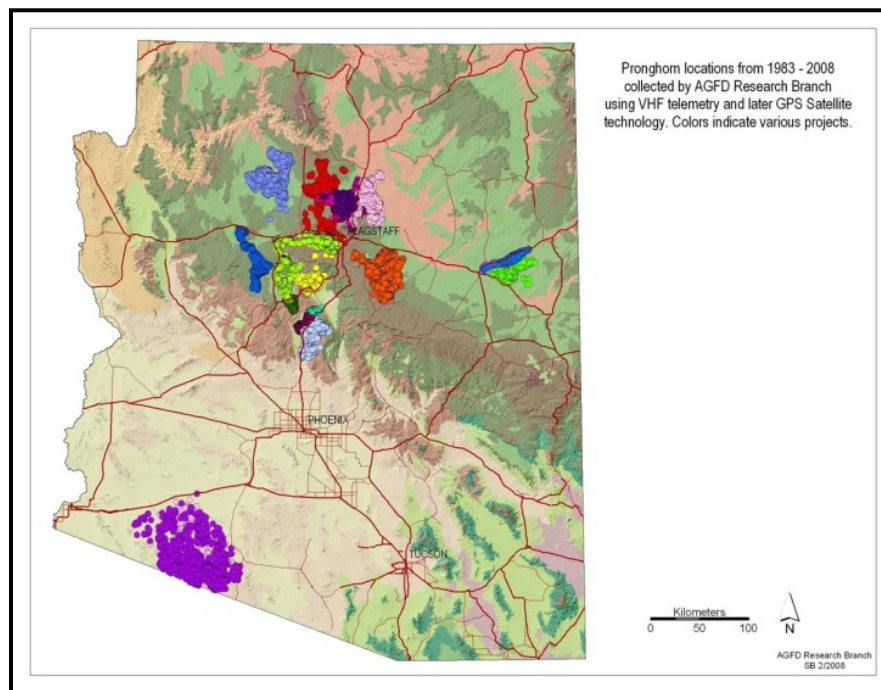
Pima County is located in southeastern Arizona and much of it is within the Sonoran Desert Ecoregion of the United States and Mexico (Brown and Lowe 1982). Wettest of all North American deserts with a bimodal rainfall pattern, combined with the local basin and range physiography and local presence of higher elevation biomes in the “sky island” mountain ranges, it’s not surprising that the Sonoran desert supports high biodiversity and is considered one of the Earth’s most biologically-valuable, and also most vulnerable, ecoregions on a global scale (Olson and Dinerstein 1998). A combination of factors set the stage for a high degree of biodiversity within Pima County: the proximity to the Sierra Madre Occidental of northern Mexico, one of the “megadiversity” centers defined by Warshall (1995); the aforementioned topographic diversity; and a long network of riparian systems. A broad array of vegetation communities support a high diversity of wildlife species, from common species to species of conservation concern and federally-listed species.

The combination of spectacular scenery and a comfortable climate create the conditions most desired for urban development. As a result, the characteristics of some of the region’s most beautiful and ecologically productive landscapes are being dramatically altered by human development.

## WHY WE NEED WILDLIFE LINKAGE PLANNING IN PIMA COUNTY

### POPULATION GROWTH

Arizona's growing human population and expanding infrastructure has consequences for Pima County's wildlife species and the habitats on which they depend. While human development and disturbance can adversely affect wildlife by causing direct loss or degradation of habitat, the disruption of wildlife movement patterns is a less obvious, but equally important, consequence. All animals move across the landscape to varying extents in order to acquire the resources necessary for survival: food, water, protective cover, and mates. Mountain lions, black bears, and mule deer roam over vast expanses that can encompass thousands of acres, while smaller animals such as Chiricahua leopard frogs engage in essential movements in a much smaller area. There is also variation in the temporal patterns of animal movement: some animal movements occur on a daily basis, while seasonal migrations may occur annually, and the dispersal of young from their natal sites to secure new breeding territories happens only once in an individual's lifetime. *Figure 1* illustrates the impact that man-made barriers can have on wildlife movement patterns, some to the degree that their presence may affect the long-term persistence of wildlife populations (Noss 1983, Wilcox and Murphy 1985, Noss 1987, Bennett 1999, Henle et al. 2004, Noss and Daly 2006).



**Figure 1:** Radio and satellite telemetry studies by the Arizona Game and Fish Department reveal that major roadways can act as barriers to pronghorn movement. Colors indicate groups of animals studied in separate projects. This barrier effect can isolate populations, potentially reducing genetic diversity and reproductive success over time.

The following touches on other barriers that, in combination with urban development, have the potential to specifically interfere with wildlife movement and interrupt wildlife connectivity within Pima County.

## TRANSPORTATION INFRASTRUCTURE

As a result of anticipated population growth in southeastern Arizona, transportation planners have significantly ramped up plans to improve existing transportation corridors such as Interstate 10 and State Route 77 and to construct other aspects of the transportation network that will support increased traffic demand. In Pima County, the need for increased transportation and planning motivated voters to approve the creation of the Regional Transportation Authority of Pima County (RTA) and its 20-year regional transportation plan through a half-cent sales tax increase (Regional Transportation Authority 2011). The Pima Association of Governments (PAG), has created a regional transportation improvement program (Pima Association of Governments 2011) and a regional transportation plan (Pima Association of Governments 2010) that guide the investment of regional transportation resources in local roadway, bus, pedestrian, bicycle, aviation, freight, and rail facilities in both the short term and over the next 20 years. The PAG data was incorporated into the statewide 50-year transportation planning process, called *Building a Quality Arizona* (Arizona Department of Transportation 2010a and 2010b).

Growth outside of Pima County will also influence the regional landscape. For example, population growth has prompted the Arizona Department of Transportation (ADOT) and US Department of Transportation's Federal Highways Administration (FHWA) to begin the North-South Corridor Study for a potential new transportation route between U.S. 60 in Apache Junction and I-10 near Eloy and Picacho (Arizona Department of Transportation 2011), inevitably bringing additional traffic into nearby Pima County.

## UTILITY INFRASTRUCTURE

The growing population in Arizona will also bring increased energy demands. The development of wind and solar energy facilities, utility corridors, and other energy-related infrastructure may be considerable over the next several decades. In 2012, the Bureau of Land Management and Department of Energy will finalize a new policy framework for utility-scale (>20 megawatt) solar energy development on BLM lands, which will govern and guide the future of this rapidly growing form of energy development across millions of acres of land in the sun-rich state of Arizona. Concurrently, the Arizona BLM's Restoration Design Energy Project will delineate low-conflict zones across multiple land ownerships where utility and sub-utility solar and wind development will be incentivized. A recently published review paper by the United States Geological Survey (Lovich and Ennen 2011) concluded, "...it appears that insufficient evidence is available to determine whether solar energy development, as it is envisioned for the desert Southwest, is compatible with wildlife conservation". While this study reveals a void of scientific studies quantifying the effects of this relatively new form of energy development on wildlife, some of the known primary impacts of this form of development (i.e. habitat conversion, fragmentation, and disturbance) have been studied extensively elsewhere and have been shown to affect habitat quantity, quality, and connectivity. The expansion of renewable energy development in the West will also spur new development and retrofit of energy transmission infrastructure. For example, the SunZia Southwest Transmission Project, sponsored by numerous energy organizations, proposes to develop approximately 460 miles of two 500-kilovolt transmission lines from Arizona to New Mexico. The proposed right-of-way corridors may be up to 1,000 feet wide (U.S. Bureau of Land Management 2009). A portion of this proposed project runs through Pima County.

## BORDER SECURITY

A large portion of the southern boundary of Pima County is shared by an international border with Mexico. Many wildlife populations have home ranges, annual movements, or other movement patterns that cross these borderlands. As described in Arizona's State Wildlife Action Plan (Arizona Game and Fish Department 2012), undocumented human immigration and drug smuggling across the Arizona-Mexico border increased dramatically in the last decade, resulting in a cumulative impact to wildlife habitats; however, apprehensions have declined 61 percent since 2005, and in 2010 apprehension numbers were at their lowest level since 1972 (Department of Homeland Security 2011). Border security measures are being stepped up throughout the Arizona-Mexico borderlands region in an attempt to address border traffic (Roberts et al. 2010). A security fence stretching along 1,125 km, more than one third of the U.S.-Mexico border, has been constructed. Fence structure segments are mostly  $\geq 4$  m tall, have vertical gaps 5-10 cm wide and are associated with vegetation clearing and roads  $\geq 25$  m wide (Flesch et al. 2010). In addition to **habitat fragmentation** caused by this barrier and areas cleared of vegetation for patrol roads, the increased traffic near the border from enforcement patrols and pursuits, as well as artificial night lighting, are also of concern due to their potential to affect wildlife habitat quality and functional transboundary **habitat connectivity**.

## WHAT WILDLIFE CONNECTIVITY MEANS

The process through which previously intact areas of habitat are divided into smaller disconnected areas by roads, urbanization, and other barriers is known as habitat fragmentation, which decreases the degree of habitat connectivity of the landscape for wildlife. The disruption of animal movement by habitat fragmentation presents problems for Arizona's wildlife, ranging from direct mortality on roadways to the genetic isolation of fragmented populations. This disruption of animal movement patterns also negatively affects human welfare by increasing the risk of wildlife-vehicle collisions and the frequency of unwanted "close encounters" with wildlife. However, the effects of habitat fragmentation can often be mitigated by identifying and protecting areas that wildlife use for movement, known as **wildlife linkages** or **wildlife corridors** (Beier and Noss 1998, Bennett 1999, Haddad et al. 2003, Eggers et al. 2009, Gilbert-Norton et al. 2010). Ridgelines, canyons, riparian areas, cliffs, swaths of forest or grassland, and other landscape or vegetation features can serve as wildlife linkages. Wildlife linkages are most effective when they connect (or are located within) relatively large and unfragmented areas referred to as **habitat blocks** or **wildland blocks**. Habitat blocks are areas large enough to sustain healthy wildlife populations and support essential biological processes into the future (Noss 1983, Noss and Harris 1986, Noss 1987, Noss et al. 1996).

In order to distinguish between different types of wildlife movement, wildlife linkages are broken down into several categories within this report.

- **Landscape movement areas** refer to a type of wildlife linkage where animals move between habitat blocks.
- Animals may also move *within* a habitat block rather than through a well-defined corridor, a type of wildlife linkage we identify as a **diffuse movement area**.

- **Riparian movement areas** refer to a type of wildlife linkage where animals move primarily through riparian habitat, including desert washes classified as xeroriparian habitat.
- Often, wildlife use crossings, such as culverts or overpasses, to move between habitat blocks or through riparian habitat where barriers exist. These **important crossing areas** have been further categorized in this report as preliminary, planned/funded, or existing. Preliminary crossing areas are those crossings which have been discussed as important but structures have yet to be built or need improvement. Planned/funded crossing areas are those that are planned and funded to be constructed in the near future. Existing crossing areas have already been placed. Stakeholders also indicated other important crossing areas along the Central Arizona Project canal.



**Figures 2a and 2b:** Along Arizona State Route 260 near Payson, ungulate-proof fencing linking a series of highway underpasses effectively increased the permeability of the highway by 60% while reducing elk-vehicle collisions by greater than 80% at an estimated cost savings of \$1 million dollars annually (Dodd et al. 2007; Photographs: Arizona Game and Fish Department).

Wildlife linkage planning should include conservation of wildlife linkages and the habitat blocks they connect, and, in most cases, require the implementation of multiple strategies such as land acquisition, community planning for developments, open space conservation, and habitat restoration. Installation of roadway mitigation features including wildlife crossing structures and fencing to funnel wildlife to crossing structures (*Figure 2a* and *Figure 2b*) are important considerations that are best incorporated into the early planning stages of transportation and development projects.

## BENEFITS OF WILDLIFE LINKAGE PLANNING

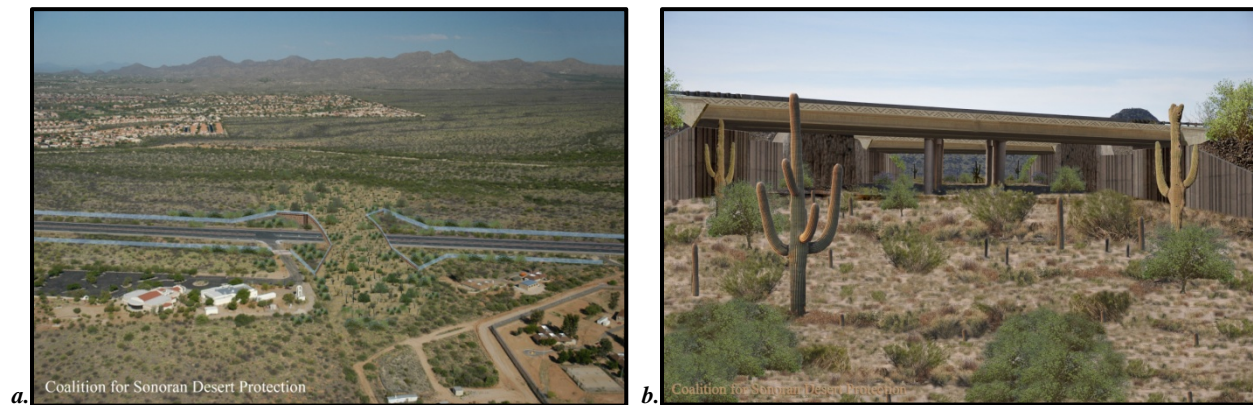
Identifying and conserving habitat connectivity by maintaining wildlife linkages can provide many important benefits for both humans and wildlife.

### BENEFITS TO WILDLIFE

By preserving the ability of wildlife species to move between or within habitat blocks, linkages allow animals to access essential resources such as food and water during their daily activities. They also allow longer seasonal migratory movements between summer and winter habitats and facilitate the dispersal movements of animals in search of mates or breeding sites. Linkages that connect otherwise isolated populations help prevent small populations from extinction (Laurance 1991, Beier and Loe 1992), help maintain genetic diversity, and reduce the risk of inbreeding



(Beier and Loe 1992, Bennett 1999). Habitat connectivity also helps ensure that critical ecological processes such as pollination and seed dispersal, which often depend on animal intermediaries, are maintained. In some cases the linkages themselves may sustain actively reproducing wildlife populations (Perault and Lomolino 2000, Beier et al. 2007). Linkages are also expected to play an important role in helping animal populations adapt to and endure the effects of climate change by allowing animals to shift their range with latitude or elevation as vegetation communities change their distribution and suitable environmental conditions shift on the landscape (Hannah et al. 2002, Glick et al. 2009).



**Figures 3a and 3b:** (a) Wildlife overpasses, like the one in this artist rendering, will facilitate wildlife movement over State Route 77. This overpass and two underpasses were funded for construction by the RTA in 2009. (b) Wildlife underpasses are important parts of wildlife connectivity planning and increase the permeability of a road or railroad for wildlife while greatly reducing the threat of vehicular collisions. Crossing structures are most effective when they are designed to meet the needs of species known to use the linkage. Many times underpasses, in the form of bridges or culverts, are already in existence under certain stretches of road but need to be modified to accommodate wildlife. This artwork depicts a proposed modification of an existing abandoned railroad underpass on I-10. (Artwork: Courtesy Coalition for Sonoran Desert Protection)

Knowledge of wildlife linkage locations helps inform project planners about what appropriate mitigation needs to occur for roads that affect many wildlife species. Roadway mitigation features such as crossing structures and parcel acquisitions, can be expensive and should be designed and implemented to accommodate “**umbrella species**” which will, by proxy, serve many species’ movements (Beier et al. 2008, Lowery and Blackman 2007). However, certain species may require specific landscape features (i.e. ridgelines, stream corridors, etc.), vegetation composition and structure, crossing structure designs (i.e. specific length or “openness”), and certain thresholds of human disturbance/activity in order to be functional. Planning for effective wildlife crossings must also consider what is going to happen on those lands in the immediate proximity of the crossing, which may also influence priorities for rural and urban open space planning and acquisition. Allowing development to occur near crossing structures and placing structures in locations that do not provide suitable habitat for the target species generally affects their use by wildlife (Beier and Loe 1992).

#### BENEFITS TO PEOPLE

Maintaining an interconnected network of wildland blocks will provide benefits to the local human communities as well, perhaps most obviously by improving public safety. It has been estimated that approximately 20% of the land area in the United States is ecologically affected by the country’s road network (Forman et al. 2003). The implications of this widespread impact

include threats to connectivity and hazards to motorists (Forman and Alexander 1998). One study estimated that each year more than 200 motorists are killed and approximately 29,000 are injured as a result of deer-vehicle collisions in the United States (Conover 1995). Such collisions can cost \$2 billion annually (Danielson and Hubbard 1998). Identifying important wildlife movement areas that traverse transportation corridors prior to the construction of new roads or road improvements allows for the informed siting of wildlife-friendly over- and underpasses that can greatly reduce the likelihood of collisions (Clevenger et al. 2001, Forman et al. 2003, Dodd et al 2007; *Figures 3a and 3b*). Along Arizona State Route 260, for example, a combination of wildlife underpasses and ungulate-proof fencing reduced elk-vehicle collisions by 80% (Dodd et al. 2007; *Figures 2a and 2b*). A study by Lowery and Blackman (2007) detected direct road kill or evidence of the presence of 55 unique species along Twin Peaks Road in Pima County.

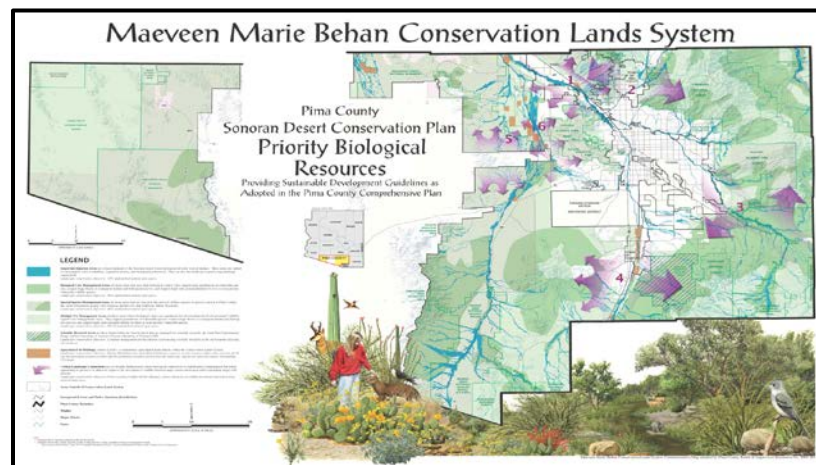
As the optimal objective of providing wildlife linkages is to maintain the connectivity between wildland blocks, there are circumstances where it is important to accommodate a linkage that, either partially or in its entirety, crosses through urban and suburban environments where open spaces invite (intended or not) passive recreation activities. In such situations, the linkage may also serve as a buffer between developed areas and wildland blocks and can help protect the wildland network from potentially damaging external influences. Incorporating and designing rural and urban greenways and/or open spaces that support wildlife movement into municipal planning efforts also helps retain the natural vistas and aesthetic attributes that Arizona residents and visitors value. Since evidence suggests that some species are sensitive to the presence of humans (Clevenger and Waltho 2000, Taylor and Knight 2003), multi-use buffer zones should be made wide enough to maintain separation between human recreation activities and the needs of the wildlife species using the corridor.

Maintaining linkages that facilitate the ecological health of wildland blocks can also be a significant investment in contributing to the diversity and vitality of an area's economy. The economic value associated with fish and wildlife-related recreation is significant for Pima County and contributes greatly to Arizona's economy. A national survey of fishing, hunting, and wildlife-associated recreation has been conducted about every five years since 1955 to evaluate national trends. The survey provides information on the number of participants in fishing, hunting, and wildlife watching (observing, photographing, and feeding wildlife), and the amount of time and money spent on these activities. In the most recent survey, it was reported that in 2006, state resident and nonresidents spent \$2.1 billion on fishing, hunting, and watchable wildlife related recreation in Arizona (U.S. Department of the Interior 2006). In 2001, a county-level analysis of the national survey data revealed that in Pima County watchable wildlife activities generated a total economic effect of \$327 million, supporting 3,196 jobs, providing residents with \$91 million in salary and wages, and generating \$2.3 million in state tax revenue (Southwick Associates 2003). Fishing and hunting recreation generated a total economic effect of \$105 million for the County, supporting 1,187 jobs, providing residents with \$18 million in salary and wages and generating \$5.4 million in state tax revenue (Silberman 2003). These economic benefits illustrate that conserving our wildlife populations, through efforts such as maintaining or restoring habitat connectivity, is also good for business in the County.

## OVERVIEW OF REGIONAL PLANNING EFFORTS THAT ACKNOWLEDGE THE IMPORTANCE OF CONSERVING WILDLIFE LINKAGES

There is a long-standing appreciation among local governments, land management agencies, transportation departments, conservation organizations, energy and utility companies, and citizens across Pima County of the importance of conserving wildlife linkages and mitigating the impacts of barriers on wildlife movement.

Open space planning efforts substantively began in Pima County in 1928 with the establishment of Tucson Mountain Park (Pima County 2009). In 1976, the Trails Access Plan was formed to maintain access to existing public lands through parcel acquisition. In 1986, the Critical and Sensitive Wildlife Habitats Study marked the first effort in Pima County to help guide conservation planning by incorporating considerations for wildlife habitat and biology. In 2001, this effort was greatly refined when Pima County's Maeveen Marie Behan Conservation Lands System (CLS) was created based on comprehensive scientific and planning input (Pima County 2011, *Figure 4*). The CLS represents the conservation reserve design of the widely-acclaimed Sonoran Desert Conservation Plan (SDCP) and was adopted into Pima County's Comprehensive Plan to provide sustainable development guidelines (Pima County 2009). It is noteworthy to point out that in implementing the CLS, the County's evaluation of comprehensive plan amendments and land uses requiring rezoning must consider potential effects to Critical Landscape Connections/CLS designated areas where preserving and enhancing wildlife movement is a primary concern.



**Figure 4:** The Maeveen Marie Behan Conservation Lands System shows the biologically preferred reserve design and works to provide sustainable guidelines for future development (Pima County 2009).

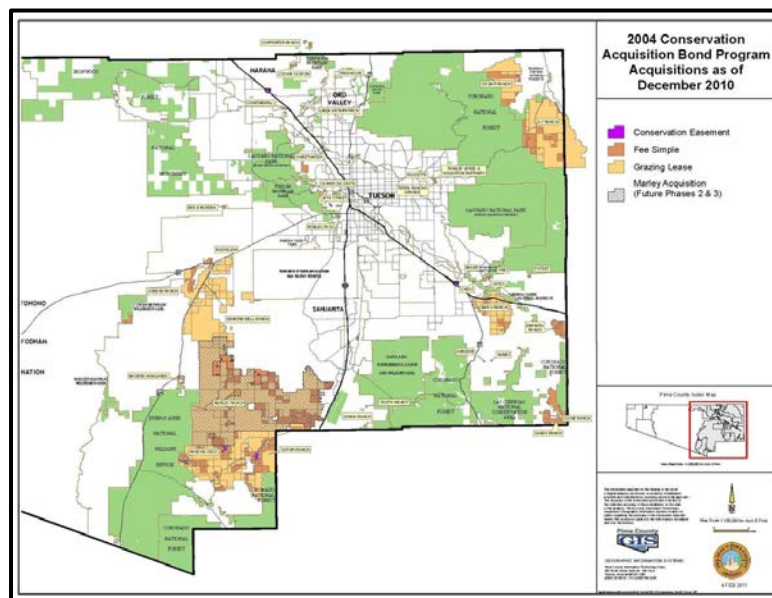
To aid the implementation of the SDCP, a committee appointed by the Pima County Board of Supervisors developed a Conservation Bond Program which recommended the acquisition of certain properties to conserve community open space and important habitat within the CLS. This \$174 million bond package was approved by Pima County voters in 2004 by an overwhelming majority (Pima County 2011). Subsequent to the voters' approval, Pima County began acquisition of these properties; to date, upwards of 175,000 acres have been conserved (48,000+ acres acquired and 127,000+ acres held as grazing leases; *Figure 5*). These bond acquisitions

actively protect a diverse array of biologically-rich areas and maintain the landscape network of habitat connectivity throughout Pima County.

In 2006, Pima County voters approved a sales tax increase that allowed the formation of the RTA to address transportation planning across Pima County (Regional Transportation Authority 2011). As part of that approval, county voters specifically ear-marked \$45 million to be used to incorporate wildlife linkage conservation into transportation projects. Over the 20-year timeframe of the RTA, these funds will mitigate barriers to wildlife movement and reduce wildlife-vehicle collisions.

RTA projects have been successful in coordinating with broader efforts to facilitate wildlife movement. For example, in 2009, two significant events occurred—the Town of Oro Valley incorporated an important wildlife linkage (Beier et al. 2006d) through the Arroyo Grande planning area as an amendment to its General Plan (Town of Oro Valley 2008); and the RTA approved the funding to construct one overpass and two underpasses as part of the Arizona Department of Transportation’s improvement to State Route 77 near the Arroyo Grande planning area (Regional Transportation Authority 2011, *Figure 3a*). In addition, a project proposed by the Tohono O’odham Nation and supported by data from the Arizona Wildlife Linkages Assessment gained final approval for RTA funding in December 2011. Through this funding, one overpass and two underpasses will be built over State Route 86 near Kitt Peak.

The need to maintain habitat connectivity for wildlife will only grow as Arizona becomes more fragmented in coming decades as development continues to meet the needs of an expanding human population. Given the relatively undeveloped status of many areas of Pima County at present, we must continue to integrate knowledge of wildlife linkages and mitigation strategies into land-use and transportation planning in the region.

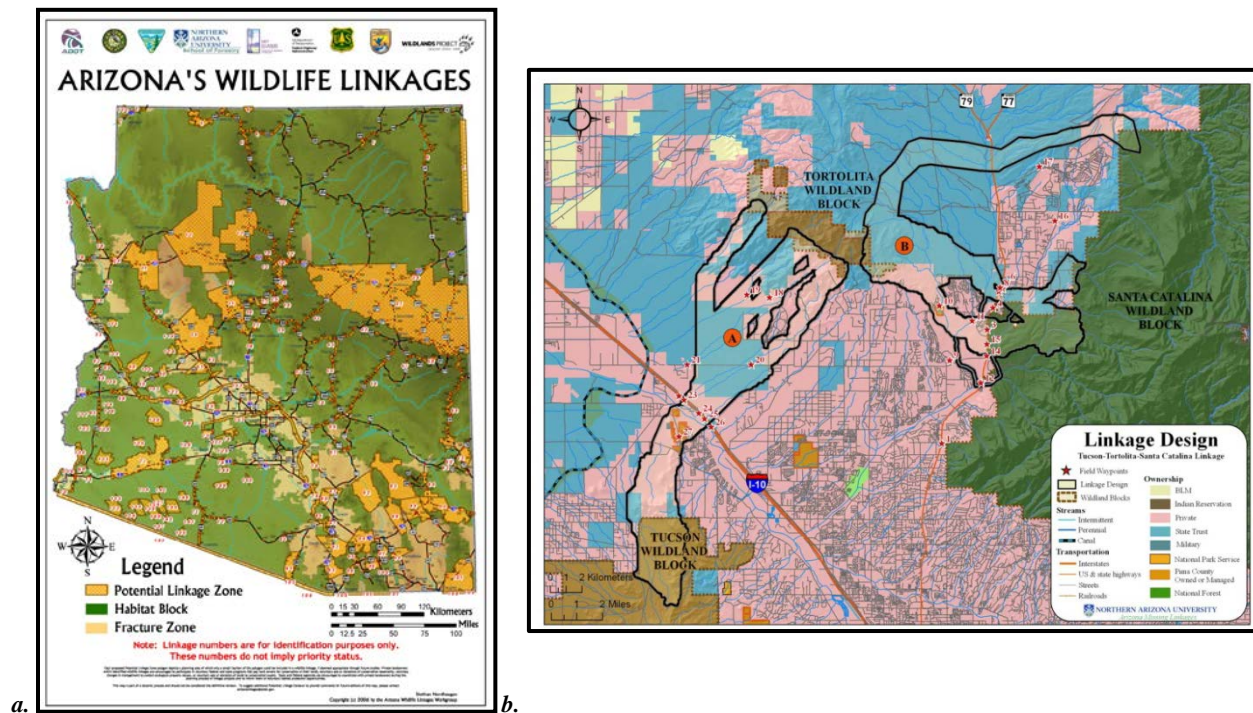


**Figure 5:** The 2004 Conservation Acquisition Bond Program was approved to help implement the Sonoran Desert Conservation Plan (Pima County 2011). Multi-use lands are important for habitat and wildlife conservation in the region.



# THE PIMA COUNTY WILDLIFE CONNECTIVITY ASSESSMENT

To assemble current knowledge of wildlife linkages and barriers to wildlife movement across Pima County and to help build collaborative partnerships with local jurisdictions for eventual implementation efforts, AGFD joined with partner organizations (please see Acknowledgments for a list) to initiate the Pima County Wildlife Connectivity Assessment. This project grew out of prior initiatives including the County's Sonoran Desert Conservation Plan and the statewide Arizona Wildlife Linkages Workgroup (AWLW) known as Arizona's Wildlife Linkages Assessment, or AWLA. The AWLA used an expert-based approach to create a statewide map of potential linkage areas and barriers at a coarse scale (Arizona Wildlife Linkages Workgroup 2006; *Figure 6a*). This Pima County Wildlife Connectivity Assessment represents a continuation of these previous efforts and is intended to identify wildlife linkages at a finer scale that may have been overlooked in the earlier assessment, as well as those that will be useful for regional and local transportation or land-use planning efforts. As mentioned, funding to support this effort was provided in large part by the Regional Transportation Authority of Pima County.



**Figures 6a and 6b:** (a) Statewide map of wildlife linkages and barriers created for Arizona's Wildlife Linkages Assessment (2006). (b) Certain high priority linkage areas identified in the Arizona's Wildlife Linkages Assessment were further refined as represented in the Tucson – Tortolita – Santa Catalina Mountains Linkage Design (Beier et al. 2006d) based on “least cost” modeling methods using habitat suitability developed by Beier et al. (2007). High priority wildlife linkages defined in this assessment will be modeled using similar methods on a per project basis (Maps: Courtesy Arizona Wildlife Linkages Workgroup and Beier et al. 2006d).

## METHODS

### INITIAL STAKEHOLDER WORKSHOP

In the Spring of 2011, the Pima County Wildlife Connectivity Workgroup hosted a workshop for stakeholders and experts in the fields of wildlife management and land-use planning. Attendees included private citizens and representatives from consulting groups, federal agencies, state agencies, non-profit organizations, and tribal and local governments. Following a brief series of presentations on wildlife connectivity principles and the goals of the Pima County Wildlife Connectivity Assessment, stakeholders were instructed to visit one or more of six work stations where a portion of the county was displayed on a paper map. These maps had backgrounds of recent aerial imagery and topographic features and represented the locations of major roads and other important features. Participants mapped important wildlife linkages and areas of known wildlife movement, including diffuse movement areas within habitat blocks and locations where wildlife cross (or may have previously crossed) barrier features between habitat blocks. Participants were encouraged to use additional clear film overlays depicting vegetation type, conservation status, and land ownership as needed for reference. For each wildlife linkage drawn, participants were instructed to fill out a datasheet describing wildlife movement patterns and existing or future land uses that may affect the wildlife in the area ([Appendix 1](#)).

A consequence of this voluntary, stakeholder-based approach is that not all geographic areas were equally represented by knowledgeable stakeholders and the information we were able to collect about wildlife linkages was more comprehensive in some areas than in others. There may be important wildlife linkages in areas of Pima County where none appear on our maps, so this absence should be interpreted with caution pending further study. Also, the type and amount of evidence on which each linkage was based varied from isolated personal observations to long-term empirical data from telemetry studies. This variation in the amount and source of stakeholder input available for each linkage may be reflected in the level of detail we were able to provide in the “Wildlife Linkage Descriptions” table below, which is derived directly from the information provided on the datasheet. Thus a relative lack of detail for a given linkage, in terms of species using the linkage, current or potential threats, or additional “Notes” (see below), should not lead to the conclusion that a linkage is not important. Additional information collected in the future should expand these descriptions, as well as point out locations of additional linkages across the County.

### GIS DIGITIZING AND EDITING METHODS

Stakeholder linkages from workshops were digitized in GIS and their associated datasheets entered into a database. Some rules or explanations in the section that follow may contain codes indicated by a letter and number combination. These codes can be used to reference particular information in the “Wildlife Linkages Descriptions” section of this report and are used to label linkages on the maps in this report. Project staff used the following guidelines when digitizing stakeholder drawings in GIS:

- Trace contour lines to digitize canyons or hills when a drawing or description indicates a topographic feature is being used.
- Where linkages overlap or fall inside larger linkages, keep only those shapes which provide unique information or show movement in contrasting directions. Otherwise

merge the shapes and combine the information from each datasheet (e.g. species using linkage) into attributes for the single merged shape.

- Do not include linkages for which the data provided are insufficient. Follow up with stakeholders whenever possible to obtain needed information about the linkage.
- Examine each digitized linkage and ensure its correct representation based on stakeholder drawings, data, and additional input.
- Categorize each linkage as a diffuse movement area (movement within a habitat block), landscape movement area (movement between habitat blocks), or riparian movement area (movement through riparian habitat) based on the landscape and the data provided by stakeholders.
- Use digitized locations of washes to replace hand drawn riparian movement areas and buffer 0.5 miles on either side for consistent representation on maps. Beier et al. (2007), used a minimum linkage width of 1 km and 1.5 km in many of their **Arizona Missing Linkage** designs. However, for the purpose of this report a minimum width of 1 mile was used to represent riparian movement areas in order to highlight the area and allow for refinement.
- Include and do not alter clearly defined riparian movement areas contributed from Pima County (e.g. R22: Lee Moore Wash Flow Corridors and Maeveen Marie Behan Conservation Lands System Important Riparian Areas).
- Include land inside the Maeveen Marie Behan Conservation Lands System as diffuse movement areas.
- Digitize preliminary and RTA planned/funded important crossing areas as points at specified mile marker locations along indicated roads and washes, using aerial imagery to confirm placement.
- Represent important crossing areas where wildlife crossings were indicated by stakeholders and label C.x (with C.x representing the number assigned to the crossing on the maps). These areas were considered important for current wildlife movement across barriers or potential future wildlife movement across barriers pending improvement or construction.
- Categorize important crossing areas as CAP canal wildlife crossings (CAWCD maintained), CAP canal wash siphons (Pima County maintained), preliminary crossings, RTA planned/funded crossings or CAP canal: below ground sections depending on the type and status of the important crossing area.
- Do not alter important crossing areas provided by other agencies (e.g. Pima County and U.S. Bureau of Reclamation).
- Do not include specific barriers. Represent generalized barriers on maps.
- Represent Arizona Missing Linkages (2007 – 2008) on maps.

## FOLLOW-UP WORKSHOP AND GIS REFINEMENT

A second stakeholder workshop was held in the Fall of 2011 to allow participants to review the digitized linkage polygons for accuracy, omissions, and redundancy. Participants were also encouraged to provide additional information about the linkages previously identified including the species in the area, habitat blocks connected, and threats to connectivity that may have been overlooked during the first workshop. Input from the second stakeholder workshop was incorporated following the decision rules described above and linkage polygons were reshaped



where necessary. This report contains the final version of the information provided through the entire stakeholder workshop process.

## INCORPORATION OF ADDITIONAL DATASETS OR CRITERIA

### SONORAN DESERT CONSERVATION PLAN: MAEEVEN MARIE BEHAN CONSERVATION LANDS SYSTEM INTEGRATION

The Maeveen Marie Behan Conservation Lands System (CLS) component of the Sonoran Desert Conservation Plan (SDCP) was adopted into Pima County's Comprehensive Plan in 2001. The CLS represents the comprehensive work of over 200 regional scientists and designates areas that are important because of their contribution to biological diversity. The restoration of wildlife linkages is a key component of the SDCP and is included in the CLS's biological resource priorities of the area (Pima County 2011). Although six of the most threatened wildlife linkages within Pima County are identified in the CLS, there has been no comprehensive effort to identify wildlife movement areas throughout the County. It is due to the SDCP's foundational work and the importance of the plan regionally that the CLS has been incorporated into this Pima County Wildlife Connectivity Assessment. Pima County and other wildlife connectivity partners decided to include all biologically-important areas previously identified in the CLS as diffuse movement areas in this report. Thus, the entire CLS functions as, and is therefore represented as, a habitat block in which wildlife movement occurs. Important Riparian Areas, as designated in the CLS, have been called out separately and are included in this report as riparian movement areas. These additional data for wildlife movement are represented in lighter shades of the same movement area category color.

### CENTRAL ARIZONA PROJECT (CAP) CANAL

The CAP canal represents a unique barrier to wildlife movement. Although the canal is a large barrier, many wildlife crossings are maintained to help facilitate wildlife movement across it. Stakeholders indicated the Central Arizona Water Conservation District (CAWCD) maintains wildlife crossings through much of the length of the CAP canal, which are important crossing areas for wildlife. Stakeholders also indicated important crossing areas through CAP canal wash siphons, where large areas of the canal exist below ground. These wash siphons exist within the CAP mitigation area and are managed by Pima County, along with the mitigation area. Crossing areas along the CAP canal are successful at facilitating movement for at least certain wildlife species, such as mule deer (Tull and Krausman 2001). Stakeholders, including Pima County and the U.S. Bureau of Reclamation, provided locations of both CAWCD-maintained wildlife crossings and the large portions of the canal that are underground in tunnels or siphons. These are represented on the maps in this report to assist planners with determining the locations of such crossings and underground canal reaches.

### U.S.-MEXICO INTERNATIONAL BORDER

The U.S.-Mexico international border infrastructure and activities have been cited by numerous stakeholders and scientists as a major threat to wildlife movement and habitat quality. The border fence already spans the majority of the Pima County-Mexico boundary. While much of the fence consists of vehicle barriers, which are lower in height and somewhat permeable to certain wildlife species, extensive lengths of the border have tall fencing with limited openings. Legislative proposals exist that call for double-layered pedestrian-style fencing to be constructed

across the entire U.S.-Mexico border. The fence, along with border activities such as vegetation clearing and road building, has been predicted to have a negative effect on wildlife movement for imperiled species such as cactus ferruginous pygmy-owl, desert bighorn sheep, jaguar, and desert tortoise as well as ground-dwelling, non-migratory birds such as wild turkey and quail (Flesch et al. 2010).

Pedestrian fence barriers of concern indicated by stakeholders include border areas in Pima County near Lukeville and Sasabe, affecting important wildlife areas such as the Organ Pipe Cactus National Monument and the Buenos Aires National Wildlife Refuge. Stakeholder input indicated that fencing in these areas extends for many miles, and in many places is greater than 12 feet high with horizontal gaps as small as 4 inches, if there are gaps present at all. These fence characteristics present a significant barrier to the movement of terrestrial animals and low flying or ground-dwelling birds. Flesch et al. (2010) note that species most susceptible to negative impacts of security infrastructure are likely those with small populations and fragmented distributions and those that are “terrestrial and large enough to be physically excluded by security infrastructure (cannot pass through a 5- to 10-cm gap), deterred by vegetation openings, or fly at heights <4 m during dispersal.”

Due to the limited spatial extent of this county-wide assessment, wildlife movements continuing from Pima County south into Mexico are not comprehensively represented in the GIS dataset or on the maps in this report. However, it will be important to consider ways to mitigate the barrier effects of the border fence and associated security activities since these cross-country habitats and wildlife linkages are important to the conservation of many species whose ranges span the international border (Flesch et al. 2010, Lasky et al. 2011). In fact, Mexico has been shown to have a great deal of biodiversity and is vital to neotropical cat species populations and movement (Grigione et al. 2009, Valdez et al. 2006). This is likely also true for the Sky Islands region in general. In their detailed border-wide analysis of fauna at risk from border security impacts, Lasky et al. (2011) highlight the Madrean Archipelago as one of three priority biologically diverse areas that merit attention for further research and conservation of trans-border connectivity.

#### ARIZONA MISSING LINKAGES

Following the 2006 AWLW publication of Arizona’s Wildlife Linkages Assessment, a sample of the mapped linkages were prioritized and modeled using GIS tools by the Corridor Design Team at Northern Arizona University. This GIS modeling was funded through the Arizona Game and Fish Department Heritage Fund and was based on methods analyzing habitat suitability characteristics of the landscape (Beier et al. 2007). A series of reports titled Arizona Missing Linkages containing maps of final linkage designs around Arizona were published to help guide transportation and development planning decisions and are available at [corridordesign.org](http://corridordesign.org). The linkage designs represented in the Arizona Missing Linkages reports are distinguished from the stakeholder-derived data on the maps in this report. Four linkage design models are located at least partly within Pima County:

- Ironwood – Picacho Mountains
- Tucson – Tortolita – Santa Catalina Mountains
- Rincon – Santa Rita – Whetstone Mountains, and
- Santa Rita – Tumacacori Mountains

## HOW TO USE THIS REPORT AND ASSOCIATED GIS DATA

### A SCREENING TOOL FOR WILDLIFE LINKAGE PLANNING

This report and the associated GIS datasets are intended to help transportation planners and engineers, land-use planners, developers, land managers, and biologists incorporate consideration of important wildlife linkages and barriers into their projects. The wildlife linkages contained in the shapefile and shown on the maps are not intended to identify finite boundaries. Instead they illustrate the *general* locations of wildlife movements on the landscape and should be regarded as the starting point for consultation with biologists and land managers including AGFD, the U.S. Fish and Wildlife Service (especially when federally-listed species may be affected), the USDA Forest Service, and other entities as appropriate—ideally in the early stages of project planning. These materials thus comprise a *screening tool* to help identify areas where linkage planning goals or concerns for wildlife connectivity may exist.

It is also important to emphasize that the information in this report reflects the views and expertise of workshop participants, and that these participants had diverse expertise and varying degrees of individual familiarity with wildlife linkages and barriers in different areas of Pima County. Given that there may have been some areas of the County for which fewer expert participants were present at the stakeholder workshops or for which less is known in general about wildlife movement patterns, this report should not be regarded as an exhaustive representation of all important wildlife linkages. While we have attempted to provide a comprehensive analysis, the information we present will benefit from further refinement through additional stakeholder input, GIS-based linkage modeling, and additional research on wildlife movement patterns.

Clarification should be given as to the species identified within linkages throughout this effort. While the stakeholders were asked to identify species known to the linkage area, these are not exhaustive lists, and may not include species of special concern as identified through AGFD's Heritage Data Management System or Environmental Online Tool (or by other local and federal natural resource agencies). If a linkage falls within a project proponent's area of interest, we recommend utilizing the Environmental Online Tool and/or contacting AGFD for further identification of species to consider within a project or planning area. More information on this and other available datasets is provided in the "Other Resources" section below.

To best integrate knowledge of wildlife linkages into planning efforts, we recommend a collaborative approach involving project proponents, local planners, transportation, wildlife and land management agency specialists, citizen groups, and others with an interest in conserving habitat connectivity for wildlife in a manner compatible with regional goals.

### GEOSPATIAL (GIS) DATASET

The geospatial dataset associated with this report should be used with GIS software to allow users to incorporate information about wildlife linkages into project planning, construction, or project-level spatial decision-making processes. As explained above, the borders of the linkages in the GIS dataset are not intended to show the exact boundaries of linkages. To obtain a copy of

the GIS dataset for use in your project planning effort, please contact the Habitat Program at AGFD's Tucson regional office at (520)-628-5376 or the Department's GIS Program at [gis@azgfd.gov](mailto:gis@azgfd.gov).

## OTHER RESOURCES

Additional tools are available from AGFD to help planners identify wildlife resources in a project planning area. These tools include the *Species and Habitat Conservation Guide* (SHCG), a model depicting areas of wildlife conservation potential; and *HabiMap™ Arizona*, an online data viewing platform that serves as an exploration tool for AGFD's wildlife datasets. Site-specific reports on wildlife species of concern and federally-listed threatened and endangered species are available through the *Online Environmental Review Tool*. All of these tools, along with additional resources such as helpful guidelines documents, can be accessed on AGFD's "Planning for Wildlife" web page at <http://www.azgfd.gov/WildlifePlanning>.

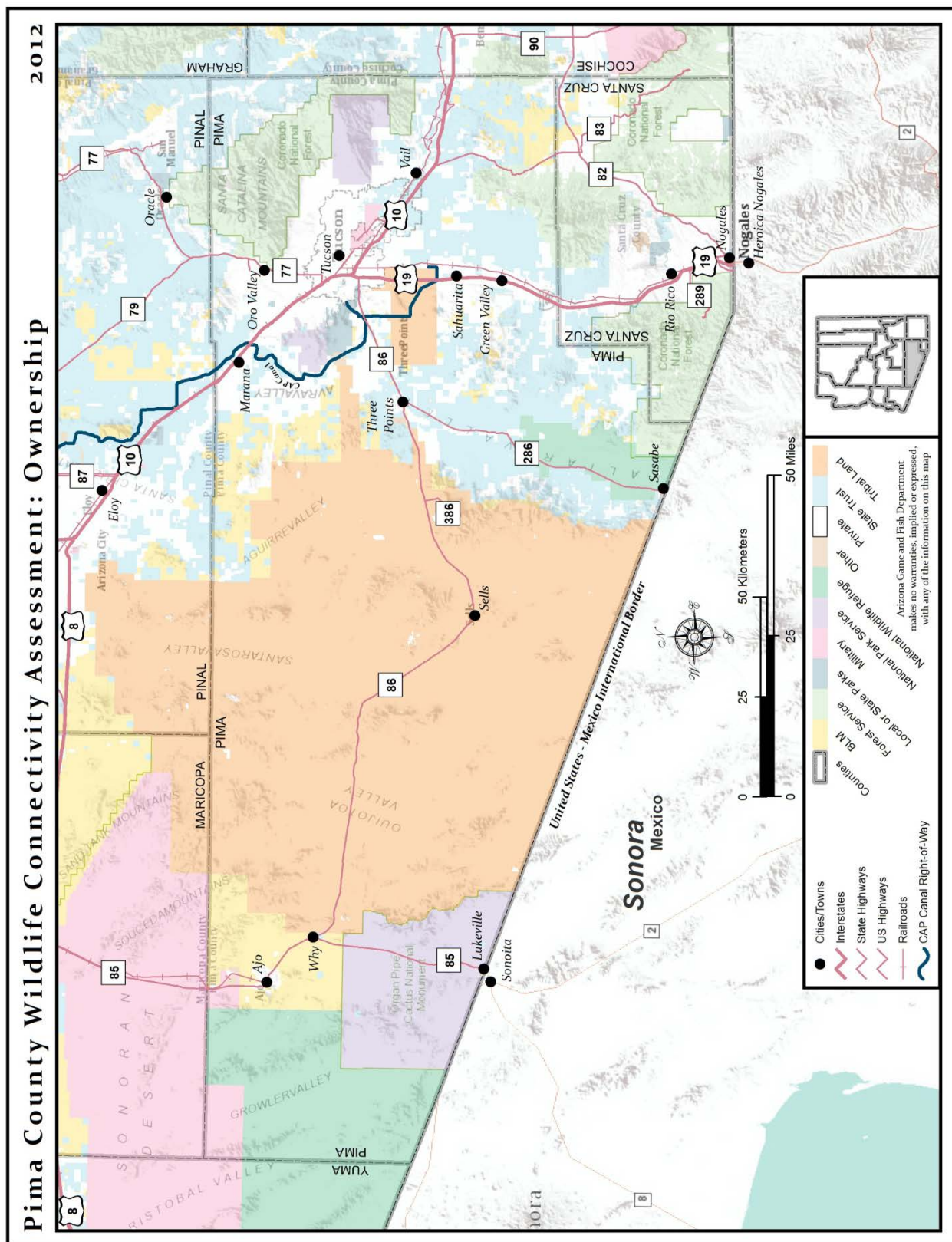
For a description of GIS wildlife corridor modeling approaches used in the Arizona Missing Linkages and to download ArcGIS modeling tools developed by scientists at Northern Arizona University, please see the CorridorDesign website at <http://corridordesign.org>. Here you will also find a number of completed wildlife linkage designs produced by the CorridorDesign team through funding provided by the Arizona Game and Fish Department's Heritage Fund.

## NEXT STEPS

Future project activities will include using the information in this and other county-level reports to support the development of finer-scale, GIS-based wildlife corridor models using established methodology (Beier et al. 2007, *Figure 6b*). These models will further refine a subset of the stakeholder-identified linkage areas represented in this report based on habitat requirements of focal wildlife species that rely on each linkage and will help identify land parcels of highest conservation priority within the stakeholder linkages—both of which are necessary for a successful implementation phase. Through the funding made available by the RTA for this effort, a number of modeled linkage designs and reports containing recommendations for implementation are currently in progress. Once finalized, these reports will be made available at the "Planning for Wildlife" web page at <http://www.azgfd.gov/WildlifePlanning>. While areas have already been identified in Pima County for further refinement, we anticipate that the creation of additional fine-scale corridor models and collaborative conservation efforts will be needed in the future as Arizona's developed landscape changes and our knowledge of wildlife habitat use and movement patterns grows.

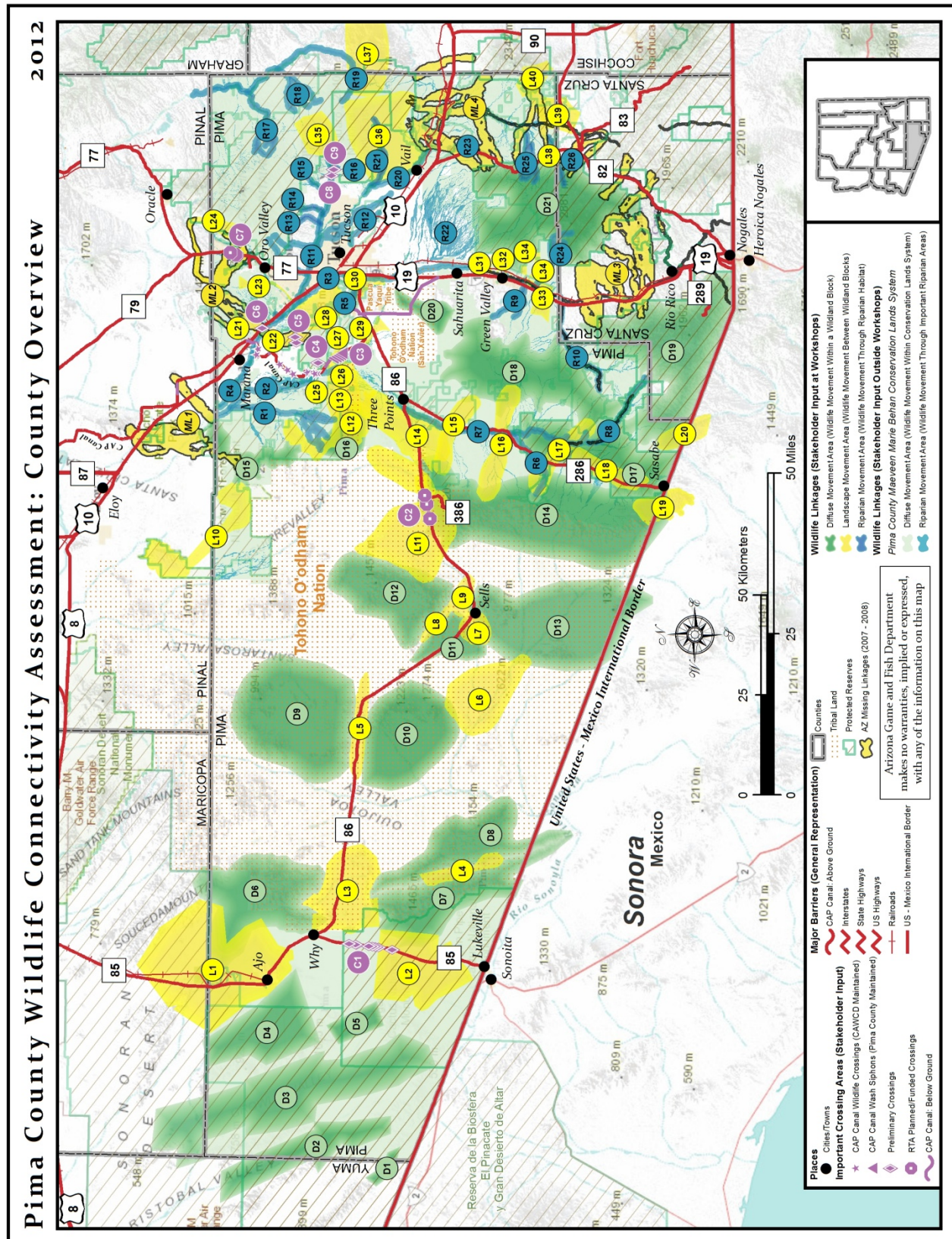
# MAPS

Figure 7: Pima County land ownership



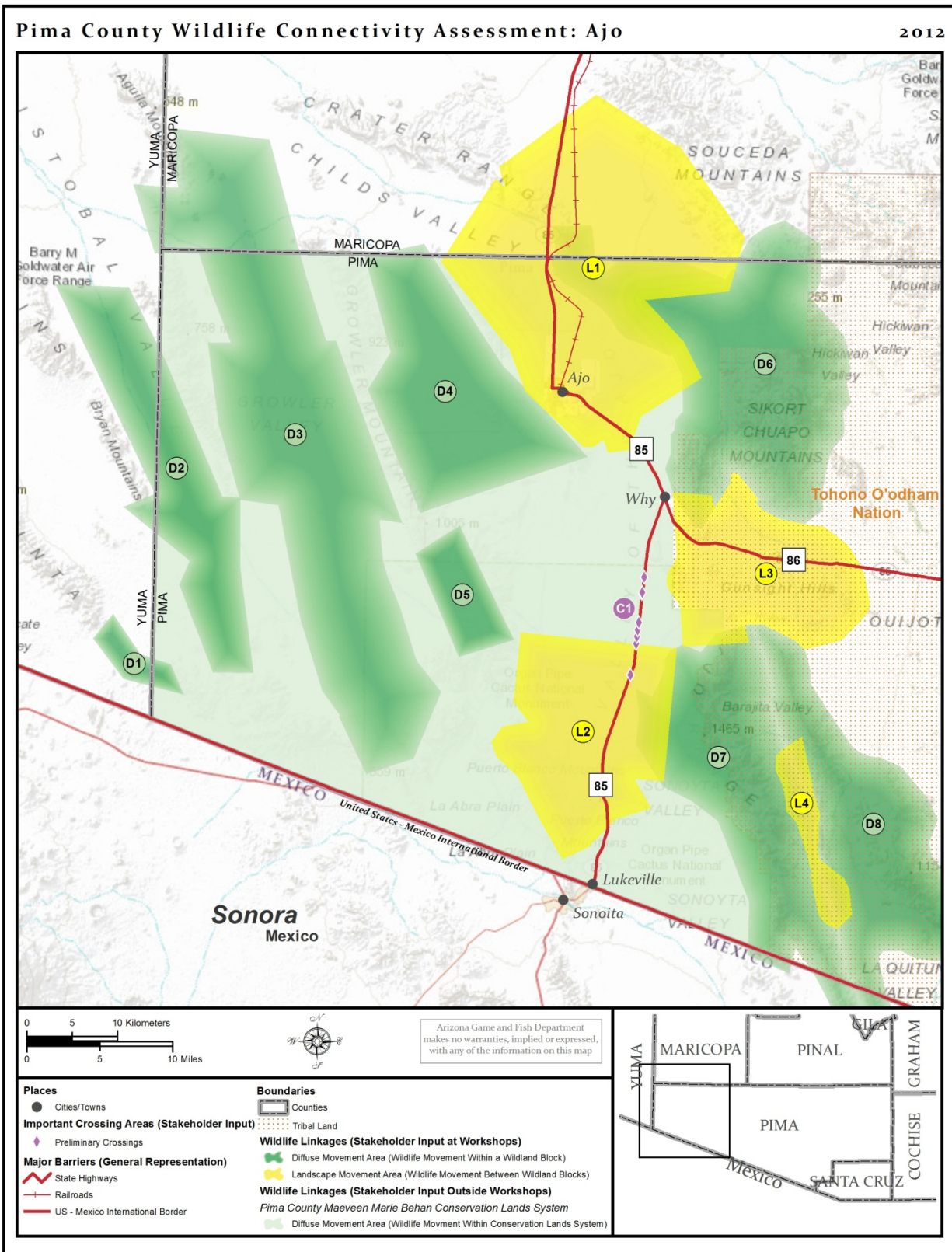


**Figure 8: Pima County stakeholder-identified linkages – County overview**





**Figure 9: Pima County stakeholder-identified linkages – Ajo**





*Figure 10: Pima County stakeholder-identified linkages – Tohono O’odham*

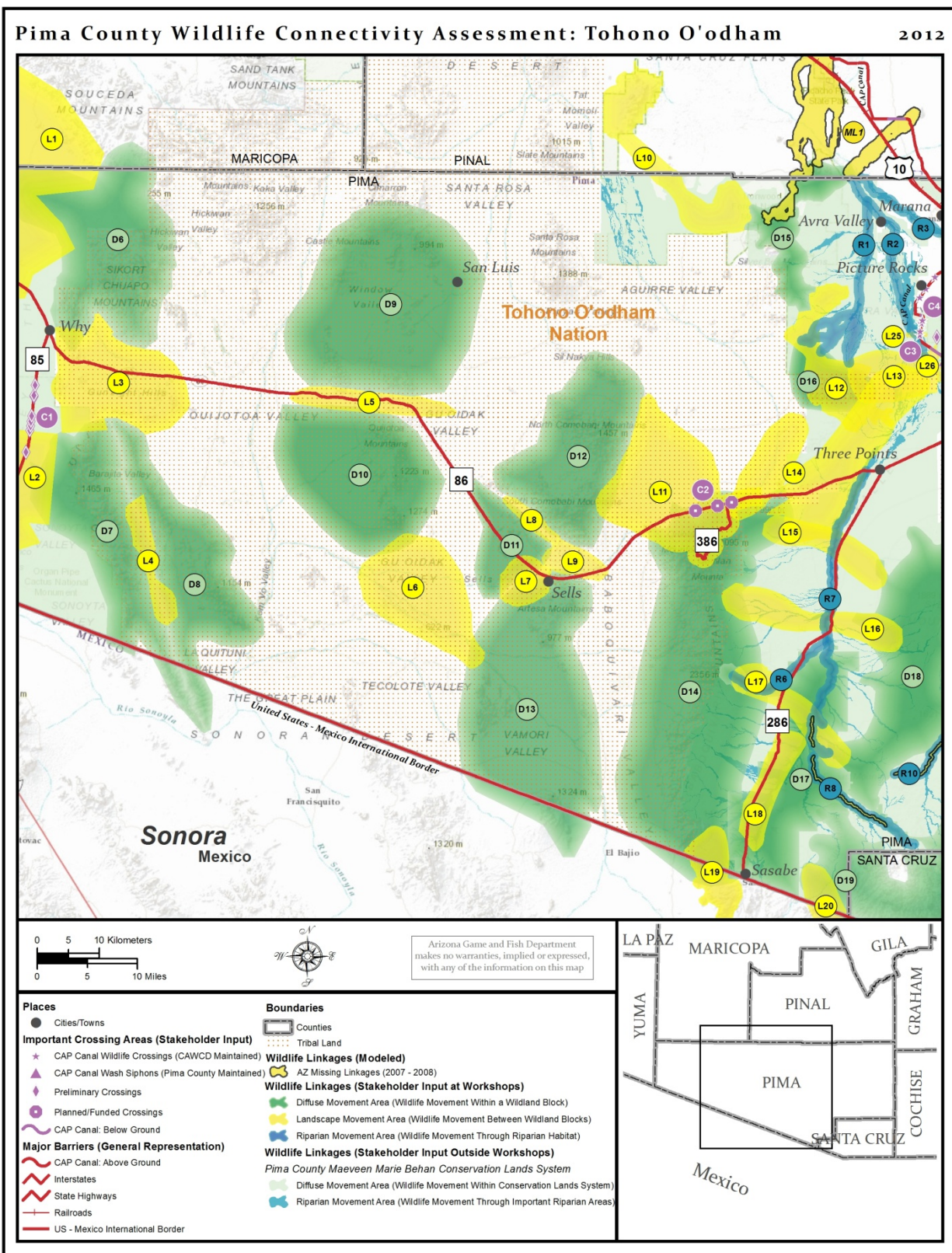




Figure 11: Pima County stakeholder-identified linkages – Marana

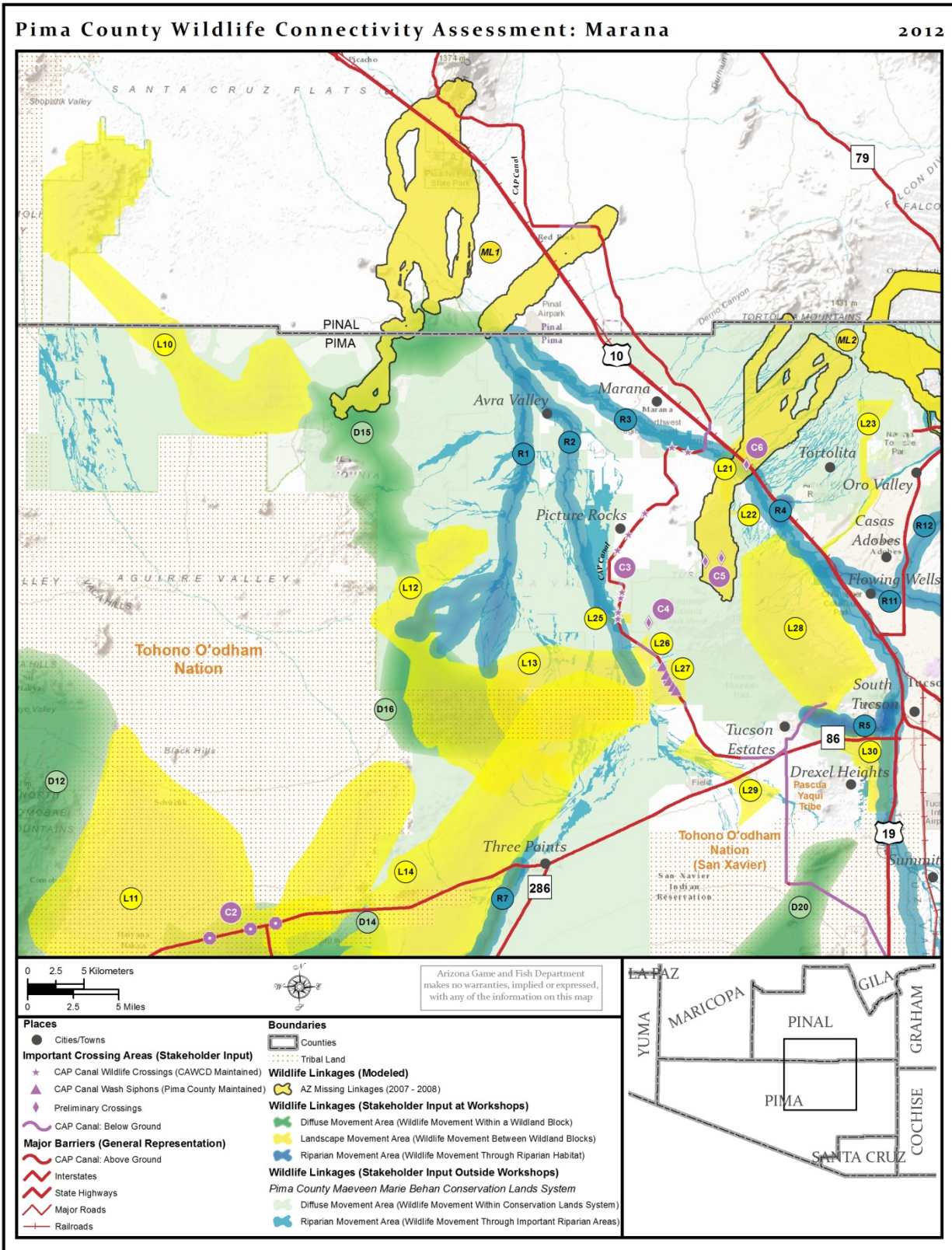




Figure 12: Pima County stakeholder-identified linkages – Tucson

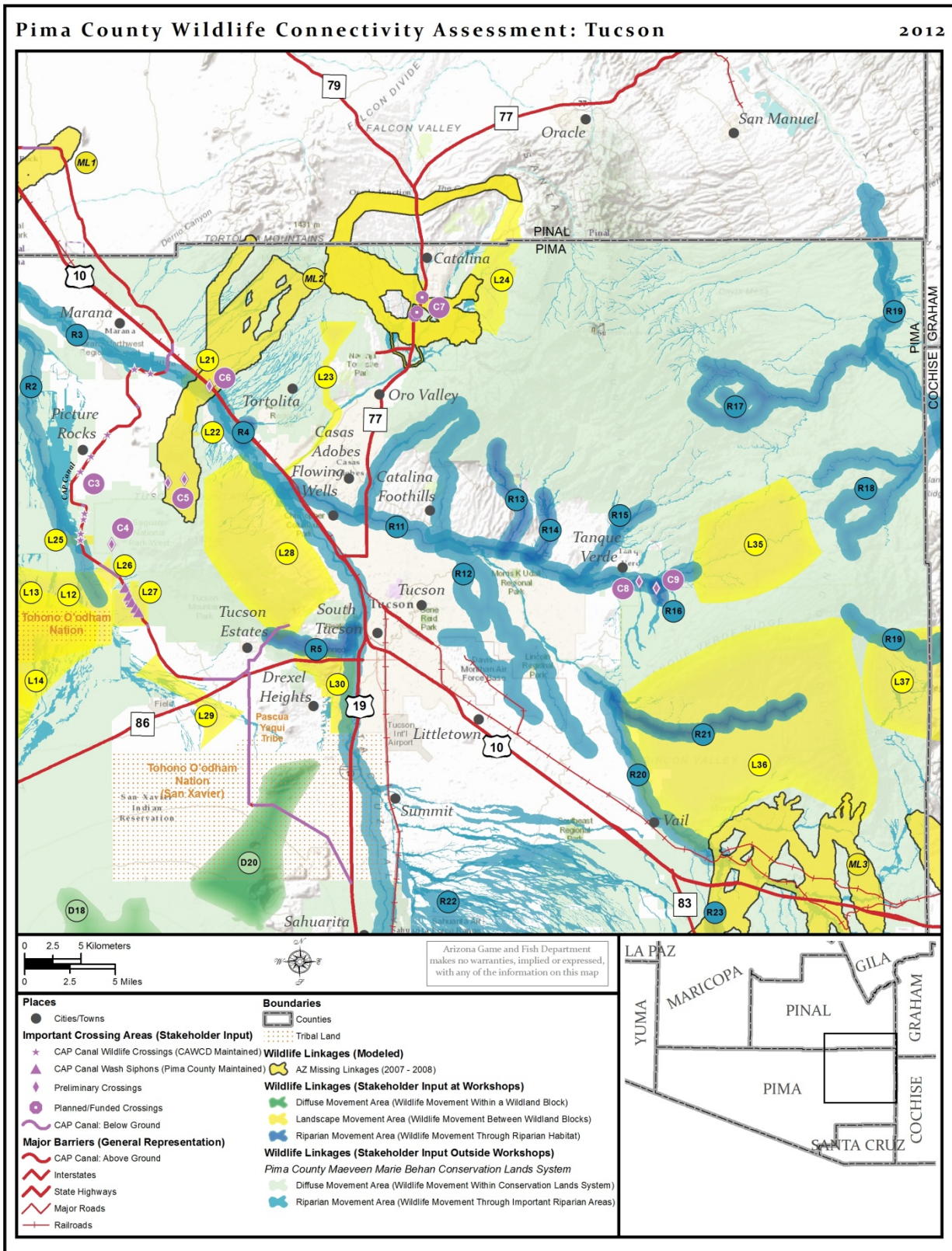




Figure 13: Pima County stakeholder-identified linkages – Sasabe

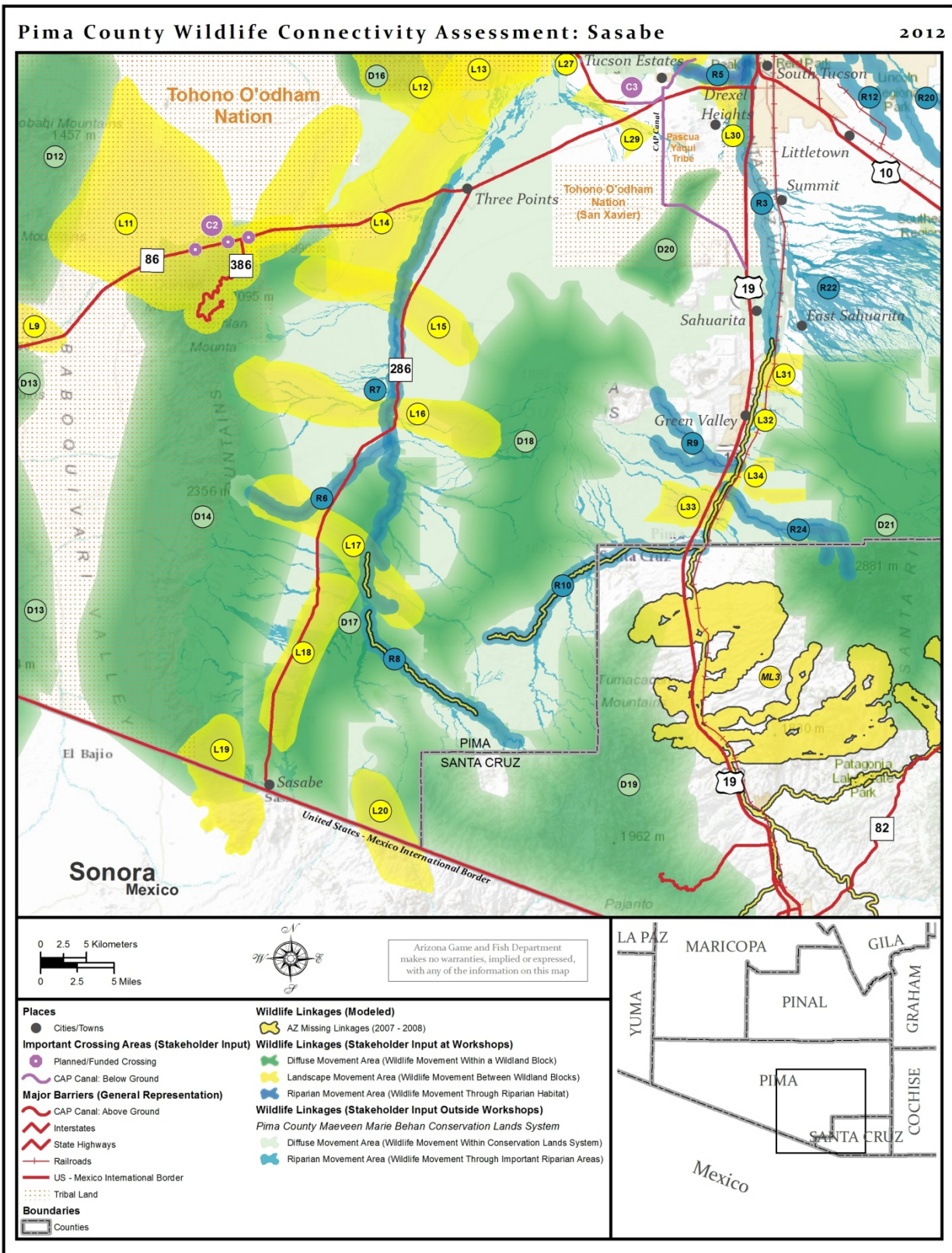
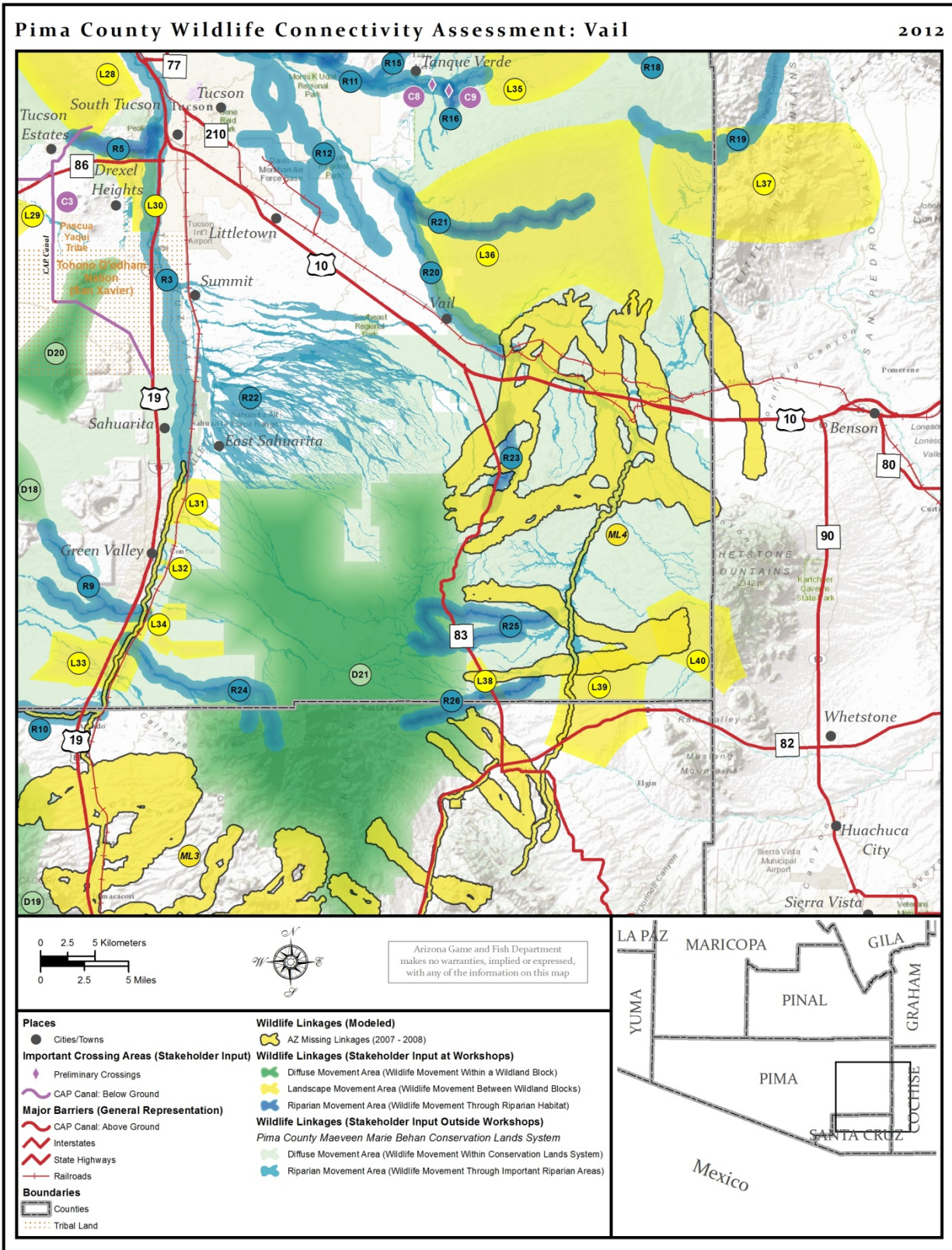




Figure 14: Pima County stakeholder-identified linkages – Vail



## PIMA COUNTY WILDLIFE LINKAGE DESCRIPTIONS

*Pima County diffuse movement areas: D1 – D21  
(Wildlife movement within a wildland block)*

### ***D1. Sierra Pinta/O'Neil Hills/Agua Dulce Mountains***

Wildland Blocks:	Within Cabeza Prieta National Wildlife Refuge
Species Identified:	Bighorn sheep; Javelina; Mule deer; Sonoran pronghorn
Current Threats/Barriers:	None listed
Notes:	Within both Yuma County and Pima County

### ***D2. San Cristobal Valley/Antelope Hills***

Wildland Blocks:	Within Cabeza Prieta National Wildlife Refuge
Species Identified:	Bighorn sheep; Javelina; Mule deer; Sonoran pronghorn
Current Threats/Barriers:	None listed
Notes:	Within both Yuma County and Pima County

### ***D3. Growler Valley***

Wildland Blocks:	Within Barry M. Goldwater Air Force Range, Cabeza Prieta National Wildlife Refuge and Organ Pipe Cactus National Monument
Species Identified:	Bighorn sheep; Javelina; Mule deer; Sonoran pronghorn
Current Threats/Barriers:	Border activities; Military activities, OHV use (drug traffic and law enforcement)
Notes:	None listed

### ***D4. Childs Valley***

Wildland Blocks:	Mostly within Cabeza Prieta National Wildlife Refuge; Childs/Little Ajo Mountains
Species Identified:	Bighorn sheep; Javelina; Mule deer; Sonoran pronghorn
Current Threats/Barriers:	None listed
Notes:	None listed

### ***D5. Bates Well***

Wildland Blocks:	Within Cabeza Prieta National Wildlife Refuge; Organ Pipe Cactus National Monument
Species Identified:	Bighorn sheep; Javelina; Mule deer; Sonoran pronghorn
Current Threats/Barriers:	Border activities; OHV use
Notes:	None listed

### ***D6. Batamote/Pozo Redondo/Souceda/Sikort Chuapo Mountains Wildland Block***

Wildland Blocks:	Within Batamote/Pozo Redondo/Souceda/Sikort Chuapo Mountains Wildland Block
Species Identified:	Bighorn sheep; Desert tortoise; Javelina; Mule deer, White-tailed deer
Current Threats/Barriers:	Agriculture (grazing); Border activities; OHV use (recreational, drug traffic, law enforcement); Pipeline (El Paso Gas expansion); Solar energy development
Notes:	Important areas include ridge line overlap and Burro Gap; A major road to aerial gunnery training goes through this area. Large portion of wildland block is within Tohono O'odham Nation.

### ***D7. Ajo Range/Barajita Valley Wildland Block***

Wildland Blocks:	Within Ajo Range/Barajita Valley Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	None listed

Notes:	Large portion of wildland block is within Tohono O'odham Nation. Portion of wildland block is within Mexico.
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#### ***D8. Gu Vo Hills/Mesquite Mountains/La Quituni Valley Wildland Block***

Wildland Blocks:	Within Gu Vo Hills/Mesquite Mountains/La Quituni Valley Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	None listed
Notes:	Wildland block was drawn on a map but without a datasheet. Wildland block is completely within Tohono O'odham Nation and Mexico.

#### ***D9. Sierra Blanca/Brownell Mountains/Window Valley Wildland Block***

Wildland Blocks:	Within Sierra Blanca/Brownell Mountains/Window Valley Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	None listed
Notes:	Wildland block was drawn on a map but without a datasheet. Wildland block is completely within Tohono O'odham Nation.

#### ***D10. Quijotoa Mountains/Quijotoa Valley Wildland Block***

Wildland Blocks:	Within Quijotoa Mountains/Quijotoa Valley Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	None listed
Notes:	Wildland block was drawn on a map but without a datasheet. Wildland block is completely within Tohono O'odham Nation.

#### ***D11. Sells/Gu Oidak Valley Wildland Block***

Wildland Blocks:	Within Sells/Gu Oidak Valley Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	None listed
Notes:	Wildland block was drawn on a map but without a datasheet. Wildland block is completely within Tohono O'odham Nation.

#### ***D12. Comobabi Mountains Wildland Block***

Wildland Blocks:	Within Comobabi Mountains Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	None listed
Notes:	Wildland block was drawn on a map but without a datasheet. Wildland block is completely within Tohono O'odham Nation.

#### ***D13. Alvarez/Artesa Mountains/Baboquivari/Vamori Valley Wildland Block***

Wildland Blocks:	Within Alvarez/Artesa Mountains/Baboquivari/Vamori Valley Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	None listed
Notes:	Wildland block was drawn on a map but without a datasheet. Wildland block is completely within Tohono O'odham Nation and Mexico.

#### ***D14. Baboquivari/Coyote/Quinlan Mountains Wildland Block***

Wildland Blocks:	Within Baboquivari/Coyote/Quinlan Mountains Wildland Block
Species Identified:	Jaguar
Current Threats/Barriers:	None listed
Notes:	Wildland block was drawn on a map but without a datasheet. Large portion of wildland



block is within Tohono O’odham Nation. Wildland block contains Coyote Mountains Wilderness, Baboquivari Peak Wilderness, Buenos Aires National Wildlife Refuge and extends into Mexico. Jaguar documented in Baboquivaris.

#### ***D15. Silver Bell/Waterman Mountains/Samaniego Hills Wildland Block***

Wildland Blocks:	Within Silver Bell/Waterman Mountains/Samaniego Hills Wildland Block
Species Identified:	Bighorn sheep; Desert Tortoise
Current Threats/Barriers:	Agriculture (grazing); Exotic species (buffelgrass); High density residential development; Industrial/commercial development; Mining (limestone); OHV use
Notes:	Mostly within Ironwood Forest National Monument. Partially within Tohono O’odham Nation. Patented mining claims have willing seller.

#### ***D16. Roskrige Mountains Wildland Block***

Wildland Blocks:	Within Roskrige Mountains Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	None listed
Notes:	Wildland block was drawn on a map but without a datasheet.

#### ***D17. Buenos Aires National Wildlife Refuge Wildland Block***

Wildland Blocks:	Within Buenos Aires National Wildlife Refuge Wildland Block
Species Identified:	Jaguar, Cactus ferruginous pygmy owl; American pronghorn; Masked bobwhite quail; Mountain lion; White-tailed deer; Mule deer; Javelina
Current Threats/Barriers:	Pedestrian fence/patrol roads; border-related traffic; non-native species; State Route 286
Notes:	Wildland block was indicated via email and based entirely on land ownership.

#### ***D18. Sierrita Mountains Wildland Block***

Wildland Blocks:	Within Sierrita Mountains Wildland Block
Species Identified:	Javelina; Mountain lion; White-tailed deer
Current Threats/Barriers:	Agriculture (grazing); Industrial/commercial development; Low density residential development; Mining; OHV use
Notes:	Wildland block partially within Buenos Aires National Wildlife Refuge. The rest of the wildland block has low land stewardship status.

#### ***D19. Tumacacori/San Luis Mountains Wildland Block***

Wildland Blocks:	Within Tumacacori/San Luis Mountains Wildland Block
Species Identified:	Jaguar; Mountain lion
Current Threats/Barriers:	High density residential development; High traffic gravel road; Low density residential development; Paved roads; Powerlines
Notes:	Wildland block mostly within Coronado National Forest but includes habitat outside boundaries.

#### ***D20. Mission Mine Wildland Block***

Wildland Blocks:	Within Mission Mine Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	High traffic gravel road (Batamote Road); Mining
Notes:	Wildland block is mostly within Tohono O’odham Nation (San Xavier). Copper mining (Mission Mine) is within the wildland block and may create habitat for certain species.

#### ***D21. Santa Rita Experimental Range/Coronado National Forest Wildland Block***

Wildland Blocks:	Within Santa Rita Experimental Range/Coronado National Forest Wildland Block
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Species Identified:	None listed
Current Threats/Barriers:	Mining (proposed Rosemont Mine)
Notes:	Wildland block digitized based on land ownership. Pima County, Arizona State Land Department, University of Arizona, and USDA Forest Service support lands in this wildland block.

***Pima County landscape movement areas: L1 – L40***  
***(Wildlife movement between wildland blocks)***

***L1. Crater Range/Childs/Little Ajo Mountains to Batamote/Sauceda Mountains***

Area Connected:	Batamote/Pozo Redondo/Sauceda Mountains Wildland Block – Crater Range/Childs/Little Ajo Mountains within Barry M. Goldwater Air Force Range and Cabeza Prieta National Wildlife Refuge.
Species Identified:	Bighorn sheep; Javelina; Mountain lion; Mule deer; Sonoran pronghorn
Current Threats/Barriers:	Agriculture (grazing); Exotic species; High density residential development; Low density residential development; Military activity; OHV use; Paved road (SR 85); Railroad
Notes:	There have been numerous road kills of burros. Projects in this linkage include border patrol residential development and future widening of SR 85. A large portion of this linkage is within the Tohono O’odham Nation, Barry M. Goldwater Air Force Range and Cabeza Prieta National Wildlife Refuge.

***L2. Bates Mountain/Puerto Blanco Mountains to Ajo Range across State Route 85***

Area Connected:	Bates/Puerto Blanco Mountains within Organ Pipe Cactus National Monument – Ajo Range/Barajita Valley Wildland Block
Species Identified:	Bighorn sheep; Javelina; Mule deer
Current Threats/Barriers:	Border activities; OHV use; Paved road (SR 85)
Notes:	Projects in this linkage include future widening of SR 85. This linkage is completely within Organ Pipe Cactus National Monument, but crosses a major barrier in SR 85.

***L3. Pozo Redondo Mountains to Ajo Range***

Area Connected:	Batamote/Pozo Redondo/Sauceda Mountains Wildland Block – Ajo Range/Barajita Valley Wildland Block & Gu Vo Hills/Mesquite Mountains/La Quituni Valley Wildland Block
Species Identified:	Bighorn sheep; Desert tortoise; Lesser long-nosed bat; Mountain lion; Small mammals
Current Threats/Barriers:	Border activities (illegal immigration); Exotic species (burros and horses); Low density residential development; Paved road (BIA Route 1); Paved road (SR 86);
Notes:	Most of this linkage is within the Tohono O’odham Nation with a portion extending into Organ Pipe Cactus National Monument.

***L4. Ajo Range to Mesquite Mountains***

Area Connected:	Ajo Range/Barajita Valley Wildland Block – Gu Vo Hills/Mesquite Mountains/La Quituni Valley Wildland Block
Species Identified:	Bighorn sheep; Desert tortoise; Herpetofauna (general); Lesser long-nosed bat; Mountain lion; Small mammals
Current Threats/Barriers:	Border activities (illegal immigration); Exotic species (Burros and horses); Low density residential development, Paved road (BIA Route 1)
Notes:	This linkage is entirely within Tohono O’odham Nation.

***L5. Quijotoa Mountains to Brownell Mountains***

Area Connected:	Sierra Blanca/Brownell Mountains/Window Valley Wildland Block – Quijotoa Mountains/Quijotoa Valley Wildland Block
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Species Identified:	Bighorn sheep; Mountain lion
Current Threats/Barriers:	Border activities (illegal immigration); Exotic species (buffelgrass)
Notes:	This linkage is entirely within Tohono O'odham Nation. Projects in this linkage include future SR 86/BIA Route 15 intersection improvements estimated to start 2013.

#### ***L6. Quijotoa Mountains to Alvarez Mountains***

Area Connected:	Quijotoa Mountains/Quijotoa Valley Wildland Block – Alvarez/Artesa Mountains/Baboquivari/Vamori Valley Wildland Block
Species Identified:	Badger; Bobcat; Herpetofauna (general); Mule deer; Mountain lion; Small mammals
Current Threats/Barriers:	Border activities (illegal immigration)
Notes:	This linkage is entirely within Tohono O'odham Nation.

#### ***L7. Sells Valley to Artesa Mountains***

Area Connected:	Sells/Gu Oidak Valley Wildland Block – Alvarez/Artesa Mountains/Baboquivari/Vamori Valley Wildland Block
Species Identified:	Bobcat; Desert tortoise; Mountain lion; Mule deer; Small mammals
Current Threats/Barriers:	Agriculture (farms); Exotic species (Buffelgrass); High density residential development; Industrial/commercial development; Low density residential development; OHV use (law enforcement, recreation); Paved road (BIA Route 21); Paved road (SR 86)
Notes:	This linkage is entirely within Tohono O'odham Nation. There has been increased Border Patrol traffic throughout the area.

#### ***L8. Sells Valley to Comobabi Mountains***

Area Connected:	Sells/Gu Oidak Valley Wildland Block – Comobabi Mountains Wildland Block
Species Identified:	Bobcat; Desert tortoise; Mountain lion; Mule deer; Small mammals
Current Threats/Barriers:	Agriculture (farms); Exotic species (Buffelgrass); High density residential development; Industrial/commercial development; Low density residential development; OHV use (law enforcement, recreation); Paved road (BIA Route 21); Paved road (SR 86)
Notes:	This linkage is entirely within Tohono O'odham Nation. There has been increased Border Patrol traffic throughout the area.

#### ***L9. Comobabi Mountains to Baboquivari Valley***

Area Connected:	Comobabi Mountains Wildland Block – Alvarez/Artesa Mountains/Baboquivari/Vamori Valley Wildland Block
Species Identified:	Bobcat; Desert tortoise; Mountain lion; Mule deer; Small mammals
Current Threats/Barriers:	Agriculture (farms); Exotic species (Buffelgrass); High density residential development; Industrial/commercial development; Low density residential development; OHV use (law enforcement, recreation); Paved road (BIA Route 21); Paved road (SR 86)
Notes:	This linkage is entirely within Tohono O'odham Nation. There has been increased Border Patrol traffic throughout the area.

#### ***L10. Sawtooth Mountains to Silver Bell Mountains***

Area Connected:	Sawtooth Mountains within Ironwood Forest National Monument – Silver Bell/Waterman Mountains/Samaniego Hills Wildland Block within Ironwood Forest National Monument
Species Identified:	Bighorn sheep
Current Threats/Barriers:	Agriculture; Exotic species; Low density residential development; OHV use (smuggling activities); Paved road (Aires Boulevard); Paved road (Sagitaris Road)
Notes:	Much of this linkage is within Ironwood Forest National Monument, but some portions in Pinal County encompass some State Trust and private land.



***L11. Kitt Peak: Comobabi Mountains to Baboquivari/Coyote/Quinlan Mountains***

Area Connected:	Comobabi Mountains Wildland Block – Baboquivari/Coyote/Quinlan Mountains Wildland Block
Species Identified:	Bighorn sheep; Desert tortoise; Eagle; Mountain lion; Mule deer
Current Threats/Barriers:	Border activities (illegal immigration); Exotic species (buffelgrass); Low density residential development (ranches, grazing etc.)
Notes:	Projects in this linkage include SR 86 widening (Santa Rosa Ranch and Kitt Peak segments) planned to start in 2012. Two RTA-funded wildlife underpasses will be constructed as part of the widening project, and a RTA-funded wildlife overpass will be constructed in 2013 or 2014. The National Optical Astronomy Observatory (NOAO) Kitt Peak National Observatory is located within this linkage.

***L12. Waterman Mountains to Roskrige Mountains***

Area Connected:	Silver Bell/Waterman Mountains/Samaniego Hills Wildland Block – Roskrige Mountains Wildland Block
Species Identified:	Desert tortoise; Mule deer
Current Threats/Barriers:	Exotic species (buffelgrass); OHV use (smuggling activities)
Notes:	Much of this linkage is within Ironwood Forest National Monument. However, linkage extends south into Roskrige Mountains within Tohono O’odham Nation and State Trust and private land.

***L13. Roskrige Mountains to Avra Valley***

Area Connected:	Saguaro National Park (West) – Roskrige Mountains Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	Agriculture; Exotic species; Mining; OHV use; Paved road (possible I-10 bypass) Solar energy development; Wind energy development
Notes:	This linkage uses the Tohono O’odham Nation (Garcia Strip), CAP wildlife crossings & mitigation corridor to connect Roskrige Mountains to Saguaro National Park (West)

***L14. Baboquivari/Coyote Mountains to Roskrige Mountains***

Area Connected:	Baboquivari/Coyote/Quinlan Mountains Wildland Block – Roskrige Mountains Wildland Block
Species Identified:	Bighorn sheep; Deer (general); Mountain lion
Current Threats/Barriers:	Border activities; Exotic species (buffelgrass); OHV use; Paved road (SR 86)
Notes:	This linkage encompasses numerous lands, including Coyote Mountains Wilderness, Ironwood Forest National Monument, State trust, private and Tohono O’odham Nation. Projects in this linkage include SR 86 widening (San Pedro segment) scheduled 2012. Numerous culverts exist along SR 86 but are not wildlife friendly. Tohono O’odham Nation is interested in coordinating linkage/crossings. Arizona Game and Fish Department, Coalition for Sonoran Desert Protection, Friends of Ironwood Forest, Pima County, Tucson Audubon Society, and U.S. Fish and Wildlife Service support this linkage.

***L15. Baboquivari Mountains through Mendoza/Fresnal Wash to Sierrita Mountains***

Area Connected:	Baboquivari/Coyote/Quinlan Mountains Wildland Block – Sierrita Mountains Wildland Block
Species Identified:	Bobcat; Coyote; Javelina; Mountain lion
Current Threats/Barriers:	Agriculture (grazing); Exotic species (buffelgrass, Lehmann's lovegrass, mesquite invasion); Low density residential development; Powerline (possible SunZia route); OHV use; Paved road (SR 286)
Notes:	Connects Maeveen Marie Behan Conservation Lands System Biological Core Management Areas in mountains across valley flats via major drainages. Biological Core Management Areas in Pima County priority acquisitions list support this linkage. Pima County purchased Kings 98 Ranch and Diamond Bell Ranch parcels in support of this linkage.

***L16. Baboquivari Mountains through Fresno Wash to Sierrita Mountains***

Area Connected:	Baboquivari/Coyote/Quinlan Mountains Wildland Block – Sierrita Mountains Wildland Block
Species Identified:	Bobcat; Coyote; Javelina; Mountain lion
Current Threats/Barriers:	Agriculture; Exotic species (buffelgrass, other invasive grasses); Mining; OHV use; Paved road (SR 286)
Notes:	The linkage follows Fresno/Cierro Prieto Washes from Baboquivari Mountains to Sierrita Mountains. Potential Pima County bond acquisitions support this linkage. Projects in this linkage include future upgrades to SR 286, estimated to begin in 2013.

***L17. Baboquivari Mountains through Brown Canyon/Las Guijas Wash to Sierrita Mountains***

Area Connected:	Buckskin Mountains – Arrastras Mountains
Species Identified:	Bobcat; Coyote; Javelina; Mountain lion
Current Threats/Barriers:	OHV use; Paved road (SR 286); Border-related impacts and traffic
Notes:	Connects Maeveen Marie Behan Conservation Lands System Biological Core Management Areas in mountains across valley flats via major drainages. Biological Core Management Areas in Pima County priority acquisitions list support this linkage. The majority of this linkage is within Buenos Aires National Wildlife Refuge.

***L18. East State Route 286 to West State Route 286***

Area Connected:	Buenos Aires National Wildlife Refuge Wildland Block East of State Route 286 – Buenos Aires National Wildlife Refuge Wildland Block West of State Route 286.
Species Identified:	American pronghorn; Mule deer
Current Threats/Barriers:	Fences; Paved road (SR 286)
Notes:	The majority of this linkage is within Buenos Aires National Wildlife Refuge Wildland Block.

***L19. Pozo Verde Mountains to Mexico***

Area Connected:	Baboquivari/Coyote/Quinlan Mountains Wildland Block & Buenos Aires National Wildlife Refuge Wildland Block - Mexico
Species Identified:	Jaguar; Ocelot; Pygmy owl
Current Threats/Barriers:	Border activities (operations/patrols); Border infrastructure (vehicle and pedestrian barriers); Exotic species (buffelgrass, Lehmann's lovegrass); Pipeline (proposed in west Altar Valley)
Notes:	This linkage follows the mountains and bajadas associated with the west side of Altar Valley along the U.S.-Mexico international border. A small portion of this linkage is located within Buenos Aires National Wildlife Refuge Wildland Block. Other portions of the linkage are located within Tohono O'odham Nation, Mexico, private and State land.

Projects in this linkage include the border fence and roads associated with it.

### ***L20. San Luis Mountains/Coches Ridge to Mexico***

Area Connected:	Tumacacori/San Luis Mountains Wildland Block - Mexico
Species Identified:	Jaguar; Ocelot; Pygmy owl
Current Threats/Barriers:	Border activities (operations/patrols); Border infrastructure (vehicle and pedestrian barriers); Exotic species (buffelgrass, Lehmann's lovegrass)
Notes:	This linkage follows the mountains and bajadas associated with the east side of Altar Valley along the U.S.-Mexico international border. The linkage is located within the Coronado National Forest and Mexico. Projects in this linkage include the construction of the border fence and roads associated with it.

### ***L21. Tucson Mountains Ridge to Santa Cruz River/Tortolita Fan***

Area Connected:	Tucson Mountains within Saguaro National Park (West) – Tortolita Mountains
Species Identified:	None listed. Species identified in Twin Peaks Road Wildlife Linkages Research Project, Rattlesnake Pass, Marana, Arizona (Lowery and Blackman 2007).
Current Threats/Barriers:	Canals (along Santa Cruz River); Concrete lined river (Santa Cruz River); Paved road (Twin Peaks Road); Residential and commercial development
Notes:	Twin Peaks Road Wildlife Linkages Research Project highlights wildlife movement along Tucson Mountains ridge to Santa Cruz River. Most of this linkage is located within Tucson – Tortolita – Santa Catalina Mountains AZ Missing Linkage. Pima County, Town of Marana, Arizona Game and Fish Department, Coalition for Sonoran Desert Protection, Tucson Audubon Society, Saguaro National Park (West), U.S. Fish and Wildlife Service support this linkage. Most of this linkage encompasses private land.

### ***L22. Northern Tucson Mountains Private Land Parcels: Santa Cruz River to Saguaro National Park (West)***

Area Connected:	Santa Cruz River Riparian Movement Area – Tucson Mountains within Saguaro National Park (West)
Species Identified:	None listed
Current Threats/Barriers:	High density residential development; Low density residential development
Notes:	This linkage is parcel based, located entirely on private lands and could increase fragmentation if developed. Numerous private land owners support this linkage, including Black Arrow Lodge and Bean Tree Farm. It was also indicated that Pima County and Arizona Land and Water Trust support this linkage.

### ***L23. Tortolita Fan to Canada del Oro***

Area Connected:	Tortolita Mountains – Canada del Oro
Species Identified:	Javelina; Mule deer; Reptiles; Small mammals
Current Threats/Barriers:	High density residential development; Low density residential development; Paved road (Tangerine Road); Paved road (La Cholla Road)
Notes:	Tangerine Road Wildlife Mortality Study (Arizona Game and Fish Department/Town of Marana) has identified increased mortalities and movement of many wildlife species.

***L24. Tucson – Tortolita – Santa Catalina Mountains AZ Missing Linkage Design Extension***

Area Connected:	Tortolita Mountains – Santa Catalina Mountains
Species Identified:	Birds (general); Bobcat; Canyon tree frog; Coati; Desert tortoise; Gila monster; Mountain lion; White-tailed deer
Current Threats/Barriers:	Agriculture; Residential and commercial development; OHV use; Paved road (SR 77); Powerline
Notes:	This linkage is an extension of the Tucson – Tortolita – Santa Catalina Mountain AZ Missing Linkage and includes the AZ Missing Linkage Design. The linkage extends north to connect with the Tucson – Tortolita – Santa Catalina AZ Missing Linkage in Pinal County. It is also extended east and north to include all foothills at the base of the Santa Catalina Mountains. Projects in this linkage include SR 77 widening to three lanes from Tangerine Road to Pinal County, estimated to start in 2013. The Arroyo Grande Planning Area open space component works to incorporate the Tucson – Tortolita – Santa Catalina Mountains AZ Missing Linkage Design and is represented in this linkage. Wildlife crossings (C7), two underpasses and one overpass are planned and funded.

***L25. Brawley Wash/Avra Valley across CAP Canal Wash Siphon to Saguaro National Park (West)***

Area Connected:	Brawley Wash Riparian Movement Area – Saguaro National Park (West)
Species Identified:	None listed
Current Threats/Barriers:	Canal (Central Arizona Project canal); Land ownership
Notes:	This linkage uses an official wildlife crossing per Central Arizona Project operations and maintenance agreement (C3). This linkage travels mostly through State Trust and private lands.

***L26. Saguaro National Park (West) across buried CAP Canal Pipeline to Avra Valley***

Area Connected:	Saguaro National Park (West) – Avra Valley
Species Identified:	Mountain lion
Current Threats/Barriers:	Low density residential development; High density residential development; Wind energy development
Notes:	Though the area within this linkage is developed, it is the only area adjacent to the park where the Central Arizona Project canal is underground (C2) and an ideal place for a wildlife crossing. Numerous organization/agencies support this linkage. This linkage is largely within private land.

***L27. CAP Wildlife Mitigation Corridor: Roskrige Mountains to Tucson Mountains***

Area Connected:	Roskrige Mountains Wildland Block & Tohono O’odham Nation (Garcia Strip) – Saguaro National Park (West)
Species Identified:	Bobcat; Mountain lion
Current Threats/Barriers:	Powerline (proposed SunZia); Paved road (ADOT proposed I-10 Bypass)
Notes:	This linkage was digitized based on land ownership and is completely within U.S. Bureau of Reclamation Central Arizona Project wildlife mitigation corridor. U.S. Bureau of Reclamation owns the corridor and Pima County Natural Resources, Parks and Recreation. This linkage contains numerous unofficial wildlife crossings per Central Arizona Project operations and maintenance agreement (C3).



***L28. Saguaro National Park (West) to Santa Cruz River***

Area Connected:	Saguaro National Park (West) – Santa Cruz River Riparian Movement Area
Species Identified:	None listed
Current Threats/Barriers:	Exotic species (buffelgrass, dogs); High density residential development; Low density residential development
Notes:	East side of Saguaro National Park (West) and Tucson Mountain Park to Santa Cruz River through subdivisions and roads. This is broad because it was not possible to provide more detail at Workshop #1. This linkage can be defined based on current development patterns and encompasses mostly private land.

***L29. Concentrated Drainages across State Route 86 towards Brawley Wash***

Area Connected:	Tohono O’odham Nation (San Xavier) & Sierrita Mountains Wildland Block – Brawley Wash Riparian Movement Area
Species Identified:	Herpetofauna (general); Javelina; Mule deer; Small mammals
Current Threats/Barriers:	Low density residential development; Paved road (SR 86)
Notes:	Area was identified during State Route 86 Wildlife Mortality Study (Arizona Game and Fish Department) as having increased movement for wildlife. This linkage encompasses the only major washes across SR 86 until Brawley Wash. This linkage is within State Trust and private land.

***L30. Tucson Mountain Park to Tohono O’odham Nation (San Xavier)/Santa Cruz River***

Area Connected:	Tucson Mountain Park – Tohono O’odham Nation (San Xavier) & Santa Cruz Riparian Movement Area
Species Identified:	Deer (general); Mountain lion
Current Threats/Barriers:	Exotic species (Buffelgrass); OHV use; Paved road (Ajo Road/SR 86); Powerline
Notes:	Numerous organizations/agencies support this linkage. Two culverts in this area need to be enlarged. Projects within this linkage include the widening of Ajo Road. This linkage is mostly within private land.

***L31. Santa Cruz River to Santa Rita Experimental Range***

Area Connected:	Santa Cruz River Riparian Movement Area – Santa Rita Experimental Range/Coronado National Forest Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	High density residential development; High traffic gravel road (Old Nogales Highway); Railroad
Notes:	This linkage connects uplands to Santa Cruz River north and south of Quail Creek development, especially along drainages. Projects within this linkage include the future Quail Crossing Boulevard extension. This linkage encompasses both State Trust and private land.

***L32. Wildlife Linkage across Old Nogales Highway to Santa Cruz River***

Area Connected:	Santa Rita Experimental Range/Coronado National Forest Wildland Block – Santa Cruz River Riparian Movement Area
Species Identified:	Coyote; Frogs; Javelina
Current Threats/Barriers:	Agriculture; High density residential development; Paved road (Old Nogales Highway); Railroad
Notes:	This linkage is located entirely within private land and would allow wildlife to access Santa Cruz River from the east. Farmers Investment Company may have desire for pecan orchard conservation. Robson and La Posada retirement communities continue development in the area.

***L33. Marley Ranch to Canoa Ranch***

Area Connected:	Sierrita Mountains Wildland Block – Santa Rita Experimental Range/Coronado National Forest Wildland Block
Species Identified:	Deer (general); Mountain lion
Current Threats/Barriers:	Concrete lined river (Esperanza Wash); Exotic species (buffelgrass); Low density residential development; OHV use; Paved road (I-19)
Notes:	This linkage is located within State Trust and private land. Projects in this linkage include future I-19 widening. Existent culverts and conservation lands on either sides of I-19 need expansion. Numerous agencies/organizations support this linkage.

***L34. Canoa Ranch to Santa Rita Experimental Range***

Area Connected:	Canoa Ranch – Santa Rita Experimental Range/Coronado National Forest Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	Low density residential development
Notes:	This linkage is located within State Trust and private land. Projects in this linkage include future I-19 widening. Existent culverts and conservation lands on either sides of I-19 need expansion.

***L35. Santa Catalina Mountains across Redington Pass to Rincon Mountains***

Area Connected:	Santa Catalina Mountains – Rincon Mountains/Saguaro National Park (East)
Species Identified:	Black bear; Black-tailed rattlesnake; Desert tortoise; Mountain lion; Tiger rattlesnake; White-tailed deer
Current Threats/Barriers:	Dumping; High traffic gravel road (Redington Road); OHV use; Paved road (Potential paving of Redington Road by USDA Forest Service); Target shooting
Notes:	This linkage is located mostly within Coronado National Forest with a connection to Saguaro National Park (East). Friends of Redington Pass support this linkage.

***L36. Saguaro National Park (East) to Rincon Valley***

Area Connected:	Saguaro National Park (East) – Rincon Valley
Species Identified:	Black bear; Coati; Coyote; Herpetofauna (general); Mountain lion
Current Threats/Barriers:	Exotic species (buffelgrass); High density residential development; Paved road (Old Spanish Trail)
Notes:	This linkage is located within mixed land ownership, including Coronado National Forest; Saguaro National Park (East); State Trust and private land. This area is a portion of a larger movement area for large vertebrates from Rincon Creek through Rincon Valley, Coyote/Pantano Washes across I-10 to Cienega Creek/San Pedro River. However, there is excellent herpetofauna habitat in the lower Rincons across Old Spanish Trail. Barriers instead of crossings may be appropriate for herpetofauna.

***L37. Saguaro National Park (East) to San Pedro River***

Area Connected:	Saguaro National Park (East) – San Pedro River Valley
Species Identified:	Coati; Desert tortoise; Gray hawk; Southwester willow flycatcher; Zone-tailed hawk
Current Threats/Barriers:	Agriculture; Exotic species (swine); Industrial/commercial development; Low density residential development; Powerline (proposed SunZia)
Notes:	This linkage is located within mixed ownership of Coronado National Forest, State Trust and private lands. These lands are currently undeveloped. The San Pedro River Valley contains crucial habitat. There is support in the local community for greater watershed protection. Projects in this linkage include the proposed SunZia Transmission Project with up to one mile wide transmission corridors.

***L38. Gardner Canyon/State Route 83 Pronghorn Linkage***

Area Connected:	Santa Rita Experimental Range/Coronado National Forest Wildland Block – Las Cienegas National Conservation Area
Species Identified:	American pronghorn
Current Threats/Barriers:	Agriculture (grazing); Border activities; Exotic species (Lehmann's lovegrass); High traffic gravel road (Gardner Canyon Road); Low density residential development; Mining; OHV use; Paved road (SR 83); Solar energy; Wind energy
Notes:	This linkage is located within mixed ownership of U.S. Bureau of Land Management, Coronado National Forest, State Trust and private land. The U.S. Bureau of Land Management is actively restoring and conserving land in this area. American pronghorn cross SR 83 in this area regularly. A wildlife overpass in this area is needed.

***L39. Las Cienegas National Conservation Area to Audubon Appleton-Whittell Research Ranch***

Area Connected:	Las Cienegas National Conservation Area – Audubon Appleton-Whittell Research Ranch
Species Identified:	American pronghorn; Badger; Birds (general); Mule deer
Current Threats/Barriers:	Agriculture (grazing); Exotic species (Lehmann's lovegrass); High traffic gravel road; Low density residential development; OHV use; Paved road (SR 82); Solar energy development; Wind energy development
Notes:	This linkage is located within mixed ownership of U.S. Bureau of Land Management, State Trust and private land. The U.S. Bureau of Land Management is actively restoring and conserving land in this area. This linkage crosses into Santa Cruz County.

***L40. Whetstone Mountains to Las Cienegas National Conservation Area***

Area Connected:	Whetstone Mountains – Las Cienegas National Conservation Area
Species Identified:	American pronghorn; Black bear; Coati; Chiricahua leopard frog; Mountain lion; Ocelot
Current Threats/Barriers:	Agriculture; Exotic species (Lehmann's lovegrass); Low density residential development; OHV use;
Notes:	This linkage is located within mixed ownership of U.S. Bureau of Land Management, Coronado National Forest, State Trust and private land. The U.S. Bureau of Land Management and Pima County are actively restoring and conserving land in this area. Sky Island Alliance has proposed wilderness designation for Whetstone Mountains.

*Pima County riparian movement areas: R1 – R26*  
(Wildlife movement through riparian habitat)

***R1. Blanco Wash***

Area Connected:	Roskrige Mountains Wildland Block – Brawley Wash Riparian Movement Area
Species Identified:	Bat (general); Pygmy owl
Current Threats/Barriers:	Agriculture; Exotic species (Buffelgrass); Low density residential development; OHV use; Paved Road (Silver Bell Road); Powerline; Solar energy development
Notes:	Land ownership in this linkage includes U.S. Bureau of Land Management, State Trust and private lands. Projects in this linkage include future solar energy projects on City of Tucson lands. Friends of Ironwood Forest support this linkage.

***R2. Brawley Wash***

Area Connected:	Tohono O’odham Nation (Garcia Strip) & CAP Wildlife Mitigation Corridor – Silver Bell/Waterman Mountains/Samaniego Hills Wildland Block
Species Identified:	None listed
Current Threats/Barriers:	Agriculture; Canals; Exotic species; High density residential development; Low density residential development; Mining; OHV use; Paved road (Potential I-10 Bypass); Solar energy development; Wind energy development
Notes:	This linkage is mostly within State Trust and private lands, with a section in Tohono O’odham Nation (Garcia Strip). This linkage connects to Ironwood-Picacho AZ Missing Linkage. Saguaro National Park (West) supports this linkage.

***R3. Santa Cruz River***

Area Connected:	Santa Rita Experimental Range/Coronado National Forest Wildland Block -Tohono O’odham Nation (San Xavier) – Silver Bell/Waterman Mountains/Samaniego Hills Wildland Block
Species Identified:	Bat (general); Birds (migratory/riparian); Bobcat; Mountain lion; Raccoon; Deer (general)
Current Threats/Barriers:	Agriculture; Exotic species; Low density residential development; High density residential development; Paved road (Ina Road); Concrete lined river
Notes:	This is a lengthy linkage area with land ownership including private, State Trust and Tohono O’odham (San Xavier). Town of Marana plans to cement river banks. Sand/gravel operations and dewatering of river effluent also threaten the linkage. There is an important bat roost underneath Ina Road Bridge.

***R4. Hardy Wash***

Area Connected:	Hardy Wash Riparian Movement Area – Santa Cruz River Riparian Movement Area
Species Identified:	None listed
Current Threats/Barriers:	Canals; High density residential development; Industrial/commercial development; Low density residential development; Paved road (I-10); Railroad (Union Pacific)
Notes:	This linkage is located within private land. Tres Rios del Norte Environment Restoration Feasibility Study identified opportunity to provide wildlife movement under I-10. Wash segments have been set aside through Countryside homes development.

***R5. West Branch Santa Cruz River***

Area Connected:	Santa Cruz River Riparian Movement Area – Tucson Mountains within Tucson Mountain Park
Species Identified:	Birds (general); Herpetofauna (general)
Current Threats/Barriers:	Exotic species; High residential development; Low residential development

Notes: Pima County and University of Arizona support this linkage.

### ***R6. Brown Wash***

Area Connected:	Baboquivari/Coyote/Quinlan Mountains Wildland Block – Buenos Aires National Wildlife Refuge Wildland Block – Altar Was Riparian Movement Area
Species Identified:	Lucy's warbler; Masked bobwhite quail; Mountain lion; Pygmy owl
Current Threats/Barriers:	Exotic species; Fire; Paved road (SR 286)
Notes:	This linkage is within Buenos Aires National Wildlife Refuge, State Trust and private land. High density cavities of cavity nesters exist in mesquites.

### ***R7. Altar Wash***

Area Connected:	Buenos Aires National Wildlife Refuge Wildland Block – North SR 86
Species Identified:	None listed
Current Threats/Barriers:	Agriculture; Exotic species; High density residential development; Low density residential development; Mining; OHV use; Powerline; Wind energy development
Notes:	This linkage is within Buenos Aires National Wildlife Refuge, private and State Trust land.

### ***R8. Arivaca/Cedar Creek***

Area Connected:	Buenos Aires National Wildlife Refuge Wildland Block – Tumacacori/San Luis Mountains Wildland Block
Species Identified:	Birds (riparian); Bobcat; Coati; Mountain lion; White-tailed deer; Jaguar
Current Threats/Barriers:	Exotic species (Johnson grass, salt cedar); Cottonwood degradation
Notes:	This linkage is within Buenos Aires National Wildlife Refuge, private and State Trust land.

### ***R9. Esperanza/Demetrie Wash***

Area Connected:	Sierrita Mountains Wildland Block – Canoa Ranch
Species Identified:	None listed
Current Threats/Barriers:	Mining
Notes:	This linkage is located within private and State Trust land. Projects within this linkage include Freeport McMoran future mine tailings. Freeport McMoran has submitted an application to the Arizona State Land Department for purchase of the land.

### ***R10. Sopori Wash***

Area Connected:	Sierrita Mountains Wildland Block – Sopori Wash Riparian Movement Area – Santa Cruz Riparian Movement Area
Species Identified:	None listed
Current Threats/Barriers:	None listed
Notes:	This linkage is located within private and State Trust land. Willing land sellers and Pima County provide support for this linkage.

### ***R11. Rillito Creek/Tanque Verde Wash***

Area Connected:	Coronado National Forest & Saguaro National Park (East) – Santa Cruz River Riparian Movement Area
Species Identified:	Birds (general)
Current Threats/Barriers:	Agriculture; Exotic species; Low density residential development
Notes:	Most of the land within this linkage is private. A small portion of the linkage includes Coronado National Forest and Saguaro National Park (East). Tucson Audubon Society and University of Arizona are concerned with invasive species in this area.





### ***R12. Tucson Urban Riparian Linkages***

Area Connected:	Santa Catalina Mountains within Coronado National Forest – South of Tucson
Species Identified:	Birds (general); Coyote; Bobcat; Javelina; Raccoon
Current Threats/Barriers:	Agriculture; Canals; Exotic species; High traffic gravel road; Industrial/commercial development; High residential development; Low residential development; Mining; OHV use; Paved road
Notes:	Allow for wildlife connectivity through Tucson

### ***R13. Ventana Canyon Wash***

Area Connected:	Santa Catalina Mountains within Coronado National Forest – Rillito Creek/Tanque Verde Wash
Species Identified:	Bobcat; Coyote; Javelina; Mountain lion; Raccoon
Current Threats/Barriers:	Exotic species; Fences; High density residential development
Notes:	This linkage is located mostly within private land with a small portion in Coronado National Forest. Large stands of cottonwood and willow exist here. Removing fencing could improve linkage permeability.

### ***R14. Sabino Creek***

Area Connected:	Santa Catalina Mountains within Coronado National Forest – Rillito Creek/Tanque Verde Wash
Species Identified:	Birds (general); Bobcat; White-tailed deer; Mountain lion
Current Threats/Barriers:	High density residential development; Low density residential development; Paved road (Snyder Road)
Notes:	This linkage is located mostly within private land with a small portion in Coronado National Forest. The Nature Conservancy maintains some conservation easements. Tucson Audubon Society supports this linkage through a variety of programs. Projects in this linkage include the potential for Snyder Road to expand in the future.

### ***R15. Agua Caliente Wash***

Area Connected:	Santa Catalina Mountains within Coronado National Forest – Rillito Creek/Tanque Verde Wash
Species Identified:	None listed
Current Threats/Barriers:	Low density residential development
Notes:	This linkage is located mostly within private land with a small portion in Coronado National Forest. Pima County owns parcels within the linkage. Projects in this linkage include widening of Tanque Verde Road from Catalina Highway to Houghton Road.

### ***R16. Monument Wash***

Area Connected:	Saguaro National Park (East) - Rillito Creek/Tanque Verde Wash
Species Identified:	Gambel's quail; Greater roadrunner; Javelina
Current Threats/Barriers:	Agriculture; Low density residential development; Paved road (Speedway Boulevard)
Notes:	This linkage is located within Saguaro National Park (East) and private land. The Stakeholder Indicated Important Crossing Speedway Boulevard/Monument Wash Crossing (C9) is located within the linkage. Local neighbors/home owners, Saguaro National Park (East) and Pima County supports this linkage. There is also important riparian/aquatic habitat to the west of the linkage near Broadway Boulevard.

***R17. Buehman Canyon/Burro Creek***

Area Connected:	San Pedro River – Santa Catalina Mountains within Coronado National Forest
Species Identified:	Birds(general/migratory); Deer (general); Desert tortoise; Native fish; Raptors
Current Threats/Barriers:	Agriculture; Exotic species; High traffic gravel road (Redington Road); Mining; OHV use; Powerline (proposed SunZia)
Notes:	The linkage is located within mixed ownership of Coronado National Forest, private and State Trust land. Some lands managed for conservation are included in this linkage.

***R18. Bolt/Soza/Youtcy Canyon***

Area Connected:	Santa Catalina & Rincon Mountains within Coronado National Forest – San Pedro River
Species Identified:	Desert tortoise; Mule deer; Predators (general); White-tailed deer
Current Threats/Barriers:	Agriculture (grazing); High traffic gravel road (Redington Road); Low density residential development; Mining; Powerline (proposed SunZia)
Notes:	The linkage is located within mixed ownership of Coronado National Forest, private and State Trust land. Pima County is actively buying conservation parcels. Projects within this linkage include historic mining claims and proposed SunZia Transmission Project.

***R19. Paige Canyon/San Pedro River***

Area Connected:	Rincon Mountains within Saguaro National Park (East) – San Pedro River
Species Identified:	Black bear; Desert tortoise; Gray hawk; Mountain lion; Southwestern willow flycatcher; Zone-tailed hawk
Current Threats/Barriers:	Agriculture; Canals; Exotic species; High density residential development; Industrial/commercial development; Low density residential development; Mining; OHV use; Paved road; Powerline (proposed SunZia); Railroad; Solar energy development; Uranium mining; Wind energy development
Notes:	The linkage is located within mixed ownership of Coronado National Forest, Saguaro National Park (East), private and State Trust land. A majority of this linkage and nearby land is undeveloped to the Galiuro Mountains. Projects within this linkage include the proposed SunZia Transmission Project.

***R20. Pantano Wash***

Area Connected:	Pantano Wash – Cienega Creek
Species Identified:	None listed
Current Threats/Barriers:	Agriculture; OHV use
Notes:	This linkage is located within private and State Trust land.

***R21. Rincon Creek***

Area Connected:	Pantano Wash – Saguaro National Park (East)
Species Identified:	None listed; Mammal species identified in Mammals of the Rincon Mountain District, Saguaro National Park (Swann 2011).
Current Threats/Barriers:	Anderson Mine Road; Alamo Road; Off-highway vehicle activity; Solar development
Notes:	This linkage is located within Saguaro National Park (East), private and State Trust land.

***R22. Lee Moore Wash Flow Corridors***

Area Connected:	Santa Rita Experimental Range/Coronado National Forest Wildland Block – Santa Cruz River Riparian Area
Species Identified:	None listed
Current Threats/Barriers:	High density residential development; Low density residential development; Paved road (I-10 Bypass); Powerline; Solar energy development
Notes:	This linkage is has mixed ownership of University of Arizona (Santa Rita Experimental

Range); U.S. Bureau of Land Management; State Trust and private land. This area similar to the Important Riparian Areas in the Maeveen Marie Behan Conservation Lands System which have city and county approval.

### ***R23. Davidson Canyon***

Area Connected:	Extends Rincon – Santa Ritas – Whetstone Mountains AZ Missing Linkage Design
Species Identified:	Birds (Migratory); Chiricahua leopard frog; Deer (general); Gila monster; Bobcat; Mountain lion; Black bear
Current Threats/Barriers:	High traffic gravel road; Industrial/commercial development; Mining (gravel/limestone); OHV use
Notes:	This linkage is located within private and State Trust land. Sky Island Alliance regularly tracks wildlife in this area. Potential Pima County Bond acquisitions in the area. Pima County Natural Preserve on Cienega Creek and Pima County Bar-V Ranch extend into Davidson Canyon in lower portion.

### ***R24. Madera Canyon***

Area Connected:	Santa Rita Experimental Range/Coronado National Forest Wildland Block – Santa Cruz River Riparian Movement Area
Species Identified:	Birds (migratory); Mammals (general)
Current Threats/Barriers:	Low density residential development
Notes:	This linkage is located within Coronado National Forest, private and State Trust land.

### ***R25. Empire Gulch/Oak Tree Canyon***

Area Connected:	Santa Rita Experimental Range/Coronado National Forest Wildland Block – Rincon – Santa Ritas – Whetstone Mountains AZ Missing Linkage Design
Species Identified:	Birds (migratory); Black bear; Coati; Mountain lion; Mule deer; Raptors; White-tailed deer
Current Threats/Barriers:	Agriculture (grazing); Border activities; Exotic species (Lehmann's lovegrass); High density residential development; Low density residential development; Mining (proposed Rosemont Mine); OHV use; Solar energy development; Wind energy development
Notes:	This linkage is located within Coronado National Forest, U.S. Bureau of Land Management, State Trust and private land. U.S. Bureau of Land Management is actively conserving and restoring land in linkage.

### ***R26. Gardner Canyon***

Area Connected:	Harcuvar Mountains – Black Mountains
Species Identified:	American pronghorn; Birds (migratory); Black bear; Chiricahua leopard frog; Coati; Mule deer; Raptors; White-tailed deer
Current Threats/Barriers:	Agriculture (grazing); Border activities; Exotic species (Lehmann's lovegrass); High density residential development; High traffic gravel road (Gardner Canyon Road); Low density residential development; Mining; OHV use; Paved road (SR 286); Solar energy development; Wind energy development
Notes:	This linkage has mixed ownership of Coronado National Forest, U.S. Bureau of Land Management, private and State Trust Land. U.S. Bureau of Reclamation is actively conserving and restoring linkage.

## *Pima County important crossing areas: C1 – C8*

### ***C1. Organ Pipe Cactus National Monument/State Route 85 Wash Crossings***

Linkage/Area Served:	Bates/Puerto Blanco Mountains to Ajo Range across State Route 85 (L2)
Target Species:	Herpetofauna (general); Sonoran pronghorn
Current Threats/Barriers to Linkage/Area Served:	Exotic species (buffelgrass, mustard grass); Paved road (SR 85)
Status:	Preliminary; Alamo Wash Bridge currently exists but needs improvement
Notes:	AGFD biologists researched culverts here. Several low water crossings along major washes have been considered to prevent road flooding and wildlife road kills. Alamo Wash Bridge is the southernmost crossing and likely functions as a wildlife underpass. The bridge is over 60 years old and if it were replaced that would be a good opportunity to enlarge it to improve wildlife permeability.

### ***C2. Kitt Peak: Comobabi Mountains to Baboquivari/Coyote/Quinlan Mountains***

Linkage/Area Served:	Comobabi Mountains Wildland Block – Baboquivari/Coyote/Quinlan Mountain Wildland Block
Target Species:	Bighorn sheep; Desert tortoise; Eagle; Mountain lion; Mule deer
Current Threats/Barriers to Linkage/Area Served:	Border activities (illegal immigration); Exotic species (buffelgrass); Low density residential development (ranching, grazing etc.); Paved road (SR 86)
Status:	RTA planned and funded
Notes:	As part of the planned widening of SR 89 along the Santa Rosa Ranch and Kitt Peak segments, scheduled to begin in 2012, RTA-funded wildlife underpasses will be constructed during the widening project (MP 131.2 and 134.9). An approved RTA-funded wildlife overpass will be constructed as a separate project in 2013 or 2014 at MP 133.5.

### ***C3. CAP Canal Wildlife Crossings (CAWCD Maintained), CAP Canal Wash Siphons (Pima County Maintained), and CAP Canal Buried Portions (Pipelines, Siphons & Tunnels): Avra Valley to Tucson Mountains***

Linkage/Area Served:	CAP Canal Wildlife Crossings (CAWCD Maintained), CAP Canal Wash Siphons (Pima County Maintained), and CAP Canal Buried Portions (Pipelines, Siphons & Tunnels): Avra Valley to Tucson Mountains (C2)
Target Species:	Badger; Bobcat; Mountain lion; Mule deer
Current Threats/Barriers to Linkage/Area Served:	Agriculture; Canals; Exotic species (Buffelgrass); High density residential development; Industrial/commercial development; Land ownership; Low density residential development; Mining; OHV use; Paved road (Sandario Road); Wind energy development
Status:	Currently exists
Notes:	CAP canal wildlife crossings are maintained by Central Arizona Water Conservation District (CAWCD) per operations and maintenance agreement. CAP canal wash siphons exist in between the CAP canal right-of-way within the CAP mitigation area managed by Pima County. Numerous organizations/agencies support using CAP canal buried portions as wildlife crossings to facilitate a linkage from Avra Valley to Tucson Mountains. U.S. Bureau of Reclamation indicated that not all buried portions of the CAP canal may be permeable to wildlife, as fencing/debris may be present.

### ***C4. Saguaro National Park (West)/Sandario Road Culvert***

Linkage/Area Served:	Within Saguaro National Park (West)
Target Species:	None listed
Current Threats/Barriers to Linkage/Area Served:	Paved road (Sandario Road)



Status:	Preliminary
Notes:	Culvert needs improvement to become more wildlife friendly

### ***C5. Saguaro National Park (West)/Picture Rocks Road Culverts***

Linkage/Area Served:	Within Saguaro National Park (West)
Target Species:	All taxa
Current Threats/Barriers to Linkage/Area Served:	Paved road (Picture Rocks Road)
Status:	Preliminary
Notes:	Culverts near Cam-Boh Picnic Area and Panther Peak Wash in Saguaro National Park (West). These need improvement to become more wildlife friendly.

### ***C6. I-10 Abandoned Railroad Underpass (Proposed for Improvement)***

Linkage/Area Served:	Tucson – Tortolita – Santa Catalina Mountains AZ Missing Linkage
Target Species:	Bobcat; Fox; Herpetofauna (general); Jackrabbit; Javelina; Sidewinder
Current Threats/Barriers to Linkage/Area Served:	Industrial/commercial development; Paved road (I-10)
Status:	Currently exists but needs improvement
Notes:	Pima County as acquired parcels adjoining this abandoned railroad I-10 underpass. The Town of Marana has included this crossing in its habitat conservation plan for wildlife corridors. Projects nearby include Tangerine Road widening from four to six lanes and Lambert Lane extension.

### ***C7. RTA Funded Oracle Road/State Route 77 Crossings (One Overpass, Two Underpasses)***

Linkage/Area Served:	Tucson – Tortolita – Santa Catalina Mountains AZ Missing Linkage
Target Species:	Badger; Bats (general); Black bear; Bobcat; Javelina; Kit fox; Mountain lion; Mule deer; Arizona whipsnake; Desert tortoise; Gila monster; Giant spotted whiptail; Gopher snake; Lowland leopard frog; Mohave rattlesnake; Sonoran desert toad; Sonoyta mud turtle; Tiger rattlesnake; Western diamondback; Cactus ferruginous pygmy owl
Current Threats/Barriers to Linkage/Area Served:	Paved road (Oracle Road/SR 77)
Status:	RTA planned and funded
Notes:	Oracle Road/SR 77 is planned to be widened to three lanes from Tangerine Road to Pinal County in fiscal year 2013. Pima County acquired Treehouse properties, Arroyo Grande planning process, Sonoran Desert Conservation Plan/Maeveen Marie Behan Conservation Lands System work to support these crossing structures.

### ***C8. Wentworth Road/Tanque Verde Wash Crossing***

Linkage/Area Served:	Rillito Creek/Tanque Verde Wash (R11)
Target Species:	Gambel's quail; Javelina; White-tailed deer
Current Threats/Barriers to Linkage/Area Served:	High traffic gravel road (Wentworth Road)
Status:	Preliminary
Notes:	Wentworth Road has the potential to be a major road in the future. Although presently a gravel road, if developed it could greatly impact wildlife movement through Tanque Verde Wash. Pima County Department of Transportation supports this crossing.

### ***C9. Speedway Boulevard/Monument Wash Crossing***

Linkage/Area Served:	Monument Wash (R16)
Target Species:	Gambel's Quail; Greater roadrunner; Javelina; Bobcat; Coyote

Current Threats/Barriers to Linkage/Area Served:	Agriculture; Low density residential development; Paved road (Broadway Boulevard); Paved road (Speedway Boulevard)
Status:	Preliminary
Notes:	Major washes crossing Speedway Boulevard need crossings. Local neighbors, home owners, Saguaro National Park (East), Pima County support this crossing.

### *Arizona Missing Linkages (2007 – 2008): ML1 – ML4 (Modeled wildlife linkages)*

#### ***ML1. Ironwood – Picacho Mountains***

Linkage Design:	Ironwood – Picacho Linkage Design (Beier et al. 2006a)
Species Identified:	See Missing Linkage report at <a href="http://www.corridordesign.org">http://www.corridordesign.org</a> for complete list of modeled species
Current Threats/Barriers:	None listed
Notes:	Not highlighted by stakeholders

#### ***ML2. Tucson – Tortolita – Santa Catalina Mountains***

Linkage Design:	Tucson – Tortolita – Santa Catalina Mountains Linkage Design (Beier et al. 2006d)
Species Identified:	See L21, L22, L24, R3, C5, C6, C7; See Missing Linkage report at <a href="http://www.corridordesign.org">http://www.corridordesign.org</a> for complete list of modeled species
Current Threats/Barriers:	See L21, L22, L24, R3, C5, C6, C7
Notes:	The Tucson – Tortolita – Santa Catalina Mountains Linkage Design was emphasized by numerous stakeholders as an important wildlife linkage in Pima County. Many landscape movement areas were identified within or near the linkage design (L21, L22, L24). It is important to note that one of these landscape movement areas (L21), occurring within and adjacent to the linkage design, is based on data from the Twin Peaks Road Wildlife Linkages Research Project (Lowery and Blackman 2007). A riparian movement area (R3) travels NW/SE through the linkage design. Important crossing areas in the linkage design exist as preliminary crossings (C5, C6) and RTA planned/funded crossings (C7).

#### ***ML3. Santa Rita – Tumacacori Mountains***

Linkage Design::	Santa Rita – Tumacacori Linkage Design (Beier et al. 2006c)
Species Identified:	See Missing Linkage report at <a href="http://www.corridordesign.org">http://www.corridordesign.org</a> for complete list of modeled species
Current Threats/Barriers:	None listed
Notes:	Not highlighted by stakeholders

#### ***ML4. Rincon – Santa Rita – Whetstone Mountains***

Linkage Design::	Rincon – Santa Rita – Whetstone Linkage Design (Beier et al. 2006b)
Species Identified:	Bobcat; Black bear; Coati; Mountain lion; Ocelot; Jaguar; See Missing Linkage report at <a href="http://www.corridordesign.org">http://www.corridordesign.org</a> for complete list of modeled species
Current Threats/Barriers:	Agriculture; Exotic species (buffelgrass/tamarisk), low-density residential development, mining (limestone, proposed Rosemont Copper), OHV use, paved road (I-10), pipeline, and railroad.
Notes:	The Rincon – Santa Rita – Whetstone Linkage Design was emphasized by numerous stakeholders as an important wildlife linkage in Pima County. The invasive wild boar has also been identified as being in the area and could affect wildlife movement within the linkage. ADOT construction on I-10 and the proposed Rosemont Copper mine have been identified by stakeholders as large future projects in the area. Sky Island Alliance

routinely does wildlife surveys/transects in many areas within the linkage design and has wildlife occurrence data available. Davidson Canyon (R23) has been highlighted as a riparian movement area within and near the linkage design.

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## REFERENCES

- Arizona Department of Administration, Office of Employment and Population Statistics. 2006. 2006-2055 Population Projections. Available at <http://azstats.gov/population-projections.aspx>.
- Arizona Department of Transportation. 2010a. Statewide Transportation Planning Framework, Final Report. Available at <http://www.bqaz.gov/StatewideTransportationPlanningFramework.asp>.
- Arizona Department of Transportation, 2010b. Draft Arizona State Rail Plan. Available at [http://www.bqaz.gov/PDF/DRAFT\\_State\\_Rail\\_Plan.pdf](http://www.bqaz.gov/PDF/DRAFT_State_Rail_Plan.pdf).
- Arizona Department of Transportation. 2011. North – South Corridor Study Potential New Transportation Route Fact Sheet. Available at <http://www.azdot.gov/northsouthcorridorstudy/PDF/FactSheet.pdf>.
- Arizona Game and Fish Department. 2012. Arizona’s State Wildlife Action Plan: 2011-2021. Arizona Game and Fish Department, Phoenix, Arizona.
- Arizona Wildlife Linkages Workgroup. 2006. Arizona’s Wildlife Linkages Assessment. Available at [http://www.azdot.gov/inside\\_azdot/OES/AZ\\_WildLife\\_Linkages/PDF/assessment/arizona\\_wildlife\\_linkages\\_assessment.pdf](http://www.azdot.gov/inside_azdot/OES/AZ_WildLife_Linkages/PDF/assessment/arizona_wildlife_linkages_assessment.pdf).
- Beier, P., E. Garding, and D. Majka. 2006a. Arizona Missing Linkages: Ironwood – Picacho Linkage Design. Report to Arizona Game and Fish Department. School of Forestry, Northern Arizona University. Available at [http://corridordesign.org/dl/linkages/reports/Ironwood-Picacho\\_LinkageDesign.pdf](http://corridordesign.org/dl/linkages/reports/Ironwood-Picacho_LinkageDesign.pdf)
- Beier, P., E. Garding, and D. Majka. 2006b. Arizona Missing Linkages: Rincon – Santa Rita – Whetstone Linkage Design. Report to Arizona Game and Fish Department. School of Forestry, Northern Arizona University. Available at [http://corridordesign.org/dl/linkages/reports/Rincon-SantaRita-Whetstone\\_LinkageDesign.pdf](http://corridordesign.org/dl/linkages/reports/Rincon-SantaRita-Whetstone_LinkageDesign.pdf)
- Beier, P., E. Garding, and D. Majka. 2006c. Arizona Missing Linkages: Santa Rita – Tumacacori Linkage Design. Report to Arizona Game and Fish Department. School of Forestry, Northern Arizona University. Available at [http://corridordesign.org/dl/linkages/reports/Tumacacori-SantaRita\\_LinkageDesign.pdf](http://corridordesign.org/dl/linkages/reports/Tumacacori-SantaRita_LinkageDesign.pdf)
- Beier, P., E. Garding, and D. Majka. 2006d. Arizona Missing Linkages: Tucson – Tortolita – Santa Catalina Mountains Linkage Design. Report to Arizona Game and Fish Department. School of Forestry, Northern Arizona University. Available at [http://corridordesign.org/dl/linkages/reports/Tucson-Tortolita-SantaCatalina\\_LinkageDesign.pdf](http://corridordesign.org/dl/linkages/reports/Tucson-Tortolita-SantaCatalina_LinkageDesign.pdf).
- Beier, P. and S. Loe. 1992. A checklist for evaluating impacts to wildlife movement. Wildlife Society Bulletin 20:434-440. Available at <http://oak.ucc.nau.edu/pb1/vitae/Beier-Loe.1992.checklist.pdf>.
- Beier, P., D. Majka, and J. Jenness. 2007. Conceptual steps for designing wildlife corridors. Available at <http://corridordesign.org/dl/docs/ConceptualStepsForDesigningCorridors.pdf>.
- Beier, P., D. Majka, and W. Spencer. 2008. Forks in the road: Choices in procedures for designing wildland linkages. Conservation Biology 22:836-851. Available at [http://oak.ucc.nau.edu/pb1/vitae/Beier\\_etal.2008.LinkageDesign.pdf](http://oak.ucc.nau.edu/pb1/vitae/Beier_etal.2008.LinkageDesign.pdf).



- Beier, P. and R. Noss. 1998. Do habitat corridors provide connectivity? *Conservation Biology* 12:1241-1252. Available at [http://oak.ucc.nau.edu/pb1/vitae/Beier-Noss\\_1998.pdf](http://oak.ucc.nau.edu/pb1/vitae/Beier-Noss_1998.pdf).
- Bennett, A. 1999. Linkages in the landscape: The role of corridors and connectivity in wildlife conservation. IUCN, Gland. Available at <http://app.iucn.org/dbtw-wpd/edocs/FR-021.pdf>.
- Brown, D. and C. Lowe. 1982. Biotic communities in the American Southwest – United States and Mexico. *Desert Plants* 4:1-342.
- Clevenger, A., B. Chruszcz, and K. Gunson. 2001. Drainage culverts as habitat linkages and factors affecting passage by mammals. *Journal of Applied Ecology* 38: 1340-1349.
- Clevenger, A. and N. Waltho. 2000. Factors influencing the effectiveness of wildlife underpasses in Banff National Park, Alberta, Canada. *Conservation Biology* 14: 47-56.
- Conover, M., W. Pitt, K. Kessler, T. Dubow, and W. Sanborn. 1995. Review of human injuries, illnesses, and economic losses caused by wildlife in the United States. *Wildlife Society Bulletin* 23: 407-414.
- Danielson, B. and M. Hubbard. 1998. Final report: A literature review for assessing the status of current methods of reducing deer-vehicle collisions. Iowa Department of Transportation, Ames, USA.
- Department of Homeland Security, Office of Immigration Statistics. 2011. Apprehensions by the U.S. Border Patrol: 2005-2010. Available at <http://www.dhs.gov/xlibrary/assets/statistics/publications/ois-apprehensions-fs-2005-2010.pdf>.
- Dodd, N., J. Gagnon, S. Boe, A. Manzo, and R. Schweinsburg. 2007. Evaluation of measures to minimize wildlife-vehicle collisions and maintain wildlife permeability across highways – State Route 260, Arizona, USA. Final Report 540 (2002–2006). Arizona Transportation Research Center, Arizona Department of Transportation, Phoenix, Arizona, USA. Available at [http://www.azdot.gov/TPD/ATRC/publications/project\\_reports/PDF/AZ540.pdf](http://www.azdot.gov/TPD/ATRC/publications/project_reports/PDF/AZ540.pdf).
- Eggers, B., A. Matern, C. Drees, J. Eggers, W. Hardtle, and T. Assmann. 2009. Value of semi-open corridors for simultaneously connecting open and wooded habitats: A case study with ground beetles. *Conservation Biology* 24:256-266.
- Flesch, A., C. Epps, J. Cain, M. Clark, P. Krausman, and J. Morgart. 2010. Potential effects of the United States-Mexico border fence on wildlife. *Conservation Biology* 24:171-181.
- Forman, R. and L. Alexander 1998. Roads and their major ecological effects. *Annual Review in Ecology and Systematics* 8:629-644.
- Forman, R., D. Sperling, J. Bissonette, A. Clevenger C. Cutshall, V. Dale, L. Fahrig, R. France, C. Goldman, K. Heanue, J. Jones, F. Swanson, T. Turrentine, and T. Winter. 2003. Road ecology: Science and solutions. Island Press, Washington, D.C.
- Gilbert-Norton, L., R. Wilson, J. Stevens, and K. Beard. 2010. A meta-analytical review of corridor effectiveness. *Conservation Biology* 24:660-668.

- Glick, P., A. Staudt, and B. Stein. 2009. A new era for conservation: Review of climate change adaptation literature. National Wildlife Federation, Washington, D.C. Available at <http://www.nwf.org/~media/PDFs/Global-Warming/Reports/NWFClimatChangeAdaptationLiteratureReview.ashx>.
- Grigione, M., K. Menke, C. Lopez-Gonzalez, R. List, A. Banda, J. Carrera, R. Carrera, A. Giordano, J. Morrison, M. Sternberg, R. Thomas, and B. Van Pelt. 2009. Identifying potential conservation areas for felids in the USA and Mexico: integrating reliable knowledge across an international border. *Fauna & Flora International, Oryx* 43:78-86.
- Haddad, N., D. Browne, A. Cunningham, B. Danielson, D. Levy, S. Sargent, and T. Spira. 2003. Corridor use by diverse taxa. *Ecology* 84:609-615.
- Hannah, L., Midgley, G. F., Lovejoy, T., Bond, W. J., Bush, M., Lovett, J. C., Scott, D., and Woodward, F. I. 2002. Conservation of biodiversity in a changing climate. *Conservation Biology* 16:264-268.
- Henle, K., Lindenmayer, D. B., Margules, C. R., Saunders, D. A. and Wissel, C. 2004. Species survival in fragmented landscapes: Where are we now? *Biodiversity and Conservation* 13: 1–8.
- Lasky, J., W. Jetz, and T. Keitt. 2011. Conservation biogeography of the US–Mexico border: a transcontinental risk assessment of barriers to animal dispersal. *Diversity and Distributions* 17(4): 673-687.
- Laurance, W. 1991. Ecological correlates of extinction proneness in Australian tropical rain forest mammals. *Conservation Biology* 5:79-89.
- Lovich, J. and J. Ennon. 2011. Wildlife Conservation and Solar Energy Development in the Desert Southwest, United States. *Bioscience* 61(12): 982-992.
- Lowery, S. and S. Blackman. 2007 Twin Peaks Road Wildlife Linkages Project Rattlesnake Pass, Marana, Arizona. Prepared for Town of Marana, Pima County, Arizona. Arizona Game and Fish Department. November 2007.
- Noss, R. 1983. A regional landscape approach to maintain diversity. *BioScience* 33:700-706.
- Noss, R. 1987. Corridors in real landscapes: A reply to Simberloff and Cox. *Conservation Biology* 1: 159-164.
- Noss, R. and K. Daly. 2006. Incorporating connectivity into broad-scale conservation planning. Pp. 587-619 in K.R. Crooks and M.A.Sanjayan, eds. *Connectivity conservation*. Cambridge University Press, Cambridge, U.K.
- Noss, R. and L. Harris. 1986. Nodes, networks, and MUMs: Preserving diversity at all scales. *Environmental Management* 10:299-309.
- Noss, R., H. Quigley, M. Hornocker, T. Merrill, and P. Paquet. 1996. Conservation biology and carnivore conservation in the Rocky Mountains. *Conservation Biology* 10:949-963.
- Olson, D. and E. Dinerstein. 1998. The Global 200: a representation approach to conserving the Earth's most biologically valuable ecoregions. *Conservation Biology* 12:502-515.

- Perault, D. and M. Lomolino. 2000. Corridors and mammal community structure across a fragmented, old growth forest landscape. *Ecological Monographs* 70:401-422.
- Pima Association of Governments. 2010. 2040 Regional Transportation Plan. Available at <http://www.pagnet.org/documents/RTP/RTP2040/RTP-2040-Adopted.pdf>.
- Pima Association of Governments. 2011. 2012 – 2016 5-year regional transportation improvement program. Available at <http://www.pagnet.org/documents/TIP/TIP2012-2016/TIP-2012-2016-FINAL.pdf>.
- Pima County. 2009. Sonoran Desert Conservation Plan. Tucson, Arizona. Available at <http://www.pima.gov/sdcp>.
- Pima County. 2011. Protecting our land, water, and heritage: Pima County's voter-supported conservation efforts. Available at <http://www.pima.gov/cmo/admin/Reports/ConservationReport/>.
- Regional Transportation Authority of Pima County. 2011. Our mobility. Available at <http://www.rtamobility.com/documents/OurMobilityMay2011.pdf>.
- Roberts, B., G. Hanson, D. Cornwell, and S. Borger. 2010. An Analysis of Migrant Smuggling Costs Along the Southwest Border. Department of Homeland Security, Office of Immigration Statistics Working Paper (November).
- Silberman, J. 2003. The Economic Importance of Fishing and Hunting. Economic data on fishing and hunting for the State of Arizona and for each Arizona County. Arizona State University School of Management, Tempe, Arizona. Available at [http://www.azgfd.gov/pdfs/w\\_c/FISHING\\_HUNTING%20Report.pdf](http://www.azgfd.gov/pdfs/w_c/FISHING_HUNTING%20Report.pdf).
- Southwick Associates. 2003. Economic Impact Analysis of Nonconsumptive Wildlife-Related Recreation in Arizona. Available at [http://www.azgfd.gov/pdfs/w\\_c/AZ%20County%20Impacts%20-%20Southwick.pdf](http://www.azgfd.gov/pdfs/w_c/AZ%20County%20Impacts%20-%20Southwick.pdf).
- Taylor, A. and R. Knight. 2003. Wildlife responses to recreation and associated visitor perceptions. *Ecological Applications* 13: 951-963.
- Town of Oro Valley. 2008. Arroyo Grande Planning Area General Plan Amendment. Powerpoint available at [http://www.orovalleyaz.gov/Assets/\\_assets/DIS/Planning/pdf/Arroyo+Grande+Open+House+Power+Point+Presentation.pdf](http://www.orovalleyaz.gov/Assets/_assets/DIS/Planning/pdf/Arroyo+Grande+Open+House+Power+Point+Presentation.pdf).
- Tull, J. and P. Krausman. 2001. Use of a wildlife corridor by mule deer. *The Southwestern Naturalist* 46:81-86
- U.S. Bureau of Land Management. 2009. Notice of intent to prepare an Environmental Impact Statement and possible Resource Management Plan amendments for the SunZia Southwest Transmission Project in Arizona and New Mexico. FR Doc. E9-12512. Available at [http://www.blm.gov/pgdata/etc/medialib/blm/nm/programs/more/lands\\_and\\_realty/sunzia/sunzia\\_doc\\_s.Par.38874.File.dat/SunZiaFRN.pdf](http://www.blm.gov/pgdata/etc/medialib/blm/nm/programs/more/lands_and_realty/sunzia/sunzia_doc_s.Par.38874.File.dat/SunZiaFRN.pdf).
- U.S. Census Bureau. 2011. 2010 Census Data. Available at <http://2010.census.gov/2010census/data/>.

- U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Available at [http://wsfrprograms.fws.gov/Subpages/NationalSurvey/nat\\_survey2006\\_final.pdf](http://wsfrprograms.fws.gov/Subpages/NationalSurvey/nat_survey2006_final.pdf).
- Valdez, R., J. Guzman-Aranda, F. Abarca, L. Tarango-Arambula, and F. Sanchez. 2006. Wildlife conservation and management in Mexico. *Wildlife Society Bulletin* 34:270-282.
- Warshall, P. 1995. The Madrean Sky Island Archipelago: A planetary overview. Pp. 6-18 in: L.F. DeBano, P.F. Ffolliott, A. Ortega-Rubio, G.J. Gottfried, R.H. Hamre, and C.B. Edminster, Tech. cords. Biodiversity and management of the Madrean Archipelago: The Sky Islands of southwestern United States and northwestern Mexico. USDA Forest Service General Technical Report. RM-GTR-264.
- Wilcox, B. and D. Murphy. 1985. Conservation strategy: The effects of fragmentation on extinction. *American Naturalist* 125: 879-887.



## APPENDIX 1 – SAMPLE DATASHEET USED IN STAKEHOLDER WORKSHOPS

### COUNTY LINKAGE DATASHEET

Your name(s) \_\_\_\_\_

Linkage number: \_\_\_\_\_

Linkage description (Please try to describe the areas being connected as much detail as possible):

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**What are the main threats to the linkage?** Use a separate line for each major paved road crossing the linkage.

**\*\* 1 is least severe and 5 is most severe\*\***

Threat	Severity (1-5)**	Details (Describe the type of threat, area impacted, etc.)
Agriculture (grazing, farming)		
Exotic species invasion		
Canals (with names)		
Mining		
OHV Use		
Pipeline		
Powerline		
Wind energy development		
Solar energy development		
Uranium mining		
Railroad		
High Density Residential Dev.		
Low Density Residential Dev.		
Industrial/Commercial Dev.		
Paved road (with name)		
Paved road (with name)		
High Traffic Gravel Road (with name)		

**Describe federal, state, or local support for conserving the linkage** (willing land sellers, agencies interested in acquisition, formal conservation planning for the linkage, etc.)


*If you have information you would prefer not appear in print but that you are willing to discuss, provide your name and contact information.*

**Provide details on FUTURE or PROPOSED road or development projects.**

Name of Project	Road/Hwy Description (e.g., realign 20 mile of existing road, 2 lanes each way) <b>Development description</b> (e.g., 20,000 new homes, plus commercial and industrial areas)	Entitled or Platted?	Funded?	Est. start date	Env. review completed?	Contact person, affiliation (e.g., "John Doe, ADOT PHX")
		Yes/No	Yes/No		Yes/No	
		Yes/No	Yes/No		Yes/No	
		Yes/No	Yes/No		Yes/No	

**Provide any other helpful information** (e.g., location, number, and size of key parcels in the linkage, ongoing restoration projects in the linkage, etc.).


**Key contacts for this linkage:** Please provide the names of one or more persons we can contact for additional information and future planning efforts.

Name	Affiliation	Phone	Email