

The Apache and Navajo Counties Wildlife Connectivity Assessment: Report on Stakeholder Input

January 2013



Photograph by B. Sitko, AGFD

Arizona Game and Fish Department



In partnership with
The Arizona Wildlife Linkages Workgroup

TABLE OF CONTENTS

LIST OF FIGURES	ii
LIST OF TABLES	ii
RECOMMENDED CITATION	iii
ACKNOWLEDGMENTS.....	iii
DEFINITIONS.....	iv
EXECUTIVE SUMMARY	1
BACKGROUND.....	2
THE APACHE AND NAVAJO COUNTIES WILDLIFE CONNECTIVITY ASSESSMENT	9
METHODS	10
HOW TO USE THIS REPORT AND ASSOCIATED GIS DATA	12
MAPS.....	14
APACHE AND NAVAJO COUNTIES WILDLIFE LINKAGE DESCRIPTIONS.....	22
REFERENCES.....	34
APPENDIX 1 – SAMPLE DATASHEET USED IN STAKEHOLDER WORKSHOPS.....	37

LIST OF FIGURES

Figure 1: Effect of roadways on movement of pronghorn

Figure 2: Wildlife underpasses in Gila County east of Payson on Arizona State Route 260

Figure 3: Fencing installation at the Arizona State Route 260 wildlife underpass project

Figure 4: Arizona’s Wildlife Linkages Assessment and Linkage Design example

Figure 5: Apache and Navajo Counties Land Ownership

Figure 6: Apache and Navajo Counties Stakeholder Data Extent

Figure 7: Apache and Navajo Counties Stakeholder-Identified Linkages – Navajo County North

Figure 8: Apache and Navajo Counties Stakeholder-Identified Linkages – Navajo County Middle

Figure 9: Apache and Navajo Counties Stakeholder-Identified Linkages – Navajo County South

Figure 10: Apache and Navajo Counties Stakeholder-Identified Linkages – Apache County North

Figure 11: Apache and Navajo Counties Stakeholder-Identified Linkages – Apache County Middle

Figure 12: Apache and Navajo Counties Stakeholder-Identified Linkages – Apache County South

LIST OF TABLES

Table 1: Economic benefits of fishing, hunting, and watchable wildlife activities by county

RECOMMENDED CITATION

Arizona Game and Fish Department. 2012. The Apache and Navajo Counties Wildlife Connectivity Assessment: Report on Stakeholder Input.

ACKNOWLEDGMENTS

This project would not have been possible without the contributions of the individuals and organizations listed below, to whom we extend our sincere appreciation.

STAKEHOLDERS:

Apache-Sitgreaves National Forest, Arizona Department of Transportation, Arizona Elk Society, Arizona Game and Fish Department, Arizona Wildlife Federation, Hopi Tribe, Logan Simpson Design Inc., Navajo County, Parsons-Brinkerhoff Associates, Salt River Project, Tierra Environmental, TRACKS, White Mountain Audubon Society, White Mountain Conservation League, White Mountain Land Trust

PARTNERS:

Arizona Wildlife Linkages Workgroup:

Arizona Department of Transportation, Arizona Game and Fish Department, AZTEC Engineering, Bureau of Land Management, Defenders of Wildlife, Northern Arizona University, Sky Island Alliance, U.S. Department of Transportation Federal Highway Administration, U.S. Fish and Wildlife Service, USDA Forest Service

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 stakeholder workshops held in Pinetop, Arizona in 2010 and 2011. At these workshops, stakeholders representing a broad range of organizations and interests identified and mapped the locations of important wildlife linkages across Apache and Navajo Counties. Participants included biologists, land managers, planners and other professionals from state, tribal, private, and non-governmental organizations. The workshops were supported by a partnership between the Arizona Game and Fish Department and the Arizona Wildlife Linkages Workgroup. 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 land-use decisions. The workshops provided a forum in which stakeholders shared and discussed their knowledge, outlined the general locations of wildlife linkages on large maps, and provided descriptive information about each linkage on datasheets. Participants also identified the locations of barriers such as highways and railroads that may interfere with wildlife movements. The hand-drawn linkages and barriers were then digitized with GIS software, and later refined after 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 Apache and Navajo Counties 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 Apache and Navajo Counties. 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 Apache and Navajo Counties.* 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 Apache and Navajo Counties. *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 6.5 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.

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.

Apache and Navajo Counties have a diverse range of habitats from Alpine Mixed Coniferous Forests in the higher elevations through Pinyon-Juniper Woodlands to the High Desert Grasslands in the lower elevations. The wildlife in the two counties are just as diverse. The White Mountains is a destination year-round for wildlife-related recreational activities such as hunting, fishing, hiking, bird watching and wildlife viewing. Game species such as elk, white-tail deer, mule deer, pronghorn, bear, turkey and mountain lion are found throughout both counties and provide economic value to the area because of the wildlife-related recreational activities. This area also has many non-game wildlife species that are important recreationally such as bald and golden eagles, a wide variety of other raptors and passerine birds. There are numerous places to fish for either native trout or for managed non-native sportfish populations such as brown trout, rainbow trout and arctic grayling.

Apache and Navajo Counties contain a great deal of “checkerboarded” landownership comprising private, state (Arizona State Land Department, Arizona Game and Fish, Arizona State Parks), and federal (Bureau of Land Management) land holdings. This creates serious land management issues and access problems for private landlocked public lands. This checkerboard style of land ownership creates serious issues with fragmentation for the area’s wildlife populations which is exacerbated further with moderate to high traffic paved roads.

WHY WE NEED WILDLIFE LINKAGE PLANNING IN APACHE AND NAVAJO COUNTIES

POPULATION GROWTH

Arizona’s growing human population and expanding infrastructure has consequences for the wildlife species in Apache and Navajo Counties and for 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. Elk, pronghorn, mule deer, mountain lions, and black bears roam over vast expanses that can encompass thousands of acres, while smaller animals such as Northern 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 may happen only once in an individual's lifetime. Man-made barriers have been shown to have an impact 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).

TRANSPORTATION INFRASTRUCTURE

County transportation plans have ramped up to improve existing transportation corridors and to construct other aspects of the transportation network that will support increased traffic and public transportation demand due to the anticipated population growth in Arizona. *Figure 1* illustrates the impact that transportation infrastructure has had on populations of pronghorn in Arizona. Local projects, such as widening State Route (SR) 260 from Heber-Overgaard to Show Low and SR 77 from US 60 to Holbrook, will also result in an increase in traffic volume that will increase the potential for wildlife-vehicle collisions. Arizona Forest Highway 43 in Apache County was recently upgraded from a dirt/gravel road to a paved two-lane highway. This upgrade will not only increase the amount of traffic through this area but also allows for an increase in vehicle speeds which will increase the **habitat fragmentation** effect caused by this road.

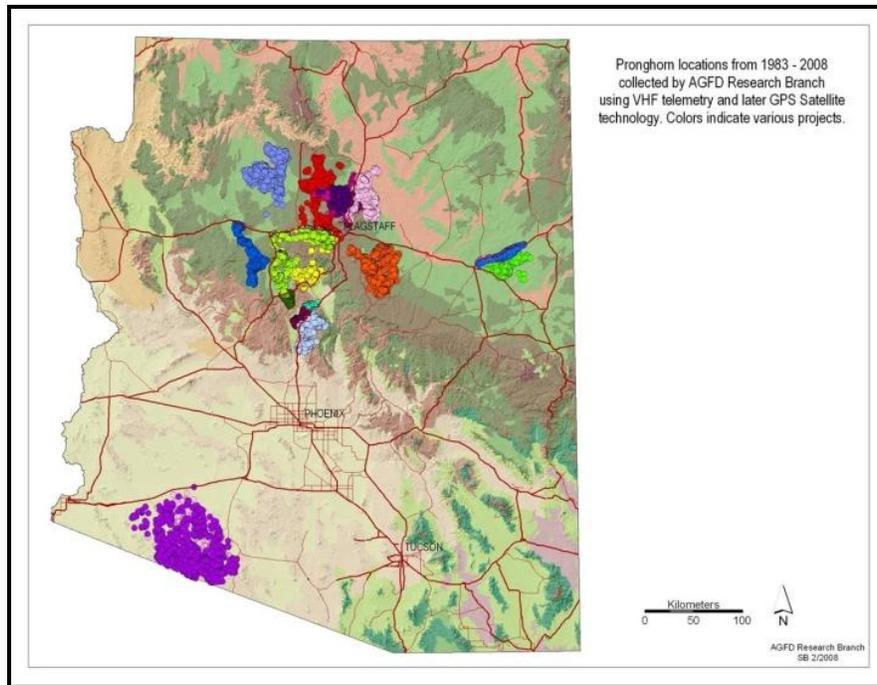


Figure 1: Radio and satellite telemetry studies by the Arizona Game and Fish Department reveal that major roadways can act as barriers to pronghorn movement. Colors indicate groups of animals studied in separate projects. This barrier effect can isolate populations, potentially reducing genetic diversity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

UTILITY INFRASTRUCTURE

The growing population in Arizona and other regional areas 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 completed a new policy framework for utility-scale (>20 megawatt) solar energy development on BLM lands that 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 delineated 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 Centennial West Clean Line Transmission Project proposes to develop approximately 900 miles of overhead, high-voltage direct current transmission line from New Mexico through Arizona to California. The proposed right-of-way corridor may be up to 300 feet wide (Clean Line Centennial West 2011). A portion of this proposed project runs through Apache and Navajo Counties.

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 separated 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, underpasses, or overpasses, to move between habitat blocks or through riparian habitat where barriers exist. These are referred to in this report as potential or **important crossing areas**.

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.

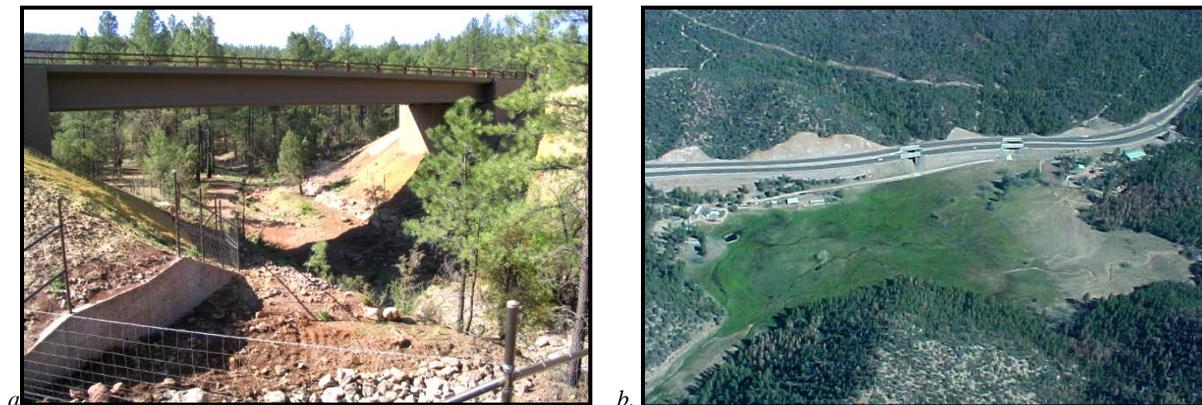
BENEFITS OF WILDLIFE LINKAGE PLANNING

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).

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.

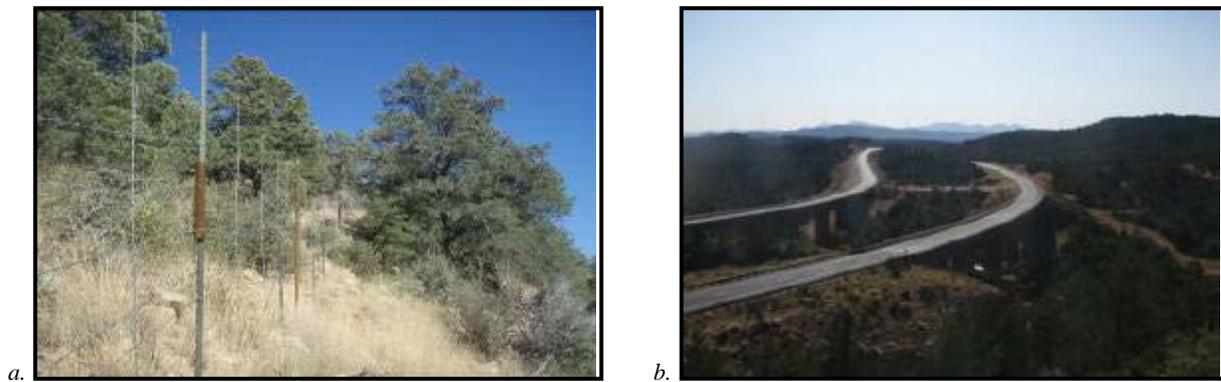


Figures 2a and 2b: Wildlife underpasses, like this one under State Route 260 in Gila County east of Payson, will facilitate wildlife movement. Wildlife underpasses and overpasses are important parts of wildlife connectivity planning and increase the permeability of a road or railroad for wildlife while 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.

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 2a and 2b*). 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 3a and 3b*). 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.



Figures 3a and 3b: 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).

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 (intentionally 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.

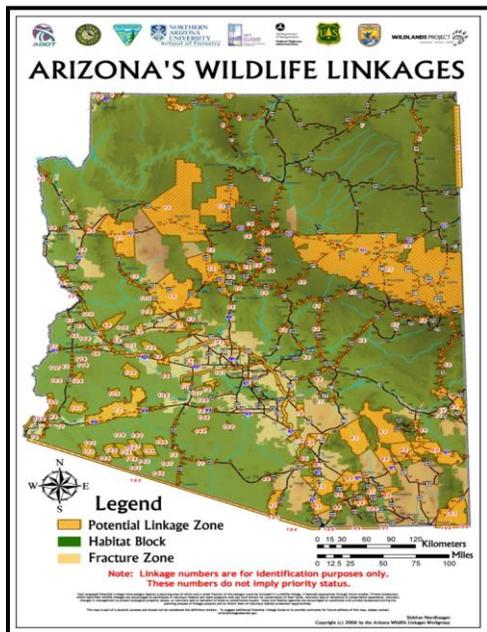
Maintaining linkages that facilitate the ecological health of wildland blocks can also be a significant investment in contributing to the diversity and vitality of an area’s economy. The economic value associated with fish and wildlife-related recreation is significant for Apache and Navajo Counties 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 residents and nonresidents combined 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 Apache County watchable wildlife activities generated a total economic effect of \$47 million, supporting 489 jobs, providing residents with \$13 million in salary and wages, and generating \$318,000 in state tax revenue (Southwick Associates 2003). Fishing and hunting recreation generated a total economic effect of \$72 million for Apache County, supporting 1,000 jobs, providing residents with \$9 million in salary and wages and generating \$3 million in state tax revenue (Silberman 2003). This same analysis of the national survey data revealed that in Navajo County watchable wildlife activities generated a total economic effect of \$46 million, supporting 452 jobs, providing residents with \$13 million in salary and wages, and generating \$310,000 in state tax revenue (Southwick Associates 2003). Fishing and hunting recreation generated a total economic effect of \$38 million for Navajo County, supporting 543 jobs, providing residents with \$5 million in salary and wages and generating \$1 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 at the county level.

		Economic Effect	Number of Jobs Supported	Amount in Salary and Wages	Amount in State Tax Revenue
Apache County	Watchable Wildlife	\$47,000,000	500	\$13,000,000	\$318,000
	Fishing and Hunting	\$72,000,000	1,000	\$9,000,000	\$3,000,000
Navajo County	Watchable Wildlife	\$46,000,000	450	\$13,000,000	\$310,000
	Fishing and Hunting	\$38,000,000	550	\$5,000,000	\$1,000,000

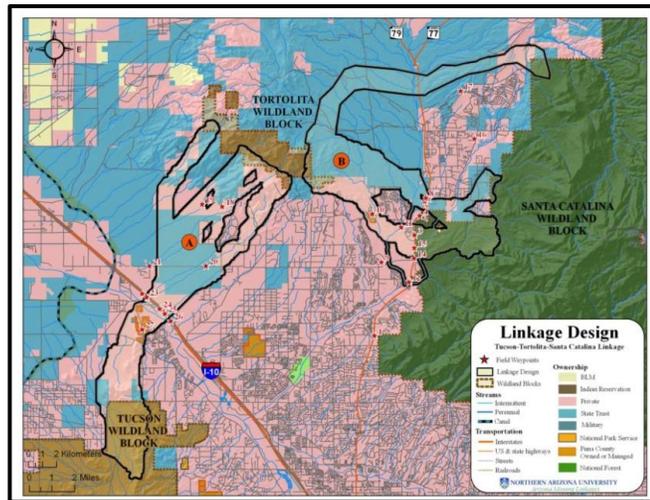
Table 1: Economic benefits of fishing, hunting, and watchable wildlife activities by county. Summarized from Southwick Associates 2003 and Silberman 2003.

THE APACHE AND NAVAJO COUNTIES WILDLIFE CONNECTIVITY ASSESSMENT

To assemble current knowledge of wildlife linkages and barriers to wildlife movement across Apache and Navajo Counties and to help build collaborative partnerships with local jurisdictions for eventual implementation efforts, AGFD initiated the Apache and Navajo Counties Wildlife Connectivity Assessment. This project grew out of prior initiatives including 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 4a*). This Apache and Navajo Counties 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. Further refinement of several of the 2006 “Potential Linkage Zones” was subsequently completed and provide detailed recommendations on activities that can be put in place to improve permeability for wildlife. These refinements are available as the Arizona Missing Linkage Reports (available through corridordesign.org) and as Detailed Linkage Reports (available at www.azgfd.gov/wildlifeplanning).



a.



b.

Figures 4a and 4b: (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. 2006) 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. 2006).

METHODS

STAKEHOLDER WORKSHOP

In July 2010, AGFD 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 Apache and Navajo Counties 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 collected about wildlife linkages was more comprehensive in some areas than in others. There may be important wildlife linkages in areas of Apache and Navajo Counties where none appear on the following 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 provided 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”, 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 streams/rivers 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.

FOLLOW-UP WORKSHOP AND GIS REFINEMENT

A second stakeholder workshop was held in 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.

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 Apache and Navajo Counties. 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 Pinetop regional office at (928)367-4281 or AGFD's GIS Program at 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, especially as relates to the SHCG. Site-specific reports on wildlife species of concern and federally-listed threatened and endangered species are available through the *Online Environmental Review Tool*. In addition, AGFD is currently completing a statewide wildlife connectivity modeling project, scheduled to be released in Spring of 2013. 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 www.azgfd.gov/wildlifeplanning.

NEXT STEPS

Future project activities could 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 4b*). These models may 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 could help identify land parcels of highest conservation priority within the stakeholder linkages—both of which are necessary for a successful implementation phase. Once finalized, any additional connectivity reports will be made available at the “Planning for Wildlife” web page at www.azgfd.gov/wildlifeplanning. While no areas in Apache and Navajo Counties have been identified 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.

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.

MAPS

Figure 5: Apache and Navajo Counties Land Ownership

Apache and Navajo Counties Wildlife Connectivity Assessment: Ownership 2012

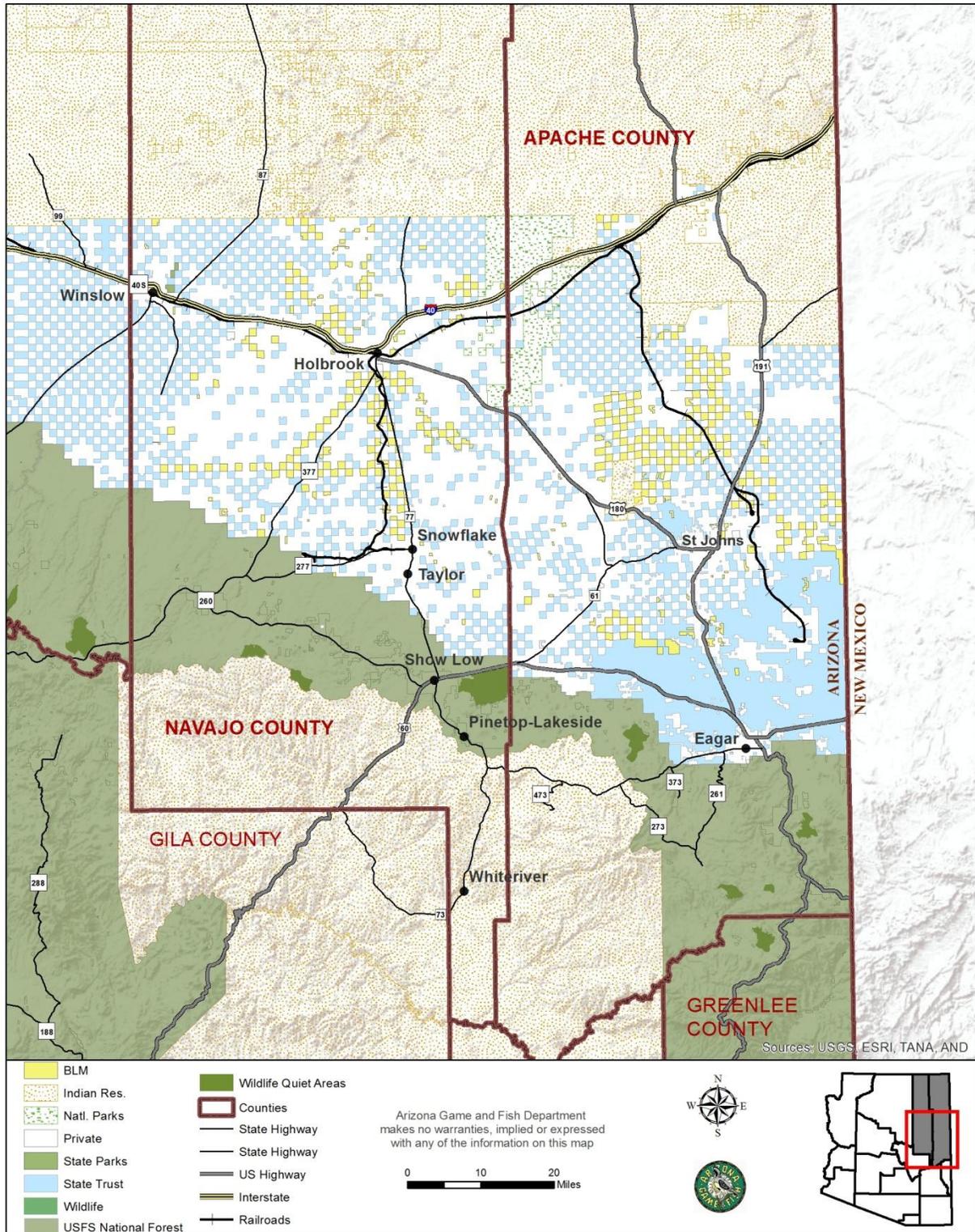


Figure 6: Apache and Navajo Counties Stakeholder Data Extent

Apache and Navajo Counties Wildlife Connectivity Assessment: County Overview 2012

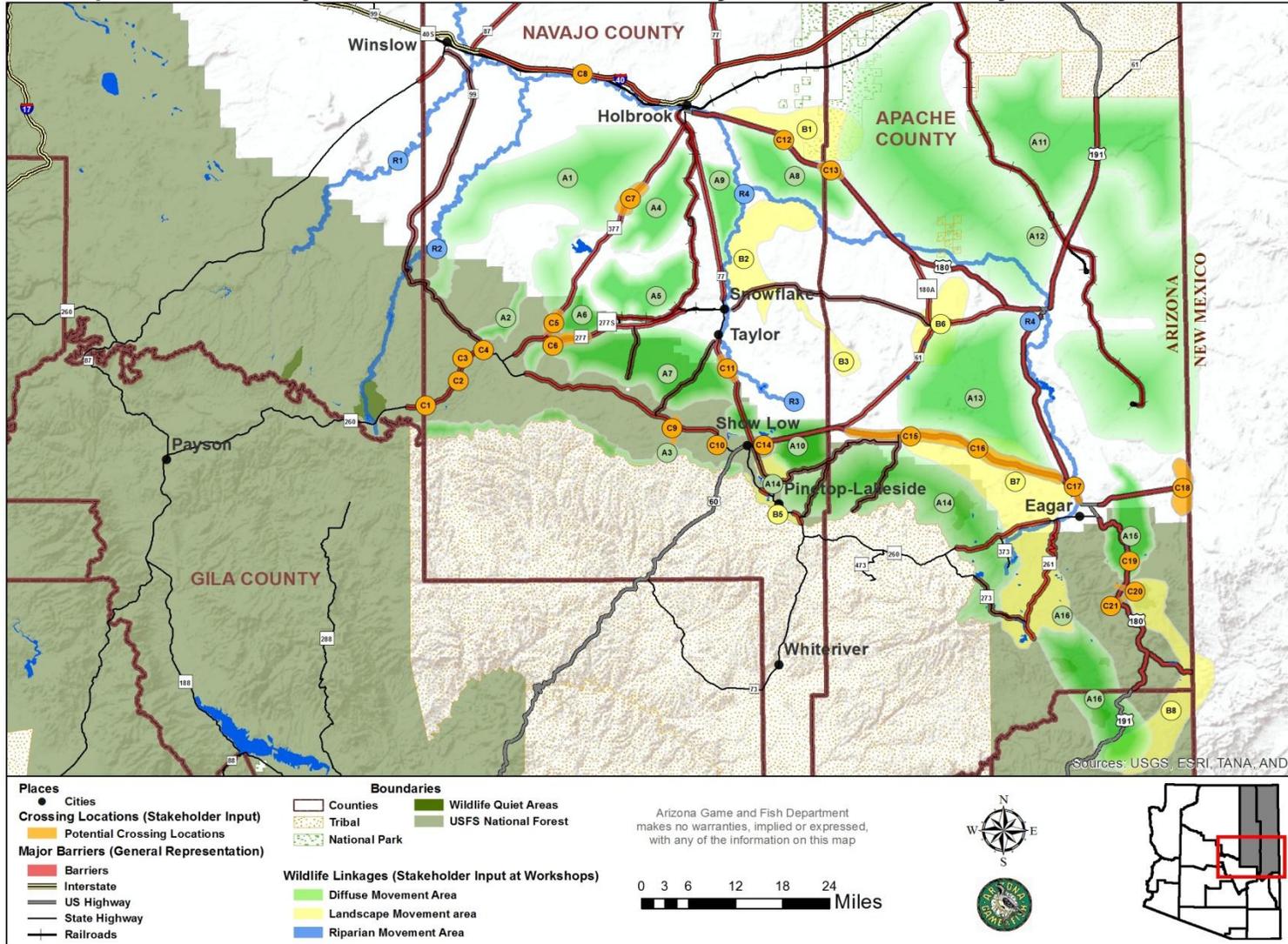


Figure 7: Apache and Navajo Counties Stakeholder Identified Linkages – Navajo County North
 Apache and Navajo Counties Wildlife Connectivity Assessment: Navajo County North 2012

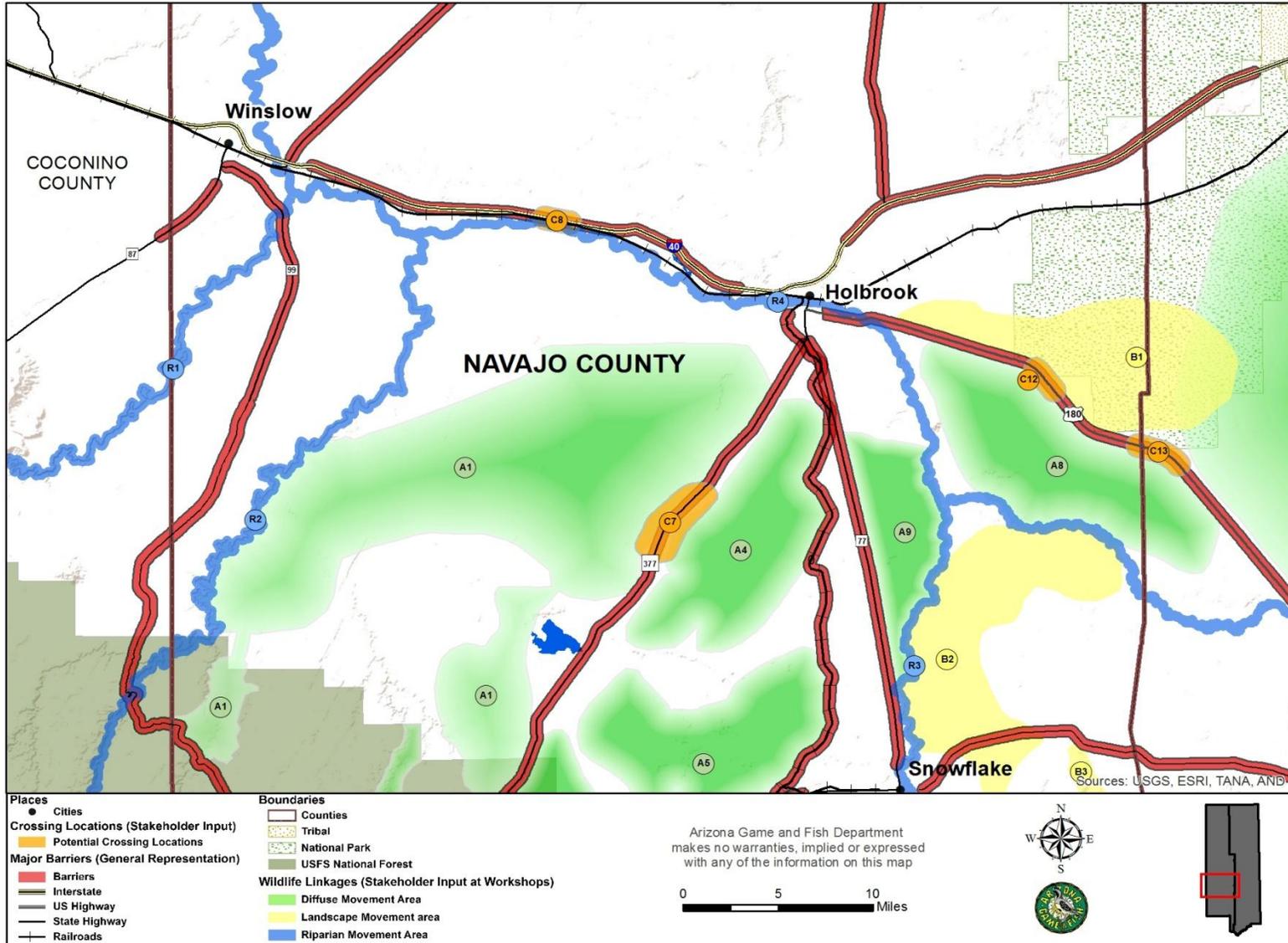


Figure 8: Apache and Navajo Counties Stakeholder Identified Linkages – Navajo County Middle
Apache and Navajo Counties Connectivity Assessment: Navajo County Middle 2012

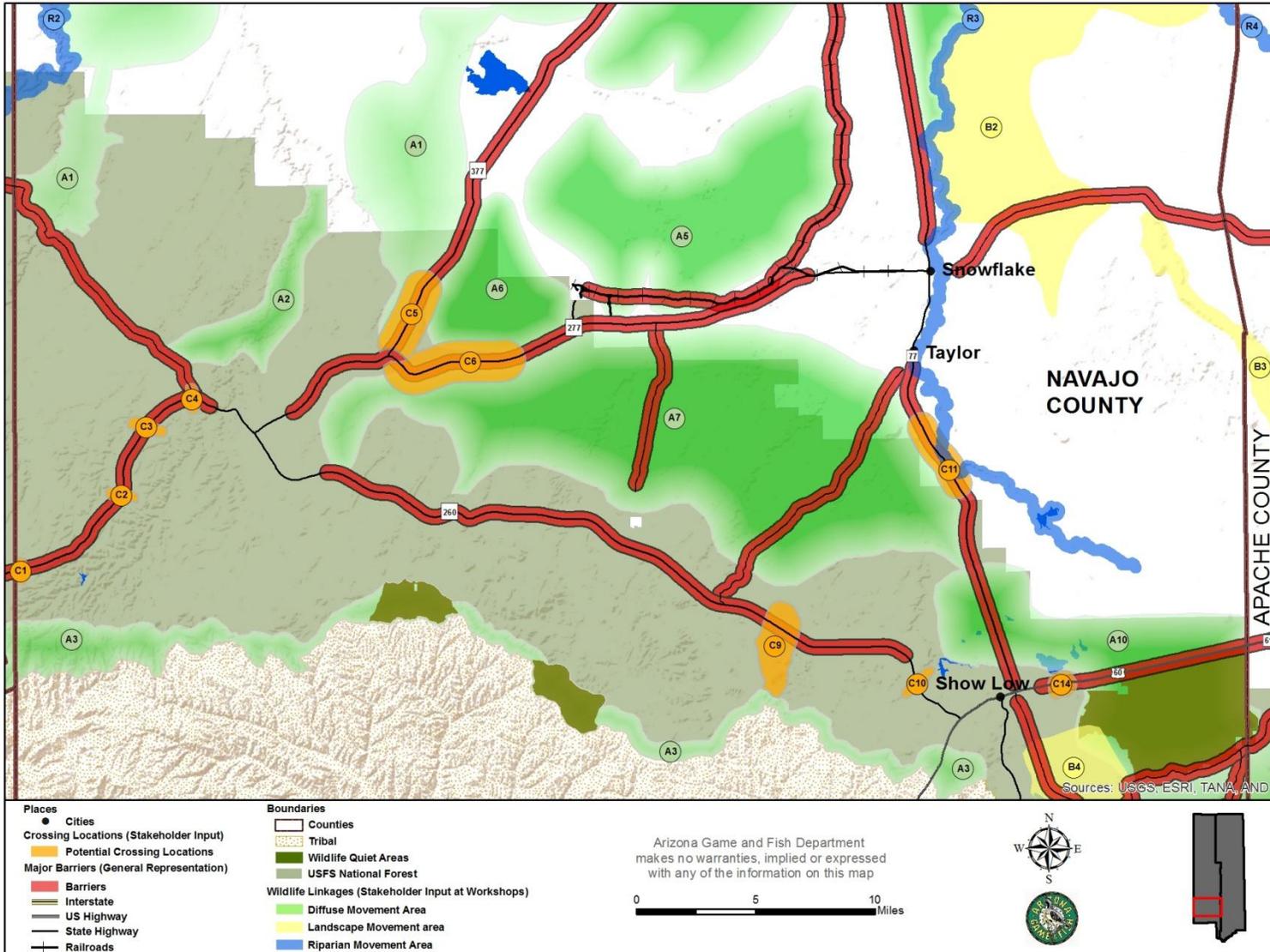


Figure 9: Apache and Navajo Counties Stakeholder Identified Linkages – Navajo County South
Apache and Navajo Counties Wildlife Connectivity Assessment: Navajo County South 2012

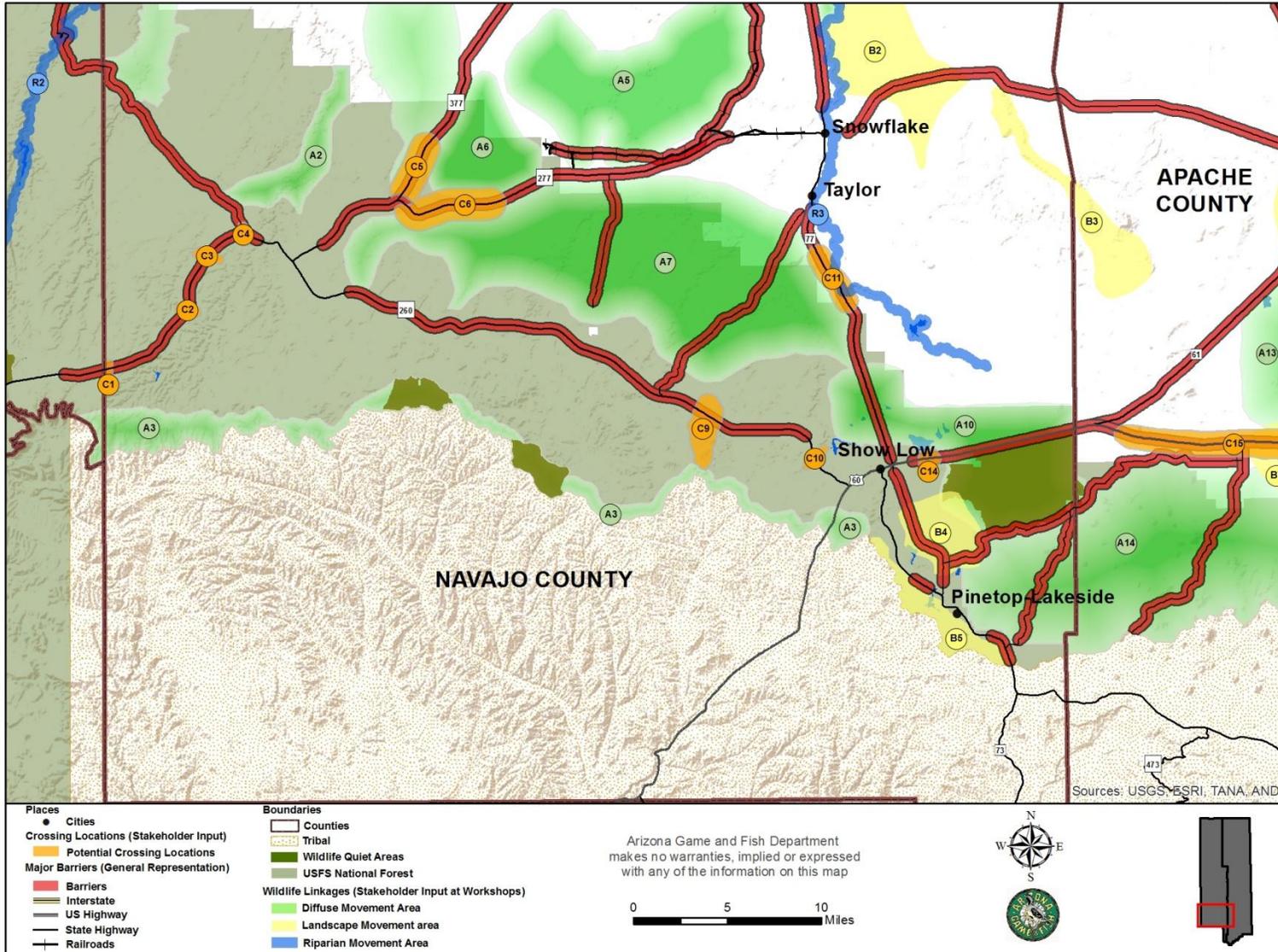


Figure 10: Apache and Navajo Counties Stakeholder Identified Linkages – Apache County North
 Apache and Navajo Counties Wildlife Connectivity Assessment: Apache County North 2012

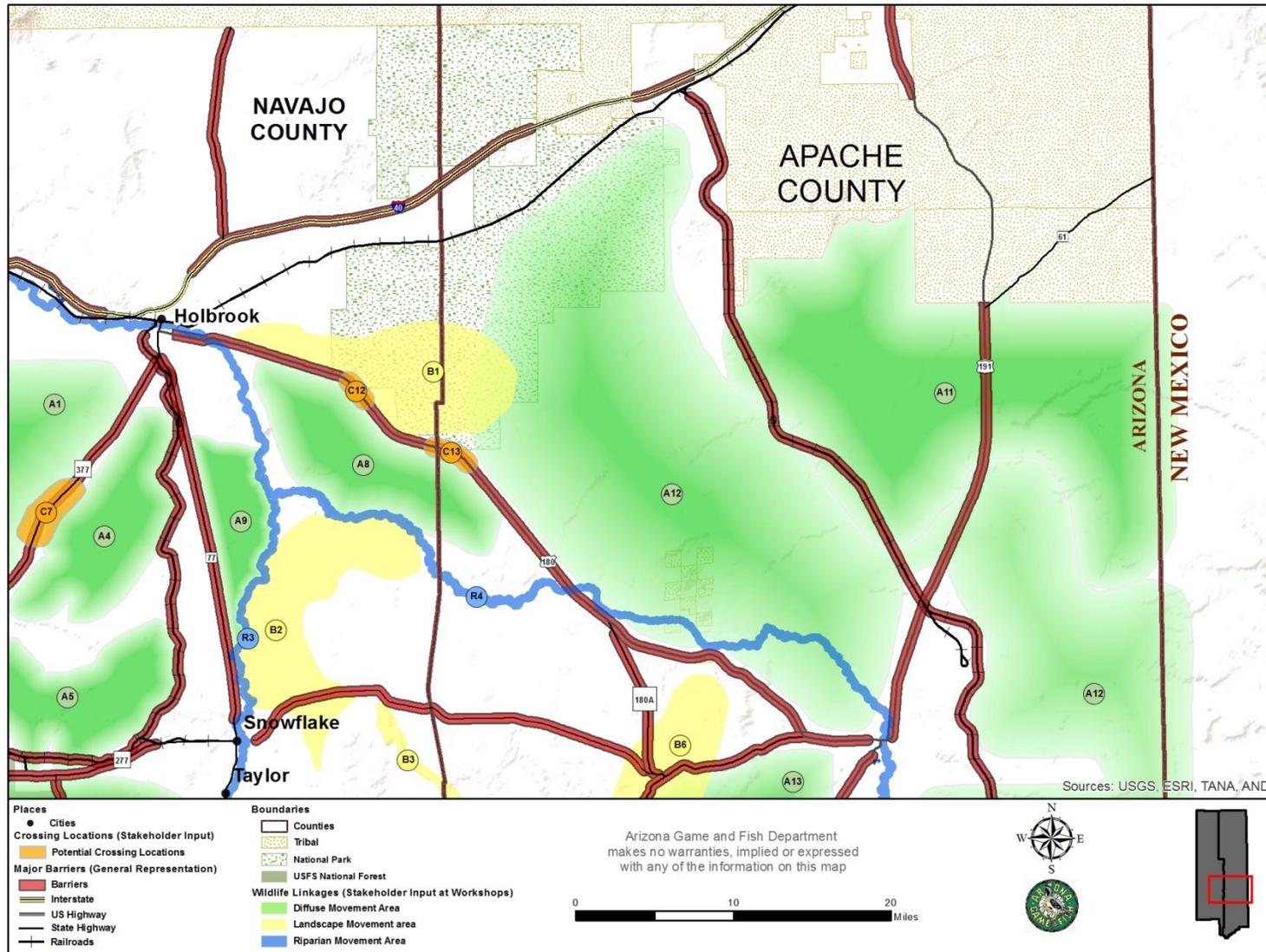


Figure 11: Apache and Navajo Counties Stakeholder Identified Linkages – Apache County Middle
 Apache and Navajo Counties Wildlife Connectivity Assessment: Apache County Middle 2012

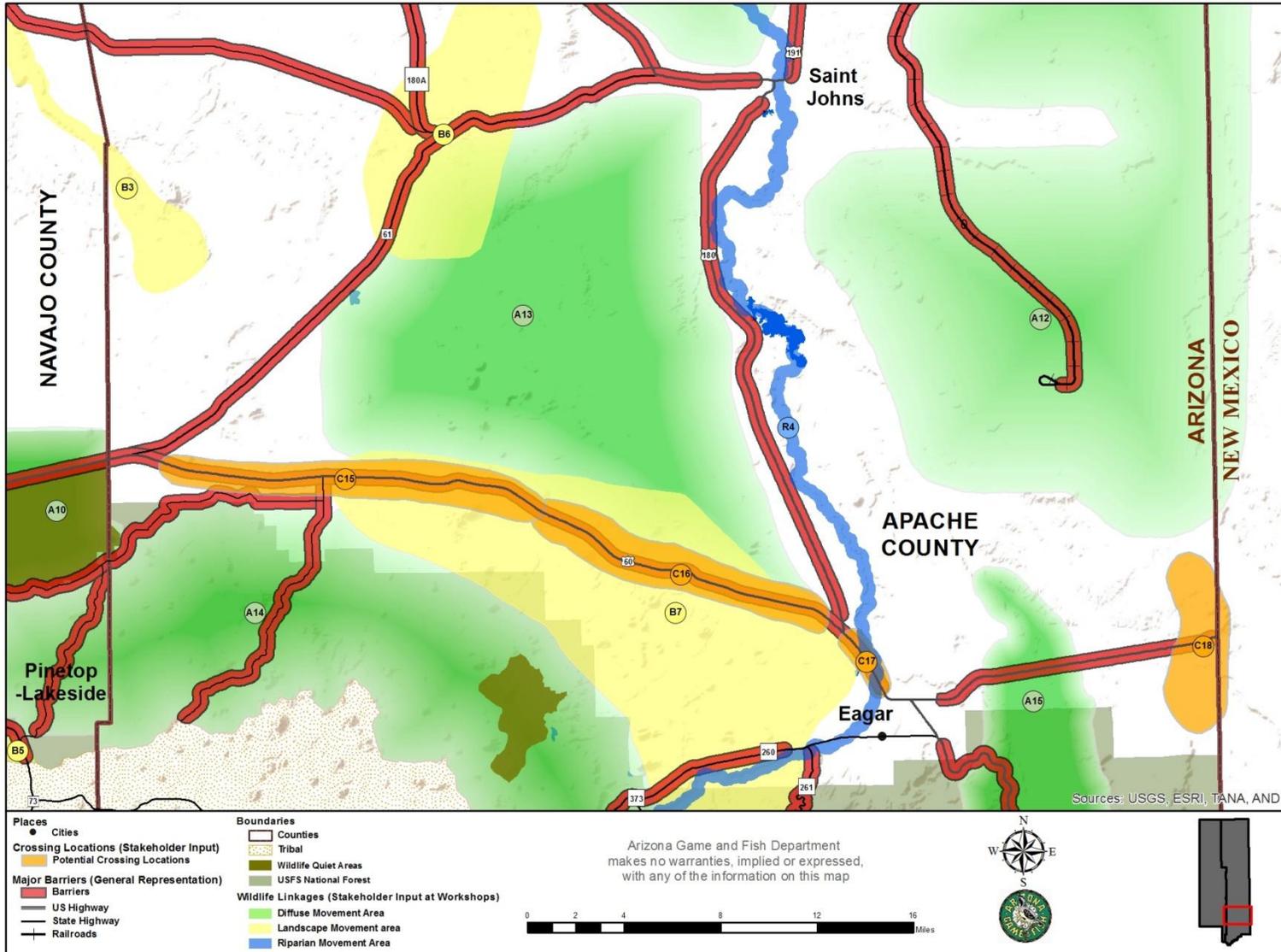
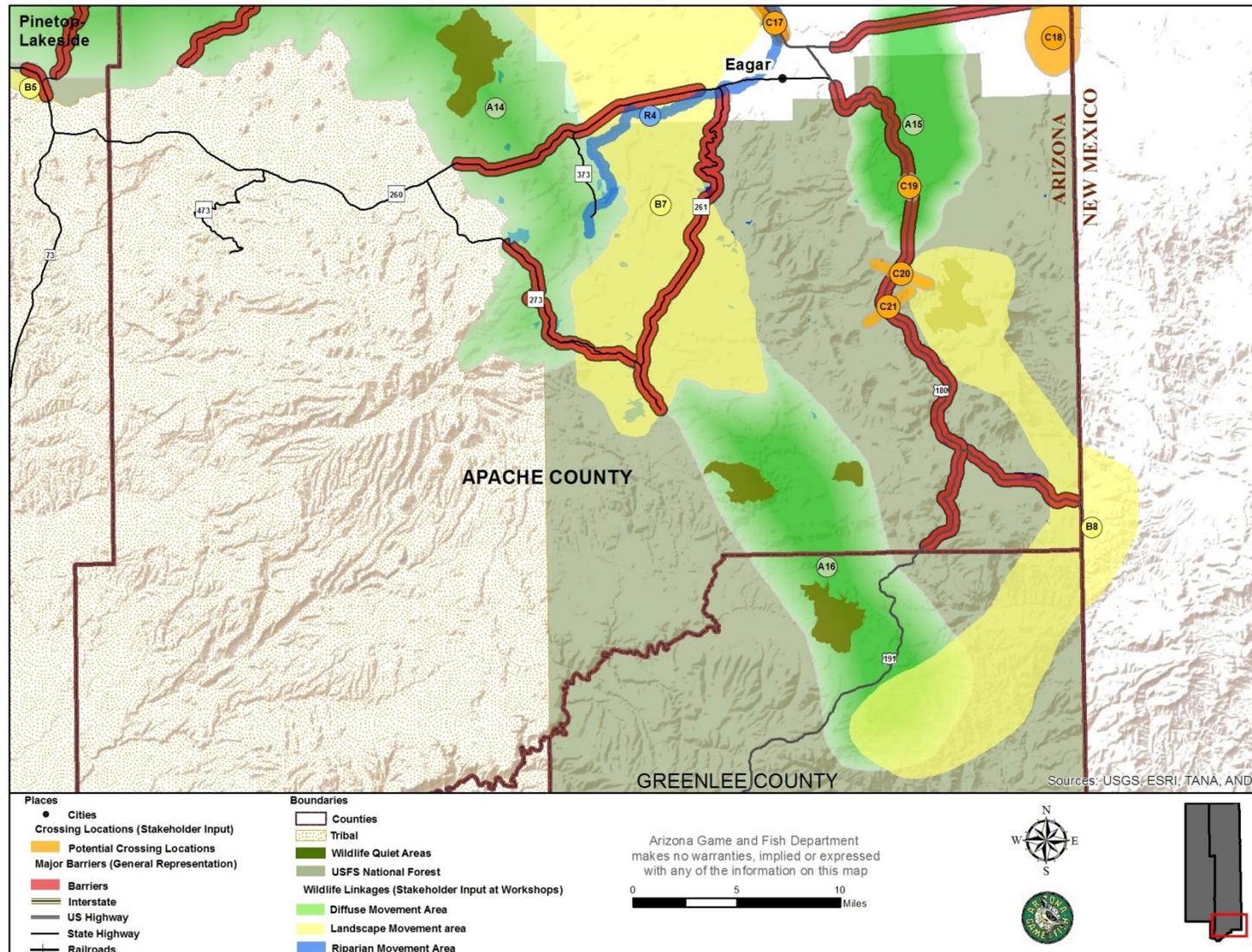


Figure 12: Apache and Navajo Counties Stakeholder Identified Linkages – Apache County South
Apache and Navajo Counties Wildlife Connectivity Assessment: Apache County South 2012



APACHE AND NAVAJO COUNTIES WILDLIFE LINKAGE DESCRIPTIONS

APACHE AND NAVAJO COUNTIES MOVEMENT AREAS: A1- A16

A1.

Wildland Blocks:	Grassland pronghorn habitat in Navajo County. A mix of Arizona State Land Department, Bureau of Land Management, USDA Forest Service, and private land ownership.
Species Identified:	Pronghorn
Current Threats/Barriers:	Subdivided lands; Fences; Juniper encroachment; Alternative energy development; Residential development; Roads
Linkage Type:	
Notes:	None listed

A2.

Wildland Blocks:	Within Apache-Sitgreaves National Forest in Navajo County
Species Identified:	Mountain Lions, Small Carnivores, Mule Deer, Elk
Current Threats/Barriers:	None listed
Linkage Type:	
Notes:	None listed

A3.

Wildland Blocks:	Rim Road 300 on USDA Forest Service land bordering White Mountain Apache Reservation west of Show Low in Navajo County to the Coconino County line. Includes the Cottonwood Seep and Bear Springs Wildlife Quiet Areas (Apache-Sitgreaves National Forest).
Species Identified:	Elk, Mule Deer, Black Bear, Turkey, Mountain Lion
Current Threats/Barriers:	Roads (medium traffic gravel Forest Service Roads); Fences
Linkage Type:	
Notes:	Seasonal movements north - south

A4.

Wildland Blocks:	The northern portion of the triangle made by State Routes 377, 277, and 77 south of Holbrook in Navajo County. A mix of Arizona State Land Department, Bureau of Land Management, and private land ownership.
Species Identified:	Elk, Mule Deer, Pronghorn
Current Threats/Barriers:	Alternative energy development (two on-line wind farms and potential development projects); Residential development (potential); Industrial development; Roads (State Routes 377 and 77); Fences
Linkage Type:	
Notes:	None listed

A5.

Wildland Blocks:	The southern portion of the triangle made by State Routes 377, 277, and 77 south of Holbrook in Navajo County. A mix of Arizona State Land Department, Bureau of Land Management, and private land ownership.
Species Identified:	Elk, Mule Deer, Pronghorn
Current Threats/Barriers:	Alternative energy development; Residential development (potential); Industrial Development (currently in place and potential); Fences; Roads (State Routes 377, 277 and 77)
Linkage Type:	
Notes:	None listed

A6.

Wildland Blocks:	The southwestern portion of the triangle made by State Routes 377, 277, and 77 south of Holbrook in Navajo County. A mix of Arizona State Land Department, Bureau of Land Management, and private land ownership.
Species Identified:	Elk, Mule Deer, Pronghorn
Current Threats/Barriers:	Alternative energy development; Residential development (potential); Industrial development (currently in place and potential); Roads (State Routes 377 and 277)
Linkage Type:	
Notes:	None listed

A7.

Wildland Blocks:	Pinyon-juniper woodlands to pine forest north of SR 260 and south of SR 277 in Navajo County. Predominately USDA Forest Service lands with some private lands.
Species Identified:	Elk, Mule Deer, Pronghorn, Turkey
Current Threats/Barriers:	Residential development (low-density); Roads (two major highways: SR 260 and SR 277 – both with moderate to high traffic volume; Lone Pine Dam Road – paved; Pinedale Road and Clay Springs Road – potential for upgrading); Fences; OHV use; Agriculture
Linkage Type:	
Notes:	General movement area.

A8.

Wildland Blocks:	High desert grassland; south of US 180 and east of the Little Colorado River after the confluence with Silver Creek. A mix of Arizona State Land Department, Bureau of Land Management, and private land ownership. Spans across the boundary of Navajo and Apache Counties.
Species Identified:	Pronghorn
Current Threats/Barriers:	Mines (potash); Alternative energy development (potential); Grazing; Roads (high use two-lane highway); Fences
Linkage Type:	
Notes:	None listed

A9.

Wildland Blocks:	High desert grassland – juniper shrub; east of SR 77 between Holbrook and Snowflake. A mix of Arizona State Land Department, Bureau of Land Management, and private land ownership.
Species Identified:	Pronghorn,
Current Threats/Barriers:	Residential development (high and low density); Roads (SR 77 – currently has high traffic volume and is being widened); Fences; Juniper encroachment; Agriculture; Alternative energy development; Industrial development (potential); Commercial development (potential)
Linkage Type:	
Notes:	None listed

A10.

Wildland Blocks:	High desert grassland/juniper/pine forest north of Porter Mountain Road across US 60 to forest boundary and west across SR 77. Road crossings between Telephone Lake/Redhead Marsh and Pintail Marsh. Predominately USDA Forest Service Lands.
Species Identified:	Elk, Pronghorn, Mule Deer, Turkey
Current Threats/Barriers:	Residential development (high and low density); Roads (US 60 – high traffic volume; SR 77 – currently has high traffic volume and is being widened Little Mormon Road and Bourdon Ranch Road – High traffic volume arteries to residential developments); Fences; Juniper encroachment; Agriculture
Linkage Type:	
Notes:	This encompasses the Woolhouse Wildlife Quiet Area and crossing locations on SR 77 and US 60 and is adjacent to the towns of Pinetop-Lakeside and Show Low.

A11.

Wildland Blocks:	High desert grassland. Northeast from Saint Johns, Arizona to the Navajo Reservation Boundary. A mix of Arizona State Land Department, Bureau of Land Management, and private land ownership.
Species Identified:	Mule Deer, Pronghorn
Current Threats/Barriers:	Grazing; Railroad; Residential development (low density); Mines (potash mine being constructed); Industrial development (ancillary to mine); Commercial development (ancillary to mine); Roads (US 191 – currently high traffic volume and will increase with mine development; County Road 7230 – high traffic dirt road); Alternative energy development (potential); Fences
Linkage Type:	
Notes:	None listed

A12.

Wildland Blocks:	High desert grassland. A mix of Arizona State Land Department, Bureau of Land Management, and private land ownership.
Species Identified:	Pronghorn, Mule Deer
Current Threats/Barriers:	Grazing; OHV use; Industrial activities (two coal fire power plants; CO ₂ well fields; potential for CO ₂ -Geothermal Project); Alternative energy developments; Mine developments (potash), Industrial development; Commercial development; High traffic roads (US 60, 180, and 191); Fences; Residential development (low density); Loose pets (dogs) harassing wildlife
Linkage Type:	
Notes:	None listed

A13.

Wildland Blocks:	High desert grasslands, Pinyon-juniper woodlands. Bordered by US 60, 191, and 61. A mix of Arizona State Land Department, Bureau of Land Management, and private land ownership.
Species Identified:	Pronghorn
Current Threats/Barriers:	OHV use; Residential development (low density); Loose pets harassing wildlife; Roads (US 60, 180, and 191 – high traffic volume); Fences; Grazing; Alternative energy development
Linkage Type:	
Notes:	None listed

A14.

Wildland Blocks:	Pinyon-juniper to mixed conifer and aspen forests; South of SR 260 and east of Pinetop-Lakeside following the curve of the White Mountain Apache Reservation to the south. Primarily on Apache-Sitgreaves National Forest but does include some Arizona State Land Department and private lands.
Species Identified:	Elk, Mule Deer, White-tail Deer, Bear, Turkey, Pronghorn
Current Threats/Barriers:	Roads (SR 260 – high traffic volume)
Linkage Type:	
Notes:	None listed

A15.

Wildland Blocks:	High desert grasslands, Pinyon-juniper woodlands and aspen-mixed conifer forests. USDA Forest Service, Arizona State Land Department, and private land ownership.
Species Identified:	Pronghorn, Elk, Mule Deer, Bear, Turkey
Current Threats/Barriers:	Grazing; Residential development (high and low density); Industrial development; Commercial development; OHV use; Roads (US 60 and 191 – high traffic volume)
Linkage Type:	
Notes:	North-south movement corridor through Coyote Creek; this area also encompasses the Sipe White Mountain Wildlife Area

A16.

Wildland Blocks:	Aspen –mixed conifer forest; Entirely within the Apache-Sitgreaves National Forest
Species Identified:	Elk, Mule Deer, White-tail Deer; Bear; Turkey,
Current Threats/Barriers:	OHV use; Fences
Linkage Type:	
Notes:	Extends to the Blue Wilderness Area

APACHE AND NAVAJO COUNTIES MOVEMENT AREAS: B1- B8

B1.

Wildland Blocks:	High desert grassland. A mix of Arizona State Land Department, Bureau of Land Management, and private land ownership in Apache and Navajo Counties
Species Identified:	Pronghorn, Mule Deer
Current Threats/Barriers:	Mines (potash mine to be developed); Industrial development; Railroad (potential to create spur to mine); Alternative energy development; Roads (US 180 – high traffic volume which will increase with development of potash mines); Fences
Linkage Type:	
Notes:	Includes the southern portion of the Petrified National Park

B2.

Wildland Blocks:	High desert grassland and juniper shrub north of Old Concho Highway east of Silver Creek in Navajo County
Species Identified:	Pronghorn, Mule Deer
Current Threats/Barriers:	Residential development (high and low density); Alternative energy development; High traffic paved road (Old Concho Highway); Grazing; Fences
Linkage Type:	
Notes:	None listed

B3.

Wildland Blocks:	High desert grassland and juniper shrub south of Old Concho Highway
Species Identified:	Mule Deer
Current Threats/Barriers:	Grazing; Residential development (low density); Fences
Linkage Type:	
Notes:	None listed

B4.

Wildland Blocks:	High desert grassland, pinyon-juniper woodland, to pine forest. USDA Forest Service lands. Connects Timber Mesa with Jacques Marsh and Show Low Creek riparian corridor
Species Identified:	Elk
Current Threats/Barriers:	Residential development (high and low density); High traffic paved roads (Penrod and Porter Mountain Roads); potential widening of Penrod Road; Powerlines; Fences
Linkage Type:	
Notes:	This is mainly within the Apache-Sitgreaves National Forest but is adjacent to the towns of Pinetop-Lakeside and Show Low.

B5.

Wildland Blocks:	Walnut Creek corridor - along the Rim and the White Mountain Apache Reservation boundary to the south of Pinetop-Lakeside.
Species Identified:	Elk, Bear, Mule Deer, White-tail Deer, Turkey
Current Threats/Barriers:	Residential Development (high and low density); OHV use; Industrial development (potential); Commercial development (potential); Roads (high traffic volume highways, arterial roads, and dirt roads)
Linkage Type:	
Notes:	Mix of private and federal land ownership (particularly Apache-Sitgreaves National Forest)

B6.

Wildland Blocks:	High desert grassland and pinyon-juniper woodland. Along the Concho Creek area.
Species Identified:	Mule Deer, Pronghorn
Current Threats/Barriers:	Grazing, OHV use; Residential development (high and low density); Roads (SR 61 and SR 180A – high traffic volume highways); Alternative energy development; Agriculture; Fences
Linkage Type:	
Notes:	None listed

B7.

Area Connected:	High desert grasslands through pinyon-juniper to aspens and mixed conifer forests
Species Identified:	Elk, Mule Deer, Pronghorn, Bear, Turkey
Current Threats/Barriers:	Grazing; Exotic species; Residential development (high and low density); Alternative energy development; Industrial development; Commercial development; OHV use; Roads (US 60, 260, and 261 – high traffic volume highways)
Linkage Type:	
Notes:	This encompasses AGFD’s Grasslands Wildlife Area. Diffuse and seasonal wildlife movement area.

B8.

Area Connected:	Mountain meadows through pinyon-juniper woodlands to aspen and mixed conifer mountain forests
Species Identified:	Elk, Mule Deer, White-tail Deer, Bear, Rocky Mountain Bighorn Sheep, Turkey
Current Threats/Barriers:	Grazing (authorized and unauthorized); Fences; Residential development; OHV use; Roads (US 191 – moderate traffic volume)
Linkage Type:	
Notes:	Potential movement corridor from Escudilla Wilderness to the Blue Primitive Area

*APACHE AND NAVAJO COUNTIES RIPARIAN MOVEMENT AREAS: R₁ – R₄
(WILDLIFE MOVEMENT THROUGH RIPARIAN HABITAT)*

R1. Clear Creek Riparian Corridor

Area Connected:	Apache-Sitgreaves National Forest Wildland Block with lower elevation grassland areas near Winslow to the confluence with the Little Colorado River. Mix of USDA Forest Service, Arizona State Land Department, and private land ownership.
Species Identified:	Bat (general); Birds (migratory/riparian); Elk, Mule Deer, Native fish – Roundtail Chub; Mountain Lion
Current Threats/Barriers:	Agriculture; Exotic species (Tamarisk); Residential development (low density); OHV use
Notes:	None listed

R2. Chevelon Creek Riparian Corridor

Area Connected:	Apache-Sitgreaves National Forest Wildland Block with lower elevation grassland areas near Winslow and the confluence with the Little Colorado River. Mix of USDA Forest Service, Bureau of Land Management, Arizona State Land Department, and private land ownership.
Species Identified:	Elk, Bats (general), Native fish (Little Colorado Spinedace); Birds (migratory/riparian); White-tail Deer, Mule Deer, Mountain Lion
Current Threats/Barriers:	Agriculture; Exotic species (Tamarisk); Residential development (low density); Mines (water use near Holbrook); OHV use; Wind energy development
Notes:	Any increase in water usage in the Holbrook area could increase the cone of depression and shorten the 50-year timeline that is already determined for lower Chevelon Creek to go dry.

R3. Silver Creek Riparian Corridor

Area Connected:	Juniper/grassland habitat just off of Apache-Sitgreaves National Forest east of Show Low to the grassland habitat southeast of Holbrook to the confluence with the Little Colorado River. Mix of Bureau of Land Management, Arizona State Land Department, Arizona Game and Fish Department, and private land ownership.
Species Identified:	Bat (general); Birds (migratory/riparian); Bobcat; Mountain lion; Deer (general); Elk; Native fish; Pronghorn;
Current Threats/Barriers:	Agriculture; Canals; Exotic species (Tamarisk); Residential development (high and low density); Roads (SR 77 - paved); Energy development
Notes:	None listed

R4. Little Colorado River Riparian Corridor

Area Connected:	Starts in ponderosa pine habitat around Greer, Arizona through pinyon-juniper and grasslands habitat (Apache and Navajo Counties) to the Navajo Reservation boundary. Mix of USDA Forest Service, Bureau of Land Management, Arizona State Land Department, Arizona Game and Fish Department, and private land ownership.
Species Identified:	Native Fish (Little Colorado Spinedace); Elk; Mule Deer; White-tail Deer; Birds (migratory/riparian), Southwestern Willow Flycatcher; Pronghorn; Bears; Mountain Lions; Bats (general); Turkey
Current Threats/Barriers:	Agriculture; Canals; Residential development (high and low density); Industrial development; Commercial development; Mines; Energy development (CO ₂ fields; CO ₂ Geothermal); Roads (I-10, SR 260, US 191, US 180); Railroad (BNSF)
Notes:	None listed

APACHE AND NAVAJO COUNTIES IMPORTANT CROSSING AREAS: C1 – C21

C1. SR 260 (Milepost 291.5)

Linkage/Area Served:	Across State Route 260. USDA Forest Service lands on both sides of SR 260.
Target Species:	Elk, Mule Deer, Bear, Turkey
Current Threats/Barriers to Linkage/Area Served:	State Route 260 Heber-Overgaard to Show Low widening project
Status:	Area of increased wildlife-vehicle collisions
Notes:	AGFD is starting a two-year elk and deer collaring study from the rim to Show Low to determine locations of frequent crossings to inform the SR 260 widening project.

C2. SR 260 (Milepost 297)

Linkage/Area Served:	Across State Route 260. USDA Forest Service lands on both sides of SR 260.
Target Species:	Mule Deer, Elk, Turkey, Bear
Current Threats/Barriers to Linkage/Area Served:	State Route 260 Heber-Overgaard to Show Low widening project
Status:	Area of increased wildlife-vehicle collisions
Notes:	AGFD is starting a two-year elk and deer collaring study from the rim to Show Low to determine locations of frequent crossings to inform the SR 260 widening project.

C3. SR 260 (Milepost 300)

Linkage/Area Served:	Across State Route 260. USDA Forest Service lands on both sides of SR 260.
Target Species:	Elk, Mule Deer, Turkey, Bear
Current Threats/Barriers to Linkage/Area Served:	State Route 260 Heber-Overgaard to Show Low widening project
Status:	Area of increased wildlife-vehicle collisions
Notes:	AGFD is starting a two-year elk and deer collaring study from the rim to Show Low to determine locations of frequent crossings to inform the SR 260 widening project.

C4. SR 260 (Milepost 302)

Linkage/Area Served:	Across State Route 260. USDA Forest Service and private lands on both sides of SR 260.
Target Species:	Mule Deer, Elk, Turkey, Bear
Current Threats/Barriers to Linkage/Area Served:	State Route 260 Heber-Overgaard to Show Low widening project
Status:	Area of increased wildlife-vehicle collisions
Notes:	AGFD is starting a two-year elk and deer collaring study from the rim to Show Low to determine locations of frequent crossings to inform the SR 260 widening project.

C5. SR 377 (Milepost 1.5)

Linkage/Area Served:	Across State Route 377. USDA Forest Service lands on both sides.
Target Species:	Pronghorn
Current Threats/Barriers to Linkage/Area Served:	Paved road, potential for increased traffic with industrial development in Navajo County.
Status:	Research data indicating this location as a pronghorn crossing area.
Notes:	None listed.

C6. SR 277 (Milepost 315)

Linkage/Area Served:	Across State Route 277. USDA Forest Service lands on both sides.
Target Species:	Pronghorn
Current Threats/Barriers to Linkage/Area Served:	Paved road, potential for increased traffic with industrial development in Navajo County.
Status:	Research data indicating this location as a pronghorn crossing area.
Notes:	None listed.

C7. SR 377 (Milepost 21)

Linkage/Area Served:	Across State Route 377. Arizona State Land Department, Bureau of Land Management and private lands on both sides of SR 377.
Target Species:	Pronghorn
Current Threats/Barriers to Linkage/Area Served:	Paved road, potential for increased traffic with industrial development in Navajo County.
Status:	Research data indicating this location as a pronghorn crossing area.
Notes:	None listed.

C8. I-40 (Milepost 272)

Linkage/Area Served:	Across Interstate 40. Arizona State Land Department, Bureau of Land Management and private lands on both sides of I-40.
Target Species:	Elk
Current Threats/Barriers to Linkage/Area Served:	High traffic interstate
Status:	
Notes:	Arizona Department of Transportation is interested in decreasing wildlife-vehicle collisions here.

C9. SR 260 (Milepost 330.5)

Linkage/Area Served:	Across State Route 260. USDA Forest Service lands on both sides.
Target Species:	Elk
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of SR 260; already a high traffic volume road); Residential development (potential); Industrial development.
Status:	Area of increased wildlife-vehicle collisions
Notes:	AGFD is starting a two-year elk and deer collared study from the rim to Show Low to determine locations of frequent crossings to inform the SR 260 Heber-Overgaard to Show Low widening project.

C10. SR 260 (Milepost 337.5)

Linkage/Area Served:	Across State Route 260. USDA Forest Service and private lands on both sides.
Target Species:	Mule Deer
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of SR 260; already a high traffic volume road); Residential development (high and low density)
Status:	Area of increased wildlife-vehicle collisions
Notes:	AGFD is starting a two-year elk and deer collared study from the rim to Show Low to determine locations of frequent crossings to inform the SR 260 Heber-Overgaard to Show Low widening project.

C11. SR 77 (Milepost 353)

Linkage/Area Served:	Across State Route 77. USDA Forest Service lands on the west side and private land on the east side.
Target Species:	Elk, Mule Deer
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of SR 77; already a high traffic volume road and volume has potential to increase); Residential development (potential); Industrial development
Status:	Area of increased wildlife-vehicle collisions
Notes:	This includes a portion of the Silver Creek Riparian Corridor.

C12. US 180 (Milepost 321)

Linkage/Area Served:	Across US Route 180. Arizona State Land Department, Bureau of Land Management, and private lands on both sides of US 180.
Target Species:	Pronghorn
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of US 180; already a high traffic volume road); Residential development (potential); Industrial development (including potash mines); Fences.
Status:	Potential
Notes:	Adjacent to Petrified National Park.

C13. US 180 (Milepost 328)

Linkage/Area Served:	Across US Route 180. Arizona State Land Department, Bureau of Land Management, and private lands on both sides of US 180.
Target Species:	Pronghorn
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of US 180; already a high traffic volume road); Residential development (potential); Industrial development (including potash mines); Fences.
Status:	Potential
Notes:	Adjacent to Petrified Forest National Park.

C14. US 60 (Milepost 344)

Linkage/Area Served:	Across US Route 60. USDA Forest Service and private lands on both sides of US 60.
Target Species:	Elk, Pronghorn
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of US 60; already a high traffic volume road); Residential development (potential); Industrial development; Fences.
Status:	Potential
Notes:	Year-round elk movement.

C15. US 60 (Milepost 362)

Linkage/Area Served:	Across US Route 60. Arizona State Land Department, Bureau of Land Management, and private lands on both sides of US 60.
Target Species:	Elk, Mule Deer, Pronghorn
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of US 60; already a high traffic volume road); Residential development (potential); Industrial development; Fences.
Status:	Potential
Notes:	Adjacent to USDA Forest Service.

C16. US 60 (Milepost 377)

Linkage/Area Served:	Across US Route 60. Arizona State Land Department, Bureau of Land Management, and private lands on both sides of US 60.
Target Species:	Elk, Mule Deer, Pronghorn
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of US 60; already a high traffic volume road); Residential development (potential); Industrial development; Fences.
Status:	Potential
Notes:	Adjacent to USDA Forest Service.

C17. US 60 (Milepost 386)

Linkage/Area Served:	Across US Route 60. Arizona State Land Department, Bureau of Land Management, and private lands on both sides of US 60.
Target Species:	Mule Deer
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of US 60; already a high traffic volume road); Residential development (potential); Industrial development; Fences.
Status:	Potential
Notes:	Adjacent to USDA Forest Service. Encompasses the Little Colorado River Riparian Movement Corridor. Links Becker and Wenima Wildlife Areas.

C18. US 60 (Milepost 401)

Linkage/Area Served:	Across US Route 60. Arizona State Land Department and private lands on both sides of US 60.
Target Species:	Elk, Mule Deer, Pronghorn
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of US 60; already a high traffic volume road); Residential development (potential); Industrial development; Fences.
Status:	Potential
Notes:	Adjacent to USDA Forest Service.

C19. US 180 (Milepost 411.5)

Linkage/Area Served:	Across US Route 180. USDA Forest Service and private lands on both sides of US 180.
Target Species:	Elk
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of US 180; already a high traffic volume road); Residential development (potential); Industrial development; Fences.
Status:	Potential
Notes:	High wildlife-vehicle collision area

C20. US 180 (Milepost 416)

Linkage/Area Served:	Across US Route 180. USDA Forest Service and private lands on both sides of US 180.
Target Species:	Elk
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of US 180; already a high traffic volume road); Residential development (potential); Industrial development; Fences.
Status:	Potential
Notes:	High wildlife-vehicle collision area

C21. US 180 (Milepost 417)

Linkage/Area Served:	Across US Route 180. USDA Forest Service and private lands on both sides of US 180.
Target Species:	Elk
Current Threats/Barriers to Linkage/Area Served:	Roads (widening of US 180; already a high traffic volume road); Residential development (potential); Industrial development; Fences.
Status:	Potential
Notes:	High wildlife-vehicle collision area

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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):

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) Development description (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