0000166588

SunZia Transmission, LLC

Supplemental Expanded Exhibits of McVie, Christina

L-00000YY-15-0318-00171

Part 1 OF 2

Barcode # 0000166588

To review Part 2 please see:

Barcode # 0000166589

ORIGINAL

DOCKET NO. L-00000YY-15-0318-00171 Supplemental Expanded Exhibits of McVie, Christina (MCV)

1 Arizona's Important Bird Area Program including the Lower San Pedro, the Pinaleno Mountains, and the Willcox Playa and Cochise Lakes

2 Pima County Wildlife Linkages Assessment: Detailed Linkages - Santa Catalina/Rincon-Galiuro Linkage Design August 2012

3 An Ecosystem Conservation Assessment of the Lower San Pedro Watershed - Wilbor 2014

4 Pima County San Pedro Valley Reserve – A – 7 Ranch PDF

5 Pima County San Pedro Valley Reserve – Six Bar and A – 7 Ranches PDF

6 Pima County Pima Prospers Comprehensive Plan Update 2015

7 Duncan & Slagle: The Upper San Pedro Partnership – 2004 PDF

8 Pima County Six Bar Ranch San Pedro Valley Reserve PDF

9 Ecosystem-Based Conservation Assessments of the Southwestern United States and Northwestern Mexico – TNC – May 2006

10 Sky Island Grass Biz Plan - 2009

11 Mapping Biodiversity Metrics Representing Ecosystem Services at the Landscape Scale in the American Southwest – Boykin and Kepner et al

12 Madrean Archipelago Rapid Ecoregional Assessment – BLM – December 2014

13 Economic Contributions of Wildlife Viewing to the Arizona Economy: A County Level Analysis - Tucson Audubon Society 2013

14 Biological and Conservation Aspects of Bird Mortality Caused by Electricity Powerlines: A Review - Bevanger 1997

15 Bird Strikes and Electrocutions at Power Lines, Communication Towers and Wind Turbines: State of the Art and State of the Science- Next Steps Toward Mitigation – Manville 2005

16 Outstanding Arizona Waters - A.A.C. R18-11-112(G) PDF

17 Arizona Missing Linkages: Galiuro-Pinaleno-Dos Cabezas Linkage Design - Beier et al 2008

18 Pinal County Open Space & Trails Master Plan – October 2007

19 Arizona Missing Linkages: Ironwood-Picacho Linkage Design - Beier et al 2007

20 Pinal County Wildlife Connectivity Assessment - April 2013

21 Map of the SunZia route in relation to the McVie Property

22 Map of Habitat Fragmentation of Wildlife Linkages by SunZia in Southeastern Arizona

23 Arizona Wildlife Linkages Assessment Report, Arizona Department of Transportation & AzGFD

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OCT 19 2015
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Arizona Corporation Commission
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Arizona's Wildlife Linkages Assessment Document 2006

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DOCKET NO. L-00000YY-15-0318-00171_MCV_1

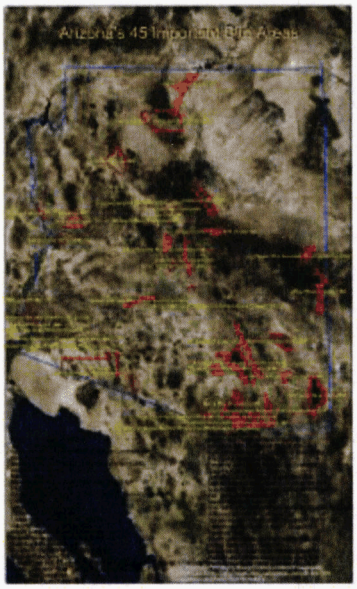
http://aziba.org/?page_id=1255 accessed 10/12/2015

1. Map of all 45 Arizona IBAs

There are currently 45 Important Bird Areas in Arizona. They range all over the state and cover a wide span of habitat types.

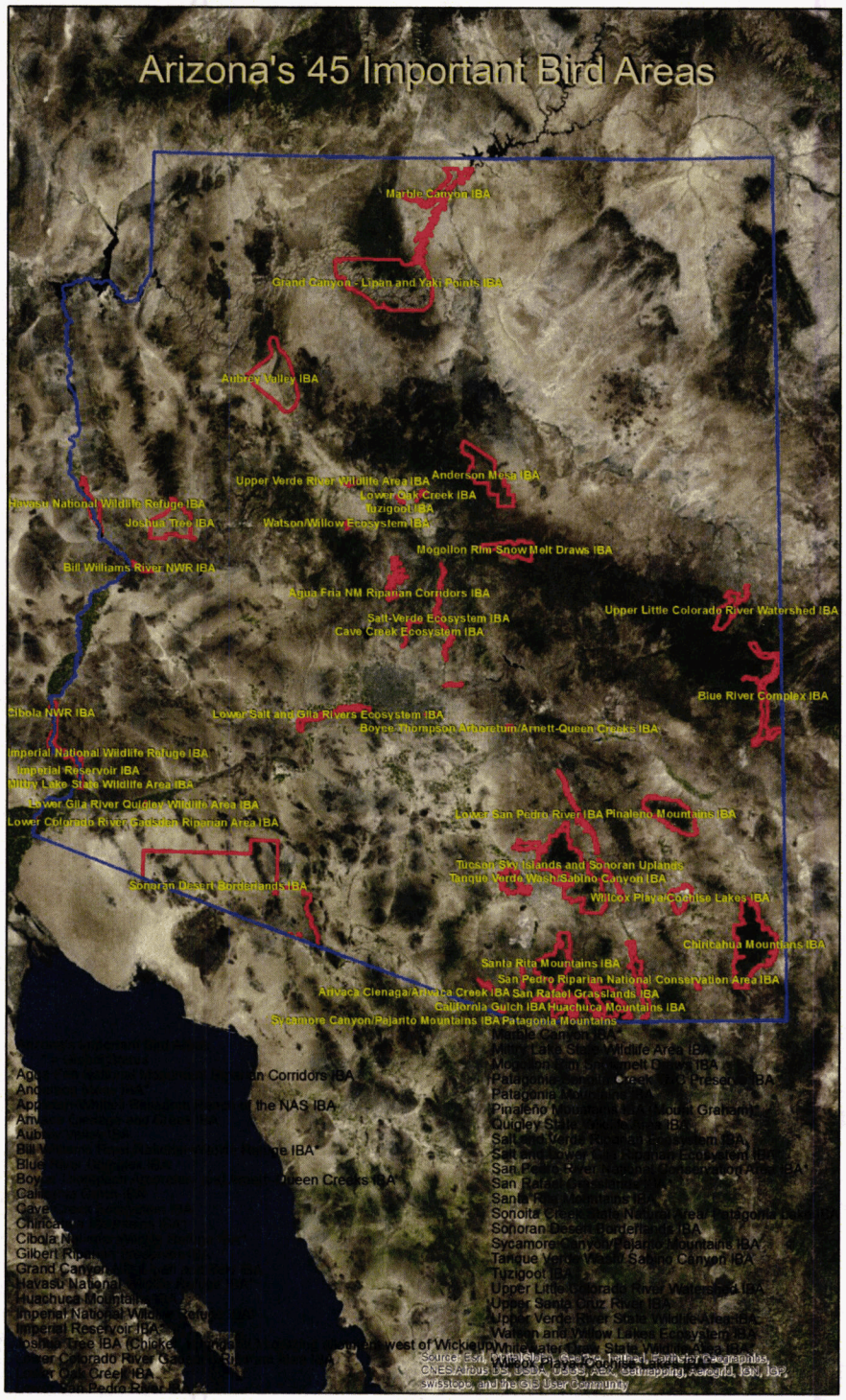
If you would like a more interactive tour of Arizona's Important Bird Areas, there are several options. You can download this KLM file of all of Arizona's IBAs that can be opened in Google Earth on your computer. You can also visit this interactive map produced by National Audubon Society for the IBAs of the entire United States. It has an option at the top to "zoom to state" if you would like.

Below is a printable image map of all the IBAs of Arizona, it is 8.5 inches by 14 (legal size paper).



Map of all 45 Important Bird Areas in Arizona

Larger version of the map:



http://aziba.org/?page_id=461 accessed 10/12/2015

Lower San Pedro River IBA ☼ ◊

Lower San Pedro River Global IBA for Bell's Vireo

Continental IBA for Abert's Towhee

Conservation Stewards: Tucson Audubon Society, The Nature Conservancy, Cascabel Working Group, Redington and Winkleman NRCDs

Size: 51.2 square miles, 32,762 acres

Identified: 01/2007, Global on 01/2008. Recognized: 02/2008

Visiting the IBA: Most of the lands in this IBA are privately owned with no public access. BLM land at San Manuel Crossing and private land at Dudleyville Crossing are open for walk in public. The privately owned 7B Ranch is located east of the town of Mammoth and has a recently developed walking trail at Copper Canyon Road.

Ownership and Management: Arizona Game and Fish Department, BLM, Bureau of Reclamation, Salt River Project, The Nature Conservancy, Pima County, Private

3Links River Site Description: The IBA is over 60 miles in length and begins at the southern boundary of 3 Links Farm in Cochise County and follows the San Pedro river downstream north (the San Pedro flows from south to north) to the confluence with the Gila River at the town of Winkleman. A free flowing river, the San Pedro has well developed cottonwood-willow gallery forest riparian habitat interspersed with old growth honey mesquite (Prosopis juliflora woodlands known as bosques. The largest intact mesquite bosque community in Arizona is located on 14 miles of the San Pedro River beginning south of the community of San Manuel and ending north of the community of Mammoth. The majority of the land is privately owned and only select properties in public ownership or under conservation easement and management are specifically included in the IBA.

Birds: The high importance of the lower San Pedro River for the recovery of the Southwestern Willow Flycatcher contributed to its designation as critical habitat for the species. Species of special conservation status and interest that use the habitats within this IBA include:

Year-round: American Kestrel, Ladder-backed & Gila Woodpeckers, Northern Flicker, Gilded Flicker, Black Phoebe, Say's Phoebe, Bewick's Wren, Abert's Towhee, Song Sparrow

Breeding: Common Black-Hawk, Gray Hawk, Zone-tailed Hawk, Mississippi Kite, White-tailed Kite, Elf Owl, Yellow-billed Cuckoo, Western Purple Martin, SW Willow Flycatcher, Vermillion Flycatcher, Northern Beardless Tyrannulet, Thick-billed Kingbird, Tropical Kingbird, Brown-crested Flycatcher, Ash-throated Flycatcher, Bell's Vireo, Lucy's Warbler, Yellow Warbler, Summer Tanager Bullock's Oriole Hooded Oriole Migration: Willow

Flycatcher, Olive-sided Flycatcher, Warbling Vireo, Yellow-rumped Warbler (Audubon's), MacGillivray's Warbler, Virginia's Warbler, Black-throated Gray Warbler, Nashville Warbler, and Wilson's Warbler, Black-headed Grosbeak, Western Tanager, Lazuli Bunting

eBird focus species: Breeding season: Gray Hawk, Mississippi Kite, Elf Owl, Yellow-billed Cuckoo, Bell's Vireo, Lucy's Warbler, Abert's Towhee

Conservation Concerns: Irrigation water diversions, development, wild fire, OHV use in riparian areas, wood cutting, invasive plants (salt cedar). Strategies: Conservation partnerships among landowners

Extended Site Description of this very complex Important Bird Area:

Portions of the IBA within Cochise County include the Three Links Farm consisting of 2,156 acres that lie along the San Pedro River. It was purchased by The Nature Conservancy (TNC) as part of their long-standing program to protect the San Pedro River and its riparian habitat. Here the banks of the San Pedro are lined by an exceptional Fremont cottonwood-Goodding willow forest and mesquite bosque. This River's forest is host to 345 species of birds including 13 species of breeding raptors, and is a major migratory pathway for neotropical birds such as Gray Hawk and the rare Western Yellow-billed Cuckoo.

It is also the residence for more than 80 species of mammals, 40 species of reptiles and amphibians, 100 species of butterflies and 20 species of bats. Beaver have migrated to the property since the Conservancy's acquisition. Three Links is a retired farm that has had 836.9 acres placed in permanent conservation easements by TNC. The easements encompass six linear miles of the San Pedro River (9.75 kilometers) sub-divided into five parcels sold to conservation owners. Agricultural wells have been dismantled, and a large proportion of the water rights are in the process of being retired from the property with the goal of increasing in stream flow in the San Pedro River. A result of TNC's actions have resulted in a majority of the former agriculture fields becoming dominated by mesquite. The river has been fenced from livestock and is a mix of closed canopy cottonwood/willow gallery forest with an open understory of tamarisk and hackberry, ash and Arizona Walnut and segments of willow stands. The uplands are Chihuahuan Desert Scrub typified by Creosote Bush (Larrea), Black Brush and Yucca (Yucca Elata). Two one kilometer long transect lines following the river channel have been established at this property. TNC is collecting riparian vegetation data at established transects that cross-section the river.

Pima County properties include the county owned Bingham Cienega – a small 503 acre parcel with an artesian fed spring, the site has a small marsh habitat and mature gallery cottonwood/willow forest along the river channel. A fire in 2004 burned the willow and tamarisk vegetation around the marsh that was suitable southwestern willow flycatcher habitat.

The uplands from Pima County north are Sonoran Desert Scrub and mixed cactus habitats. Saguaro (Cereus gigantea), Foothill and Blue Palo Verde (Cercidium microphyllum and C. floridum), Ocotillo (Foquieria splendens), and a variety of cacti and small shrubs cover the uplands. Mesquite (Prosopis juliflora), Catclaw Acacia (Acacia greggii), Burrobush

(Hymenoclea monogyra), and Desertbroom (Baccharis sarothroides) line xeric washes, while Goodding Willow (Salix gooddingii), Fremont Cottonwood (Populus fremontii), Velvet Ash (Fraxinus velutina), and Netleaf Hackberry (Celtis reticulata) cluster along wetter drainage ways interspersed with Sonoran Desert grasslands typified by grama grasses (Boutaloua spp.), Three-awns (Aristida spp.), and Mulenberghia spp

Pinal County. The majority of this IBA is in Pinal County.

San Manuel Crossing is a small BLM parcel (160 acres) in Township 9 South and Range 18 East; Southeast Quarter of Section 31 and Township 10 South and Range 18 East, Southwest Quarter of the Northwest Quarter Section 6. One 1 kilometer long transect lines following the river channel have been established at this property. A mile further south from this location is a property acquired by Salt River Project (SRP) for Southwest Willow Flycatcher and Yellow-billed Cuckoo mitigation known as Spirit Hollow that encompasses approximately one linear kilometer of river located at Township 10 South and Range 18 East; East Half of Section 8 and the North Half of the Southwest Quarter of Section 9, the site is almost entirely cottonwood/willow gallery forest. An additional 50 acres adjacent and south of Spirit Hollow has been acquired by the US BOR for Willow Flycatcher mitigation and is being managed by SRP.

7B Ranch is located east of the town of Mammoth. The 3,200 acre property covers 7 river miles and is owned by Resolution Copper Company and is being offered in a land exchange with the federal government for conservation purposes. Two 1 kilometer long transect lines through the mesquite bosque have been established at this property.

The 7B property is contiguous with another 7 miles of river to the south owned by BHP-Billiton mining company at San Manuel. Combined, these two properties represent the largest intact mesquite bosque in Arizona. The BHP-Billiton land also has cottonwood/willow gallery forest that is contiguous with the San Manuel Crossing properties and has equally high conservation values for birds. The highest numbers of nesting Southwest Willow Flycatcher on the San Pedro River have been documented at this location. The Arizona IBA program is actively surveying this portion of the Lower San Pedro.

Aravaipa Crossing (approximately160 acres) has the next highest densities of southwestern willow flycatcher habitat. The Triangle Bar property was privately owned by ASARCO and transfer of ownership to Arizona Game and Fish is currently in process. Salt River Project also has mitigation lands at this location (the Stillinger Preserve and the Adobe Parcel) which are managed by TNC and are included in the IBA. A one kilometer long avian transect line following the river channel has been established at this property

Cook's Lake/Cienega Seep – Bureau of Reclamation (BOR) and Salt River Project (Adobe Preserve) own mitigation land for southwestern willow flycatcher totaling approximately 320 acres which is managed by The Nature Conservancy. ASARCO mining company owns parcels to the north and south comprising about 160 acres of river land that are included in the Lower San Pedro IBA. One 1 kilometer long avian transect line following the river channel has been established across these properties.

Dudleyville Crossing and TNC San Pedro River Preserve - A well-developed cottonwood/willow gallery forest with a mature tamarisk understory. The properties extend from the Dudleyville Crossing (Schwenesen property) north and total about 1,300 acres. A small 160 acre parcel is just south of the confluence with the Gila River. A nesting colony of Mississippi Kite has been documented at this location. The land at Dudleyville Crossing was privately owned with a conservation easement held by BLM. An eminent domain of this property by Pinal County is in process and the land is currently being managed by Pinal County. A one kilometer long avian transect line following the river channel has been established at this property.

The TNC San Pedro Preserve is a former fish farm with two ponds now being managed for marsh bird habitat. The majority of the property is retired agricultural fields returning to mesquite. The cottonwood/willow gallery forest had a fire in 2004. A one kilometer long avian transect line following the river channel has been established at this property.

Maps of this Important Bird Area:

Lower San Pedro River IBA GIS Map – zoomed out

State of the IBAs 2014 Baseline – More Technical info about the status of this Important Bird Area

Location: 32° 51' 41" N 110° 43' 12" W

Counties: Cochise, Pima, Pinal

Site Status: Identified 01/2007, Identified Global 01/2008, Recognized 02/2008

Area: 51.2 square miles, 32,762 acres

Ownership: BLM, Salt River Project, Bureau of Reclamation, The Nature Conservancy, Pima County, Private

Criteria: A1: Global; Species of Conservation Concern – Bell's Vireo (113 breeding adults – 2011)

B1: Continental; Species of Conservation Concern – Abert's Towhee (434 individuals – 2005)

D1 – Site Important to Special Status Avian Species: SW Willow Flycatcher (Federally Listed in Arizona), Gray Hawk, Yellow-billed Cuckoo, Bell's Vireo, Northern Beardless-Tyrannulet, Lucy's Warbler, Abert's Towhee, Brewer's Sparrow

D3 – Rare, Unique, or Exceptional Representative Habitat/Ecological Community – Low Elevation Riparian River

D4i - Significant Concentrations of Birds: SW Willow Flycatcher >40% Arizona breeding population, Mississippi Kite >40% Arizona breeding population and Gray Hawk >30% Arizona breeding population.

D4ii – Land birds (significant #s, density, and/or diversity): Bell's Vireo, Yellow Warbler

Site Description: The San Pedro River serves as a corridor between the Sky Islands of the Madrean Archipelago in northern Sonora and southern Arizona in its southernmost reaches and, in the north, Arizona's Central Highlands. The river is not only a major corridor between varied habitat types and ecoregions; it represents a ribbon of water and riparian vegetation in an otherwise arid environment. The river thus exhibits a remarkably high biodiversity, both in resident and migratory species. The lower reaches of the San Pedro River, from the so-called Narrows upstream of the community of Cascabel to the Gila River confluence, are surrounded by saguaro cactus-dominated Sonoran Desertscrub, rather than the Chihuahuan Desert-influenced uplands adjoining the upper San Pedro River. The IBA designation with the southern boundary beginning at 3 Links Farms and ending at the Narrows.

Lower San Pedro River IBA Vegetation Analysis

IBA28 The Lower San Pedro River is characterized by well-developed cottonwood-willow gallery forest riparian habitat interspersed with old growth mesquite (Prosopis juliflora woodlands known as bosques. The largest intact mesquite bosque community in Arizona is located on 14 miles of the San Pedro River beginning south of the community of San Manuel and ending north of the community of Mammoth. Seven river miles of this bosque are on lands acquired by Resolution Copper Company for conservation purposes and are included in the nomination for IBA. Saguaro (Cereus gigantea), Foothill and Blue Palo Verde (Cercidium microphyllum and C. floridum), Ocotillo (Foquieria splendens), and a variety of cacti and small shrubs cover the uplands. Mesquite), Catclaw Acacia (Acacia greggii), Burrobush (Hymenoclea monogyra), and Desertbroom (Baccharis sarothroides) line xeric washes, while Goodding Willow (Salix gooddingii), Fremont Cottonwood (Populus fremontii), Velvet Ash (Fraxinus velutina), and Netleaf Hackberry (Celtis reticulata) cluster along wetter drainage ways. Interspersions of Sonoran Desert grassland typified by grama grasses (Boutaloua spp.), Three-awns (Aristida spp.), and Mulenberghia spp.

The IBA begins at the southern boundary of 3 Links Farm in Cochise County and follows the San Pedro river downstream north (the San Pedro flows from south to north) to the confluence with the Gila River at the town of Winkleman. The majority of the land is privately owned and only select properties in public ownership or under conservation easement and management are specifically included in the IBA.

Vegetation Description Hectares

CHIHUAHUAN DESERTSCRUB 154764.9

COTTONWOOD – WILLOW COMMUNITIES 17.00033

CREOSOTEBUSH – BURSAGE (LOWER COLORADO R. VALLEY) COMMUNITIES 10390.34

DESERT (SCRUB) GRASSLAND 950265.4

MESQUITE BOSQUE COMMUNITIES 4751.138

MIXED PALOVERDE – CACTI COMMUNITIES 1929900

PLAINS GRASSLAND 44.49856

WHITETHORN COMMUNITIES 32648.73

GREAT BASIN DESERTSCRUB 98475.27

Ornithological Summary: Species of raptors that nest on the lower San Pedro River include Gray Hawk (Asturina nititda=Buteo nitidus), Mississippi Kite (Ictinia mississippiensis), Common Black Hawk (Buteogallus anthracinus), and Zone-tailed Hawk (Buteo albonotatus). Western Yellow-billed Cuckoos (Coccyzus americanus occidentalis), currently a candidate for Federal listing as a threatened or endangered species, nest in numbers on the lower reaches of San Pedro River.

The high importance of the lower San Pedro River for the recovery of the Southwestern Willow Flycatcher contributed to its designation as critical habitat for the species. Critical habitat includes approximately 60 river miles of the lower San Pedro River between points approximately 3.5 river miles south of Hot Springs Canyon to the Gila River confluence. Arizona Game and Fish Department Surveys documented within the Winkleman Study Area 143 pairs in 2004 representing 43.8% of the total Arizona monitored nests (Source 1A) and 136 pairs in 2005 representing 43.45% of the total Arizona monitored nests (Source 1B). These data and the 157 pairs recorded at locations in the nomination area in 2004 and qualify the nomination for B1 Continental designation for this species. (Thresholds are 20 breeding pairs/60 individuals for Empidonax traillii extimus).

The reach between Three Links Farm, which is in a conservation easement held by The Nature Conservancy and included in the IBA, and the Gila River confluence is densely occupied by Southwestern Willow Flycatchers at sites where there is suitable habitat. In 2005 this section contained 164 southwestern willow flycatcher territories consisting of 308 adult birds. Over 40% of the nesting population in Arizona is found here.

The mesquite bosque at 7 B Ranch supports excellent breeding populations of Lucy's Warbler and Bell's Vireo. Gavin and Sowls documented bird diversity at this same location through repeated monitoring during a nine month period in 1974 and 1975.

Two survey efforts were organized by the Audubon Society in the spring and summer of 2006. Volunteer surveyors completed nine one kilometer long transects and eighteen point counts positioned at the beginning and end of each transect on May 20, 2006. Conservation species total

numbers observed were as follows: Abert's Towhee-50; Bell's Vireo-88; Broad-billed Hummingbird-2; Gray Hawk-5; Gilded Flicker-1; Hooded Oriole-15; Lucy's Warbler-91; Northern Beardless-Tyrannulet-5; Olive-sided Flycatcher-1; SW Willow Flycatcher-12; Summer Tanager-46; Yellow Warbler-186.

The second survey effort occurred just before the monsoon rains and five of the nine transects and ten of the eighteen point count locations were surveyed on July 25, 2006 (4 transects: Aravaipa Creek confluence, Dudleyville crossing, Cook's Lake, TNC Preserve north of Dudleyville) and August 2, 2006 (San Manuel Crossing). Flood conditions prevented access to the 3 Links Farms transects and scheduling conflicts resulted in the 7B transect not being run a second time.

The transect and point count surveys, CBC, and the NAMC do not adequately detect the raptors that nest on the lower San Pedro River. Gray Hawk, Zone-tailed Hawk, Common Black Hawk, and Mississippi Kite are represented on the entire reach. Levy (1971) documented up to 10 Mississippi Kite nests and Corman and Gervais-Wise (2005) describe the lower San Pedro River as being the Arizona breeding population stronghold and supporting the majority of nesting sites for this species in Arizona. Corman and Gervais-Wise describe the Gray Hawk as "locally common" along segments of the San Pedro River. The six Gray Hawks observed on the May 20, 2006 transect surveys supports this claim. An organized survey for raptors is recommended to better catalog the densities and occurrences.

State Species of Conservation Concern: Western Yellow-billed Cuckoo, Belted Kingfisher, Red-naped Sapsucker, Olive-sided Flycatcher, Southwestern Willow Flycatcher, Tropical Kingbird, Thick-billed Kingbird, Western Purple Martin Gray Hawk, Common Black Hawk, Zone-tailed Hawk, Mississippi Kite

Conservation and Stewardship: Threats to the area include transition of land use from mining and agriculture to suburban development, Interstate 10 bypass, groundwater withdrawal, OHV damage in riparian zones, fuel wood cutting, excessive livestock grazing in riparian zones, unnatural fire regime. Conservation Actions: Conservation easements and management, fencing and protection of riparian habitats from trespass livestock grazing and wood cutters. Reclamation of abandoned mine tailings, protection from OHV, retirement of agriculture and associated wells. Tucson Audubon Society is the Stewardship Group for this IBA (tucsonaudubon.org). The Schwennesen family has dedicated Liz's Grove at Dudleyville Crossing as a riparian preserve accessible to walkers and horse riders.

The TNC San Pedro Preserve is a former fish farm with two ponds now being managed for marsh bird habitat. The majority of the property is retired agricultural fields dominated by mesquite. The cottonwood/willow gallery forest experienced a fire in 2004. A one kilometer long avian transect line following the river channel has been established at this property.

http://aziba.org/?page_id=1150 accessed 10/12/2015

Pinaleño Mountains IBA

Location: UTM 12S 605570 3618850

County: Graham

Site Status: Identified 02/2013

Ownership: Coronado National Forest – Safford Ranger District

Area: 212 sq miles, perimeter: 161 miles

Criteria: D1: State: Species of Conservation Concern

D3: State: Species in rare/unique habitat

Site Description:

The Pinaleño Mountains are one of the most northern of the Coronado Forest "Sky Islands". Located in Graham County and south of the agricultural community of Safford, this mountain has provided resources for settlers in the region. The Douglas fir and pine provided lumber for surrounding communities. During the military campaigns Heliograph Peak was so named because a U.S. Army heliograph station was located there. The heliographs were a mirror signal communication system from Santa Fe to San Diego. The paved road is access to a fishing lake constructed by the Arizona Game and Fish Department and numerous campgrounds.

Located near the northern limit of the Chiricahua Apache homeland and the southern margins of Western Apache territory, the range is one of the Western Apache's four holiest mountains and is considered sacred by all of the region's Native peoples. Since a determination by the Keeper of the Register in 2002, Dził Nchaa Si An, as it is known in the Western Apache language, ranks as the largest and most extensive (~330,000 acres) property listed on or formally determined eligible for the National Register of Historic Places.

Unlike many of the other mountains in the area, the Pinaleños have no lava deposits. The lava-based mountains found throughout Arizona tend to be barren, whereas the Pinaleños (and others) have a large number of trees, including many that pre-date Columbus's arrival in the Americas. Researchers from the University of Arizona Tree Ring Laboratory have discovered living trees that date back to 1257 and 1270 AD. Botanists say the Douglas firs have survived because the rocky cliffs of the mountains have served as a fire barrier for them. The scientists also found dead firs that dated as far back as 1102 AD.

Ornithological Summary: The Pinaleño Mountains (commonly referred to as Mt. Graham, the highest peak in southern Arizona at 10,800 feet) are an excellent example of a high elevation Sky Island ecosystem comprised of Madrean Evergreen Woodland, Petran Montane Conifer Forest

and Petran Subalpine Conifer Forest and this Sky Island spans the greatest elevation change on the Coronado National Forest rising roughly 6,800 feet from semi-desert grasslands at the desert floor to mountainous woodlands at the highest peaks. This Sky Island is the highest of the chain of Madrean Occidental Sky Islands that extend into Mexico but is far enough away from its neighboring Sky Islands to notably lack several bird species found in other similar habitats. This lack of a few SE Arizona 'specialty birds' such as Mexican Chickadee and Elegant Trogon makes this the least birded of Arizona's Sky Islands. However, the exceptional high elevation habitat of this extensive range, representative of Rocky Mountain flora and fauna to the north, makes this a vital area for the many diverse bird species.

The weekend of May 18-20, 2012 an Arizona IBA survey crew conducted 6 transect surveys and one nocturnal survey and recorded 58 species. These surveys showed this range to be important to at least twelve special conservation status species in Arizona. Additionally, our surveys found this mountain range to be important for its outstanding high elevation habitat supporting an exceptionally diverse avian community.

One bird species listed in the Endangered Species Act as a Threatened Species breeds in this range in high abundance. The Mexican Spotted Owl has been specifically surveyed by Amanda Moors on behalf of the Forest Service and has documented more than enough breeding pairs to qualify this site as a Global IBA in the future. Species of conservation concern found by the IBA survey team in 2012 include: Wild Turkey, Peregrine Falcon, Mexican Whip-poor-will, Mountain Pygmy Owl, Magnificent Hummingbird, Dusky-capped Flycatcher, Olive Warbler, Virginia's Warbler, Black-throated Warbler, Grace's Warbler, Red-faced Warbler and Yellow-eyed Junco.

The presence of the above twelve special status species qualifies this site under the Arizona IBA Criterion, Site Importance to Special Status Avian Species.

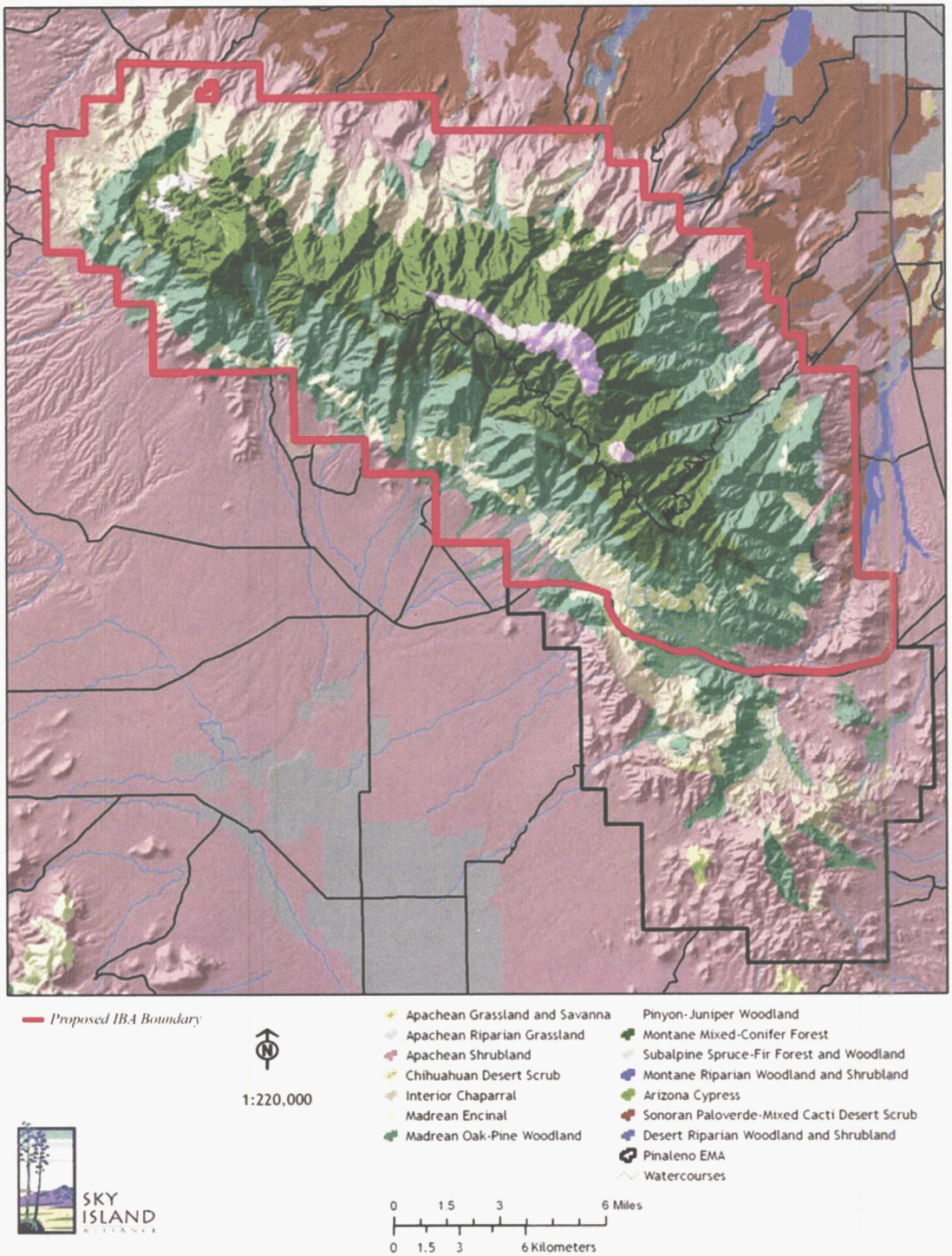
While this area is not frequented by birders nearly as often as other Sky Islands in Arizona, there is still a good baseline of data for this area within that database. Within eBird.org a total of 149 checklists have been submitted to the 'hotspots' within this range and 137 species have been reported, 31 of which are special status species.

It should be noted that the Pinaleño Mountains have historically been habitat for American Dippers, especially along Ash Creek, there are two eBird reports (Surveys 2B) of this species in the proposed IBA, one from 1987, the other from 1992. American Dippers are also shown as breeding along Ash Creek in the Pinaleño Mountains in the 2005 Arizona Breeding Bird Atlas. If you are birding in the Pinaleño Mountains and see an American Dipper please let either Arizona IBA office know as soon as you can.

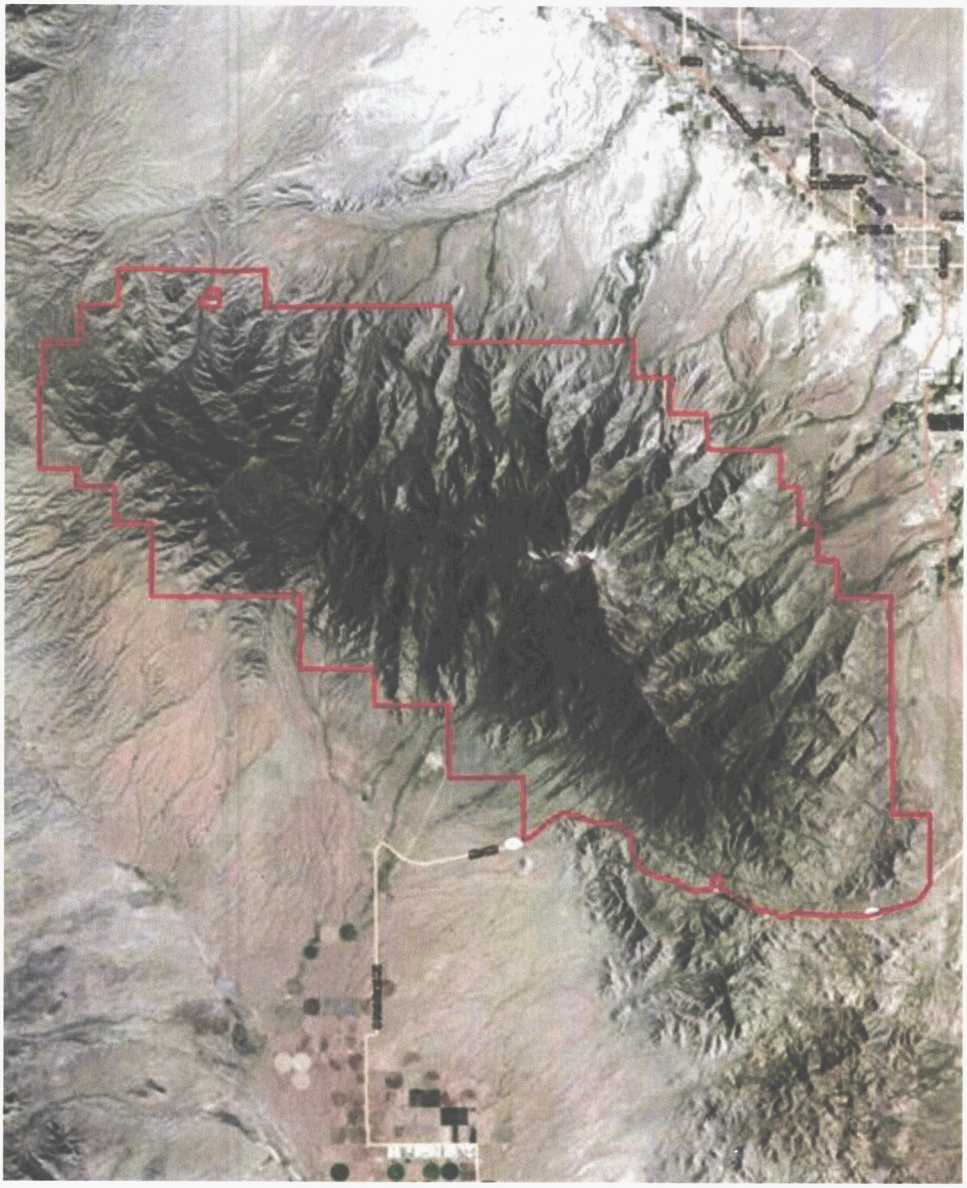
Conservation Issues: This is such a fragile eco-system that even small climate changes can have a profound effect. With potentially larger climate changes underway, the ecology of the Pinaleños could be threatened. This is the interpretation of the Forest Service. In particular some view the fires of 2004 as an event possibly driven in part by global warming. The agency states that "global climate change and drought are helping to poise the Pinaleños for epidemic insect or disease outbreaks and catastrophic, stand-replacing fires. Indeed, both of these events have taken

place in recent years. The flora and fauna have not evolved to tolerate these new conditions or catastrophic events, so there is a need to use silvicultural management and prescribed burning to begin to restore the natural balance in the remaining forests and woodlands

Ecological Systems of the Pinaleños. Map courtesy of Sky Island Alliance



Piñaleno Mountains IBA boundary



http://aziba.org/?page_id=712 accessed 10/12/2015

Willcox Playa/Cochise Lakes IBA

Location: 609284 N 3557623 E UTM NAD27

County: Cochise

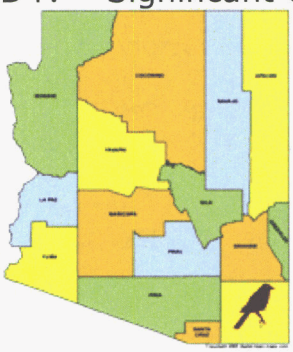
Site Status: Identified 06/2009, Global Identified 10/2011

Ownership: Federal, State and City of Willcox

Area: 74 square miles, 47,343 acres

Criteria: D1 – Site Important to Special Status Avian Species – Swainson's Hawk, Scaled Quail, Chestnut-collared Longspur and Cassin's Sparrow

D4v – Significant Concentrations of Birds – Shorebirds (100+)



D4vi – Significant Concentrations of Birds – Cranes (2000+)

Site Description: The heart of this IBA is the massive Willcox Playa, a broad alkaline lakebed fringed with semi-desert grassland (primarily saltgrass and sacaton) and mesquite. The playa is seasonally flooded to a shallow depth. Outlying this playa are the satellite lakes/wetlands of Cochise Lakes (or aka Lake Cochise), alkali flats, and Willcox Playa Wildlife Area containing Crane Lake. The Playa itself is a former bombing range, and owned by the Department of Defense and administered by the U.S. Army Corps of Engineers. It is not managed in anyway, and is posted no trespassing. On the upper east side of the playa is the Arizona Game and Fish Department managed Willcox Playa Wildlife Area, consisting of 555 acres. The purpose of the Wildlife Area is primarily for optimizing waterfowl habitat and providing for hunting opportunities. There are ten "pot hole" ponds, and one 30-acre impoundment at the Wildlife Area. Over-wintering Sandhill Cranes and migratory and wintering shorebirds, waterfowl, and water birds use the playa, the Wildlife Area (Crane Lake), and Cochise Lakes for roosting, resting, and feeding. Sandhill Cranes depend heavily on the surrounding agricultural lands of the broader Sulphur Springs Valley for feeding, particularly in fields of waste corn.

Ornithological Importance: Willcox Playa and Crane Lake, within the northern portion of the Sulphur Springs Valley of Southeast Arizona, supports the second largest over-wintering concentration of Sandhill Cranes (Grus canadensis) in Arizona, typically 4,000 to 9,000 birds (White Water Draw is the area with the largest number of over-wintering cranes, 10,000 to 22,000 and increasing). Crane numbers are typically 5,000 to 8,000 birds using the Playa, and another 4,000 to 5,000 birds using Crane Lake (with much variability at Crane Lake). There are occasional years when crane numbers spike when a large number of birds (>13,000) from White Water Draw switch to roosting in this area (using either the Playa or Crane Lake). By the late 1940s the expansion of agriculture within the Sulphur Springs Valley (through the advent of groundwater pumping), provided the waste crop food base (corn) to attract Sandhill Cranes to over-winter in the valley. The wetter period of the mid 1980s brought large increases in crane numbers, and since then numbers have been steadily increasing at both White Water Draw and the Willcox Playa/Crane Lake within the Valley. This area easily qualifies under the AZ IBA Program criteria for Cranes (2000+ birds). Cochise Lakes and an area of nearby alkaline lakes, also provide important habitat for a great number of bird species in this IBA.

This IBA also qualifies under the Arizona IBA Shorebird criteria (100+ shorebirds at one time during some part of the year). Most significantly both in spring and late summer the shorebirds can stop-over in very substantial numbers at both the playa and along Cochise Lakes (numbering 400-800 individuals at Cochise Lakes). These in-migration shorebird species using the playa and Cochise Lakes, include: Wilson's Phalarope (April, May, July, Aug., Sept.), Willet (April), Least Sandpiper (April, Aug., Sept.), Western Sandpiper (April, Aug., Sept.), Long-billed Dowitcher (May, Sept.), Black-necked Stilt (July, Aug., Sept.), and American Avocet (July, Aug., Sept.), plus lesser numbers of other shorebird species (Killdeer, Marbled Godwit, Spotted Sandpiper, Solitary Sandpiper, Greater Yellowlegs, Long-billed Curlew, Baird's Sandpiper, Pectoral Sandpiper, Stilt Sandpiper, and Red-necked Phalarope). Small numbers of some shorebirds occasionally breed within the IBA, including American Avocet and rarely Snowy Plover (Audubon WatchList 2007-Yellow, AZGFD Species of Greatest Conservation Need 2006).

One waterbird species is notably abundant also during migration, this is the White-faced Ibis (April), reaching numbers occasionally in the low 100s (~300).

Cochise Lakes support many species of ducks and grebes. Ducks over-winter on the lakes in large flocks, primarily composed of American Wigeon (low 100s), Northern Shovelor (low 100s), and Green-winged Teal (15-50+). In spring, March and April and again in fall, September and October, large numbers of waterfowl pass through and use Cochise Lakes, including: Ruddy Duck (low 100s), Lesser Scaup (occasionally 100+), Ring-necked Duck (< 50), and Cinnamon Teal (<50). In rare very wet winters, waterfowl in huge numbers (>15,000, half or which are Green-winged Teal) come to feed and rest within the Playa. Mallard "Mexican" ducks nest within the Willcox Playa Wildlife Area. Small numbers of Pied-billed Grebe, and rarely Eared Grebe may also nest.

The alkaline (mud) lakes are important to feeding shorebirds, so are the margins of the Playa and Cochise Lakes. Peregrine Falcon and Merlin are frequently in the IBA in the winter preying on the duck and shorebird community.

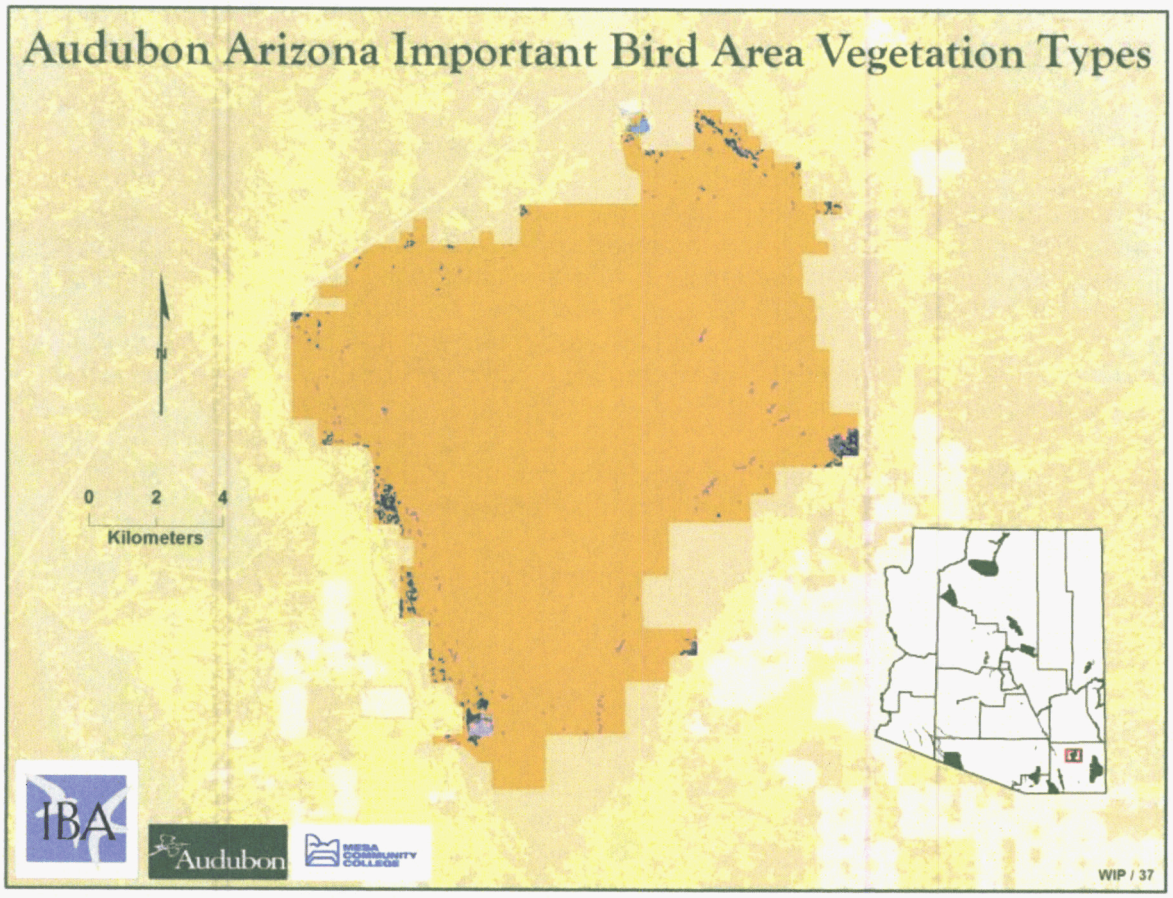
Scaled Quail (Audubon WatchList 2007-Yellow), Cassin's Sparrows (AZ PIF Priority 1999), Bendire's Thrashers – very rare (IUCN Vulnerable, Audubon WatchList 2007-Red), and Swainson's Hawks (Audubon WatchList 2007-Yellow) nest on the perimeter of the playa. Occasionally, flocks of Chestnut-collared Longspurs (Mar, Oct. <100) (Audubon

WatchList 2007-Yellow), and McCown's Longspur (Nat. PIF WatchList 2004, Homer Hansen pers. com.), over-winter and/or pass through during migration, foraging in the grasslands within this IBA.

Conservation Issues: The primary threat to the Willcox Playa/Lake Cochise is urban/suburban development surrounding the playa and the resulting concurrent increase in groundwater pumpage leading to declining groundwater levels. This would impact the taller riparian vegetation, potentially leading to die-offs of native riparian trees. Additionally, urban/suburban development would increase human disturbance of wildlife using the playa (particularly through associated OHV use), and increase predation rates by humans inadvertently enhancing local predator populations, and by human pets (particularly feral cats) and therefore causing overall higher predation rates and/or displacement of nesting, roosting, or foraging bird populations.

An additional threat is non-native animals (bull frogs) and plants (Giant Reed, Tamarisk, and others), and their resulting impact and competition with native fauna and flora.

Apparently, no active steps for site conservation management are taking place at present (with regards to the above).



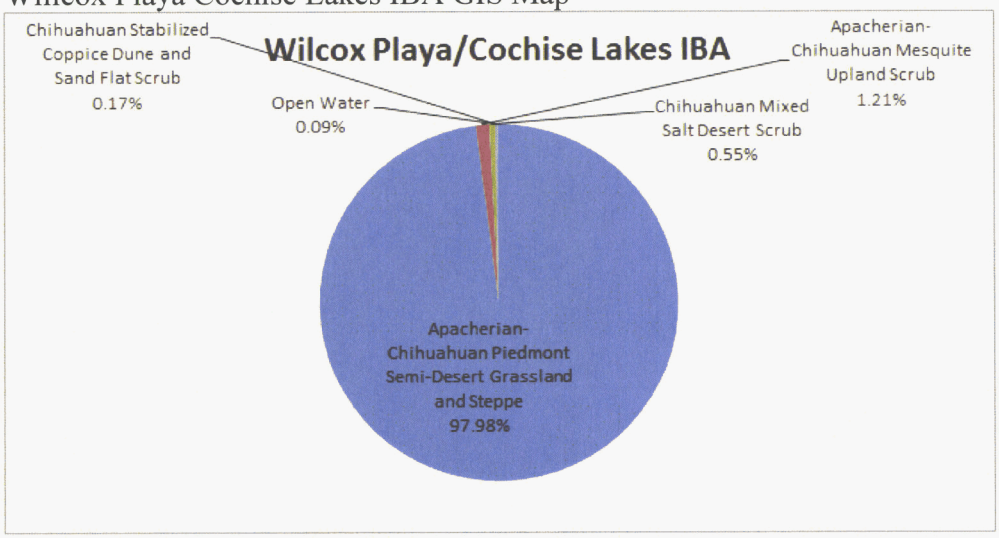
Wilcox Playa / Cochise Lakes IBA

Southwest Regional GAP Analysis Project

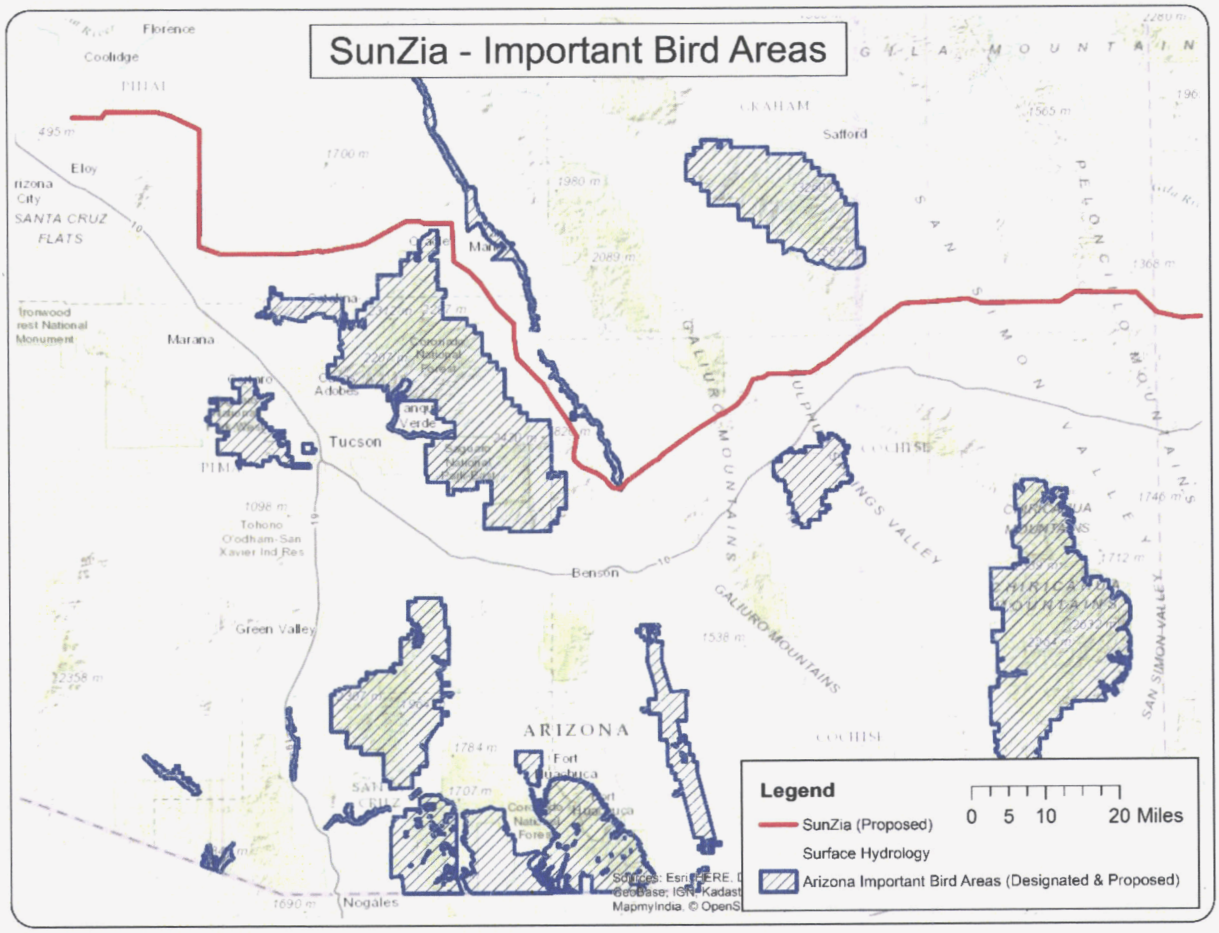
- Apacherian-Chihuahuan Mesquite Upland Scrub
- Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe
- Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub
- Chihuahuan Mixed Salt Desert Scrub
- Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub
- Developed, Medium - High Intensity
- Developed, Open Space - Low Intensity
- Mesquite
- North American Warm Desert Pavement
- Open Water
- Riparian

Willcox PlayaCochise Lakes IBA GIS Map – zoomed out

Willcox Playa Cochise Lakes IBA GIS Map



Map illustrating SunZia route in relationship to IBAs



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DOCKET NO. L-00000YY-15-0318-00171-MCV_2

August 2012

Pima County Wildlife Connectivity Assessment: Detailed Linkages

Santa Catalina/Rincon – Galiuro Linkage Design

Lower San Pedro River

Prepared for Pima County Regional Flood Control District

Prepared by Pima County Office of Conservation Science

RFCD

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Executive Summary

Habitat loss and fragmentation are the leading threats to biodiversity, both globally and in Arizona. These threats can be mitigated by conserving well-connected networks of wild areas where natural ecological and evolutionary processes operate over large spatial and temporal scales. Large wildland blocks connected by corridors can maintain top-down regulation by large predators, natural patterns of gene flow, pollination, dispersal, energy flow, nutrient cycling, inter-specific competition, and mutualism. Corridors allow ecosystems to recover from natural disturbances such as fire or flood, and to respond to human-caused disturbance such as climate change and invasions by exotic species. A healthy ecosystem has a direct impact on the economy of an area as well. In an effort to maintain habitat connectivity in southern Arizona, the Arizona Game and Fish Department, in collaboration with the Regional Transportation Authority of Pima County, has developed this GIS-based linkage design.

Arizona is fortunate to have large conserved wildlands that have not yet been fragmented by development pressures, but there are many man-made barriers on the landscape that prevent a truly interconnected ecological system. With funding through the Regional Transportation Authority of Pima County, two workshops were held in 2011, bringing together a broad range of stakeholders with backgrounds in planning, wildlife conservation, development, academia, and government to identify and map important wildlife movement areas across Pima County. Stakeholders and partners also highlighted five linkage planning areas where wildlife connectivity is of particular importance to conserve, and that would benefit from a more detailed conservation plan which addresses wildlife permeability issues. These were areas previously not modeled, and largely followed the Critical Landscape Connections broadly-defined in Pima County's Conservation Lands System, as part of the county's Sonoran Desert Conservation Plan.

In this report, we used a scientific modeling approach (described at http://corridordesign.org) to create a corridor (linkage design) that will conserve and enhance wildlife movement between two protected wildland blocks east of Tucson, Arizona: the Santa Catalina and Rincon Mountains (Catalina/Rincon), and the Galiuro Mountains (Galiuro). These areas represent a large public investment in biological diversity, and the linkage design presented in this report works to maintain and increase the value of that investment. This linkage design facilitates movement and reproduction of wildlife between the Santa Catalina and Rincon Mountains, and Galiuro Mountains (see *Figure 1* below).

This linkage design is based on a focal species approach. We identified 18 focal species to model, which are known to inhabit or which historically inhabited the previously mentioned wildland blocks, based on the recommendations of workshop participants, and other agency and academic scientists. Species of Greatest Conservation Need potential species distributions, as identified and modeled in Arizona's State Wildlife Action Plan, were also used to confirm possible focal species presence, through Habimap Arizona$_{TM}$. Focal species, in which habitat and/or corridors were modeled as part of this report, include eleven mammals, five reptiles, and two amphibians (see *Table 1* below). Species selected are sensitive to habitat loss and fragmentation, and represent the range of habitat and movement requirements of wildlife found in the region. For example, species such as mule deer are averse to crossing roads. Mountain lion require very large areas to ensure population viability and successful dispersal, and Gila monster and desert tortoise require specialized habitats for survival. The 18 species used to create this linkage design thus provide for the connectivity needs of many others not modeled that are found in the region, as represented by tables of known element occurrence within the linkage design recorded in Arizona's Heritage Data Management System (see *Appendix D* at the end of this report) at the end of this report.

Many of the species identified as having element occurrence within the linkage design are also recognized by Pima County's Sonoran Desert Conservation Plan as priority vulnerable, or are federally listed as threatened or endangered.

To identify potential routes between existing protected areas we used GIS methods to identify a biologically best corridor for each focal species to move between the Catalina/Rincon and Galiuro wildland blocks. We also analyzed the size and configuration of suitable habitat patches to verify that the final linkage design provides live-in or move-through habitat for each focal species. We visited focus areas in the field to identify and evaluate barriers to wildlife movement, and we provide detailed mitigations for those barriers in the section titled Linkage Design and Recommendations.

The Santa Catalina/Rincon – Galiuro linkage currently contains few obstacles to wildlife movement. The San Pedro River Valley, in which this linkage passes through, is a relatively pristine place. National Forest, and large ranches currently provide much open space for wildlife to move through. However, some threats to connectivity in this area do exist. Redington and Cascabel Roads, although currently gravel, and passable by wildlife, are increasing in traffic volume. Utility transmission lines are a particular threat to this area, due to the large amounts of riparian habitat within the linkage, and the numerous birds that live and breed here. While this area has seen little development thus far, it is important that a plan to conserve connectivity be established before threats to wildlife movement are well established. Conservation of this linkage requires a proactive planning approach, rather than a reactionary one. This area remains permeable to a wide variety of wildlife species, and that permeability should be maintained into the future. It is important to consider this linkage design for any future projects that may threaten wildlife movement in the future.

This report contains recommendations to maintain permeability for wildlife throughout the linkage design, ultimately allowing the movement of wildlife populations, and associated flow of genes, between the Santa Catalina and Rincon Mountains, and the Galiuro Mountains to continue. This linkage design presents a vision that would maintain large-scale ecosystem processes that are essential to the continued integrity of existing conservation investments. Without accommodating wildlife needs through thoughtful land-use and project planning, the high level of connectivity in this area will suffer.

Next Steps

This linkage design is a science-based starting point for conservation actions. The plan can be used as a resource for regional land managers to understand their critical role in sustaining biodiversity and ecosystem processes. Relevant aspects of this plan can be folded into management plans of agencies managing public lands. Regulatory agencies can use this information to help inform decisions regarding impacts on streams and other habitats. This report can also help motivate and inform watershed planning, habitat restoration, conservation easements, zoning, and land acquisition. Implementing this plan will take decades, and collaboration among county planners, land management agencies, resource management agencies, land conservancies, and private landowners.

Public education and outreach is vital to the success of this effort, both to change land use activities that threaten wildlife movement, and to generate appreciation for the importance of the linkage design. Public education can encourage residents at the urban-wildland interface to become active stewards of the land and to generate a sense of place and ownership for local habitats and processes. Such voluntary cooperation is essential to preserving linkage function. The biological information, maps, figures, tables, and photographs in this plan are ready materials for interpretive programs.

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Introduction

Nature Needs Room to Move

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 wildlife 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. These diverse movement patterns ensure individual survival and in doing so help protect local populations from extinction (Laurance 1991; Beier and Loe 1992), ensure genetic diversity and reduce the risk of inbreeding via gene flow (Beier and Loe 1992; Bennett 1999), and facilitate critical ecological processes such as pollination and seed dispersal.

Habitat fragmentation, or the process through which previously intact areas of habitat are divided into smaller disconnected areas by roads, urbanization, and other barriers, decreases the degree of habitat connectivity of the landscape for wildlife that once moved freely through a mosaic of natural vegetation types. Habitat fragmentation is a major reason for regional declines in native species and can have consequences 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 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).

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 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 height), 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). 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).

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; see *Figure 2* below). The CLS represents the conservation reserve design of the widely-acclaimed Pima County 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, shown by the purple arrows in the map below (see *Figure 2* below).

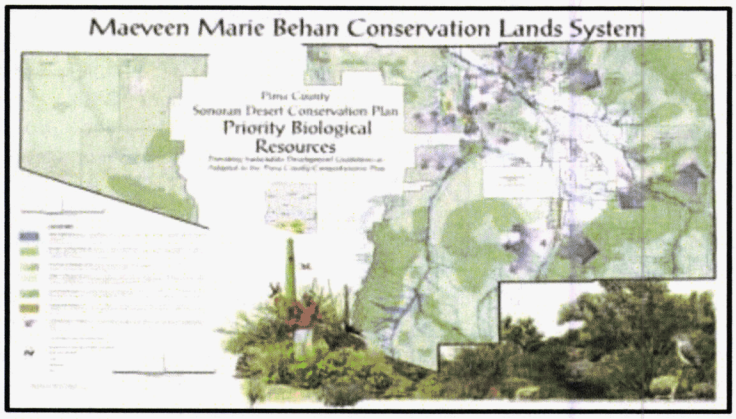


Figure 2: *The Maeveen Marie Behan Conservation Lands System shows the biologically preferred reserve design and works to provide sustainable guidelines for future development. Critical Landscape Connections, or broadly-defined areas where wildlife connectivity is significantly compromised, but can still be improved, are shown by the purple arrows (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). These bond acquisitions actively protect a diverse array of biologically-rich areas and maintain the landscape network of habitat connectivity throughout Pima County.

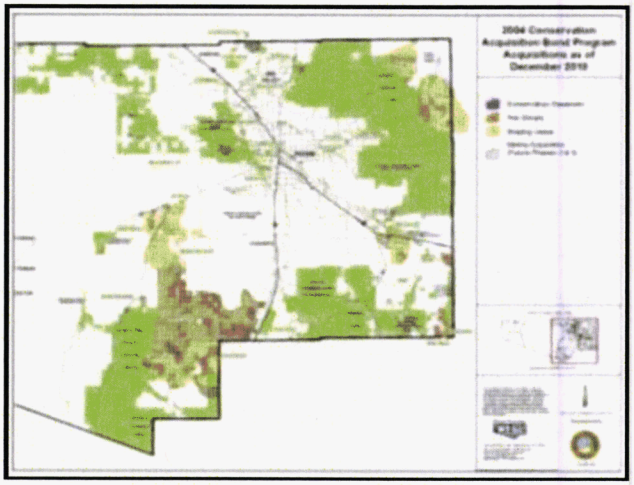


Figure 3: *The 2004 Conservation Acquisition Bond Program was approved to help implement the Sonoran Desert Conservation Plan (Pima County 2011). Multi-use lands are important for habitat and wildlife conservation in the region.*

In 2006, Pima County voters approved a sales tax increase that allowed the formation of the Regional Transportation Authority of Pima County (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 the Tucson – Tortolita – Santa Catalina Mountains Linkage Design (Beier et al. 2006a) 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). 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.

Linkage Planning in Arizona: A Statewide-to-Local Approach

Habitat connectivity can be represented at various spatial scales. In Arizona, we have found it valuable to identify statewide, county-wide, and fine-scale habitat blocks and wildlife linkages to serve different conservation and planning objectives. The linkage planning tools created at each scale have led to a progressive refinement of our knowledge of wildlife movement areas and threats to habitat connectivity across the state, and the fine-scale linkage design presented in this report owes much to the broader-scale efforts that preceded it.

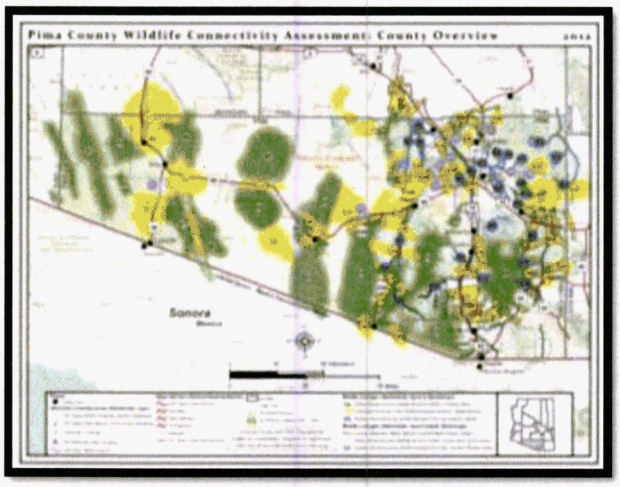
Arizona's statewide wildlife linkage planning efforts began in 2004 when federal, state, municipal, academic, and non-governmental biologists, and land managers participated in a workshop to map important habitat blocks, linkages, and potential threats to connectivity across the state. This workshop was convened by the Arizona Wildlife Linkages Workgroup, a collaboration that included the Arizona Game and Fish Department (AGFD), Arizona Department of Transportation, Federal Highways Administration, Northern Arizona University (NAU), Sky Islands Alliance, US Bureau of Land Management, US Fish and Wildlife Service, US Forest Service, and the Wildlands Network, and resulted in Arizona's Wildlife Linkages Assessment (AWLA; Arizona Wildlife Linkages Workgroup 2006; see *Figure 4* below). The AWLA provides a vision for maintaining habitat connectivity in a rapidly growing state and has served as the foundation for subsequent regional and local efforts, including the creation of fine-scale GIS linkage designs by scientists at NAU (available at www.corridordesign.org) which provided the template for this report.

The statewide assessment was followed by an effort to map wildlife linkages and potential barriers within individual Arizona counties. Beginning in 2008 the AGFD partnered with county planners to organize workshops which gathered stakeholders with backgrounds in planning, wildlife conservation, transportation, academia and government.

Overview of the Pima County Wildlife Connectivity Assessment

Continuing with the statewide strategy to identify and prioritize linkages at the county level for GIS modeling of wildlife connectivity, AGFD received funding from the Regional Transportation Authority of Pima County. This funding allowed AGFD 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. To accomplish these tasks, AGFD joined with partner organizations (please see Acknowledgments for a list of members of the Pima County Wildlife Connectivity Workgroup) to initiate the Pima County Wildlife Connectivity Assessment. This project built on prior initiatives including the SDCP and AWLA. The Pima County Wildlife Connectivity Assessment (available at http://www.azgfd.gov/w_c/conn_Pima.shtml) represented a continuation of these previous efforts by identifying wildlife linkages at a finer scale that may have been overlooked in the earlier products, as well as those that will be useful for regional and local transportation or land-use planning efforts (see *Figure 5* below). With input gathered by the stakeholders at the workshops and with additional input by the Pima County Wildlife Connectivity Workgroup, five areas encompassing numerous wildlife linkages were suggested as priorities for the development of detailed linkage designs with specific recommendations for implementation. These priority areas largely followed the broadly-defined Critical Landscape Connections from the SDCP. However, additional areas not previously considered as Critical Landscape Connections were also added as a priority to model, due to their biological resources, and threats to wildlife. The Catalina/Rincon - Galiuro linkage planning area was one of those prioritized areas. Other areas include Coyote – Ironwood – Tucson, Kitt Peak, Mexico – Tumacacori – Baboquivari, and Sierrita – Santa Rita.

4)



5)

Figure 4 and Figure 5: *Statewide map of wildlife linkages and barriers created by the Arizona Wildlife Linkages Workgroup (2006). County-wide map of wildlife linkage created for the Pima County Wildlife Connectivity Assessment: Report on Stakeholder Input (2012 (Maps: Courtesy Arizona Wildlife Linkages Workgroup and Arizona Game and Fish Department).*

Ecological Significance and Existing Conservation Investments of the Santa Catalina/Rincon – Galiuro Linkage Planning Area

In this section, we describe the ecology and conservation investments of the linkage planning area, including the wildland blocks, and the potential linkage area between them:

Ecological Significance of the Santa Catalina/Rincon – Galiuro Linkage Planning Area

The Santa Catalina/Rincon – Galiuro linkage area in Pima County lies at the crossroads of two major ecoregions: the Apache Highlands, which create the mountainous sky islands, and the Sonoran Desert, which extends west and south into Mexico. The Sonoran Desert is the most tropical of North America's warm deserts (Marshall et al. 2000). Bajadas sloping down from the mountains support forests of ancient saguaro cacti, palo verde, and ironwood; creosote bush and bursage desert scrub dominate the lower desert. The Sonoran Desert Ecoregion is home to more than 200 threatened species, and its uniqueness lends to a high proportion of endemic plants, fish, and reptiles (Marshall et al. 2000; The Nature Conservancy 2006). More than 500 species of birds migrate through, breed, or permanently reside in the ecoregion, which are nearly two-thirds of all species that occur from northern Mexico to Canada (Marshall et al. 2000). The Sonoran Desert Ecoregion's rich biological diversity prompted Olson and Dinerstein (1998) to designate it as one of 233 of the earth's most biologically valuable ecoregions, whose conservation is critical for maintaining the earth's biodiversity.

This diversity supports many mammals, reptiles, birds, and amphibian species. Wide-ranging mammals include among others, and badger, mountain lion, and mule deer. Many of these animals move long distances to gain access to suitable foraging or breeding sites, and would benefit significantly from corridors that link large areas of habitat (Turner et al. 1995). Less-mobile species and habitat specialists such as Gila monsters also need corridors to maintain genetic diversity, allow populations to shift their range in response to climate change, and promote recolonization after fire or epidemics.

Two wildland blocks exist here: the Santa Catalina and Rincon Mountains (Catalina/Rincon), and the Galiuro Mountains (Galiuro). These wildland blocks are separated by various topographic features, including the flat lands of San Pedro Valley between the Catalina/Rincon and Galiuro wildland blocks. Man-made features separating the blocks include: gravel roads, and the farming communities Cascabel and Redington.

Maintaining connectivity between these wildland blocks would help to provide the contiguous habitat necessary to sustain viable populations of sensitive and far ranging species in these ecoregions, and provide the chance for important focal species, such as desert bighorn sheep, to expand their range to historically used habitats. Providing connectivity is paramount in sustaining this unique area's diverse natural heritage. Future human activities could sever natural connections and alter the functional integrity of this natural system. Conserving linkages will ensure that wildlife will thrive in the wildland blocks and the potential linkage area.

Below is a description of the ecological significance of each wildland block (see *Figure 6* below for a map of land cover categories):

Catalina/Rincon Wildland Block

The Catalina/Rincon wildland block encompasses over 336,000 acres of the Santa Catalina and Rincon Mountains, east of Tucson, Arizona. These mountains are dominated by pine-oak forest and woodland, which comprise the largest percentages of its land cover classification, along with chaparral and pinyon-

juniper woodland. The wildland block is also comprised of encinal oak woodland, mesquite upland scrub, ponderosa pine woodland, and semi-desert grassland and steppe, among various other land cover types. Elevation here ranges from 2,638 feet to 9,147 feet.

Galiuro Wildland Block
The Galiuro wildland block includes over 144,000 acres of land encompassing the Galiuro Mountains. The majority of the land cover within the wildland block is comprised of pine-oak forest and woodland, chaparral, and pinyon-juniper woodland. Mesquite upland scrub, ponderosa pine woodland, and semi-desert grassland and steppe, also make up the wildland block, among various other land cover types. Barren lands comprise most of the remaining portions. Elevation in this block ranges from 3,419 feet to 7,635 feet.

Conservation Investments in the Santa Catalina/Rincon – Galiuro Linkage Planning Area

The Catalina/Rincon and Galiuro wildland blocks represent large conservation investments that protect habitat for different wildlife species in the linkage planning area. Connectivity between these wildland blocks helps to provide the contiguous habitat necessary to sustain viable populations of sensitive and far ranging species in the Apache Highlands and Sonoran Desert, and provide the chance for important focal species, such as desert bighorn sheep, to expand their range to historically used habitats. Maintaining connectivity is paramount in sustaining this unique area's diverse natural heritage. Future human activities could sever natural connections and alter the functional integrity of this natural system. Conserving and restoring linkages will ensure that wildlife will thrive in the wildland blocks and the potential linkage area:

Below is a description of the conservation investments of each wildland block (see *Figure 7* below for a map of conservation investments):

Catalina/Rincon Wildland Block
The Catalina/Rincon wildland block includes the Pusch Ridge Wilderness which is over 56,000 acres managed by the U.S. Forest Service. Also included is the over 36,000 acre Rincon Mountain Wilderness, administered by the U.S. Forest Service, and the over 71,000 acre Saguaro East Wilderness administered by the U.S. National Park Service. Besides these wilderness areas, the Catalina/Rincon wildland block includes over 265,000 acres of the Coronado National Forest.

Galiuro Wildland Block
Both the over 77,000 acre Galiuro Wilderness, administered by the U.S. Forest Service, and the Redfield Canyon Wilderness, administered by the U.S. Bureau of Land Management, are within a portion of the Galiuro wildland block. Also included as part of this wildland block, is the over 134,000 acres portion of the Coronado National Forest

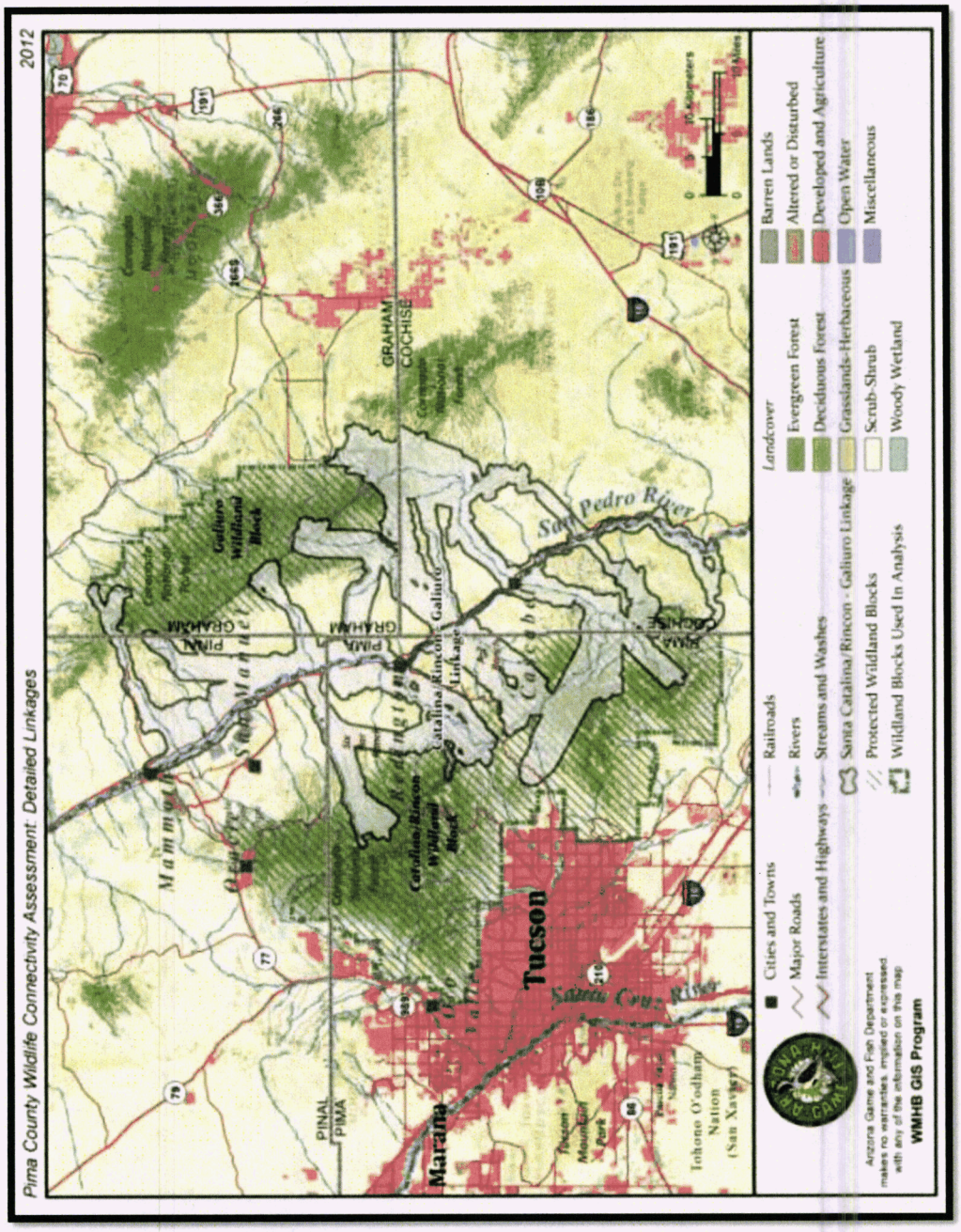


Figure 6: *Land cover in the Santa Catalina/Rincon – Galiuro linkage design*

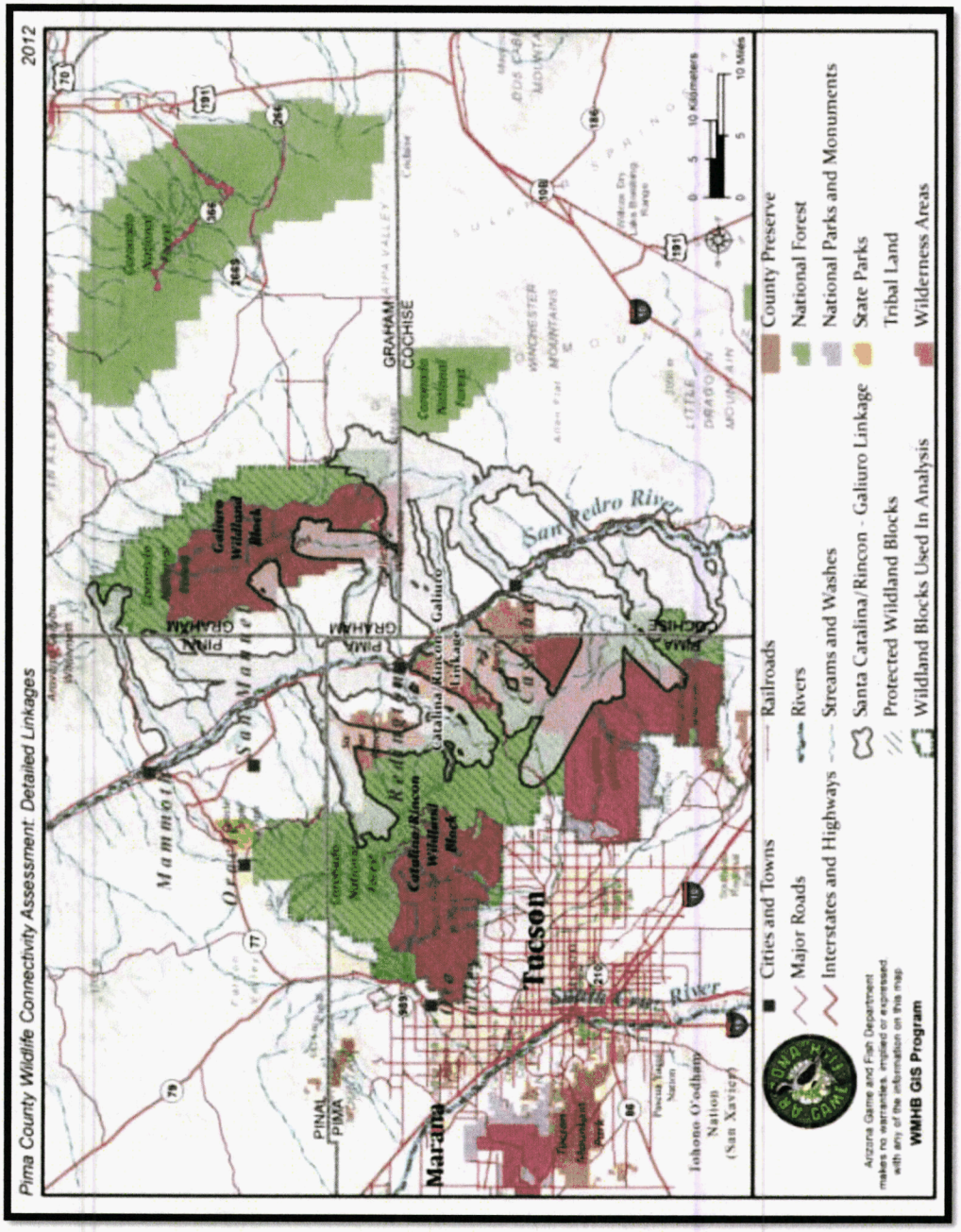


Figure 7: *Existing conservation investments in the Santa Catalina/Rincon – Galiuro linkage design*

The Santa Catalina/Rincon - Galiuro Linkage Design

In this section, we describe the linkage design and summarize the barriers to animal movement it encompasses. Methods for developing the linkage design are described in *Appendix A*.

One Linkage Provides Connectivity Across a Diverse Landscape

- Provide move-through habitat for diverse group of species
- Provide live-in habitat for species with dispersal distances too short to traverse linkage in one lifetime
- Provide adequate area for a metapopulation of corridor-dwelling species to move through the landscape over multiple generations
- Provide a buffer protecting aquatic habitats from pollutants
- Buffer against edge effects such as pets, lighting, noise, nest predation and parasitism, and invasive species
- Allow animals and plants to move in response to climate change

The Santa Catalina/Rincon – Galiuro Linkage

The Santa Catalina/Rincon - Galiuro linkage runs between the Catalina/Rincon wildland block and the Galiuro wildland block, across the San Pedro Valley. It spans about 36 km (22 mi) in a straight-line between each wildland block used in this analysis. The linkage design encompasses 336,007 acres (135,978 ha) of land, of which over 46% is State Trust land, 23% is administered by the U.S. Forest Service, 19% is private land, 8% is administered by the U.S. Bureau of Land Management, and the rest by the U.S. National Park Service (see *Figure 1* for a map of the linkage design and land ownership at the beginning of this report). It is primarily composed of mesquite upland scrub (18.2%), semi-desert grassland and steppe (13.8%), miscellaneous desert scrub (11.5%), encinal oak woodland (11.5%), creosotebush, mixed desert and thorn scrub (11.5%) and paloverde-mixed cacti desert scrub (11.1%; see *Table 2* below). A range of topographic diversity exists within the linkage design, providing for the ecological needs of the focal species, as well as creating a buffer against a potential shift in ecological communities due to climate change (see *Figure 8* below). The average slope within the linkage is 9.4% (Range: 0 – 240.9%, SD: 17.9). Most of the land (49.4%) is steep sloped, and flat-gentle sloped (33.2%), with the rest a mix of canyon bottom and ridgetop. Most land aspects are well represented, with the exception of flat aspects.

This linkage between the Santa Catalina and Rincon Mountains, and Galiuro Mountains is a relatively undeveloped and intact landscape. However, barriers to wildlife connectivity still exist:

Redington/Cascabel Road

An animal moving terrestrially between the Catalina/Rincon and Galiuro wildland blocks eventually must cross Redington/Cascabel Roads. Although Redington/Cascabel Roads are currently gravel, Pima County stakeholders indicated traffic volume is increasing (Arizona Game and Fish Department 2012b). Also, this transportation route has been considered for major transportation projects in the past, such as the I-10 bypass (Arizona Department of Transportation 2008).

Stream Impediments

The San Pedro River's riparian habitat is crucial for many species of wildlife, and represents a rare commodity in the arid southwest. The Nature Conservancy (2012) states, "The San Pedro River's cottonwood-shaded corridor provides critical stopover habitat for millions of migrating birds each year. It is one of only two major rivers that flow north out of Mexico into the United States and is one of the last large undammed rivers in the Southwest." Threats to this riparian habitat include groundwater withdrawal and damage from off-highway vehicles (Tucson Audubon Society 2012).

Utility Infrastructure

The San Pedro Valley has been considered as a preferred Route for the SunZia Southwest Transmission Project (U.S. Bureau of Land Management 2012). Utility infrastructure can be a particular threat in the San Pedro Valley due to the numerous bird species that depend on the San Pedro riparian corridor. The Tucson Audubon Society in partnership with the Arizona Game and Fish Department have designated the Lower San Pedro River as an Important Bird Area, highlighting the importance of this area for a variety of bird species (Tucson Audubon Society 2012).

Table 2: *Approximate land cover found within the Santa Catalina/Rincon – Galiuro linkage design*

Land Cover Group	Land Cover Class	% of Linkage Design
Evergreen Forest	Encinal (Oak Woodland)	0.5%
Evergreen Forest	Pinyon-Juniper Woodland	0.2%
Grasslands-Herbaceous	Semi-Desert Grassland and Steppe	0.8%
Scrub-Shrub	Chaparral	0.1%
Scrub-Shrub	Creosotebush, Mixed Desert and Thorn Scrub	0.4%
Scrub-Shrub	Creosotebush-White Bursage Desert Scrub	9.6%
Scrub-Shrub	Desert Scrub (misc)	1.7%
Scrub-Shrub	Mesquite Upland Scrub	4.2%
Scrub-Shrub	Paloverde-Mixed Cacti Desert Scrub	64.5%
Woody Wetland	Riparian Mesquite Bosque	1.4%
Woody Wetland	Riparian Woodland and Shrubland	4.7%
Barren Lands	Barren Lands, Non-specific	2.1%
Barren Lands	Bedrock Cliff and Outcrop	0.2%
Barren Lands	Wash	2.7%
Developed and Agriculture	Agriculture	5.2%
Developed and Agriculture	Developed, Medium - High Intensity	0.7%
Developed and Agriculture	Developed, Open Space - Low Intensity	1.3%

Impacts of Stream and Riparian Impediments on Wildlife

Importance of Riparian Systems in the Southwest

Riparian systems are one of the rarest habitat types in North America. In the arid Southwest, about 80% of all animals use riparian resources and habitats at some life stage, and more than 50% of breeding birds nest chiefly in riparian habitats (Krueper 1996). They are of particular value in lowlands (below 5,000 feet) as a source of direct sustenance for diverse animal species (Krueper 1993). For example, the San Pedro River (see *Figure 19* below), and entire San Pedro River Valley, has been called, "One of the last great places..." by The Nature Conservancy (2012), and which also stated about the area's biodiversity, "The San Pedro River basin is home to 84 species of mammals, 14 species of fish, and 41 species of reptiles and amphibians." The Tucson Audubon Society, in partnership with the Arizona Game and Fish Department, has highlighted the San Pedro Valley's importance to birds, by designating it in their Important Bird Area's (IBA) program as the Lower San Pedro River IBA. The San Pedro River riparian habitat is crucial for numerous species of birds, including many that are federally listed as candidate, threatened, or endangered, such as the western yellow-billed cuckoo and southwestern willow flycatcher (Tucson Audubon Society 2012).

Stream Impediments in the Linkage Design

Most streams in Arizona have areas without surface water or riparian vegetation, and thus are naturally fragmented from the perspective of many wildlife species. But nearly all riparian systems in the Southwest also have been altered by human activity (Stromberg 2000) in ways that increase fragmentation. Fortunately, the San Pedro River is one of the last undammed rivers in the Southwest. Unfortunately, development and active agriculture near the river, is lowering the water table, and parts of the San Pedro River are no longer perennially flowing (The Nature Conservancy 2012). Off-highway vehicle use threatens the riparian vegetation established along the San Pedro River channel (Tucson Audubon Society 2012).

For animals associated with streams or riparian areas, impediments are presented by road crossings, vegetation clearing, livestock grazing, invasion of non-native species, accumulation of trash and pollutants in streambeds, farming in channels, and gravel mining. Groundwater pumping, upland development, water recharge basins, dams, and concrete structures to stabilize banks and channels change natural flow regimes which negatively impacts riparian systems. Increased runoff from urban development not only scours native vegetation but can also create permanent flow or pools in areas that were formerly ephemeral streams. Invasive species, such as bullfrogs and giant reed, displace native species in some permanent waters.

Development increasingly threatens the San Pedro River within the linkage design. Protection of the river and associated riparian areas and will ensure the utility of this corridor remains intact into the future.

Meyerson 2002). Elimination of unnatural perennial surface pools can eradicate water-dependent invasives like bullfrogs, crayfish, and mosquitofish.

6) **Where possible, protect or restore a continuous strip of native vegetation at least 200 m wide along each side of the channel.** Buffer strips can protect and improve water quality, provide habitat and connectivity for a disproportionate number of species (compared to upland areas), and provide numerous social benefits including improving quality of life for residents and increasing nearby property values (Fisher and Fischenich 2000; Parkyn 2004; Lee et al. 2004). Continuous corridors provide important wildlife connectivity but recommended widths to sustain riparian plant and animal communities vary widely (from 30 to 500 m) (Wenger 1999; Fisher and Fischenich 2000; Wenger and Fowler 2000; Environmental Law Institute 2003). At a minimum, buffers should capture the stream channel and the terrestrial landscape affected by flooding and elevated water tables (Naiman et al. 1993). Buffers of sufficient width protect edge sensitive species from negative impacts like predation and parasitism. We therefore recommend buffer strips on each side of the channel at least 200 m wide measured perpendicular to the channel starting from the annual high water mark.

7) **Enforce existing regulations.** We recommend aggressive enforcement of existing regulations restricting dumping of soil, agricultural waste, and trash in streams, and of regulations restricting farming, gravel mining, and building in streams and floodplains. Restricted activities within the buffer should include OHV use which disturbs soils, damages vegetation, and disrupts wildlife (Webb and Wilshire 1983).

Figure 19: *Riparian vegetation along the lower San Pedro River*

Impacts of Utility Infrastructure on Wildlife

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 (AGFD 2012b).

Specifically, one of the proposed routes, and the U.S. Bureau of Land Management (BLM) preferred alternative for the SunZia Southwest Transmission Project, travels through the San Pedro Valley and this linkage design (see *Figure 20* below). This proposed route threatens habitat connectivity for numerous wildlife species here, particularly that of the many bird species which depend on the mature riparian habitat along the San Pedro River (see *Appendix D* at the end of this report for a list of birds which have element occurrence data within the linkage design as recorded by Arizona's Heritage Data Management System).

Existing utility infrastructure in the Linkage Design
Some small above ground utility lines were observed within the linkage design during field observations. However, these transmission lines are much smaller in size than the SunZia two 500-kilovolt transmission lines proposed for construction through this area. The current utility infrastructure that exists within the linkage design may have little effect on the wildlife species that occur here. However, future large-scale utility infrastructure projects, like the proposed SunZia Southwest Transmission Project, may have numerous negative impacts on wildlife in the San Pedro Valley. Large-scale utility infrastructure projects would threaten wildlife connectivity in this linkage, specifically for the numerous rare bird species that use the area for reproduction (see *Appendix D* at the end of this report).

We provide the following recommendations from the Arizona Game and Fish Department (2009a) as a baseline for mitigating existing utility infrastructure, and the construction of utility infrastructure within the linkage design. However, the construction of large-scale utility infrastructure, like that proposed by the SunZia Southwest Transmission Project, may be devastating to the area's wildlife, regardless of the mitigation measures implemented.

Recommendations and Guidelines for Mitigating Utility Infrastructure

1) **To prevent avian collisions and electrocutions, bury all connecting power lines** associated with the solar development, unless burial of the lines would result in greater impacts to biological or archeological resources.
2) **Follow existing disturbed areas during installation to minimize habitat alterations**. In low areas where the power line crosses drainages, the soil should be compacted to reduce the potential for erosion.
3) **Trenching and backfilling crews should be close together** to minimize the amount of open trenches at any given time.
4) **Ideally, trenching should occur during the cooler months** (October – March) when wildlife are less active. However, there may be exceptions (e.g. critical wintering areas) that need to be assessed on a site-specific basis.
5) **Avoid leaving trenches open overnight** as they can be effective traps for wildlife. Where trenches cannot be back-filled immediately, escape ramps should be constructed at least every 45 meters. Escape ramps can be short lateral trenches or wooden planks sloping to the surface. The slope should be less than 45 degrees (1:1).
6) **Trenches that have been left open overnight should be inspected daily**, prior to work beginning, and any animals removed. Prior to backfilling, the trenches should be inspected and any animals removed. A monitoring schedule should be developed for each segment of the underground power line installation to ensure minimizing potential impacts to wildlife.
7) **All above-ground lines, transformers, or conductors should fully comply with the Avian Power Line Interaction Committee (APLIC) 2006 Standards** to prevent avian fatality, including use of various bird deterrents and avian protection devices. These are available online: http://www.aplic.org/uploads/files/2643/SuggestedPractices2006(LR-2).pdf.

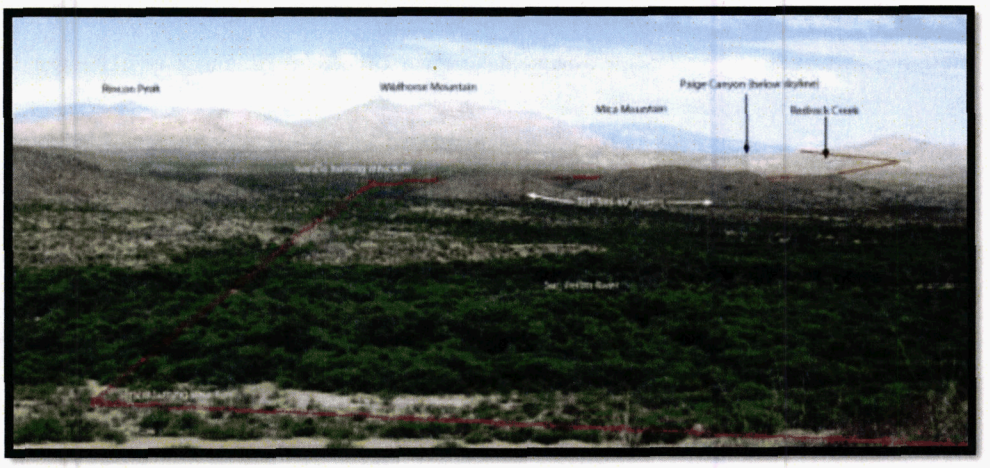


Figure 20: *Artist rendition of the estimated crossing location of the SunZia Southwest Transmission Project across the San Pedro River in the southern portion of the Santa Catalina/Rincon – Galiuro linkage design (Photo: Courtesy Norm Meader, Cascabel Working Group)*

3

AN ECOSYSTEM CONSERVATION ASSESSMENT OF THE LOWER SAN PEDRO WATERSHED IN ARIZONA

by

Scott L. Wilbor

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communities and agriculture (Ffolliott et al. 2004). In a few limited areas along the lower San Pedro River agriculture operations have modified immediately adjacent floodplains and constrained the river channel: in the past century this was more extensive, and many of these areas are now supporting shrub-tree mesquite thickets (Oleksyszyn 2001, Stromberg 2009b).

Upland communities of Sonoran desert scrub and shrub-mixed Sonoran semi-desert grassland and chaparral are threatened by habitat fragmentation, such as by new infrastructure projects and associated vegetation clearing (e.g., a proposed energy transmission line project, the SunZia Southwest Transmission Project), and by new roads and housing development (e.g., recent expansive housing development immediately to the west of the watershed). These latter threats can have landscape-levels effects, such as increased watershed erosion levels, the spread of invasive species, impaired landscape connectivity, and loss of climate-adaptation potential for species through disruption of local or regional movement opportunities.

Climate change, observed by increased annual temperatures of +1.4° F for the upper and lower San Pedro from 1951-2006 (Robles and Enquist 2010), is exacerbating drought conditions from 1996 to present (Richter 2008, ADWR 2013). On-going drought may further limit perennial water reaches and shallow groundwater zones supportive of riparian gallery forests, impact springs and seeps, and stress range conditions throughout the uplands. Riparian corridors can provide the major connectivity linkages of an ecosystem. They provide enhanced cover, shelter, forage and prey resources for dispersing individuals of species within a meta-population structure (Hilty et al. 2006). These same characteristics also allow species to adapt to changing climate by facilitating movement to suitable new habitat conditions or to more restricted climate refugia sites (Beier 2012). Additionally, continuous undisturbed landscape gradients, from valley lowlands to montane highlands, provide diverse physical environments (i.e., "land facets" -suites of geology, soils, and topography) that can promote evolutionary adaptation through a period of climate change (Beier and Brost 2010). Employing an ecosystem resilience adaptation approach is a favored climate adaptation strategy for biodiversity conservation (Morecroft et al. 2012). "Resilience" is defined by the ability of an ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change (IPCC 2007).

1.3 Conservation in the lower San Pedro Watershed

Within the lower San Pedro watershed stakeholders have diverse conservation interests and place value on a large spectrum of the watershed's natural resources. Land and

Based on these results, and continued networking over the study period, I assembled 15 GIS layers representing landscape-grounded conservation values for conservation value/target analysis, plus an additional 11 digital datasets for landscape analysis and climate adaptation modeling (Table 1).

Table 1. GIS spatial data layers and tools used in in landscape conservation prioritization within the lower San Pedro watershed, Arizona.

Data Layers	Source (time period)
Upland	
Grasslands - Apacherian-Chihuahuan Semi-Desert Grassland	NatureServe Terrestrial Eco-communities (2002)
Upland Sonoran Desert - Sonoran Paloverde-Mixed Cacti Desert Scrub	NatureServe Terrestrial Eco-communities (2002)
Riparian	
Surface Water - Perennial Reaches (length)	TNC Freshwater Assessment, TNC of AZ (2010)
Cottonwood/Willow (patches)	Digitized (SRP Imagery 2013, 0.61m res.)
Sycamore/Cottonwood (patches)	Digitized (SRP Imagery 2013, 0.61m res.)
Mesquite Bosque (≥ 5m)	Digitized (SRP Imagery 2013, 0.61m res.)
Valley Grasslands- Apacherian-Chihuahuan Semi-Desert Grassland (>99.9% this type, *Bouteloua sp./Muhlenbergi sp.* and many other grass sp.). Chihuahuan Loamy Plains Desert Grassland (Tobosa grass dominated), Chihuahuan-Sonoran Desert Bottomland and Swale Grassland (sacaton dominated)	NatureServe Terrestrial Eco-communities (2002)
Riparian Species	
Fish Habitat- Endangered Fish Habitat (as a percent of perennial water length by riparian reaches): Gila chub (*Gila intermedia*), Spikedace (*Meda fulgida*), and Loach minnow (*Tiaroga cobitis*)	AZGFD Heritage Program (Sep. 2013, dates 1976-2010) TNC Freshwater Assessment, TNC of AZ (2010)
Fish Habitat- All native fish (as a single coverage): loach minnow (*Tiaroga cobitis*), Spikedace (*Meda fulgida*), Roundtail chub (*Gila robusta*), Gila chub (*Gila intermedia*), Speckled dace (*Rhinicthys osculus*), longfin dace (*Agosia chrysogaster*), Desert sucker (*Catostomus clarki*), and Sonora sucker (*Catostomus insignis*)	AZGFD Heritage Program (Sep. 2013, dates 1976-2010)
Southwestern Willow Flycatcher (*Empidonax traillii extimis*)	U.S. Fish and Wildlife Service (2005-2010)
Yellow-billed Cuckoo (*Coccyzus americanus*)	Tucson Audubon Society, IBA Program (2013) Bureau of Reclamation (2011, 2013)
Gray Hawk (*Buteo nitidus*), Common Black-Hawk (*Buteogallus anthracinus*)	Tucson Audubon Society, IBA Program (2009, 2011) U.S. Geological Survey (2010, 2011)
Bird Habitat (comprehensive of various community and habitat types): Designated Lower San Pedro (Global) Important Bird Area, 2008	Tucson Audubon Society, IBA Program (2013)
American Beaver (*Castor canadensis*)	TNC of Arizona (2013) This study (2013)

Data Layers	Source (time period)
Coati (*Nasus nasua*)	Tucson Audubon Society. IBA Program (2012, 2013) This study 2013
Landscape Analysis	
Hydrological Unit Codes (8: watershed and 12s:sub-basins)- HUC 12s used for Upland Analysis Units and Riparian Analysis Unit mapping	U.S. Geological Survey (2013)
Aerial Imagery. San Pedro River (mainstem, 2ft. res.)	Salt River Project (2013)
Aerial Imagery. Counties of: Cochise, Pima, Pinal, and Graham	National Agriculture Inventory Project. NAIP, 1.0m res. (2013)
Holocene River Alluvium- used for Riparian Analysis Unit mapping	Cook et al. 2009
Digital Elevation Model- used for HLI, TRI, and Elevation Range	U.S. Geological Survey (2013)
Heat Load Index (HLI)- used in Climate Adaptation Modeling	U.S. Geological Survey (2013) Evans et al. 2013 (Feb. 2013)
Topographic Variability- Topographic Roughness Index (TRI), used in Climate Adaptation modeling	U.S. Geological Survey (2013) Evans et al. 2013 (Feb. 2013)
Elevation Range (max)- used in Climate Adaptation modeling	U.S. Geological Survey (2013) Arc-GIS Tools
Springs- Springs & Seeps- used in Climate Adaptation modeling	National Hydrological Database (2004)
Surface Water- Perennial Reaches (riparian, climate adaptation model, and bird & fish group analyses)	TNC Freshwater Assessment. TNC of AZ (2010)
Southeast Arizona Protected Lands	TNC of AZ (2013)
Landscape Analysis Tools	
Arc-GIS 10.2.1 Spatial Analyst Ext.	ESRI. Redlands, CA (2014)
Geomorphometric and Gradient Metrics Toolbox	Evans et al. 2013 (Feb. 2013)

3.3 Spatial Analysis Units

In order to conduct a spatial conservation prioritization analysis of the watershed, I divided the landscape into uplands and riparian corridors. I did this because certain ecological processes that influence eco-community development are different between the uplands and riparian corridors (e.g., overall greater plant species dependence on groundwater interaction within the riparian corridor). Management and conservation options are also likely to be different based on these geographic divisions. Uplands are the region above the mapped floodplain boundaries of selected riparian corridors (see below), thus spanning in elevation from Sonoran desert-scrub, through chaparral, encinal woodlands, and pine oak, to mixed conifer communities among the included mountainous regions of the watershed. Riparian corridors included the floodplains of the San Pedro River and major tributaries (i.e., Aravaipa, Hot Springs, Bass, Paige, Buehman, Redfield, Edgar, Copper, Putnam/Camp Grant, and Turkey).

I designed analysis units based on sub-basin watersheds of the larger lower San Pedro watershed in order to capture ecological/hydrological processes common to distinct geographical areas (based on recommendations of Moilanen et al. 2009). These sub-basins defined both upland and riparian reach analysis units (reaches based on contributing sub-basin watersheds). I used the U.S. Geological Survey Hydrological Unit Code 12 sub-basins for my watershed and riparian reach divisions (Figure 2: upland sub-basins, n= 65; Figure 3: riparian reaches, n=42). These sub-basins best encompass key hydrological and ecological processes important to ecosystem function within both divisions. For the uplands, these processes are likely to include similar rainwater infiltration and collection, soil development, vegetation growth, and fire-fuel characteristics. For riparian reaches, these processes are likely to include similar upslope contributing precipitation run-off profile, groundwater sub-flow and surface flow hydrological input, flood disturbance regime, and flood plain development characteristics. I included watershed sub-basins that narrowly intersected with the San Pedro River or Aravaipa Creek, but did not encompass a reach of river, in the adjacent downstream riparian reach. For some tributaries, lower reaches were delineated from upper reaches, as determined by breaks in consistent geomorphology and hydrology. Additionally I digitized the lateral floodplain extent of riparian reaches by use of a background GIS layer of the Holocene alluvium along the San Pedro River, Aravaipa Creek, and lower portions of tributaries (Cook et al. 2009), and used riparian vegetation extent in the upper tributaries.

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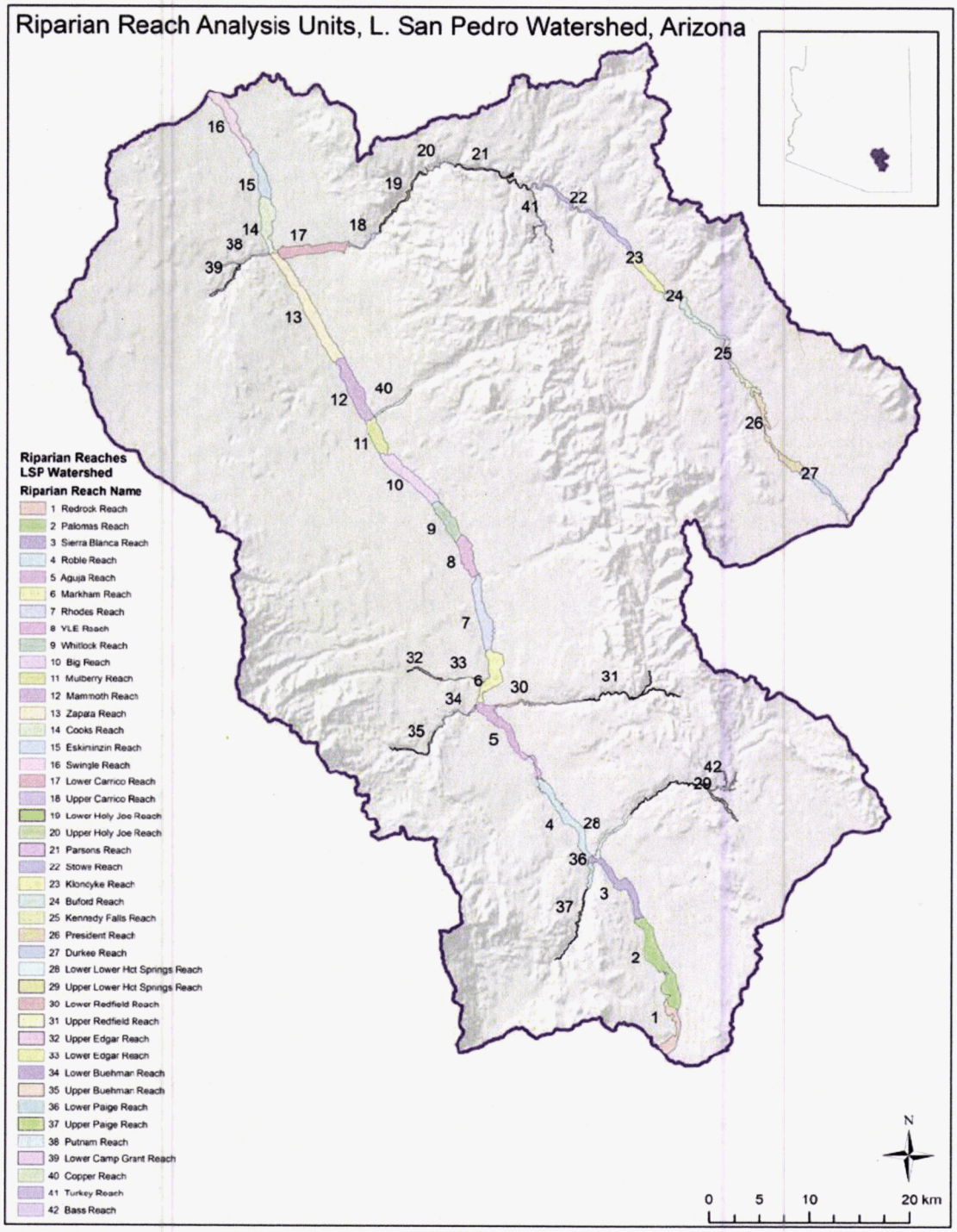

Figure 3. Riparian reach analysis units, in lower San Pedro watershed, Arizona.

3.4 Translation of Survey Responses to Conservation Targets

Based on results of the conservation values survey, I divided the responses into "uplands" and "riparian corridors" categories. I interpreted responses as fitting into landscape-grounded "conservation targets" (based on conservation values); of which many corresponded to available GIS spatial datasets. For example the expressed importance of surface water to biodiversity in riparian corridors was best represented by a perennial water distribution data layer in Arizona available through The Nature Conservancy of Arizona, circa 2009 (TNC AZ 2010). I was able to obtain GIS data layers for most of the commonly cited conservation values for both the upland and riparian corridor survey responses. Certain ecological and hydrological data layers were created through GIS digitizing or analyses (see Appendix C for details).

For certain spatially identifiable conservation values, there were no comprehensive GIS data layers available for the watershed (e.g., Uplands: soil type diversity, Riparian Corridors: groundwater) and for less frequently cited conservation values I chose not to conduct new GIS analyses to generate new data layers. Certain conservation values that were cited by survey respondents (e.g., upland/lowland springs, topographic variability, and elevation gradient), were already (prior to the survey) incorporated into the climate change adaptation modeling, and thus these values were captured in this assessment.

3.5 GIS Spatial Analysis

3.5.1 Conservation Targets

The survey results (from a very small sample of stakeholders) provided a guide to the conservation values of individual stakeholder groups and overall (all-groups) values, based on percentage response values by group and value percentage totals for all groups. The final selection of conservation targets was made by this researcher. In making this decision I based it on the survey's conservation values *totals* for the three stakeholder groups. I noted that water and the natural vegetation communities cited by respondents, best corresponded to GIS spatial data layers that could be readily obtained for perennial waters and land cover vegetation, or could be practically created (i.e. communities could be digitized) within the time constraints of this project. Additionally, a goal of this assessment was to meet the biodiversity conservation interests of the USFWS (as well as the stakeholder groups'), and the species of interest to this agency (i.e., the conservation of riparian-dependent birds and mammals, and aquatic habitat dependent native/endangered fish) could best be captured comprehensively by focusing on a perennial waters and vegetation eco-community conservation target approach. Thus, I

chose for analysis the natural eco-community types commonly cited by the stakeholder groups as conservation targets.

I conducted GIS analysis to present the spatial distribution and quantities (ranked) of conservation targets, in both the upland analysis units and the riparian corridor analysis units (see Appendix D for details). Evaluation of conservation targets for spatial conservation prioritization (i.e., by areal extent, percent, and length) considered the highest statistical tiers, i.e., tier 1 for the upland sub-basins and tiers 1 and 2 in the riparian reaches using Natural Breaks-Jenks (Jenks 1967). Conservation targets within riparian reaches were more skewed towards high values in a select few reaches, thus indicating the need to evaluate the second tier division as well. Riparian connectivity considerations also indicated the need to spatially prioritize more reaches for inclusion in the watershed conservation design.

Natural Breaks-Jenks is a statistical clustering method which optimizes categorization of values into classes or tiers; as such it minimizes the variances within tiers and maximizes the variance among tiers (Jenks 1967). Typically higher values were of higher conservation value; hence tier 1 and 2 levels. I consistently used five Natural Breaks-Jenks classes/tiers in all my analyses (therefore quantity values for tiers vary). Natural Break-Jenks allows for comparability among resources analyzed when the measurement method of quantity varies. Additionally, re-coding Natural Break-Jenks organized data, into a consistent range of values (e.g., 1-5) is facilitated by this statistical method, allowing for the summation of combined target values. Thus, this statistic allowed me to analyze individual and combined conservation targets most efficiently (Table 2).

In order to comprehensively evaluate conservation values for spatial conservation focus among riparian reaches, I weighted landscape elements by the corresponding conservation value survey responses, and then combined them. I first re-coded the actual values from the landscape element analyses for the riparian reaches into classes of 1-5 (from Natural Breaks-Jenks), independently, with five being the highest class (quantity) of the element within riparian reaches. I applied weights from the survey results (the percentage value from the survey results, range 0-1), and then summed these landscape elements values by riparian reach (results range 0-8.0). This allowed there to be a higher score value corresponding to higher conservation value (subsequently tier 1 and 2 levels).

Table 2. Conservation targets analyzed for spatial conservation prioritization within the lower San Pedro watershed, Arizona.

Zone/GIS Layer	Year of GIS layer	Map Unit	Quantity measured
Upland Sub-basin			
Grasslands	2002	30m pixel	percent
Upland Sonoran Desert	2002	30m pixel	percent
Riparian Reach			
Perennial Water	2009	line (perennial)	length
Cottonwood/Willow (c/w)	2013	patch	area
Sycamore/Cottonwood (s/c)	2013	patch	area
Valley Grasslands (vg)	2002	30m pixel	area
Mesquite Bosque (mb)	2013	polygon patch	area
SW Willow Flycatcher/Yellow-billed Cuckoo/Gray Hawk Habitat	2013	line (perennial) and patch (c/w + s/c + mb)	Recode*, then sum
Common Black-Hawk Habitat	2013	line (perennial, tributaries only)	length
Endangered Fish Habitat	1976-2010 (perennial water 2009)	patch and buffered line (End. fish + perennial)	percent
Conservation Value Survey (combo**): Conservation groups, Nat. Resource Profs., Ranchers & Farmers, "all-groups"	2002 (grasslands), 2009 (per. water), 2013 (c/w, s/c, mb)	30m pixel (vg) length (per. water) patch (c/w, s/c, mb)	Recode, apply Weights***, then sum

*Recode: Individual landscape element analysis quantity by Natural Breaks-Jenks (5 classes), recoded correspondingly to 0-5 (5 highest).

**Combo: Combination of the most commonly reported landscape elements of conservation importance from survey.

***Weights: Determined from percentage response for landscape elements by groups and using "all-groups" in total from survey.

3.5.2 Climate Adaptation Model

I evaluated the entire watershed again by HUC12 sub-basins, including riparian corridors, for climate adaptation value to biodiversity following a conservation approach for ecosystem resilience. This analysis was based on a synthesis and simplification of proposed climate adaptation strategies for biodiversity conservation with climate change (Heller and Zavaleta 2009, Hodgson et al. 2009, Mawdsley et al. 2009, Anderson and Ferree 2010, Bier and Brost 2010, Bier 2012, and Morecroft et al. 2012). It was also based on a generalized hotter and drier scenario for the Southwest region within the United States, i.e., continued warming, variable summer monsoon, increased precipitation intensity, and drier winters (Overpeck and Udall 2010).

The USFWS also desired a climate adaptation approach be incorporated into a landscape conservation design developed through this ecosystem assessment. Again, availability geospatial data and practical development geospatial data through analysis, along with the application of climate adaptation biodiversity conservation theory, drove the selection and analysis of this data.

My approach was to prioritize particular landscape features supportive of maintaining biodiversity, and then select for landscape connectivity (e.g., along mountain ranges and cross-valley spanning low to high elevation), thus maximizing adaptive capacity locally and broad-scale. I performed GIS analyses on five landscape variables: heat load index, topographic roughness index, spring abundance (percentage of all springs in the watershed), elevation range (maximum), and perennial water distribution, and I assessed spatial patterns of landscape connectivity, particularly involving water (see Appendix E for details). I developed a six-step rule set for landscape prioritization, focused on selecting the top tiers of landscape features through statistical analysis Natural Breaks-Jenks (Table 3).

Table 3. Six-step rule set for landscape prioritization to develop climate change adaptation model used for lower San Pedro watershed, Arizona. Selection for inclusion in the model is based on characteristics of sub-basin watersheds (HUC 12) (steps 1-5) and riparian reaches (step 6).

Step	Landscape Features/Factors	Measurement	Tier Selection*	Step Action
1	Heat Load Index (HLI) *or* Topographic Roughness Index (TRI)	HLI: lower value pixels > 2 std. dev. TRI: mean	Tiers 1 & 2 (both features)	Select sub-basins, i.e., "HLI-TRI"
2	Spring Abundance (SA) Elevation Range (ER)	SA: percent of watershed ER: maximum	SA: Tiers 1 & 2 ER: Tier 1	Retain from selected HLI-TRI sub-basins
3	Perennial Waters	Presence in sub-basin (> 2km)	n/a**	Retain from selected HLI-TRI sub-basins
4	Connectivity	Spatial adjacency between HLI-TRI "pairs", facilitating cross-valley or mountain ridge connectivity	n/a	Retain from selected HLI-TRI sub-basins
5	Cross-valley Connection	Spatial connectivity to previously selected sub-basins: (HLI+TRI+SA or HLI+TRI+ER)	n/a	Add sub-basins
6	Valley Bottom Perennial Reaches	Presence in valley bottom riparian reaches	n/a	Add riparian reaches (portions with perennial water)

*Natural Break-Jenks (5 tiers).
**Not applicable.

3.5.3 Conservation Gap Analysis

I evaluated the high priority riparian reaches, both priority riparian reaches from combined conservation targets analysis and climate adaptation model additions, for current protection/conservation management status (e.g. conservation easements, ownership status by conservation organization or public agency-county, state, or federal) (TNC of Arizona Protected Area Layer 2013). I conducted a protection/management gap

analysis to determine priority riparian reaches with less than or equal to 20% conservation protection/management (Scott et al. 1987, Scott and Schipper 2006). The conservation gap analysis assessed the top two tiers from the *combined conservation target reach analysis* and the additional *climate reaches*, to assess the conservation coverage (i.e., the land within conservation/protection legal status) of priority riparian reaches and more broadly the conservation of riparian corridors.

3.5.4 Species Mapping

I mapped the spatial distribution of select riparian-associated and aquatic species that USFWS and surveyed respondents viewed as critical/important to conserve in this watershed. Watershed-wide distribution survey information for individual bird and mammal riparian-associated species were lacking and habitat models (based on available vegetation classifications) for these species were found insufficient for this watershed. Therefore, species distributions (where survey records occur), were used as a check on the conservation design proposed in this study, assessing the potential riparian/aquatic habitat quality for the species, and as an ecological indicator of an area's broader biodiversity conservation value (Table 4).

Table 4. Species evaluated for distribution for ecological evaluation of riparian reach priorities within conservation design for the lower San Pedro watershed, Arizona.

Species	Status	Ecological
Birds*		
Southwestern willow flycatcher (*Empidonax traillii extimis*)	Endangered	Riparian -perennial with dense understory vegetation
Western yellow-billed cuckoo (*Coccyzus americanus*)	Candidate	Riparian -multi-tiered forests
Gray hawk (*Buteo nitidus*)	n/a	Riparian -with adjacent tall stature mesquite bosque
Common black-hawk (*Buteogallus anthracinus*)	n/a	Riparian -perennial with pools
Mammals**		
American beaver (*Castor canadensis*)	n/a	Aquatic/Riparian-cottonwood/willow (keystone species: creating ponded water/marshes)
Coati (*Nasus nasua*)	n/a	Riparian -perennial
Fish***		
Gila chub (*Gila intermedia*)	Endangered	Aquatic -pools of smaller streams
Spikedace (*Meda fulgida*)	Endangered	Aquatic -shallow riffles (sand, gravel, substrates)
Loach minnow (*Tiaroga cobitis*)	Endangered	Aquatic -shallow riffles, swift water (cobble substrate)

*Corman and Wise-Gervais 2005
**Pers. obs. 2012-2013
***USFWS Southwest Region. Arizona Ecological Services Field Office. General Species Information.

3.5.5 Conservation Design

A final proposed conservation design considered: 1) climate adaptation priority sub-basin watersheds and riparian reaches by a rule set, 2) riparian reaches evaluated by multiple data layers combined (weighted by survey results) and individual data layers, 3) upland sub-basins with the highest proportion of eco-community types (conservation survey result informed), 4) a review of the conservation coverage gap status of riparian reaches, 5) select species occurrence (field survey result informed), where available, and 6) underlying land use and current settlement pattern assessed by aerial imagery.

3.6 Implementation Assessment

Based on the completed conservation design, conservation implementation organizations were asked for suggestions on the most practical and implementable conservation actions and strategies, particularly considering land ownership and jurisdictions. This assessment was conducted by either personally meeting with implementing organizations or by an email survey. Organizations were provided with a brief summary of the conservation assessment, how the design was derived, and maps showing high conservation focus areas and landscape connections in the watershed. Results were synthesized comprehensively into favored conservation actions/strategies. A table matrix was constructed to subjectively evaluate these actions/strategies' conservation influence (if implemented) on natural resources of high importance to stakeholder groups, which were synthesized from community networking. Conservation influence relates to enhancement/restoration of the resource or long-term conservation of the resource from development or degradation from a variety of stressors.

vegetation and regional wildlife populations (including threatened and endangered species) along the San Pedro River. Conservationists cite the primary threats as the potential for new housing development, and increased agriculture demand occurring with on-going drought.

Native riparian vegetation needs groundwater at accessible root depth for establishment, persistence, and to develop to their potential size and structure. Fremont cottonwoods need groundwater less than 2.6m (8.5 ft.) from the surface and annual fluctuations less than 0.5m (1.6 ft.) (Lite and Stromberg 2005). Mature tall stature velvet mesquite, in order to form *bosques* most beneficial to wildlife, i.e., those 5.0m (16.4 ft.) and greater in height (canopy dominants at 12m) and with a mostly closed canopy, need groundwater at depths 2 to 10m (7-33 ft.) and up to 13.5m, to develop to this height/structure potential (Stromberg 1993, Stromberg et al. 1993, Scott et al. 2006). Sacaton grass (a facultative riparian grassland community) begins to lose access to groundwater at 3m and completely by 4m, but can survive from rainfall when precipitation is sufficient (Scott et al. 2006, Stromberg et al. 2009b). Groundwater discharging to the riverbed surface in arid watersheds, such as the San Pedro River, results in perennial or seasonal perennial reaches of surface water flow (Stromberg et al. 2009a). Surface water flow is responsible for additional biodiversity potential in its support of aquatic niche space, water provision for species, and increased trophic food webs within communities (Stromberg and Tellman 2009).

Major Threat: Urban/suburban development and associated high groundwater water usage.
Secondary Threat: Long-term drought, particularly coupled with increased pumping by current users in the watershed (e.g., increased agricultural requirements). Placement of new wells close to perennial reaches.

4.2.2 Landscape Integrity/Connectivity

Landscape integrity and connectivity is of high value to Conservation groups and Natural resource professionals. Wildlife connectivity among mountain ranges, and facilitating a meta-population structure is a concern for both these groups (e.g., black bears, *Ursus americanus*, mountain lions, *Puma concolor*, coati, *Nasua nasua*, potentially big horn sheep, *Ovis canadensis*, and others). Additionally, Professionals cite landscape connectivity, especially extending over undisturbed elevation gradients, as an important landscape characteristic for species adapting through movement to changing climate conditions. Conservation groups are very concerned about infrastructure projects that impact landscape integrity over a wide swath (e.g., a proposed large-scale transmission line); as well as new roads and development, and the potential pathways for invasive

plant species introduction. Ranchers and farmers would also like to maintain un-fragmented landscape and prevent major infrastructure projects that do not serve the human communities, as this could negatively impact the natural resource base of the watershed (e.g., impact grazing lease lands).

Many wildlife populations are structured in meta-populations that require individuals to periodically disperse to find new mates, enhance sub-population genetic diversity and demographics, and (re)colonize areas (Hilty et al. 2006, Gregory and Beier 2014). Some wildlife populations require movement for annual migrations, and these mostly occur seasonally in response to changes in food availability and/or reproductive opportunities (Hilty et al. 2006). Lastly, species are expected to find landscape linkages essential for adapting to changing climate conditions (Heller and Zavaleta 2009, Mawdsley et al. 2009, Beier 2012, Chester et al. 2012, Groves et al. 2012, Hilty et al. 2012). This expectation is evidenced in the Paleo-ecological historic record as species moved in response to the changing climate conditions of the last glacial maximum period (Dawson et al. 2011).

Major Threat: New infrastructure (e.g., transmission lines and service roads) in the uplands.
Secondary Threat: Current mining and future mining (expansion), and associated service roads. New large-scale residential development projects. Highway development and/or new secondary road development.

4.2.3 Floodplain Integrity/Connectivity

Natural resource professionals and Conservation groups again both emphasized floodplain integrity/connectivity as an important component to a healthy functioning ecosystem. Both groups extend this value to encompass both the mainstem of the San Pedro and its major tributaries (particularly lower reaches). Natural resource professionals promoted the conservation of sufficient active floodplain space for channel movement, floodplain development, and overbank flooding. Professionals promoted the idea that the river needs to continue to meander, unconstrained by levees or bank protection, for ecological function (vegetation dynamics) and ecosystem benefits (flood amelioration, floodplain groundwater recharge). Additionally, they called for the restoration of floodplain space for channel hydraulics where needed. Active restoration of desired channel characteristics was cited as an option to be explored. Conservationists emphasized the importance of ensuring the undeveloped character of riparian corridors for wildlife habitat and movement. Off-road vehicle (all-terrain vehicle) control through floodplains was also cited as a key issue by Conservationists. Ranchers and farmers also

Table 5. Conservation focal areas identified by a stakeholder-based "all-groups" spatial analysis of weighted and combined conservation targets within the lower San Pedro watershed, Arizona.

High Conservation Value Focal Areas	**Riparian Reaches***
Northern San Pedro	Swingle, Eskiminzin, Cooks, Zapata
Aravaipa Region	Lower Holy Joe, Parsons, Stowe
Middle San Pedro	Big, Whitlock
Galiuro Canyons	Upper Redfield, Upper-Lower Hot Springs
Lower-Middle San Pedro	Roble
South San Pedro	Palomas

*Names from corresponding HUC12 sub-basins (shortened).

4.4 Climate Change Adaptation Model

I conducted climate change adaptation modeling over the watershed's sub-basins and riparian reaches. The model used a six-step rule set, selecting landscape factors by sub-basins and reaches, promoting biodiversity adaptation to climate change (warmer/drier conditions) following a resilience strategy. This model yielded a landscape design spanning the highlands of the Galiuro Mountains north through to the Aravaipa Canyon region and northwest to the Santa Teresa Mountains, and included five cross-valley connections and four additional valley-to-range elevation gradient connections (Figure 9). One selected sub-basin with aerial imagery identified mining activity and high road density, had to be replaced with a spatially close and similar characteristic alternative sub-basin (i.e., Copper sub-basin replaced with Clark sub-basin).

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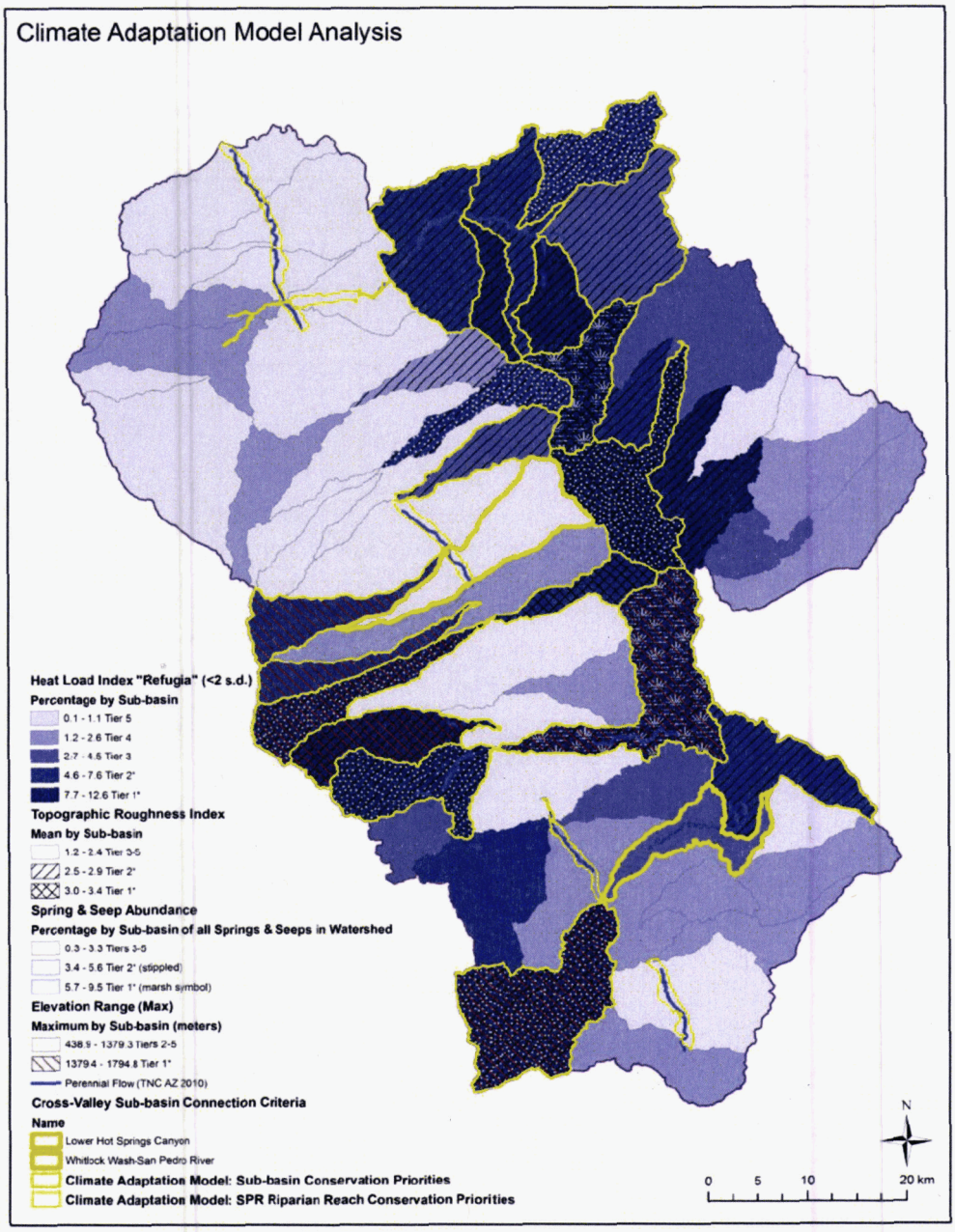

Figure 9. Climate adaptation model for biodiversity conservation developed from a 6-step rule set focused on landscape-level ecosystem resilience for the lower San Pedro watershed, Arizona. Background layer of Heat Load Index (< 2 std. dev. HLI), all tiers, is provided for context. See Table 3 for the six-step rule set selecting sub-basins and reaches (* = tiers for these features were used in the rule set). The yellow outlined sub-basins and reaches delineate the climate adaptation model.

Table 6. Conservation gap analysis of priority riparian reaches. Priority reaches were determined from an "all-groups" multiple conservation target analysis (based from stakeholder groups' conservation values) and a climate adaptation model (see text). Priority reaches were assessed with a "conservation protection/management" spatial layer, and a criteria of 20% or less spatial coverage in conservation land status, in order to highlight high value areas with minimal conservation within the lower San Pedro watershed, Arizona (reaches listed north to south).

"Conservation Gap" Riparian Reaches*	Criteria: "All-Groups" combined conservation targets	Criteria: Climate Change Adaptation Model	Total Area of Reach (Ha)	Present Conservation Coverage** (%)
L. Carrico-Aravaipa Crk.		X	606.9	10.8
U. Carrico-Aravaipa Crk.		X	78.9	17.4
Putnam Wash		X	62.6	4.0
Big-San Pedro R.	X	X	730.0	0.0
Whitlock-San Pedro R.	X	X	437.3	12.5
Lower Edgar Wash		X	37.5	0.3
Lower Redfield Wash		X	139.5	0.3
Upper Page Crk.		X	70.3	0.0
Aguja (s. section)-San Pedro R.		X	85.4	6.0

*Names from corresponding HUC12 sub-basins (shortened).
**Southeast Arizona protected area shapefile from The Nature Conservancy-Arizona Chapter, March 2013.

4.6 Conservation Design

I evaluated tier 1 sub-basins for semi-desert grassland extent (i.e., percent coverage) across the watershed. I included all six sub-basins in the conservation design, prioritized as grassland conservation and management focal areas (Figure 11). I also evaluated tier 1 sub-basins for extent of Upland Sonoran Desert (focus: saguaros) across the watershed. To reduce the selection of these tier 1 sub-basins (7), which covered a large portion of the northern region of the watershed, I chose to set a strategic objective of selecting two sub-basins for conservation focus that would provide a high quality large wildland block of this eco-community type. I thus evaluated each tier 1 sub-basin by the percentage Sonoran Desert within, and chose the sub-basin with the highest coverage and then selected the next largest contiguous tier 1 sub-basin. I additionally checked for road density in select sub-basins, which if found significant would have warranted a different selection set. Two sub-basins in the Aravaipa uplands region, with Sonoran Desert coverage of 54% and 41%, respectively, were identified as conservation focal areas to be included in the conservation design (i.e., Carrico Springs sub-basin encompassing lower Aravaipa Creek and contiguous Zapata Wash sub-basin) (Figure 11).

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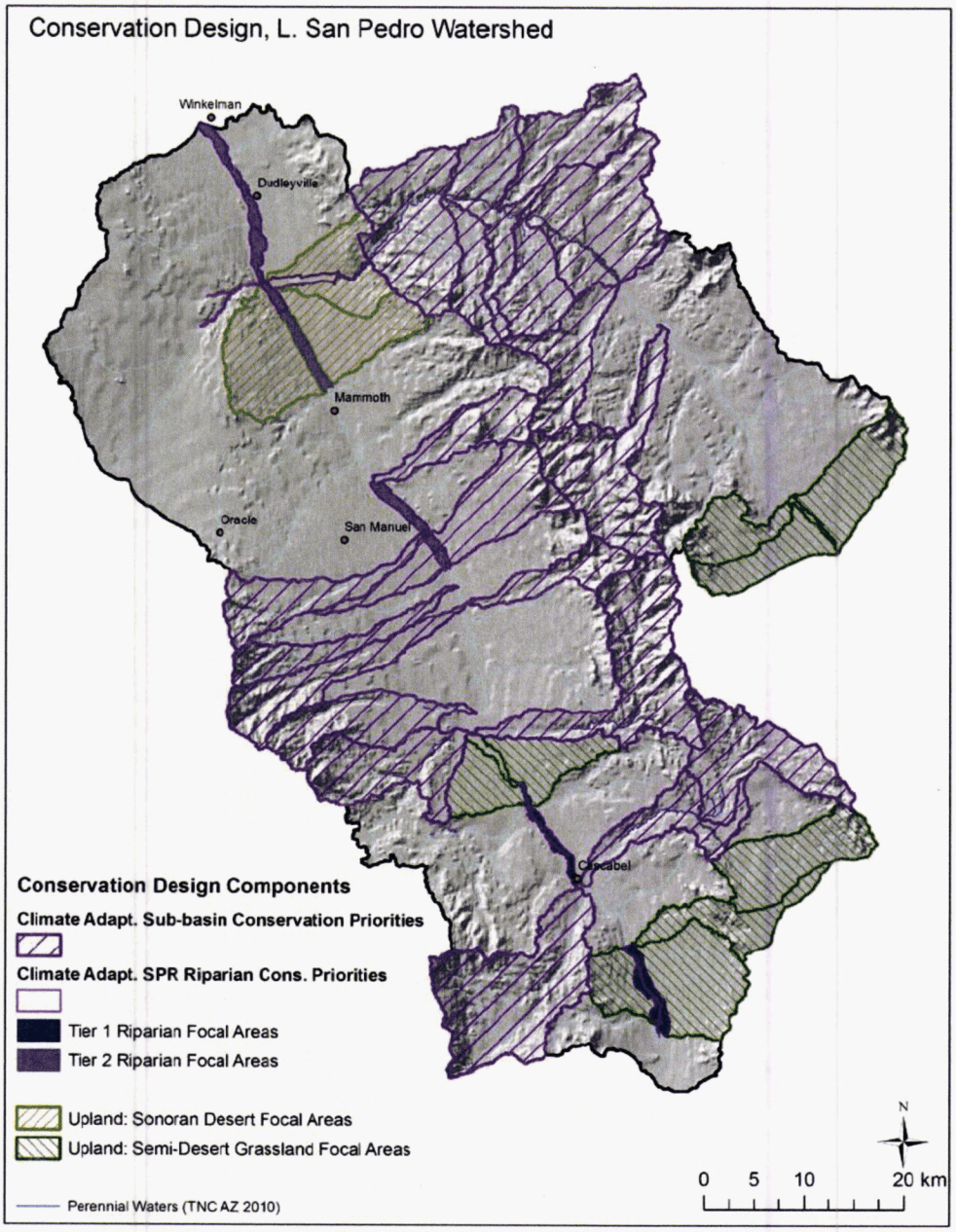


Figure 11. Conservation design encompassing climate adaptation model, riparian focal areas ("all-group" analysis), and upland focal areas for Sonoran desert and semi-desert grassland, for the lower San Pedro watershed, Arizona.

Key components of the landscape conservation design for climate adaptation were the San Pedro cross-valley sub-basin pairs (5) and the adaptation and "refugia" facilitating landscape characteristics captured within the sub-basins of the high mountain ranges. The highest priorities for connectivity conservation focus are the southernmost San Pedro cross-valley sub-basin pair (Paige-Lower Hot Springs) and the two northern most connections across the San Pedro valley (Peppersauce-Whitlock, and Alder/Stratton-Kielberg). An additional high value landscape linkage is the riparian corridor connection through the main tributary (Aravaipa) and into a smaller drainage system to the west of the San Pedro with a perennial spring (Putnam). Three high range contiguous sub-basins in the Galiuro Mountains (i.e., Redfield, Rattlesnake, and Four Mile) have critical landscape components: high topographic roughness, high spring/seep abundance, and higher elevation, all landscape characteristics providing the potential for species adaptation to climate change and to exploit micro-climate "refugia" conditions.

I selected the combined "all-group" high conservation value riparian reaches for inclusion in the conservation design. The selection of this multiple stakeholder grouping sets a priority conservation focus (with applied weights) towards perennial waters (i.e., potential for perennial waters in a given year), existing riparian gallery forest of 2013 (but also high groundwater availability), and to a lesser emphasis the proximal occurrence of mesquite *bosque* and valley grassland. The above combined set also captures high value reaches for riparian-associated birds and endangered fish (see Appendix H, Figures 20-22). An overview map of the conservation design provides additional context showing the widespread distribution of *conservation value* lands throughout the watershed and diversity of landownership and jurisdiction (Figure 12).

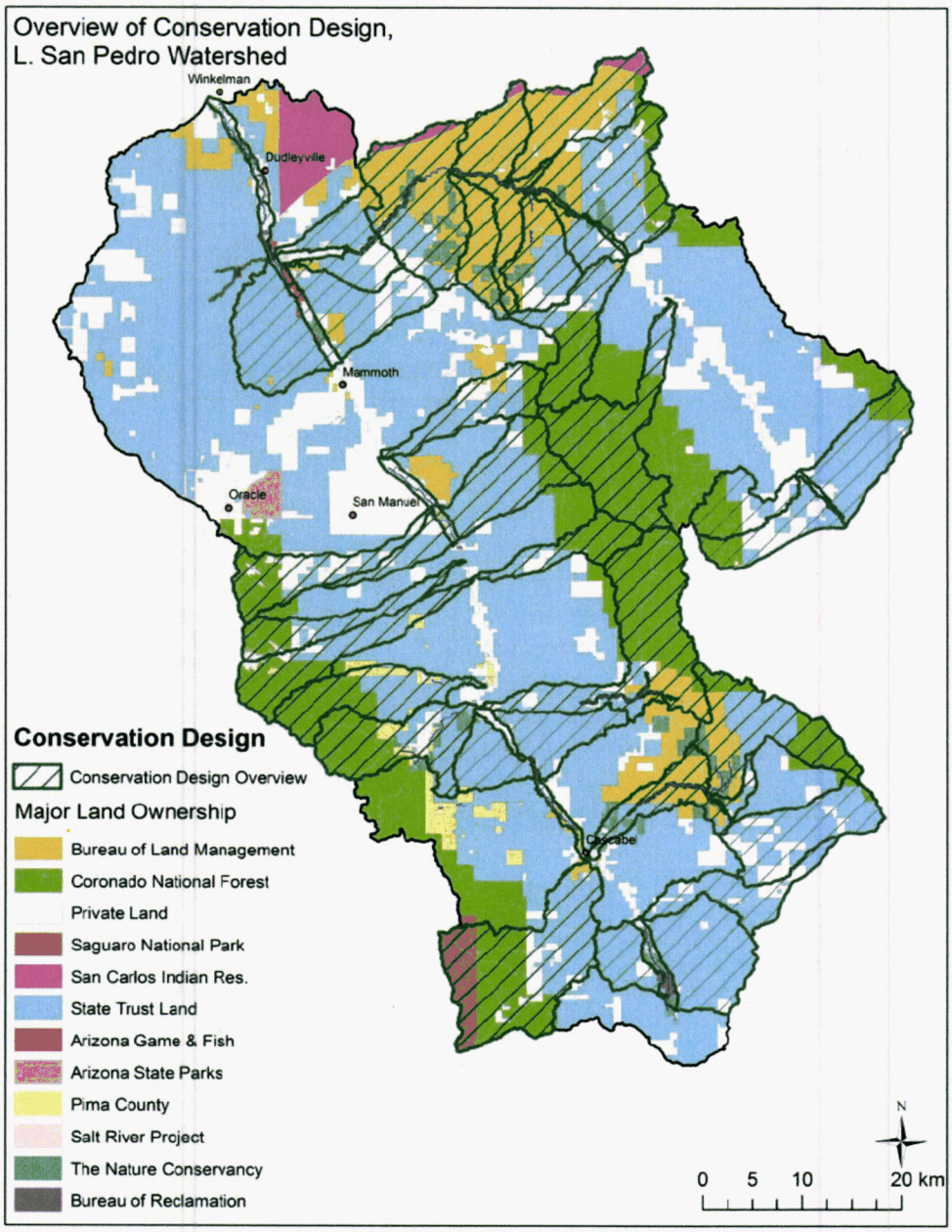
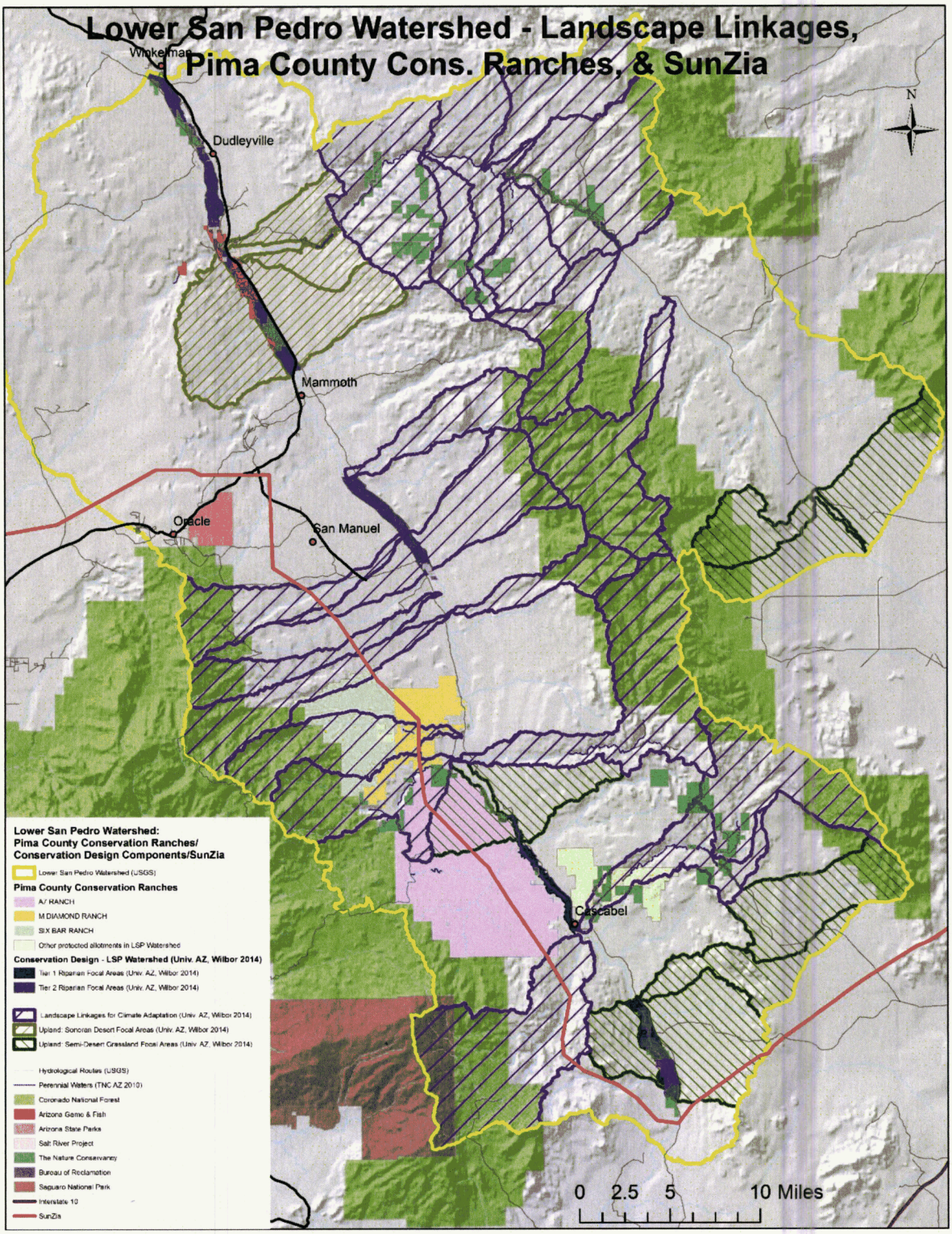
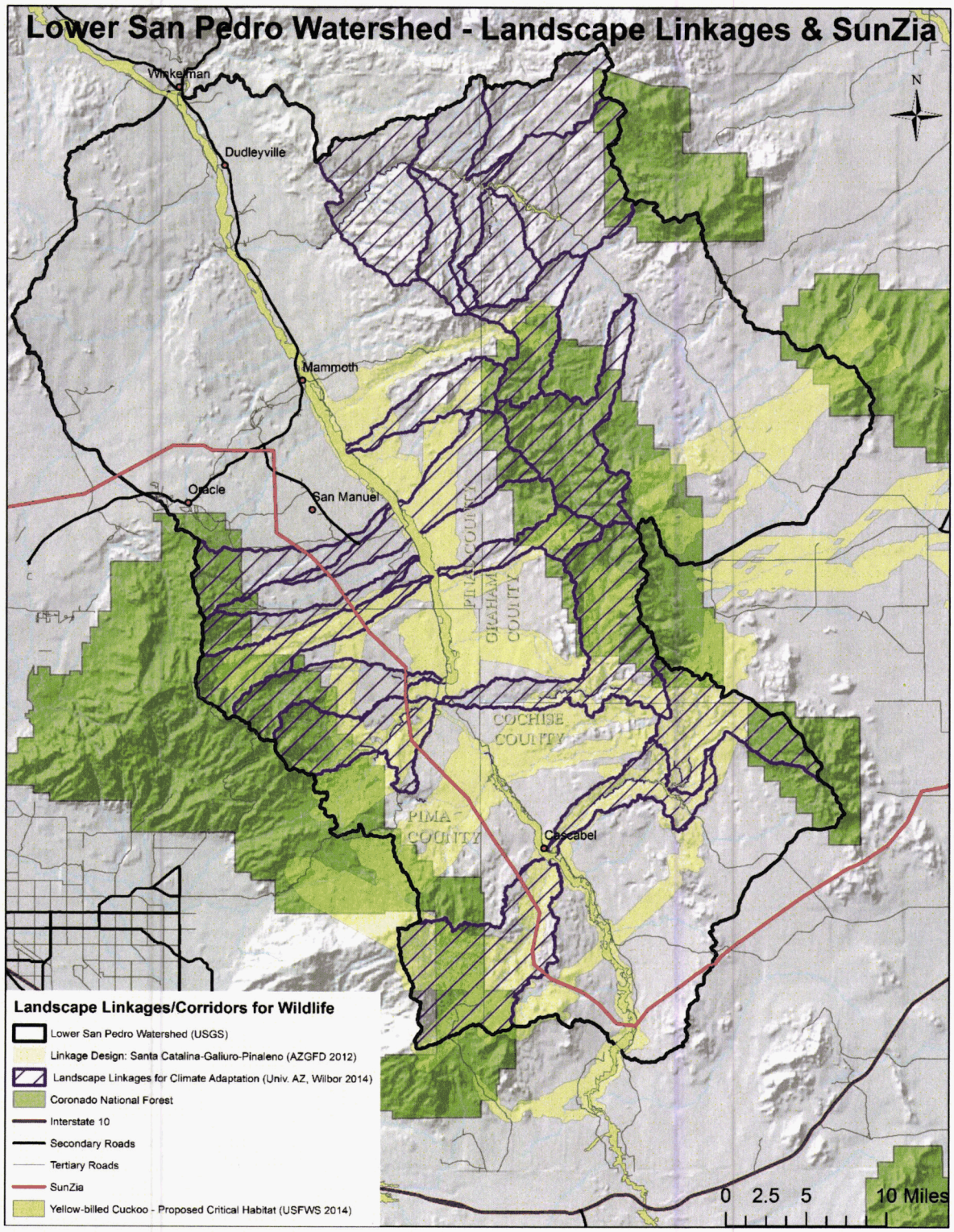
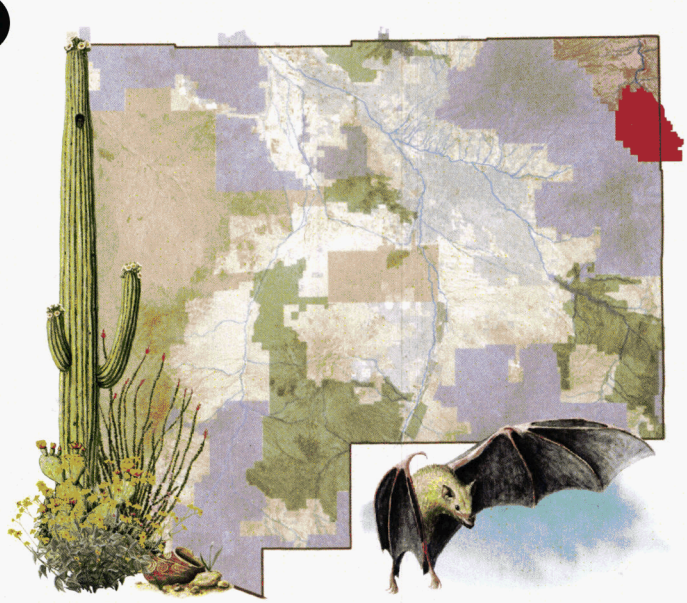


Figure 12. An overview of all lands identified by geospatial analysis from a stakeholder-based survey of conservation values, and a climate adaptation model, that are included in the conservation design for the lower San Pedro watershed, Arizona. Various types of land management and conservation strategies could be employed on these lands depending ownership/jurisdiction.


Lower San Pedro Watershed - Landscape Linkages,
Pima County Cons. Ranches, & SunZia
Wrightman
Dudleyville
Mammoth
Oracle
San Manuel
Cascabel
N
Lower San Pedro Watershed:
Pima County Conservation Ranches/
Conservation Design Components/SunZia
Lower San Pedro Watershed (USGS)
Pima County Conservation Ranches
A/ RANCH
M DIAMOND RANCH
SIX BAR RANCH
Other protected allotments in LSP Watershed
Conservation Design - LSP Watershed (Univ. AZ, Wilbor 2014)
Tier 1 Riparian Focal Areas (Univ. AZ, Wilbor 2014)
Tier 2 Riparian Focal Areas (Univ. AZ, Wilbor 2014)
Landscape Linkages for Climate Adaptation (Univ. AZ, Wilbor 2014)
Upland: Sonoran Desert Focal Areas (Univ. AZ, Wilbor 2014)
Upland: Semi-Desert Grassland Focal Areas (Univ. AZ, Wilbor 2014)
Hydrological Routes (USGS)
Perennial Waters (TNC AZ 2010)
Coronado National Forest
Arizona Game & Fish
Arizona State Parks
Salt River Project
The Nature Conservancy
Bureau of Reclamation
Saguaro National Park
Interstate 10
SunZia
0 2.5 5 10 Miles


Lower San Pedro Watershed - Landscape Linkages & SunZia
Winkelman
Dudleyville
Mammoth
Oracle
San Manuel
PINAL COUNTY
GRAHAM COUNTY
COCHISE COUNTY
PIMA COUNTY
Cascabel
N
0 2.5 5 10 Miles
Landscape Linkages/Corridors for Wildlife
Lower San Pedro Watershed (USGS)
Linkage Design: Santa Catalina-Galiuro-Pinaleno (AZGFD 2012)
Landscape Linkages for Climate Adaptation (Univ. AZ, Wilbor 2014)
Coronado National Forest
Interstate 10
Secondary Roads
Tertiary Roads
SunZia
Yellow-billed Cuckoo - Proposed Critical Habitat (USFWS 2014)

4



A-7 Ranch

Fee lands: 6,829 acres fee lands
State grazing leases: 34,195 acres
BLM grazing permit: 80 acres
Cost: $2,041,933
Acquired: September 15, 2004
Fund: 2004 Bond Funds

Background

The 41,000 acre A-7 Ranch lies northeast of Tucson along Redington Road, between the Catalina and Rincon Mountains and the San Pedro River. The County acquired the ranch from the City of Tucson in 2004. The City had purchased the ranch in 1999. Prior to the City's purchase, the ranch was part of a larger ranch totaling about 96,000 acres known as the Bellota Ranch, which was owned and operated by the Riley-West Corporation for 20 years. The A-7 portion of the Bellota Ranch was sold to the City, while the Forest Service grazing permit was sold to the owners of the Tanque Verde Guest Ranch. Approximately 3,700 acres were sold to The Nature Conservancy. The County's purchase included 65 acres in Cochise County, 471 acres under conservation easement held by The Nature Conservancy, cattle, equipment, buildings and water rights.

Historical and Cultural Resources

In the A-7 Ranch area, the Reeve Ruin site, dating to A.D. 1200-1450, is situated on the terrace overlooking the San Pedro River. Reeve Ruin is defensively located above the San Pedro floodplain and further protected by a series of walls. The site contains a central room block surrounded by two plazas that are bounded by walls and lines of contiguous rooms. More than thirty structures are present, including a possible kiva, or Puebloan ceremonial room, within the central room block. By 1450, archaeological evidence suggests that the valley was largely abandoned. Apache speakers were driven out by Anglo settlers in the 19th century whose ranches today hold the stories of this historic landscape.

Biological Resources

The ranch is located in the lower San Pedro River Valley and includes woodland vegetation communities at higher elevations, semi-desert grasslands at lower elevations, and riparian habitat along the canyon bottoms and the San Pedro River. In addition, the property includes limestone outcrops, perennial and intermittent streams, springs and shallow groundwater areas. Populations of Priority Vulnerable Species such as long-fin dace, lowland leopard frog, and Abert's towhee, exist on the property and provide suitable habitat for several other Priority Vulnerable Species. The majority of the ranch lies within the Biological Core of the Conservation Lands System, with a lesser amount within the Multiple Use Management and Important Riparian Area categories. The location of the property between the Catalina, Rincon, and Galiuro Mountains, provides for a corridor of open lands for wildlife movement back and forth between the mountain ranges.

Management

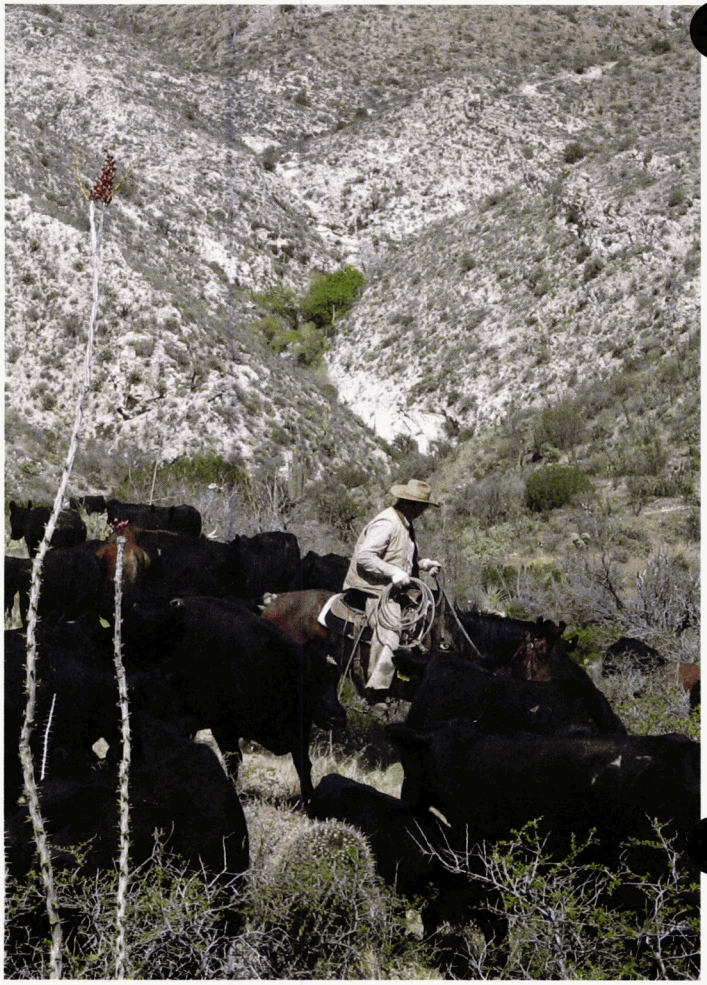
This is the only ranch that the County operates itself with County employees and owns the cattle herd. Pima County is one of only a few county governments that has its own brand - A7. The ranch is currently managed as a cow/calf operation to help offset costs of maintaining the ranch, with a base herd of approximately 300 head. This is about 40% of the allowed use on the State Trust grazing lease lands. The ranch is maintained as a working landscape while protecting and conserving biological and ecological values of the lands. Management activity has primarily focused on monitoring and maintaining a sustainable grazing program while offering recreational use of the ranch by the public. Significant work has been done to enhance the water systems and water storage on the ranch to provide year-round wildlife friendly water for wildlife while at the same time taking pressure off natural springs.

Farm land on A-7 Ranch. Photo by John Sullivan.

Recreation

A-7 ranch offers a wealth of recreational activities. The County has entered into a recreational access agreement with Arizona Game and Fish Department to provide and maintain designated routes to other public lands within and adjacent to A-7 for recreational users. The ranch lands offer camping, hiking, hunting, wildlife viewing, nature study, ATV/ Off Highway vehicle routes, biking, outdoor photography, equestrian trails and access to outdoor open space. Because the ranch is mostly Arizona State Trust lands, recreational users are encouraged to follow all applicable rules, regulations and necessary recreation permit requirements established by State Land as well as those of Pima County Natural Resources, Parks and Recreation (NRPR). Because of its location off Redington Road, A-7 gets significant recreational visits on an annual basis with most of the use in the fall through spring.

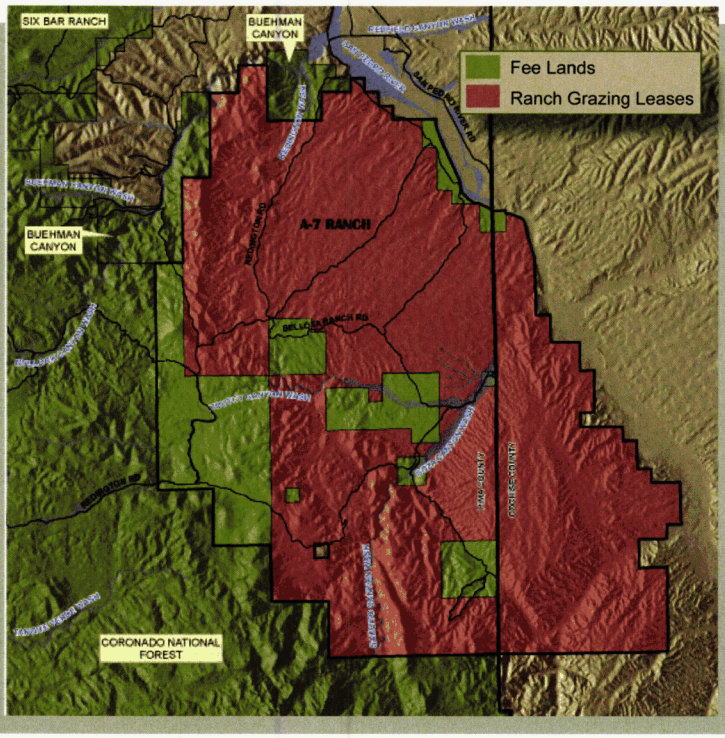
NRPR has been converting many old windmills and generator driven water pump systems to solar. This unit helps bring year-round water to over 56 square miles of the A-7 Ranch. Photo by John Sullivan.



County cattle on A-7 Ranch. Photo by John Sullivan.

Ongoing Property Improvements

- The County has put much of its effort in enhancing the basic infrastructure and baseline information available on the ranch.
- Water enhancements and solar generation for power have been two major ongoing efforts.
- Over 50 square miles of the ranch now has a dependable water supply via pipelines and storage tanks.
- Additional vegetative monitoring sites have been established on the ranch and are monitored annually to measure trends in plant community diversity and productivity.
- Additional effort has been made to improve the livestock management system and productivity of the herd.
- Stabilization efforts continue on historic buildings and residences present on the ranch which are still being used as part of the working ranch.



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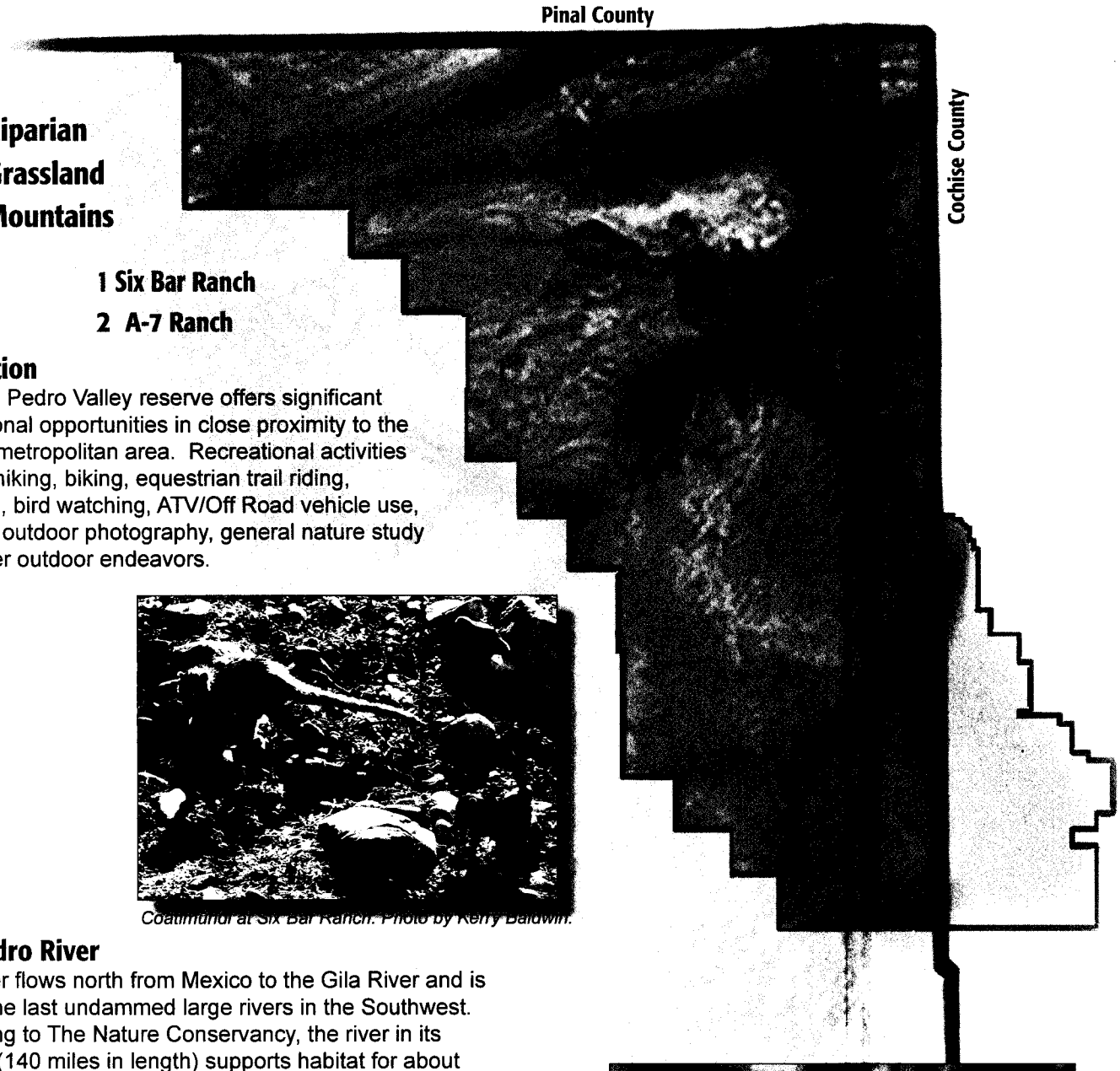
San Pedro Valley Reserve



Riparian
Grassland
Mountains

1 Six Bar Ranch
2 A-7 Ranch

Recreation

The San Pedro Valley reserve offers significant recreational opportunities in close proximity to the Tucson metropolitan area. Recreational activities include hiking, biking, equestrian trail riding, camping, bird watching, ATV/Off Road vehicle use, hunting, outdoor photography, general nature study and other outdoor endeavors.

Coatimundi at Six Bar Ranch. Photo by Kerry Baldwin.

San Pedro River

This river flows north from Mexico to the Gila River and is one of the last undammed large rivers in the Southwest. According to The Nature Conservancy, the river in its entirety (140 miles in length) supports habitat for about 350 bird species and stopover habitat for up to 4 million birds migrating each year between North, Central and South America.

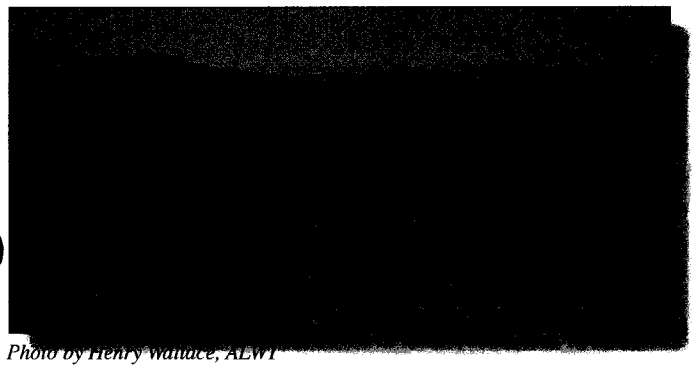
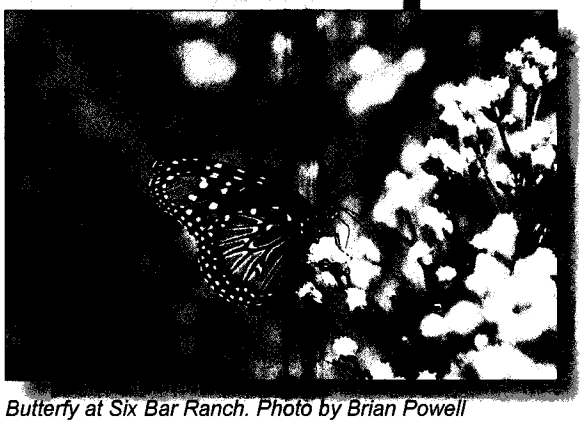
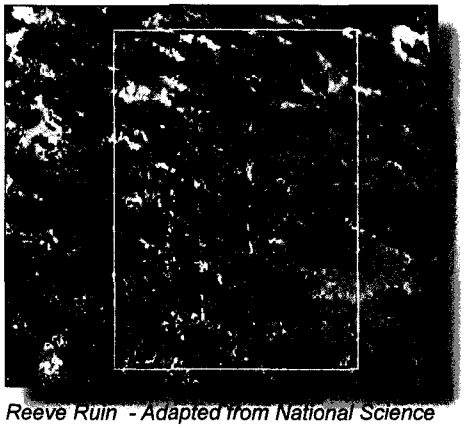


Photo by Henry Wallace, AZWT



Butterfly at Six Bar Ranch. Photo by Brian Powell



Reeve Ruin - Adapted from National Science Foundation online publication, "Archaeology from Reel to Real, a Special Report,: July 10, 2010

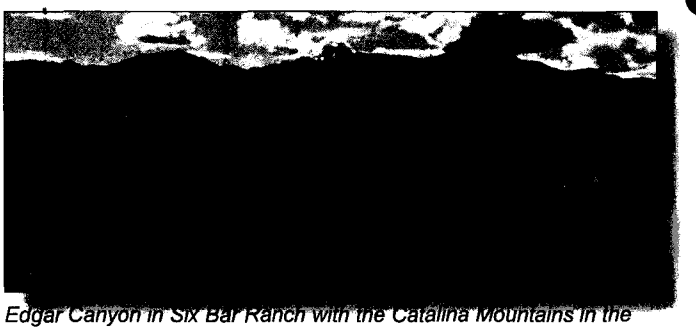
Cultural and Archaeological Resources

The San Pedro River Valley was an important historical crossroads of the Southwest from early prehistoric times to the historic era when the 1540 Coronado Expedition traveled through the San Pedro River corridor. Archaeological sites in the river valley represent the remains of human occupation from 13,000 years ago. The Lehner Mammoth Kill Site in the upper San Pedro River valley provides some of the first conclusive evidence of human hunting of mammoths in North America. This is also the site of the significant Reeve Ruin, located on the terrace overlooking the San Pedro River, dating back to A.D. 1200-1450

Bingham Cienega Natural Preserve. Photo by Priscilla Titus

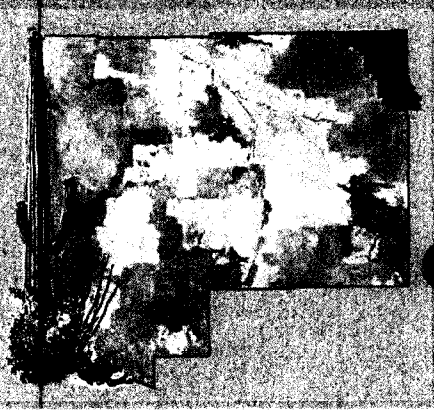
Bingham Cienega Natural Preserve

In 1989, the Pima County Regional Flood Control District acquired 285 acres of land along the San Pedro River to preserve a spring-fed marsh known as Bingham Cienega. Because of the site's remote location and sensitive environment, the District entered into a long-term agreement with The Nature Conservancy to manage the property. Historically used for ranching and farming, the fallow fields began to be restored by Conservancy volunteers and marsh wetlands, mesquite bosques and riparian forests began to reclaim the land. The Conservancy has also restored sacaton and other native floodplain vegetation to the area.



Edgar Canyon in Six Bar Ranch with the Catalina Mountains in the background. Photo by Brian Powell.

The San Pedro Valley Reserve is located in the northeastern corner of Pima County, east of the Catalina Mountains, and encompasses a segment of the San Pedro River, one of the last free-flowing rivers in the Southwest. The river and its tributaries support riparian vegetation and intermittent stream flow providing habitat for species such as the Southwest willow flycatcher and the Gila spotted whiptail lizard. The upland semi-desert grasslands and woodlands provide habitat for species such as the Lesser Long-nosed bat and Desert box turtle. Archaeological findings suggest that the river valley has been occupied by humans for nearly 13,000 years. More recently its history has been dominated by ranching and agricultural efforts in support of ranching. Overtime, the ranches in this area have grown larger in an attempt to maintain profitability and weather the less than optimum range conditions due to continued drought and changing climate patterns. Free range grazing in this location is often supplemented with irrigated pastures adjacent to the river. Both Pima County and the Nature Conservancy have been active in purchasing and managing land in this reserve, conserving wildlife, river habitat, and archeological sites.



6

DOCKET NO. L-00000YY-15-0318-00171-MCV_6

PIMA PROSPERS
comprehensive plan initiative

Comprehensive Plan

Comprehensive Plan Update
Pima Prospers

Planning and Zoning Commission Public Hearing Draft

Prepared for:
The Pima County Planning and Zoning Commission
March 25, 2015

File Number: C07-13-10

PIMA County *The Planning Center* *ESI Corporation* *Kaneen* *PSOMAS*

Policy Volume

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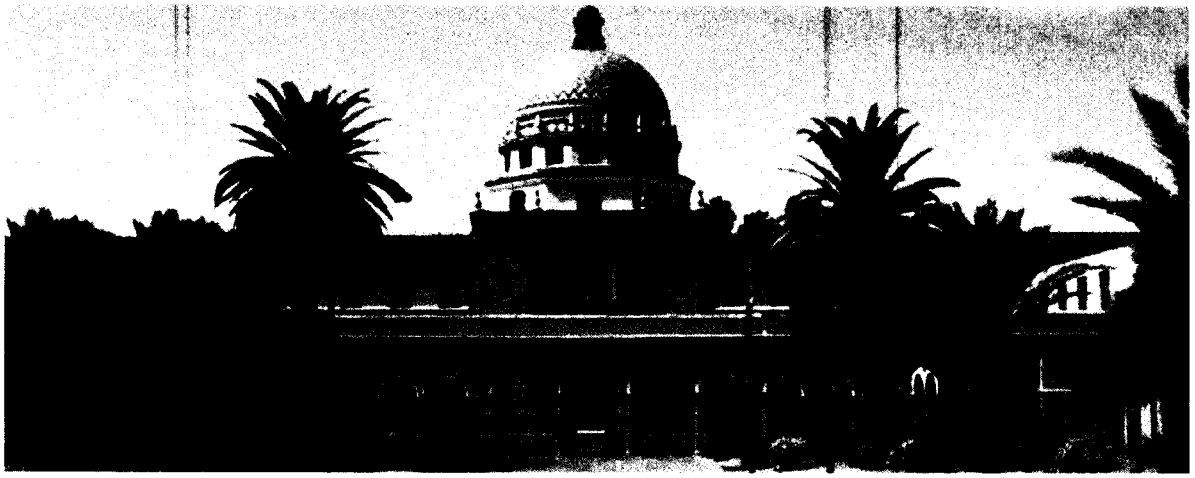

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Natural Resources, Pima County, Arizona

The Environmental Planning Element calls for analysis, policies and strategies to address anticipated effects of implementation of plan elements on natural resources. Policies and strategies under this plan element are designed to have countywide applicability. Conservation actions are to be encouraged, and protection of biological resources is considered an essential component of land-use planning.

The Maeveen Marie Behan Conservation Lands System (CLS) is designed to protect biodiversity and provide land use guidelines consistent with the conservation goal of the Sonoran Desert Conservation Plan (SDCP).

The CLS identifies areas important to the conservation of our natural resources heritage and embodies the biological goal of the SDCP which is to "ensure the long-term survival of the full spectrum of plants and animals that are indigenous to Pima County through maintaining or improving the habitat conditions and ecosystem functions necessary for their survival."

Exhibits 3.4.1 and 3.4.2 show the Conservation Lands System for eastern and western Pima County are located at the end of this section.

Goal 1: Conserve and protect natural resources

Policy 1: CLS category designations and conservation guidelines apply to land uses and activities undertaken by or under the jurisdiction of Pima County or Pima County Regional Flood Control District (Flood Control District) as follows:

a) Pima County and the Flood Control District will seek consistency with the CLS for federal and state land-use decision plans and processes;
b) Application of CLS designations or guidelines shall not alter, modify, decrease or limit existing and legal land uses, zoning, permitted activities, or management of lands;
c) When applied to development of land subject to county or Flood Control District authority, CLS designations and guidelines will be applied to:
    1. New rezoning and specific plan requests;
    2. Time extension requests for rezoning cases;
    3. Requests for modifications or waivers of rezoning or specific plan conditions, including substantial changes;
    4. Requests for Comprehensive Plan amendments;
    5. Type II and Type III conditional use permit requests; and
    6. Requests for waivers of subdivision platting requirement of a zoning plan.
d) Implementation of these policies shall achieve the level of conservation necessary to protect a site's conservation values, preserve landscape integrity, and provide for the movement of native fauna and pollination of native flora across and through the landscape; and
e) Projects subject to these designations and guidelines will be evaluated against the conservation guidelines for the CLS categories provided in conservation guideline policies, where applicable, to determine their appropriateness.

Conservation Guidelines

Policy 2: The Conservation Guideline for the associated CLS designation applies to the total acreage of the site that lies within the boundaries of that designation:

a) If a CLS designation applies to a portion of a site, Conservation Guidelines for that designation will apply only to that portion of the site affected by that category;
b) For purposes of this policy, site is defined as a single lot or combination of contiguous lots; and
c) Where more than one CLS categories overlap, the more protective Conservation Guideline will apply to the affected portion.

Policy 3: The following conservation guidelines apply to Important Riparian Areas:

a) Across the entirety of the CLS landscape, at least 95 percent of the total acreage of lands within this designation shall be conserved in a natural or undisturbed condition;

b) Every effort should be made to protect, restore and enhance the structure and functions of Important Riparian Areas, including their hydrological, geomorphological and biological functions;
c) Areas within an Important Riparian Area that have been previously degraded or otherwise compromised may be restored and/or enhanced;
d) Such restored and/or enhanced areas may contribute to achieving the 95 percent conservation guideline for Important Riparian Areas (IRA);
e) Restoration and/or enhancement of degraded IRA may become a condition or requirement of approval of a comprehensive plan amendment and/or rezoning; and
f) On-site mitigation is preferable, however mitigation may be provided on-site, off-site, or in combination.

Policy 4: The following conservation guidelines apply to Biological Core Management Areas:

a) Across the entirety of the CLS landscape, at least 80 percent of the total acreage of lands within this designation shall be conserved as undisturbed natural open space;
b) Land use and management focus on the preservation, restoration, and enhancement of native biological communities including, but not limited to, preserving the movement of native fauna and flora across and through the landscape and promoting landscape integrity; and
c) Projects subject to this policy and within this designation will yield four conserved acres (mitigation) for each acre to be developed:
    1. Mitigation acres may be provided on-site, off-site, or in combination;
    2. The preference is for the mitigation acres to be within Biological Core Management Area or Habitat Protection Priority Areas;
    3. For purposes of this policy, Habitat Protection Priority Areas are those areas referenced and mapped as part of the 2004 Conservation Bond Program or subsequent conservation bond programs;
    4. The 4:1 mitigation ratio will be calculated according to the extent of impacts to the total surface area of that portion of any parcel designated as Biological Core Management Areas;
    5. Development shall be configured in the least sensitive portion(s) of the property;
    6. On-site mitigation area(s) of undisturbed natural open space will be configured to maximize conservation values and preserve the movement of native fauna and pollination of native flora across and through the landscape; and
    7. A Transfer of Development Rights (TDR) may be used in order to secure mitigation lands.

Policy 5: The following conservation guidelines apply to Scientific Research Areas:

a) Scientific Research Areas should continue to be managed for the purpose of scientific research on the environment and natural resources;
b) Scientific research activities should minimize any long-lasting impacts that may affect adjacent or nearby CLS lands; and
c) Any land-use changes subject to Pima County jurisdiction should achieve the conservation goals of the underlying CLS category.

Policy 6: The following conservation guidelines apply to Multiple Use Management Areas:

a) Across the entirety of the CLS landscape at least 66 ⅔ percent of the total acreage of lands within this designation shall be conserved as undisturbed natural open space;
b) Land use and management goals within these areas focus on balancing land uses with conservation, restoration, and enhancement of native biological communities and must:
    1. Facilitate the movement of native fauna and pollination of native flora across and through the landscape;
    2. Maximize retention of on-site conservation values; and
    3. Promote landscape integrity.
c) Projects subject to this policy within this designation will yield two conserved (mitigation) acres for each acre developed:
    1. Mitigation acres may be provided on-site, off-site, or in combination;
    2. The preference is for mitigation acres to be within Multiple Use Management Areas, any more protective category of the CLS, or Habitat Protection Priority Areas;
    3. For purposes of this policy, Habitat Protection Priority Areas are those areas referenced and mapped as part of the 2004 Conservation Bond Program or any subsequent conservation bond program;
    4. The 2:1 mitigation ratio will be calculated according to the extent of impacts to the total surface area of that portion of any parcel designated as Multiple Use Management Areas;
    5. Development shall be configured in the least sensitive portion(s) of the property;
    6. On-site mitigation area(s) of undisturbed natural open space will maximize conservation values and facilitate the movement of native fauna and pollination of native flora across and through the landscape;
    7. Additional conservation exceeding 66⅔ percent will be encouraged through the use of development-related incentives and may utilize undisturbed natural open space on individual lots; and

8. A Transfer of Development Rights (TDR) may be used in order to secure lands utilized for mitigation, restoration, and/or enhancement purposes.

Policy 7: The following conservation guidelines apply to Agriculture In-Holdings within the Conservation Lands Systems:

a) Intensifying land uses of these areas will emphasize the use of native flora, facilitate the movement of native fauna and pollination of native flora across and through the landscape, and conserve on-site conservation values when they are present; and

b) Development within these areas will be configured in a manner that does not compromise the conservation values of adjacent and nearby CLS lands.

Policy 8: The following conservation guidelines apply to Special Species Management Areas:

a) Across the entirety of the CLS landscape, at least 80 percent of the total acreage of lands within this designation shall be conserved as undisturbed natural open space and will provide for the conservation, restoration, or enhancement of habitat for the affected Special Species;

b) Projects subject to this policy and within this designation will yield four conserved (mitigation) acres for each acre to be developed:

1. Mitigation acres may be provided on-site, off-site, or in combination;
2. The preference is for the mitigation acres to be within a designated Special Species Management Area;
3. The 4:1 mitigation ratio will be calculated according to the extent of impacts to the total surface area of that portion of any parcel designated as Special Species Management Area;
4. Development shall be configured in the least sensitive portion(s) of the property;
5. On-site area(s) of undisturbed natural open space will be configured to facilitate the movement of the relevant Special Species through the landscape and will include conservation values essential to survival of the relevant Special Species; and
6. A Transfer of Development Rights (TDR) may be used in order to secure mitigation lands.

c) Special Species and associated Conservation Guidelines may be added or deleted in the future based on the best available regional scientific information as developed by the Science Technical Advisory Team and added to or deleted from the Special Species Management Areas as shown on the CLS map; and

d) Additions and/or deletions to the list of Special Species or conservation guidelines for Special Species Management Areas will be processed as a comprehensive plan amendment.

Policy 9: The following conservation guidelines apply to Critical Landscape Connections:

a) Land-use changes in these broadly defined areas should protect existing biological linkages;
b) Where they occur, barriers to the movement of native fauna and pollination of native flora across and through the landscape should be removed and fragmented corridors of native biological communities should be restored;
c) Opportunities to remove barriers and restore corridor connectivity may arise as part of other, non-land use related activities (e.g., new construction for or upgrade of infrastructure services). Such opportunities should be pursued; and
d) High priority shall be given to identifying, preserving, and re-establishing the connection between native biological communities especially where natural connectivity is most constrained.

Policy 10: The Board of Supervisors has the sole authority to modify mitigation specified in any conservation guideline or otherwise determined the appropriate amount of mitigation necessary for a comprehensive plan amendment or rezoning to comply with the CLS, including increases, reductions, and exemptions:

a) Requests to modify or be exempt from providing mitigation will be deliberated on a case-by-case basis; and
b) Staff may review proposals and make recommendations for the modification of mitigation ratios, including exemption.

Conservation Lands System Mitigation Lands:

Policy 11: The following guidelines apply to lands being considered for off-site mitigation:

a) The location of off-site mitigation properties should be within the same general geographic region of the original project site;
b) Off-site mitigation property should provide the same or better resource values as the original project site including, but not limited to:
    1. Conservation Lands System (CLS) designations inclusive of 2004 Conservation Bond Habitat Protection Priority designations or subsequent conservation bond programs;
    2. Vegetation community type(s);
    3. Habitat values for applicable CLS Special Species (e.g., breeding, dispersal);
    4. Surface water or unique landforms such as rock outcrops;
    5. Contribution to landscape connectivity; and
    6. Demonstration that the resource and conservation values of the off-site mitigation property will be protected in perpetuity.

c) Off-site mitigation of IRA may include the purchase and transfer of water rights that directly impact and/or support groundwater dependent ecosystems.

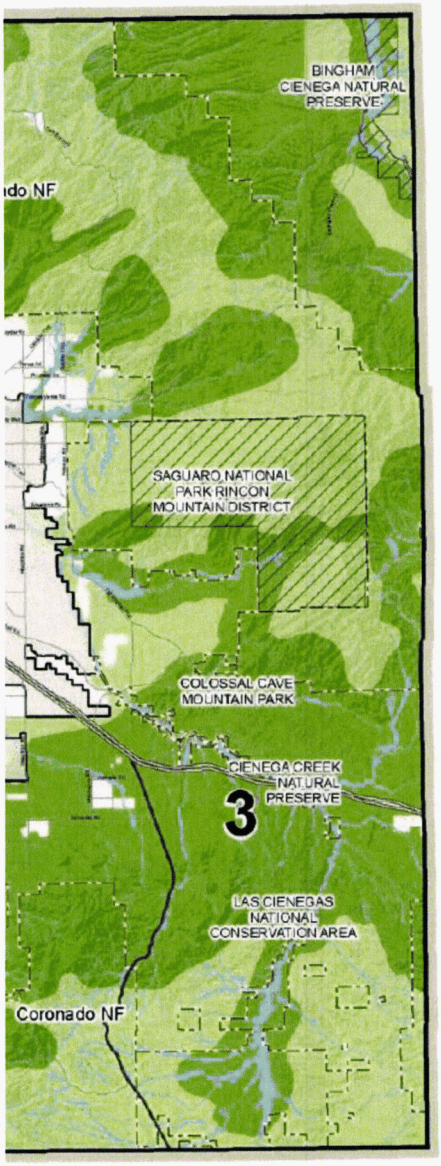
Policy 12: Lands that are to be reserved from development and which will provide CLS mitigation shall be conserved and managed, in perpetuity, for the benefit of the natural resources:

a) Various means may be utilized to protect conservation or mitigation lands including, but not limited to, the transfer of deeded property to Pima County, pending approval by the Board of Supervisors, or other conservation entities and the granting of conservation easements;

b) CLS mitigation lands shall be established as separate, natural open space parcel(s) from the development area; and

c) Residents, or associations of residents, of a development may not serve as the sole administrator or enforcement entity for the management and protection of those conservation or mitigation lands.

PAGE 65 of the PDF: EXCERPT of the MAP referencing eastern Pima County, showing the San Pedro area



PIMA PROSPERS
comprehensive plan initiative

Exhibit 3.4.1

Conservation Lands System
Eastern Pima County

- Important Riparian Areas
- Biological Core Management Areas
- Multiple Use Management Areas
- Agriculture Inholdings
- 5 Critical Landscape Connections
- Special Species Management Areas

Climate and Emerging Environmental Issues

Pima County has made sustainability, reduction of greenhouse gas emissions, and preparing for the impacts of climate change a high priority by leading by example.

Over time, climate change stands to adversely impact the natural environment of the rich and diversified Sonoran Desert, threatening (a) the resilience and vitality of our economy; (b) the health and safety of vulnerable populations; (c) our limited water supply with more frequent and persistent drought; (d) more intense flooding; and (e) the overall well-being of our community and surrounding natural areas through increased frequency and intensity of extreme heat, cold, drought and wildland fires.

Proper planning and execution of that planning is necessary on a local, regional and statewide basis to both prepare adaptation strategies and to address ways we can make modifications that improve public health, reduce the stress on the environment and benefit the economy.

The County has taken a number of steps in collaboration with other organizations and agencies to plan for – and mitigate – the negative effects of climate change and increase the resilience of the human and natural dimensions of the environment to climate-induced changes. Work has included:

- Sonoran Desert Conservation Plan (2001)
- Pima County Drought Response Plan and Water Wasting Ordinance (2007,2014)
- Pima County Sustainability Resolution (2007)
- Regional Optimization Master Plan (2007)
- PAG Regional Greenhouse Gas Inventory (2008, 2010, 2012, 2014)
- Travel Reduction Ordinance
- LEED Silver Building Standards for County Facilities
- 2011-2015 Action Plan for Water Sustainability (2010)
- Community Wildfire Protection Plan (2013)
- Planning for Change in Southern Arizona forum (2013)
- Pima County Sustainability Action Plan for County Operations (2008, 2014)
- Multi-Jurisdictional Hazard Mitigation Plan (2012)

Goal 2: Minimize the negative impacts of climate change on Pima County and increase the resiliency of the human, economic, and natural environment

Policy 1: Support climate adaptation strategies that benefit the public health, economy, and the environment by:

a) Developing drought response preparedness plans and other emergency management plans;
b) Improving stormwater management strategies to minimize runoff and flooding in urban areas by considering incorporation of Low Impact Development (LID) principles, and making beneficial use of stormwater;
c) Adopting strategies to reduce loss of life and property from flooding and erosion; and
d) Retaining natural open space.

Policy 2: Pursue adaptive, flexible, cost effective, multi-pronged preparedness strategies such as diversification of water supplies, water conservation, improved demand management and increased reliance on water harvesting.

Policy 3: Reduce greenhouse gas emissions and heat island effects by:
a) Establishing targets and monitoring progress;
b) Reducing barriers to the production of renewable energy;
c) Continuing to increase energy efficiency including energy efficiency standards in both County-owned and privately owned buildings;
d) Developing strategies and providing incentives to reduce single-occupancy Vehicle Miles Traveled (VMT);
e) Promoting, designing and constructing multi-modal (alternative modes) transportation and transit systems.

Policy 4: Ensure the viability of the natural environment in context of climate change by:
a) Preserving watershed and ecological function, connectivity, and resiliency;
b) Identifying and protecting areas that have served as ecological refugia for species during time of past climatic variability (e.g., riparian areas, talus, limestone);
c) Ensuring the availability of an adequate water supply for the natural environment in the context of climate change including using best management practices to establish and maintain water for wildlife and their habitats;
d) Protecting the carbon dioxide (CO2) sequestration functions of the natural environment including maintaining a balance between preserving natural, grassland and riparian areas that can absorb excess carbon from the atmosphere and developed areas by implementing the Maeveen Marie Behan Conservation Lands System.
e) Creating consistency in regulatory requirements, policies, and practices for the restoration and re-vegetation of construction activities impacting undisturbed desert areas.

Policy 5: Enter a regional conversation on carbon footprint reduction (see carbon footprint illustration of page 4.25 of the Physical Infrastructure Connectivity chapter).

Policy 6: Support and strengthen Pima County based policies and programs to control and eradicate buffelgrass and other invasive species to reduce the threat of wildfire and loss of native species.

Policy 7: Support the establishment of an integrated and adaptive drought management strategies plan for the County that:

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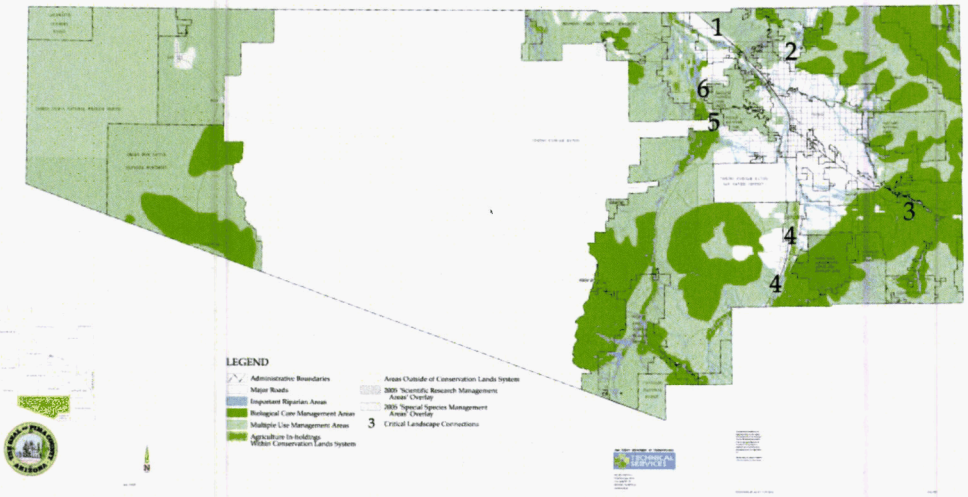
PIMA COUNTY CONSERVATION LANDS SYSTEM
Adopted June 21, 2005



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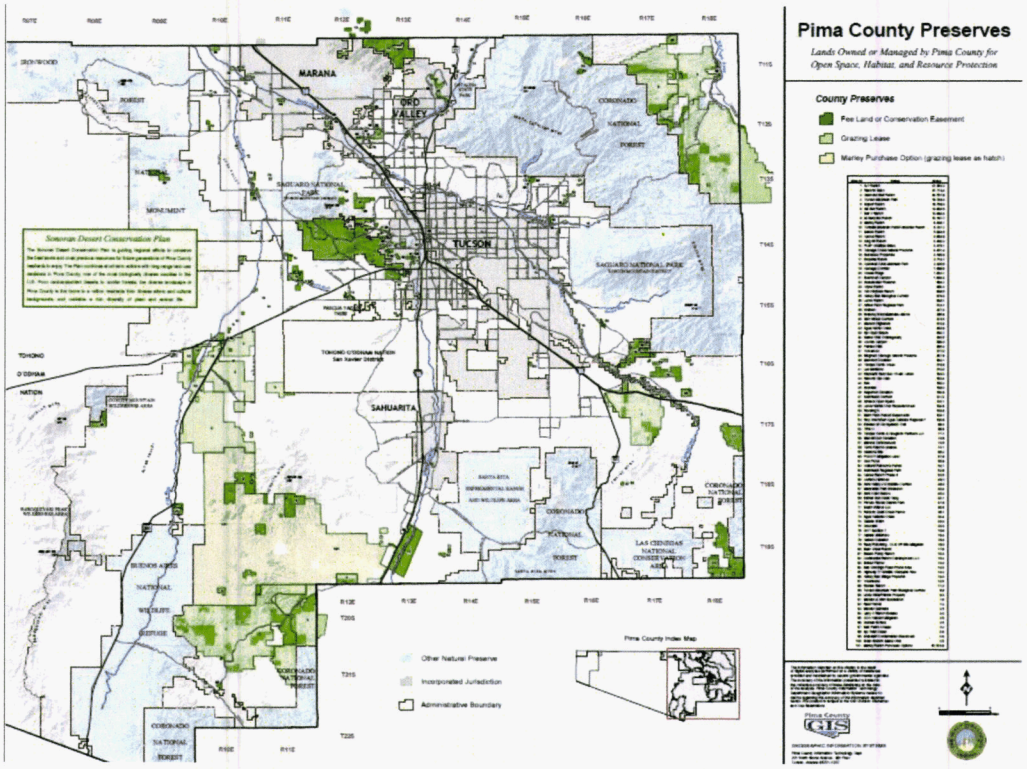

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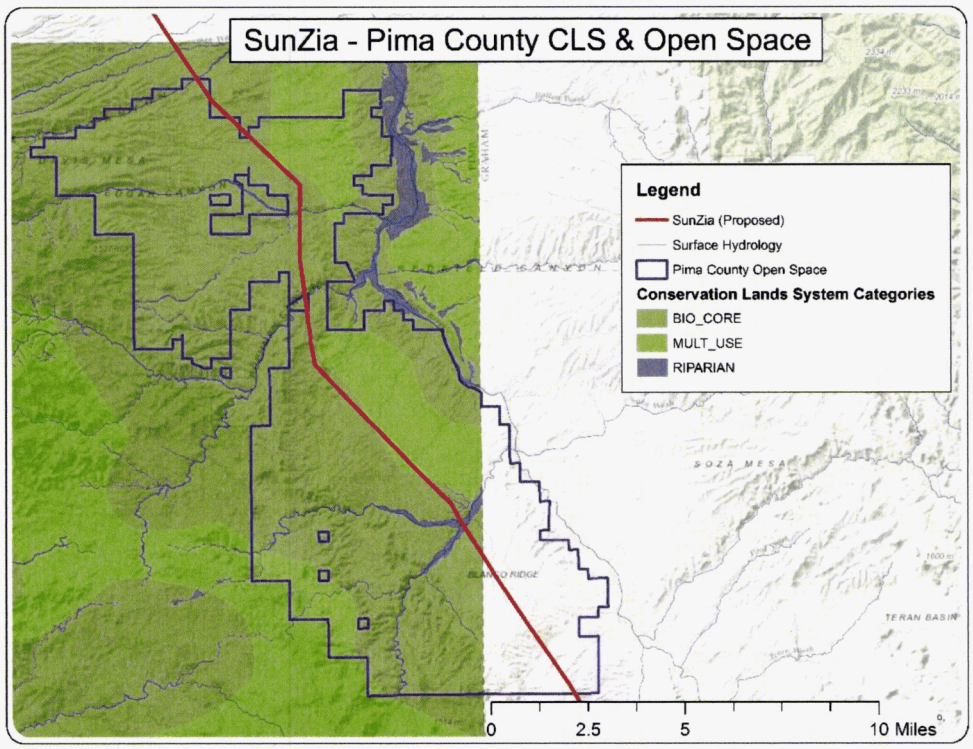

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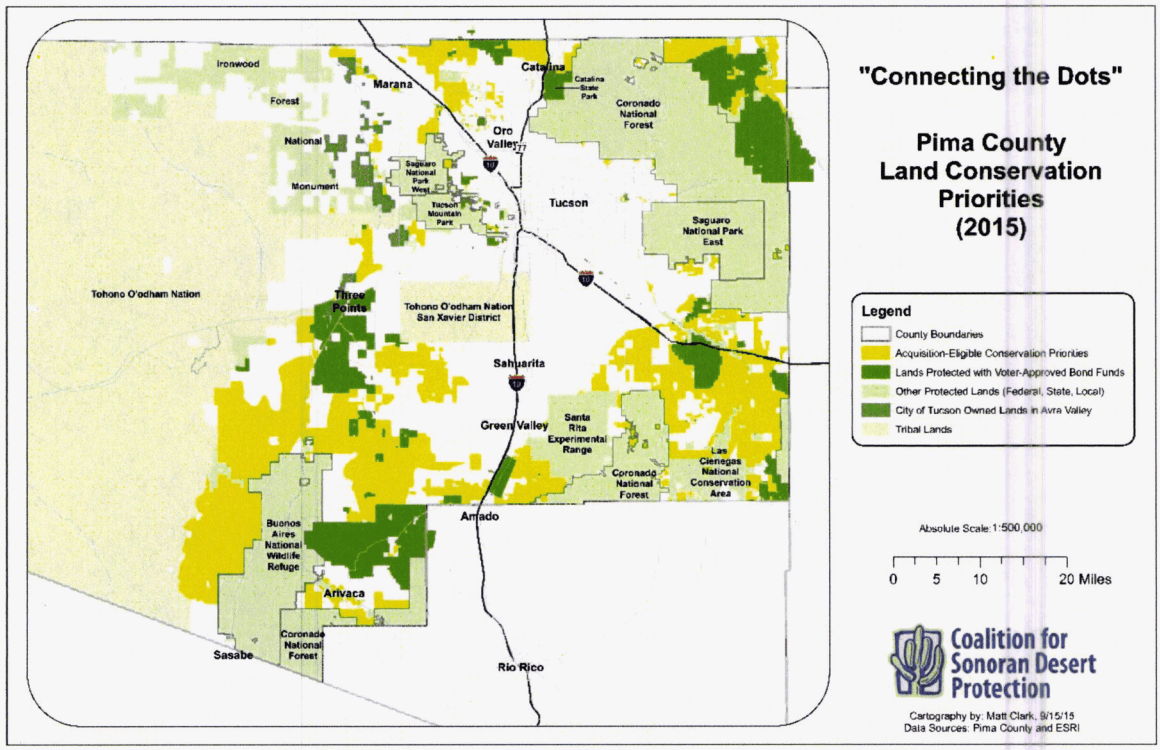

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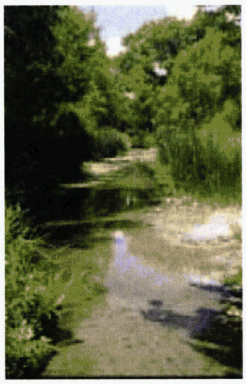
The Upper San Pedro Partnership

by Doug Duncan and
Lynn Slagle



Upper San Pedro River
Photo by William G. Kepner/EPA

People have lived in the desert Southwest for thousands of years. To survive in this arid land, early settlers had to develop special skills and adapt to a desert-based way of life. Today, communities throughout the region face a similar challenge: learning how to grow sustainably while conserving water and functioning ecosystems.

This part of the country has an old saying: "Whiskey's for drinkin' and water's for fighting." There are no easy answers for managing water resources in the arid Southwest, but cooperative approaches have made fighting unnecessary. In southeastern Arizona, 21 government agencies and private organizations have banded together as a group to ensure that the region will continue to have an adequate ground water supply for area residents and the natural resources of the San Pedro River. They call this group the Upper San Pedro Partnership.

The purpose of the Partnership is to cooperate in identifying, prioritizing, and implementing policies and projects to assist in meeting water needs in the Sierra Vista Subwatershed of the Upper San Pedro River Basin.

The Challenge

The San Pedro is considered one of the most significant perennial undammed desert rivers in the United States. It provides important habitat for almost 400 species of migratory birds, 80 species of mammals, and 40 species of reptiles and amphibians. Many of these animals rely on the riparian vegetation of the Bureau of Land Management's San Pedro Riparian National Conservation Area (SPRNCA), which Congress designated in 1988. This area includes marshland, cottonwood-willow forest, mesquite forest, and various shrub lands. The water stored in the aquifer supports this vegetation and the perennial flow of surface water.

The Upper San Pedro River Basin and the San Pedro River are home to several listed species and provide suitable or potential habitat for several more. The river provides most of the occupied habitat for the endangered Huachuca water-umbel (*Lilaeopsis schaffneriana* var. *recurva*). This small, cryptic, semi-aquatic plant has 33 miles (53 km) of designated critical habitat along the San Pedro River. The San Pedro River also contains critical habitat for two threatened fish species, the spikedace (*Meda fulgida*) and loach minnow (*Tiaroga cobitis*), and potential habitat for a host of other native fishes.

The Upper San Pedro Basin uplands provide significant habitat for the threatened Mexican spotted owl (*Strix occidentalis lucida*) and the nectar-feeding lesser long-nosed bat (*Leptonycteris curosoae yerbabuenae*). This endangered bat occurs seasonally in protected roosts on Fort Huachuca and the Coronado National Memorial. The watershed also provides potentially

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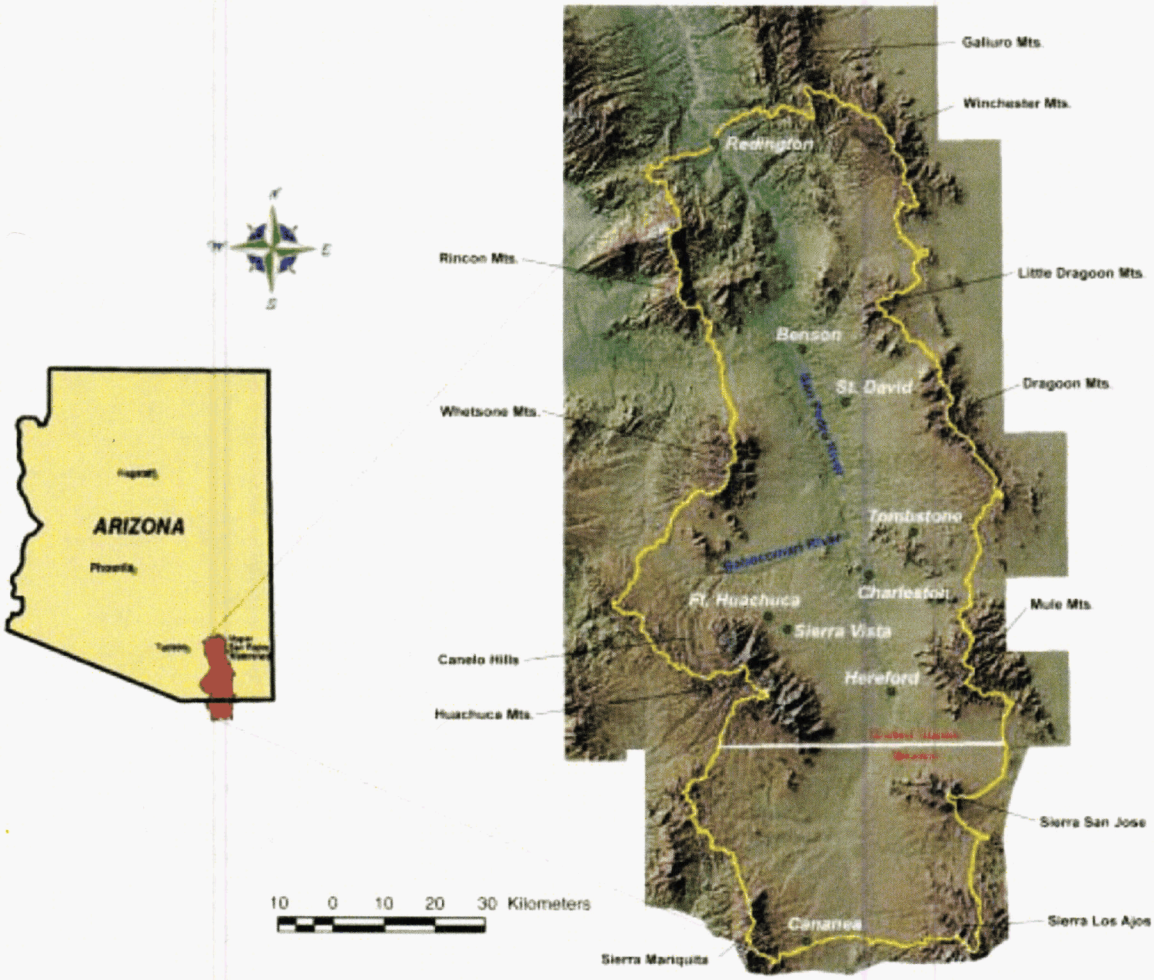
Upper San Pedro Watershed



EXCERPT PAGE 4 of the PDF

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8

Six Bar Ranch

Fee lands: 3,292 acres
State grazing lease: 9,000 acres
Conservation easement: 40 acres
Cost: $11,525,322
Acquired: August 23, 2006
Fund: 2004 Bond Funds
Partner: Arizona Land & Water Trust

Background

The 12,000 acre Six-Bar Ranch is located along the eastern flank of the Catalina Mountains, adjacent to the Coronado National Forest and northwest of the County's A-7 Ranch. It is visible from Catalina Highway at the San Pedro overlook and can be accessed via several trails from the top of the Catalina Mountains. The Ranch contains a major tributary to the San Pedro River – Edgar Canyon. The property expands upon other conserved lands in the area, including the Coronado National Forest, The Nature Conservancy's Buehman Canyon Preserve, and the County's A-7 Ranch, Bingham-Cienega Preserve and Oracle Ridge Properties. A 24,000-acre Forest Service grazing permit is associated with this property. The ranch is a rugged complex of canyons and drainages off the east slopes of the Catalina Mountains down towards the San Pedro Valley.

Lowland leopard frog. Photo by Bill Singleton

Historical and Cultural Resources

Archaeological sites in the Six-Bar Ranch area suggest a long period of prehistoric human occupation associated with the San Pedro River Valley villages sites. In addition, a cultural resources survey dated July 2006 identified a historic ranch house and related outbuildings along the southeastern bank of Edgar Canyon – the major tributary to the San Pedro River. This complex is located on a 40-acre conservation easement held by the County, and is used today. Records show that this is likely the O.R. Parker House depicted on the General Land Office map for this area, filed in 1924. The Parker family was involved in the original development of Redington Pass road, and at one time owned some, if not all, of the land associated with the County's A-7 Ranch, southeast of the Six-Bar Ranch.

Biological Resources

The Ranch is located in the lower San Pedro River Valley and is composed of rugged uplands along the eastern flanks of the Catalina Mountains, alternating with narrow, incised valleys formed by generally east trending tributary washes draining into the San Pedro River. The property contains important stands of cottonwoods, sycamore, hackberry and ash trees along the Edgar Canyon drainage, along with intermittent streams and springs, and limestone outcrops. The uplands contain dense stands of saguaros in many places. The property contributes to the conservation of several Priority Vulnerable Species, including Lowland leopard frog, Lesser long-nosed bat, Mexican long-tongued bat, Western red bat, and the Giant spotted whiptail. Fish and frogs have been reported in Edgar Canyon. All of the ranch lies within the Biological Core of the Conservation Lands System and contains portions of Important Riparian Areas. The location of the property between the Catalina and Galiuro Mountains provides for a corridor of open lands for wildlife movement back and forth between the mountain ranges.

Edgar Canyon on Six Bar Ranch. Photo by Brian Powell.

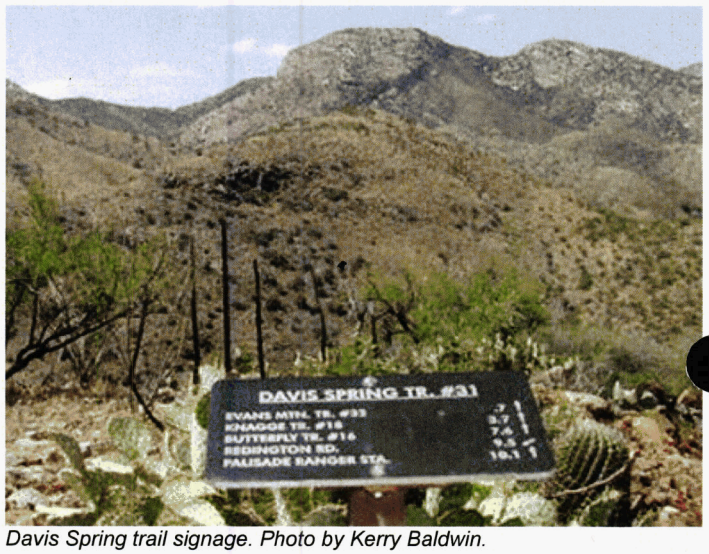
Management

The Six Bar Ranch is a working ranch landscape. The ranch is currently stocked at a light rate, about 20% of allowed use, to reflect ongoing drought conditions. The County maintains a Ranch Management Agreement over all aspects of use of the ranch by an independent operator. The rugged ranch has few roads and is generally accessible only by horseback or on foot. The ranch is being monitored twice annually to establish some baseline data on the overall range condition and trend in vegetative community diversity and productivity. Existing waters are being modified to be more wildlife friendly. Public recreation access on the major road into Edgar Canyon and Davis Mesa is being managed under an agreement with the Arizona Game and Fish Department. All visitors are required to check in and out at an information kiosk as the road passes through private and enters County lands.

Stream in Edgar Canyon. Photo by Locana de Souza.

Recreation

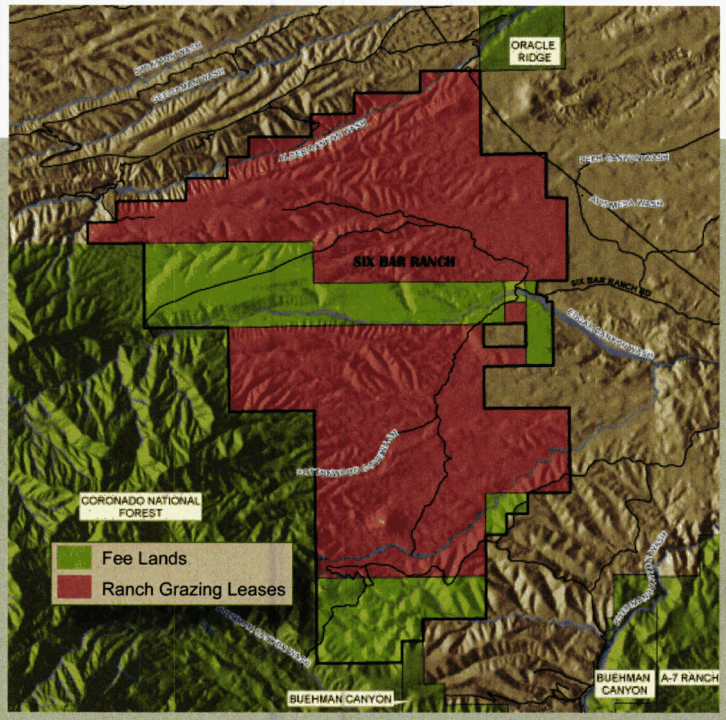
The fee lands along Edgar Canyon contain an existing trailhead for the Davis Spring Trail, which leads up the eastern slopes of the Catalinas to the Palisades Ranger Station from Davis Mesa. The ranch is a popular area for hunting both small game like quail and big game like deer and javelina. Other recreational activities like ATV/OHV riding, wildlife viewing and biking are popular uses of the ranch. This ranch is more remote and has limited access points so it does not get as much use as many of the other ranch properties.



Davis Spring trail signage. Photo by Kerry Baldwin.

Ongoing Property Improvements

- Most of the ongoing activities on the ranch are related to establishing representative long-term monitoring data points and gathering information about the ranch ecosystem.
- Waters are being maintained for wildlife and livestock with escape ramps being installed to prevent wildlife drowning incidents in open troughs and tanks.
- Challenges exist in protecting the historic ranch buildings because of changes in the dynamics of flood water flows in Edgar Canyon due to the buildings being built on the active flood plain of the stream channel.
- Other routine activities include monitoring of recreational use and users.



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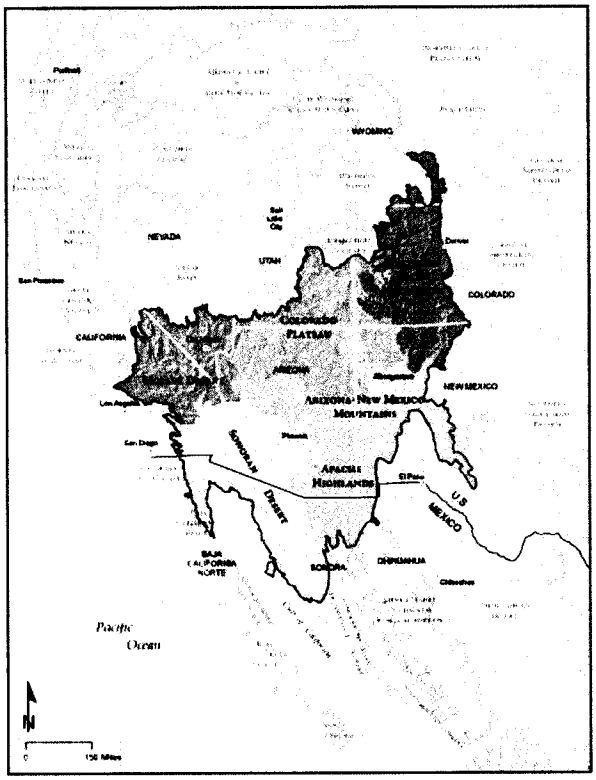
Ecoregion-Based Conservation Assessments of the Southwestern United States and Northwestern Mexico

A Geodatabase for Six Ecoregions, Including the Apache Highlands, Arizona-New Mexico Mountains, Colorado Plateau, Mojave Desert, Sonoran Desert, and Southern Rocky Mountains

Rob Marshall, Michael List, and Carolyn Enquist

May 2006



The Nature Conservancy

SAVING THE LAST GREAT PLACES ON EARTH

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EXECUTIVE SUMMARY

In 1995 The Nature Conservancy developed a new conservation framework – ecoregional assessments – to guide development of a blueprint for regional-scale conservation efforts. Ecoregions are large areas of land and water – on the scale of tens of millions of acres – characterized by distinct plant and animal communities, similar landforms, and environmental conditions such as climate. The framework's foundation was a systematic and comprehensive scientific analysis intended to serve as a guide for prioritizing the organization's work, engaging collaborators, and providing a context for understanding how individual projects fit into a larger conservation vision. Agency, university, institutional, and tribal resource professionals played a major role in the development of the assessments. Conservation assessments were completed for the southwestern U.S. and northwestern Mexico between 1999 and 2004.

Ecoregions are based on ecological rather than political boundaries. As a result they often bisect federal, state, private, and tribal jurisdictional boundaries, complicating the use of assessment data by public land managers and others. The six assessments covering the southwestern U.S. and northwestern Mexico were completed independent of one another; the methodology used did not ensure that data could be aggregated by simply combining the six assessments. Without additional data standardization and reconciliation, the utility of ecoregional assessments would be limited to the boundaries of each respective ecoregion. To solve this problem and to create a cross-ecoregional dataset that would facilitate analyses at multiple scales, we aggregated and standardized data from the six assessments into a single spatial dataset, referred to as the "six-ecoregion geodatabase."

A primary goal in compiling the six-ecoregion geodatabase was to facilitate conservation-related analyses and problem-solving at multiple scales and across jurisdictional and political boundaries. Several additional goals included:

- Enable review and analysis with a single dataset of conservation priorities across a large multi-state region.
- Introduce conservation priorities for a large region that shares similar challenges of habitat loss and fragmentation and increasing pressures on limited water resources from rapid urban and ex-urban growth, and, likely, climate-induced changes in the distribution of habitat for the region's biological diversity.
- Enable land managers, planners, policy-makers, and conservationists to evaluate, visualize, plan, and implement conservation actions across jurisdictional and political boundaries.

The six assessments compiled in this study evaluated 238 million acres across 11 states and two countries. Overall, more than 1300 species and 350 native plant communities and ecological systems were analyzed as part of the assessment process. The end result was a network of lands comprising 100 million acres (42% of the study area) where conservation should play a significant role if we are to maintain the region's biological diversity. The median size class of the areas comprising the network is from 50,000 to 250,000 acres. The comprehensive datasets and systematic analyses used to identify the network represent a new, synthetic data source for agencies, institutions, and organizations engaged in land-use planning and conservation land management.

Sixty-five percent of the network occurs on federal lands with Bureau of Land Management (BLM) and U.S. Forest Service (USFS) lands comprising 47% of the total network. Private lands, the next largest category, comprise 19% of the network. Underscoring the importance of the federal estate for conservation management, the U.S. Forest Service, Department of Defense, and Bureau of Land Management each has between 44% and 51% of their holdings within the network; the U.S. Fish and

Wildlife Service and National Park Service have 84% and 78%, respectively, of their holdings within the network. Moreover, 54% of the individual areas that make up the network have at least three major land managers responsible for on-the-ground management, affirming the fact that ecosystems don't stop at jurisdictional boundaries.

Conservation assessments purporting to identify priorities, typically, are identifying a set of tradeoffs. Identifying tradeoffs explicitly is one of the purposes of ecoregional assessments. In rapidly-growing areas, such as the southwestern U.S., conservation options are foreclosed on a daily basis and resources are inadequate to protect all important lands and waters. The assessment work represents the first attempt for this region at a systematic, comprehensive analysis and identification of conservation priorities at a scale commensurate with the scope and magnitude of change caused by human activities. The comprehensive, systematic, and explicit nature of the assessments can better enable decision-makers and other leaders in institutions and agencies to plan, fund, and implement conservation-related activities in a manner that enhances biological diversity while carrying out unrelated activities in a manner that minimizes further losses of biological diversity.

There are several important applications of ecoregional data. The network represents an important geography on federal, state, and private lands for which land-use allocations may be evaluated for their compatibility with the conservation values present. The broad diversity of systems and species used to represent the region's biological diversity provide a starting point for evaluations of the extent to which natural disturbance regimes – important for perpetuating habitat – are operating on the landscape. Furthermore, reducing stressors and threats in this geography will increase the likelihood that the region' ecological systems and species remain viable, an important component of management focused on maintaining "healthy ecosystems." Action to promote natural disturbance processes at appropriate scale and minimize known stressors and threats throughout the network should, over time, limit the need for additional listings under the Endangered Species Act.

Many federal, state, county, and municipal agencies are completing land-use, land management, wildlife conservation, or habitat conservation plans. These efforts typically encourage or require collaboration and planning across jurisdictional boundaries to leverage limited funding and increase overall effectiveness. Ecoregional data are well-suited for these purposes and have been integrated into numerous planning efforts throughout the U.S. Among the unique aspects of ecoregional assessments is the integration of aquatic/riparian- and terrestrial-based data into unified geographies that lend themselve to "watershed" or "ecosystem-based" management. With the proliferation of planning efforts underway, such as the National Fish Habitat Initiative, State Comprehensive Wildlife Conservation Plans, federal land management plans etc., ensuring integration of the terrestrial and aquatic realms into a cohesive and effective set of management strategies will be paramount. The prospect of achieving large-scale system-level restoration and management presents a unique challenge for all planning efforts because funding fo such work remains limited. If large-scale, cooperative conservation planning is the new prerequisite for capturing federal, state, and private conservation funds, then a first step for emerging efforts might be to critically evaluate the opportunities that can be leveraged with contemporary, cross-boundary ecoregiona assessments that unify terrestrial and aquatic conservation priorities before additional investments are made in new priority-setting exercises.

native grasslands would maximize viability for grassland species. Note that despite the lack of fine filter data for the Mexico portion, 47% of the conservation area lies on the Mexico side of the border. This is largely the result of the extensive grassland that occurs in the Mexico portion. This graphic illustrates how good coarse filter data, combined with conservation goals at a meaningful scale, can compensate for gaps in fine filter data in the delineation of conservation areas.

Figure 4 illustrates one type of viability assessment used in the ecoregional assessment process – a "cost" surface or suitability index. The graphic illustrates the effect of "cost" on the delineation of conservation areas. Increasing cost is depicted by increasingly dark shades of red. Cost is an additive but unit-free value represented by the extent of human infrastructure, such as mines and other industrial development, agriculture, urban development, and roads (see Marshall et al. 2004). The algorithm that delineated conservation areas was programmed to avoid high cost areas where conservation may be incompatible and or prohibitively costly. The Huachuca Mountains conservation area is delineated in green; the graphic illustrates how higher cost areas were largely avoided, such as the major highway corridor that borders the western boundary. Some high cost areas, such as the east side of the Huachuca Mountains adjacent to the city of Sierra Vista, were included, however. This is due to the high number of endemic species occurring in this mountain range. The inclusion of "high cost" areas indicates there are limited or no other alternatives in the ecoregion in which to protect those conservation targets. Cost analyses were used in the Apache Highlands, Colorado Plateau and Southern Rocky Mountain ecoregional assessments (**Table 1**).

The conservation area network

Carried out across an entire ecoregion, the process of identifying conservation areas described in **Figures 2 – 4** yields the primary end product of the ecoregional assessment process, a network of "conservation areas." The term "conservation area" is shorthand for the locations identified that capture the most important places to protect the 366 ecological systems and 1374 species analyzed over the six-ecoregion study area. The term does not convey special status to those areas; rather, the network of conservation areas is a blueprint for where enhanced attention to conservation management would contribute to a larger regional conservation vision. The purpose of this project was to aggregate and standardize conservation area data across the six-ecoregion study area.

The aggregation and standardization process resulted in a network of 568 conservation areas comprising nearly 100 million acres, or 42% of the six-ecoregion study area. **Figure 5** depicts this network as a series of irregularly shaped polygons in green. Conservation areas range in size from just over 100 acres to approximately 5.7 million acres. **Figure 6** provides a frequency distribution for the size of conservation areas. The vast majority of conservation areas (82%) are less than 250,000 acres in size; the median for all conservation areas was 50,000 acres. There are at least five factors that account for the size, shape, and distribution of the conservation area network, including:

1. The distribution of species and ecological systems is not uniform across the southwestern U.S. and northwestern Mexico. The considerable range in elevation (sea level to 14,000 feet) and complex topography in the six-ecoregion study area yields a non-uniform distribution of systems and species.
2. Habitat and other life-history requirements of target systems and species differ. For example, the San Fransciso groundsel (*Senecio franciscanus*) is restricted to alpine areas on the San Francisco Peaks in the Arizona – New Mexico Mountains ecoregion, whereas the endangered Sonoran pronghorn (*Antilocapra americana sonoriensis*) roams across nearly 6 million acres along the Arizona – Sonora borderlands in the Sonoran Desert ecoregion. The net result is that the size and shape of conservation areas is, in part, a function of the spatial occurrence of the conservation targets selected and the requirements of those targets as expressed by conservation goals.

3. Species-level target data are not uniformly sampled across the landscape. Species-level datasets often contain taxonomic and geographic sampling biases. These biases are inherent in any analysis using species-level data. However, coarse-filter conservation targets may help overcome this bias as hypothesized in **Figures 2-4**.
4. The advent of computerized conservation area selection algorithms enabled assessment teams to program boundary modifier values that affect perimeter to interior ratios and the degree to which conservation areas were "connected." Assessments, such as the Apache Highlands used higher values for the boundary modifier which yielded large, "connected" conservation areas.
5. Conservation area selection algorithms are programmed to identify an "efficient" network where conservation goals are met with a minimum amount of area. Thus, if a conservation target is found in two locations, but one location includes two additional conservation targets, the algorithm will select the area with the additional conservation targets (assuming viability and other factors are equal).

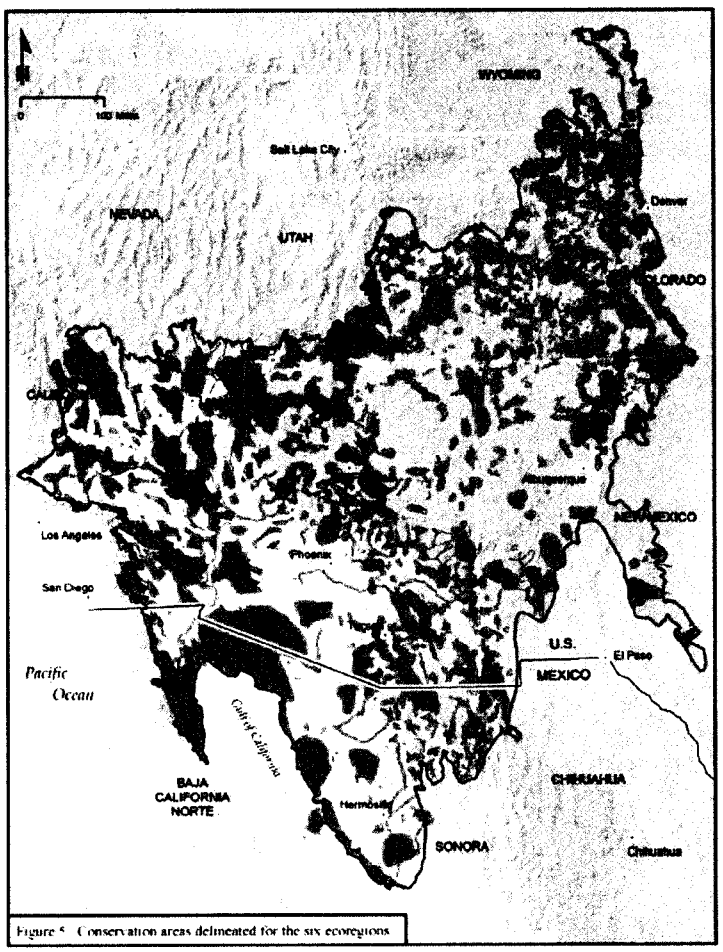

Figure 5. Conservation areas delineated for the six ecoregions

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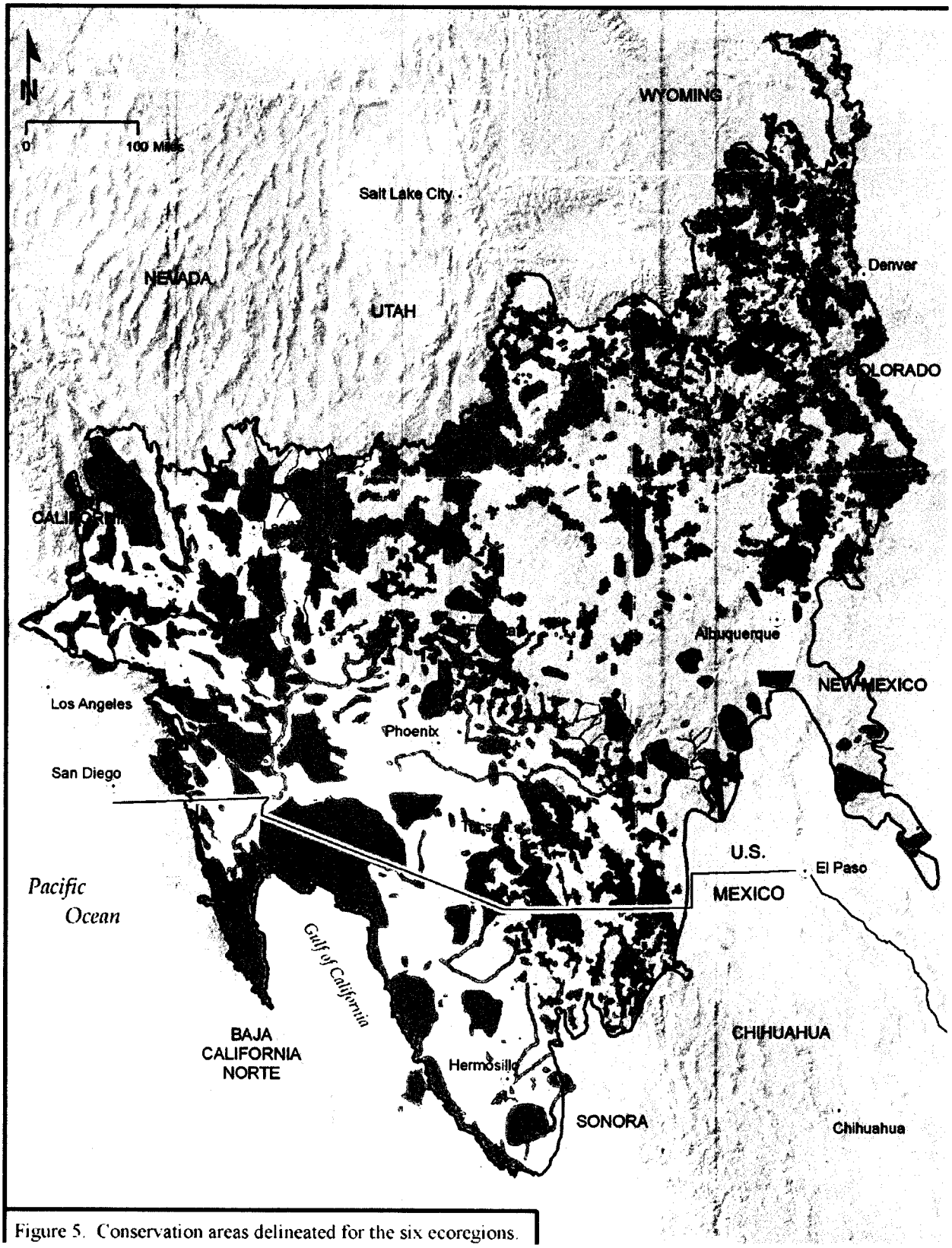

Figure 5. Conservation areas delineated for the six ecoregions.

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State wildlife conservation plans

In 2001 Congress created the State Wildlife Grants program as the nation's core program for keeping wildlife from becoming endangered. Federal funding to states is predicated on the completion of State Wildlife Conservation Plans. These plans, also referred to as State Wildlife Action Plans, define a vision of conservation success for the nation's wildlife. Among the eight elements state plans address is a requirement for states to coordinate implementation of conservation measures with federal, state, and local agencies and Tribes. This requirement provides an opportunity for states to play a leadership role in focusing state and federal funding on geographies and approaches that will enable states to meet the vision intended by Congress. Many states have integrated ecoregional assessment data, in whole or part, into their plans. And some groups, such as the Huachuca Area Fire Partners described above, have already begun collaborative efforts that focus on enhancing ecosystem health at conservation areas identified through the ecoregional assessment process.

However, there is a considerable need to expand the number of outcome-focused collaborations working to improve ecosystem health at a meaningful scale. As an example, **Figure 10** ranks the network of conservation areas based on the number of terrestrial species with status under the Endangered Species Act or that are non-listed but rare. Sixty-two percent of the conservation areas (over 350 areas) support rare or endangered terrestrial species and their habitat. Eighty-two conservation areas support habitat for between 5 and 20 rare or endangered species, comprising approximately 47.8 million acres. Maintaining healthy ecosystems for these species as well as limiting the need for additional listings under the ESA presents a significant challenge in an era of decreasing budgets. Collaborative, cross-boundary projects

focused on ecosystem condition provide one avenue to meet this challenge. Consider that 54% of the conservation areas in the U.S. portion of **Figure 10** are managed by at least three major land managers. More than 100 conservation areas are managed by USFS and BLM and 84 are managed by USFS, BLM and a state agency. These data affirm the well-known fact that ecosystems don't stop at jurisdictional boundaries. Given the median size for conservation areas is from 50,000 to 250,000 acres, these data also underscore that the conservation and land management community will have to increase the scale of conservation management, a significant challenge in an era of limited funding. Under the auspices of State Wildlife Conservation Plans, and armed with regional datasets, states have an opportunity to play a leadership role in convening, implementing, and learning how to manage ecosystems for the benefit of biodiversity.

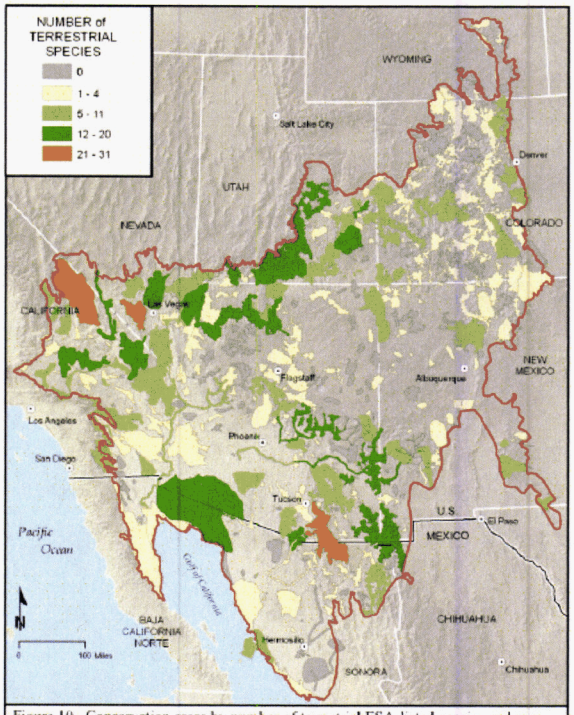

Figure 10. Conservation areas by number of terrestrial ESA-listed species and non-listed rare species.

National Fish Habitat Initiative

The International Association of Fish and Wildlife Agencies, in conjunction with the U.S. Fish & Wildlife Service and National Marine Fisheries Service, is leading a nation-wide effort to address the loss and degradation of aquatic habitats that supports the nation's fish biodiversity – the National Fish Habitat Initiative (NFHI). Noting significant gains made in the enhancement of aquatic habitat with the advent of environmental regulations introduced in the 1970s, NFHI's Action Plan cautions that "these efforts have not kept pace with impacts resulting from population growth and land-use changes" (NFHI 2006). The Plan includes a number of ambitious goals, including: preparation of a *Status of Fish Habitats in the United States* by 2010; protection of all healthy and intact fish habitats by 2015; and improvement in the condition of 90% of priority habitats and species targeted by Fish Habitat Partnerships by 2020. Among the Initiative's strategies is support to foster new partnerships and communicate the status and needs of aquatic habitats. A science and data strategy notes the need to "utilize an integrated landscape approach that includes the upstream/downstream linkages of large scale habitat condition factors" (NFHI 2006).

The Plan's ambitious goals and strategies will require biological and ecological assessments and data syntheses to support effective use of funds and successful outcomes. The six-ecoregion geodatabase provides one source of contemporary assessment information that can be used to quickly identify high priority aquatic systems and species. Native aquatic- and riparian-dependent species were a major focal point of ecoregional assessment for the southwestern U.S. Of the 1374 fine-filter conservation targets analyzed in the six-ecoregion study area, 39% were aquatic- or riparian-obligate species. Each conservation target was assigned a conservation goal and is represented in one or more conservation areas throughout the network. Moreover, conservation areas typically capture several or more aquatic systems

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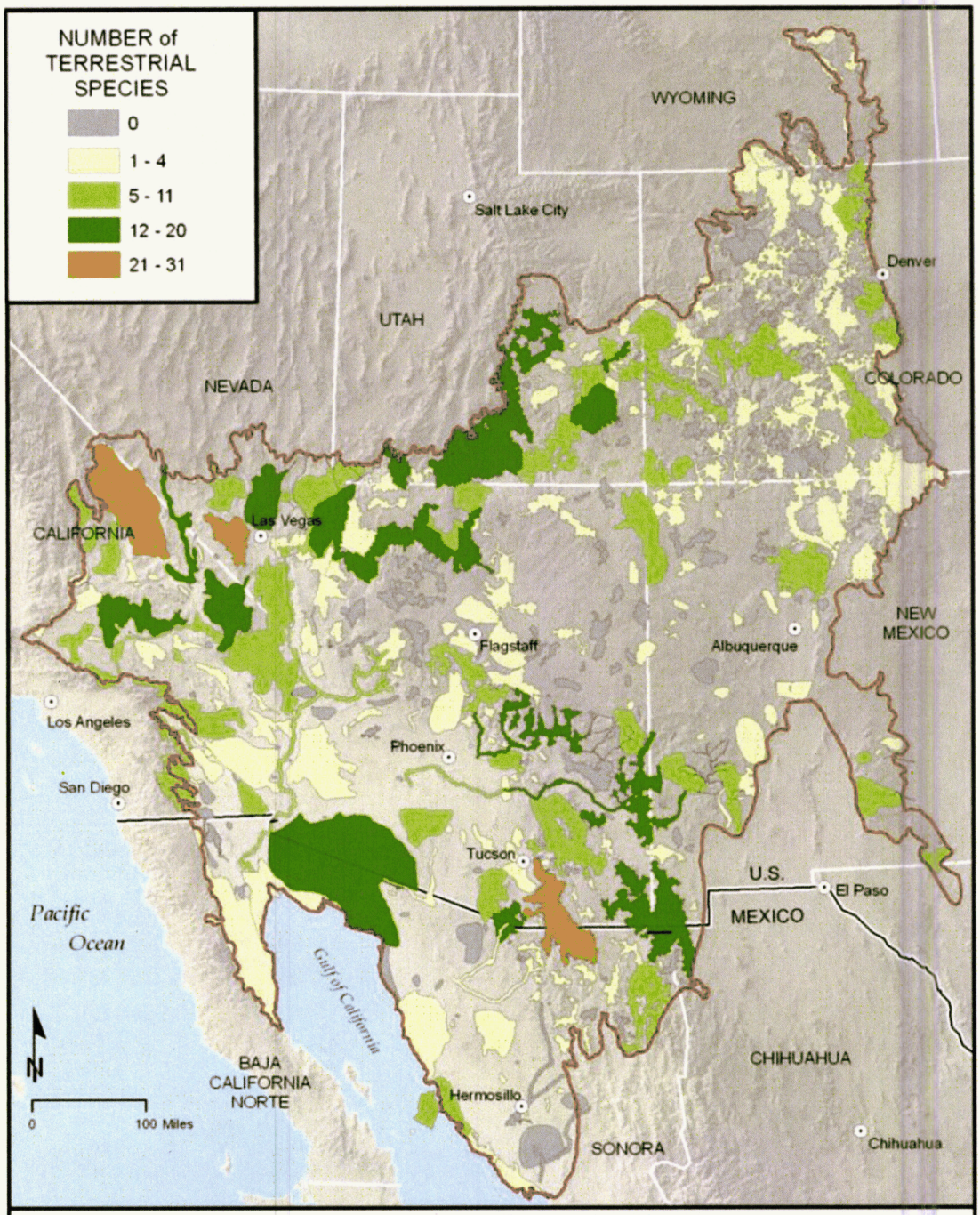

Figure 10. Conservation areas by number of terrestrial ESA-listed species and non-listed rare species.

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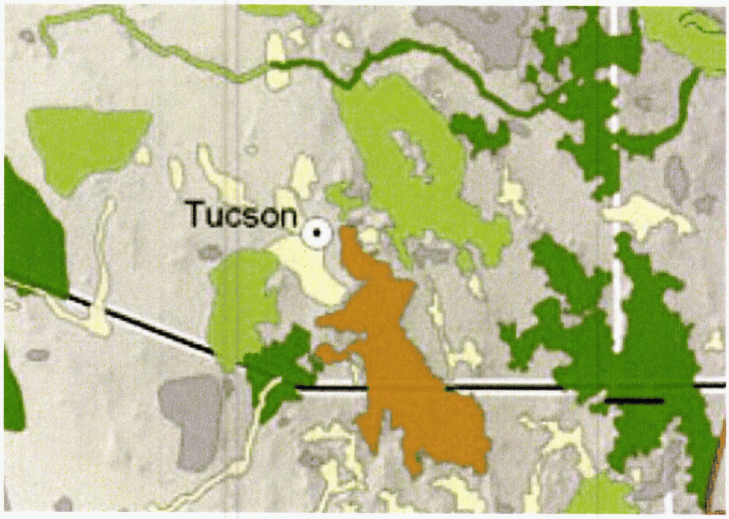

and species (**Figure 11**) and, thus, form a good starting point for evaluating the conservation activities needed to maintain the viability of those systems and species.

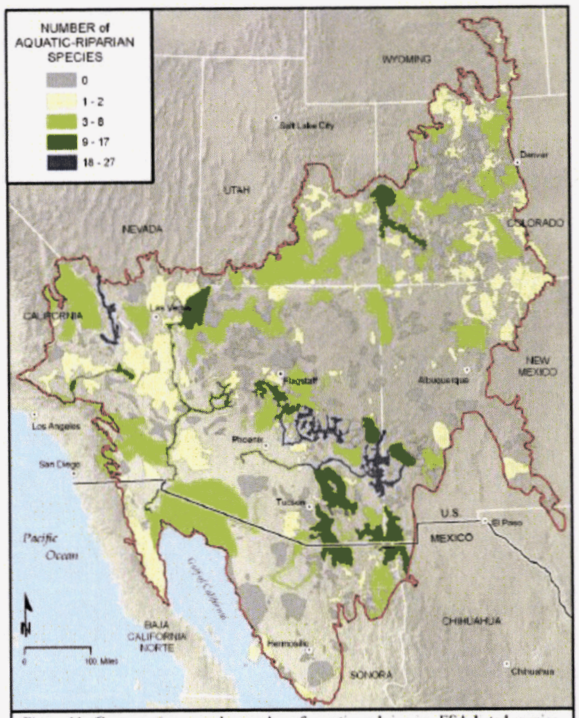

Figure 11. Conservation areas by number of aquatic and riparian ESA-listed species and non-listed rare species.

In **Figure 11** conservation areas are ranked by the number of aquatic and riparian species that are rare or have status under the ESA. This analysis demonstrates the importance of aquatic habitat throughout the arid Southwest; it is also a sobering illustration of the state of imperilment of our aquatic systems with several large conservation areas harboring nearly 30 rare and endangered aquatic and riparian species. Although NFHI's goals extend to introduced sport fisheries, ecoregional assessment data provide highly synthesized data for those efforts that wish to pursue native fish conservation. Moreover, ecoregional assessment data also facilitate NFHI's intent to "utilize an integrated landscape approach," because locations identified to capture aquatic systems and species are imbedded within their larger terrestrial conservation areas providing NFHI efforts an opportunity to evaluate system-level management actions that might benefit terrestrial as well as aquatic and riparian systems and species. For example, Gori and Backer (2005) found a ten-fold increase in populations of Gila chub (*Gila intermedia*), proposed for listing under the ESA, over the course of a 12-year period where grazing rest and prescribed burning were used to improve watershed conditions on a 50,000-acre watershed jointly managed by BLM and TNC in southeastern Arizona. The study also documented significant improvement in aquatic habitats, such as increasing pool depth, number of pools per km, and extent of bank cover. These changes occurred during a period of decreasing stream flows indicating that the habitat improvements likely resulted from structural changes in the stream channel rather than increases in stream flow.

The National Fish Habitat Initiative's caution about the causes of current aquatic habitat loss and degradation – impacts from population growth and land-use changes – are the same issues facing conservation efforts within the terrestrial domain. Thus, the prospect of unifying aquatic- and terrestrial-based conservation efforts around a shared geography with shared priorities and the gamut of strategies, including large-scale system-level restoration and management, presents a unique challenge for efforts like NFHI and State Wildlife Conservation Plans. If large-scale, cooperative conservation planning is the new prerequisite for capturing federal, state, and private conservation funds then a first step for existing and emerging efforts might be to critically evaluate the opportunities that can be leveraged with contemporary, cross-boundary assessments that unify terrestrial and aquatic conservation priorities before additional investments are made in new priority-setting exercises.

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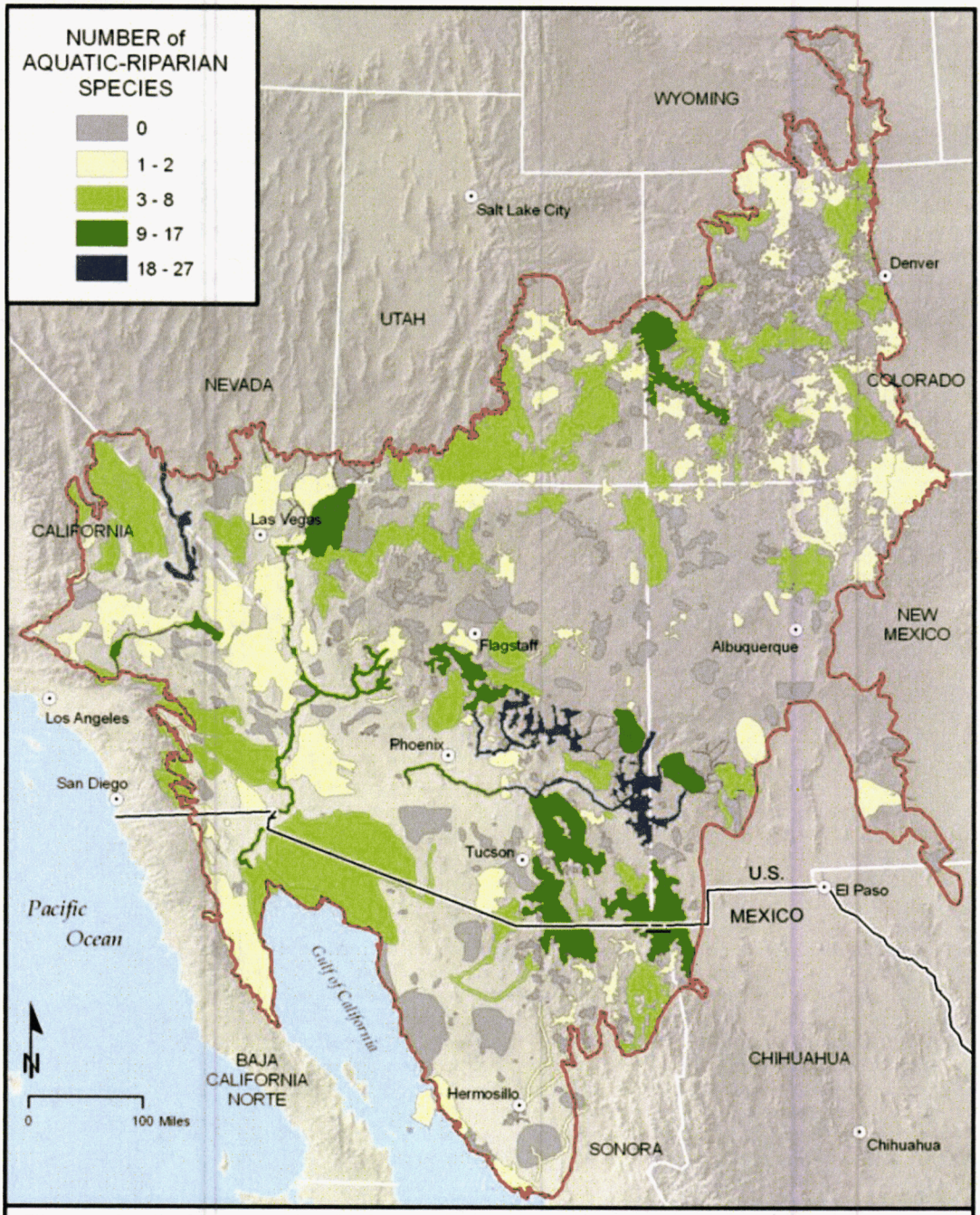

Figure 11. Conservation areas by number of aquatic and riparian ESA-listed species and non-listed rare species.

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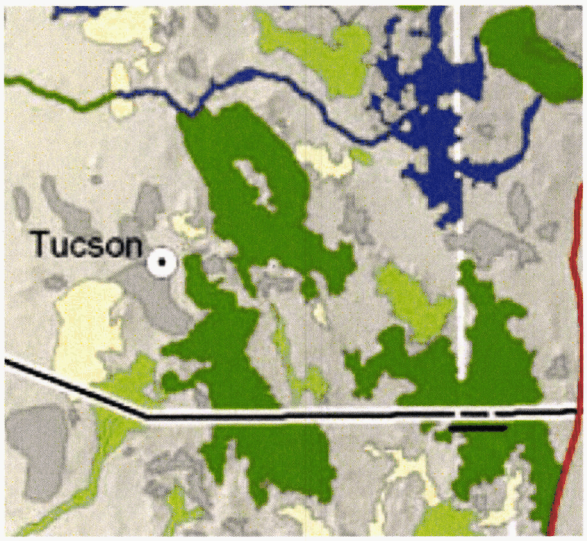

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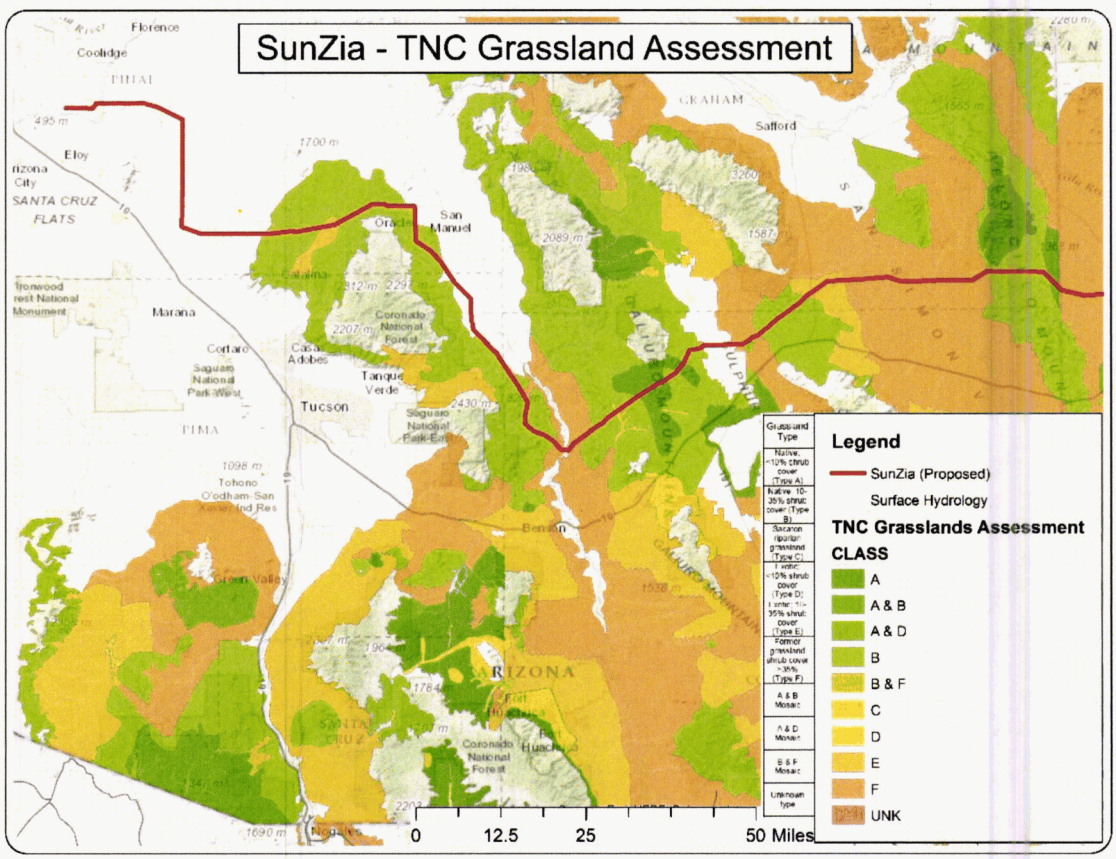

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National Fish and Wildlife Foundation

Draft Business Plan for the Sky Island Grasslands

March 24, 2009

Summary

The Sky Islands are a unique region of more than 40 isolated mountain ridges surrounded by a sea of dry grasslands that straddles the Mexico/Arizona/New Mexico border. It is one of America's great hotspots for wildlife diversity, hosting more twice as many mammal species as Yellowstone National Park and supporting the nation's highest diversity of reptiles, bees and ants.

Of the 13 million acres of grassland which once dominated this 30 million acre landscape, at least 2 million acres still have exceptional wildlife values and another 4 to 7 million acres of grassland could be restored. These grasslands are centered around 10 valley landscapes, each of which contain more than 100,000 acres of grassland habitat of exceptional value, and most of which support embedded wetlands. Within these landscapes we are targeting jaguar, bison, pronghorn, black-tailed prairie dog, Chiricahua leopard frogs, pronghorn and grassland sparrows as wildlife whose population response to conservation investments will be the best indicators of success.

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Conservation Need

The Sky Islands is a region on the U.S./Mexico boundary that is a world renowned Biodiversity Hotspot, linking the North American continent's temperate and tropical latitudes. The region also bridges the lowest point in the Continental Divide, melding two of the largest deserts (Sonoran and Chihuahuan) in the western Hemisphere with short-grass prairie and semi-desert grasslands, which are interspersed with towering mountains of pine-oak, mixed conifer, and spruce-fir forests. This landscape still supports a community of ranchers and others whose livelihoods are still largely a land-based economy.

The Sky Island region is defined as much by the grassland sea as by the mountains that rise from it. These grasslands include semi-desert and Plains grasslands, as well as sacaton grassland bottomlands and many variations on the three types. Built on the alluvial fans of rock worn off mountainsides and come to rest as valley soils, these grasslands serve as the stage for extraordinary plant life; one

...

In the face of climate change, this region provides unique opportunities for wildlife to follow the conditions they depend on — upwards in elevation along the steep gradients created by the Sky Island's many mountain ranges, or northwards through valleys or along mountain chains. The north-south orientation of the region's topography is already credited with promoting mixing of floras and faunas, and will continue to facilitate wildlife movement. This region is already at the northern frontier of many species' ranges, making it the anchor point for their journeys further north. These factors make preserving both corridors across latitudes and continuity across valleys even more important as conditions continue to shift.

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EXCERPT PAGE 9 of the PDF

Pronghorn are indicators for ecological and landscape integrity. These wide-ranging grassland specialists require sight lines unbroken by shrubs and movement corridors unfragmented by human development. Because of this, they are among the first species to decline when shrubs take over grasslands, and among the first to disappear as roads, fences, and homes block the paths they use to wander in search of fresh food.

Grassland bird populations have shown a steeper, more consistent, and more geographically widespread decline than any other guild of North American bird species. Breeding Bird Survey data collected from 1966 to 1993 indicate that approximately 70% of the grassland bird species surveyed had negative population trends. The grasslands of the southwestern US and northern Mexico are the primary over-wintering grounds for most North American grassland bird species and are therefore, continentally important to their survival.

EXCERPT PAGE 10 of the PDF

This plan will be focused around a core set of large grassland landscapes in Arizona, New Mexico and Mexico which have extensive high quality and restorable grasslands and support many of the most important grassland biodiversity values. Together these areas create important north-south corridors that connect grassland habitats as well as the 'Sky Island' mountain ranges among the grasslands.

EXCERPT PAGE 16 of the PDF

permanent, but the indirect effects to surrounding natural habitat due to fragmentation of wildlife movement corridors, disruption of watershed function, and introduction of exotic species can have far-reaching impacts. For some valleys it is already too late; unfragmented, valley-wide grassland habitat has already been lost. However, there are several valleys where protection of sustainable, ecologically functional grassland ecosystems is still possible. To achieve our long-term goals for grass land conservation, protection of natural grassland habitat from fragmentation is the foundation upon which all other conservation strategies depend.

EXCERPT PAGE 17 of the PDF

The criteria used to establish land protection priorities often include presence of important water rights or vulnerable aquifers. For example, in the Upper San Pedro Basin ground water modeling that identifies core groundwater recharge zones is used to guide land protection. For these reasons, water protection is an integral part of all land protection goals. Nevertheless, explicit policy and planning work to protect water resources is sometimes needed in addition to land protection.

In recognition of the importance of protecting natural habitat, the residents of Pima County passed an Open Space Bond for $174 million for purchase of conservation easements and other land protection. Conservation goals — largely focused on grassland and riparian target species — guided the spending of these public monies, which is now protecting ranch land in some of the area's most important grassland valleys. Additional grassland purchases are being negotiated, and a second open space bond initiative is now being planned. Although both threats and land costs are highest in Pima

EXCERPT PAGE 18 of the PDF

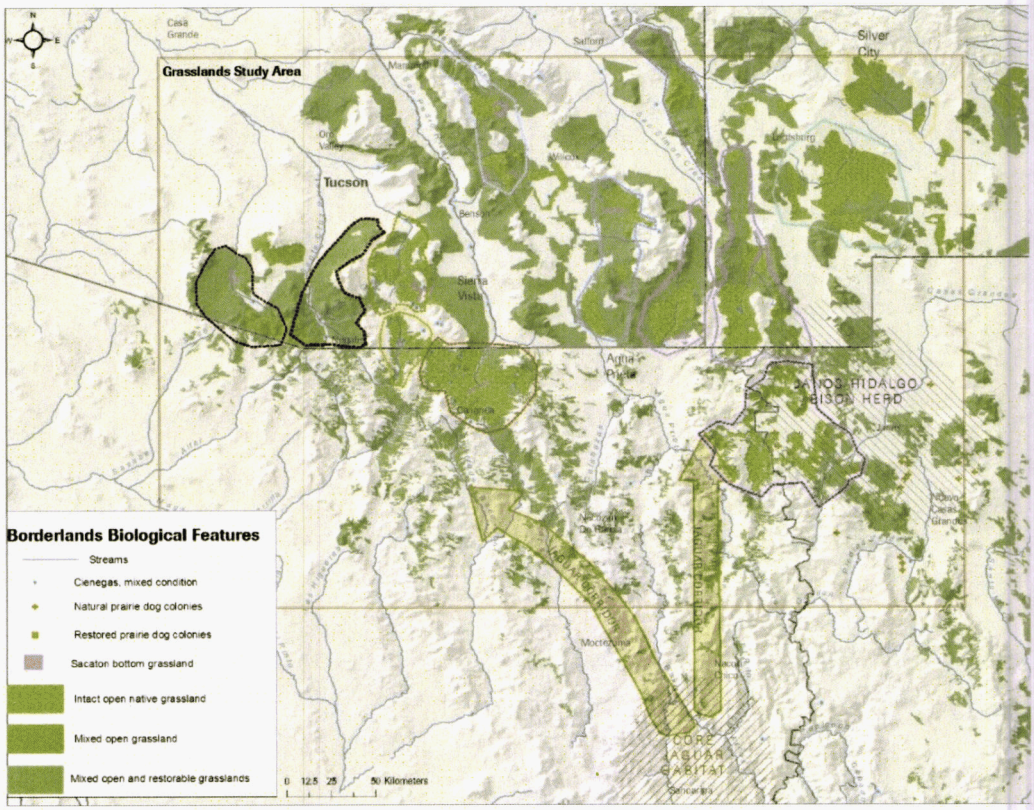
acquisition of land, water, and easements has been funded by many stakeholders for a wide range of purposes, including Pima County to protect communities from flooding, reduce infrastructure costs for new growth, and mitigate for effects of other developments; the Department of Defense and

EXCERPTS PAGE 19 of the PDF

Wise land use planning can steer population and infrastructure growth towards areas where it will have the least impacts on natural infrastructure (community open-space lands, wildlife corridors, aquifer recharge zones, groundwater-dependent wetlands, etc.). Growth projections in Arizona show major overlap with high-value lands and waters. Engaging county planners and other policymakers to examine how alternative growth scenarios affect natural and human systems is already improving planning outcomes in Arizona. Similarly, using ecological flows and other methodologies can highlight tradeoffs between increased human water use and loss of wetland function and other ecosystem

services.

EXCERPT PAGE 23 of the PDF

The grasslands of the southwestern US and northern Mexico are the primary over-wintering grounds for most North American grassland bird species and are therefore, continentally important to their

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