An Ecological Analysis of Conservation Priorities in the Apache Highlands Ecoregion

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The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

IMADES
Instituto del Medio Ambiente y el Desarrollo Sustentable del estado de Sonora

Cover Photo: South side of the Huachuca Mountains, Arizona, as seen from Rancho Los Fresnos, Sonora, in the heart of Conservation Area 66. This privately-owned ranch in Mexico retains some of the largest and healthiest grasslands in the Apache Highlands Ecoregion but lacks permanent conservation protections. It also contains some of the finest ciénega habitat in the ecoregion, in a watershed that flows from the U.S. to Mexico and back to the U.S. as part of the San Pedro River. Photo by Dale Turner.

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Executive Summary

A bi-national team worked from August 2001 through February 2003 to systematically analyze the best scientific information available for the 30-million acre (12-million ha) Apache Highlands ecoregion. The objective was to identify a network of conservation areas that, with proper management, would ensure the long-term persistence of the ecoregion's biological diversity. The technical team included staff from The Nature Conservancy, Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora (IMADES), and the Arizona Game and Fish Department. A companion study initiated to fill a critical data gap - on the status of the ecoregion's grasslands – was completed with the assistance of the Natural Resources Conservation Service, University of Arizona, Bureau of Land Management, U.S. Forest Service, and Instituto Naciónal de Investigaciónes Forestales, Agricolas y Pecuarias (INIFAP). To generate awareness of the project and attract assistance we initiated an outreach program with more than a dozen presentations made to public agencies, tribes, private entities, and regional conferences and symposia.

The Apache Highlands ecoregion comprises portions of four states in two countries: Arizona and New Mexico in the U.S., and Sonora and Chihuahua in Mexico. It is bounded on the north by the Mogollon Rim (the southern edge of the Colorado Plateau), to the west by the Sonoran and Mojave deserts, to the south by the Sierra Madre Occidental, and to the east by the Chihuahuan Desert. We selected a representative sample of the ecoregion's species and ecological systems to serve as the focal units of analysis, or conservation targets. In total, 223 species of amphibians, birds, fish, mammals, reptiles, invertebrates, and vascular plants were selected with special emphasis given to imperiled, endemic, or keystone species, or those which are limited by area, dispersal, or particular ecological processes. Twenty-six terrestrial ecological systems were identified and incorporated into the analysis as conservation targets.

We developed numerical conservation goals for all targets as a quantitative basis for guiding analyses and evaluating outcomes. Conservation goals also serve as a hypothesis for evaluating two critical questions in conservation - How much is enough? How many discrete populations and in what spatial distribution are needed for long-term viability? The combination of selecting a representative suite of conservation targets and setting quantitative goals for targets are two attributes, in particular, that distinguish this regional conservation planning effort.

We used a variety of spatial and traditional data sets to assist in the identification of conservation areas, including species' population data housed in Natural Heritage programs, Conservation Data Centers, and museums throughout North America, and spatially-referenced data on vegetation, land use, land management, hydrography, topography, infrastructure, and protection status. In addition, we developed three new spatial data sets: a literature review to develop a complete spatial coverage depicting the location of the ecoregion's ciénegas; a 14-month field study done in conjunction with agency partners to delineate and characterize the status of the ecoregion's remaining grasslands; and a linear mapping of native fish distributions in streams.

We used the computer algorithm, SITES, to identify the network of conservation areas. SITES selects areas to meet established conservation target goals while balancing objectives of efficiency, defined as the greatest number of goals met for the lowest "cost" or least amount of suitable land. The capability of the program to integrate multiple data sets in a repeatable process enabled rapid evaluation of alternative conservation area configurations. We developed and evaluated 27 different scenarios before settling on a draft conservation area network. The

draft network was reviewed by regional experts to identify omissions of areas that are important to conservation targets as well as commissions of areas where conservation is no longer feasible.

The final network consists of 90 conservation areas encompassing just over 12.5 million acres (5 million hectares), about 40% of the ecoregion. Conservation areas range in size from 1,235 to 1.9 million acres (500 to 757,500 ha), with an average of 138,967 acres (56,239 ha). Individual conservation areas captured from 1 to 119 conservation targets, with an average of 17 targets. The network captured 2,118 miles (3,408 km) of perennial streams, 86% of the perennial stream length in the ecoregion. Aquatic or riparian targets occur in 69 (77%) of the conservation areas.

Conservation goals were met for 83% of the targets, including 189 species and 12 ecological system targets. We came close to meeting goals (90% or more) for an additional 24 targets. Some conservation areas incorporate a continuous area from valley bottom to mountaintop; others span continuous areas from mountain range to mountain range. The former approach, if fully protected, should buffer conservation targets against the impacts of climate-induced changes in habitat, while the latter approach is needed to maintain dispersal areas and connectivity for wide-ranging, forest-dwelling species such as black bear.

Nearly 3.7 million acres (1.4 million ha) were identified for conservation in the Mexico portion of the ecoregion, while the remaining 8.8 million acres (3.6 million ha) of the conservation network was identified in the U.S. An analysis of protected status using a modified Gap classification revealed that only 5% of the ecoregion is in Gap categories 1 and 2, the highest levels of protection afforded. Twenty-seven percent of the ecoregion is in Gap category 3, where protection of natural land cover is balanced with extractive uses (e.g., federal multiple-use lands in the U.S.). Nearly 60% of the ecoregion, however, permits intensive land uses and lacks mandates preventing the conversion of native vegetation cover by anthropogenic uses.

We used two measures to rank the biodiversity value of the 90 conservation areas; target richness, or the number of targets found in each conservation area, and a measure of the uniqueness or "irreplaceability" of each area. Of the 10 highest-ranking conservation areas identified in the two analyses, 8 areas were the same across analyses. In both the richness and irreplaceability measures the Huachuca Mountains Grassland Valley Complex (#66) and Sierra San Luis/Peloncillo Mountains (#67) were the first- and second-ranked areas, respectively. Both conservation areas straddle the U.S.-Mexico border region. The Upper Verde Watershed (#9) ranks 3rd in richness and 4th in irreplaceability, while the Chiricahua Mountains (#58) ranks 3rd in irreplaceability and 4th in richness.

Several key stressors will continue to challenge our collective ability to grow sustainably and promote conservation of the region's biological diversity. Growth in urban, ex-urban and rural areas that does not consider the region's biological diversity will continue to foreclose opportunities and will result in the extirpation of more species. With increasing residents region-wide comes increasing demands on our limited surface and groundwater supplies. Again, a lack of planning that effectively integrates the needs of our aquatic and riparian fauna and flora will needlessly limit options for conservation and will likely result in expensive, crisis-driven recovery programs as more species receive protection under the Endangered Species Act. The effects of altered fire regimes in our forests are now more widely appreciated by the public after several years of catastrophic fires. But awareness is still low on the importance of fire in maintaining the region's dwindling grasslands. Finally, invasive species, particularly in our aquatic systems, have placed some native species and native vegetation communities at a competitive disadvantage.

Proactive conservation efforts, such as Pima County's Sonoran Desert Conservation Plan, need to be replicated throughout the ecoregion before conservation issues reach crisis proportions, at which time it will be far more costly to develop effective solutions. Such efforts will not only require the best available scientific information, as presented here, but also commitments by community leaders to engage the public in a focused dialogue about balancing future growth with conservation of the natural heritage we have inherited. The results of this analysis and the data developed for this study, collectively, provide a scientific basis for decision-making by federal, state, county and municipal agencies in planning for land and water conservation.

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Table of contents

Figures

Tables

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1. Introduction

Background and Purpose

Any comprehensive effort to protect our rich biological heritage must answer two questions: "What are the most important places?" and "How much conservation is enough?"

In 1996, The Nature Conservancy began developing ecoregion-based conservation assessments for the entire United States and portions of the 31 other countries in which the Conservancy works. Assessments are science-based attempts to determine how much and what parts of the landscape are needed to maintain biological diversity over the long term. They require large amounts of data and a wide array of agency, academic, institutional, Tribal, and private-sector expertise.

Ecoregions are large areas of land and water – on the scale of tens of millions of acres – that are characterized by distinct plant communities, species, and environmental conditions such as climate and landforms. The Nature Conservancy used the U.S. Forest Service ECOMAP framework (Bailey 1994, 1995, 1998) as the basis for delineating North American ecoregions, making minor modifications where regional data sets or expertise resulted in enhanced boundaries for conservation-based analyses.

There are several advantages to analyzing the conservation needs of biological diversity at an ecoregional scale. First, ecoregions typically capture large proportions, if not entire distributions, of major plant communities and individual species. By capturing a large proportion of a species' distribution in a single unit of analysis, conservation goals may be developed that better integrate two important components of biological diversity - ecological and genetic variation. Second, maintenance or recovery of declining species may be more effectively planned for and accomplished at ecoregional scales, particularly if the target organism requires large expanses of unfragmented habitat (e.g., pronghorn), relies on disturbance regimes or other ecological processes that occur across multiple agency/jurisdictional boundaries, or the organism's population structure is maintained by immigration and emigration over a large area. Finally, accommodating potential changes in the distribution of plant communities and species that result from changes in climate may require conservation efforts carried out at ecoregional scales.

The foundation of ecoregional assessments is a comprehensive scientific analysis of existing and, in some cases, newly-developed data (Groves et al. 2000). Integral components to the analysis include:

1) identification of conservation targets, or a group of organisms and ecological systems that comprehensively represent an ecoregion's biological diversity. Targets include ecological systems, typically characterized by plant community (e.g., ponderosa pine forest) and supporting ecological processes, and a broad range of species representing major taxonomic groups (e.g., amphibians, birds, fish, insects, mammals, mollusks, plants, reptiles) and spanning all levels of rarity (i.e., rare to common). For example, 223 species and 26 ecological systems were analyzed for the Apache Highlands;
2) identification of conservation goals for each target that serve as a hypothesis about the number and distribution needed to maintain long-term viability;
3) identification of conservation areas sufficient in size and distribution to capture ecological variation and meet conservation goals for targets.

Collectively, ecoregional assessments represent the most comprehensive scientific analyses on important areas to manage for biological diversity. They also represent a new source

of information to better frame conservation issues, support development of conservation strategies, and support partner needs for new scientific information.

This document presents the results for the Apache Highlands Ecoregion and represents the fifth and final assessment for ecoregions that overlap Arizona. This project was conducted as a bi-national assessment in collaboration with colleagues from IMADES, the Sonora State Institute for Environment and Sustainable Development, in Mexico.

The Apache Highlands Ecoregion

The Apache Highlands ecoregion spans 30 million acres (12 million hectares) and portions of four states in two countries: Arizona and New Mexico in the U.S., and Sonora and Chihuahua in Mexico. It is bounded on the north by the Mogollon Rim (the southern edge of the Colorado Plateau), to the west by the Sonoran and Mojave deserts, to the south by the Sierra Madre Occidental, and to the east by the Chihuahuan Desert (Figure 1).

The region is best known among the scientific community for its "sky islands." Over 40 mountain ranges cloaked in pine-oak woodland and mixed conifer forests rise abruptly from surrounding basins comprised of grassland and desert scrub to form forested islands among a "desert sea" (Figure 2; Marshall 1957). These have also been called the "Madrean archipelago" for their similarity to a chain of islands extending off the "continent" of the Sierra Madre (DeBano et al. 1995).

The mountains of the Apache Highlands are unique on Earth, for they form the only sky island complex that extends from the sub-tropical to the temperate latitudes (Warshall 1995). The ecological result of these geographic and geologic phenomena is an unusually rich fauna and flora whose evolutionary patterns continue to be influenced by different environmental conditions to the south and north. As a result, jaguar and thick-billed parrots meet bighorn sheep and northern goshawks. More than 4,000 vascular plant species have been documented, as have 110 mammals (Felger et al. 1997, Simpson 1964). At least 468 bird species have been verified in southeastern Arizona during the past 50 years, along with more than 240 butterfly species and 580 species of wood-rotting fungi (Edison et al. 1995, Bailowitz and Brock 1991, Gilbertson and Bigelow 1998).

While the sky island moniker has helped focus research and conservation attention on the region's mountains, it also may have inadvertently relegated the "desert seas" in between to second-class biological status. Although there are distinct differences in species richness between the basins comprised of desert or grassland and our sky island Madrean forests, species richness is only one attribute of biological diversity that is important to protect. The juxtaposition and change in major biotic communities as one moves across landscape gradients has played a critical role in the evolution of the biodiversity present today and, likely, will continue to play a role in shaping the biodiversity of tomorrow. Without conservation focused on the grassland basins of the Apache Highlands we are unlikely to recover species such as the black-tailed prairie dog or maintain wide-ranging species such as the pronghorn. Protecting the full variety of biotic communities characteristic of a complex ecoregion such as the Apache Highlands is the fundamental challenge of conservation in the rapidly growing southwestern U.S. and northwestern Mexico.

Land management forms one major influence on current patterns of biodiversity and threats to it (Table 1). All of the major mountain ranges in the U.S. portion of the ecoregion are managed by the U.S. Forest Service or Bureau of Land Management, and thus are largely protected from permanent development. This contrasts with our grassland basins, which are

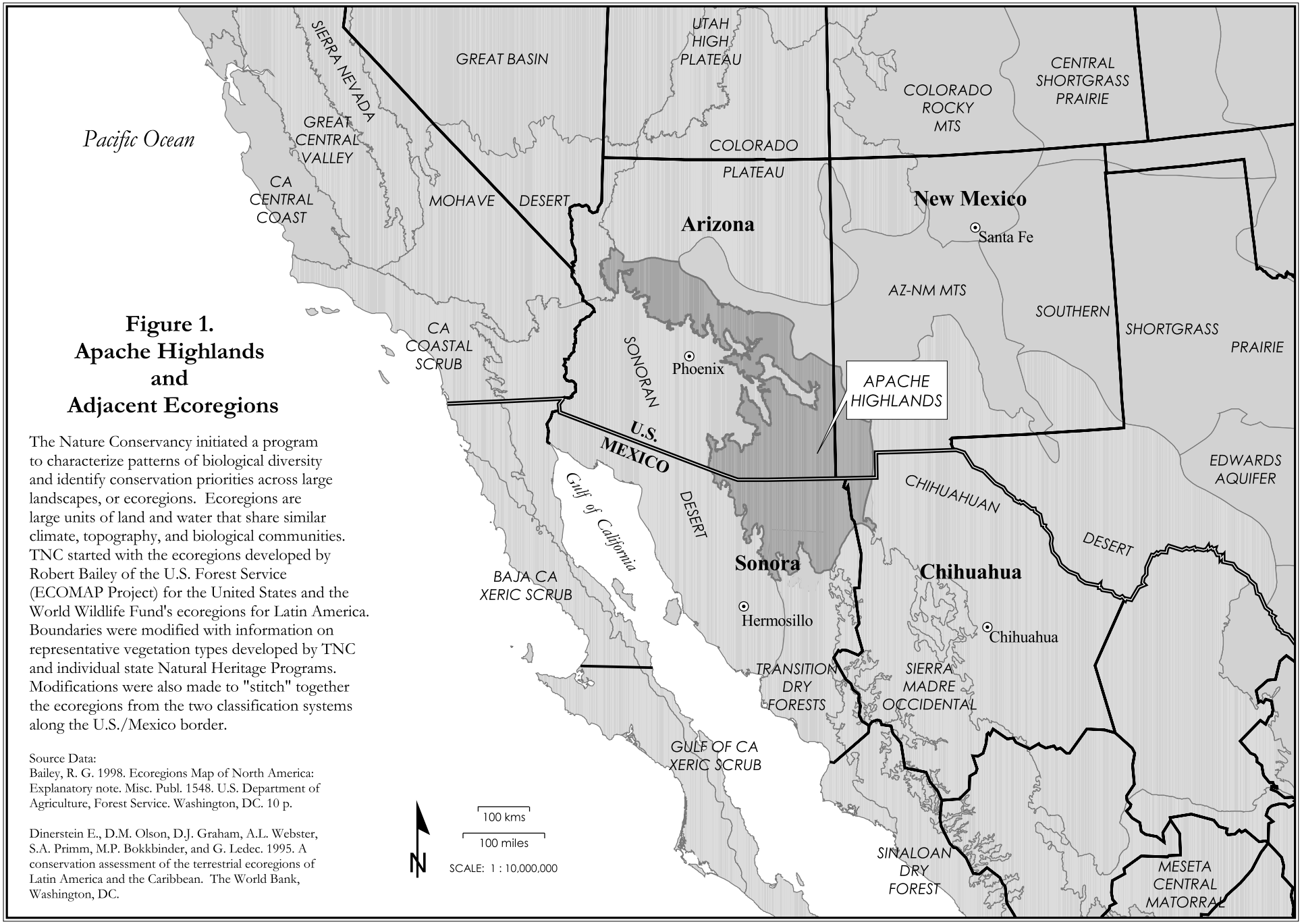

Figure 1. Apache Highlands and Adjacent Ecoregions

The Nature Conservancy initiated a program to characterize patterns of biological diversity and identify conservation priorities across large landscapes, or ecoregions. Ecoregions are large units of land and water that share similar climate, topography, and biological communities. TNC started with the ecoregions developed by Robert Bailey of the U.S. Forest Service (ECOMAP Project) for the United States and the World Wildlife Fund's ecoregions for Latin America. Boundaries were modified with information on representative vegetation types developed by TNC and individual state Natural Heritage Programs. Modifications were also made to "stitch" together the ecoregions from the two classification systems along the U.S./Mexico border.

Source Data:
Bailey, R. G. 1998. Ecoregions Map of North America: Explanatory note. Misc. Publ. 1548. U.S. Department of Agriculture, Forest Service. Washington, DC. 10 p.

Dinerstein E., D.M. Olson, D.J. Graham, A.L. Webster, S.A. Primm, M.P. Bokkbinder, and G. Ledec. 1995. A conservation assessment of the terrestrial ecoregions of Latin America and the Caribbean. The World Bank, Washington, DC.

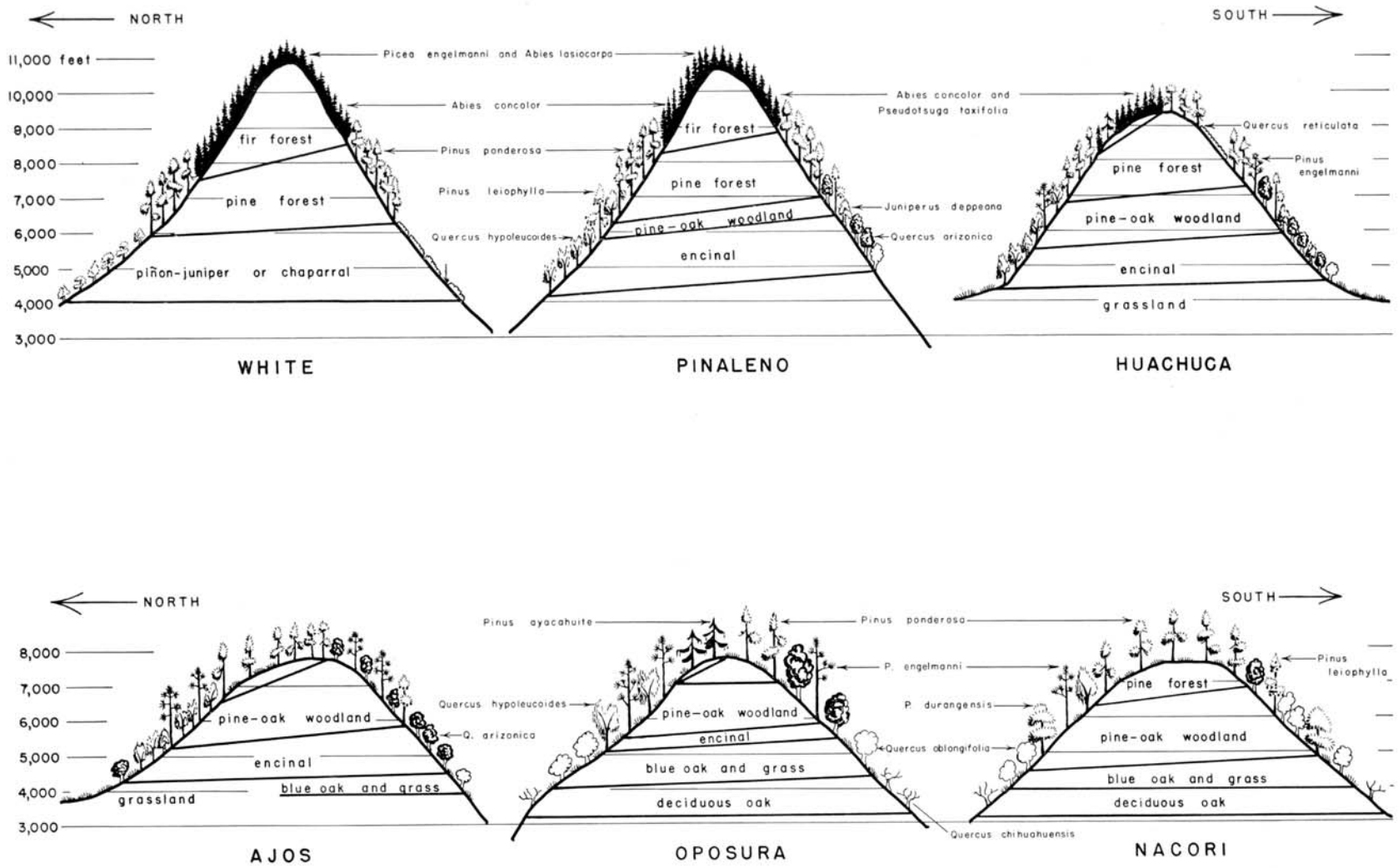

Figure 2. Sequence of montane vegetation communities with altitude and latitude. The White Mountains, just to the north of the Apache Highlands, are close to the Rocky Mountain flora and fauna. The Sierra Nacori, just south of the Apache Highlands, represents the full expression of the Sierra Madre communities (from Marshall 1957, figure copyrighted by the Cooper Ornithological Society, reprinted with permission).

Table 1. Land management status in the Apache Highlands.

Land Manager	Acres	Hectares
Arizona		
U.S. Forest Service	5,686,797	2,301,447
Private Lands	3,909,791	1,581,802
State Trust Lands	3,757,026	1,520,468
Tribal Lands	2,533,502	1,025,308
Bureau of Land Management	1,722,299	697,014
U.S. Fish & Wildlife Service	117,219	47,439
Dept. of Defense	107,614	43,551
National Park Service	71,304	28,857
State Game and Fish	5,202	2,105
State Parks & Recreation	3,297	1,334
County Land	409	166
Other	467	189
Sub-Total	**17,913,716**	**7,249,681**
New Mexico		
Private Lands	1,052,940	426,125
Bureau of Land Management*	966,330	391,074
State Trust Lands	497,852	201,481
U.S. Forest Service**	182,836	73,994
Sub-Total	**2,699,958**	**1,092,673**
Sonora		
Private and Ejido Lands	7,991,065	3,233,984
Protected Areas	404,300	163,620
Sub-Total	**8,395,365**	**3,397,604**
Chihuahua		
Private and Ejido Lands	**811,220**	**328,301**
Ecoregion Total	**29,820,260**	**12,068,259**

Unit	Acres
Tonto NF	2,005,242
Coronado NF	1,637,407
Prescott NF	1,229,300
Apache-Sitgreaves NF	433,532
Coconino NF	340,387
Kaibab NF	40,930

Unit	Acres
San Carlos	1,321,661
White Mountain Apache	1,106,403
Tohono O'odham	96,375
San Xavier	6,540
Yavapai Prescott Apache	1,379
Yavapai Apache	576
Indian Allotments	487
Yavapai Tonto Apache	82

Unit	Acres
Safford FO	892,579
Kingman FO	441,688
Tucson FO	217,702
Phoenix FO	170,329

Unit	Acres
Buenos Aires NWR	112,094
Leslie Canyon NWR	2,757
San Bernadino NWR	2,368

Unit	Acres
Fort Huachuca	79,365
Willcox Range	27,326
Military Reservation	922

Unit	Acres
Saguaro NP	52,502
Chiricahua NM	12,163
Coronado NM	4,173
Fort Bowie NHS	1,561
Montezuma Castle NM	573
Montezuma Well NM	270
Tuzigoot NM	43
Tumacacori NM	10
Tonto NM	8

Unit	Acres
Sierra La Madera	193,296
Sierra El Tigre	155,724
Ajos-Bavispe	55,295

* All in Las Cruces Field Office
**All in Coronado National Forest

comprised mainly of private and state trust lands. Grasslands have experienced and continue to undergo rapid change. Gori and Enquist (2003) documented a substantial decline in the area of grasslands throughout the Apache Highlands; 37% of historic grasslands were found to have undergone a permanent cover-type conversion to shrublands and an additional 32% had a level of shrub encroachment that, without grazing rest and re-introduction of fire, would be converted to shrubland in the near future.

By virtue of their position on the landscape – covering the large valleys where the climate is suitable for human habitation – grasslands are now subject to economic and demographic forces causing a wave of land conversion as traditional land uses, such as ranching and agriculture, give way to new subdivisions for growing communities. Prescott, Tucson, Sierra Vista, Nogales, and Douglas are all experiencing population growth rates at or exceeding three times the U.S. national average. This expansion, occurring at the margins of these communities in what recently was rural, mostly unfragmented land, presents a challenge on two fronts.

First, increasing the degree of fragmentation of the landscape with roads and subdivisions makes conservation increasingly more challenging and costly, and it raises the prospect of additional species requiring protection under the Endangered Species Act. Precluding species from reaching such low population levels as to warrant listing as endangered or threatened should be a high priority for communities and conservationists, alike, if we are to pass on to future generations the lifestyle and natural heritage that has made the sky island region such a special place.

Second, while the Apache Highlands covers approximately 25% of Arizona, it contains 32% of the state's perennial stream systems. Arizona's freshwater systems, including rivers, streams, creeks, ciénegas, other wetland types, and their associated riparian habitats, support a disproportionately high number of species relative to their total extent throughout the state. In addition, the riparian communities along these streams provide migratory birds and pollinating insects and bats with critical trans-hemispheric travel corridors.

It is difficult to overstate the importance of Arizona's freshwater systems. The status of these resources – their quantity, quality, distribution, and the biological diversity they harbor - is the single most important issue to both the sustainability of biological diversity and human communities in Arizona. Water resources in many of the sub-basins of the Gila River watershed, including the San Pedro, Verde, and Santa Cruz, are already over-allocated such that conflicts are increasing between human uses and maintenance of biological diversity. Without better, proactive land and water management planning we will not accommodate rapidly increasing population growth without serious consequences to the quality of life, including the rich biological heritage we have inherited.

Use of Ecoregional Assessments

This study is meant to inform proactive efforts to shape the future of our region. We integrated the use of a sophisticated new assessment tool – SITES – that enables rapid selection of conservation areas with boundaries that account for both biological values and social constraints. This tool, described in Chapter 6, makes the tradeoffs explicit in ways that can be adjusted repeatedly in pursuit of an optimum solution. In performing analyses this way we have created a baseline that can be refined as new data become available regarding changes across the landscape that affect land use and conservation needs.

Perhaps a testament to the way communities value the biological heritage of this region is simply the number of active conservation efforts already ongoing. Pima County has shepherded

its award-winning Sonoran Desert Conservation Plan to its final stages and will hold a bond election in May of 2004 to develop the necessary funding. The Upper San Pedro Partnership, composed of many federal, state, municipal and private entities, is working to solve the water deficit facing the San Pedro River in Arizona. Just across the border in Sonora, IMADES is working with landowners in the Mexican portion of the San Pedro River basin to restore grasslands and riparian areas. In the same area, the Mexican National Agency for Environment and Natural Resources (SEMARNAP in Spanish) is conducting sustainable development projects with local residents. The Malpai Borderlands Group has implemented the best example of a multi-partner science-based adaptive management plan for a large grassland, desert and forested landscape. And the Sonoita Valley Partnership is working with the Bureau of Land Management to develop a similar approach for the Las Ciénegas Conservation Area in the Empire Valley. Numerous groups, such as the Sky Island Alliance, are working to restore important habitats on private and public lands or to conduct land and species inventories to better inform public planning processes.

Proactive conservation efforts need to be replicated throughout the ecoregion before issues reach crisis proportions, at which time it will be far more costly to develop effective solutions. Such efforts will not only require the best available scientific information as presented here but also commitments by community leaders to engage the public in a focused dialogue about balancing future growth with conservation of the natural heritage we have inherited.

Outreach, Coordination and Engagement with Partners

The initial exercise of compiling and analyzing data for the Apache Highlands Ecoregion involved scientists, land managers, and other technical experts familiar with the Ecoregion's landscapes. To help ensure broad understanding of the effort by both those we had hoped to engage on the technical issues as well as others interested in the process, The Nature Conservancy developed and carried out an outreach program over an 18-month period to a broad suite of interests within and beyond the Ecoregion.

The purpose of this effort was to build an understanding of the project's goals, the scientific foundation underlying the project, the various project steps; to illustrate how the results might be used in a variety of local and regional conservation or other land planning/management efforts; and to garner support for participation by various agencies, institutions, and individuals. Over this period we took the opportunity to introduce the project at numerous meetings throughout the Ecoregion. In some cases special meetings were called. In many cases we took advantage of other gatherings to inform and update different audiences, with special attention given to public land managers, non-governmental organizations, Tribal and community leaders.

As detailed in the acknowledgements, this wide array of partners was then engaged as resources to develop and strengthen the plan. They helped identify conservation targets and provided technical data and advice on species, vegetation communities, geology, threats, and modes of analysis. Staff from other offices of The Nature Conservancy shared planning expertise and helped coordinate this effort with those for adjacent ecoregions. Key partners reviewed the draft maps and reports and greatly improved them with their comments.

Outreach and Coordination Efforts.
Below is a partial accounting of our outreach efforts during this project.

Tonto National Forest, Forest Leadership Team Meeting, Mesa, AZ, May 2001. Audience: resource managers, forest leadership.
Prescott National Forest, Forest Leadership Team Meeting, Prescott, AZ, June 2001. Audience: resource managers, forest leadership.
Joint Coconino and Kaibab National Forest, Forest Leadership Team Meeting, Flagstaff, AZ, June 2001. Audience: resource managers, forest leadership.
Coronado National Forest, Forest Leadership Team Meeting, Tucson, AZ, August 2001. Audience: resource managers, forest leadership.
Natural Resources Conservation Service, Tucson Resource Support Office, August 2001. Audience: range management specialists.
The Nature Conservancy, Tucson Field Office, August 2001. Audience: agency resource managers, university staff, conservation groups, interested individuals.
Phelps Dodge Corporation, Phoenix, AZ, October 2001. Audience: Corporate heads of natural resource management.
White Mountain Apache Tribe, Wildlife & Outdoor Recreation Division, November 2001. Audience: Wildlife Program Managers and technical staff.
USDA Agricultural Research Station, Tucson, AZ, November 2001. Audience: agency researchers.
U.S. Bureau of Land Management, Tucson, AZ, December 2001. Audience: State leadership.
U.S. Fish & Wildlife Service, Phoenix, AZ, March 2002. Audience: State leadership and biologists.
4th Conference on Research and Resource Management in the Southwestern Deserts: Meeting Resource Management Information Needs. Tucson, AZ, May 2002. Audience: State, Federal, Tribal, and Private natural resource managers and biologists.
All-Bird Conference, Phoenix, AZ, September 2002. Audience: State, Federal, Tribal, and Private biologists and planners involved with developing Bird Conservation Plans.
U.S. Forest Service Region 3 Forest Planners Meeting, Tucson, AZ, November 2002. Audience: Forest Planners, NEPA, and Resource staff.

2. Biodiversity Conservation Targets

The ultimate goal of this project is to maintain the native biodiversity of the Apache Highlands. For this study we consider biodiversity as: *the natural variety and variability among living organisms, the ecological complexes in which they naturally occur, and the ways in which they interact with each other and the natural environment* (Redford and Richter 1999). We used the key components of biodiversity – variety, variability, ecological complexes, and interaction – in identifying the basic unit for this analysis, the conservation target.

Conservation targets are the basic unit of analysis for this study. To determine the places and priorities for protecting biodiversity across a landscape as large as the Apache Highlands, the ideal approach would be to consider the needs of all native species. Despite the steady accumulation of biological knowledge and recent advances in computational ability, that ideal remains far out of reach. Instead, we focused on a much smaller but carefully-selected set of conservation targets – species, native vegetation communities, and ecological systems – to represent the full suite of biological diversity within the ecoregion.

Our selection was based on the Coarse Filter/Fine Filter approach to conservation planning (Groves et al. 2002). We assume that protection for plant communities and ecological systems serves as a coarse filter to capture most of the biological diversity present, while the fine filter is the deliberate choice of species with distributions that might otherwise fall through the gaps or which have particular characteristics which would not otherwise be protected.

Coarse-filter conservation targets

The Coarse Filter is comprised of terrestrial and aquatic ecological systems. These are assemblages of plant communities or aquatic systems found in recurring patterns across the landscape. We assumed that because ecological systems occur at broader scales than individual species they also capture abiotic components that support biodiversity and ecological processes (e.g., soil types, microclimates)(Poiani et al. 2000). Thus, they were used to represent the vast majority of species in the ecoregion from common plants to insects to soil microbes. We also assumed that for a community occurrence to persist over long time frames it must be large enough to sustain, absorb, and buffer natural disturbances such as fire, flood, and insect outbreaks, as part of a dynamic landscape mosaic (Anderson et al. 1999). We chose coarse-filter targets representing the full range of spatial scales from small patch vegetation communities found in ciénegas to large matrix systems like Chihuahuan desert scrub.

Terrestrial Ecological Systems

1. Share similar ecological processes (e.g. fire, flooding), substrates (e.g. shallow soils, limestone bedrock), and/or environmental gradients (e.g. local climate, hydrology).

2. Spatial and temporal criteria influence the grouping of communities and habitats. Spatial aggregations are intermediate in scale (10 ha – 100,000 ha), persisting for at least 50-100 years.

This coarse-filter approach requires development and refinement of classifications for terrestrial and freshwater ecological systems. In developing these classifications, we addressed the conceptual and spatial scales of the resulting ecological systems so that they would be most useful for conservation action (e.g., mapping, land management, monitoring).

All mapped native vegetation community types were grouped to define ecological systems with a modified biotic communities classification similar to that mapped by Brown and Lowe (1980). This classification includes explicit assumptions about the composition and structure of ecosystems, and about key ecological processes that operate on them. This grouping was chosen for the finest resolution of data available for vegetation community types across the whole region.

Coarse-filter targets were identified by using existing maps of vegetation communities, from the GAP program for the U.S. portions and the Forest Inventory 2000 for the Mexico portions (Halvorson et al. 2002, Palacio Prieto et al. 2000, Velázquez et al. 2001). We regrouped vegetation communities from each state into the single classification system (Appendix 1) and reconciled border differences.

Existing knowledge of the characteristic spatial pattern, environmental setting, and driving ecological processes for plant associations formed the basis for defining terrestrial ecological systems. While dominant vegetation is commonly used to name these systems, they represent an integration of vegetation, environment, and disturbance regimes. Examples of Apache Highlands terrestrial ecological systems include Pinyon-Juniper Woodland, and Madrean Encinal.

We augmented the existing vegetation data with original data collection for grasslands, using condition classes for the grasslands as separate targets (Gori and Enquist 2003). We also collated data from many sources for the location of extant ciénegas (Weinstein 2002a).

Ecological systems were categorized by their typical spatial expression in the Ecoregion (Table 2) and global distribution pattern (Table 5) to ensure that records were captured based on both qualitative and quantitative characteristics and to ensure that evaluations of biodiversity were based on criteria other than global rarity ranks (*e.g.*, distribution).

All 26 of the native terrestrial ecological systems identified as occurring in the Apache Highlands ecoregion were considered as conservation targets in the analysis (Appendix 9).

This classification provided the basis for biophysical modeling (Chapter 7) and for integrating all mapped information on the occurrence of terrestrial ecological systems (Figure 3). Among the major ecological systems, Apachean Shrubland and Chihuahuan Desert Scrub combined have the highest relative distribution (27%) within the Apache Highlands, followed by Pinyon Juniper Woodland (12%), Apachean Grassland Condition Class B and Madrean Encinal each at (11%), and Interior Chaparral (8%). Other systems each have less than 6% cover within the ecoregion.

Fine-filter conservation targets

Individual species comprise fine filter targets, and we worked with taxonomic experts to choose 223 species or subspecies of amphibians, birds, fish, mammals, reptiles, invertebrates, and vascular plants (Appendix 9). For these, we chose imperiled, endemic, or keystone species, or those which are limited by area, dispersal, resources, or ecological processes (Groves et al. 2002).

Part of our selection was based on the principle that some species have particular habitat needs that may not be met by the coarse-filter approach without special consideration, such as the barking frog (*Eleutherodactylus augusti*) which depends on deeply-fissured limestone or rhyolite outcrops in this region (Bezy et al. 1966, Goldberg and Schwalbe 2000). We also chose species which may be so rare that every population needs to be accounted for in conservation

Table 2. Typical spatial patterns for natural vegetation communities used to define ecological systems[1].

Spatial Pattern	Characteristics
Matrix	Vegetation communities form extensive and contiguous cover 2,000 to 500,000 ha in size. Occur on Ecoregion's most extensive landforms and typically have wide ecological tolerances; aggregate of all matrix communities covers 70-80% of Ecoregion; often influenced by large-scale processes (*e.g.,* climate patterns). *Example*: Chihuahuan desert scrub.
Large Patch	Vegetation communities with interrupted cover ranging in size from 50 to 2,000 ha. Aggregate of all large patch communities may cover as much as 20% of the Ecoregion. *Examples:* montane mixed conifer forest, playa.
Small Patch	Vegetation communities that form small, discrete areas of cover one to 50 ha in size. Occur in very specific ecological settings, such as on specialized landform types or in unusual microhabitats. May contain disproportionately large percentage of Ecoregion's total flora, and also support a specific and restricted set of specialized fauna. *Examples:* ciénega, montane grassland.
Linear	Communities occur as linear strips. Often represent ecotone between terrestrial and aquatic systems. Aggregate of all linear communities covers only a small percentage of the natural vegetation of the Ecoregion. Local scale processes, such river flow regimes, strongly influence community structure and function, leaving communities highly vulnerable to alterations in the surrounding land- and water-scape. *Examples:* montane riparian woodland and shrubland, desert wash.

[1] spatial pattern characteristics from Anderson *et al.* 1999.

planning, such as the Fish Creek fleabane (*Erigeron piscaticus*) which has two known populations worldwide (AGFD 1994a).

We used the Natural Heritage Program ranking system to assist in selecting fine filter targets. That system describes species' rarity with a five-category ranking, whereby the rarest species get a G1 (Global 1) rank and the most common are ranked G5 (Tables 3, 4). Global ranks were also used in setting conservation goals for species. Complex ranks such as G2G3 were conservatively treated as the rarest category (thus G2G3 would be considered a G2; see Appendix 2). Target species were also classified as endemic, limited, disjunct, widespread, or peripheral, relative to the Apache Highlands ecoregion (Table 5, Appendix 9). This allowed consideration of distribution in target selection and the setting of conservation goals.

We selected most of the viable imperiled, threatened, and endangered species in the ecoregion, including: all species with a global rank of G1 or G2, most species listed or proposed for listing under the U.S. Endangered Species Act, and most species listed as endangered (Peligro de Extincion) under the Mexican Endangered Species List (NOM-059-ECOL-1994).

Table 3. Global Priority Ranking Definitions. Priority ranking (1 to 5) based on the number of occurrences throughout the entire range of the element (from Arizona Game and Fish Department Heritage Data Management System, 1/12/94).

Global Rank	State Rank	
G1	**S1**	Very Rare: 1 to 5 occurrences or very few individuals or acres.
G2	**S2**	Rare: 6 to 20 occurrences or few individuals or acres
G3	**S3**	Uncommon or Restricted: 21 to 100 occurrences, rather rare throughout a fairly wide range, or fairly common in a rather restricted range.
	S3S4	Fairly Common: 51 to 100 occurrences and found over a rather wide range within the State.
G4	**S4**	Apparently Secure: more than 100 occurrences, though it could be quite rare in some parts of its range.
G5	**S5**	Demonstrably Secure: more than 100 occurrences.
GU		Unranked.

We also selected other species of concern which are not included under the above categories, which may not be captured by system-level targets, and which have ecological characteristics of concern. These include: wide-ranging species which depend on very large areas (e.g., pronghorn), narrowly endemic species that have apparently healthy populations but which only occur at one or a few sites (e.g., Wet Canyon talussnail), keystone species whose impact on a community is disproportionately large for their abundance (e.g., prairie dog), extirpated species for which reintroduction has a high probability of success (e.g., prairie dog), and indicators of trophic integrity (e.g., river otter). We also chose a few species which serve as good surrogates for particular natural community types and for which there is better data for the species than for the community type (e.g., common black-hawk for riparian areas in Mexico).

Table 4. Conservation targets for the Apache Highlands Ecoregion by taxonomic group and global rank.

Taxon	Total	G1 (rarest)	G2	G3	G4	G5 (most common)	GU (unranked)
Amphibian	12	2	0	4	2	3	1
Bird	24	1	3	6	8	6	0
Fish	21	3	7	7	3	1	0
Mammal	28	3	0	6	9	10	0
Reptile	14	3	0	5	4	2	0
Invertebrate	29	17	8	2	0	0	2
Vascular plant	95	27	49	17	2	0	0
Total	**223**	**56**	**67**	**47**	**28**	**22**	**3**

Table 5. Global Distribution Characteristics for Conservation Targets[1].

Distribution	Characteristics
Restricted/ Endemic	Species or vegetation community occurs primarily in one Ecoregion: it is either entirely endemic to the Ecoregion or has more than 80% of its range within Ecoregion.
Limited	Species or vegetation community occurs in the Ecoregion, but also within a few other adjacent Ecoregions (*i.e.,* its core range is in one or two Ecoregions, yet it may be found in several other Ecoregions).
Widespread	Species or vegetation community is distributed widely in several to many Ecoregions, and is distributed relatively equally among Ecoregions. Widespread does not necessarily mean "common." For example, some wetland types are distributed widely, although total acreage is small and the occurrences are widely separated.
Disjunct	Species or vegetation community occurs in the Ecoregion as a disjunct from the core of its distribution (less than 10% of its total distribution is in Ecoregion), and is more commonly found in other Ecoregions. Disjunct occurrences of communities reflect similarly disjunct occurrences of key environmental factors or ecological processes, and these occurrences may represent variation in composition, structure, and potential for evolutionary divergence.
Peripheral	Species or vegetation community is more commonly found in other adjacent Ecoregions (less than 10% of its total distribution is in the ecoregion of interest). Peripheral occurrences may or may not represent significant variation relative to occurrences in adjacent ecoregions. Goals for peripheral communities should account for the fact that most of their conservation will take place in other ecoregions. Opportunistic capture of these types often may be sufficient. Selection of examples for conservation should be informed by consideration of how they compare in size, quality, and variation with those in the adjacent or other ecoregions.

[1] distribution characteristics from Anderson et al. 1999.

Several large carnivores native to this region were not chosen as targets, despite their high profile in the conservation community. Mountain lions (*Felis concolor*) are habitat generalists with apparently secure populations in this region. They have general needs for habitat connectivity, but it remains unclear if those connections require specific landscape characteristics beyond an absence of physical barriers (Logan and Sweanor 2001). The Mexican wolf (*Canis lupus baileyi*) was extirpated from this region and has recently been reintroduced in the adjacent Arizona-New Mexico Mountains ecoregion. It is a habitat generalist which once ranged throughout the ecoregion, and its successful recovery depends more on human attitudes than on any land tenure changes which might result from this conservation analysis. The grizzly bear (*Ursus arctos*) historically ranged throughout the ecoregion, but was extirpated in 1935 (Hoffmeister 1986). Another generalist, its recovery will depend on changes in human attitude and a reintroduction program, neither of which seem likely in the foreseeable future.

Comparing our target species with those of several management agencies shows substantial overlap: our targets include 142 (72%) of the sensitive species considered by the U.S. Forest Service for forests in this region (Table 6), and 34 (51%) of the sensitive species for the Arizona Bureau of Land Management districts in this region (Table 7). With these high levels of overlap, this ecoregional analysis should provide a useful context for prioritizing agency protection efforts.

Table 6. Overlap with USFS sensitive species. Comparison of USFS Southwestern Region Sensitive Species list (7/1999 draft) to Apache Highlands target list (8/2001 draft), using only those species shown on USFS lists as found on forests in the Apache Highlands (Coronado, Coconino, Tonto, Prescott, Kaibab, Apache-Sitgreaves).

	ON Apache Highlands list and USFS	OFF Apache Highlands list but on USFS	total on USFS list shown to be on A.H. forests*
AZ plants	63	49	112
invertebrates	21	0	20
birds	5	2	7
amphibians	5	1	6
fish	3	0	2
mammals	4	3	7
reptiles	6	0	6
ESA listed	35	2**	37
TOTALS	**142**	**55**	**197**

* Two totals do not add up due to species on Apache Highlands list and USFS which were not listed as in Apache Highlands forests.
** Mexican gray wolf, desert tortoise

Table 7. Overlap with BLM sensitive species. Comparison of Arizona BLM Sensitive Species list (10/2000) to Apache Highlands target list (8/2001 draft), using only those species shown on BLM lists as on districts in the Apache Highlands (Kingman, Phoenix, Safford, Tucson).

	ON Apache Highlands list and BLM	OFF Apache Highlands list but on BLM	total on BLM list shown to be on A.H. districts
plants	13	18	31
invertebrates	2	6	8
birds	1	3	4
fish	4	1	5
mammals	11	2	13
reptiles	3	3	6
TOTALS	**34**	**33**	**67**

Aquatic conservation targets

In this relatively arid region where water is key to both human and wild communities, aquatic species have generally suffered the greatest habitat losses. We addressed their conservation by several different means.

To insure the protection of whole aquatic communities, we invested significant efforts in improving our mapped coverage of perennial streams, riparian woodlands, and ciénegas (valley-bottom wetlands; Weinstein 2002a). These involved combining state and federal map sources with scientific literature and expert interviews.

Ciénegas were of particular concern, being a wetland community type important to fish and invertebrate diversity. Approximately one-third of native fish species and subspecies in the arid southwestern U.S. are restricted to springs and ciénegas (Meffe 1989). A variety of invertebrates in the ecoregion are restricted to ciénegas, including the Sunrise skipper,

(*Adopaeoides prittwitzi*) (Bailowitz and Brock 1991). Some snails are endemic to one or a few nearby ciénegas, such as the Page springsnail (*Pyrgulopsis morrisoni*) which is found only in a complex of six ciénegas near the town of Page Springs, Arizona (Landye 1981, USFWS 1999). Ciénegas also host several plants with very limited distributions, such as the Canelo Hills ladies tresses (*Spiranthes delitescens*)(AGFD 2000). The Apache Highlands ecoregion includes the area of greatest known past and present abundance of ciénegas, but they "have been reduced in recent times from a formerly widespread distribution to small, scattered remnants" (Hendrickson and Minckley 1984).

We also identified playas (seasonally-filled valley-bottom lakes) as a community target on the basis of their unique biotic assemblages (warm-temperate interior strand; Minckley and Brown 1994:265). Playas are also significant as they increase the distribution and extent of surface water on a seasonal basis, serving an important role for migratory waterfowl, wading birds such as the sandhill crane (*Grus canadensis*) and other wildlife (AGFD 1997a, 1997b).

In addition, we chose a suite of 47 aquatic target species, including plants, beetles, snails, frogs, mammals, and most fish native to the ecoregion (Table 8). Among these are species with particular stream habitat requirements ranging from tiny mountain streams to large rivers, along with some that depend on ciénegas, permanent springs, or permanent pools in otherwise ephemeral streams.

For the stream-dwelling fish targets, we enhanced the available data by integrating existing point localities for fish specimens and expert input on fish distributions with our GIS coverage of perennial stream segments. Specifically, point localities were examined to determine the approximate stream reaches in which individual fish species are known or believed to occur.

We acquired digitized point localities from the Arizona Game & Fish Department's Heritage Data Management System and a database compiled by the late Dr. Wendell Minckley of ichthyology specimens (Fagan et al. 2002). For the initial attribution we used only recent (1975 or later) records. We used perennial stream segments from an Arizona Land Resource Information System digital file ("HYDRO") and a stream file from Mexico.

Using ArcView 3.3 (Environmental Systems Research Institute), we attributed each perennial stream segment with each native fish species and the total number of species found there, based on proximity of each point (<1 mile from the stream segment) and the stream name listed in each point's locality data field. For the initial attribution, all stream segments with the same name (e.g., East Verde River) were combined and given the same species attributions. Where we could identify breaks in stream continuity with biological significance (e.g., ephemeral stream reaches, dams), attribution for a given species stopped at the break and only resumed on the next segment if there was an additional record adjacent to that segment.

The process of attributing lines from points involved making assumptions to interpolate distribution between and beyond points. This created a risk of overstating current distribution due to variations in stream habitat between headwaters and the low-elevation big rivers. It also disregarded varying exotic species presence and other human influences.

To address these issues, we got review by agency and academic biologists to refine and validate the resulting map, with particular attention to which streams still have which species, and where each species starts and ends within a given stream.

Linear stream segments were thus attributed with each native fish species present (Figure 4). The resultant spatial data set enabled development of conservation goals for fish that better reflect the actual habitat occupied by each species.

Determining viability

In gathering and using data for this analysis, we used several criteria of population viability for our conservation targets, incorporating measures of size, condition and landscape context. The goal was to focus our selection of conservation areas on those populations expected to remain viable for at least the next 100 years. Marginally viable occurrences of some targets were almost certainly captured in some portfolio areas where the focus was on other targets, but the intent was to identify intact, functional, viable areas for conservation. For this purpose, we considered a functional conservation area as "a geographic domain that maintains focal ecosystems, species, and supporting ecological processes within their natural ranges of variability" (Poiani et al. 2000).

We used three measures to assess viability. To determine the landscape context for potential conservation areas, we used road density as a measure of fragmentation and human disturbance. We compiled the best available road data for the ecoregion, and classified the type and density of roads into a "cost" surface that was integrated into our analyses (Chapter 6).

Where they existed, we used the element occurrence ranks from the Arizona and New Mexico Natural Heritage Programs to determine the condition of localities of target species. Occurrences with ranks of "poor" ("D") were considered not viable and dropped from consideration. There were no ranks available for ecological system targets.

We consulted experts about the viability of some species' populations, and used both experts and available literature to evaluate occurrences of vegetation communities. For grassland communities, in particular, we conducted extensive field mapping, expert interviews and quantitative sampling in the field to verify results (Chapter 3). For ciénegas we compiled an expert-verified GIS data set that focused on capturing all extant, viable ciénega systems remaining in the ecoregion (Weinstein 2002a).

We also used minimum size criteria for ecological system targets to maintain minimum dynamic areas where natural disturbance regimes and metapopulation dynamics can be maintained (Wilcox 1980) and to minimize capture of system occurrences with questionable viability. We examined frequency distributions for the current size of all ecological system types and compared them to available data on historical spatial patterns. Minimum dynamic areas were set separately for each target and were distributed within each of three stratification units in an attempt to maintain viability of those targets across their current distribution (Chapter 4).

Table 8. Aquatic target species in the Apache Highlands.

Taxonomic group	Scientific name	English common name	Spanish common name
Amphibian	*Ambystoma rosaceum*		Salamandra
Amphibian	*Ambystoma tigrinum stebbinsi*	Sonoran tiger salamander	Salamandra tigre
Amphibian	*Rana blairi*	Plains leopard frog	
Amphibian	*Rana chiricahuensis*	Chiricahua leopard frog	Rana leopardo Chiricahua
Amphibian	*Rana pipiens* *	Northern leopard frog	
Amphibian	*Rana subaquavocalis*	Ramsey Canyon leopard frog	
Amphibian	*Rana tarahumarae*	Tarahumara frog	Rana de Tarahumara
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	Rana de Yavapai
Reptile	*Thamnophis eques megalops*	Mexican garter snake	
Mammal	*Lontra canadensis sonora*	Southwestern river otter	
Mammal	*Lontra longicaudis*		Nutria neotropical
Fish	*Agosia chrysogaster*	Longfin dace	Charalito aleta larga
Fish	*Campostoma ornatum*	Mexican stoneroller	Rodapiedra mexicana
Fish	*Catostomus bernardini*	Yaqui sucker	Matalote yaqui
Fish	*Catostomus clarki*	Desert sucker	Matalote del desierto
Fish	*Catostomus insignis*	Sonora sucker	Matalote sonorense
Fish	*Catostomus wigginsii*		Matalote opata
Fish	*Cyprinella formosa*	Beautiful shiner	Sardinita hermosa
Fish	*Cyprinodon macularius*	Desert pupfish	Pupo del desierto
Fish	*Gila ditaenia*	Sonora chub	Charalito de Concepcion
Fish	*Gila eremica*	Desert chub	Charalito desierto
Fish	*Gila intermedia*	Gila chub	Charal de Gila
Fish	*Gila purpurea*	Yaqui chub	Charalito Yaqui
Fish	*Gila robusta*	Roundtail chub	
Fish	*Ictalurus pricei*	Yaqui catfish	Bagre Yaqui
Fish	*Meda fulgida*	Spikedace	
Fish	*Oncorhynchus apache*	Apache (Arizona) trout	
Fish	*Poeciliopsis occidentalis occidentalis*	Gila topminnow	Charalito de Sonora
Fish	*Poeciliopsis occidentalis sonoriensis*	Yaqui topminnow	
Fish	*Rhinichthys osculus*	Speckled dace	
Fish	*Tiaroga cobitis*	Loach minnow	
Fish	*Xyrauchen texanus*	Razorback sucker	
Invertebrate	*Abedus herberti*	Giant water bug	
Invertebrate	*Anodonta californiensis*	California floater	
Invertebrate	*Cylloepus parkeri*	Parker's cylloepus riffle beetle	
Invertebrate	*Heterelmis stephani*	Stephan's heterelmis riffle beetle	
Invertebrate	*Metrichia volada*	Page Spring micro caddisfly	
Invertebrate	*Psephenus arizonensis*	Arizona water penny beetle	
Invertebrate	*Pyrgulopsis bernardina*	San Bernardino springsnail	
Invertebrate	*Pyrgulopsis glandulosa*	Verde Rim springsnail	
Invertebrate	*Pyrgulopsis montezumensis*	Montezuma Well springsnail	
Invertebrate	*Pyrgulopsis morrisoni*	Page springsnail	
Invertebrate	*Pyrgulopsis simplex*	Fossil springsnail	
Invertebrate	*Pyrgulopsis sola*	Brown springsnail	
Invertebrate	*Pyrgulopsis thompsoni*	Huachuca springsnail	
Vascular plant	*Carex ultra*	Arizona giant sedge	
Vascular plant	*Lilaeopsis schaffneriana* var. *recurva*	Huachuca water umbel	

* Occurrence records of *Rana pipiens* from Mexico are assumed to be either *R. chiricahuensis* or *R. yavapaiensis. Rana pipiens* was split into several additional species and is no longer thought to exist in Mexico.

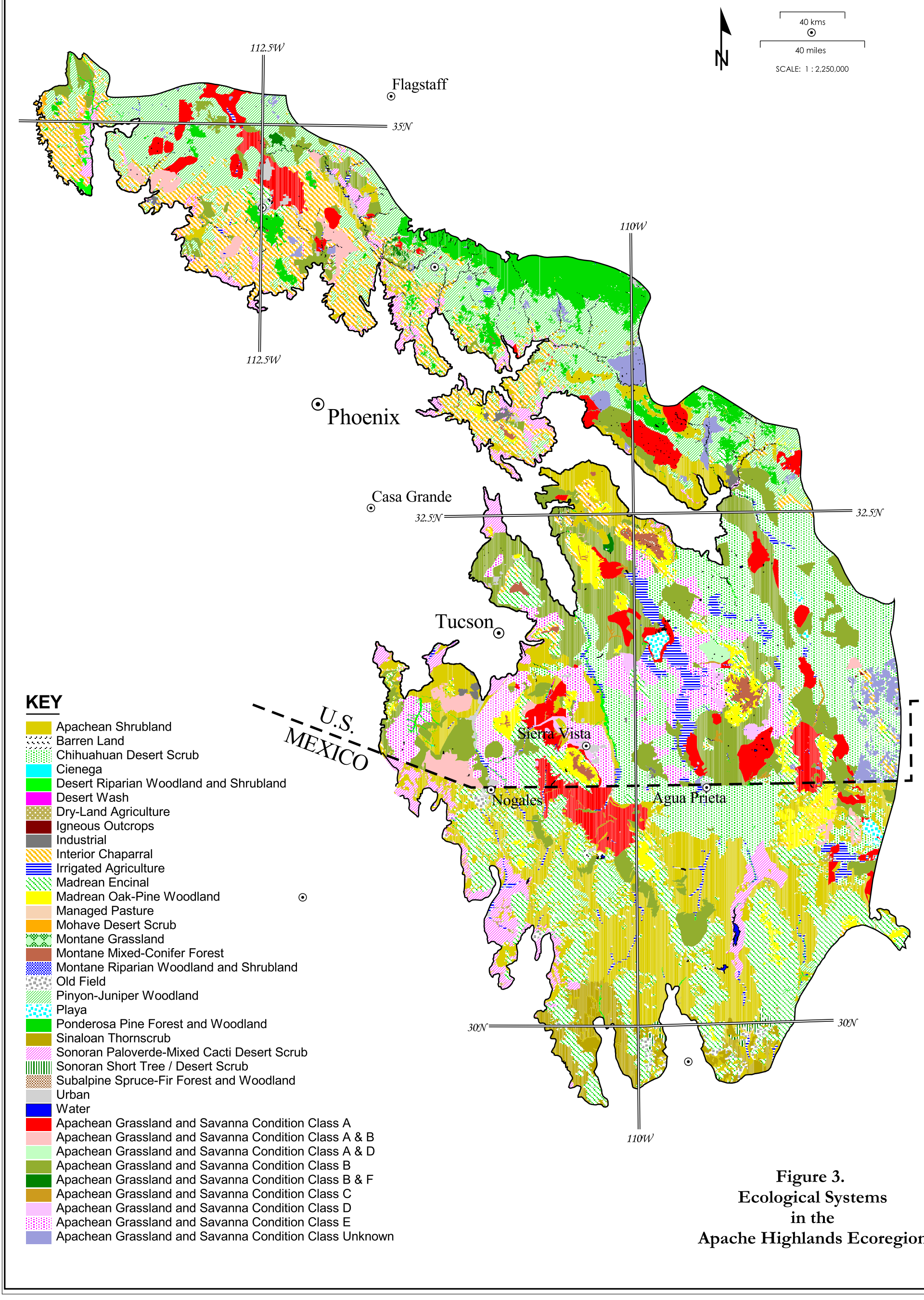

Figure 3.
Ecological Systems
in the
Apache Highlands Ecoregion

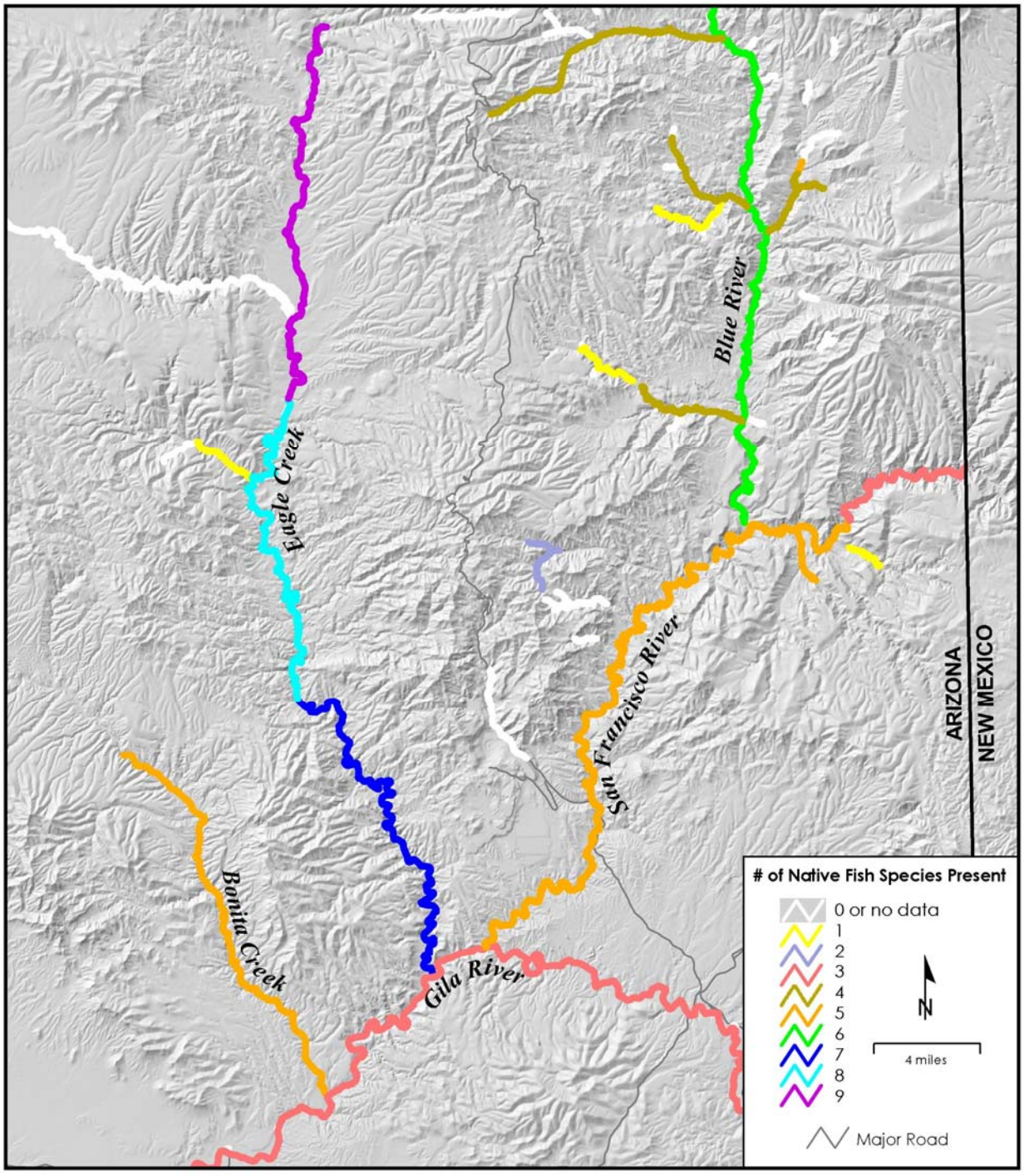

Figure 4. Native Fish Species in Eagle Creek and Blue River. Species richness shown is a composite of separate mappings of all native fish distributions, derived from perennial stream maps, fish specimen records, and scientific literature. Similar mapping was done for all perennial streams in the Apache Highlands.

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3. Grassland Assessment

Grasslands of the Apache Highlands have undergone dramatic vegetation changes over the last 130 years, including encroachment by shrubs, loss of perennial grass cover, and spread of non-native species.

These changes have affected a variety of animal species in addition to the plant communities. While not all animals associated with grasslands are strictly dependent on natural conditions, at least 23 native species of mammals and birds have been extirpated from grasslands in the Southwest or have experienced significant range reductions (Brown and Davis 1995).

Changes in grassland composition and structure have not occurred uniformly across the region, and their extent and distribution are poorly understood at a regional scale. Moreover, these changes are dynamic and ongoing. As part of this ecoregional analysis, we conducted a study to assess and characterize the extent of vegetation changes to grasslands and to identify the best remaining native and restorable grasslands for conservation planning and ecological management purposes (Gori and Enquist 2003).

We used an expert-based approach, interviewing 24 range management specialists from the Forest Service (USFS), Natural Resources Conservation Service, Bureau of Land Management (BLM), University of Arizona, Arizona State Land Department, The Nature Conservancy, New Mexico Natural Heritage Program, Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora (IMADES), and Instituto Naciónal de Investigaciónes Forestales, Agricolas y Pecuarias (INIFAP). Expert input was verified and corrected where necessary through extensive field reconnaissance and quantitative vegetation sampling at random sampling points.

Six primary grassland condition types were identified through the course of this study: native grassland with low shrub cover (Type A); shrub-encroached native grassland with restoration potential using prescribed fire (Type B); sacaton riparian grassland (Type C); non-native grassland with low shrub cover (Type D); shrub-encroached non-native grassland (Type E); and former grassland that has undergone a type conversion to shrubland (Type F). Experts identified 13,115,000 acres (5,310,000 ha) in the U.S. and Mexico as current or former grassland; we assume that this represents the historic distribution/extent of grasslands. Most current and former grasslands, 10,724,000 acres (4,342,000 ha), occur in the U.S. portion of the study area.

Vegetation change in grasslands has been extensive and dramatic (Table 9). Native grasslands with low shrub cover now cover only 2 million acres or 15% of historic grassland. Roughly three-quarters of this high-quality native grassland, or 1.4 million acres, occurs in the U.S. Shrub encroachment has occurred on over 9.2 million acres or 71% of historic grasslands. Approximately 3.8 million acres (29%) of this is restorable back to native grassland using grazing rest and prescribed burns. However, shrub cover has exceeded a threshold producing a type conversion from grassland to shrubland on over 4.1 million acres (31%).

In the U.S., shrub encroachment has been more extensive and severe, affecting over 84% of historic U.S. grasslands. Shrub-invaded native grasslands with restoration potential make up approximately 3.5 million acres (33%) of this total, while type conversion to shrubland has occurred on approximately 3.8 million acres (36%). Thus, the opportunity for restoration of shrub-invaded native grassland using prescribed fire is substantial in the U.S. and time-sensitive, considering the amount of grassland that has already been converted to shrubland.

The opportunities for grassland restoration are also significant in Mexico. Shrub-invaded native grasslands with restoration potential occur on about 351,000 acres, 31% of current and former grasslands there.

The spread of non-native perennial grasses within grasslands has also been significant. Lehmann lovegrass (*Eragrostis lehmanniana*) and, to a lesser extent, Boer lovegrass (*Eragrostis curvula*), are now common or dominant on more than 1.4 million acres. Restricted to

Table 9. Extent, in acres, and percent abundance of grassland types in U.S. and Mexico (Gori and Enquist 2003).

Grassland Type	U.S. Acres	MX Acres	U.S.-MX Acres	% All Grasslands*
Native (A, A&D)	1,472,056	547,046	2,019,098	15.4
Native with Restoration Potential (A&B, B)	3,478,246	350,702	3,828,948	29.2
Non-Native (D, E)	1,469,319	0	1,469,319	11.2
Riparian (C)	45,735	7,239	52,974	0.4
Former Grassland (F)	3,837,691	215,635	4,053,326	30.9
Unknown (UNK)	381,386	1,270,018	1,651,404	12.6

* Value represents the proportion of the total grassland acreage (13,114,857) for each U.S.-MX grassland type.

southeastern Arizona where the two species were originally introduced, non-native grasslands comprise 23% of current U.S. grasslands.

Although high-quality native grasslands are more abundant in overall acreage in the U.S., these grasslands (types A, A&D) are proportionately 3.6 times more common in Mexico (57% in Mexico vs. 14% in the U.S., excluding unknown grasslands from the analysis) and sacaton riparian grasslands are 1.5 times more common in Mexico (0.6% vs. 0.4%).

In the U.S., most remaining native grasslands with low shrub cover are privately owned or are managed by the State Land Dept. (Table 10). Shrub-invaded native grasslands with restoration potential include 1.3 million acres of BLM and USFS land and 1.2 million acres of State lands.

Most native grasslands have no legal protective status which would prevent conversion or clearing of their natural land cover (Weinstein 2002b). In the Mexico portion of the ecoregion, essentially all remaining grasslands are on private land and have no permanent protection. In the U.S. portion, only 1.2% of native grasslands with low shrub cover are permanently protected from land cover conversion and have a mandated management plan to maintain them in a primarily natural state. In contrast, 59% of these grasslands have no protective status. Similarly, only 5% of restorable native grasslands in the U.S. are highly protected compared to 55% of these that have no protective status. Thus, in a region that is experiencing one of the highest rates of population growth in the U.S., native grasslands are extremely vulnerable to urban, suburban, and exurban development (Gorenflo 2003).

Restoration and maintenance of native grasslands can be achieved through a significant portion of the ecoregion but will require coordinated management of fire and grazing, along with protection from development.

Table 10. Grasslands and shrublands, in acres, by land manager in the U.S. portion of the Ecoregion (Gori and Enquist 2003).

Land Manager	Native, <10% Shrub Cover (A, A&D)	Non-Native (D, E)	Riparian Grassland (C)	Shrubland-Former Grassland (F)	Unknown Grassland	Native w/ Restoration Potential (B, A&B)
State Land	342,333 (23.3%)	456,718 (31.1%)	10,032 (21.9%)	1,289,518 (33.7%)	14,946 (3.9%)	1,171,278 (33.8%)
Private	549,055 (37.3%)	641,092 (43.6%)	26,680 (58.3%)	935,198 (24.5%)	92,074 (24.1%)	752,831 (21.7%)
USFS	137,823 (9.4%)	157,975 (10.8%)	149 (0.3%)	145,814 (3.8%)	17,164 (4.5%)	747,803 (21.6%)
BLM	112,591 (7.7%)	19,903 (1.4%)	1,199 (2.6%)	1,094,944 (28.6%)	104,002 (27.3%)	534,597 (15.4%)
Native Americans	212,427 (14.4%)	--	--	311,133 (8.1%)	141,989 (37.2%)	123,281 (3.6%)
Private NGO	102,780 (7.0%)	501 (0.0%)	4,056 (8.9%)	21,944 (0.6%)	11,206 (2.9%)	97,032 (2.8%)
USFWS	0 (0%)	95,844 (6.5%)	3,120 (6.8%)	6,076 (0.2%)	--	16,170 (0.5%)
Arizona State Parks	2,967 (0.2%)	2,657 (0.2%)	498 (1.1%)	672 (0.0%)	--	10,440 (0.3%)
USDOD	8,881 (0.6%)	48,849 (3.3%)	--	1,237 (0.0%)	--	622 (0.0%)
City of Tucson	0 (0%)	671 (0.0%)	--	--	--	5,769 (0.2%)
AGFD	614 (0%)	19 (0.0%)	--	429 (0.0%)	--	2,562 (0.1%)
U of A	0 (0%)	41,657 (2.8%)	--	1,570 (0.0%)	--	2,214 (0.1%)
Pima County	0 (0%)	434 (0.0%)	--	6,483 (0.2%)	--	2,038 (0.1%)
USNPS	1,485 (0.1%)	2,600 (0.2%)	--	7,034 (0.2%)	--	16 (0.0%)
N/A	0 (0%)	0 (0.0%)	--	--	--	154 (0.0%)
TOTAL	**1,470,956**	**1,468,921**	**45,735**	**3,822,054**	**381,382**	**3,466,808**

4. Conservation Goals

In this effort, we used explicit goals to direct conservation efforts for targeted species, communities, and systems. Goals provide the quantitative basis for identifying and prioritizing areas that contribute to the reserve network. Reserve design is appropriately dictated by target goals, thus creating a vision of landscape functionality at a regional scale. Establishing conservation goals is among the most difficult - and most important - scientific questions in biodiversity conservation (e.g., How much is enough? How many discrete populations and in what spatial distribution are needed for long-term viability?). Estimates made in various settings have reached different conclusions, but one review estimated that the land area needed to represent and protect most elements of biodiversity, including wide-ranging species, is about 50% (Soulé and Sanjayan 1998). These questions can't really be answered by theory, but require an empirical approach, target-by-target, and a commitment to monitoring and continual re-evaluation over the long-term (Noss 1996, Soulé and Sanjayan 1998).

Fine filter strategies emphasize recovery and evolutionary adaptation of individual species. In addition to species viability, coarse filter strategies emphasize the conservation of ecosystem services (e.g. air, water, nutrient cycling, etc.), perhaps better characterized as ecological integrity at an ecoregion scale (Pimentel et al. 2000). These differences may result in different approaches for setting conservation goals. While conservation goals for species correctly emphasize genetic fitness and the functional roles of species in ecosystems, coarse filter goals focus more strongly on representation of ecological variability and environmental gradients (Comer 2001).

For this effort, our goals were set based on current distributions of the targets. Ideally, our goals would be stated in terms of historical extent to better inform recovery efforts for those targets that have declined, but we lacked adequate data for most targets to approximate their historic distributions across the ecoregion.

To maintain consistency across boundaries, we set conservation goals using methods similar to those used for the Sonoran Desert Ecoregional Analysis (Marshall et al. 2000).

Stratification

The available data on species distributions were not evenly distributed. The commonly-recognized history of more biological research in the U.S. portion has produced far more data in the U.S., despite the greater levels of species richness and endemism known to occur in the Mexican portion (Felger et al. 1997, MacArthur and Wilson 1967:116). In using program SITES (Chapter 6), we faced a serious risk of weighting the conservation portfolio in favor of U.S. areas due simply to lack of data from Mexico.

We also had to address the changes in a few vegetation communities distributed across the ecoregion, which were partially a result of grouping communities into coarse-scale ecological systems. For example, the Madrean oak-pine woodland has progressively fewer species of both oak and pine as one moves from south to north, forming different assemblages in each mountain range (Marshall 1957), and we wanted to capture places along that range of variation.

We also faced some large differences in land management history. The montane forests of northern Mexico have had little or no fire suppression, resulting in communities that probably have higher resilience and habitat diversity than those in the U.S. (Swetnam and Baisan 1996).

In making the final portfolio selection, we tried to ensure that conservation targets were captured in a distribution that approximates the current distribution of those species or

communities. To do this we divided the input data according to a stratification scheme, breaking the ecoregion into nearly equal thirds (Figure 5).

The northern 33% covered the area below the Mogollon Rim, and included about 27% of the species locality data. It was bounded on its south side by a line near the Gila River, taken from a U.S. Forest Service map of their section/subsection classifications (Cleland 1997, http://www.na.fs.fed.us/sustainability/nhfeu.htm). This Forest Service effort refines the more widely-used biotic community map of Brown and Lowe (1980). This stratification unit is mostly comprised of the Tonto Transition Section (Section 313C), along with small pieces of the Mojave Desert Section (322A), Sonoran Desert Section (322B), and White Mountain/San Francisco Peaks/Mogollon Rim Section (M313A).

The central 36%, incorporating the U.S. sky island region, was bounded on the south by the international boundary. It contained about 59% of the species data. This stratification unit is comprised almost entirely of the Basin & Range Section (Chihuahuan Semi-Desert) (321A), with a few small pieces of the Sonoran Desert Section (322B).

The southern 31% contains the sky islands of Mexico. Its southern boundary, the edge of the ecoregion, was dictated by the approximate edge of the continuous Sierra Madre ranges and, in the valleys, by the northern edge of the tropical deciduous forest. It included about 14% of the species data.

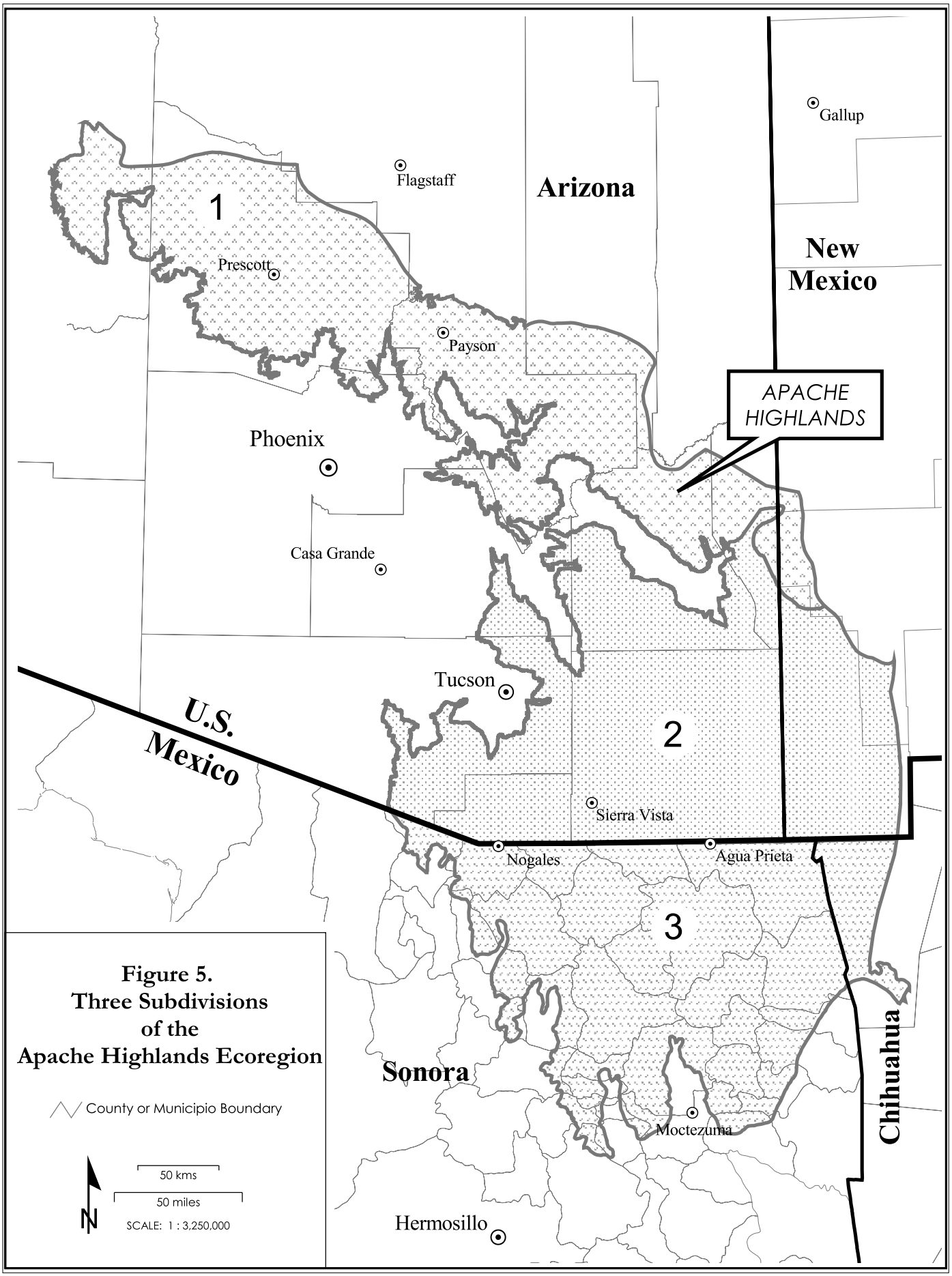
Species target goals

We used the global rarity ranks (G-rank) for most species to set their conservation goals, with higher goals for the rarest species (Table 11). For those species ranked G3 to G5, we developed their goals based on the G3 definition of "21 to 100 occurrences." Working from a conceptual goal of keeping species from becoming "rare" we set a numeric goal of 24 occurrences or 100% of the known populations, whichever is less (Marshall et al. 2000). The overall goal for each species was then broken into subgoals, one for each of the three stratification units where that species occurs.

We did not assume each locality record for a species to represent a population since some species are highly mobile and for a few species (e.g., Chiricahua leopard frog) we had many records in close proximity. In those cases, we used a function of program SITES to set a minimum separation distance between records that would count toward achieving the target goals.

Ecological system target goals

We first examined frequency distributions for the current size of all ecological system types and compared them to available historical data on spatial patterns to identify gross-scale changes in the status of ecological systems and as a basis for identifying conservation goals. We initially selected a minimum goal of 40% of current extent for each system in the ecoregion. This percentage suggests that we could lose between 15% and 25% of native species currently present if the natural land cover is reduced to only that portion (Figure 6). We then considered each system according to its distribution, spatial pattern, and ecological significance (i.e., rarity and magnitude of historic losses), and modified individual goals (Table 12). Some goals were raised, but for large patch and matrix systems which have their primary distribution in adjacent ecoregions, the goals were lowered to 30% on the assumption that they are better conserved there and to match the goals set in those ecoregions.


Gallup
Flagstaff
Arizona
1
Prescott
New
Mexico
Payson
APACHE
HIGHLANDS
Phoenix
Casa Grande
Tucson
U.S.
Mexico
2
Sierra Vista
Nogales
Agua Prieta
3
Sonora
Chihuahua
Moctezuma
Hermosillo
Figure 5.
Three Subdivisions
of the
Apache Highlands Ecoregion
County or Municipio Boundary
50 kms
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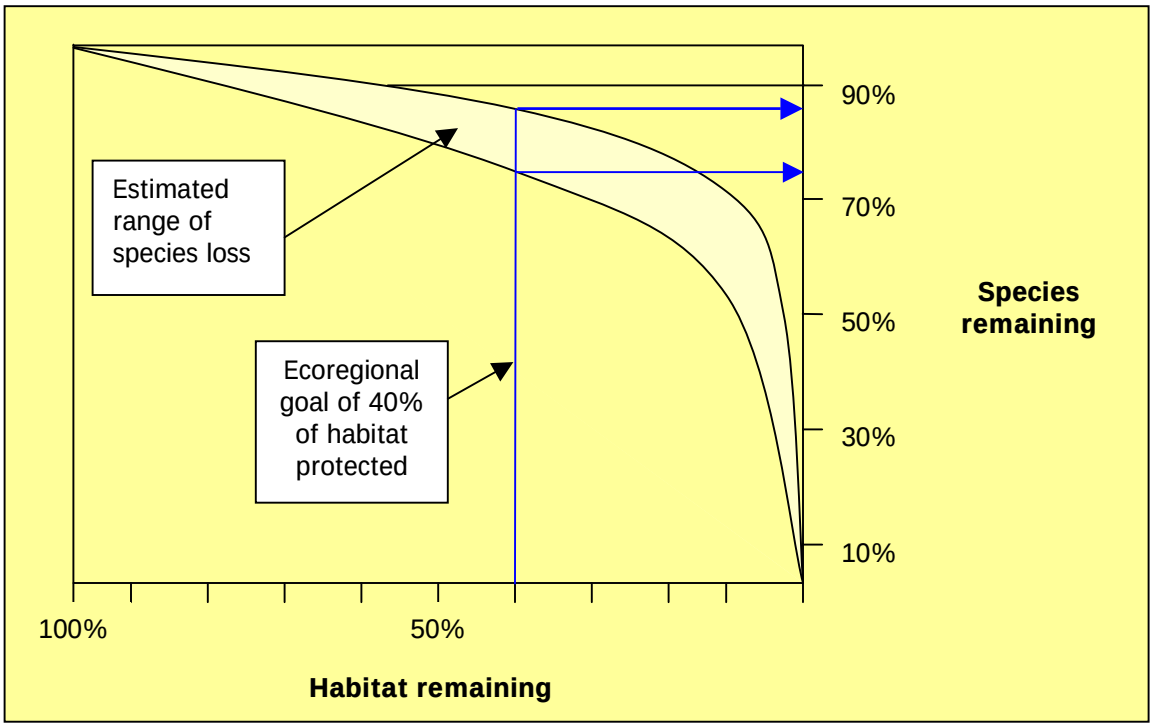


Figure 6. Estimated species loss with % habitat loss over time (modified from Dobson 1996).

Once we set an overall goal for each system, we divided it into separate goals for all subdivisions where the system occurs. Those subdivision goals were set according to the proportion of modern occurrence in the subdivisions. For example, of the overall distribution of Desert Riparian Woodland and Shrubland, 38% occurs in the Northern subdivision, 48% in the Central, and 14% in the Southern, and the subdivision goals match those proportions.

Goals for the grasslands were set differently because we had current information on their condition (Gori and Enquist 2003). We began with an overall goal of 62% for current and confirmed grasslands, determined by visual inspection of a species/area graph as the amount needed to protect approximately 90% of the native species diversity (Figure 6). That overall goal was divided among the different condition classes such that we would try to conserve all remaining occurrences that are in good condition and dominated by native grass species, while setting lower goals for lower condition classes. The resulting goal for each condition class was then broken into proportional subdivision goals, as described above.

We recognize that using species/area curves for predictive modeling is somewhat problematic without empirical data on actual species/area relationships for the systems of interest (Brown and Lomolino 1998). We felt its use was appropriate in this case for setting rough goals for the first analysis of a large ecoregion, but suggest that future iterations of this analysis should incorporate additional data to better refine these models.

In setting goals for ecological system targets, we set minimum size limits for patches that would be counted toward meeting the representation goals. This insured that we wouldn't settle for many small fragments of a system target which historically occurred as large patches or landscape matrices, on the assumption that the largest remaining patches are likely to be the most viable. We examined a frequency distribution of map polygon sizes for each system target and typically selected the 75% or 90% quantile as the minimum cutoff size, taking into account its

historic spatial pattern and the requirements of target species occurring there. Minimum sizes were set separately for each subdivision in which the targets occurred, to maintain the natural variation in patch sizes that occurs across the ecoregion.

Aquatic target goals

The Apache Highlands contains two major types of aquatic systems, perennial streams and ciénegas. Both are extremely important to maintaining biodiversity in the region and both have been greatly reduced in number and size in the ecoregion, though exact accounting of losses is difficult (Hendrickson and Minckley 1984, Tellman et al. 1997). A recent study (TNC unpubl. data) found that 91% of the free-flowing perennial miles on Arizona's big rivers (i.e., Colorado, Gila, Salt, Verde) and 37% of perennial reaches on mid-sized streams (i.e., San Pedro, Santa Cruz, Little Colorado, White, Black, Blue, San Francisco and Babocomari rivers) have been lost.

Native fish in this ecoregion have declined with the loss of perennial streams: 17 of the 21 fish species have global status ranks of G1-G3, 12 are listed or candidates for listing under the U.S. Endangered Species Act, and 11 are listed under Mexico's equivalent law (NOM-059-ECOL-1994). Among the declining native species in the ecoregion, fish have suffered some of the biggest losses (Minckley and Deacon 1968, Minckley and Rinne 1991, Williams et al. 1985). In particular, native fishes in this ecoregion face a high and growing risk of extinction due to habitat fragmentation caused by water diversions, dam construction, introduction of exotic species, and other human influences (Fagan et al. 2002).

Beyond that, fish serve as good surrogates for communities of organisms dependent on perennial water, critical in this region since many aquatic organisms are poorly known, particularly invertebrates (Williams et al. 1985). Fremont Cottonwood/ Goodding's Willow riparian forests are largely restricted to perennial stream floodplains, and have thus become a rare (G2) community type (Minckley and Brown 1994:269). One analysis found that about 70% of the rare species in Arizona and New Mexico depend on aquatic or riparian habitat, while some 90% of that habitat has been lost (Johnson 1989). In this arid region, migratory birds make heavy use of both continuous riparian corridors and isolated riparian oases as stopover sites, and even small, disjunct patches serve as critical links (Skagen et al. 1998).

Due to the importance of stream systems in this ecoregion and a desire to develop conservation goals that better reflect habitat requirements, particularly for fish, we set conservation goals in kilometers of occupied stream for each fish species (see page 15 for description of point data conversion to stream reaches). We established conservation goals of 100% for all but the three most-common fish species: Longfin dace, Desert sucker, and Speckled dace (*Agosia chrysogaster*, *Catostomus clarki*, and *Rhinichthys osculus*, respectively, listed in declining order by number of streams in which they're found). This was justified because an analysis of the distribution of fish targets revealed that 13 of the 19 stream-dwelling species currently occur in 10 or fewer stream systems (out of 200 total in the ecoregion) and 15 occur in less than 600 km of stream length (out of 4,000 km total perennial reaches). Also, recovery plans for listed species call not only for maintenance of all existing populations but also recovery of populations in historic locations (USFWS 1991a, 1991b), which reflects the critical status of more than half of the fish targets in the Apache Highlands ecoregion.

Table 11. Conservation Goals for Species Targets in the Apache Highlands Ecoregion.

Species Target (Based on Combined Global Ranks)	Conservation Goal	Justification
G1-G2	All viable occurrences.	All remaining populations may be critical to survival of species with status of "very rare" or "rare."
G3-G5	At least 24 viable occurrences maintaining current extent of geographic representation.	Maintains species that are "fairly common," "apparently secure," and "demonstrably secure" in same status and geographic extent.
Special Cases:		
American Pronghorn	All occurrences for which viability is not dependent on translocations, as determined in post-hoc analysis.	Widespread but declining and sensitive to habitat fragmentation. Evaluation of viability will require review of population data and expert input.
Black Bear	Include potential or known movement corridors between draft conservation areas in post-hoc analysis.	Habitat generalist and poor discriminator of specific landscape features or habitat types. Primary conservation issue is habitat isolation resulting from barriers to movement between ranges.
Gunnison's Prairie Dog	All remaining occurrences.	Keystone species. Most populations in ecoregion lost due to eradication or plague.
Black-tailed Prairie Dog	All remaining occurrences, with primary reintroduction sites added in post-hoc analysis.	Keystone species. All populations in U.S. lost due to eradication, but reintroduction plan has been drafted.
All bat species except Lesser Long-Nosed	All occurrences of roosting sites.	Each of these is a G3-G5 species with limited occurrence data on habitat use.
Baird's Sparrow	All viable occurrences.	Total non-breeding season distribution limited to small area of Apache Highlands and Chihuahuan Desert.
Sandhill Crane	Entire wintering range in ecoregion	This migratory species overwinters in only two sites in ecoregion.
All native fish species except Longfin Dace, Speckled Dace, and Desert Sucker	All occupied stream reaches.	Most are G1-G3 species with major threats to their limited habitat. Recovery goals for listed species require maintenance of all existing populations plus recovery in historically-occupied areas.

Table 12. Conservation goals for terrestrial and aquatic systems in the Apache Highlands Ecoregion. Goals stated in hectares except for "Ciénega point" which is in number of occurrences.

Ecological System	Distribution	Spatial Pattern	Northern Subdivision Goal	Central Subdivision Goal	Southern Subdivision Goal	Justification
Apachean Grassland and Savanna Condition Class A	limited	large patch	269,778	302,530	170,811	Captures 100% of community reflecting fact that 60% has been lost or shrub invaded.
Apachean Grassland and Savanna Condition Class A & B	limited	large patch	48,954	51,192	12,663	Captures 65% of community.
Apachean Grassland and Savanna Condition Class A & D	limited	large patch		17,738		Captures 100% of community.
Apachean Grassland and Savanna Condition Class B	limited	large patch	160,059	644,928	85,237	Captures 65% of community.
Apachean Grassland and Savanna Condition Class C (Sacaton Grassland)	limited	small patch		17,534	2,929	Captures 100% of community. *Sporobolus wrightii* occupies less than 5% of its original distribution (Humphrey 1960).
Apachean Grassland and Savanna Condition Class D	limited	large patch		39,211		Captures 85% of community.
Apachean Shrubland	endemic	matrix	66,186	95,768	388,163	Captures 30% of community.
Chihuahuan Desert Scrub	limited	matrix	15,388	327,232	93,142	Captures 30% of community.
Cienega polygon	endemic	small patch	9	177		Captures 100% of community.
Cienega point	endemic	small patch	25	36	14	Captures 100% of community.
Desert Riparian Woodland and Shrubland	limited	linear	12,218	15,521	4,335	Captures 75% of community.
Desert Wash	peripheral	linear	324	223		Captures 30% of community.
Interior Chaparral	widespread	matrix	244,378	23,359	4,137	Captures 30% of community.
Madrean Encinal	limited	matrix	12,153	91,829	404,502	Captures 40% of community in large blocks.
Madrean Oak-Pine Woodland	limited	matrix	5,383	76,258	45,144	Captures 40% of community in large blocks.
Mohave Desert Scrub	peripheral	matrix	1,981			Captures 30% of community; achieves parity with Mohave goals; areas identified should be contiguous with Mohave Conservation Areas.
Montane Grassland	disjunct	small patch	35			Captures single occurrence
Montane Mixed-Conifer Forest	disjunct	large patch	1,579	16,500		Captures 30% of community; achieves parity with AZ-NM Mtns.
Montane Riparian Woodland and Shrubland	disjunct	linear	2,219	2,508	35	Captures 75% of community.
Pinyon-Juniper Woodland	widespread	matrix	548,932	4,252	10,141	Captures 40% of community.
Playa	widespread	large patch	98	13,641	9,533	Captures 75% of community with no size limitation.
Ponderosa Pine Forest and Woodland	peripheral	matrix	136,625	25		Captures 30% of community; achieves parity with AZ-NM Mtns goals; areas identified should be contiguous with AZ-NM Mtns Conservation Areas.
Sinaloan Thornscrub	peripheral	matrix			68,013	Captures 30% of community; achieves parity with Sonoran goals; areas identified should be contiguous with Sonoran Desert Ecoregional Conservation Areas.
Sonoran Paloverde-Mixed Cacti Desert Scrub	peripheral	large patch	65,564	22,383	71,083	Captures 30% of community; achieves parity with Sonoran goals; areas identified should be contiguous with Sonoran Desert Ecoregional Conservation Areas.
Sonoran Short Tree / Desert Scrub	peripheral	large patch			5,247	Captures 30% of community; achieves parity with Sonoran goals; areas identified should be contiguous with Sonoran Desert Ecoregional Conservation Areas.
Subalpine Spruce-Fir Forest and Woodland	disjunct	large patch		862		Captures 90% of community.

5. Data Preparation and Sources

Delineation of ecoregion boundaries

Ecoregions are large areas of land and water that share similar climate, physiography, and biotic communities (Bailey 1998). The Apache Highlands Ecoregion was initially defined using the U.S. Forest Service ECOMAP Province scale (Bailey 1994). The final boundary for the Apache Highlands was subsequently modified on the west, north, and east sides through refinements of the adjacent ecoregional boundaries.

The result was a very large ecoregion extending from central Arizona south to Jalisco. An Ecoregion Stitch Working Group meeting was held in June 1997 to finalize boundaries of ecoregions in southwestern North America. The map that came out of that workshop delineated a region comprised of the sub-Mogollon Rim transition zone between the Arizona-New Mexico Mountains and the Sonoran Desert, along with the sky islands to the south. The southern boundary was chosen, in part, to reflect the transition between the Sierra Madre Occidental and the Madrean Archipelago, where the mountain mass breaks into discrete ranges surrounded by much lower valleys. Within the valleys of Sonora, it approximates the northern edge of the tropical deciduous forest. That southern boundary was further modified in 2001 by the Arizona Chapter of The Nature Conservancy, based on additional expert input.

Species locality sources

Natural Heritage Program Databases in Arizona and New Mexico, along with the Centro de Datos para la Conservación in Sonora, provided approximately 10,800 records for conservation target species that occur within or near the Apache Highlands Ecoregion and other species of concern in the region which were not selected as conservation targets for this analysis. All records were spatially referenced and depicted as points, though the U.S. data were deliberately "fuzzed" by up to a mile. Some, but not all records, included estimates of viability and dates of last observation. Heritage data were not available for Chihuahua.

We received 7,838 records in the region from a database of fish specimens compiled by Dr. Wendell Minckley of Arizona State University (Fagan et al. 2002). Data requests to other museums, searches of online museum databases (Appendix 3), and data from experts provided an additional 362 specimen records for target species in the region.

We also were given a database of reputable bird observations from Sonora compiled by Dr. Stephen Russell with University of Arizona (Russell and Monson 1998), which yielded 459 localities of target species.

After removing non-target species, duplicate records, old records (prior to 1970 for most species), and localities outside the ecoregion, we incorporated 4,565 point localities into this analysis.

As noted in the discussion of aquatic targets, we combined point localities for specimens of the stream-dwelling fishes and expert input on fish distributions with our GIS coverage of perennial stream segments. This allowed us to identify the linear stream segments occupied by each native fish species (Turner in prep). Those linear distributions replaced the point records for subsequent analyses.

Ecological systems data

Occurrences of individual plant communities typically take the form of small to medium-sized polygons, representing discrete identifiable patches on the landscape. Occurrences of

extensive terrestrial ecological systems are typically large mapped polygons. We obtained Gap Analysis Program (GAP) vegetation coverages for Arizona and New Mexico, and the Forest Inventory 2000 for Sonora and Chihuahua. Those data were developed from imagery dating from the early 1990s (Halvorson et al. 2002, Palacio Prieto et al. 2000, Thompson et al. 1996, Velázquez et al. 2001). Those data were supplemented for riparian ecological systems with results from the Arizona Statewide Riparian Inventory and Mapping Project and the USGS National Land Cover Data (AGFD 1993, USGS 2000). Differences in the cover classifications between states were reconciled, particularly along borders, to form a consistent coverage for the ecoregion.

Biophysical analysis

In many cases, ecoregion-wide data are both geographically and biologically incomplete. To enhance the interpretation of existing data, we used a model that predicts the general location, extent and range of environmental gradients within ecological communities. This method uses the underlying abiotic ecological features while factoring in the derived terrestrial ecological systems distribution to predict the potential range of topographic variation within a community type. Terrestrial analysis (Moore et al. 1988, 1993, Fels and Zobel 1995, Skidmore 1990) was done using a digital elevation model (DEM) to create a landform layer which was combined with data layers of surficial geology, terrestrial ecological systems and elevation derived from the DEM, to form ecological features, or Ecological Land Units (ELU). The developed ELUs attempt to extract the key biotic and abiotic factors while still using widely available data (Anderson et al. 1998; see Appendix 4).

The DEM used for the analysis was a mosaic of data from two sources. We used 100-meter resolution USGS 1998 North American Landscape Characterization (NALC) data for Sonora and Chihuahua. We used 30-meter resolution 1999 USGS National Elevation Dataset (NED) data for Arizona and New Mexico, but resampled it to 100-meter resolution for consistency.

Surficial geology was derived from existing geologic data from Arizona (Reynolds 1988), New Mexico (Anderson and Jones 1994), Sonora and Chihuahua (INEGI 1998). Geologic formations from each state were re-grouped into a lower-resolution classification system and border differences were reconciled (Appendix 4).

Data storage

Tabular data compiled or developed for this assessment were integrated into the Conservation Planning Tool, a standardized database developed in Microsoft Access 2000 by The Nature Conservancy. The primary archive copy for this database is in the Tucson office of The Nature Conservancy.

6. Identification of Conservation Areas

Analytical Steps

Conservation areas (also known as Areas of Biodiversity Significance) were identified through a combination of computer-assisted and manual processes that evaluated the following data: (1) point localities for conservation targets; (2) spatial data sets for the ecoregion's topography, hydrography, land use/land cover, terrestrial ecosystem data, land management status, and Thematic Mapper satellite imagery; and (3) ecoregional cost surface/suitability index.

We attempted to select an interconnected network of conservation areas (portfolio) using a systematically explicit and replicable process. Computer analysis facilitated the selection process with a site-selection software program, SITES, designed for ecoregional assessment and developed for TNC by the National Center for Ecological Analysis and Synthesis, University of California at Santa Barbara (Andelman et al. 1999). SITES incorporates target occurrences represented as points, polygons, or lines in a Geographic Information System (GIS) environment, allowing us to set conservation goals as numbers of point occurrences, area, or linear distances. The capability of the program to integrate many spatial data sets such as land use pattern and conservation status enables a rapid evaluation of alternative portfolio configurations. Millions of potential combinations of portfolio designs are compared before determining the "optimal" portfolio. SITES selects areas to meet established conservation target goals while balancing objectives of efficiency, defined as the greatest number of goals met for the lowest cost or least amount of suitable land. The following equation summarizes the program's algorithm (Andelman et al. 1999):

Total Portfolio Cost =	*Σ Cost of Selected Area +*	*Σ Target Penalty +*	*Σ Boundary Length*
Minimized by selecting a set of conservation areas which covers as many targets as possible as cheaply as possible in as compact a set of areas as possible.	The score total for all units selected for the portfolio from the suitability index parameters (road density, ag/urban, mining/industrial and minimum cost per hex).	Cost of not meeting conservation goals for each target.	Cost of spatial dispersion of the selected areas as measured by the total boundary length of the portfolio.

See Appendix 5 for Suitability Index parameters and Appendix 6 for SITES run parameters.

A uniform hexagon grid with a cell size of 1,235 acres (500 ha) was established as the unit of analysis for input into SITES. Hexagon polygons are a common spatial unit for habitat analysis which effectively captures natural variability, especially among spatially heterogeneous data sets (Keister et al. 1996, White et al. 1992). The shape also approximates a circle, having a low edge/area ratio, most desired for this type of analysis (Elkie et al. 1999). The 500 ha size was selected to effectively divide a topographically diverse landscape (some areas have elevation changes of approximately 7,000 ft (2,100 m) within a 6.5 mile (10.5 km) horizontal distance) and to appropriately capture rural area fragmentation patterns.

The division of the ecoregion into hexagons resulted in 25,446 analysis units. Individual hexagons were attributed by intersecting GIS data with points and polygon information for targeted species, terrestrial ecological systems, and the suitability index.

Suitability Index/Cost Surface

The representative cost of conserving an area was derived through the Apache Highlands suitability index, which integrated major land use factors, such as road class density, mines/industrial development, agricultural/urban development, and minimum land area (Figure 7, Appendix 5). The suitability index is a hypothesis that provides a measure for environmental conditions on the landscape. It is not a direct measure of ecological integrity however the model does determine a level of potential habitat fragmentation. A unit-free value was applied as a "cost" factor to each 500-hectare hexagon. Index factors were assigned different weight depending on the assumed impact the factor might have on conservation targets (e.g., four-lane paved roads have greater impact than one-lane dirt roads, and are thus assigned higher values). A base land "cost" of 250 was also assigned to each hex in recognition that all land has some inherent costs associated with protecting it. The resulting index had cell values ranging from 250 and 2300.

Target penalty

Each conservation target was assigned a quantitative *goal* (number of occurrences, area, or linear distance) expressed as a numeric value for each stratification unit (Appendix 9). Failure to meet the goal for a target in the resultant portfolio had a *penalty* value set at 200 points per target. For coarse-filter targets, a *minimum size* was established (e.g., at least 50,000 contiguous hectares for the Ponderosa Pine Forest and Woodland ecosystem to represent the minimum dynamic area necessary for maintaining viability and integrity). This requires SITES to find contiguous hexagons that contain sufficient area or length of each target in order to count toward the conservation goal of the target. A *boundary length modifier* of 1.0 was used to reduce fragmentation of the portfolio and increase clustering of the conservation areas. The modifier is a factor multiplied by the total perimeter of the portfolio. The model attempts to minimize this overall perimeter measure, so a higher boundary length modifier results in a more "clumped" portfolio. Selection of the boundary length modifier was done through trial and error. A modifier that is too high will force the model to bring in hexagons that may lack conservation targets, simply to increase "clumping."

SITES in operation

At the start of each SITES run, a "seed" portfolio is derived from a randomly chosen set of hexagons. Another randomly selected set of hexagons is chosen, and then compared with the first to determine which is better at meeting conservation goals for the least cost. The better portfolio is kept and the process is repeated one million times per run (the "simulated annealing" algorithm), with the whole process repeated for a total of 10 runs. If the portfolio produced by one run meets the goal for one less target than an alternative portfolio, it is assigned a penalty cost of 200 points, making its total cost higher than the alternative portfolio. By selecting the best of those ten runs, this process configures a portfolio that is most efficient in meeting conservation goals while incurring the lowest possible conservation cost.

We used the SITES algorithm in an iterative, experimental approach designed to test the algorithm's sensitivity to different input values. We ran 27 separate iterations of SITES before settling on a draft portfolio that met the greatest number of conservation goals. Appendix 6 lists

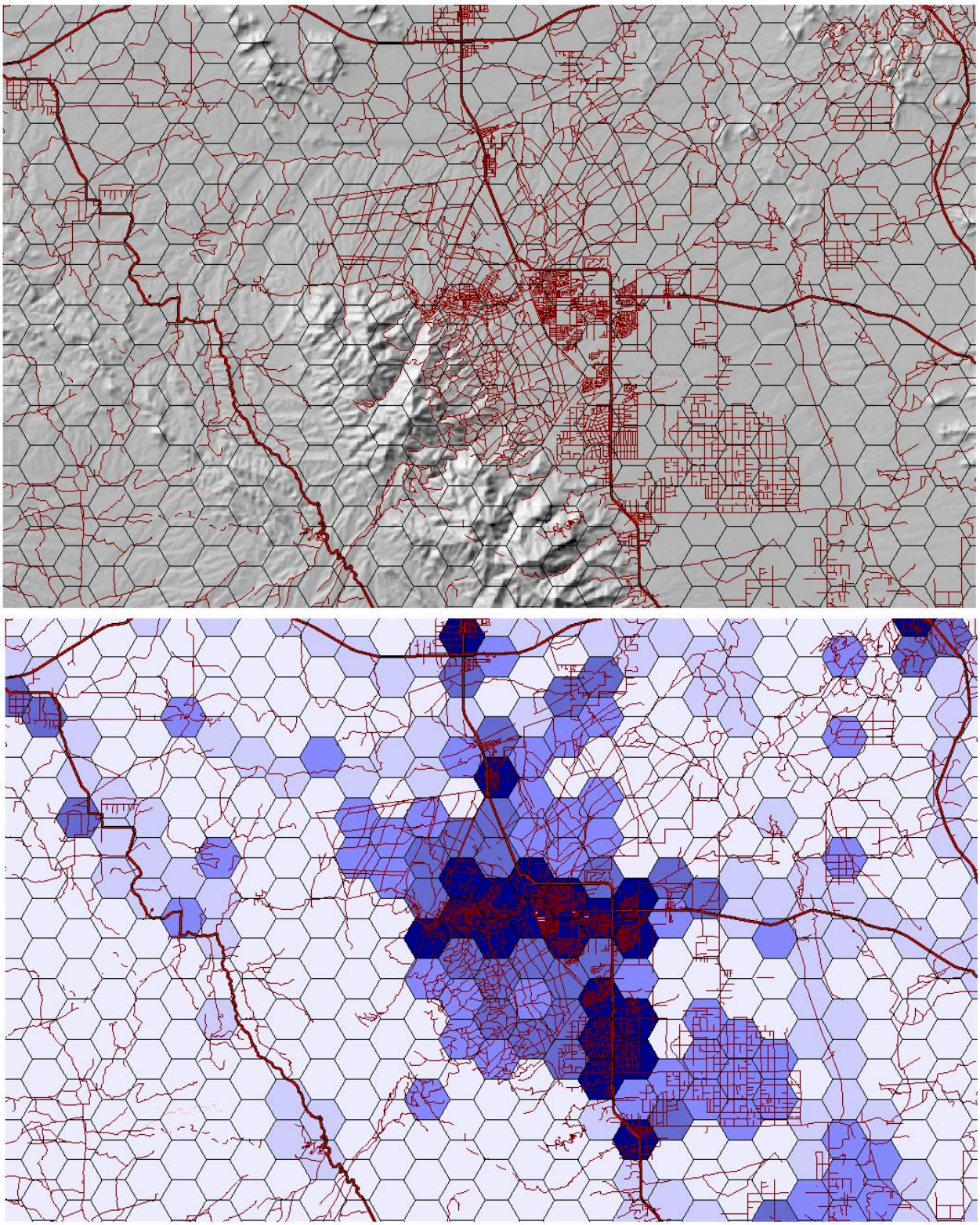


Figure 7. Cost Surface for the Sierra Vista Area.
a.) Analysis grid of 500-ha hexagons shown for vicinity of Sierra Vista and Huachuca Mountains, Arizona, with the road network and shaded topographic relief.
b.) Analysis grid for the same area shown with cost surface assigned, using weighted values for road class density and other factors. Darker cells represent a higher "cost" for protecting biodiversity.

the input values used and the major lesson learned from each iteration. The resultant portfolio was used as a draft map, subject to refinement (Chapter 7). Adjustments to area boundaries were made at the hex unit level; finer boundary modifications will be made during site conservation planning.

Conservation areas deleted or changed

In seven places, relatively small areas remained unselected by Program SITES despite being surrounded by large areas, a result of the targets present there having their goals met elsewhere; these "doughnut holes" were filled to maintain landscape connectivity.

Team examination of several large "doughnut holes" in large mountainous conservation areas within Mexico revealed a classification discrepancy between the Arizona Gap vegetation and the Mexico Forest Inventory classes for the terrestrial ecological system, Montane Mixed-Conifer. The Mexico classification had combined all conifer community types into Madrean Oak-Pine Woodland. Using the elevation break of greater than 6,000 ft (1,830 m) for the distribution of the Douglas-fir-Mixed Conifer association found in the Arizona Gap vegetation report (Halvorson et al. 2002), hexagons meeting this criteria were added in the Sierra de San Luis and the Sierra el Tigre.

More common were small areas, ≤12,355 ac (5,000 ha), selected by SITES for the presence of a single target occurrence record. These were judged on a case-by-case basis to evaluate their likely viability and whether they were critical to the survival of the species or ecological system present. A few were incorporated into larger, nearby areas, but most were eliminated as not viable for conservation action.

In a few cases, larger areas were eliminated due to considerations that couldn't be adequately modeled in SITES. For example, an area north of Oracle, Arizona, had been selected solely to protect a "B" class grassland identified during our grassland assessment. We learned later that the northern third of the area was private or state trust land with all the planning and zoning in place for an 8,500-home development. As a "B" grassland it has undergone significant shrub encroachment and would require an aggressive fire program to restore healthy grassland conditions, something unlikely to be allowed in this social context.

We also made minor changes to remaining areas, based on expert input. For example, a small area between the Galiuro and Winchester mountains was added based on advice from Arizona Game and Fish Department biologists that it serves as an important movement corridor for pronghorn.

7. Portfolio of Conservation Areas

Program SITES generated a draft portfolio of conservation areas which met most of our numeric goals, but the results needed careful review and adjustment. We incorporated expert input, analysis of species distribution maps, comparison to land parcel boundary maps, and consideration of restoration potential in considering the boundaries of each area. The draft portfolio was reviewed by biologists with Arizona Game and Fish Department and IMADES, along with several taxonomic group experts from Mexico, and revisions made based on review comments.

The resulting portfolio consists of 90 areas which encompass just over 12.5 million acres (5 million hectares), about 40% of the ecoregion (Figure 9, Table 13. Areas range in size from 1,235 to 1.9 million acres (500 to 757,500 ha), with an average of 138,967 acres (56,239 ha; Figure 8). Individual areas captured from 1 to 119 conservation targets, with an average of 17 targets (Table 14, Appendix 10).

The final conservation portfolio captured 2,118 miles (3,408 km) of perennial streams, 86% of the perennial stream length in the ecoregion. Aquatic or riparian targets occur in 69 (77%) of the conservation areas (Table 17).

We met our conservation goals for 83% of the targets, including 189 species and 12 ecological system targets (Appendix 9). We came close to meeting the goals (90% or more) for an additional 24 targets.

Major ecological gradients and variability are well represented across the portfolio of conservation areas, as shown by the high degree of representation of ecological systems and the abiotic variables that occur within each (e.g., elevation, aspect). Many areas incorporate a continuous area from valley bottom to mountaintop. If fully protected, that sort of elevational range should help buffer the conservation targets against the impacts of climate change and other unanticipated stresses.

Some of the larger areas contain continuous areas from mountain to mountain, identifying the connectivity that may be needed for wide-ranging species such as black bear.

Figure 8. Frequency distribution for the size of conservation areas.

Table 13. Conservation areas and targets. This list includes all 90 areas that were identified but the numbering runs to 91 since one area (#45) was deleted after area numbers were assigned.

Area #	Conservation Area Name	Total Conservation Targets	Proportion of Ecoregion Targets	CONSERVATION TARGETS BY TAXONOMIC GROUP							
				Ecological System	Amphibian	Bird	Fish	Invertebrate	Mammal	Reptile	Plant
1	Peacock/ Cottonwood Mountains	10	4.0%	10							
2	Hualapai Mountains	22	8.8%	10		3			9		
3	Trout Creek	11	4.4%	5	1	1	4				
4	Chino Valley	14	5.6%	7	1				5		1
5	Trout Creek/ Big Sandy River Confluence	12	4.8%	6	2		4				
6	Burro Creek Watershed	27	10.8%	10	2	4	5	1	2		3
7	NW Diamond Joe Peak	6	2.4%	4					2		
8	Cottonwood/ Smith Canyon	15	6.0%	5	1	1	4		2		2
9	Upper Verde River Watershed	65	26.0%	16	5	8	9	8	6	2	11
10	Twentynine Mile Lake	3	1.2%	1	1				1		
11	Bradshaw Mountains	9	3.6%	6		1			2		
12	Cinch Hook Butte	3	1.2%	1					1		1
13	Webber Creek	5	2.0%	1			1		2		1
14	McCloud Mountains	4	1.6%	3				1			
15	Agua Fria River/ Sycamore Mesa	28	11.2%	10	2	3	6	2	4	1	
16	Kirkland Creek/ Peeples Valley Grassland	10	4.0%	6	2		1		1		
17	Bunger Point	3	1.2%	1	1				1		
18	Canyon Creek Complex	16	6.4%	3	2	4	2		3	1	1
19	Castle Creek/Black Canyon	7	2.8%	3	2		1		1		
20	Hassayampa River/ Blind Indian Creek	11	4.4%	3	2	2	3		1		
21	Tonto Creek/ Hellsgate Wilderness	40	16.0%	14	4	5	6	1	4	2	4
22	New River Mountains	8	3.2%	5					2		1
23	Cooley Mountain	6	2.4%	4					2		
24	Deadman Creek/ Mazatzal	20	8.0%	11	1	1	5		2		
25	Camp Creek/ New River Mesa	16	6.4%	5	2	2	3		1		3
26	Salt River Watershed	45	18.0%	14	3	6	6	2	4	1	9
27	Four Peaks	10	4.0%	6	1				2		1
28	Campaign Creek/ Superstition Mountains	8	3.2%	4	1		2		1		
29	Apache Peaks	10	4.0%	6					3		1
30	Pinal Creek	5	2.0%	4							1
31	Pinto Creek/ Webster Mountain	8	3.2%	5	2			1			
32	Barge Canyon/ Superstition Mountains	3	1.2%	2							1
33	Sawtooth Ridge/ Superstition Mountains	10	4.0%	5	1	1			1		2
34	Ash Flat	23	9.2%	13	2	3	3		2		
35	Pinal Mountains	15	6.0%	7	1	2			2		3
36	Mescal Creek/ Upper Gila River	7	2.8%	5			1		1		
37	Dripping Spring Mountains	5	2.0%	3					1		1
38	Bonita Creek/ Gila Box Wilderness	15	6.0%	6		2	5		2		
39	Blue River/ Eagle Creek	43	17.2%	14	4	8	9		3	1	4
40	Santa Teresa Mountains	7	2.8%	4		1			1		1
41	Gila Mountains/ Superb Beardtongue Penstemon	4	1.6%	2					1		1
42	Blue Creek/ Lemmons Canyon	7	2.8%	4			3				
43	Aravaipa Watershed	41	16.4%	15	2	6	7	2	4		5
44	Pinaleno Mountains	35	14.0%	14	1	4	1	7	2	1	5
46	Kielberg Canyon	7	2.8%	5					1		1
47	Knight Canyon/ Thompson Canyon	2	0.8%	2							
48	Buehman Canyon/ Bingham Ciénega	10	4.0%	4	1	2	1		1		1
49	Dos Cabezas/ Pinaleno Foothills	10	4.0%	6		1			2		1
50	Pusch Ridge/ Sabino Creek	28	11.2%	9	1	3	2	3	2	1	7
51	Langford Mountains	1	0.4%	1							

Table 13 continued.

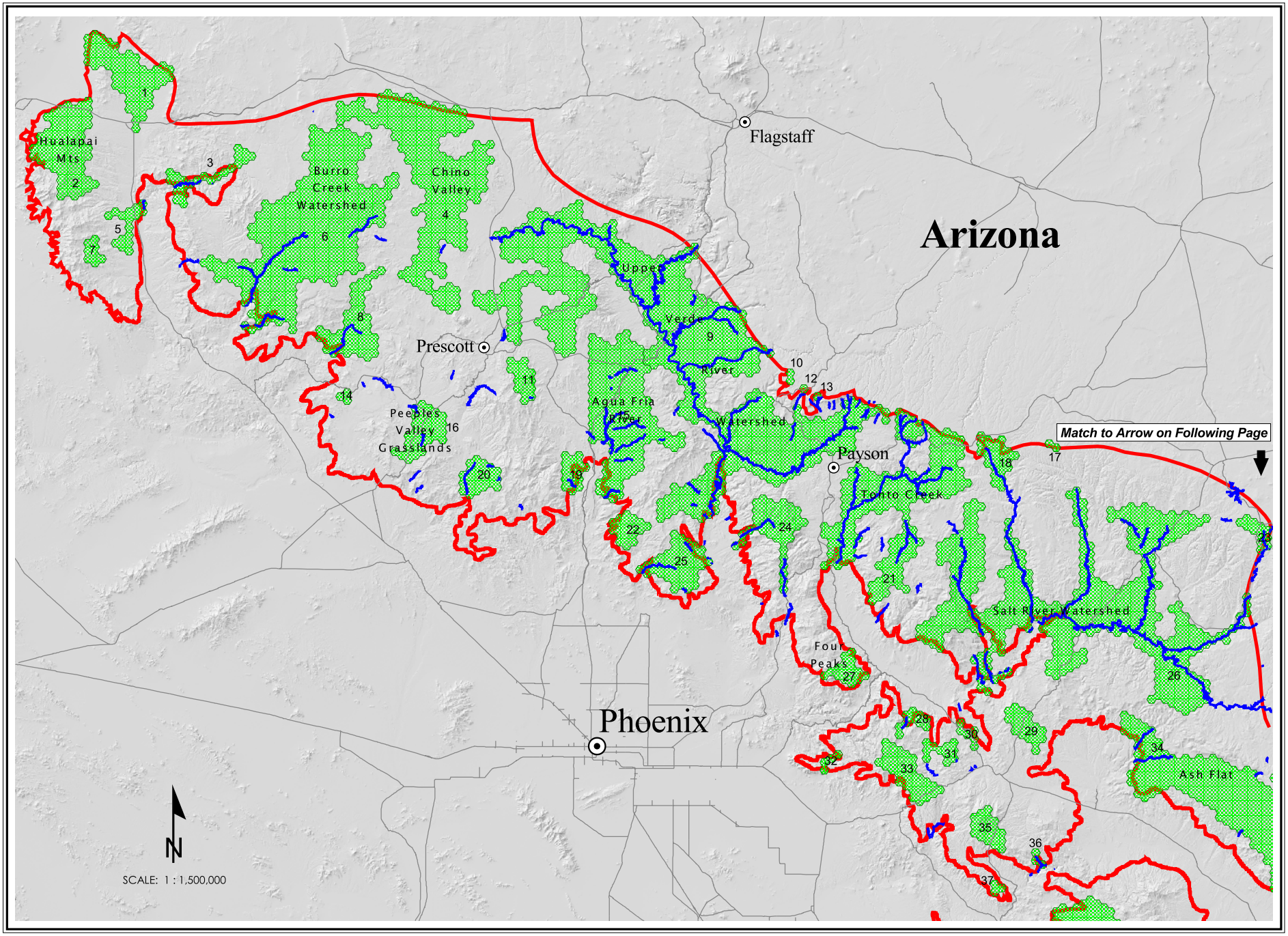
Area #	Conservation Area Name	Total Conservation Targets	Proportion of Ecoregion Targets	CONSERVATION TARGETS BY TAXONOMIC GROUP							
				Ecological System	Amphibian	Bird	Fish	Invertebrate	Mammal	Reptile	Plant
52	Peloncillo Mountains/ Lordsburg Playas and Valley	7	2.8%	4		1				1	1
53	Winchester Mountains/ Allen Flat/ Willcox Playa	53	21.2%	15	3	11	6	1	7	2	8
54	Tanque Verde Ridge	18	7.2%	7	1	1			4	1	4
55	Comobabi Wash	3	1.2%	3							
56	San Pedro River/ Little Dragoon Mountains	8	3.2%	6		1					1
57	Helmet Peak	6	2.4%	1		1		1	2		1
58	Chiricahua Mountains	62	24.8%	14	2	7	3	2	11	4	19
59	Dragoon Mountains	16	6.4%	4	1	2			4		5
60	Baboquivari Mountains	15	6.0%	6		1			1		7
61	Sierrita Mountains/ Black Hills	9	3.6%	5	1	2					1
62	San Pedro River/ Mule Mountains	25	10.0%	6	2	7	2		2	2	4
63	Altar Valley	28	11.2%	10	1	8			5	1	3
64	Big Hatchet Mountains	6	2.4%	4				2			
65	Atascosa/ Pajarito Mountains	53	21.2%	8	4	10	4	2	6	2	17
66	Huachuca Mountains Grassland Valley Complex	119	47.6%	18	7	20	8	6	13	9	38
67	Sierra San Luis/ Peloncillo Mountains	71	28.4%	15	3	15	9	3	10	7	9
68	Patagonia Mountains	12	4.8%	1		4			3	1	3
69	El Fresnal Arroyo	3	1.2%	2		1					
70	Arroyo La Ciénega	7	2.8%	4		3					
71	Sierra Cibuta/ Sierra Pinito	19	7.6%	6	3	9				1	
72	Sierra Cibuta/ Punta de Agua	2	0.8%	2							
73	Sierra Los Azules/ Arroyo Los Azules Grassland	9	3.6%	6		2			1		
74	Canon El Pulpito	5	2.0%	2	1	1			1		
75	Arroyo Bambuto/ Rio Magdalena	10	4.0%	3		2	1			2	2
76	Sierra Buenos Aires	4	1.6%	4							
77	Cerro El Picacho/ Upper Rio Sonora	20	8.0%	4		8	5			1	2
78	Sierra La Madera	5	2.0%	3	1	1					
79	Sierra Azul	6	2.4%	4		1			1		
80	Mesa Las Guacamayas/ Sierra El Palomo	4	1.6%	4							
81	Canon La Palma	4	1.6%	3							1
82	Sierra El Tigre/ Rio Bavispe	57	22.8%	10	8	16	8		6	3	6
83	Rio Fronteras	23	9.2%	7	1	7	5			2	1
84	Arroyo Agua Caliente/ Sierra Jucaral	24	9.6%	5	1	12	2			2	2
85	Sierra El Carmen	2	0.8%	2							
86	Arroyo La Sauceda/ Cerro Caloso	5	2.0%	2	3						
87	Sierra La Sandia/ Sierra La Madera	4	1.6%	4							
88	Cordon El Alamo	6	2.4%	3		3					
89	Sierra El Oso/ Sierra Verde	5	2.0%	3	1					1	
90	Sierra Aconchi	14	5.6%	3	3	5			1	1	1
91	Sierra Del Jaralito	3	1.2%	2		1					

Table 14. Comparison of conservation areas by target richness. Rare targets are those with G1 or G2 ranks. Areas are sorted by proportion of all ecoregional conservation targets present in each, then by size.

Area #	Conservation Area Name	Area Size (ha)	Rare and Endemic Targets	System Targets	Total Conservation Targets	Proportion of Ecoregion Targets	Total Target Occurrences	Proportion (%) of Area by GAP Protected Status			
								GAP 1	GAP 2	GAP 3	GAP 4
66	Huachuca Mountains Grassland Valley Complex	569,000	52	18	119	47.8%	786	1.4	5.5	26.5	66.5
67	Sierra San Luis/ Peloncillo Mountains	757,500	22	15	71	28.5%	295	0.3	2.0	29.4	68.3
9	Upper Verde River Watershed	312,000	23	16	65	26.1%	244	0.1	15.7	63.0	19.1
58	Chiricahua Mountains	107,500	22	14	62	24.9%	247	4.8	26.9	25.2	42.4
82	Sierra El Tigre/ Rio Bavispe	381,000	13	10	57	22.9%	146			15.0	83.6
65	Atascosa/ Pajarito Mountains	107,000	19	8	53	21.3%	198	1.1	2.1	59.7	37.1
53	Winchester Mountains/ Allen Flat/ Willcox Playa	203,500	11	15	53	21.3%	131	1.9	6.7	10.3	81.0
26	Salt River Watershed	230,500	15	14	45	18.1%	95		4.4	22.8	68.1
39	Blue River/ Eagle Creek	351,000	13	14	43	17.3%	119	1.8	2.6	54.2	39.0
43	Aravaipa Watershed	136,500	9	15	41	16.5%	81	1.8	5.9	21.6	62.6
21	Tonto Creek/ Hellsgate Wilderness	92,500	8	14	40	16.1%	92		13.2	81.5	1.7
44	Pinaleno Mountains	49,500	11	14	35	14.1%	98	0.4		76.9	19.7
50	Pusch Ridge/ Sabino Creek	21,000	8	9	28	11.2%	53	65.0	0.0	29.2	0.3
63	Altar Valley	56,500	4	10	28	11.2%	95	61.5		11.4	27.1
15	Agua Fria River/ Sycamore Mesa	79,000	5	10	28	11.2%	59		1.3	84.6	10.6
6	Burro Creek Watershed	158,000	5	10	27	10.8%	55		6.0	29.4	62.5
62	San Pedro River/ Mule Mountains	44,500	5	6	25	10.0%	73	35.3		14.7	50.0
84	Arroyo Agua Caliente/ Sierra Jucaral	55,000	4	5	24	9.6%	43				100.
83	Rio Fronteras	123,500	5	7	23	9.2%	32		1.2		98.8
34	Ash Flat	166,000	2	13	23	9.2%	29		0.8	3.6	91.7
2	Hualapai Mountains	38,500	0	10	22	8.8%	36		0.3	82.8	15.6
24	Deadman Creek/ Mazatzal Wilderness	22,000	4	11	20	8.0%	22		75.9	17.6	0.3
77	Cerro El Picacho/ Upper Rio Sonora	51,000	6	4	20	8.0%	22				100.
71	Sierra Cibuta/ Sierra Pinito	45,500	0	6	19	7.6%	29				100.
54	Tanque Verde Ridge	11,500	2	7	18	7.2%	26	69.2		3.5	5.0
59	Dragoon Mountains	10,500	4	4	16	6.4%	29			89.7	10.3
18	Canyon Creek Complex	12,000	1	3	16	6.4%	27			42.0	37.9
25	Camp Creek/ New River Mesa	22,000	4	5	16	6.4%	23			84.8	1.8
35	Pinal Mountains	9,500	3	7	15	6.0%	19			50.5	49.5
38	Bonita Creek/ Gila Box Wilderness	9,500	4	6	15	6.0%	21		12.9	17.4	47.2
8	Cottonwood/ Smith Canyon	24,500	5	5	15	6.0%	19			32.5	61.6
60	Baboquivari Mountains	27,500	6	6	15	6.0%	23	2.7	3.0	5.1	82.5
90	Sierra Aconchi	37,000	0	3	14	5.6%	25				97.5
4	Chino Valley	112,000	0	7	14	5.6%	22		0.6	18.0	77.8
68	Patagonia Mountains	5,500	5	1	12	4.8%	19			91.0	9.0
5	Trout Creek/ Big Sandy River Confluence	8,000	3	6	12	4.8%	13			47.3	44.2
3	Trout Creek	11,500	3	5	11	4.4%	12				62.4
20	Hassayampa River/ Blind Indian Creek	11,500	1	3	11	4.4%	13		0.9	77.6	21.5
27	Four Peaks	8,000	2	6	10	4.0%	12	70.1	15.8	3.0	
75	Arroyo Bambuto/ Rio Magdalena	9,500	4	3	10	4.0%	12				90.5
29	Apache Peaks	10,000	1	6	10	4.0%	10			59.4	40.6
16	Kirkland Creek/ Peeples Valley Grassland	16,500	1	6	10	4.0%	11			4.9	95.1
33	Sawtooth Ridge/ Superstition Mountains	17,500	2	5	10	4.0%	24		51.3	42.3	3.1
48	Buehman Canyon/ Bingham Ciénega	24,500	2	4	10	4.0%	11	1.5		28.3	57.7
49	Dos Cabezas/ Pinaleno Foothills	27,500	1	6	10	4.0%	10			20.6	79.4
1	Peacock/ Cottonwood Mountains	33,000	0	10	10	4.0%	10			13.2	78.5
11	Bradshaw Mountains	8,000	1	6	9	3.6%	9			92.6	7.4
61	Sierrita Mountains/ Black Hills	20,500	1	5	9	3.6%	14			1.0	99.0

Table 14 continued.

Area #	Conservation Area Name	Area Size (ha)	Rare and Endemic Targets	System Targets	Total Conservation Targets	Proportion of Ecoregion Targets	Total Target Occurrences	Proportion (%) of Area by GAP Protected Status			
								GAP 1	GAP 2	GAP 3	GAP 4
73	Sierra Los Azules/ Arroyo Los Azules Grassland	37,000	1	6	9	3.6%	14				100.
28	Campaign Creek/ Superstition Mountains	5,000	1	4	8	3.2%	10		25.8	43.9	0.1
31	Pinto Creek/ Webster Mountain	5,500	0	5	8	3.2%	10			92.3	6.0
22	New River Mountains	9,000	1	5	8	3.2%	28			93.4	0.1
56	San Pedro River/ Little Dragoon Mountains	13,500	0	6	8	3.2%	10			1.1	98.9
40	Santa Teresa Mountains	1,500	1	4	7	2.8%	7		67.3	15.8	16.9
36	Mescal Creek/ Upper Gila River	1,500	0	5	7	2.8%	7		8.7	18.8	32.8
70	Arroyo La Ciénega	2,000	0	4	7	2.8%	8				90.9
46	Kielberg Canyon	3,500	1	5	7	2.8%	7		57.2	0.0	40.1
42	Blue Creek/ Lemmons Canyon	5,000	2	4	7	2.8%	7			1.9	95.9
19	Castle Creek/Black Canyon	8,000	0	3	7	2.8%	9		0.0	72.3	1.3
52	Peloncillo Mountains/ Lordsburg Playas and Valley	73,500	1	4	7	2.8%	12		3.4	45.9	50.8
57	Helmet Peak	2,000	2	1	6	2.4%	7			18.4	80.0
88	Cordon El Alamo	3,500	0	3	6	2.4%	7			17.0	83.0
7	NW Diamond Joe Peak	4,000	0	4	6	2.4%	6			92.1	7.9
23	Cooley Mountain	6,000	1	4	6	2.4%	8				83.5
64	Big Hatchet Mountains	10,500	2	4	6	2.4%	7		32.1	36.0	31.9
79	Sierra Azul	32,500	0	4	6	2.4%	7				100.
13	Webber Creek	500	1	1	5	2.0%	5			84.1	
37	Dripping Spring Mountains	1,500	1	3	5	2.0%	5			81.3	12.0
30	Pinal Creek	3,000	1	4	5	2.0%	10			63.6	18.1
74	Canon El Pulpito	5,500	1	2	5	2.0%	8				100.
86	Arroyo La Sauceda/ Cerro Caloso	9,000	0	2	5	2.0%	6			73.5	26.5
78	Sierra La Madera	10,500	0	3	5	2.0%	6				100.
89	Sierra El Oso/ Sierra Verde	24,000	1	3	5	2.0%	5				100.
41	Gila Mountains/ Superb Beardtongue Penstemon	500	2	2	4	1.6%	4			51.9	48.1
14	McCloud Mountains	1,500	0	3	4	1.6%	4				100.
76	Sierra Buenos Aires	4,500	0	4	4	1.6%	4		20.1		79.9
81	Canon La Palma	8,000	1	3	4	1.6%	7				92.2
80	Mesa Las Guacamayas/ Sierra El Palomo	18,500	0	4	4	1.6%	4				86.0
87	Sierra La Sandia/ Sierra La Madera	19,000	0	4	4	1.6%	4			56.6	43.4
12	Cinch Hook Butte	500	1	1	3	1.2%	3			32.2	
10	Twentynine Mile Lake	1,000	0	1	3	1.2%	4			1.3	
17	Bunger Point	1,000	0	1	3	1.2%	4			27.6	5.0
32	Barge Canyon/ Superstition Mountains	2,000	1	2	3	1.2%	5		63.8		
69	El Fresnal Arroyo	4,000	0	2	3	1.2%	3				75.4
91	Sierra Del Jaralito	4,500	0	2	3	1.2%	3				91.2
55	Comobabi Wash	7,500	0	3	3	1.2%	3				89.7
72	Sierra Cibuta/ Punta de Agua	7,000	0	2	2	0.8%	2				100.
85	Sierra El Carmen	25,000	0	2	2	0.8%	2				100.
47	Knight Canyon/ Thompson Canyon	25,500	0	2	2	0.8%	2			40.4	52.5
51	Langford Mountains	8,500	0	1	1	0.4%	1			3.8	88.7


Arizona
Flagstaff
Prescott
Phoenix
Payson
Hualapai Mts
Burro Creek Watershed
Chino Valley
Upper Verde River
Agua Fria River
Peebles Valley Grasslands
Tonto Creek
Salt River Watershed
Four Peaks
Ash Flat
Match to Arrow on Following Page
N
SCALE: 1 : 1,500,000

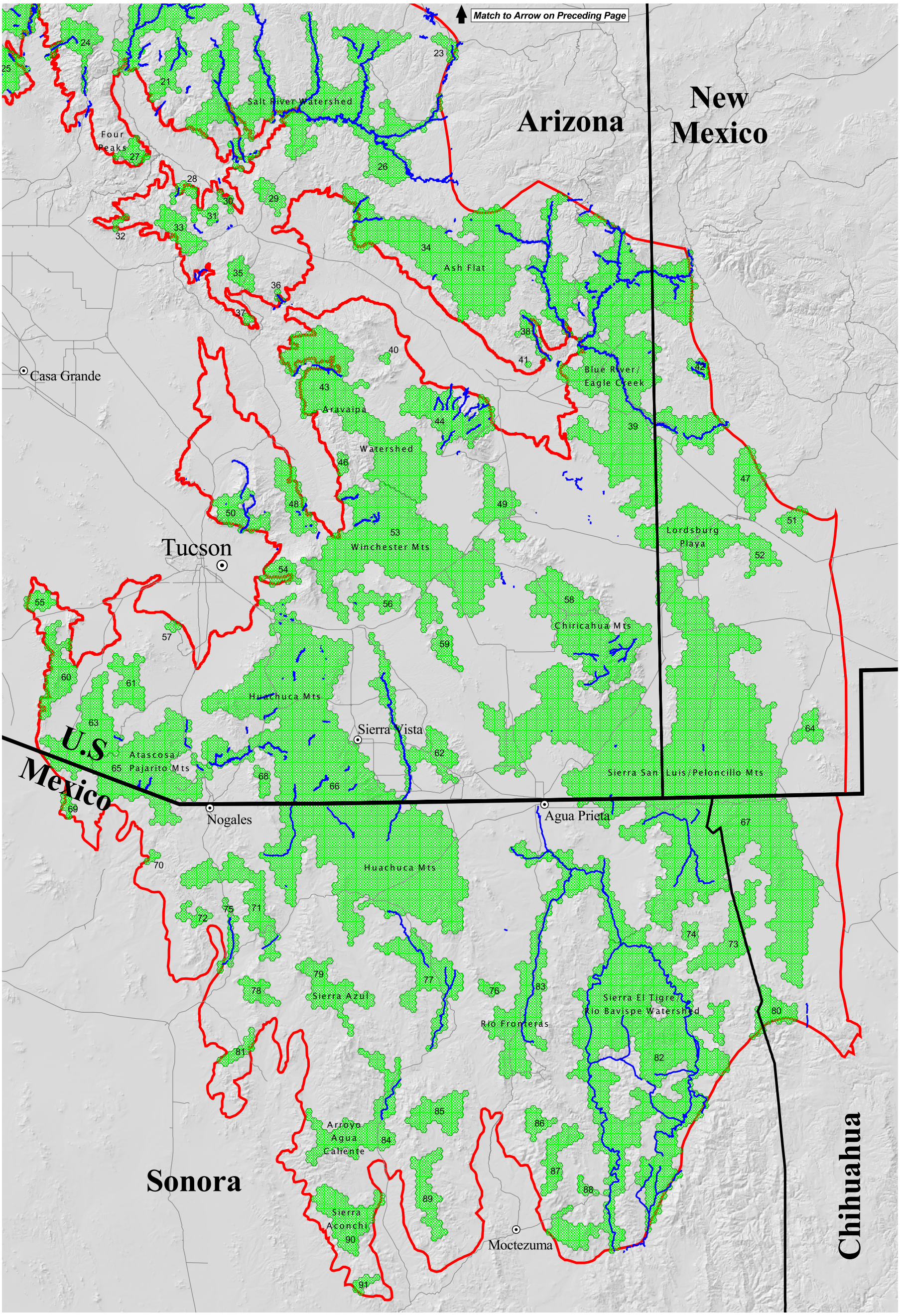


Figure 9.
Conservation Areas
in the
Apache Highlands Ecoregion

Apache Highlands
Conservation Area & ID
Perennial Stream
Major Road
N
25 kms
25 miles
SCALE: 1 : 1,500,000

Portfolio analyses

We conducted a variety of analyses on the portfolio after the fact, using spatial data that were difficult to integrate into the SITES algorithm. Most of those data sets were only available for Arizona. These included maps of population densities for several wildlife game species, Breeding Bird Atlas survey blocks which contained some bird species, and designated Critical Habitat for some species protected under the Endangered Species Act (Appendix 7).

The portfolio captured 95-100% of Critical Habitat for 10 of the 11 species for which that has been designated under the Endangered Species Act. It only captured 64% of Critical Habitat for the Mexican spotted owl, missing portions of Saguaro National Park but also capturing large areas of occupied spotted owl habitat which did not receive official protection. It captured 33% of the first draft Critical Habitat for Cactus ferruginous pygmy owl, a species more thoroughly captured in the adjacent Sonoran Desert ecoregion (a second draft of Critical Habitat was published shortly before this document was completed and was not analyzed).

One goal of this ecoregional assessment was to design an interconnected network of landscapes and waterscapes that represent all major environmental gradients. This approach aids in conserving ecological processes and species habitats within their natural range of variability. Conserving environmental variability and gradients provides a buffer against a changing environment, either through changes in climate, or through other agents. When evaluating an ecoregional portfolio, we need to ask, "*Does this set of conservation areas represent the ecoregion as a whole?*"

To address this goal, we used a biophysical model of the Apache Highlands ecoregion as a tool to represent the natural variability of terrestrial and freshwater ecological systems (Chapter 5, Appendix 4). This model coupled with mapped information of conservation targets enabled us to determine if the portfolio captured environmental gradients throughout the draft network of conservation areas. We found the portfolio captured all "ecological land units" derived through the biophysical model.

We compared the portfolio against private property parcel boundaries in the two Arizona counties (Pima and Yavapai) for which those boundaries were available digitally. We then modified or deleted several conservation areas due to extensive subdivision in those areas which would make conservation work difficult or impossible.

Land management and ownership

Reflecting the overall land management pattern in the U.S. portion of the ecoregion, the majority of conservation areas identified in Arizona and New Mexico are lands managed by federal or state public agencies (Table 15). In Mexico, private land and communal ejido property comprise most of the areas.

Most of The Nature Conservancy's existing Arizona preserves fall within the Apache Highlands, so it was interesting to note that all the preserves and 97% of the preserve area within the ecoregion fell within conservation areas (Appendix 7), even though nothing in the input data or post-hoc adjustments biased that selection. The area for preserves shown in Table 15 does not include federal lands cooperatively managed by The Nature Conservancy.

Table 15. Land management status summary for conservation areas.

Land Manager/Owner	Total Conservation Areas Managed	Acres within Conservation Areas	Hectares within Conservation Areas
Mexico Private or Ejido	27	3,466,859	1,403,038
U.S. Forest Service	42	2,935,528	1,188,008
U.S. Private Land	59	2,007,868	812,584
U.S. State Trust Land	39	1,666,311	674,356
U.S. Bureau of Land Management	37	1,032,086	417,685
U.S. Tribal Land	16	953,545	385,900
Mexico Protected Areas	7	219,897	88,992
U.S. Fish & Wildlife Service	3	87,881	35,565
U.S. Military	3	68,491	27,718
U.S. National Park Service	7	44,303	17,929
The Nature Conservancy	7	17,008	6,883
AZ Game & Fish Department	6	3,801	1,538
U.S. State Parks	2	2,891	1,170
Other	4	721	292
Total		**12,507,188**	**5,061,659**

Setting priorities

The portfolio of conservation areas represents a hypothetical minimum area which, if managed well, would maintain the native biodiversity of the ecoregion through the next century. Acknowledging that, we recognize that practical constraints dictate some setting of priorities for conservation action among the various areas.

The two most common criteria for setting priorities are relative measures of biodiversity present and relative levels of threat (Groves 2003).

One approach to assess biodiversity value is a comparison of target richness within the areas. In Table 14, we sorted conservation areas by the number of targets contained in each, then by conservation area size, on the principles that more targets are better than fewer, and a smaller area is better than a larger one with the same number of targets. This comparison has an obvious bias toward larger areas, given that larger areas typically contain more species (Wilcox 1980), but the correlation is fairly loose. In the most noticeable anomaly, the largest area has only 61% of the targets and 38% of the target occurrences of the second-largest area. A less-obvious but more troublesome bias stems from the inconsistent biological knowledge between the U.S. and Mexico. While we attempted to select targets and gather locality data that would minimize the difference, there clearly has been far less study in Mexico of species, communities, and their distribution, which constrained our knowledge of appropriate targets there.

Another measure of priorities is whether a particular conservation area contains species found in few or no other places. To determine this, we calculated an index to the biological uniqueness or "irreplaceability" of an area in the portfolio (Pressey et al. 1994). For each conservation target, we determined the number of conservation areas in which it occurs, then calculated the inverse of that number to represent the importance of a particular area. Thus, a target that occurs at 20 areas would have an index value of 1/20, since protecting any of those 20 areas would protect an occurrence of the target. Targets captured at fewer areas would have higher index values (e.g., 1/2 is larger than 1/20), thus giving them greater weight. We then added those index values for all targets present in a given conservation area:

Index = 1/(count of areas with target *a*) + 1/(count of areas with target *b*) + 1/(count of areas with target *c*). . . for all targets at a given area.

The resulting score compares the difficulty of protecting the conservation targets in that area by substituting another area in the portfolio if the first area is lost or compromised. This was calculated twice: first using all conservation targets (Table 16) and then using only aquatic and riparian targets (Table 17). Once again, this analysis is biased by lack of information from Mexico, but it provides an important measure of the critical places to protect first.

As described in Chapter 8, we also compared the areas by their GAP protected status as one measure of the level of threats they face. Since most have little or no land in the highest protective status – GAP 1 or 2 – this comparison serves primarily as a filter for the few places that are already largely protected.

Particular threats are discussed in Chapter 9.

Table 16. Prioritization index for conservation areas. All conservation areas are sorted by an index of irreplaceability and then by total targets present.

Priority Order	Conservation Area Name	Index	Total Conservation Targets	Area #	Subdivision
1	Huachuca Mountains Grassland Valley Complex	38.75	119	66	Central/Southern
2	Sierra San Luis/ Peloncillo Mountains	20.00	71	67	Central/Southern
3	Chiricahua Mountains	19.77	62	58	Central
4	Upper Verde River Watershed	16.32	65	9	Northern
5	Pinaleno Mountains	13.65	35	44	Central
6	Sierra El Tigre/ Rio Bavispe Watershed	11.28	57	82	Southern
7	Atascosa/ Pajarito Mountains	9.96	53	65	Central/Southern
8	Salt River Watershed	7.97	45	26	Northern
9	Winchester Mountains/ Allen Flat/ Willcox Playa	6.94	53	53	Central
10	Pusch Ridge/ Sabino Creek	6.49	28	50	Central
11	Blue River/ Eagle Creek	5.94	43	39	Central/Northern
12	Aravaipa Watershed	4.97	41	43	Central
13	Altar Valley	4.47	28	63	Central/Southern
14	Baboquivari Mountains	3.43	15	60	Central
15	Burro Creek Watershed	3.22	27	6	Northern
16	Tonto Creek/ Hellsgate Wilderness	3.20	40	21	Northern
17	Cerro El Picacho/ Upper Rio Sonora	3.20	20	77	Southern
18	San Pedro River/ Mule Mountains	3.09	25	62	Central
19	Agua Fria River/ Sycamore Mesa	3.06	28	15	Northern
20	Hualapai Mountains	2.92	22	2	Northern
21	Rio Fronteras	2.70	23	83	Southern
22	Arroyo Agua Caliente/ Sierra Jucaral	2.61	24	84	Southern
23	Camp Creek/ New River Mesa	2.37	16	25	Northern
24	Chino Valley	2.33	14	4	Northern
25	Canyon Creek Complex	2.28	16	18	Northern
26	Big Hatchet Mountains	2.13	6	64	Central
27	Patagonia Mountains	2.11	12	68	Central
28	Arroyo Bambuto/ Rio Magdalena	1.75	10	75	Southern
29	Tanque Verde Ridge	1.73	18	54	Central
30	Dragoon Mountains	1.73	16	59	Central
31	Helmet Peak	1.62	6	57	Central
32	Sierra Cibuta/ Sierra Pinito	1.59	19	71	Southern
33	Cottonwood/ Smith Canyon	1.58	15	8	Northern
34	Pinal Mountains	1.56	15	35	Northern
35	Sierra Aconchi	1.56	14	90	Southern
36	Ash Flat	1.11	23	34	Northern
37	Peloncillo Mountains/ Lordsburg Playas and Valley	1.07	7	52	Central
38	Canon La Palma	1.06	4	81	Southern
39	Barge Canyon/ Superstition Mountains	1.04	3	32	Northern
40	Sierra Los Azules/ Arroyo Los Azules Grassland	0.90	9	73	Southern
41	Deadman Creek/ Mazatzal Wilderness	0.89	20	24	Northern
42	Cordon El Alamo	0.87	6	88	Southern
43	Sawtooth Ridge/ Superstition Mountains	0.79	10	33	Northern
44	Trout Creek/ Big Sandy River Confluence	0.78	12	5	Northern
45	Sierra El Oso/ Sierra Verde	0.78	5	89	Southern

Priority Order	Conservation Area Name	Index	Total Conservation Targets	Area #	Subdivision
46	Canon El Pulpito	0.75	5	74	Southern
47	Dos Cabezas/ Pinaleno Foothills	0.72	10	49	Central
48	Bonita Creek/ Gila Box Wilderness	0.70	15	38	Northern
49	Sierrita Mountains/ Black Hills	0.68	9	61	Central
50	Peacock/ Cottonwood Mountains	0.67	10	1	Northern
51	Apache Peaks	0.63	10	29	Northern
52	Cinch Hook Butte	0.57	3	12	Northern
53	NW Diamond Joe Peak	0.53	6	7	Northern
54	Buehman Canyon/ Bingham Ciénega	0.51	10	48	Central
55	Hassayampa River/ Blind Indian Creek	0.50	11	20	Northern
56	Four Peaks	0.50	10	27	Northern
57	San Pedro River/ Little Dragoon Mountains	0.50	8	56	Central
58	New River Mountains	0.48	8	22	Northern
59	Trout Creek	0.45	11	3	Northern
60	Kirkland Creek/ Peeples Valley Grassland	0.44	10	16	Northern
61	Santa Teresa Mountains	0.42	7	40	Central
62	Pinto Creek/ Webster Mountain	0.41	8	31	Northern
63	Arroyo La Ciénega	0.41	7	70	Southern
64	Kielberg Canyon	0.39	7	46	Central
65	Bradshaw Mountains	0.35	9	11	Northern
66	Webber Creek	0.32	5	13	Northern
67	Campaign Creek/ Superstition Mountains	0.30	8	28	Northern
68	Mescal Creek/ Upper Gila River	0.30	7	36	Northern
69	Castle Creek/Black Canyon	0.30	7	19	Northern
70	Blue Creek/ Lemmons Canyon	0.29	7	42	Northern
71	Arroyo La Sauceda/ Cerro Caloso	0.29	5	86	Southern
72	Pinal Creek	0.28	5	30	Northern
73	Sierra La Madera	0.27	5	78	Southern
74	Twentynine Mile Lake	0.27	3	10	Northern
75	Sierra Del Jaralito	0.26	3	91	Southern
76	Cooley Mountain	0.24	6	23	Northern
77	Gila Mountains/ Superb Beardtongue Penstemon	0.23	4	41	Northern
78	Dripping Spring Mountains	0.22	5	37	Northern
79	Sierra La Sandia/ Sierra La Madera	0.21	4	87	Southern
80	McCloud Mountains	0.19	4	14	Northern
81	Bunger Point	0.17	3	17	Northern
82	Sierra Azul	0.16	6	79	Southern
83	Sierra Buenos Aires	0.12	4	76	Southern
84	El Fresnal Arroyo	0.11	3	69	Southern
85	Mesa Las Guacamayas/ Sierra El Palomo	0.09	4	80	Southern
86	Knight Canyon/ Thompson Canyon	0.08	2	47	Central
87	Comobabi Wash	0.06	3	55	Central
88	Langford Mountains	0.06	1	51	Central
89	Sierra Cibuta/ Punta de Agua	0.04	2	72	Southern
90	Sierra El Carmen	0.04	2	85	Southern

Table 17. Prioritization index for conservation areas with aquatic systems. Conservation areas containing aquatic or riparian conservation targets are sorted by priority index and then by total aquatic or riparian targets.

Aquatic Priority Order	Conservation Area Name	Index	Total Aquatic or Riparian Conservation Targets	Area #	Subdivision
1	Huachuca Mountains Grassland Valley Complex	11.55	40	66	Central/Southern
2	Upper Verde River Watershed	9.07	34	9	Northern
3	Sierra San Luis/ Peloncillo Mountains	4.88	26	67	Central/Southern
4	Sierra El Tigre/ Rio Bavispe Watershed	4.64	25	82	Southern
5	Chiricahua Mountains	3.77	17	58	Central
6	Winchester Mountains/ Allen Flat/ Willcox Playa	3.58	23	53	Central
7	Aravaipa Watershed	3.49	21	43	Central
8	Pusch Ridge/ Sabino Creek	3.38	12	50	Central
9	Salt River Watershed	2.77	19	26	Northern
10	Agua Fria River/ Sycamore Mesa	2.36	16	15	Northern
11	Blue River/ Eagle Creek	2.22	21	39	Central/Northern
12	Atascosa/ Pajarito Mountains	1.81	16	65	Central/Southern
13	Cerro El Picacho/ Upper Rio Sonora	1.56	8	77	Southern
14	Pinaleno Mountains	1.51	8	44	Central
15	Rio Fronteras	1.44	10	83	Southern
16	Arroyo Agua Caliente/ Sierra Jucaral	1.30	12	84	Southern
17	Tonto Creek/ Hellsgate Wilderness	1.26	17	21	Northern
18	Sierra Cibuta/ Sierra Pinito	1.01	9	71	Southern
19	Arroyo Bambuto/ Rio Magdalena	0.94	5	75	Southern
20	San Pedro River/ Mule Mountains	0.93	12	62	Central
21	Altar Valley	0.90	8	63	Central/Southern
22	Canyon Creek Complex	0.73	8	18	Northern
23	Burro Creek Watershed	0.70	12	6	Northern
24	Sierra Aconchi	0.58	4	90	Southern
25	Ash Flat	0.54	10	34	Northern
26	Deadman Creek/ Mazatzal Wilderness	0.53	9	24	Northern
27	Bonita Creek/ Gila Box Wilderness	0.51	9	38	Northern
28	Camp Creek/ New River Mesa	0.45	7	25	Northern
29	Buehman Canyon/ Bingham Ciénega	0.44	7	48	Central
30	Trout Creek	0.38	8	3	Northern
31	Hassayampa River/ Blind Indian Creek	0.37	7	20	Northern
32	Cottonwood/ Smith Canyon	0.32	6	8	Northern
33	Trout Creek/ Big Sandy River Confluence	0.30	6	5	Northern
34	Dragoon Mountains	0.29	3	59	Central
35	Pinto Creek/ Webster Mountain	0.26	4	31	Northern
36	Arroyo La Sauceda/ Cerro Caloso	0.26	3	86	Southern
37	Kielberg Canyon	0.25	1	46	Central
38	Mescal Creek/ Upper Gila River	0.22	3	36	Northern
39	Canon El Pulpito	0.21	2	74	Southern
40	Sierra Los Azules/ Arroyo Los Azules Grassland	0.21	2	73	Southern
41	Campaign Creek/ Superstition Mountains	0.21	4	28	Northern
42	Webber Creek	0.19	2	13	Northern
43	Tanque Verde Ridge	0.18	3	54	Central
44	Peacock/ Cottonwood Mountains	0.18	3	1	Northern
45	Sierra La Madera	0.17	1	78	Southern

Aquatic Priority Order	Conservation Area Name	Index	Total Aquatic or Riparian Conservation Targets	Area #	Subdivision
46	Blue Creek/ Lemmons Canyon	0.16	3	42	Northern
47	Arroyo La Ciénega	0.15	2	70	Southern
48	Castle Creek/Black Canyon	0.14	2	19	Northern
49	McCloud Mountains	0.13	1	14	Northern
50	Baboquivari Mountains	0.13	1	60	Central
51	Hualapai Mountains	0.12	3	2	Northern
52	Peloncillo Mountains/ Lordsburg Playas and Valley	0.11	1	52	Central
53	Cordon El Alamo	0.10	2	88	Southern
54	Bunger Point	0.10	1	17	Northern
55	Sierra El Oso/ Sierra Verde	0.10	1	89	Southern
56	Sierra Del Jaralito	0.10	1	91	Southern
57	Kirkland Creek/ Peeples Valley Grassland	0.10	3	16	Northern
58	Cooley Mountain	0.09	2	23	Northern
59	Sierrita Mountains/ Black Hills	0.09	2	61	Central
60	Pinal Mountains	0.08	2	35	Northern
61	Four Peaks	0.08	2	27	Northern
62	Sawtooth Ridge/ Superstition Mountains	0.07	2	33	Northern
63	Chino Valley	0.07	2	4	Northern
64	New River Mountains	0.07	2	22	Northern
65	Patagonia Mountains	0.05	1	68	Central
66	Sierra Buenos Aires	0.05	1	76	Southern
67	Bradshaw Mountains	0.04	1	11	Northern
68	NW Diamond Joe Peak	0.03	1	7	Northern
69	San Pedro River/ Little Dragoon Mountains	0.03	1	56	Central

8. Protected Areas Assessment

Land management in the Apache Highlands forms a patchwork with varying levels of commitment to biodiversity conservation. We conducted a Gap analysis of land stewardship to highlight critical areas that lack legally binding protection (Weinstein 2002b).

The National Gap Analysis Program (GAP) developed a ranking scheme to indicate the level of commitment to management for biodiversity protection for a land unit. A GAP status rank is assigned based on four main criteria: a) the permanence of protection from conversion of natural land cover to unnatural cover, b) the relative amount of the land unit managed for natural cover, c) the inclusiveness of the management (single species or whole system focus) and d) the degree to which management allows the maintenance (or mimicking) of natural ecological processes (Crist et al. 2000).

The GAP method of assigning management status ranks is not entirely clear about how each of the four criteria listed above contribute to a rank, making some rank assignments subjective and difficult to repeat. In an attempt to remedy this deficiency and address some ecoregion-specific land uses, a slightly modified version of the GAP ranking scheme was adopted and applied to the Apache Highlands Ecoregion. It was developed by evaluating the criteria used in Gap analyses done at different scales: nationally, state-wide in Arizona, and for Pima County, Arizona (Crist et al. 2000, Halvorson et al. 2002, RECON 2001). We attempted to clarify all uncertainties and inconsistencies in ranking strategies, and to develop a ranking scheme that was clear and detailed from the outset, in order to create a ranking method as repeatable and objective as possible (Table 18).

We made two primary changes to the national GAP ranking scheme. Gap status 2 was split into subgroups as defined by different levels of unnatural land cover and degrading activities. We also added a new status, Gap 5, to distinguish those unprotected lands (Gap 4) from those with unknown levels of protection (Gap 5). The national GAP combined those two categories, but that would have meant assigning a Gap 4 status to Native American lands which comprise more than 2.5 million acres (1.0 million ha) in the Apache Highlands Ecoregion, since we have essentially no information about their protected status.

An additional change, which did not directly affect GAP status, was to characterize each land unit by the degree to which protection was binding. Information on the permanence of protection is useful as it shows potential opportunities to increase protective management as natural resource management plans are revised.

To develop an accurate land management spatial layer, we updated and refined the boundaries of Arizona (ALRIS) and New Mexico (RGIS) base layers with 57 additional GIS layers received from land managing agencies, incorporating changes like new national monuments and wilderness areas. We also digitized some boundaries of Arizona State Parks and private lands derived from legal descriptions and hard copy maps. Gap ranks were assigned to 209 land units in the ecoregion based on information from numerous management plans and interviews with 27 land managers and other experts. An important component of our analysis was including all known private lands in the ecoregion with legally binding protection, such as conservation easements and Habitat Conservation Plans. This incorporated 43 parcels representing 344,865 acres (139,567 ha) that were classified as a higher protected status than other private lands.

Table 18. Criteria used to assign Gap status ranks for the Apache Highlands Ecoregion. Bold cells within a row indicate the characteristics that define the Gap status ranking and distinguish it from a more protected status.

GAP status	Permanent protection of natural land cover[1]	Relative amount of land managed for natural cover	Inclusiveness of management	Management of natural processes/ disturbance	Management activities that may degrade land	Other comments
1	Protected legally; institutionally binding	**<5% is unnatural/ anthropogenic**	**Biodiversity**	Allows and/or mimics natural disturbance	May be subject to/contain heavy visitation, trails, visitor centers, military activity on <5% of the tract	Invasive species management will be noted, but will not influence GAP status ranking because of difficulties in addressing this threat
2a	Protected legally; institutionally binding	<5% is unnatural/ anthropogenic	**Selected species**	Natural processes suppressed	May be subject to/contain heavy visitation, trails, visitor centers, military activity on <5% of the tract	May include retired grazing allotments
2b	Protected legally; institutionally binding	**>5% is unnatural/ anthropogenic**	Selected species	Natural processes suppressed	**May include low-level anthropogenic disturbance such as grazing, logging or recreation**	Low-level grazing is defined by adhering to BLM's revised grazing regulations and/or seasonal grazing
3	Protected legally; institutionally binding	>5% is unnatural/ anthropogenic	Selected species	Natural processes suppressed	**May include disturbances that are broad, low level** (e.g. logging, grazing) or local and intense (e.g. mining, bombing, residential development)	Anthropogenic disturbances are greater in this ranking than in status 2b.
4	**No management plan or no legally-binding protection conferred**				**Allows intensive use and conversion to anthropogenic cover throughout the land tract**	e.g. Most State Trust lands
5	**Unknown**					Includes some Tribal lands and private parcels

[1] Where land units have legal protection or a binding management plan (all Gap Ranks except 4 and 5), legal protection is subcategorized as follows: (1) Legally binding according to Mission Statement or Organic Act or (2) Binding according to a periodically revised management plan. The subcategorization does not directly affect Gap Ranks.

The analysis revealed that 59% of the ecoregion permits intensive land uses and lacks mandates preventing the conversion of native vegetation cover by anthropogenic uses (Gap status 4; Table 19, Figure 10). We found 96% (9 million acres, 3.6 million ha) of the Mexican portion of the ecoregion is in Gap 4, although more than half of this area (5,461,373 acres; 2,210,218 ha) has been declared a priority for conservation by branches of the Sonoran state and Mexican federal governments but is not legally protected by a presidential decree. Only 1% of the ecoregion achieves Gap 1, the highest level of protection of biodiversity, characterized by a legally-binding management plan, 95% of the land unit protected from disturbances that alter natural cover types, and management that is inclusive of all biodiversity elements and natural ecological processes. The majority of land units in Gap 1 are small, disjunct parcels, with a mean size of 2,049 acres (829 ha).

Table 19. Land area in each Gap status.

Gap Rank	Acres	Hectares	% of ecoregion	Number of land units
1	319,599	129,342	1%	155
2a	20,696	8,376	0%	5
2b	1,185,242	479,667	4%	77
3	8,173,255	3,307,716	27%	151
4	17,793,939	7,201,207	59%	324
5	2,542,084	1,028,781	8%	30
Total	30,034,814	12,155,089	100%	742

Livestock grazing is a particularly important activity that affects the protected status of land in the ecoregion. While not an automatic disqualifier from high protected status, we required evidence of grazing management plans with high standards and range condition assessments showing good conditions. For example, of the 974,922 acres (394,551 ha) that are designated wilderness and managed by the USFS and BLM, only 5% are in Gap 1. The remaining wilderness areas are subject to livestock grazing and there were insufficient data to demonstrate that at least 95% of the natural cover of these areas was maintained under the current grazing management practices—a requirement in order to achieve Gap 1 status. With additional information on range condition and trend, or improvement in range management where necessary, the grazed wilderness areas could attain Gap 1 Status, increasing the area of land in Gap 1 by over 50%, and doubling the size of the largest parcel currently in this protection category.

We attempted to address this issue by gathering monitoring data from management agencies. We contacted 25 agency staff requesting data on the approximately 1,572 grazing allotments in the ecoregion. About 58% of the allotments had no data available, including none for state or private lands. Most of the available data were old, with at least 78% gathered before 1990. Only 19% of the reports described the monitoring methods used, and 81% of those relied on qualitative judgements. The quantitative methods used were inconsistent between and within agencies, making it hard to compare results. As a result, we concluded that the existing data do not meet an information standard that warrants changing the Gap status of any area.

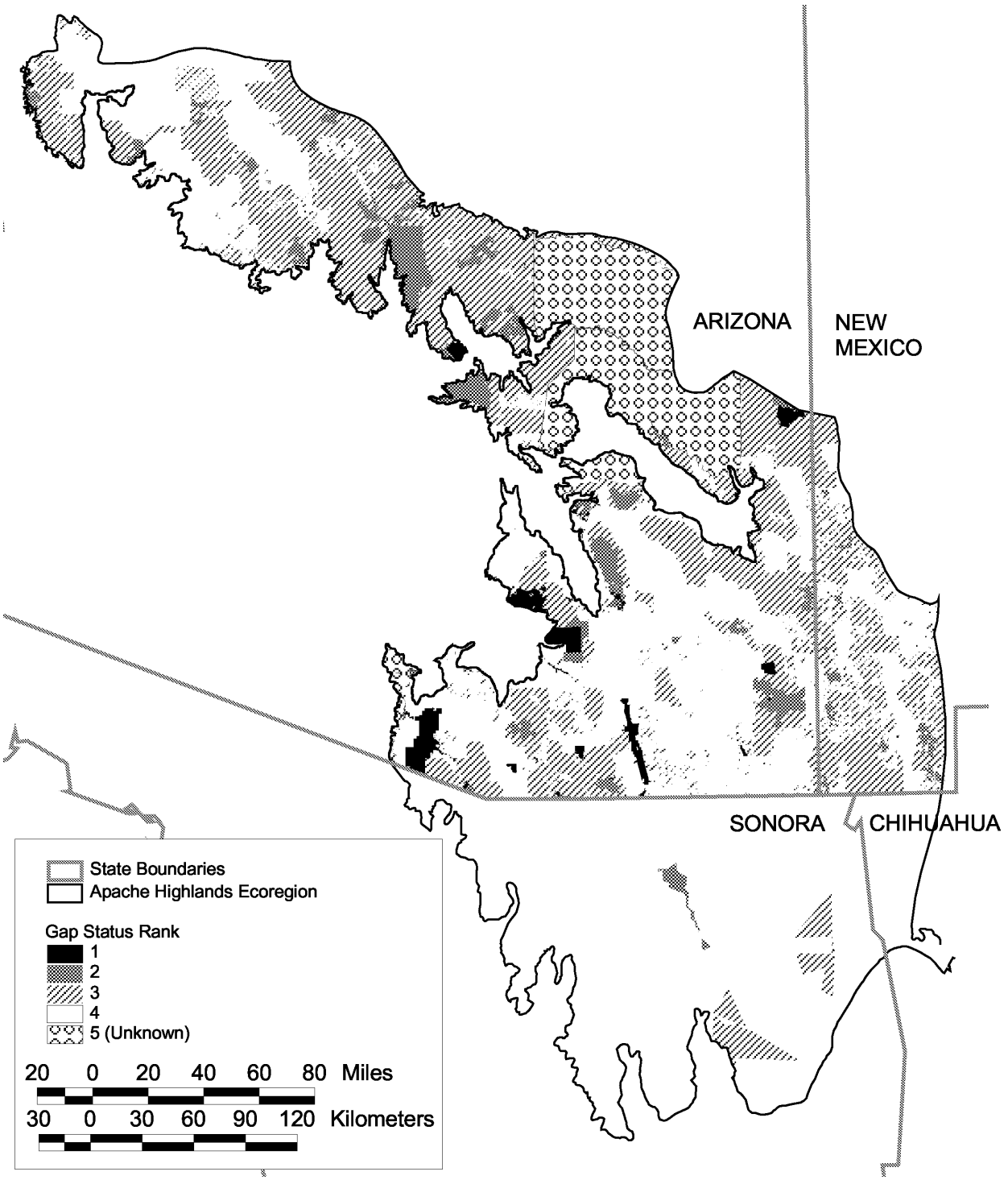


Figure 10. Gap Status of Land Stewardship in the Apache Highlands Ecoregion. See Table 18 for ranking criteria.

9. Threats to Biodiversity

Threats to biodiversity form a major consideration in determining conservation priorities for an ecoregion. They contribute to both the urgency of conservation needs and the feasibility of taking effective action.

We attempted to identify threats that apply across much of the ecoregion to aid in identifying strategies that can be applied at that scale and to help determine priorities among conservation areas. Because of its scale, this analysis cannot go into the threats facing each conservation area with adequate detail to plan site-specific actions; that approach must be addressed in individual site conservation planning efforts.

Based on available literature, expert interviews, Conservancy site conservation plans, and our collective experience in conservation efforts in this region, we identified the following threat categories as currently most important across the Apache Highlands Ecoregion: human population growth, altered fire regimes, altered hydrologic regimes, and invasive species. An additional threat – global climate change – was identified as something that may cause new problems and compound many other threats but is still poorly understood.

Human population growth

The human population of the Apache Highlands remained low and largely dispersed into the first half of the 20th Century, but economic and technological changes have brought dramatic growth since then. By 1990 ecoregion population approached 569,000. By 2000, population of the region exceeded 797,000—an increase of 40% in only 10 years and more than the entire population of Arizona only five decades earlier (Gorenflo 2003).

Analysis of population density by U.S. census blocks and the Mexican equivalent (*areas geoestadisticas basicas*) indicates that ecoregion inhabitants tend to reside in definite concentrations: the hamlets, towns, and cities that characterize most human settlement throughout the modern world (Table 20). Surrounding these communities are geographic units containing less-dense population, declining with distance from population centers (Figure 11). The distribution of people in the Apache Highlands differs from patterns found in many other places in the extremely sparse settlement found outside of communities and their immediate surroundings (Gorenflo 2003).

It should also be noted that the ecoregional boundaries neatly exclude the rapidly-growing urban areas of Phoenix and Tucson, but the suburban sprawl from those cities has moved into the ecoregion, as have effects of recreational use (Gorenflo 2002).

Recent patterns of population change varied considerably among census blocks, with different patterns in the United States and Mexico portions of ecoregion. Consistent with evidence of widespread population growth among most counties in the region, the vast majority of U.S. block groups experienced increases in population during the 1990s. Moreover, much of the widespread population growth was quite rapid (in excess of 4.0% annually), with more than 8 percent of the block groups doubling their population every 10 years (Gorenflo 2003).

In the Mexican portion of the ecoregion, however, slightly more than half the census blocks *lost* population between 1990 and 2000. Most of those that gained population were those with established communities. As a consequence, areas of population growth tend to be more concentrated—yielding a more narrowly-focused pattern of population growth than found north of the border, amidst widespread rural demographic decline (Gorenflo 2003).

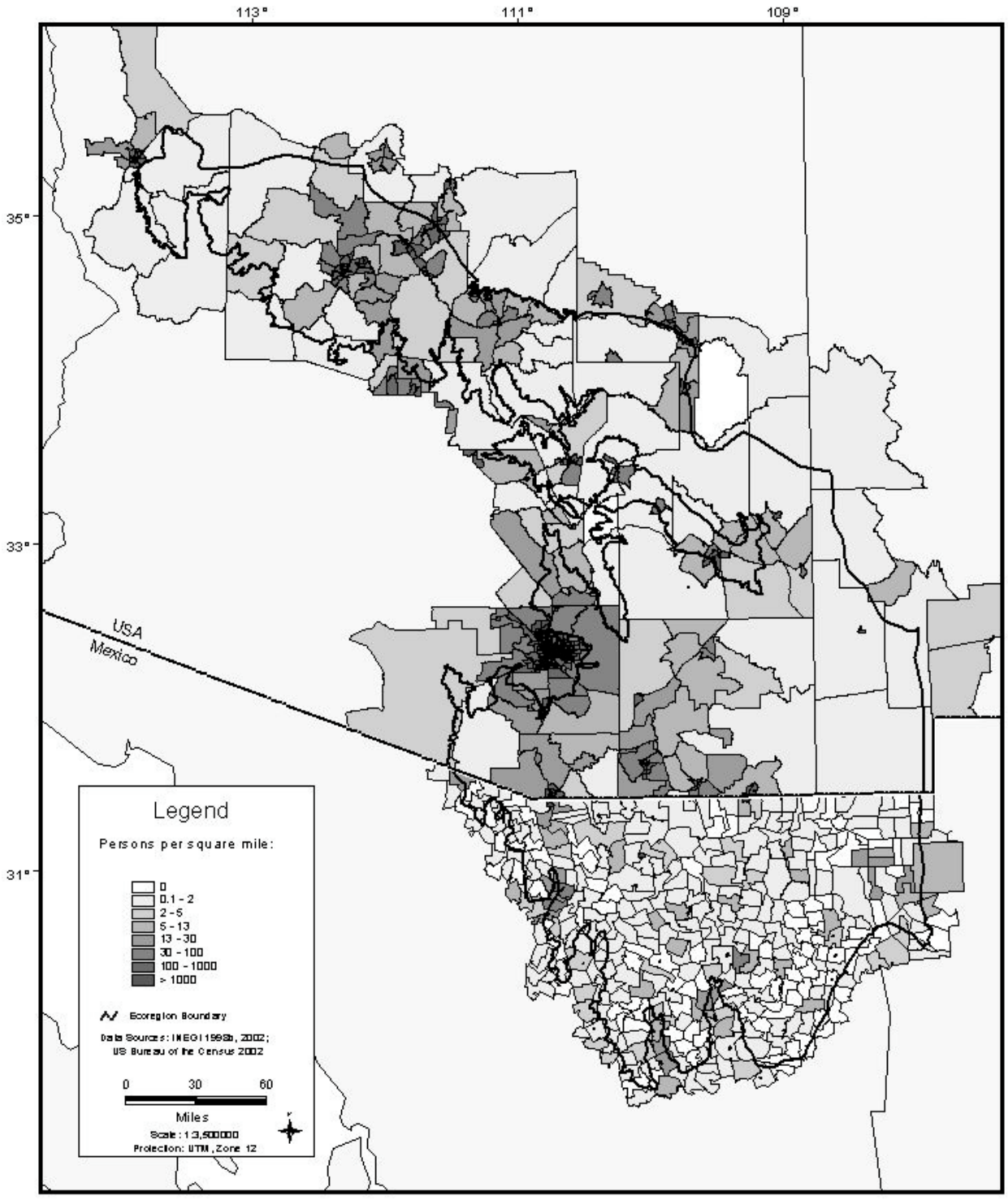


Figure 11. Apache Highlands population density, year 2000. Reprinted from Gorenflo 2003.

Table 20. Population statistics for U.S. counties and Mexican municipios in or adjacent to Apache Highlands Ecoregion: 1950, 1990, 2000 (Gorenflo 2003).

State	County/ Municipio	County/ Municipio % Area in Ecoregion	1950 Population	1990 Population	2000 Population	1990-2000 Average Annual Change (%)	Doubling Time (approx. years)
Arizona	Apache [1]	-	27,767	61,591	69,423	1.2	58
Arizona	Cochise	99.4	31,488	97,624	117,755	1.9	37
Arizona	Coconino	0.4	23,910	96,591	116,320	1.9	37
Arizona	Gila	83.6	24,158	40,216	51,335	2.5	29
Arizona	Graham	73.7	12,985	26,554	33,489	2.3	31
Arizona	Greenlee	67.6	12,805	8,008	8,547	0.7	101
Arizona	Maricopa	4.5	331,770	2,122,101	3,072,149	3.8	19
Arizona	Mohave	9.6	8,510	93,497	155,032	5.2	14
Arizona	Navajo	9.6	29,446	77,658	97,470	2.3	31
Arizona	Pima	25.8	141,216	666,880	843,746	2.4	30
Arizona	Pinal	14.8	43,191	116,379	179,727	4.4	15
Arizona	Santa Cruz	100.0	9,344	29,676	38,381	2.6	27
Arizona	Yavapai	73.1	24,991	107,714	167,517	4.5	15
New Mexico	Catron	1.1	3,533	2,563	3,543	3.3	22
New Mexico	Grant	20.8	21,649	27,676	31,002	1.1	63
New Mexico	Hidalgo	95.1	5,095	5,958	5,932	-	
Chihuahua	Casas Grandes	0.2	10,679	10,042	10,027	-	
Chihuahua	Janos	47.6	4,201	10,898	10,225	-0.6	
Sonora	Aconchi	38.8	1,775	2,356	2,412	0.2	>200
Sonora	Agua Prieta	100.0	13,121	39,120	61,821	4.7	15
Sonora	Altar[1]	-	2,036	6,458	7,224	1.1	63
Sonora	Arizpe	100.0	4,659	3,855	3,397	-1.3	
Sonora	Bacadéhuachi	57.7	1,659	1,499	1,347	-1.1	
Sonora	Bacerac	33.7	2,573	1,775	1,369	-2.6	
Sonora	Bacoachi	100.0	2,095	1,593	1,497	-0.6	
Sonora	Banámichi	90.5	1,617	1,701	1,478	-1.4	
Sonora	Baviácora	29.9	3,122	3,979	3,700	-0.7	
Sonora	Bavispe	95.7	2,299	1,755	1,383	-2.4	
Sonora	Benjamin Hill [2]	0.1	NA	5,939	5,729	-0.4	
Sonora	Cananea	100.0	18,869	26,931	32,074	1.8	39
Sonora	Cucurpe	54.1	1,902	1,036	935	-1.0	
Sonora	Cumpas	73.5	6,284	6,932	6,188	-1.1	
Sonora	Divisaderos	23.5	1,098	901	823	-0.9	
Sonora	Fronteras	100.0	4,183	6,336	7,872	2.2	32
Sonora	Granados	99.0	1,271	1,290	1,214	-0.6	
Sonora	Huachinera [3]	38.1	NA	1,503	1,146	-2.7	
Sonora	Huásabas	100.0	1,621	1,084	983	-1.0	
Sonora	Huépac	35.4	1,236	1,262	1,144	-1.0	
Sonora	Imuris	97.1	4,999	7,365	10,006	3.1	23
Sonora	Magdalena	64.8	9,034	20,071	24,409	2.0	35
Sonora	Moctezuma	37.0	3,132	3,947	4,185	0.6	117
Sonora	Naco	100.0	2,495	4,645	5,352	1.4	50
Sonora	Nácori Chico	0.2	2,594	2,513	2,252	-1.1	

State	County/ Municipio	County/ Municipio % Area in Ecoregion	1950 Population	1990 Population	2000 Population	1990-2000 Average Annual Change (%)	Doubling Time (approx. years)
Sonora	N` de García	100.0	5,500	13,171	14,344	0.9	79
Sonora	Nogales	94.7	26,016	107,936	159,103	4.0	18
Sonora	Opodepe	18.3	3,899	3,288	2,842	-1.4	
Sonora	Rayón	25.4	2,250	1,838	1,602	-1.4	
Sonora	S.F. de Jesús	71.7	830	470	429	-0.9	
Sonora	Santa Ana	25.2	9,974	12,745	13,534	0.6	117
Sonora	Santa Cruz	100.0	1,456	1,476	1,642	1.1	63
Sonora	Sáric	42.2	1,479	2,112	2,252	0.6	117
Sonora	Tubutama[1]	-	2,186	1,842	1,790	-0.3	
Sonora	Ures	5.6	8,603	10,140	9,553	-0.6	
Sonora	Villa Hidalgo [4]	100.0	3,262	2,233	1,995	-1.1	

"-" = a percent that rounds to 0; "NA" = "not available"
1: Outside though near ecoregion
2: Part of Trincheras Municipio in 1950
3: Part of Bacerac Municipio in 1950
4: Named Oputo in 1950
Sources: Dirección General de Estadística 1952a, 1952b; INEGI 1996, 2001; U.S. Bureau of the Census 1996, 2000.

Most of the high population densities and rapid growth has occurred in the region's broad valleys. One effect of this has been subdivision and development of private lands in the remaining grasslands, often in the form of low-density suburban or exurban housing (Figure 12). This has caused direct habitat loss for grassland-dependent wildlife like pronghorn and loss of wildlife corridors between mountain ranges through creation of barriers like roads and fences (Ockenfels et al. 1994, Heckert 1994). It also has long-term implications for the viability of remaining grasslands nearby, as a growing human population creates growing social resistance to grassland fires which are needed to maintain or restore healthy grasslands.

Subdivision of rural landscapes is fragmenting and destroying important valley-bottom habitat more rapidly than conservation action can be taken to protect key areas. An analysis of land ownership near the Chiricahua Mountains in 2002 showed that habitat connections to adjacent mountains are being lost as traditional ranches are subdivided. On the east side of the Chiricahuas all of the private land in a ten mile-wide swath between the Chiricahua and Peloncillo Mountains has been subdivided. On the south end of the Chiricahuas, most of the private land between the Chiricahua and the Perilla Mountains was subdivided in the late 1990's. Within less than four years, thousands of acres were split into over 80 tracts, mostly of 40 and 80 acres each. The buyers of these parcels live in 20 different states from all parts of the U.S., as far away as Hawaii and Florida, and from Canadian provinces from British Columbia to Quebec. Most of those lots are currently undeveloped, but their splits and subsequent sales have greatly inflated land values and multiplied the number of land owners, making land protection strategies even more expensive and complex (Peter Warren, personal communication).

Local decision-makers have an opportunity to minimize the impacts of future population growth by directing land subdivision and development away from the conservation areas identified in this assessment.

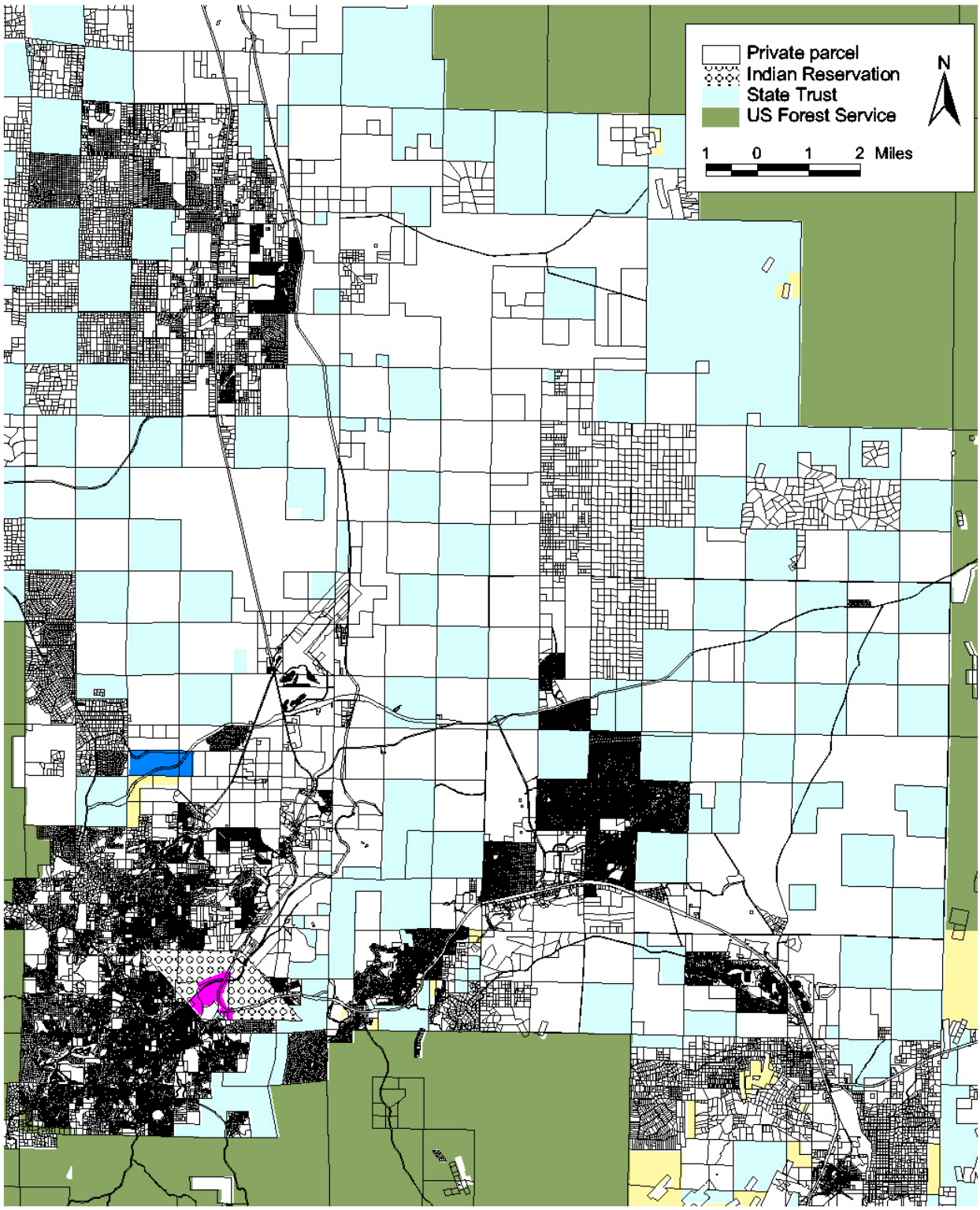


Figure 12. Land Subdivision Patterns in the Prescott Area. Most of the area shown is open grassland or was recently subdivided for residential uses. The city of Prescott, Arizona, is shown in the lower left. Areas in black depict dense concentrations of small parcels. Derived from Yavapai County parcel data, June 2002.

Altered fire regimes

People have made both deliberate and accidental changes in the natural fire regimes throughout the region, with dramatic consequences for the health and viability of natural plant and animal communities. Fire regime changes include reduced frequency of fire at a given place and a general shift from low-intensity ground fires to high-intensity crown fires

Deliberate changes have come through governmental programs of fire suppression, particularly in National Forest lands of the US. Active suppression programs for much of the last century, combined with removal of fine fuels through grazing, have caused abnormally high tree densities in places, especially within the high-elevation ponderosa pine communities (Moore et al. 1999, Barton et al. 2001). That condition has increased the likelihood of large, stand-replacing fires, especially when combined with recent die-offs caused by drought and insect infestations (Baisan and Swetnam 1990, Swetnam and Betancourt 2001).

Montane forests in Mexico have been largely free from fire suppression activities until recently (Swetnam and Baisan 1996), with the effect that they exhibit a far more natural mosaic of tree stand densities.

Fire suppression has also affected vegetation communities at lower elevations, but larger effects have come as an unintended consequence of livestock grazing on both sides of the international border. With steady grazing pressure for more than a century in the grassland and encinal communities, lack of fine fuels (i.e., dried grass) has limited the spread of any fires that ignite. The result has been encroachment of woody shrubs like mesquite and juniper into areas previously dominated by grasses, along with reductions in plant species diversity (Gori and Enquist 2003, McPherson 1995, Valone and Kelt 1999).

A spatial analysis of fire conditions based on U.S. Forest Service data found that 84% of forested lands in the Apache Highlands within the U.S. have a moderately or severely altered fire regime, with 60% of grasslands and shrublands in those conditions (Table 21)(Schmidt et al. 2002, Yanoff 2003). Fire conditions within the conservation portfolio are very similar to the ecoregion overall.

Table 21. Current fire regime conditions in the Apache Highlands.
Adapted from Yanoff (2003). Total may not match values shown elsewhere due to different data sources.

	Ecoregion	Forested	Not Forested
Total hectares	8,330,800	1,953,500	6,200,000
Intact	33.4%	16.1%	39.8%
Moderately altered	54.8%	42.4%	60.2%
Significantly altered	9.8%	41.5%	0.0%

There are a variety of barriers to restoration of historical fire regimes through use of prescribed burns or wildland fires. These include:

- High fuel loads in forest communities;
- Wildland/urban interface (WUI) issues;
- Public misunderstanding of the natural role of fire in Apache Highland ecosystems, and of the risks of living in or near burnable vegetation;
- Reluctance to allow fires to burn in non-WUI areas due to risks of damage to private property (e.g., dwellings, livestock developments);
- Federal and state funding that favors mechanical fuel treatments in WUI areas over fire management in non-WUI natural areas;

- Greater federal and state agency experience with fire suppression than with using fire to meet ecological objectives;
- Lack of prescriptions for prescribed burns in woodland or forest communities with high fuel loads;
- Inadequate fire behavior models and fuel load assessment methodologies;
- Uncertainty about effects of low- and high-intensity fires on watershed functions, endangered species, invasive species, and the composition of vegetation communities;
- Difficulties to planning across jurisdictional boundaries, even between federal agencies.

Strategies to remove some of these barriers could bring great progress toward ecologically sustainable fire management.

Altered hydrologic functions

Human activities have changed both surface water and groundwater functions across the Apache Highlands, with resulting ecological effects.

Groundwater pumping in the ecoregion has lowered local aquifers enough to reduce or eliminate perennial surface flows in some streams, such as the San Pedro River (CEC 1999). It has also caused the disappearance of springs and ciénegas, eliminating whole communities of aquatic and riparian life (Hendrickson and Minckley 1984, Contreras-B. and Lozano-V. 1994).

Streams and ciénegas have also been lost due to floodplain incision, where stream channels become deep gullies which carry surface waters away instead of allowing them to infiltrate, and which intersect and drain shallow aquifers (Hendrickson and Minckley 1984). These effects, and their likely sources in overgrazing and wood-cutting, were described as early as 1904 during fish surveys in the Gila River basin (Minckley 1999), and the greatest impact may have been during a cattle boom in 1873-1893 (Bahre and Shelton 1996, Sayre 1999).

Dam construction has also altered surface flows, creating impoundments that range from large reservoirs to small lakes and stock-watering ponds. The volume of surface water stored in the ecoregion has probably increased, but the effects on native wildlife have been largely negative due to the presence of non-native species. The native aquatic fauna, particularly fish and frogs, evolved with highly variable flow regimes and are generally unharmed by flood events or normal seasonal periods of low flow. Non-native predators or competitors, such as or bullfrogs or the many fish introduced for sport, are strongly affected by flooding or drying but gain an advantage in the pooled waters behind dams (Rosen et al. 1994, Williams et al. 1985). Paradoxically, stock ponds have become important habitat for two federally-protected native amphibians, Chiricahua leopard frog (*Rana chiricahuensis*) and Sonoran tiger salamander (*Ambystoma tigrinum stebbinsi*), in the absence of the streams and ciénegas which they presumably once occupied (USFWS 2002a, 2002b).

Invasive species

Invasive, non-native plants and animals form a large and growing threat to biodiversity worldwide (Paddock 2000). Their impacts and threats are as diverse as the species involved, ranging from competition for habitat, as in tamarisk (*Tamarix* sp.) which displace native riparian trees and shrubs, to predation, as in bullfrogs (*Rana catesbeiana*) which eat native leopard frogs and any other animals they can swallow (Tellman 2002).

We compiled a list of known invasive species in the Apache Highlands, using descriptions of Weed Management Areas in the region, existing Conservancy site conservation plans, and agency lists (Appendix 8). Problematic invasive species have recently been listed and discussed for the adjacent Sonoran Desert ecoregion (Tellman 2002) and many of the same species occur in the Apache Highlands, but no comparable analysis has focused specifically on this ecoregion.

One of the most troublesome invasive species in the Sonoran Desert – buffel grass (*Pennisetum ciliare*) – has undergone selection to form a cold-tolerant variety and is currently being tested in Sonora. This could cause serious competition for native plants and significantly change natural fire regimes in the Apache Highlands, just as it has in the Sonoran Desert.

The regional warming anticipated as a result of climate change may favor the spread of some invasive species already present. For example, Lehmann lovegrass is currently dominant in some semidesert grasslands but rare or absent in adjacent oak savannas. A small increase in regional temperature would allow the species to move up in elevation and invade the savannas (McPherson 1997).

Climate change

Although a wide variety of threats and influences are typically considered in the Conservancy's ecoregional and conservation area planning efforts, the threat of climate change has received relatively little attention. Because a greater understanding of this threat may be important to ultimately preventing an unnatural wave of species extinctions, we attempted to analyze the ecological impacts of future climate change in the Apache Highlands Ecoregion. Our goals were to:

- Acquire a better understanding of the state of the knowledge;
- Determine which species or communities may be most vulnerable to climate change;
- Develop a suite of computer-generated models, or future scenarios, that would depict spatial shifts in the distributions of species and communities resulting from predicted climate change to better inform the selection of ecoregional portfolio areas, or at least determine what information we would need to make further analyses more tenable in the future;
- In the context of conservation planning, determine the steps we might take to maintain the existence and viability of vulnerable species and communities in the ecoregion.

Lessons Learned

State of the knowledge: Climate Change. In the past 100 years, our climate has changed with unusual speed, apparently due to the effects of some human activities (IPCC 2001). This has spurred the development of sophisticated predictive climate models (General Circulation Models). While much uncertainty still exists, general predictions for the southwestern U.S. show an increase in mean annual temperature of 2-3˚ C (4-5˚ F) by 2030 and 4-7˚ C (7-12˚ F) by 2090 (SRAG 2000). They also predict an increase in winter precipitation up to 5mm/day (0.2 inches/day) by 2090.

State of the knowledge: Impacts on Species and Communities. Determining how predicted changes will affect native species and ecological communities is challenging on many levels. On a general level, most changes are non-linear and complex, making predictions difficult based on ecological theory or short-term empirical studies (Brown et al. 2001). Environmental changes can be tempered or amplified depending on factors specific to local ecosystems. Within

these systems, species at the limits of their distribution or those that are otherwise stressed are likely to be most affected (Brown et al. 2001). On the species level, each will respond to changes in a unique way, depending on climatic tolerances, other habitat requirements, and ability to disperse across the landscape (Gleason 1926, Whittaker 1975, Davis and Zabinsky 1992).

In light of these findings, it is generally agreed that species most likely to persist in an era of rapid change are those that are short-lived and opportunistic with "weedy" characteristics such as high reproductive rates, broad habitat tolerances, and rapid dispersal ability (Huntley et al. 1995). For those species and communities whose distribution is currently limited by high temperatures, their persistence during a regional warming trend may depend on their ability to shift to a cooler place. For mountain dwellers, that may be achieved by the population moving up in elevation, since a vertical rise of 500 m produces cooling of about 3˚ C (Peters and Darling 1985). For the rest, it will require a latitudinal shift toward the nearest polar region. These shifts will not be simultaneous, since species-specific time lags in movement are to be expected (Davis 1986).

Species and community vulnerability in the Apache Highlands Ecoregion. We have particular concern for two groups of species: the mountaintop and valley-floor endemics. This region of "sky islands" contains a variety of species that occupy only high-elevation portions of the tallest mountains. Species such as the Mount Graham red squirrel, twin-spotted rattlesnake, and subalpine fir persisted on mountaintops when the regional climate warmed after the last ice age. Future warming trends may completely eliminate suitable habitat in the region for these species, whereas those that occupy mid-elevation slopes may be able to disperse to sites at higher elevations (McDonald and Brown 1992). A slightly different set of conditions may affect those species restricted to valley floors of the ecoregion, such as the blacktailed prairie dog (*Cynomys ludovicianus*). If these species require the deep soils found in valleys, or are dependent on plants that require deep soils, and are also constrained by climate, then the nearest suitable habitat may be in valleys far to the north and east, outside the boundaries of the ecoregion.

Another confounding issue related to the physical landscape is increased substrate heterogeneity with elevation. The open aspect of many valley floor grasslands is at least partially a function of homogenous soil horizons. As soil texture and moisture patchiness increases with elevation, competition with other plant growth forms (e.g., subshrubs, shrubs, and trees) becomes more prevalent (Burgess 1995). In the event of predicted climate changes, the persistence of open-aspect grasslands and their associated flora and fauna may be more closely tied to latitudinal than elevational dispersal ability.

Furthermore, increased winter rainfall over the past century has already been linked to increased shrub encroachment in Apacherian grasslands (Brown et al. 1997). Predicted regional climate changes, coupled with the continued alteration of natural fire regimes, may only continue to exacerbate the current loss and degradation of native grasslands via the encroachment of shrubs and exotic grasses, over-grazing, and human-induced development.

Future Scenario Modeling. We found that because our first adopted methodology (developed by USGS; Thompson et al. 1999a, 1999b, 2001) over-predicted the current spatial distribution of our selected climate-sensitive focal species, we did not have adequate confidence in predicting future distributions (or, more appropriately, suitable habitat) based on the modeled current distributions. We then adopted a more sophisticated modeling approach ("GARP," Genetic Algorithm for Rule-set Prediction; Stockwell and Peters 1999, Townsend Peterson 2001, Townsend Peterson et al. 2002) that was specifically designed to predict current species distributions. Not only did we encounter numerous technical problems, we also experienced

extensive data incongruities between the U.S. and Mexico portion of the ecoregion (e.g., not at a comparable resolution, lack of source data, etc.). We concluded that we would need both time and resources beyond the scope of the Apache Highlands ecoregional analysis to generate reasonable results.

Conclusion

Although our understanding of the ecological impacts of climate change is clouded by uncertainty, it is unequivocal that the issue warrants attention. Indeed, the stakes are high. This is especially true for the Apache Highlands Ecoregion, home to nearly 10% of all species found in the U.S. (EPA 1998). Of these species, it is clear that those associated with native grasslands and high elevation sites are the ones that will likely suffer the consequences of climate change most severely.

10. Next Steps and Recommendations

This analysis was completed primarily to identify those areas most important for maintaining biodiversity in the ecoregion. Determining the conservation action to be taken in those areas must be done in a separate process, both to determine the site-specific needs and opportunities, and to find strategies that address issues across multiple conservation areas. However, during this process we identified some particular steps that would contribute to such efforts, including data gaps that need to be filled.

Focus on Grasslands

Approximately 43% of the ecoregion, historically, was comprised of grasslands (Gori and Enquist 2003). Today that figure has been reduced to 22%, highlighting the fact that the basins of this ecoregion have experienced the heaviest human impacts. Among those impacts is the absence of fire, which has contributed to an increase in shrubs at the expense of grasses. Research completed for this analysis produced a contemporary, accurate map of remaining grasslands (Gori and Enquist 2003), which should serve as a guide to important places for protection, management, and restoration. Also notable were the conclusions that the highest proportion of healthy native grasslands in the U.S. is on private lands, while the greatest areas of grassland with restoration potential are found on federal and state lands.

- In areas where shrub encroachment is increasing but where grassland can be restored (see Gori and Enquist 2003) implement a schedule of grazing rest - to promote development of fine fuels - and prescribed fire to improve grassland and watershed conditions (see Brunson et al. 2001).
- Catalyze the formation of, or participate in, partnerships between private and agency land managers (e.g., Malpai Borderlands Group) so that coordinated grazing and fire management can be targeted at the region's most important grasslands.
- Reduce the loss of grasslands by integrating the results of this analysis and that of Gori and Enquist (2003) in local and county land use planning efforts to determine where community objectives for conservation, open space, watershed, and aquifer protection overlap with areas identified as important for the protection of biological diversity. Work with community leaders and conservation organizations to identify available tools that could be used to accomplish these objectives, such as conservation easements, purchase of development rights, transfers of development rights, habitat conservation plans, open space initiatives, and the USDA Grassland Reserve Program.

Maintain or Restore Natural Fire Regimes

Fire has been identified as a critical ecological factor in most vegetation communities in the ecoregion. Much work has been done to understand the historic frequency and extent of fire in various communities, but restoring those historic fire regimes remains an elusive goal. Land managers in northern Mexico oversee forests with little or no history of fire suppression, and those in the U.S. can learn from the Mexican examples which benefit biological diversity and reduce long-term management costs.

This analysis identified a variety of barriers to restoring fire in the Apache Highlands. Some potential solutions include:

- Increase public education on the ecological role of fire in natural vegetation communities, including the risks and responsibilities associated with living adjacent to natural areas;
- Work with agencies to promote fuels reduction in wildland/urban interface areas, wildland fire use, and prescribed burning of grasslands (*these efforts should include monitoring and research components to document the ecological effects of burning, especially the relationship between shrub or tree reduction and perennial grass response, and watershed-scale hydrologic effects*);
- Increase funding for private partnerships and non-governmental organizations to catalyze cross-jurisdictional fire management planning and implementation.

Improve Conservation Management at Conservation Areas

In the course of our protected areas assessment, we noted whether the existing protections appear binding. This was distinguished by language in the mission statement or organic act of the land steward which is institutionally binding versus an administrative management plan which is periodically updated and revised. While this did not affect protected status rank for the areas, it provided some useful insight. Perhaps the greatest potential for increasing the commitment to conservation management in the Apache Highlands exists on the 25% of the ecoregion (7.6 million acres; 3.1 million ha) that is subject to periodically revised management plans, such as multiple-use BLM and USFS lands. This potential could be achieved if agencies would ensure that permitted activities maintain or restore natural ecological processes on the landscape and support the continued persistence of native plant cover. Agencies could implement robust monitoring programs that clearly demonstrate the effects of their management and inform adaptive changes in management.

For private and state trust lands, local decision-makers have an opportunity to minimize the impacts of future population growth on biodiversity by directing land subdivision and development away from the conservation areas identified in this assessment.

Strengthen Binational Conservation Efforts

The native species of the Apache Highlands exist on both sides of the U.S./Mexico boundary, as do the major threats to their persistence. Collaborative efforts are underway in several places along the border, such as the San Pedro River watershed. This analysis identified several new areas along the border that rank in the top 5 of biodiversity importance and that would benefit from enhanced collaborative conservation efforts or, at minumum, provide opportunities to share knowledge and resources across borders.

Plan for Climate-Induced Changes in Habitat

Review of the scientific literature on climate change and discussion with experts led us to several recommendations for ecoregional planning which we incorporated into this analysis through post-hoc review of the portfolio. We also derived recommendations for future conservation area planning and land management.

Land management and policy: (1) Reduce edge effects and promote landscape connectivity by adaptively managing the surrounding semi-natural matrix via regional collaborations; (2) maintain native species and community viability by avoiding fragmentation of natural areas, promoting habitat diversity, and protecting climatic gradients and refugia at multiple scales; (3) restore or maintain natural fire regimes; (4) ensure the persistence of genetic

variation within species; and (5) attempt to minimize exogenous threats to vulnerable habitats (Halpin 1997, Noss 2001, Hannah et al. 2002).

Generation of future scenarios: (1) More time and resources are needed to fully develop data sets to better capture ecological variables affecting species distributions and to be more consistent across the international boundary; (2) while the GARP modeling tool shows promise in predicting species distributions, two additional approaches should be examined that have recently demonstrated some success: Vegetation/Ecosystem Modeling and Analysis Project (VEMAP, Pan et al. 1998) and Multivariate Geographic Clustering (Hargrove and Hoffman 1999). We believe that modeling potential suitable habitat under varying degrees of climate change could still be a useful conservation planning tool. Future analysis on the state-wide impacts of climate change should be pursued with the assistance of a graduate student or a post-doctoral fellow.

Ecoregional planning and portfolio area selection: (1) Capture both elevational and latitudinal ecological gradients when selecting sites, including potential refugia (Noss 2001, Saxon 2003); (2) select redundant sites for each target community to hedge against future losses (Halpin 1997, Saxon 2003); (3) in future ecoregional analyses, the approach to target selection may need to be modified to (a) include three levels of biological organization: landscape/ ecosystem, community, species, and (b) include carbon sequestration sites/systems as targets (Saxon 2003).

Conservation area planning: (1) On the level of species, observe phenological change and behavior (timing may be out of sync); (2) on the level of communities, plan for increased frequency of extreme events and amplified disturbance regimes; (3) identify species that are already stressed and implement specific conservation strategies; and (4) prepare for increased invasions by exotics as well as the arrival of new assemblages of native species (Halpin 1997, Saxon 2003).

Fill Data Gaps

This ecoregional analysis was conducted using the best scientific information available. However, a variety of gaps still exist and filling them will be an important part of moving forward with protection or restoration of the region's biodiversity, and for improving future iterations of this analysis. The following are what we believe to be the most important to address.

- Better mapping and analysis of the distribution of rare and declining species in aquatic and riparian communities, and the threats to those communities. While those communities are widely recognized as among the most threatened, only limited work (aside from this assessment) has been done to prioritize freshwater areas according to the biological diversity present. Likewise, there have been few efforts in this ecoregion to identify the freshwater areas most threatened by activities such as groundwater pumping or dam operations. The combination of threat and biodiversity maps would support focused conservation efforts for key places.
- Field inventories on the distribution of rare species in northeastern Sonora and northwestern Chihuahua. Within the Apache Highlands, there are far fewer known localities for nearly all species south of the international border. This data weakness affects all taxonomic groups, though in relative terms birds and fish appear to be the best-sampled groups. Better knowledge of species distributions would allow better prioritization of which species need protection and more efficient conservation efforts.

- Better knowledge of needs for and distribution of movement corridors between mountain ranges. We have general knowledge of long-distance movements by some large mammals (e.g., cougar, jaguar, black bear) but do not know whether particular landscape corridors or habitat features are critical to those movements. Such knowledge would support focused conservation efforts for key places.
- Better vegetation community mapping. The best existing maps on a landscape scale are becoming outdated and use categories that are inconsistent across state and national boundaries. Better mapping would enable better evaluation of conservation requirements for large suites of species. The current effort to update the Gap vegetation maps for Arizona and New Mexico may fill this need for the U.S. portion of the region.
- Field surveys on the status and condition of ciénegas. We were able to verify the existence of mapped ciénegas using expert input, but there has been no systematic survey of current conditions.
- Predictions about the effects of climate change on species or vegetation communities in this region. This will require better climate modeling for the portion in Mexico and better modeling of climate-driven species distributions across the region. Such predictions would allow better planning for the effects of climate change, and may allow the orderly prevention of extinctions.
- A comprehensive survey of invasive plant and animal species in the ecoregion, and a coordinated strategy for their control. This would be an important contribution to land management efforts throughout the region.

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Appendix 1. Terrestrial Ecological Systems Classification Crosswalk.

State/ Country	Apache Highlands Ecoregion Terrestrial Ecological Systems	Original Vegetation Type - Arizona Gap[1], New Mexico Gap[2], and Mexico Forest inventory[3]	Revision Rationale	Original Acreage
AZ	**Apachean Grassland and Savanna[4]**	GB Mixed Grass-Mixed Scrub		460,836.39
AZ	**Apachean Grassland and Savanna[4]**	Semidesert Mixed Grass-Yucca-Agave	Veg-type polygons changed to Apachean Shrubland in some areas informed by Grassland Assessment Class F, east of San Pedro River and goes to Chihuahuan Desert Scrub per Peter Warren-increase in Chihuahuan elements due to elevation change, GA-F and BLP.	326,861.45
AZ	**Apachean Grassland and Savanna[4]**	Semidesert Tobosa Grass-Scrub	Veg-type polygons changed to Apachean Shrubland in some areas informed by Grassland Assessment Class F, east of San Pedro River and goes to Chihuahuan Desert Scrub per Peter Warren-increase in Chihuahuan elements due to elevation change, GA-F and BLP.	160,361.82
NM	**Apachean Grassland and Savanna[4]**	Chihuahuan Foothill-Piedmont Desert Grassland	Several polygons recoded to Chihuahuan Desert Scrub informed by the Grassland Assessment Classes F, BLP (east of San Pedro), D.Gori, C.Enquist, P.Warren.	535,333.45
MEX	**Apachean Grassland and Savanna[4]**	BOSQUE BAJO-ABIERTO		250,299.67
MEX	**Apachean Grassland and Savanna[4]**	BOSQUE BAJO-ABIERTO CON VEGETACION SECUNDARIA ARBUSTIVA Y HERBACEA		34,341.75
MEX	**Apachean Grassland and Savanna[4]**	PASTIZAL NATURAL (INCLUYE PASTIZAL-HUIZACHAL)	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	2,386,295.98
AZ	**Apachean Grassland and Savanna[4]**	GB Mixed Grass	Plains Grassland type (mixed short grass)	67,058.43
NM	**Apachean Grassland and Savanna[4]**	Mid-Grass Prairie		79,751.36
NM	**Apachean Grassland and Savanna[4]**	Short Grass Steppe	Several polygons recoded to Chihuahuan Desert Scrub informed by the Grassland Assessment Classes F, BLP (east of San Pedro), D.Gori, C.Enquist,Pwarren.	238,746.58
AZ	**Apachean Riparian Grassland[5]**	GB Riparian/Sacaton Grass Scrub	fr: Desert Riparian Woodland, per D.Gori, C. Enquist presence of Sacaton.	204.15
AZ	**Apachean Riparian Grassland[5]**	Son. Riparian/Sacaton Grass Scrub		4,935.80
NM	**Apachean Riparian Grassland[5]**	Chihuahuan Lowland/Swale Desert Grassland	Several polygons recoded to Chihuahuan Desert Scrub informed by the Grassland Assessment Classes F, BLP (east of San Pedro), D.Gori, C.Enquist,Pwarren.	54,657.51
AZ	**Apachean Shrubland[6]**	Mohave Mixed Scrub		498.39
AZ	**Apachean Shrubland[6]**	Semidesert Mixed Grass-Mesquite	Veg-type remains as Apachean Shrubland informed by Grassland Assessment Class F east of San Pedro River and goes to Chihuahuan Desert Scrub per Peter Warren-increase in Chihuahuan elements due to elevation change, GA-F and BLP. Others go to Apachean Grassland and Savanna informed by GA/ A-E polys.	1,742,705.34
AZ	**Apachean Shrubland[6]**	Semidesert Mixed Grass-Mixed Scrub	Veg-type remains as Apachean Shrubland informed by Grassland Assessment Class F east of San Pedro River and goes to Chihuahuan Desert Scrub per Peter Warren-increase in Chihuahuan elements due to elevation change, GA-F and BLP. Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	3,500,605.31
MEX	**Apachean Shrubland[6]**	MEZQUITAL (INCLUYE HUIZACHAL)		93,206.76
MEX	**Apachean Shrubland[6]**	MEZQUITAL (INCLUYE HUIZACHAL) CON VEGETACION SECUNDARIA		60,519.03
NM	**Barren Land**	Barren	Several polygons recoded to Apachean Grassland and Savanna informed by the Grassland Assessment Classes A - E. Several polygons recoded to Chihuahuan Desert	35,588.42

State/ Country	Apache Highlands Ecoregion Terrestrial Ecological Systems	Original Vegetation Type - Arizona Gap[1], New Mexico Gap[2], and Mexico Forest inventory[3]	Revision Rationale	Original Acreage
			Scrub informed by the Grassland Assessment Classes F, BLP (east of San Pedro), D.Gori, C.Enquist,Pwarren.	
MEX	**Barren Land**	AREA SIN VEGETACION APARENTE		30,035.55
AZ	**Chihuahuan Desert Scrub**	Chihuahuan Creosotebush-Tarbush Scrub	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	412,885.18
AZ	**Chihuahuan Desert Scrub**	Chihuahuan Mesquite Shrub Hummock	Team consensus on keeping Chihuahuan associations all in Chihuahuan Desert scrub. Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	38,365.36
AZ	**Chihuahuan Desert Scrub**	Chihuahuan Mixed Scrub	Team consensus on keeping Chihuahuan associations all in Chihuahuan Desert scrub. Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	190,099.35
AZ	**Chihuahuan Desert Scrub**	Chihuahuan Whitethorn Scrub	Team consensus on keeping Chihuahuan associations all in Chihuahuan Desert scrub. Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	135,872.44
NM	**Chihuahuan Desert Scrub**	Chihuahuan Broadleaf Deciduous Desert Scrub	Several polygons recoded to Apachean Grassland and Savanna informed by the Grassland Assessment Classes A - E.	600,096.10
NM	**Chihuahuan Desert Scrub**	Chihuahuan Broadleaf Evergreen Desert Scrub	Several polygons recoded to Apachean Grassland and Savanna informed by the Grassland Assessment Classes A - E.	467,322.96
MEX	**Chihuahuan Desert Scrub**	MATORRAL DESERTICO MICROFILO		2,391,786.41
MEX	**Chihuahuan Desert Scrub**	MATORRAL DESERTICO MICROFILO CON VEGETACION SECUNDARIA		265,168.39
MEX	**Chihuahuan Desert Scrub**	MATORRAL DESERTICO ROSETOFILO		487.76
AZ	**Cienega**	GB Riparian/Reed-Cattail Marsh	fr:DesRip Wood, area from former Verde R meander near Peck's Lake,P.Warren	16.01
AZ	**Cienega**	Son./Chih. Riparian/Reed-Cattail Marsh		474.37
AZ	**Desert Riparian Woodland and Shrubland[7]**	GB Riparian Forest/Mixed Riparian Scrub	Elevation break of < 4500 ft	6,318.47
AZ	**Desert Riparian Woodland and Shrubland[7]**	GB Riparian/Wet Mountain Meadow	Elevation break of < 4500 ft	26.19
AZ	**Desert Riparian Woodland and Shrubland[7]**	Riparian/Flood-damaged 1993	Elevation break of < 4500 ft	5,645.35
AZ	**Desert Riparian Woodland and Shrubland[7]**	Son. Riparian/Cottonwood-Mesquite Forest	Elevation break of < 4500 ft	1,312.05
AZ	**Desert Riparian Woodland and Shrubland[7]**	Son. Riparian/Cottonwood-Willow Forest	Elevation break of < 4500 ft	2,341.91
AZ	**Desert Riparian Woodland and Shrubland[7]**	Son. Riparian/Low-lying Riparian Scrub	Elevation break of < 4500 ft	1,861.79
AZ	**Desert Riparian Woodland and Shrubland[7]**	Son. Riparian/Mesquite Forest	Elevation break of < 4500 ft	3,379.51
AZ	**Desert Riparian Woodland and Shrubland[7]**	Son. Riparian/Mixed Broadleaf Forest	Elevation break of < 4500 ft	2,786.13
AZ	**Desert Riparian Woodland and Shrubland[7]**	Son. Riparian/Mixed Riparian Scrub	Elevation break of < 4500 ft	13,460.39
MEX	**Desert Riparian Woodland and Shrubland[7]**	VEGETACION DE GALERIA (INCLUYE BOSQUE, SELVA Y VEGETACION DE GALERIA)		14,394.04
AZ	**Desert Wash**	Son. Riparian/Leguminous Short-Tree		4,599.45

State/ Country	Apache Highlands Ecoregion Terrestrial Ecological Systems	Original Vegetation Type - Arizona Gap[1], New Mexico Gap[2], and Mexico Forest inventory[3]	Revision Rationale	Original Acreage
		Forest/Scrub		
MEX	**Dry-Land Agriculture**	AGRICULTURA DE TEMPORAL CON CULTIVOS ANUALES		24,689.82
NM	**Igneous Outcrops**	Rock Outcrop		54,961.26
AZ	**Industrial**	Industrial		64,389.95
AZ	**Interior Chaparral**	GB Blackbrush-Mixed Scrub	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	26,845.78
AZ	**Interior Chaparral**	GB Mixed Scrub	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	1,163.57
AZ	**Interior Chaparral**	Int. Chaparral (Mixed)/Son. Paloverde-Mixed Cacti	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	181,195.74
AZ	**Interior Chaparral**	Int. Chaparral-Mixed Evergreen Sclerophyll	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	1,071,058.41
AZ	**Interior Chaparral**	Int. Chapparal (Mixed)/Mixed Grass-Scrub Complex	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	179,903.92
AZ	**Interior Chaparral**	Int. Chapparal-Shrub Live Oak-Pointleaf Manzanita	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	943,710.27
NM	**Interior Chaparral**	Rocky Mountain Montane Scrub & Interior Chaparral	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	198,565.96
MEX	**Interior Chaparral**	CHAPARRAL	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	33,580.27
MEX	**Interior Chaparral**	CHAPARRAL CON VEGETACION SECUNDARIA	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	547.63
AZ	**Irrigated Agriculture**	Agriculture		357,697.38
NM	**Irrigated Agriculture**	Irrigated Agriculture		7,434.09
MEX	**Irrigated Agriculture**	AGRICULTURA DE RIEGO (INCLUYE RIEGO EVENTUAL)		151,862.30
AZ	**Madrean Encinal**	Arizona Cypress	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	20,906.26
AZ	**Madrean Encinal**	Encinal Mixed Oak	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	320,169.34
AZ	**Madrean Encinal**	Encinal Mixed Oak-Mesquite	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	48,651.61
AZ	**Madrean Encinal**	Encinal Mixed Oak-Pinyon-Juniper	changed from Pinyon-Juniper woodland, distinctly different from other PJ veg types with oak.	241,935.14
AZ	**Madrean Encinal**	Encinal Mixed Oak/Mixed Chapparal/Semidesert Grass	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	53,836.79
NM	**Madrean Encinal**	Madrean Open Oak Woodland (Encinal)	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	240,524.83
MEX	**Madrean Encinal**	BOSQUE DE ENCINO	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	1,189,740.95
MEX	**Madrean Encinal**	BOSQUE DE ENCINO CON VEGETACION SECUNDARIA ARBUSTIVA Y HERBACEA	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	934,823.52
AZ	**Madrean Oak-Pine Woodland**	Encinal Mixed Oak-Mexican Mixed Pine		491,784.89
AZ	**Madrean Oak-Pine Woodland**	Encinal Mixed Oak-Mexican Pine-Juniper		2,329.78

State/ Country	Apache Highlands Ecoregion Terrestrial Ecological Systems	Original Vegetation Type - Arizona Gap[1], New Mexico Gap[2], and Mexico Forest inventory[3]	Revision Rationale	Original Acreage
NM	**Madrean Oak-Pine Woodland**	Madrean Closed Conifer Woodland		68,108.03
NM	**Madrean Oak-Pine Woodland**	Madrean Lower Montane Conifer Forest		1,125.61
MEX	**Madrean Oak-Pine Woodland[8]**	BOSQUE DE PINO		25,825.87
MEX	**Madrean Oak-Pine Woodland[8]**	BOSQUE DE PINO CON VEGETACION SECUNDARIA ARBUSTIVA Y HERBACEA		5,421.05
MEX	**Madrean Oak-Pine Woodland[8]**	BOSQUE DE PINO-ENCINO (INCLUYE ENCINO-PINO)		204,423.03
MEX	**Madrean Oak-Pine Woodland[8]**	BOSQUE DE PINO-ENCINO (INCLUYE ENCINO-PINO) CON VEGETACION SECUNDARIA		43,030.31
MEX	**Managed Pasture**	PASTIZAL CULTIVADO		6,131.58
AZ	**Mohave Desert Scrub**	Mohave Blackbrush-Mixed Scrub		235.68
AZ	**Mohave Desert Scrub**	Mohave Catclaw Acacia-Mixed Scrub		2,872.23
AZ	**Mohave Desert Scrub**	Mohave Creosotebush-Bursage-Mixed Scrub		11,145.41
AZ	**Mohave Desert Scrub**	Mohave Creosotebush-Yucca spp. (incl. Joshuatree)		5,125.11
AZ	**Mohave Desert Scrub**	Mohave Joshuatree		102.21
AZ	**Montane Grassland**	Madrean Dry Meadow		85.84
NM	**Montane Grassland and Wet Meadow**	Rocky Mountain Subalpine and Montane Grassland		186.45
AZ	**Montane Mixed-Conifer Forest8**	Douglas Fir-Mixed Conifer		5,412.16
AZ	**Montane Mixed-Conifer Forest8**	Douglas Fir-Mixed Conifer (Madrean)		17,313.48
AZ	**Montane Mixed-Conifer Forest8**	Ponderosa Pine (Madrean)	fr: Madrean Oak-Pine,Team concensus-Gap assoc. sp. warrant placing in mixed conifer	126,235.82
AZ	**Montane Riparian Woodland and Shrubland[7]**	Int. Riparian/Cottonwood-Willow Forest	Elevation break of > 4500 ft.	6,215.07
AZ	**Montane Riparian Woodland and Shrubland[7]**	Int. Riparian/Mesquite Forest	Elevation break of > 4500 ft.	19,920.60
AZ	**Montane Riparian Woodland and Shrubland[7]**	Int. Riparian/Mixed Broadleaf Forest	Elevation break of > 4500 ft.	7,133.41
AZ	**Montane Riparian Woodland and Shrubland[7]**	Int. Riparian/Mixed Riparian Scrub	Elevation break of > 4500 ft.	50,843.08
AZ	**Montane Riparian Woodland and Shrubland[7]**	Madrean Riparian/ Wet Meadow	Elevation break of > 4500 ft.	63.90
MEX	**Old Field**	PASTIZAL INDUCIDO	Polygons evaluated with 92 TM Mosaic Satellite imagery and recoded to surrounding vegetation	310,635.86
AZ	**Pinyon-Juniper Woodland**	GB Juniper		548.70
AZ	**Pinyon-Juniper Woodland**	Pinyon-Juniper (Mixed)	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	338,657.11
AZ	**Pinyon-Juniper Woodland**	Pinyon-Juniper-Mixed Grass-Scrub	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	184,838.21
AZ	**Pinyon-Juniper Woodland**	Pinyon-Juniper-Mixed Shrub	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	18,382.33
AZ	**Pinyon-Juniper Woodland**	Pinyon-Juniper-Shrub Live Oak-Mixed Shrub		63,192.66
AZ	**Pinyon-Juniper Woodland**	PJ (Mixed)/Mixed Chapparal-Scrub		2,981,994.42

State/ Country	Apache Highlands Ecoregion Terrestrial Ecological Systems	Original Vegetation Type - Arizona Gap[1], New Mexico Gap[2], and Mexico Forest inventory[3]	Revision Rationale	Original Acreage
AZ	**Pinyon-Juniper Woodland**	PJ-Shrub/Ponderosa Pine-Gambel Oak-Juniper		84,918.02
AZ	**Pinyon-Juniper Woodland**	PJ/Sagebrush/Mixed Grass-Scrub	Some Polygons to Apachean Grassland and Savanna informed by Grassland Assessment classes A-E	277,452.17
NM	**Pinyon-Juniper Woodland**	Rocky Mnt/Great Basin Closed Conifer Woodland		65,360.88
NM	**Pinyon-Juniper Woodland**	Rocky Mnt/Great Basin Open Conifer Woodland		55,959.99
MEX	**Pinyon-Juniper Woodland**	BOSQUE DE TASCATE		67,797.88
AZ	**Playa**	GB Shadscale-Mixed Grass-Mixed Scrub		5.70
AZ	**Playa**	Mohave Saltbush-Mixed Scrub		2.52
AZ	**Playa**	Playa/Semi-Permanent Water		35,324.37
MEX	**Playa**	VEGETACION HALOFILA Y GIPSOFILA	Some polygons on eastern border evaluated using 92 TM Mosaic Satellite images and recoded to surrounding vegetation type	45,691.60
AZ	**Ponderosa Pine Forest and Woodland**	Ponderosa Pine		316,617.19
AZ	**Ponderosa Pine Forest and Woodland**	Ponderosa Pine-Gambel Oak-Juniper/Pinyon-Juniper		72,423.74
AZ	**Ponderosa Pine Forest and Woodland**	Ponderosa Pine-Mixed Conifer		8,744.78
AZ	**Ponderosa Pine Forest and Woodland**	Ponderosa Pine/Pinyon-Juniper		738,640.20
NM	**Ponderosa Pine Forest and Woodland**	Rocky Mountain Lower Montane Conifer Forest		1,911.56
NM	**Ponderosa Pine Forest and Woodland**	Rocky Mountain Montane Deciduous Scrub		38.52
MEX	**Sinaloan Thornscrub**	MATORRAL SUBTROPICAL		322,930.51
MEX	**Sinaloan Thornscrub**	MATORRAL SUBTROPICAL CON VEGETACION SECUNDARIA ARBUSTIVA Y HERBACEA		236,442.67
AZ	**Sonoran Paloverde-Mixed Cacti Desert Scrub**	Sonoran Brittlebush-Mixed Scrub		884.68
AZ	**Sonoran Paloverde-Mixed Cacti Desert Scrub**	Sonoran Creosotebush-Bursage Scrub	Team concensus on keeping all desert associations within the desert location name for accepted naming conventions with outside partners and experts.	27,824.63
AZ	**Sonoran Paloverde-Mixed Cacti Desert Scrub**	Sonoran Creosotebush-Bursage-Paloverde-Mixed Cacti	Team concensus on keeping all desert associations within the desert location name for accepted naming conventions with outside partners and experts.	5,600.53
AZ	**Sonoran Paloverde-Mixed Cacti Desert Scrub**	Sonoran Crucifixion Thorn		5,057.92
AZ	**Sonoran Paloverde-Mixed Cacti Desert Scrub**	Sonoran Paloverde Mixed Cacti/Sonoran Creosote-Bur		55,025.43
AZ	**Sonoran Paloverde-Mixed Cacti Desert Scrub**	Sonoran Paloverde-Mixed Cacti-Mixed Scrub		640,728.03
AZ	**Sonoran Paloverde-Mixed Cacti Desert Scrub**	Sonoran Paloverde-Mixed Cacti/Semidesert Grassland		531,872.45
MEX	**Sonoran Short Tree / Desert Scrub**	MATORRAL SARCOCAULE		10,234.87
MEX	**Sonoran Short Tree / Desert Scrub**	MATORRAL SARCOCAULE CON		32,987.76

State/ Country	Apache Highlands Ecoregion Terrestrial Ecological Systems	Original Vegetation Type - Arizona Gap[1], New Mexico Gap[2], and Mexico Forest inventory[3]	Revision Rationale	Original Acreage
		VEGETACION SECUNDARIA		
AZ	**Subalpine Spruce-Fir Forest and Woodland**	Englemann Spruce-Mixed Conifer		2,365.81
AZ	**Urban**	Mixed		67,977.86
AZ	**Urban**	Urban		83,632.78
MEX	**Urban**	ASENTAMIENTO HUMANO		24,617.21
AZ	**Water**	Water		16,724.97
NM	**Water**	Riverine/Lacustrine		256.03
MEX	**Water**	CUERPO DE AGUA		13,328.56
AZ		State Boundary		8,724.50

1. Arizona Gap Analysis Project (Halvorson et al. 2002) - 1:250,000 scale vegetation maps created using Landsat Thematic Mapper data (Dates: May 1993 - June 1993) and Airborne Video (Dates: Nov 1991 - May 1992)

2. New Mexico Gap (Thompson et al. 1996).

3. El Inventario Forestal Nacional 2000 (Velázquez et al. 2001) - 1: 250,000 scale maps created using Landsat Thematic Mapper ETM + data (Dates: Nov 1999 - May 2000).

4. Augmented Gap with Grassland Assessment Data Apachean Grassland and Savanna Condition Classes A,B, D, E, A&B, A&D, B&F (Gori and Enquist 2003).

5. Augmented Gap with Grassland Assessment Data - Apachean Grassland and Savanna Condition Class C (Gori and Enquist 2003).

6. Augmented Gap with Grassland Assessment Data Apachean Grassland and Savanna Condition Class F (Gori and Enquist 2003).

7. Applied an elevation break critera of < 4500 ft. for Desert Riparian and >4500 ft. for Montane Riparian and augmented Gap with data from: **Arizona Game and Fish Department Statewide Riparian Inventory and Mapping Project 1993 types cottonwood and mixed broadleaf** - This data set was developed at Arizona Game & Fish Department in 1993 - 1994. It identifies riparian vegetation associated with perennial waters mapped in response to the requirements of the Waters -Riparian Protection Program (Laws 1992, Ch. 298). Maps were created using two major sources of imagery - Landsat Thematic Mapper digital satellite data and Multiple Resolution Aerial Videography.
National Land Cover Dataset 1992 (NLCD) types 91 Wood Wetlands and 92 Emergent Herbaceous Wetlands - This land cover data set was produced as part of a cooperative project between the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency (USEPA) to produce a consistent, land cover data layer for the conterminous U.S. based on 30-meter Landsat thematic mapper (TM) data (Dates:Sep 1988 - July 1993). National Land Cover Data (NLCD) was developed from TM data acquired by the Multi-resoultion Land Characterization (MRLC) Consortium. Partners include the USGS (National Mapping, Biological Resources, and Water Resources Divisions), USEPA, the U.S. Forest Service, and the National Oceanic and Atmospheric Administration.

8. This vegetation type was not modified in the resultant Ecological Systems map, however a finer resolution classification in the Arizona vegetation data has Madrean Oak Woodland type and a Montane Mixed Conifer type. In the final assessment for the design of the portfolio an 1,830 m elevation break was applied to compensate for the lack of a Mixed Conifer type in Mexico.

Appendix 2. Global Rank And Federal Status Definitions.

Criteria for Converting Global Ranks to Combined Global Ranks

G1=	G1, G1Q, G1T1, G4T1, G3T1Q, G5T1Q, G4G5T1, G5T1, G1G2
G2=	G2, G2?, G3T2, G1G3, G2G3, G3T2, G3G4T2, G2G4T1T2Q, G4T1T2, G4T2, G4?T2?, G5T2, G5T1T2, G5T1T2Q
G3=	G3, G3?, G3Q, G3?Q, G2G3Q, G2G4, G2G4T?, G3G4T3, G3G4, G3QT2T3, G3T3Q, G4T2T3, G4T3, G4T3?, G4?T3, G4?T3, G5T2T3, G5T3, G5T3?, G5T2T3Q
G4=	G4, G4?, G?, G4T4, G3G5, G4T3T4, G5T4, G5T3T4, G4G5T3T4, G4G5T4, G4G5
G5=	G5, G5?, G5T, G5T?

U.S. Endangered Species Status Definitions

Federal U.S. Status under Endangered Species Act of 1973 (as amended) U.S. Department of Interior, Fish and Wildlife Service (from Arizona Game and Fish Department Heritage Data Management System, 7/23/99).

Listed Species

LE	Listed Endangered: imminent jeopardy of extinction.
LT	Listed Threatened: imminent jeopardy of becoming Endangered.
XN	Experimental Nonessential population.

Species Proposed for Listing

PE	Proposed Endangered.
PT	Proposed Threatened.

Candidates for Listing (Federal Notice of Review: 1996)

C	Candidate. Species for which USFWS has sufficient information on biological vulnerability and threats to support proposals to list as Endangered or Threatened under ESA. However, proposed rules have not yet been issued because such actions are precluded at present by other listing activity.

Protected Status In Mexico

Mexican Federal Endangered Species List (May 16, 1994)
Secretaría de Desarollo Social, NORMA Oficial Mexicana NOM-059-ECOL-1994

P	Peligro de Extincion (in danger of extinction)
A	Amenazadas (threatened)
R	Raras (rare)
Pr	Sujetas a Proteccion Especial (subject to special protection)
SN(T)	Determined Threatened in Sonora: could become endangered if factors causing habitat deterioration or population decline continue.

Appendix 3. Sources of Target Species Locality Data.

Databases searched which provided useful locality data

Arizona Game & Fish Dept. Heritage Data Management System
New Mexico Natural Heritage Program
IMADES Centro de Datos para la Conservación
Wendell Minckley's database of fish records: Sonora and Chihuahua fish
Steve Russell's database of bird records: Sonora birds
University of California Museum Vertebrate Zoology, Berkeley: Ornithology, Mammalogy
University of Arizona: Herbarium, Herpetology, Mammalogy
Field Museum: Sonora and Chihuahua herps
Los Angeles County Museum: Sonora herps
University of Kansas: Sonora and Chihuahua herps
California Academy of Science: Sonora and Chihuahua herps
University of Illinois Museum of Natural History: Sonora and Chihuahua herps
University of Michigan: Sonora herps, Sonora and Chihuahua fish
New Mexico Museum of Southwestern Biology
The Herbarium of the Institute of Ecology
The Herbarium of the University of Sonora, Mexico
The Herbarium of the University of Texas, Austin
The Herbarium of the New York Botanical Garden

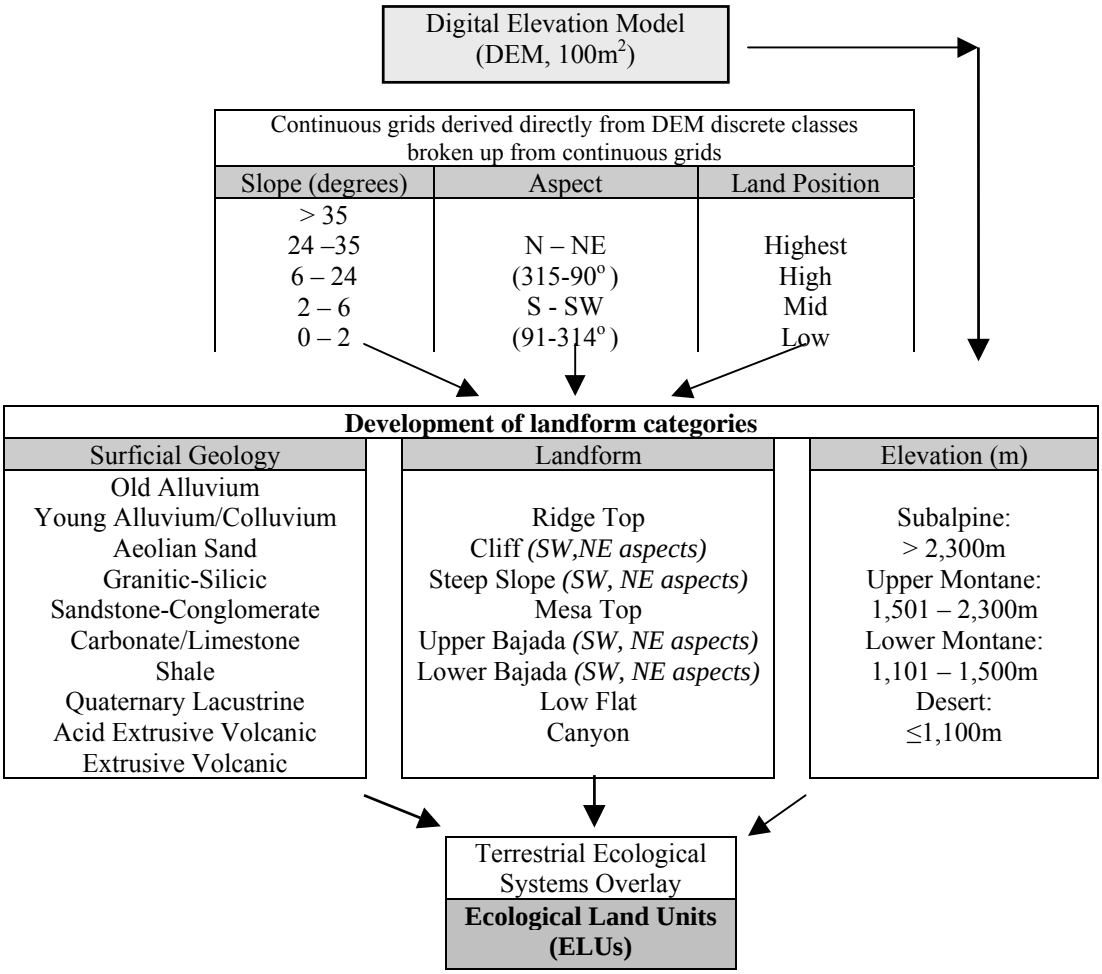
Other databases searched from which no data was used

San Diego Natural History Museum: herpetology
The Herbarium of the Institute of Ecology, A.C. Mexico
The Herbarium of the National school of Biological Sciences, MX
National Vegetable Germplasm Bank, MX
Collection of Pines from the Northeast of Mexico
The Herbarium of the National Institute of Biodiversity of Costa Rica
Collection of Native Trees and Shrubs for Restoration and Reforestation of MX
Collection of Mammals, Museum of Zoology, MX
Collection of Mammals from Southeast of MX
Collection of Mammals from Nuevo Leon, MX
Collection of Mammals of the Museum of Zoology 'Alfonso L. Herrera', MX

Appendix 4. Methodology for Terrestrial Ecological Land Units

A variety of factors, such as insolation, temperature, soil moisture, and nutrients, are considered to be driving abiotic variables that influence vegetation patterns. A model depicting these variables (or indirect measures of them) can be combined with a vegetation map to characterize and assess biophysical variation in terrestrial ecological systems. Indirect measures applicable in the Apache Highlands could include climatic zone, elevation, landform, slope, aspect, hydrologic regime, fire regime, soil depth, soil texture, soil pH and salinity, exposed bedrock, and others.

Using available spatial data, the team created and mapped terrestrial *Ecological Land Units* (ELUs) to represent the scope of biophysical variation on the Apache Highlands. Variables used to develop these ELUs were derived from documented knowledge of driving ecological factors within the ecoregion (e.g. Dick-Peddie 1993, West and Young 2000). Spatial data sets used in the analysis were elevation and landform derived from a digital elevation model (DEM) using a grid of $100m^2$ cells. and surficial geology from each state in the region and overlayed with the Apache Highlands ecological systems map (Figure 3). The following is a schematic diagram of the process used to develop these ecological land units, and a description of the process.



Schematic for development of terrestrial ecological land units in the Apache Highlands.

The DEM was used to develop a classification of eight major landforms that are known to influence vegetation pattern. Landform character is primarily a function of slope angle (e.g. from flat topography to steep cliff faces), and landscape position (from low to highest) relative to adjacent areas. As shown above, the continuous elevation grid of the DEM was broken into discrete classes for slope angle and landscape position. Five classes of slope angle were created, ranging from very flat topography at low angles, to steep cliff faces at higher angles. Four classes of landscape position were also identified; they represent a relative measure assigned to each grid cell using the relative elevation of surrounding grid cells. For example, if a given cell were fully surrounded by cells of higher elevation, then that cell received a positive value; conversely, a cell surrounded by others of lower elevation received a negative value. Cells along side slopes (with surrounding cells both higher and lower) and cells along flat topography (elevations similar to original grid cell) received neutral values. All $100m^2$ grid cells were categorized into the four major landscape positions, highest, high, mid, low. The various combinations of slope angle and landscape position were then combined to highlight characteristic landforms for the ecoregion.

<table>
<tr><th rowspan="2">Slope Angle</th><th colspan="4">Landscape Position</th></tr>
<tr><th>Highest</th><th>High</th><th>Mid</th><th>Low</th></tr>
<tr><td>> 35°</td><td colspan="4">Cliff</td></tr>
<tr><td>24° - 35°</td><td colspan="4">Steep Slope</td></tr>
<tr><td>6° - 24°</td><td rowspan="3">Ridge Top flat summit</td><td colspan="2">Upper Bajada</td><td rowspan="3">Canyon slope bottom</td></tr>
<tr><td>2° - 6°</td><td colspan="2">Lower Bajada</td></tr>
<tr><td>0° - 2°</td><td>Mesa Top</td><td>Low Flat</td></tr>
</table>

Landform types derived from relative landscape position and slope angle.

All landforms were nested within four major elevation zones that are reflected in major vegetation distributions: Desert, Lower Montane, Upper Montane, and Subalpine (Brown and Lowe 1980, Brown 1994).

ELEVATION ZONES	APPROXIMATE RANGE	Brown, Lowe, & Pase
SUBALPINE	>2,300m	121.3
UPPER MONTANE	1,501-2,300m	122.3, 122.4, 123.3
LOWER MONTANE	1,101-1,500m	142.1, 143.1, 133.3, 134.3
DESERT	≤1,100m	145.13, 153.1, 153.2, 154.12

Each landform was further classified by one of ten classes for surficial geology, developed from groups modified from digital geology maps for Arizona, New Mexico, Sonora and Chihuahua (see geology crosswalk below). Three classes of unconsolidated deposits used are old alluvium, young alluvium/colluvium, and aeolian sand. Six classes of bedrock exposed at the surface were defined by major physical and chemical properties likely to affect vegetation: granitic-silicic, sandstone-conglomerate, quaternary lacustrine, shale, extrusive volcanic, and acid extrusive volcanic.

Surficial Geology of the Apache Highlands Crosswalk				
GEO CLASS	**ARIZONA[1] FORMATIONS**	**NEW MEXICO[2] FORMATIONS**	**SONORA[3] FORMATIONS**	**CHIHUAHUA[4] FORMATIONS**
OLD ALLUVIUM	Qo			
YOUNG ALLUVIUM-COLLUVIUM	Q, Qy,	Qa, Qpl, Qp	Q(al)	Q(al)
EOLEAN SAND		Qe		Q(eo)
GRANITIC-SILICIC	Pz, Jg, Tg, Ti, Tkg, TKgm, Yg, Xg, Xm, Yxg	QTg, Ti, TKi, Tli, Tuim, Yp, Kbm	K(D), M(Gd), M(Gn)*, M(Gr), P(Gr), PE(D), PE(E), T(Da), T(Gd), T(Gr)	
SANDSTONE-CONGLOMERATE	KJs, Js, Ks, P, Tsm, Tso, Tsy, Xms, Ys	M, M_, MD, O_, P, Pz, QTp, SO_, Tps, Kl, Tus*	C(cg), M(cg),	C(cg)
EXTRUSIVE VOLCANIC	Tv, Kv, Jv, Jsv, QTb, Tb, Tby, Td, Tsv, Tvy, Xmv, Yd, Xq	Qb, Tkav, Tla, Tlrf, Tlrp, Tlv, Tnb, Tnr, Tos, Tpb, Tual, Tuau, Turf, Turp, Tuv, Xm	C(B), C(A), C(ar-cg-lm), C(ar), K(ar-cg), Ks(Rd-Ta), M(A), M(R-Rd), M(ar), M(lm-ar), M(lu-ar), T(A-Ti), T(Cataclasita), T(Mz), T(R), T(Rd-Ta), T(Rd), T(porfido)	C(B), T (R)
ACID EXTRUSIVE VOLCANIC			C(Bva), C(Bvb), K(R - Ta), Ks (ar-Ta), M(Ta), T(R-Ta), T(Ta), T(ar-Ta)	T (R - Ta)
CARBONATE - LIMESTONE	MC,	P&	K(cz), Ki(cz-lm), P(cz), T(cz-lu)*	K(cz)
SHALE	PP	Ku		
***QUATERNARY LACUSTRINE**			Q(la)	Q(la)

[1] Reynolds, Stephen J. 1988. Arizona Geological Survey. The Geologic Map of Arizona. Digital map scale of 1:1,000,000.

[2] Anderson, O. J., and Jones, G. E., 1994, Geologic Map of New Mexico: New Mexico Bureau of Mines and Mineral Resources, Open-file Report 408-A and B, Geologic map and 15 magnetic disks, 1:500,000.

[3] INEGI, 1984 Geology of Sonora at 1:250,000.

[4] INEGI, 1984 Geology of Chihuahua at 1:250,000. (Digitization by IMADES 2003).

The unique combinations of the landform, surficial geology, and elevation classes were used to produce a draft set of ELU types, mapped across the Apache Highlands. This data set yielded a total of 384 ELU types.

As previously mentioned, a comprehensive map of existing vegetation was produced by combining data from the Gap Analysis Programs of Arizona, New Mexico, and the Mexico National Forest Inventory 2000 for Sonora and Chihuahua. Map classes were reconciled across state borders and re-coded appropriately to represent terrestrial ecological systems (Chapter 2, Figure 3, Appendix 1). This refined vegetation map was then overlaid on the combined grids of surficial geology, landform and elevation to create the final ELU grid. With additional smoothing to eliminate minor combinations (<100 hectares total, or <1% of the region's vegetative extent), a total of 446 vegetation/ELU combinations were defined as the tool to represent variability within the dominant terrestrial ecosystem targets, and to capture the major physical gradients for the ecoregion. In a post-hoc assessment of the SITES-derived portfolio, the ELUs were then intersected with the conservation areas to confirm that the portfolio fully captured the range of environmental gradient variability within the ecoregion. This post-hoc assessment is on file in The Nature Conservancy's Arizona field office.

Appendix 5. Suitability Index/Cost Surface Parameters for SITES input.

Suitability Index (Cost Surface A[1]) - Road Density Costs Index values for each column category are added to the cost separately per 500 hectare hexagon						
Road Density km/ 500 hectare hexagon[2]	**Highway (Hwy)**	**Hwy public[3]**	**Local road**	**Local public[3]**	**4wd road**	**4wd public[3]**
.001 -5 km	75	20	25	5	10	0
5.001-10 km	250	40	50	10	20	5
10.001-20 km	750	60	350	15	30	10
20.001-63.52 km	1500	80	700	20	40	15

Land Use Costs hectares/ 500 hectare hexagon	**Open Pit Mines** (from NLCD-92[4] & GapVeg[5])	**Agriculture** (from gapveg)	**Urban** (from gapveg)
0 - 250 hectares	100	100	100
251-500 hectares	200	200	200

Suitability Index (Cost Surface B [6]) **Grassland Assessment Condition Class "Benefit"** Index Values for each column category are added separately per hexagon. These values are added to those of Cost Surface A.						
Grassland Assessment "Benefit" hectares/ 500 hectare hexagon	**Class A, C**	**Class A&B**	**Class B**	**Class D, B&F**	**Class E**	**Class F[7]**
0 - 250 hectares	1	11	21	301	501	0
251-500 hectares	0	10	20	300	500	0

1 Road data derived from 1997 TIGER/Line files as enhanced by ESRI.

2 Cost Surface A included both index costs for Road density and Land use.
An additional **minimum hex area cost = 250** was applied only on SITES runs > 4.2

3 Land Management Agency criteria for roads on public lands = USFS, USNPS, USFWS, State Parks, AGFD.

4 National Land Cover Dataset 1992 (NLCD) types: 21-Low density residential, 22-High desity residential, 23-Commercial/Industrial/Transportation. (USGS 2000)

5 Arizona Gap Analysis Project (Halvorson et al. 2002) - 1:250,000 scale vegetation maps created using Landsat Thematic Mapper data (Dates: May 1993 - June 1993) and Airborne Video (Dates: Nov 1991 - May 1992)
New Mexico Gap Vegetation Map (Thompson et al. 1996) - 1:250,000 scale vegetation map created using Landsat Thematic Mapper data 1992-1993.

6 Cost Surface B included a **minimum hex area cost = 250** in addition to all the index values for Cost Surface A and the Grassland Assessment Condition Class "Benefit". The concept of the "benefit" was to lower the cost of SITES selecting desired condition class grasslands. This was abandoned and achieved through adding each Grassland condition class as a separate conservation target.

7 Class F treated in terrestrial ecological systems crosswalk as Apachean Shrubland.

Appendix 6. SITES Run Parameters.

Run	Species EOs	Point value	Penalty factor	Minimum area	Boundary modifier	Seed portfolio	Algorithm	Cost surface	Grassland Assessment	Riparian	Cienegas	How dealt with border	Misc. notes	Lessons Learned
1.0	2039	1	1	1	0.2?	not set	Annealing	A	no	no	no	not	Includes all G1, G2.	selection driven by data density.
1.1	2039	1000	1	1	0.2?	not set	Annealing	A	no	no	no	not	Includes all G1, G2.	
1.2	3588	1000	1	1	0.0	not set	Annealing	A	no	no	no	not	Includes all G1, G2.	Not all EOs included-problem with access query.
1.3	3588	1000	1	2	0.0	not set	Annealing	A	no	no	no	not	Includes all G1, G2.	
1.4	3588	1000	1	2	0.0	not set	Greedy Heuristic	A	no	no	no	not	Includes all G1, G2.	
2.0	3963	1	1000	1	0.0	not set	Annealing	B	yes	no	yes	not	Includes all G1, G2, point EOs for cienegas.	Cost surface works well, but selection not clumped. Need to refine comm. goals.
2.1	2980	1	1000	1	0.0	not set	Annealing	B	yes	no	yes	not	Includes only G3-G5.	Captured ~30% of G1/G2 EOs.
2.2	0	1	1000	1	0.0	not set	Annealing	B	yes	no	yes	not	No species targets included.	Captured ~20% of G1/G2 EOs.
3.0	4656	1	1000	1	0.0	not set	Annealing	B	yes	yes	yes	not	Includes all species targets.	minimum area unit is the number of hexes not hectares
3.1	4656	1	1000	1	0.0	not set	Annealing	B	yes	yes	yes	not	Includes all species targets, but goal set to "0" for G1, G2 species.	minimum area unit is the number of hexes not hectares
3.2	4656	1	1000	1	0.0	not set	Annealing	B	yes	yes	yes	not	Includes all species targets, but goal set to "0" for all species.	minimum area unit is the number of hexes not hectares
4.0	4656	1	325	1	0	not set	Annealing	B	yes	yes	yes	not	Species targets same as 3.0, adjusted penalty factor through quartiles analysis of cost surface.Cienagas points not included however poly data was included.	3 hours run time. Captured about half of ecoregion.
4.1	4657	1	325	1	0	not set	Annealing	B	yes	yes	yes	not	Species targets same as 3.1, adjusted penalty factor through quartiles analysis of cost surface.Cienagas includes (non-overlapping) points and polygons.	Captured about half of ecoregion.
4.2	4657	1	325	1	0	not set	Annealing	B	yes	yes	yes	not	Species targets same as 3.2, adjusted penalty factor through quartiles analysis of cost surface.Cienagas includes (non-overlapping) points and polygons.	Captured about half of ecoregion, yet stopped at about 100% of goal for most community targets. Did a very poor job of capturing species EOs.Still need more clumping.
5.0a	3442	1	275	1	0	not set	Annealing	A	yes	yes	yes	not	Cost surface A used, Grassland Condition classes were converted to targets. Goals for Grassland Condition classes, Pine and Montane Mixed conifer increased. Fish pt. data replaced with lines.	Mixed conifer mostly captured. P-pine minimum still too low. Most perennial streams w/ fish captured, but not all. Captured 39% of ecoregion.
5.1a	3442	1	275	1	0	not set	Annealing	A	yes	yes	yes	not	Goals for Grassland Condition classes modified	Same as 5.0a but captured 41% of ecoregion.

Run	Species EOs	Point value	Penalty factor	Minimum area	Boundary modifier	Seed portfolio	Algorithm	Cost surface	Grassland Assessment	Riparian	Cienegas	How dealt with border	Misc. notes	Lessons Learned
6.0	3442	1	275	*	**0.1**	seeded GAP 1&2, edge sites	Annealing	A	yes	yes	yes	not	Increased p-pine minimum to 25K. Adjusted grassland & other community minimums to reflect polygon quantiles. Grassland classes not weighted.	Seeding favored U.S. part of ecoregion. Slight clumping. Didn't handle linear features at all (omitted from puvspr.dat).
6.1	3442	1	275	*	**0.2**	seeded GAP 1&2, edge sites	Annealing	A	yes	yes	yes	not		
6.2	3442	1	275	*	**0.4**	seeded GAP 1&2, edge sites	Annealing	A	yes	yes	yes	not		
6.3	3442	1	275	*	**0.6**	seeded GAP 1&2, edge sites	Annealing	A	yes	yes	yes	not		Reasonable clumping, but could be better.
7.0	3442	1	275	*	**0.6**	none	Annealing	A	yes	yes	no	not	Use weighted goals for grassland classes (Method B, run 1). Merge subdivided polygons. Up p-pine min. to 50K. Set shrubland goal to 30%, including grassland class F. Include linear features in puvspr.	P-pine better, though still not the monolithic site we expected. Large site on SE edge may be artifact of GAP veg data. Still slighting sites in MX. Cienega pts accidently omitted.
7.1	3442	1	275	*	**0.8**	none	Annealing	A	yes	yes	no	not		Much better clumping, nearly adequate. Should try a run with boundary mod. of 1. Also lower penalty factor for species goals.
8.0	3442	1	200	*	**0.8**	none	Annealing	A	yes	yes	yes	stratified	Include cienega points. Set minimum community size and overall conservation goals by subdivision. Lowered goals for 3 common fish species. Separation distances set for selected species.	Captured 39.7% of ecoregion. Some linear fish occurrence data omitted from puvspr.dat. ID # reversed for cienega pt/Apachean shrubland in central stratum.
8.1	3442	1	200	*	**0.6**	none	Annealing	A	yes	yes	yes	stratified		Captured 39.5% of ecoregion
8.2	3442	1	200	*	**1.0**	none	Annealing	A	yes	yes	yes	stratified		Testing lower penalty factor and effect of goals by subdivision. Captured 40% of ecoregion
9.0	3442	1	200	*	**1.0**	none	Annealing	A	yes	yes	yes	stratified	Re-run 8.2 with corrected puvspr.dat & species.dat	Captured 40.5% of ecoregion. Didn't meet goals for most fish.
9.1	3442	1	200	*	**1.0**	seeded GAP 1&2	Annealing	A	yes	yes	yes	stratified	8.2 rerun corrected with seeding Gap and post-hoc comparison to ELU.	Captured 40.6% of ecoregion.

***minimum area set distinctly for community polygons for assisting aggregation**

Appendix 7. Post-hoc Analyses of Portfolio.

Target	Scientific Name	Description	Data Source	Total area or length in Ecoregion		Percent of Target Captured by Portfolio
portfolio draft 1/20		SITES output, after removal of sites <5000 ha that had only community targets present.	run9_0_cleaned_dislv_merge.shp	12,723,000	ha	40%
SITES run 9.0		SITES output.	run9_0dslv.shp	12,723,000	ha	41%
perennial streams			ah_perennial14.shp	4,062	km	84%
intermittent streams			ah_intermit.shp	5,234	km	44%
black bear	*Ursus americanus*	High/ 0.8 - 1.0 Animals per Square Mile	AGFD Bear Distribution 1989	494,332	ha	43%
black bear	*Ursus americanus*	Medium/ 0.5 - 0.8 Animals per Square Mile		431,988	ha	52%
black bear	*Ursus americanus*	Low/ 0.2 - 0.5 Animals per Square Mile		665,868	ha	31%
pronghorn	*Antilocapra americana*	high quality with no problems	AGFD Pronghorn Habitat Evaluation Model 1997	3,815	ha	100%
pronghorn	*Antilocapra americana*	high quality with problems		47,229	ha	93%
pronghorn	*Antilocapra americana*	moderate quality		443,727	ha	79%
pronghorn	*Antilocapra americana*	low quality		758,595	ha	53%
pronghorn summer	*Antilocapra americana*	High/ 2.5 - 4.0 Animals per Square Mile	AGFD Pronghorn Summer Distribution 1997	24,873	ha	91%
pronghorn summer	*Antilocapra americana*	Medium/ 1.5 - 2.5 Animals per Square Mile		134,764	ha	67%
pronghorn summer	*Antilocapra americana*	Low/ 0.5 - 1.5 Animals per Square Mile		319,612	ha	73%
Botteri's sparrow	*Aimophila botterii*	Breeding bird blocks with the species present	AGFD Breeding Bird Atlas 2000 data (AGFD 1994b)			75%
Grasshopper sparrow	*Ammodramus savannarum* var. *ammolegus*					78%
Scaled quail	*Callipepla squamata*					74%
Scaled quail	*Callipepla squamata*	Current distribution of primary range in Arizona. Digitized by TNC.	AGFD map, undated	1,234,216	ha	42%
Southwestern willow flycatcher	*Empidonax traillii extimus*	designated Critical Habitat	AGFD digitized USFWS Critical Habitat 1995	289	km	97%
loachminnow	*Tiaroga cobitis*	designated Critical Habitat	AGFD digitized USFWS Critical Habitat 1999	795	km	95%
Mount Graham red squirrel	*Tamiasciurus hudsonicus grahamensis*	designated Critical Habitat		749	ha	100%
razorback sucker	*Xyrauchen texanus*	designated Critical Habitat		293	km	99%

Target	Scientific Name	Description	Data Source	Total area or length in Ecoregion		Percent of Target Captured by Portfolio
Yaqui Catfish, Yaqui chub, Yaqui shiner	*Ictalurus pricei, Gila purpurea, Cyprinella formosa*	designated Critical Habitat		1	km	100%
Sonora chub	*Gila ditaenia*	designated Critical Habitat		12	km	100%
Huachuca water umbel	*Lilaeopsis schaffneriana* var *recurva*	designated Critical Habitat	AGFD digitized USFWS Critical Habitat 2000	84	km	99%
Spikedace	*Meda fulgida*	designated Critical Habitat		763	km	95%
Cactus ferruginous pygmy owl	*Glaucidium brasilianum cactorum*	draft Critical Habitat	AGFD digitized USFWS Critical Habitat 2001	82,424	ha	23%
Mexican spotted owl	*Strix occidentalis lucida*	designated Critical Habitat		34,988	ha	66%
Swwf Acquisition priorities	*Empidonax traillii extimus*		BOR SWWF Rangewide Habitat Assessment 2000	7,594	ha	88%
Cave fauna site potential		Identified from limestone formations	Apache Highlands Surficial Geology TNC 2003*	288,751	ha	55%
Gunnison's prairie dog	*Cynomys gunnisoni*	Existing prairie dog colonies.	Status assessment by David Wagner, NAU	92	ha	74%
Black-tailed prairie dog	*Cynomys ludovicianus*	Potential prairie dog habitat for reintroduction. Digitized by TNC.	AGFD Draft Interagency Management Plan, 2001	1,197,239	ha	40%
Southwestern river otter	*Lontra canadensis sonora*	Historic distribution in Arizona.	Hoffmeister, 1986. Mammals of Arizona. Visual comparison with maps in book.			100%
Beaver	*Castor canadensis*	Historic distribution in Arizona.				90%
Beaver	*Castor canadensis*	Current distribution along Rio Bavispe, Sonora.	Gallo-Reynosa et al., 2002. Southwestern Naturalist 47:501-504.	68	km	100%
Arizona tree squirrel	*Sciurus arizonensis*	Current distribution in Arizona. Digitized by TNC.	Brown, 1984. Arizona's Tree Squirrels.	1,552,568	ha	43%
black bear	*Ursus americanus*	Current distribution in San Simon and San Bernardino Valleys.	Tomberlin, 2002. Chiricahua Foothills Wildlife Project Final Report. Visual comparison with maps.			100%
pronghorn	*Antilocapra americana*	Current distribution in San Simon and San Bernardino Valleys.				100%
Mexico Proposed Protected Areas (Priority Conservation Sites)				2,210,148	ha	43%
Mexico Protected Areas			Apache Highlands Gap Land Status Analysis TNC 2002	163,621	ha	46%
National Audubon Society		Audubon Research Ranch.		3,142	ha	100%
The Nature Conservancy		The Nature Conservancy preserves. Area includes only TNC private lands, without associated federal lands that are cooperatively managed.		6,489	ha	97%

Appendix 8. Invasive Species in the Apache Highlands.

Compiled from lists developed by state and federal agencies, weed management areas (Chambers and Hall 2001), Conservancy site conservation plans (Devine 1994, Fichtel 1994, Fichtel 1999, Jones 1996, Marshall 1999, Turner 2002), species listing and recovery plans (USFWS 2002a, 2002b), and Rosen et al. 1995. This is not intended as a comprehensive list of non-native species, but of those non-native species found to be problematic for native species.

Invasive plant species.

Scientific name	Family	Common	Synonym
Acroptilon repens	Asteraceae	Russian knapweed	*Centaurea repens*
Aegilops cylindrica	Poaceae	jointed goatgrass	
Ailanthus altissima	Simaroubaceae	tree of heaven	
Alhagi maurorum	Fabaceae	camel thorn	*A. pseudalhagi* (Bieb.) Desv., *A.camelorum*
Arundo donax	Poaceae	giant reed	
Asphodelus fistulosus	Lilaceae	asphodel, onionweed	
Avena fatua	Poaceae	wild oat	
Brassica tournefortii	Brassicaceae	African mustard, Sahara mustard	
Bromus madritensis ssp. *rubens*	Poaceae	red brome	*B. rubens*
Bromus rigidus	Poaceae	ripgut brome	
Cardaria draba	Brassicaceae	white-top, hoary cress	
Cardaria pubescens	Brassicaceae	hairy whitetop	
Carduus nutans	Asteraceae	musk thistle	
Centaurea biebersteinii	Asteraceae	spotted knapweed	*C. maculosa* L., *Acosta maculosa*
Centaurea diffusa	Asteraceae	diffuse knapweed	
Centaurea melitensis	Asteraceae	Malta starthistle	
Centaurea solstitialis	Asteraceae	yellow starthistle	
Chorispora tenella	Brassicaceae	blue mustard	
Cirsium vulgare	Asteraceae	bull thistle	
Conium maculatum	Apiaceae	poison hemlock	
Convolvulus arvensis	Convolvulaceae	field bindweed	
Cynodon dactylon	Poaceae	Bermuda grass	
Descurainia sophia	Brassicaceae	flixweed	
Eichhornia crassipes	Pontederiaceae	common water hyacinth	
Elaeagnus angustifolia	Elaeagnaceae	Russian olive	
Eragrostis cilianensis	Poaceae	stink grass	
Eragrostis curvula	Poaceae	Boer lovegrass	
Eragrostis lehmanniana	Poaceae	Lehmann lovegrass	
Erodium cicutarium	Geraniaceae	redstem filaree	
Erysimum repandum	Brassicaceae	spreading wallflower	
Euphorbia esula	Euphorbiaceae	leafy spurge	
Euphorbia myrsinites	Euphorbiaceae	myrtle spurge	
Euryops subcarnosus vulgaris	Asteraceae	sweet resinbush, hawk's eye	*E. multifidus*
Hordeum murinum	Poaceae	wild barley	
Kochia scoparia	Chenopodiaceae	kochia; Mexican fireweed	*Bassia scoparia*
Lepidium latifolium	Brassicaceae	broad-leaved pepperweed	
Linaria dalmatica	Scrophulariaceae	Dalmatian toadflax	*L. genistifolia* ssp. *dalmatica*
Marrubium vulgare	Lamiaceae	horehound	
Myriophyllum spicatum	Haloragaceae	Eurasian water milfoil	
Onopordum acanthium	Asteraceae	Scotch thistle	
Panicum antidotale	Poaceae	blue panic	
Pennisetum setaceum	Poaceae	fountaingrass	
Pentzia incana	Asteraceae	karoobush; African sheepbush	
Rhus lancea	Anacardiaceae	African sumac	
Rubus discolor	Rosaceae	Himalayan blackberry	*R. procerus*
Salsola kali	Chenopodiaceae	Russian thistle	*S. tragus, S. australis, S. iberica*
Salvia aethiopis	Laminaceae	Mediterranean sage	
Schismus arabicus	Poaceae	Mediterranean grass	
Sisymbrium irio	Brassicaceae	London rocket	
Sorghum halepense	Poaceae	Johnson grass	
Tamarix chinensis	Tamaricaceae	saltcedar	
Tamarix gallica	Tamaricaceae	saltcedar	
Tamarix parviflora	Tamaricaceae	saltcedar	
Tamarix ramosissima	Tamaricaceae	saltcedar	*T. pentandra*
Tribulus terrestris	Zygophyllaceae	puncturevine	
Verbascum thapsus	Scrophulariaceae	common mullein	
Vinca major	Apocynaceae	periwinkle	

Invasive animal species.

Scientific name	Family	Common name	Synonym
INVERTEBRATES			
Elatobium abietinum	Aphididae	spruce aphid	
Orconectes virilis	Cambaridae	virile crayfish	
VERTEBRATES			
Rana catesbeiana	Ranidae	bullfrog	
Ameiurus melas	Ictaluridae	Black bullhead	
Ameiurus natalis	Ictaluridae	Yellow bullhead	
Cyprinella lutrensis	Cyprinidae	Red shiner	
Cyprinus carpio	Cyprinidae	Carp	
Gambusia affinis	Poeciliidae	Mosquitofish	
Ictalurus punctatus	Ictaluridae	Channel catfish	
Lepomis cyanellus	Centrarchidae	Green sunfish	
Lepomis macrochirus	Centrarchidae	Bluegill sunfish	
Micropterus dolomieui	Centrarchidae	Smallmouth bass	
Micropterus salmoides	Centrarchidae	Largemouth bass	
Onchorhynchus mykiss	Salmonidae	Rainbow trout	
Pylodictis olivaris	Ictaluridae	Flathead catfish	
Pimephales promelas	Cyprinidae	Fathead minnow	

Appendix 9. Conservation Targets by Taxonomic Group.

Species targets with an asterisk (*) shown after the conservation goal had some occurrences documented as distribution polygons or survey blocks; those occurrences were not included in calculations of "total amount captured."

In some cases there are apparent discrepancies between the "Number of areas in subdivision" and "Amount captured in subdivision" columns, because some Conservation Areas overlap subdivision boundaries. Each area was assigned to the ecoregional subdivision which held the majority of its surface area, and a target's presence was attributed to that subdivision for the former count. The latter count was based strictly on the location of target occurrences relative to subdivision boundaries.

For ecological system targets, only those occurrences that met minimum size criteria were included in the accounting of "Number of areas in subdivision" and "Amount captured in subdivision."

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
Ecological System							
Apachean Grassland and Savanna Condition Class A	GU			8	7	1	16
	Endemic	Matrix	743,119 Hectares	232,100	283,548	170,816	686,464 Hectares
Apachean Grassland and Savanna Condition Class A&B	GU			4	6		10
	Endemic	Matrix	112,809 Hectares	43,046	49,471	14,388	106,905 Hectares
Apachean Grassland and Savanna Condition Class A&D	GU				1		1
	Endemic	Matrix	17,738 Hectares		17,739		17,739 Hectares
Apachean Grassland and Savanna Condition Class B	GU			14	19	2	35
	Endemic	Matrix	890,224 Hectares	154,362	584,338	84,891	823,591 Hectares
Apachean Grassland and Savanna Condition Class C	GU				6		6
	Endemic	Small Patch	20,463 Hectares		17,535	2,929	20,464 Hectares
Apachean Grassland and Savanna Condition Class D	GU				5		5
	Endemic	Matrix	39,211 Hectares		38,049		38,049 Hectares
Apachean Shrubland	GU			18	20	22	60
	Endemic	Matrix	550,117 Hectares	61,868	91,641	371,774	525,283 Hectares
Chihuahuan Desert Scrub	GU			1	15	2	18
	Widespread	Matrix	435,762 Hectares	12,339	266,812	85,571	364,722 Hectares
Cienega point	GU			7	10	4	21
	Widespread	Small Patch	75 Occurrences	24	35	15	74 Occurrences
Cienega polygon	GU			1	2		3
	Widespread	Small Patch	186 Hectares	9	177		186 Hectares
Desert Riparian Woodland and Shrubland	GU			20	14	3	37
	Peripheral	Linear	32,074 Hectares	9,729	15,424	4,458	29,611 Hectares
Desert Wash	GU			9	4		13
	Peripheral	Linear	547 Hectares	920	742		1,662 Hectares
Interior Chaparral	GU			33	16	2	51
	Widespread	Matrix	271,874 Hectares	220,726	18,255	11,060	250,041 Hectares
Madrean Encinal	GU			10	21	21	52
	Limited	Matrix	508,484 Hectares	7,642	126,165	416,532	550,339 Hectares
Madrean Oak-Pine Woodland	GU			8	15	8	31
	Limited	Matrix	126,785 Hectares	4,782	111,198	94,196	210,176 Hectares
Mohave Desert Scrub	GU			3			3
	Peripheral	Matrix	1,981 Hectares	2,146			2,146 Hectares
Montane Grassland	GU			1			1
	Limited	Small Patch	35 Hectares	35			35 Hectares
Montane Mixed-Conifer Forest	GU			6	7		13
	Endemic	Large Patch	18,079 Hectares	2,460	45,943		48,403 Hectares

Common Name / Scientific Name	Global Rank / Distribution	ESA Status / Patch Type	Conservation Goal	Northern	Central	Southern	Total Areas with Target / Total Amount Captured
				Number of Areas in Subdivision / Amount Captured in Subdivision			
Montane Riparian Woodland and Shrubland	GU			17	9		26
	Limited	Linear	4,762 Hectares	2,026	2,544	45	4,615 Hectares
Pinyon-Juniper Woodland	GU			29	5	4	38
	Widespread	Matrix	563,325 Hectares	514,590	9,663	9,808	534,061 Hectares
Playa	GU			3	5	1	9
	Endemic	Large Patch	23,272 Hectares	107	17,502	10,164	27,773 Hectares
Ponderosa Pine Forest and Woodland	GU			18	2		20
	Widespread	Matrix	136,650 Hectares	133,941	83		134,024 Hectares
Sinaloan Thornscrub	GU					7	7
	Peripheral	Matrix	68,013 Hectares			62,879	62,879 Hectares
Sonoran Paloverde-Mixed Cacti Desert Scrub	GU			26	11	9	46
	Peripheral	Large Patch	159,030 Hectares	60,648	13,954	56,229	130,831 Hectares
Sonoran Short Tree / Desert Scrub	GU					2	2
	Peripheral	Large Patch	5,247 Hectares			5,439	5,439 Hectares
Subalpine Spruce-Fir Forest and Woodland	GU				1		1
	Disjunct	Large Patch	862 Hectares		957		957 Hectares
Amphibian							
Salamandra	GU					3	3
Ambystoma rosaceum	Peripheral		7 Occurrences			7	7 Occurrences
Sonoran tiger salamander	G1	LE			1	1	2
Ambystoma tigrinum stebbinsi	Endemic		36 Occurrences		38	2	40 Occurrences
Arizona toad	G3			13	1	1	15
Bufo microscaphus microscaphus	Limited		24 Occurrences	27		1	28 Occurrences
Western barking frog	G3				2		2
Eleutherodactylus augusti cactorum	Limited		5 Occurrences		4	1	5 Occurrences
Great Plains narrowmouth toad	G5				1	1	2
Gastrophryne olivacea	Peripheral		14 Occurrences		11	2	13 Occurrences
Mountain treefrog	G4			4	1		5
Hyla eximia	Limited		16 Occurrences	10	6		16 Occurrences
Plains leopard frog	G5				3		3
Rana blairi	Peripheral		19 Occurrences		17		17 Occurrences
Chiricahua leopard frog	G3	LT		4	11	2	17
Rana chiricahuensis	Limited		53 Occurrences	18	154	2	174 Occurrences
Northern leopard frog	G5			3	2	5	10
Rana pipiens	Peripheral		14 Occurrences	6		8	14 Occurrences
Ramsey Canyon leopard frog	G1				1		1
Rana subaquavocalis	Endemic		9 Occurrences		5		5 Occurrences

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
Tarahumara frog	G3					6	6
Rana tarahumarae	Limited		23 Occurrences			23	23 Occurrences
Lowland leopard frog	G4			18	11	3	32
Rana yavapaiensis	Limited		25 Occurrences	77	45	6	128 Occurrences
Bird							
Northern goshawk	G5			6	7	1	14
Accipiter gentilis	Peripheral		27 Occurrences	11	37	4	52 Occurrences
Botteri's sparrow	G4				5	3	8
Aimophila botterii	Peripheral		23 Occurrences		45	6	23 Occurrences
Rufous-winged sparrow	G4				2	7	9
Aimophila carpalis	Limited		25 Occurrences		1	24	25 Occurrences
Baird's sparrow	G4				4		4
Ammodramus bairdii	Limited		22 Occurrences		17	5	22 Occurrences
Northern gray hawk	G3				7	6	13
Asturina nitida maxima	Peripheral		39 Occurrences	0	44	20	64 Occurrences
Western burrowing owl	G4			1	4	1	6
Athene cunicularia hypugaea	Widespread		8 Occurrences	1	4	2	7 Occurrences
Zone-tailed hawk	G4			7	9	4	20
Buteo albonotatus	Peripheral		36 Occurrences	12	31	17	60 Occurrences
Common black-hawk	G4			11	6	5	22
Buteogallus anthracinus	Limited		43 Occurrences	86	28	22	136 Occurrences
Scaled quail	G5				13	2	15
Callipepla squamata	Peripheral		5 Occurrences		16	4	4 Occurrences
Belted kingfisher	G5			2	2	6	10
Ceryle alcyon	Widespread		19 Occurrences	4		14	18 Occurrences
Green kingfisher	G5				4	4	8
Chloroceryle americana	Peripheral		22 Occurrences		9	12	21 Occurrences
Western yellow-billed cuckoo	G3	C		3	9	8	20
Coccyzus americanus occidentalis	Peripheral		42 Occurrences	30	55	26	111 Occurrences
Masked bobwhite	G1	LE			1		1
Colinus virginianus ridgwayi	Endemic		16 Occurrences		16		16 Occurrences
Montezuma quail	G4				1	7	8
Cyrtonyx montezumae	Peripheral		18 Occurrences			17	17 Occurrences
Southwestern willow flycatcher	G2	LE		2	4	4	10
Empidonax traillii extimus	Limited		29 Occurrences	13	9	7	29 Occurrences
Northern aplomado falcon	G2	LE			2		2
Falco femoralis septentrionalis	Peripheral		9 Occurrences		7	2	9 Occurrences

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
American peregrine falcon	G3			4	11	2	17
Falco peregrinus anatum	Widespread		27 Occurrences	19	25	3	47 Occurrences
Cactus ferruginous pygmy-owl	G3	LE			6		6
Glaucidium brasilianum cactorum	Limited		16 Occurrences		14	2	16 Occurrences
Sandhill crane	G5				1		1
Grus canadensis	Widespread		1 Occurrences		1		1 Occurrences
Bald eagle	G4	LT		4	2	1	7
Haliaeetus leucocephalus	Peripheral		25 Occurrences	17		9	26 Occurrences
Abert's towhee	G3				3		3
Pipilo aberti	Limited		4 Occurrences	1	1	1	3 Occurrences
Thick-billed parrot	G2	LE					
Rhynchopsitta pachyrhyncha	Peripheral						
Mexican spotted owl	G3	LT		9	9	6	24
Strix occidentalis lucida	Limited		44 Occurrences	40	79	25	144 Occurrences
Elegant trogon	G5				4	5	9
Trogon elegans	Peripheral		38 Occurrences		44	21	65 Occurrences
Crustacean							
Arizona cave amphipod	G2				1		1
Stygobromus arizonensis	Endemic		1 Occurrences		1		1 Occurrences
Fish							
Longfin dace	G4			14	10	3	27
Agosia chrysogaster	Endemic		582 Stream kilometers	1,061	326	459	1,846 Stream kilometers
Mexican stoneroller	G3				2	4	6
Campostoma ornatum	Disjunct		191 Stream kilometers		20	171	191 Stream kilometers
Yaqui sucker	G4				1	2	3
Catostomus bernardini	Endemic		522 Stream kilometers			522	522 Stream kilometers
Desert sucker	G3			14	5		19
Catostomus clarki	Limited		561 Stream kilometers	1,463	312	33	1,809 Stream kilometers
Sonora sucker	G3			10	5		15
Catostomus insignis	Endemic		1,493 Stream kilometers	1,244	249	0	1,493 Stream kilometers
Matalote opata	G3				1	2	3
Catostomus wigginsii	Endemic		6 Occurrences			6	6 Occurrences
Beautiful shiner	G2	LT			1	2	3
Cyprinella formosa	Limited		234 Stream kilometers		4	230	234 Stream kilometers
Desert pupfish	G1	LE		1	1		2
Cyprinodon macularius	Limited		2 Occurrences	1	1		2 Occurrences

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
Sonora chub	G2	LT			1	1	2
Gila ditaenia	Limited		35 Stream kilometers		15	20	35 Stream kilometers
Desert chub	G4					2	2
Gila eremica	Limited		59 Stream kilometers			59	59 Stream kilometers
Gila chub	G2	C		6	5		11
Gila intermedia	Endemic		367 Stream kilometers	247	91	25	363 Stream kilometers
Yaqui chub	G1	LE			2		2
Gila purpurea	Disjunct		58 Stream kilometers		19	39	58 Stream kilometers
Roundtail chub	G2			8	3	1	12
Gila robusta	Limited		1,098 Stream kilometers	959	28	110	1,098 Stream kilometers
Yaqui catfish	G2	LT			1	1	2
Ictalurus pricei	Peripheral		91 Stream kilometers		4	87	91 Stream kilometers
Spikedace	G2	LT		1	2		3
Meda fulgida	Limited		259 Stream kilometers	186	73		259 Stream kilometers
Apache (Arizona) trout	G3	LT			1		1
Oncorhynchus apache	Limited		10 Stream kilometers		10		10 Stream kilometers
Gila topminnow	G3	LE		7	2		9
Poeciliopsis occidentalis occidentalis	Limited		308 Stream kilometers	162	112	33	308 Stream kilometers
Yaqui topminnow	G3	LE			1	3	4
Poeciliopsis occidentalis sonoriensis	Endemic		491 Stream kilometers		5	473	477 Stream kilometers
Speckled dace	G5			11	4		15
Rhinichthys osculus	Widespread		310 Stream kilometers	878	99		977 Stream kilometers
Loach minnow	G2	LT			3		3
Tiaroga cobitis	Endemic		183 Stream kilometers	127	56		183 Stream kilometers
Razorback sucker	G1	LE		2	1		3
Xyrauchen texanus	Peripheral		228 Stream kilometers	228			228 Stream kilometers
Insect							
Giant water bug	GU			1	7		8
Abedus herberti	Limited		24 Occurrences	1	25		26 Occurrences
Agathon arizonicus	G1			1			1
Agathon arizonicus	Endemic		1 Occurrences	1			1 Occurrences
Huachuca giant-skipper	G2				1		1
Agathymus evansi	Limited		1 Occurrences		1		1 Occurrences
Sabino Canyon damselfly	G1				1		1
Argia sabino	Endemic		1 Occurrences		1		1 Occurrences
Arizona metalmark	G3				3		3
Calephelis arizonensis	Endemic		5 Occurrences		5		5 Occurrences

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
Maricopa tiger beetle	G3			7	1		8
Cicindela oregona maricopa	Limited		18 Occurrences	14	1		15 Occurrences
Parker's cylloepus riffle beetle	G1			1			1
Cylloepus parkeri			3 Occurrences	3			3 Occurrences
Pinaleno monkey grasshopper	G2				1		1
Eumorsea pinaleno	Endemic		1 Occurrences		1		1 Occurrences
Stephan's heterelmis riffle beetle	G2	C			1		1
Heterelmis stephani	Endemic		3 Occurrences		3		3 Occurrences
Page Spring micro caddisfly	GU			1			1
Metrichia volada	Endemic		1 Occurrences	1			1 Occurrences
Arizona water penny beetle	G2				1		1
Psephenus arizonensis	Endemic		1 Occurrences		1		1 Occurrences
Mammal							
Pronghorn	G5			7	6		13
Antilocapra americana	Widespread			12	10		
Beaver	G5						
Castor canadensis	Widespread						
Gunnison's prairie dog	G5			1			1
Cynomys gunnisoni	Peripheral			2			
Black-tailed prairie dog	G4	C			2	1	3
Cynomys ludovicianus	Widespread		22 Occurrences			20	20 Occurrences
Spotted bat	G4			2			2
Euderma maculatum	Limited		3 Occurrences	3			3 Occurrences
Greater western mastiff bat	G4			1	2	1	4
Eumops perotis californicus	Widespread		7 Occurrences	4	1	1	6 Occurrences
Allen's big-eared bat	G3			2	2		4
Idionycteris phyllotis	Limited		7 Occurrences	2	5		7 Occurrences
Lesser long-nosed bat	G3	LE			7		7
Leptonycteris curasoae yerbabuenae	Limited		25 Occurrences		29	1	30 Occurrences
White-sided jack rabbit	G3				1		1
Lepus callotis	Peripheral		14 Occurrences		12	1	13 Occurrences
Southwestern river otter	G1						
Lontra canadensis sonora	Widespread						
Nutria neotropical	G4						
Lontra longicaudis	Peripheral						
California leaf-nosed bat	G4				3	1	4
Macrotus californicus			9 Occurrences	0	4	3	7 Occurrences

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
Western small-footed myotis	G5			1	2		3
Myotis ciliolabrum			6 Occurrences	3	3		6 Occurrences
Occult little brown bat	G3			5			5
Myotis lucifugus occultus			7 Occurrences	6			6 Occurrences
Fringed myotis	G4			6	3		9
Myotis thysanodes			16 Occurrences	10	6		16 Occurrences
Cave myotis	G5			2	9	1	12
Myotis velifer			25 Occurrences	2	30	2	34 Occurrences
Long-legged myotis	G5			2	1		3
Myotis volans			9 Occurrences	6	3		9 Occurrences
Yuma myotis	G5					1	1
Myotis yumanensis			2 Occurrences			2	2 Occurrences
Big free-tailed bat	G5			1	1		2
Nyctinomops macrotis			4 Occurrences	1	3		4 Occurrences
Jaguar	G3	LE			4		4
Panthera onca	Peripheral		5 Occurrences		4	1	5 Occurrences
Pale Townsend's big-eared bat	G4			3	5	1	9
Plecotus townsendii pallescens			24 Occurrences	5	24	1	30 Occurrences
Arizona tree squirrel	G4			13	6		19
Sciurus arizonensis	Endemic		1 Occurrences	14	9		1 Occurrences
Chiricahua fox squirrel	G1				1	1	2
Sciurus nayaritensis chiricahuae	Endemic		5 Occurrences		4	1	5 Occurrences
Yellow-nosed cotton rat	G4				8		8
Sigmodon ochrognathus			24 Occurrences		25		25 Occurrences
Arizona shrew	G3				3		3
Sorex arizonae	Endemic		14 Occurrences		13	1	14 Occurrences
Mount Graham red squirrel	G1	LE			1		1
Tamiasciurus hudsonicus grahamensis	Endemic		4 Occurrences		4		4 Occurrences
Southern pocket gopher	G5				1		1
Thomomys umbrinus	Disjunct		24 Occurrences		29		29 Occurrences
Black bear	G5			28	16	3	47
Ursus americanus	Widespread			33	35	3	
Mollusk							
Animas Peak woodlandsnail	G1				1		1
Ashmunella animasensis	Endemic		2 Occurrences		2		2 Occurrences
Hacheta Grande woodlandsnail	G1				1		1
Ashmunella hebardi	Endemic		2 Occurrences		2		2 Occurrences

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
Pinaleno mountainsnail	G2				1		1
Oreohelix grahamensis	Endemic		14 Occurrences		14		14 Occurrences
San Bernardino springsnail	G1				1		1
Pyrgulopsis bernardina	Endemic		1 Occurrences		1		1 Occurrences
Verde Rim springsnail	G1			1			1
Pyrgulopsis glandulosa	Endemic		1 Occurrences	1			1 Occurrences
Montezuma Well springsnail	G1			1			1
Pyrgulopsis montezumensis	Endemic		1 Occurrences	1			1 Occurrences
Page springsnail	G1	C		1			1
Pyrgulopsis morrisoni	Endemic		4 Occurrences	4			4 Occurrences
Fossil springsnail	G1			1			1
Pyrgulopsis simplex	Endemic		1 Occurrences	1			1 Occurrences
Brown springsnail	G1			1			1
Pyrgulopsis sola	Endemic		1 Occurrences	1			1 Occurrences
Huachuca springsnail	G2	C			1		1
Pyrgulopsis thompsoni	Endemic		11 Occurrences		11		11 Occurrences
Hacheta mountainsnail	G1				1		1
Radiocentrum hachetana	Endemic		1 Occurrences		1		1 Occurrences
Animas talussnail	G1				1		1
Sonorella animasensis	Endemic		2 Occurrences		2		2 Occurrences
Clark Peak talussnail	G1				1		1
Sonorella christenseni	Endemic		4 Occurrences		4		4 Occurrences
San Xavier talussnail	G1				1		1
Sonorella eremita	Endemic		2 Occurrences		2		2 Occurrences
Pinaleno talussnail	G1				1		1
Sonorella grahamensis	Endemic		5 Occurrences		5		5 Occurrences
Mimic talussnail	G2				1		1
Sonorella imitator	Endemic		11 Occurrences		11		11 Occurrences
Wet Canyon talussnail	G1	C			1		1
Sonorella macrophallus	Endemic		1 Occurrences		1		1 Occurrences
Reptile							
Giant spotted whiptail	G3				5	2	7
Cnemidophorus burti stictogrammus	Limited		24 Occurrences		16	5	21 Occurrences
Huico de oputo	G1				1	1	2
Cnemidophorus opatae	Endemic		12 Occurrences			12	12 Occurrences
Twin-spotted rattlesnake	G5				3		3
Crotalus pricei	Disjunct		24 Occurrences		24		24 Occurrences

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
New Mexico ridgenose rattlesnake	G1	LT			1		1
Crotalus willardi obscurus	Endemic		6 Occurrences		5	1	6 Occurrences
Arizona ridgenose rattlesnake	G3				2	1	3
Crotalus willardi willardi	Endemic		24 Occurrences		30	3	33 Occurrences
Mountain skink	G5				2		2
Eumeces callicephalus	Peripheral		10 Occurrences		10		10 Occurrences
Texas horned lizard	G4				6	1	7
Phrynosoma cornutum	Peripheral		29 Occurrences		19	3	22 Occurrences
Rock horned lizard	G1					2	2
Phrynosoma ditmarsi	Endemic		2 Occurrences			2	2 Occurrences
Bunch grass lizard	G4				3		3
Sceloporus slevini	Limited		24 Occurrences		25		25 Occurrences
Striped plateau lizard	G4				2		2
Sceloporus virgatus	Peripheral		7 Occurrences		6	1	7 Occurrences
Desert massasauga	G3				1		1
Sistrurus catenatus edwardsii	Limited		12 Occurrences		11		11 Occurrences
Desert box turtle	G4				2	2	4
Terrapene ornata luteola	Limited		5 Occurrences		3	2	5 Occurrences
Mexican garter snake	G3			3	4	4	11
Thamnophis eques megalops	Limited		27 Occurrences	11	24	6	41 Occurrences
Narrow-headed garter snake	G3			4	1		5
Thamnophis rufipunctatus	Limited		24 Occurrences	24			24 Occurrences
Vascular plant							
Thurber indian mallow	G2				1	1	2
Abutilon thurberi	Endemic		3 Occurrences		2	1	3 Occurrences
Arizona agave	G1	LE		4			4
Agave arizonica	Endemic		24 Occurrences	24			24 Occurrences
Tonto Basin agave	G2			5			5
Agave delamateri	Limited		24 Occurrences	26			26 Occurrences
Maguey	G3				1	3	4
Agave parviflora ssp flexiflora	Limited		9 Occurrences			8	8 Occurrences
Santa Cruz striped agave	G3				3		3
Agave parviflora ssp parviflora	Endemic		24 Occurrences		39		39 Occurrences
Trelease agave	G1				1		1
Agave schottii var treleasei	Limited		5 Occurrences		5		5 Occurrences
Goodding onion	G4				1		1
Allium gooddingii	Limited		4 Occurrences		4		4 Occurrences

Common Name **Scientific Name**	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	**Northern** Number of Areas in Subdivision Amount Captured in Subdivision	**Central** Number of Areas in Subdivision Amount Captured in Subdivision	**Southern** Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
Saiya	G1				1		1
Amoreuxia gonzalezii	Limited		3 Occurrences		3		3 Occurrences
Large-flowered blue star	G2				2	2	4
Amsonia grandiflora	Endemic		24 Occurrences		15	6	21 Occurrences
Kearney's blue star	G1	LE			1		1
Amsonia kearneyana	Endemic		7 Occurrences		7		7 Occurrences
Chiricahua rock flower	G2				1		1
Apacheria chiricahuensis	Limited		8 Occurrences		8		8 Occurrences
Chiricahua rock cress	G1				2		2
Arabis tricornuta	Endemic		4 Occurrences		4		4 Occurrences
Greene milkweed	G3				1		1
Asclepias uncialis	Widespread		2 Occurrences		2		2 Occurrences
Asplenium dalhousiae	G3				1	1	2
Asplenium dalhousiae	Limited		2 Occurrences		1	1	2 Occurrences
Lemmon's aster	G2				1	1	2
Aster potosinus	Widespread		14 Occurrences		4	10	14 Occurrences
Coppermine milk-vetch	G2				2		2
Astragalus cobrensis var maguirei	Endemic		10 Occurrences		10		10 Occurrences
Huachuca milk-vetch	G1				2		2
Astragalus hypoxylus	Endemic		6 Occurrences		6		6 Occurrences
Creeping milk vetch	G2			1			1
Astragalus troglodytus			1 Occurrences	1			1 Occurrences
Griffith saltbush	G2				2		2
Atriplex griffithsii	Endemic		8 Occurrences		8		8 Occurrences
Bernardia myricaefolia	G2					1	1
Bernardia myricaefolia	Endemic		2 Occurrences			2	2 Occurrences
Palma lisa	G1					1	1
Brahea nitida	Limited		4 Occurrences			4	4 Occurrences
Elusive new browallia species	G2				1		1
Browallia eludens	Endemic		3 Occurrences		3		3 Occurrences
Arizona giant sedge	G3			1	6	2	9
Carex ultra	Endemic		23 Occurrences	1	18	4	23 Occurrences
Santa Cruz star leaf	G2				1		1
Choisya mollis	Endemic		11 Occurrences		11		11 Occurrences
Arizona bugbane	G2			1			1
Cimicifuga arizonica	Endemic		2 Occurrences	2			2 Occurrences

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
Playa spider plant	G2				1		1
Cleome multicaulis	Widespread		1 Occurrences		1		1 Occurrences
Mexican hemlock parsley	G2				1		1
Conioselinum mexicanum	Endemic		1 Occurrences	1			1 Occurrences
Cochise pincushion cactus	G1	LT			1		1
Coryphantha robbinsorum	Endemic		3 Occurrences		3		3 Occurrences
Pima pineapple cactus	G2	LE			5		5
Coryphantha scheeri var robustispina	Endemic		24 Occurrences		25		25 Occurrences
Gentry indigo bush	G1				2	2	4
Dalea tentaculoides	Endemic		17 Occurrences		10	7	17 Occurrences
Standley whitlow-grass	G2				1		1
Draba standleyi	Limited		9 Occurrences		9		9 Occurrences
Mexican shield fern	G1				1		1
Dryopteris patula var rossii			2 Occurrences		2		2 Occurrences
Arizona hedgehog cactus	G2	LE		4			4
Echinocereus triglochidatus var arizonicus	Endemic		18 Occurrences	18			18 Occurrences
Needle-spined pineapple cactus	G3				4		4
Echinomastus erectocentrus var erectocentrus	Limited		22 Occurrences		18		18 Occurrences
Mogollon fleabane	G2			4			4
Erigeron anchana	Endemic		8 Occurrences	8			8 Occurrences
Erigeron arisolius	G2				3		3
Erigeron arisolius	Endemic		21 Occurrences		18	2	20 Occurrences
Pinalenos fleabane	G1				1		1
Erigeron heliographis	Endemic		7 Occurrences		7		7 Occurrences
Chiricahua fleabane	G1				1		1
Erigeron kuschei	Endemic		7 Occurrences		7		7 Occurrences
Lemmon fleabane	G1	C			1		1
Erigeron lemmonii	Endemic		1 Occurrences		1		1 Occurrences
Fish Creek fleabane	G1				1		1
Erigeron piscaticus	Endemic		2 Occurrences		2		2 Occurrences
Pringle's fleabane	G2			1	1		2
Erigeron pringlei	Endemic		3 Occurrences	1	2		3 Occurrences
Apache wild-buckwheat	G1			1			1
Eriogonum apachense	Endemic		12 Occurrences	12			12 Occurrences
Ripley wild-buckwheat	G2			2			2
Eriogonum ripleyi	Limited		13 Occurrences	13			13 Occurrences

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
Bigelow thoroughwort	G2				1		1
Eupatorium bigelovii	Limited		2 Occurrences		2		2 Occurrences
Woodland spurge	G4				2		2
Euphorbia macropus	Endemic		9 Occurrences		9		9 Occurrences
Wislizeni gentian	G2				2		2
Gentianella wislizeni	Limited		9 Occurrences		9		9 Occurrences
Bartram stonecrop	G3				6		6
Graptopetalum bartramii	Endemic		17 Occurrences		17		17 Occurrences
Mock pennyroyal	G3				8		8
Hedeoma dentatum	Limited		24 Occurrences		33	1	34 Occurrences
Sparseleaf hermannia	G2				1		1
Hermannia pauciflora	Limited		1 Occurrences		1		1 Occurrences
Huachuca golden aster	G2				2		2
Heterotheca rutteri	Endemic		14 Occurrences		13		13 Occurrences
Chisos coral-root	G1				2		2
Hexalectris revoluta	Limited		3 Occurrences		3		3 Occurrences
Texas purple spike	G2				2		2
Hexalectris warnockii	Limited		3 Occurrences		3		3 Occurrences
Pringle hawkweed	G2				1		1
Hieracium pringlei	Endemic		6 Occurrences		6		6 Occurrences
Rusby hawkweed	G2				1		1
Hieracium rusbyi	Limited		1 Occurrences		1		1 Occurrences
Pinaleno mountain plummera	G1			1	3		4
Hymenoxys ambigens var ambigens	Endemic		6 Occurrences	1	9		10 Occurrences
Pinaleno mountain rubberweed	G2						
Hymenoxys ambigens var neomexicana	Endemic		4 Occurrences		4		4 Occurrences
Hymenoxys jamesii	G2			2			2
Hymenoxys jamesii			3 Occurrences	3			3 Occurrences
Huachuca water umbel	G2	LE			4	1	5
Lilaeopsis schaffneriana var recurva	Endemic		34 Occurrences		26	8	34 Occurrences
Lemmon lily	G3				2		2
Lilium parryi	Endemic		13 Occurrences		11	2	13 Occurrences
Horseshoe deer vetch	G1			1			1
Lotus mearnsii var equisolensis			1 Occurrences	1			1 Occurrences
Huachuca mountain lupine	G2				1		1
Lupinus huachucanus	Endemic		8 Occurrences		6	2	8 Occurrences

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
Lemmon's lupine	G1				4		4
Lupinus lemmonii	Widespread		4 Occurrences	1	3		4 Occurrences
Mapleleaf false snapdragon	G2			1			1
Mabrya acerifolia			3 Occurrences	3			3 Occurrences
Supine bean	G2				2		2
Macroptilium supinum	Limited		19 Occurrences		10	6	16 Occurrences
Wiggins milkweed vine	G3				3		3
Metastelma mexicanum	Endemic		10 Occurrences		10		10 Occurrences
Box Canyon muhly	G1				1		1
Muhlenbergia dubioides	Endemic		2 Occurrences		2		2 Occurrences
Nissolia schottii	G2						
Nissolia schottii			3 Occurrences			3	3 Occurrences
Lemmon cloak fern	G3				3		3
Notholaena lemmonii	Limited		10 Occurrences		10		10 Occurrences
Beardless chinch weed	G3				3		3
Pectis imberbis	Endemic		7 Occurrences		7		7 Occurrences
Catalina beardtongue	G2				5		5
Penstemon discolor	Endemic		15 Occurrences		14		14 Occurrences
Maguire's penstemon	G1				1		1
Penstemon linarioides ssp maguirei	Endemic		1 Occurrences	1			1 Occurrences
Flagstaff beardtongue	G2			2			2
Penstemon nudiflorus	Limited		2 Occurrences	2			2 Occurrences
Superb beardtongue	G2			2	5		7
Penstemon superbus	Endemic		11 Occurrences	6	5		11 Occurrences
Chiricahua rock daisy	G1				1		1
Perityle cochisensis	Endemic		2 Occurrences		2		2 Occurrences
Gila rock daisy	G2			1			1
Perityle gilensis var salensis			1 Occurrences	1			1 Occurrences
Fish Creek rock daisy	G1			1			1
Perityle saxicola	Limited		1 Occurrences	1			1 Occurrences
Arizona phlox	G2			2			2
Phlox amabilis	Endemic		4 Occurrences	4			4 Occurrences
Broad-leaf ground-cherry	G1				3		3
Physalis latiphysa	Endemic		3 Occurrences		3		3 Occurrences
Hinckley's ladder	G2				1		1
Polemonium pauciflorum ssp hinckleyi	Widespread		11 Occurrences		11		11 Occurrences

Common Name Scientific Name	Global Rank Distribution	ESA Status Patch Type	Conservation Goal	Northern Number of Areas in Subdivision Amount Captured in Subdivision	Central Number of Areas in Subdivision Amount Captured in Subdivision	Southern Number of Areas in Subdivision Amount Captured in Subdivision	Total Areas with Target Total Amount Captured
White-flowered cinquefoil	G2				1		1
Potentilla albiflora	Endemic		4 Occurrences		4		4 Occurrences
Mexican bare-ray-aster	G2				1		1
Psilactis gentryi	Limited		1 Occurrences		1		1 Occurrences
Arizona cliff rose	G1	LE		1			1
Purshia subintegra	Limited		7 Occurrences	7			7 Occurrences
Blumer's dock	G3			5	3		8
Rumex orthoneurus	Limited		25 Occurrences	18	15	2	35 Occurrences
Aravaipa sage	G2			1	3		4
Salvia amissa	Endemic		11 Occurrences	2	9		11 Occurrences
Verde Valley sage	G3			1			1
Salvia dorrii ssp mearnsii	Endemic		24 Occurrences	37			37 Occurrences
Chiricahua mountain brookweed	G2				3		3
Samolus vagans	Endemic		14 Occurrences		13	1	14 Occurrences
Huachuca groundsel	G2				2		2
Senecio huachucanus	Endemic		8 Occurrences		8		8 Occurrences
Toumey groundsel	G2				1		1
Senecio neomexicanus var toumeyi	Endemic		1 Occurrences		1		1 Occurrences
Madrean ladies'-tresses	G1	LE			1		1
Spiranthes delitescens	Endemic		4 Occurrences		4		4 Occurrences
Porsild's starwort	G1				1		1
Stellaria porsildii	Limited		2 Occurrences		2		2 Occurrences
Pinos Altos flame flower	G2				1		1
Talinum humile	Limited		2 Occurrences		2		2 Occurrences
Tepic flame flower	G2				1		1
Talinum marginatum	Limited		6 Occurrences		5	1	6 Occurrences
Tusayan flame flower	G3			3			3
Talinum validulum	Limited		16 Occurrences	16			16 Occurrences
Aravaipa wood fern	G3				2		2
Thelypteris puberula var. sonorensis	Limited		2 Occurrences		2		2 Occurrences
Limestone Arizona rosewood	G3				1		1
Vauquelinia californica ssp pauciflora	Limited		8 Occurrences		8		8 Occurrences

Appendix 10. Conservation Targets Identified within Conservation Areas.

For ecological system targets, only those occurrences that met minimum size criteria were included in the accounting for each conservation area. Thus, other ecological systems may be present in a given conservation area, but their occurrence there was considered nonviable and therefore was not among the motivations for identifying that area.

This appendix includes all ninety areas that were identified but the numbering runs to 91 since one area (#45) was deleted after area numbers were assigned.

Conservation Area	**1 Peacock/ Cottonwood Mountains**	Total Conservation Targets	**10**
Site size (hectares):	33,000	(acres):	81,543

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Mohave Desert Scrub	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Playa	GU	
		Ponderosa Pine Forest and Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	

Conservation Area	**2 Hualapai Mountains**	Total Conservation Targets	**22**
Site size (hectares):	38,500	(acres):	95,134

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Mohave Desert Scrub	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Ponderosa Pine Forest and Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
Mammal	*Euderma maculatum*	Spotted bat	G4	
	Eumops perotis californicus	Greater western mastiff bat	G4	
	Idionycteris phyllotis	Allen's big-eared bat	G3	
	Myotis ciliolabrum	Western small-footed myotis	G5	
	Myotis lucifugus occultus	Occult little brown bat	G3	
	Myotis thysanodes	Fringed myotis	G4	
	Myotis velifer	Cave myotis	G5	
	Myotis volans	Long-legged myotis	G5	
	Plecotus townsendii pallescens	Pale Townsend's big-eared bat	G4	

Conservation Area	**3 Trout Creek**	Total Conservation Targets	**11**
Site size (hectares):	11,500	(acres):	28,417

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	G4	
Bird	*Buteogallus anthracinus*	Common black-hawk	G4	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila robusta	Roundtail chub	G2	

Conservation Area	**4 Chino Valley**	Total Conservation Targets	**14**
Site size (hectares):	112,000	(acres):	276,752

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	

		Apachean Grassland and Savanna Condition Class B	GU
		Desert Riparian Woodland and Shrubland	GU
		Interior Chaparral	GU
		Madrean Encinal	GU
		Montane Riparian Woodland and Shrubland	GU
		Pinyon-Juniper Woodland	GU
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3
Mammal	*Antilocapra americana*	Pronghorn	G5
	Cynomys gunnisoni	Gunnison's prairie dog	G5
	Euderma maculatum	Spotted bat	G4
	Myotis thysanodes	Fringed myotis	G4
	Ursus americanus	Black bear	G5
Vascular plant	*Talinum validulum*	Tusayan flame flower	G3

Conservation Area **5 Trout Creek/ Big Sandy River Confluence** Total Conservation Targets **12**
Site size (hectares): 8,000 (acres): 19,768

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Mohave Desert Scrub	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
	Rana yavapaiensis	Lowland leopard frog	G4	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila robusta	Roundtail chub	G2	

Conservation Area **6 Burro Creek Watershed** Total Conservation Targets **27**
Site size (hectares): 158,000 (acres): 390,418

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class A&B	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Ponderosa Pine Forest and Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
	Haliaeetus leucocephalus	Bald eagle	G4	LT
Fish	*Agosia chrysogaster*	Longfin dace	G4	
Fish	*Catostomus clarki*	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila robusta	Roundtail chub	G2	
	Rhinichthys osculus	Speckled dace	G5	
Insect	*Cicindela oregona maricopa*	Maricopa tiger beetle	G3	
Mammal	*Antilocapra americana*	Pronghorn	G5	
	Ursus americanus	Black bear	G5	
Vascular plant	*Astragalus troglodytus*	Creeping milk vetch	G2	
	Phlox amabilis	Arizona phlox	G2	
	Talinum validulum	Tusayan flame flower	G3	

Conservation Area	**7 NW Diamond Joe Peak**	Total Conservation Targets	**6**
Site size (hectares):	4,000	(acres):	9,884

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Pinyon-Juniper Woodland	GU	
Mammal	*Myotis thysanodes*	Fringed myotis	G4	
	Myotis volans	Long-legged myotis	G5	

Conservation Area	**8 Cottonwood/ Smith Canyon**	Total Conservation Targets	**15**
Site size (hectares):	24,500	(acres):	60,540

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Pinyon-Juniper Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
Bird	*Buteo albonotatus*	Zone-tailed hawk	G4	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila robusta	Roundtail chub	G2	
Mammal	*Antilocapra americana*	Pronghorn	G5	
	Ursus americanus	Black bear	G5	
Vascular plant	*Penstemon nudiflorus*	Flagstaff beardtongue	G2	
	Phlox amabilis	Arizona phlox	G2	

Conservation Area	**9 Upper Verde River Watershed**	Total Conservation Targets	**65**
Site size (hectares):	312,000	(acres):	770,952

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class A&B	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Cienega point	GU	
		Cienega polygon	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Montane Mixed-Conifer Forest	GU	
		Montane Riparian Woodland and Shrubland	GU	
Ecological System		Pinyon-Juniper Woodland	GU	
		Playa	GU	
		Ponderosa Pine Forest and Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
	Hyla eximia	Mountain treefrog	G4	
	Rana chiricahuensis	Chiricahua leopard frog	G3	LT
	Rana pipiens	Northern leopard frog	G5	
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Buteogallus anthracinus	Common black-hawk	G4	
	Ceryle alcyon	Belted kingfisher	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Empidonax traillii extimus	Southwestern willow flycatcher	G2	LE
	Falco peregrinus anatum	American peregrine falcon	G3	
	Haliaeetus leucocephalus	Bald eagle	G4	LT
	Strix occidentalis lucida	Mexican spotted owl	G3	LT

Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila intermedia	Gila chub	G2	C
	Gila robusta	Roundtail chub	G2	
	Meda fulgida	Spikedace	G2	LT
	Poeciliopsis occidentalis	Gila topminnow	G3	LE
	Rhinichthys osculus	Speckled dace	G5	
	Xyrauchen texanus	Razorback sucker	G1	LE
Insect	*Abedus herberti*	Giant water bug	GU	
	Cicindela oregona maricopa	Maricopa tiger beetle	G3	
	Cylloepus parkeri	Parker's cylloepus riffle beetle	G1	
	Metrichia volada	Page Spring micro caddisfly	GU	
Mammal	*Antilocapra americana*	Pronghorn	G5	
	Myotis lucifugus occultus	Occult little brown bat	G3	
	Myotis thysanodes	Fringed myotis	G4	
	Nyctinomops macrotis	Big free-tailed bat	G5	
	Sciurus arizonensis	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	
Mollusk	*Pyrgulopsis montezumensis*	Montezuma Well springsnail	G1	
	Pyrgulopsis morrisoni	Page springsnail	G1	C
	Pyrgulopsis simplex	Fossil springsnail	G1	
	Pyrgulopsis sola	Brown springsnail	G1	
Reptile	*Thamnophis eques megalops*	Mexican garter snake	G3	
	Thamnophis rufipunctatus	Narrow-headed garter snake	G3	
Vascular plant	*Agave delamateri*	Tonto Basin agave	G2	
	Carex ultra	Arizona giant sedge	G3	
	Erigeron anchana	Mogollon fleabane	G2	
	Eriogonum apachense	Apache wild-buckwheat	G1	
	Eriogonum ripleyi	Ripley wild-buckwheat	G2	
	Hymenoxys jamesii	Hymenoxys jamesii	G2	
	Penstemon nudiflorus	Flagstaff beardtongue	G2	
	Purshia subintegra	Arizona cliff rose	G1	LE
	Rumex orthoneurus	Blumer's dock	G3	
	Salvia dorrii ssp *mearnsii*	Verde Valley sage	G3	
	Talinum validulum	Tusayan flame flower	G3	

Conservation Area **10 Twentynine Mile Lake** Total Conservation Targets **3**
Site size (hectares): 1,000 (acres): 2,471

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Ponderosa Pine Forest and Woodland	GU	
Amphibian	*Hyla eximia*	Mountain treefrog	G4	
Mammal	*Ursus americanus*	Black bear	G5	

Conservation Area **11 Bradshaw Mountains** Total Conservation Targets **9**
Site size (hectares): 8,000 (acres): 19,768

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Montane Mixed-Conifer Forest	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Ponderosa Pine Forest and Woodland	GU	
Bird	*Strix occidentalis lucida*	Mexican spotted owl	G3	LT
Mammal	*Sciurus arizonensis*	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	

Conservation Area **12 Cinch Hook Butte** Total Conservation Targets **3**
Site size (hectares): 500 (acres): 1,236

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Ponderosa Pine Forest and Woodland	GU	
Mammal	*Ursus americanus*	Black bear	G5	

Vascular plant	*Hymenoxys jamesii*	Hymenoxys jamesii	G2

Conservation Area **13 Webber Creek** Total Conservation Targets **5**
Site size (hectares): 500 (acres): 1,236

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Ponderosa Pine Forest and Woodland	GU	
Fish	*Rhinichthys osculus*	Speckled dace	G5	
Mammal	*Sciurus arizonensis*	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	
Vascular plant	*Rumex orthoneurus*	Blumer's dock	G3	

Conservation Area **14 McCloud Mountains** Total Conservation Targets **4**
Site size (hectares): 1,500 (acres): 3,707

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Interior Chaparral	GU	
		Pinyon-Juniper Woodland	GU	
Insect	*Cicindela oregona maricopa*	Maricopa tiger beetle	G3	

Conservation Area **15 Agua Fria River/ Sycamore Mesa** Total Conservation Targets **28**
Site size (hectares): 79,000 (acres): 195,209

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class A&B	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Cienega point	GU	
Ecological System		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Buteo albonotatus*	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Cyprinodon macularius	Desert pupfish	G1	LE
	Gila intermedia	Gila chub	G2	C
	Poeciliopsis occidentalis	Gila topminnow	G3	LE
	Rhinichthys osculus	Speckled dace	G5	
Insect	*Cicindela oregona maricopa*	Maricopa tiger beetle	G3	
Mammal	*Antilocapra americana*	Pronghorn	G5	
	Myotis lucifugus occultus	Occult little brown bat	G3	
	Sciurus arizonensis	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	
Mollusk	*Pyrgulopsis glandulosa*	Verde Rim springsnail	G1	
Reptile	*Thamnophis eques megalops*	Mexican garter snake	G3	

Conservation Area **16 Kirkland Creek/ Peeples Valley Grassland** Total Conservation Targets **10**
Site size (hectares): 16,500 (acres): 40,772

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A&B	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Pinyon-Juniper Woodland	GU	

		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3
	Rana yavapaiensis	Lowland leopard frog	G4
Fish	*Agosia chrysogaster*	Longfin dace	G4
Mammal	*Antilocapra americana*	Pronghorn	G5

Conservation Area **17 Bunger Point** Total Conservation Targets **3**
Site size (hectares): 1,000 (acres): 2,471

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Ponderosa Pine Forest and Woodland	GU	
Amphibian	*Rana pipiens*	Northern leopard frog	G5	
Mammal	*Ursus americanus*	Black bear	G5	

Conservation Area **18 Canyon Creek Complex** Total Conservation Targets **16**
Site size (hectares): 12,000 (acres): 29,652

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Montane Grassland	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Ponderosa Pine Forest and Woodland	GU	
Amphibian	*Hyla eximia*	Mountain treefrog	G4	
	Rana pipiens	Northern leopard frog	G5	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Buteogallus anthracinus	Common black-hawk	G4	
Bird	*Ceryle alcyon*	Belted kingfisher	G5	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
Fish	*Catostomus clarki*	Desert sucker	G3	
	Rhinichthys osculus	Speckled dace	G5	
Mammal	*Myotis thysanodes*	Fringed myotis	G4	
	Sciurus arizonensis	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	
Reptile	*Thamnophis rufipunctatus*	Narrow-headed garter snake	G3	
Vascular plant	*Rumex orthoneurus*	Blumer's dock	G3	

Conservation Area **19 Castle Creek/Black Canyon** Total Conservation Targets **7**
Site size (hectares): 8,000 (acres): 19,768

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Interior Chaparral	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
	Rana yavapaiensis	Lowland leopard frog	G4	
Fish	*Poeciliopsis occidentalis*	Gila topminnow	G3	LE
Mammal	*Ursus americanus*	Black bear	G5	

Conservation Area **20 Hassayampa River/ Blind Indian Creek** Total Conservation Targets **11**
Site size (hectares): 11,500 (acres): 28,417

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Interior Chaparral	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Buteogallus anthracinus*	Common black-hawk	G4	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Poeciliopsis occidentalis	Gila topminnow	G3	LE
Mammal	*Ursus americanus*	Black bear	G5	

Conservation Area **21 Tonto Creek/ Hellsgate Wilderness**	Total Conservation Targets **40**
Site size (hectares): 92,500 (acres): 228,568	

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Cienega point	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Mixed-Conifer Forest	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Ponderosa Pine Forest and Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
	Hyla eximia	Mountain treefrog	G4	
Amphibian	*Rana chiricahuensis*	Chiricahua leopard frog	G3	LT
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Buteogallus anthracinus	Common black-hawk	G4	
	Falco peregrinus anatum	American peregrine falcon	G3	
	Haliaeetus leucocephalus	Bald eagle	G4	LT
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila intermedia	Gila chub	G2	C
	Gila robusta	Roundtail chub	G2	
	Rhinichthys osculus	Speckled dace	G5	
Insect	*Cicindela oregona maricopa*	Maricopa tiger beetle	G3	
Mammal	*Myotis thysanodes*	Fringed myotis	G4	
	Plecotus townsendii pallescens	Pale Townsend's big-eared bat	G4	
	Sciurus arizonensis	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	
Reptile	*Thamnophis eques megalops*	Mexican garter snake	G3	
	Thamnophis rufipunctatus	Narrow-headed garter snake	G3	
Vascular plant	*Agave arizonica*	Arizona agave	G1	LE
	Agave delamateri	Tonto Basin agave	G2	
	Erigeron anchana	Mogollon fleabane	G2	
	Rumex orthoneurus	Blumer's dock	G3	

Conservation Area **22 New River Mountains**	Total Conservation Targets **8**
Site size (hectares): 9,000 (acres): 22,239	

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Mammal	*Antilocapra americana*	Pronghorn	G5	
	Ursus americanus	Black bear	G5	
Vascular plant	*Agave arizonica*	Arizona agave	G1	LE

Conservation Area **23 Cooley Mountain**	Total Conservation Targets **6**
Site size (hectares): 6,000 (acres): 14,826	

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Cienega point	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	

		Ponderosa Pine Forest and Woodland	GU	
Mammal	*Sciurus arizonensis*	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	

Conservation Area **24 Deadman Creek/ Mazatzal Wilderness** Total Conservation Targets **20**
Site size (hectares): 22,000 (acres): 54,362

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
Ecological System		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Ponderosa Pine Forest and Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	G4	
Bird	*Strix occidentalis lucida*	Mexican spotted owl	G3	LT
Fish	*Catostomus clarki*	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila intermedia	Gila chub	G2	C
	Gila robusta	Roundtail chub	G2	
	Rhinichthys osculus	Speckled dace	G5	
Mammal	*Sciurus arizonensis*	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	

Conservation Area **25 Camp Creek/ New River Mesa** Total Conservation Targets **16**
Site size (hectares): 22,000 (acres): 54,362

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Interior Chaparral	GU	
		Pinyon-Juniper Woodland	GU	
		Playa	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Buteo albonotatus*	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Poeciliopsis occidentalis	Gila topminnow	G3	LE
	Rhinichthys osculus	Speckled dace	G5	
Mammal	*Ursus americanus*	Black bear	G5	
Vascular plant	*Agave arizonica*	Arizona agave	G1	LE
	Eriogonum ripleyi	Ripley wild-buckwheat	G2	
	Lotus mearnsii var *equisolensis*	Horseshoe deer vetch	G1	

Conservation Area **26 Salt River Watershed** Total Conservation Targets **45**
Site size (hectares): 230,500 (acres): 569,566

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Ciénega point	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Mixed-Conifer Forest	GU	
		Montane Riparian Woodland and Shrubland	GU	

		Pinyon-Juniper Woodland	GU	
		Ponderosa Pine Forest and Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
	Rana chiricahuensis	Chiricahua leopard frog	G3	LT
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	G4	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Buteogallus anthracinus	Common black-hawk	G4	
	Empidonax traillii extimus	Southwestern willow flycatcher	G2	LE
	Falco peregrinus anatum	American peregrine falcon	G3	
	Haliaeetus leucocephalus	Bald eagle	G4	LT
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila robusta	Roundtail chub	G2	
	Rhinichthys osculus	Speckled dace	G5	
	Xyrauchen texanus	Razorback sucker	G1	LE
Insect	*Agathon arizonicus*	Agathon arizonicus	G1	
	Cicindela oregona maricopa	Maricopa tiger beetle	G3	
Mammal	*Idionycteris phyllotis*	Allen's big-eared bat	G3	
	Myotis lucifugus occultus	Occult little brown bat	G3	
	Sciurus arizonensis	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	
Reptile	*Thamnophis rufipunctatus*	Narrow-headed garter snake	G3	
Vascular plant	*Agave arizonica*	Arizona agave	G1	LE
	Agave delamateri	Tonto Basin agave	G2	
	Cimicifuga arizonica	Arizona bugbane	G2	
	Echinocereus triglochidatus var *arizonicus*	Arizona hedgehog cactus	G2	LE
	Erigeron anchana	Mogollon fleabane	G2	
	Perityle gilensis var *salensis*	Gila rock daisy	G2	
	Perityle saxicola	Fish Creek rock daisy	G1	
	Rumex orthoneurus	Blumer's dock	G3	
	Salvia amissa	Aravaipa sage	G2	

Conservation Area **27 Four Peaks** Total Conservation Targets **10**
Site size (hectares): 8,000 (acres): 19,768

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Cienega point	GU	
		Interior Chaparral	GU	
		Madrean Oak-Pine Woodland	GU	
		Pinyon-Juniper Woodland	GU	
		Ponderosa Pine Forest and Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	G4	
Mammal	*Sciurus arizonensis*	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	
Vascular plant	*Agave delamateri*	Tonto Basin agave	G2	

Conservation Area **28 Campaign Creek/ Superstition Mountains** Total Conservation Targets **8**
Site size (hectares): 5,000 (acres): 12,355

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Pinyon-Juniper Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	G4	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Poeciliopsis occidentalis	Gila topminnow	G3	LE
Mammal	*Ursus americanus*	Black bear	G5	

Conservation Area **29 Apache Peaks** Total Conservation Targets **10**
Site size (hectares): 10,000 (acres): 24,710

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Interior Chaparral	GU	
		Pinyon-Juniper Woodland	GU	
		Ponderosa Pine Forest and Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Mammal	*Myotis velifer*	Cave myotis	G5	
	Plecotus townsendii pallescens	Pale Townsend's big-eared bat	G4	
	Ursus americanus	Black bear	G5	
Vascular plant	*Echinocereus triglochidatus* var *arizonicus*	Arizona hedgehog cactus	G2	LE

Conservation Area **30 Pinal Creek** Total Conservation Targets **5**
Site size (hectares): 3,000 (acres): 7,413

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Interior Chaparral	GU	
		Pinyon-Juniper Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Vascular plant	*Agave delamateri*	Tonto Basin agave	G2	

Conservation Area **31 Pinto Creek/ Webster Mountain** Total Conservation Targets **8**
Site size (hectares): 5,500 (acres): 13,591

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	
		Madrean Oak-Pine Woodland	GU	
		Pinyon-Juniper Woodland	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
	Rana yavapaiensis	Lowland leopard frog	G4	
Insect	*Cicindela oregona maricopa*	Maricopa tiger beetle	G3	

Conservation Area **32 Barge Canyon/ Superstition Mountains** Total Conservation Targets **3**
Site size (hectares): 2,000 (acres): 4,942

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Interior Chaparral	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Vascular plant	*Mabrya acerifolia*	Mapleleaf false snapdragon	G2	

Conservation Area **33 Sawtooth Ridge/ Superstition Mountains** Total Conservation Targets **10**
Site size (hectares): 17,500 (acres): 43,243

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Interior Chaparral	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Mixed-Conifer Forest	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	G4	
Bird	*Strix occidentalis lucida*	Mexican spotted owl	G3	LT
Mammal	*Ursus americanus*	Black bear	G5	
Vascular plant	*Echinocereus triglochidatus* var *arizonicus*	Arizona hedgehog cactus	G2	LE
	Erigeron anchana	Mogollon fleabane	G2	

Conservation Area **34 Ash Flat** Total Conservation Targets **23**
Site size (hectares): 166,000 (acres): 410,186

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Cienega point	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Ponderosa Pine Forest and Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana chiricahuensis*	Chiricahua leopard frog	G3	LT
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Athene cunicularia hypugaea*	Western burrowing owl	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
	Falco peregrinus anatum	American peregrine falcon	G3	
Fish	*Catostomus clarki*	Desert sucker	G3	
	Gila intermedia	Gila chub	G2	C
	Rhinichthys osculus	Speckled dace	G5	
Mammal	*Sciurus arizonensis*	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	

Conservation Area **35 Pinal Mountains** Total Conservation Targets **15**
Site size (hectares): 9,500 (acres): 23,475

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Mixed-Conifer Forest	GU	
		Pinyon-Juniper Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	G4	
Bird	*Buteo albonotatus*	Zone-tailed hawk	G4	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
Mammal	*Myotis lucifugus occultus*	Occult little brown bat	G3	
	Ursus americanus	Black bear	G5	
Vascular plant	*Echinocereus triglochidatus* var *arizonicus*	Arizona hedgehog cactus	G2	LE
	Erigeron pringlei	Pringle's fleabane	G2	
	Hymenoxys ambigens var *ambigens*	Pinaleno mountain plummera	G1	

Conservation Area **36 Mescal Creek/ Upper Gila River** Total Conservation Targets **7**
Site size (hectares): 1,500 (acres): 3,707

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	
		Pinyon-Juniper Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Fish	*Poeciliopsis occidentalis*	Gila topminnow	G3	LE
Mammal	*Ursus americanus*	Black bear	G5	

Conservation Area **37 Dripping Spring Mountains** Total Conservation Targets **5**
Site size (hectares): 1,500 (acres): 3,707

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Interior Chaparral	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Mammal	*Ursus americanus*	Black bear	G5	
Vascular plant	*Penstemon superbus*	Superb beardtongue	G2	

Conservation Area **38 Bonita Creek/ Gila Box Wilderness** Total Conservation Targets **15**
Site size (hectares): 9,500 (acres): 23,475

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	
		Pinyon-Juniper Woodland	GU	
		Ponderosa Pine Forest and Woodland	GU	
Bird	*Buteo albonotatus*	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila intermedia	Gila chub	G2	C
	Rhinichthys osculus	Speckled dace	G5	
Mammal	*Sciurus arizonensis*	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	

Conservation Area **39 Blue River/ Eagle Creek** Total Conservation Targets **43**
Site size (hectares): 351,000 (acres): 867,321

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Chihuahuan Desert Scrub	GU	
		Cienega point	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Ponderosa Pine Forest and Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Bufo microscaphus microscaphus*	Arizona toad	G3	
	Rana chiricahuensis	Chiricahua leopard frog	G3	LT
Amphibian	*Rana pipiens*	Northern leopard frog	G5	
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Athene cunicularia hypugaea*	Western burrowing owl	G4	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Empidonax traillii extimus	Southwestern willow flycatcher	G2	LE
	Falco peregrinus anatum	American peregrine falcon	G3	
	Pipilo aberti	Abert's towhee	G3	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila intermedia	Gila chub	G2	C
	Gila robusta	Roundtail chub	G2	

	Meda fulgida	Spikedace	G2	LT
	Rhinichthys osculus	Speckled dace	G5	
	Tiaroga cobitis	Loach minnow	G2	LT
	Xyrauchen texanus	Razorback sucker	G1	LE
Mammal	*Eumops perotis californicus*	Greater western mastiff bat	G4	
	Sciurus arizonensis	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	
Reptile	*Thamnophis rufipunctatus*	Narrow-headed garter snake	G3	
Vascular plant	*Conioselinum mexicanum*	Mexican hemlock parsley	G2	
	Lupinus lemmonii	Lemmon's lupine	G1	
	Penstemon linarioides ssp *maguirei*	Maguire's penstemon	G1	
	Penstemon superbus	Superb beardtongue	G2	

Conservation Area **40 Santa Teresa Mountains** Total Conservation Targets **7**
Site size (hectares): 1,500 (acres): 3,707

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
Bird	*Falco peregrinus anatum*	American peregrine falcon	G3	
Mammal	*Ursus americanus*	Black bear	G5	
Vascular plant	*Hymenoxys ambigens* var *ambigens*	Pinaleno mountain plummera	G1	

Conservation Area **41 Gila Mountains/ Superb Beardtongue Penstemon** Total Conservation Targets **4**
Site size (hectares): 500 (acres): 1,236

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Mammal	*Sciurus arizonensis*	Arizona tree squirrel	G4	
Vascular plant	*Penstemon superbus*	Superb beardtongue	G2	

Conservation Area **42 Blue Creek/ Lemmons Canyon** Total Conservation Targets **7**
Site size (hectares): 5,000 (acres): 12,355

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Chihuahuan Desert Scrub	GU	
		Interior Chaparral	GU	
		Madrean Oak-Pine Woodland	GU	
		Pinyon-Juniper Woodland	GU	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
Fish	*Catostomus clarki*	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	

Conservation Area **43 Aravaipa Watershed** Total Conservation Targets **41**
Site size (hectares): 136,500 (acres): 337,292

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class A&B	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Grassland and Savanna Condition Class C	GU	
		Apachean Shrubland	GU	
		Chihuahuan Desert Scrub	GU	
		Cienega point	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Mixed-Conifer Forest	GU	
		Montane Riparian Woodland and Shrubland	GU	

		Pinyon-Juniper Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana chiricahuensis*	Chiricahua leopard frog	G3	LT
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Asturina nitida maxima*	Northern gray hawk	G3	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
	Callipepla squamata	Scaled quail	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Falco peregrinus anatum	American peregrine falcon	G3	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila robusta	Roundtail chub	G2	
	Meda fulgida	Spikedace	G2	LT
	Rhinichthys osculus	Speckled dace	G5	
	Tiaroga cobitis	Loach minnow	G2	LT
Insect	*Abedus herberti*	Giant water bug	GU	
	Cicindela oregona maricopa	Maricopa tiger beetle	G3	
Mammal	*Antilocapra americana*	Pronghorn	G5	
	Idionycteris phyllotis	Allen's big-eared bat	G3	
	Sigmodon ochrognathus	Yellow-nosed cotton rat	G4	
	Ursus americanus	Black bear	G5	
Vascular plant	*Erigeron piscaticus*	Fish Creek fleabane	G1	
	Penstemon discolor	Catalina beardtongue	G2	
	Penstemon superbus	Superb beardtongue	G2	
	Salvia amissa	Aravaipa sage	G2	
	Thelypteris puberula var. *sonorensis*	Aravaipa wood fern	G3	

Conservation Area **44 Pinaleño Mountains** Total Conservation Targets **35**

Site size (hectares): 49,500 (acres): 122,315

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Chihuahuan Desert Scrub	GU	
		Cienega point	GU	
Ecological System		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Mixed-Conifer Forest	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Playa	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
		Subalpine Spruce-Fir Forest and Woodland	GU	
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	G4	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Callipepla squamata	Scaled quail	G5	
	Falco peregrinus anatum	American peregrine falcon	G3	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
Fish	*Oncorhynchus apache*	Apache (Arizona) trout	G3	LT
Insect	*Abedus herberti*	Giant water bug	GU	
	Eumorsea pinaleno	Pinaleno monkey grasshopper	G2	
Mammal	*Tamiasciurus hudsonicus grahamensis*	Mount Graham red squirrel	G1	LE
	Ursus americanus	Black bear	G5	
Mollusk	*Oreohelix grahamensis*	Pinaleno mountainsnail	G2	
	Sonorella christenseni	Clark Peak talussnail	G1	
	Sonorella grahamensis	Pinaleno talussnail	G1	
	Sonorella imitator	Mimic talussnail	G2	
	Sonorella macrophallus	Wet Canyon talussnail	G1	C
Reptile	*Crotalus pricei*	Twin-spotted rattlesnake	G5	
Vascular plant	*Erigeron heliographis*	Pinalenos fleabane	G1	
	Eupatorium bigelovii	Bigelow thoroughwort	G2	
	Hymenoxys ambigens var *ambigens*	Pinaleno mountain plummera	G1	

	Potentilla albiflora	White-flowered cinquefoil	G2
	Rumex orthoneurus	Blumer's dock	G3

Conservation Area **46 Kielberg Canyon** Total Conservation Targets **7**
Site size (hectares): 3,500 (acres): 8,649

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
Mammal	*Ursus americanus*	Black bear	G5	
Vascular plant	*Salvia amissa*	Aravaipa sage	G2	

Conservation Area **47 Knight Canyon/ Thompson Canyon** Total Conservation Targets **2**
Site size (hectares): 25,500 (acres): 63,011

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Chihuahuan Desert Scrub	GU	

Conservation Area **48 Buehman Canyon/ Bingham Cienega** Total Conservation Targets **10**
Site size (hectares): 24,500 (acres): 60,540

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Cienega point	GU	
Ecological System		Desert Riparian Woodland and Shrubland	GU	
		Madrean Encinal	GU	
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	G4	
Bird	*Buteo albonotatus*	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
Mammal	*Ursus americanus*	Black bear	G5	
Vascular plant	*Lilaeopsis schaffneriana* var *recurva*	Huachuca water umbel	G2	LE

Conservation Area **49 Dos Cabezas/ Pinaleño Foothills** Total Conservation Targets **10**
Site size (hectares): 27,500 (acres): 67,953

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Chihuahuan Desert Scrub	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
Bird	*Callipepla squamata*	Scaled quail	G5	
Mammal	*Sigmodon ochrognathus*	Yellow-nosed cotton rat	G4	
	Ursus americanus	Black bear	G5	
Vascular plant	*Physalis latiphysa*	Broad-leaf ground-cherry	G1	

Conservation Area **50 Pusch Ridge/ Sabino Creek** Total Conservation Targets **28**
Site size (hectares): 21,000 (acres): 51,891

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	

		Madrean Encinal	GU	
		Montane Mixed-Conifer Forest	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	G4	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Falco peregrinus anatum	American peregrine falcon	G3	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Gila intermedia	Gila chub	G2	C
Insect	*Abedus herberti*	Giant water bug	GU	
	Argia sabino	Sabino Canyon damselfly	G1	
	Calephelis arizonensis	Arizona metalmark	G3	
Mammal	*Sciurus arizonensis*	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	
Reptile	*Cnemidophorus burti*	Giant spotted whiptail	G3	
Vascular plant	*Agave schottii* var *treleasei*	Trelease agave	G1	
	Allium gooddingii	Goodding onion	G4	
	Hedeoma dentatum	Mock pennyroyal	G3	
	Hermannia pauciflora	Sparseleaf hermannia	G2	
	Notholaena lemmonii	Lemmon cloak fern	G3	
	Penstemon discolor	Catalina beardtongue	G2	
	Thelypteris puberula var. *sonorensis*	Aravaipa wood fern	G3	

Conservation Area **51 Langford Mountains** Total Conservation Targets **1**
Site size (hectares): 8,500 (acres): 21,004

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Chihuahuan Desert Scrub	GU	

Conservation Area **52 Peloncillo Mountains/ Lordsburg Playas and Valley** Total Conservation Targets **7**
Site size (hectares): 73,500 (acres): 181,619

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Chihuahuan Desert Scrub	GU	
		Playa	GU	
Bird	*Athene cunicularia hypugaea*	Western burrowing owl	G4	
Reptile	*Phrynosoma cornutum*	Texas horned lizard	G4	
Vascular plant	*Atriplex griffithsii*	Griffith saltbush	G2	

Conservation Area **53 Winchester Mountains/ Allen Flat/ Willcox Playa** Total Conservation Targets **53**
Site size (hectares): 203,500 (acres): 502,849

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Grassland and Savanna Condition Class C	GU	
		Apachean Grassland and Savanna Condition Class D	GU	
		Apachean Shrubland	GU	
		Chihuahuan Desert Scrub	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Mixed-Conifer Forest	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Playa	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana blairi*	Plains leopard frog	G5	
	Rana chiricahuensis	Chiricahua leopard frog	G3	LT

	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Aimophila carpalis	Rufous-winged sparrow	G4	
	Asturina nitida maxima	Northern gray hawk	G3	
	Athene cunicularia hypugaea	Western burrowing owl	G4	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
	Callipepla squamata	Scaled quail	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Falco peregrinus anatum	American peregrine falcon	G3	
	Grus canadensis	Sandhill crane	G5	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Gila intermedia	Gila chub	G2	C
	Rhinichthys osculus	Speckled dace	G5	
	Tiaroga cobitis	Loach minnow	G2	LT
Insect	*Abedus herberti*	Giant water bug	GU	
Mammal	*Antilocapra americana*	Pronghorn	G5	
	Eumops perotis californicus	Greater western mastiff bat	G4	
	Leptonycteris curasoae	Lesser long-nosed bat	G3	LE
	Myotis velifer	Cave myotis	G5	
	Sciurus arizonensis	Arizona tree squirrel	G4	
	Sigmodon ochrognathus	Yellow-nosed cotton rat	G4	
	Ursus americanus	Black bear	G5	
Reptile	*Cnemidophorus burti*	Giant spotted whiptail	G3	
	Phrynosoma cornutum	Texas horned lizard	G4	
Vascular plant	*Atriplex griffithsii*	Griffith saltbush	G2	
	Carex ultra	Arizona giant sedge	G3	
	Echinomastus erectocentrus var *erectocentrus*	Needle-spined pineapple cactus	G3	
	Hedeoma dentatum	Mock pennyroyal	G3	
	Lupinus lemmonii	Lemmon's lupine	G1	
	Penstemon discolor	Catalina beardtongue	G2	
	Salvia amissa	Aravaipa sage	G2	
	Samolus vagans	Chiricahua mountain brookweed	G2	

Conservation Area **54 Tanque Verde Ridge** Total Conservation Targets **18**

Site size (hectares): 11,500 (acres): 28,417

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Mixed-Conifer Forest	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana yavapaiensis*	Lowland leopard frog	G4	
Bird	*Glaucidium brasilianum cactorum*	Cactus ferruginous pygmy-owl	G3	LE
Mammal	*Leptonycteris curasoae*	Lesser long-nosed bat	G3	LE
	Myotis velifer	Cave myotis	G5	
	Sciurus arizonensis	Arizona tree squirrel	G4	
	Ursus americanus	Black bear	G5	
Reptile	*Cnemidophorus burti*	Giant spotted whiptail	G3	
Vascular plant	*Echinomastus erectocentrus* var *erectocentrus*	Needle-spined pineapple cactus	G3	
	Graptopetalum bartramii	Bartram stonecrop	G3	
	Hedeoma dentatum	Mock pennyroyal	G3	
	Notholaena lemmonii	Lemmon cloak fern	G3	

Conservation Area **55 Comobabi Wash** Total Conservation Targets **3**
Site size (hectares): 7,500 (acres): 18,533

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Interior Chaparral	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	

Conservation Area **56 San Pedro River/ Little Dragoon Mountains** Total Conservation Targets **8**
Site size (hectares): 13,500 (acres): 33,359

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
Ecological System		Chihuahuan Desert Scrub	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
Bird	*Callipepla squamata*	Scaled quail	G5	
Vascular plant	*Echinomastus erectocentrus* var *erectocentrus*	Needle-spined pineapple cactus	G3	

Conservation Area **57 Helmet Peak** Total Conservation Targets **6**
Site size (hectares): 2,000 (acres): 4,942

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
Bird	*Callipepla squamata*	Scaled quail	G5	
Mammal	*Macrotus californicus*	California leaf-nosed bat	G4	
	Myotis velifer	Cave myotis	G5	
Mollusk	*Sonorella eremita*	San Xavier talussnail	G1	
Vascular plant	*Coryphantha scheeri* var *robustispina*	Pima pineapple cactus	G2	LE

Conservation Area **58 Chiricahua Mountains** Total Conservation Targets **62**
Site size (hectares): 107,500 (acres): 265,633

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class A&D	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Grassland and Savanna Condition Class C	GU	
		Apachean Grassland and Savanna Condition Class D	GU	
		Apachean Shrubland	GU	
		Chihuahuan Desert Scrub	GU	
		Cienega point	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Mixed-Conifer Forest	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
Amphibian	*Rana blairi*	Plains leopard frog	G5	
	Rana chiricahuensis	Chiricahua leopard frog	G3	LT
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Callipepla squamata	Scaled quail	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Falco peregrinus anatum	American peregrine falcon	G3	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
	Trogon elegans	Elegant trogon	G5	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Campostoma ornatum	Mexican stoneroller	G3	
	Gila purpurea	Yaqui chub	G1	LE

Insect	*Abedus herberti*	Giant water bug	GU	
	Psephenus arizonensis	Arizona water penny beetle	G2	
Mammal	*Idionycteris phyllotis*	Allen's big-eared bat	G3	
	Leptonycteris curasoae	Lesser long-nosed bat	G3	LE
	Myotis ciliolabrum	Western small-footed myotis	G5	
	Myotis thysanodes	Fringed myotis	G4	
	Myotis velifer	Cave myotis	G5	
	Myotis volans	Long-legged myotis	G5	
	Nyctinomops macrotis	Big free-tailed bat	G5	
Mammal	*Plecotus townsendii pallescens*	Pale Townsend's big-eared bat	G4	
	Sciurus nayaritensis chiricahuae	Chiricahua fox squirrel	G1	
	Sorex arizonae	Arizona shrew	G3	
	Ursus americanus	Black bear	G5	
Reptile	*Crotalus pricei*	Twin-spotted rattlesnake	G5	
	Phrynosoma cornutum	Texas horned lizard	G4	
	Sceloporus slevini	Bunch grass lizard	G4	
	Sceloporus virgatus	Striped plateau lizard	G4	
Vascular plant	*Apacheria chiricahuensis*	Chiricahua rock flower	G2	
	Arabis tricornuta	Chiricahua rock cress	G1	
	Astragalus cobrensis var *maguirei*	Coppermine milk-vetch	G2	
	Carex ultra	Arizona giant sedge	G3	
	Draba standleyi	Standley whitlow-grass	G2	
	Erigeron arisolius	Erigeron arisolius	G2	
	Erigeron kuschei	Chiricahua fleabane	G1	
	Gentianella wislizeni	Wislizeni gentian	G2	
	Hedeoma dentatum	Mock pennyroyal	G3	
	Hexalectris warnockii	Texas purple spike	G2	
	Lilium parryi	Lemmon lily	G3	
	Lupinus lemmonii	Lemmon's lupine	G1	
	Perityle cochisensis	Chiricahua rock daisy	G1	
	Polemonium pauciflorum ssp *hinckleyi*	Hinckley's ladder	G2	
	Rumex orthoneurus	Blumer's dock	G3	
	Samolus vagans	Chiricahua mountain brookweed	G2	
	Senecio huachucanus	Huachuca groundsel	G2	
	Senecio neomexicanus var *toumeyi*	Toumey groundsel	G2	
	Stellaria porsildii	Porsild's starwort	G1	

Conservation Area **59 Dragoon Mountains** Total Conservation Targets **16**
Site size (hectares): 10,500 (acres): 25,946

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class D	GU	
		Chihuahuan Desert Scrub	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
Amphibian	*Rana chiricahuensis*	Chiricahua leopard frog	G3	LT
Bird	*Callipepla squamata*	Scaled quail	G5	
	Falco peregrinus anatum	American peregrine falcon	G3	
Mammal	*Leptonycteris curasoae*	Lesser long-nosed bat	G3	LE
	Myotis thysanodes	Fringed myotis	G4	
	Plecotus townsendii pallescens	Pale Townsend's big-eared bat	G4	
	Ursus americanus	Black bear	G5	
Vascular plant	*Carex ultra*	Arizona giant sedge	G3	
	Graptopetalum bartramii	Bartram stonecrop	G3	
	Hedeoma dentatum	Mock pennyroyal	G3	
	Lupinus lemmonii	Lemmon's lupine	G1	
	Penstemon discolor	Catalina beardtongue	G2	

Conservation Area **60 Baboquivari Mountains** Total Conservation Targets **15**
Site size (hectares): 27,500 (acres): 67,953

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	

Ecological System		Madrean Oak-Pine Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Bird	*Glaucidium brasilianum cactorum*	Cactus ferruginous pygmy-owl	G3	LE
Mammal	*Panthera onca*	Jaguar	G3	LE
Vascular plant	*Abutilon thurberi*	Thurber indian mallow	G2	
	Amsonia kearneyana	Kearney's blue star	G1	LE
	Dalea tentaculoides	Gentry indigo bush	G1	
	Graptopetalum bartramii	Bartram stonecrop	G3	
	Hedeoma dentatum	Mock pennyroyal	G3	
	Hexalectris revoluta	Chisos coral-root	G1	
	Metastelma mexicanum	Wiggins milkweed vine	G3	

Conservation Area **61 Sierrita Mountains/ Black Hills** Total Conservation Targets **9**
Site size (hectares): 20,500 (acres): 50,656

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A&B	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Madrean Encinal	GU	
Amphibian	*Rana chiricahuensis*	Chiricahua leopard frog	G3	LT
Bird	*Callipepla squamata*	Scaled quail	G5	
	Glaucidium brasilianum cactorum	Cactus ferruginous pygmy-owl	G3	LE
Vascular plant	*Coryphantha scheeri* var *robustispina*	Pima pineapple cactus	G2	LE

Conservation Area **62 San Pedro River/ Mule Mountains** Total Conservation Targets **25**
Site size (hectares): 44,500 (acres): 109,960

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Chihuahuan Desert Scrub	GU	
		Cienega point	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Playa	GU	
Amphibian	*Rana chiricahuensis*	Chiricahua leopard frog	G3	LT
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Aimophila botterii*	Botteri's sparrow	G4	
	Ammodramus bairdii	Baird's sparrow	G4	
	Asturina nitida maxima	Northern gray hawk	G3	
	Callipepla squamata	Scaled quail	G5	
	Chloroceryle americana	Green kingfisher	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Empidonax traillii extimus	Southwestern willow flycatcher	G2	LE
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
Mammal	*Leptonycteris curasoae*	Lesser long-nosed bat	G3	LE
	Myotis velifer	Cave myotis	G5	
Reptile	*Phrynosoma cornutum*	Texas horned lizard	G4	
	Thamnophis eques megalops	Mexican garter snake	G3	
Vascular plant	*Asplenium dalhousiae*	Asplenium dalhousiae	G3	
	Gentianella wislizeni	Wislizeni gentian	G2	
	Graptopetalum bartramii	Bartram stonecrop	G3	
	Lilaeopsis schaffneriana var *recurva*	Huachuca water umbel	G2	LE

Conservation Area **63 Altar Valley** Total Conservation Targets **28**
Site size (hectares): 56,500 (acres): 139,612

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A&B	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Grassland and Savanna Condition Class C	GU	
		Apachean Shrubland	GU	
		Cienega point	GU	

		Cienega polygon	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana chiricahuensis*	Chiricahua leopard frog	G3	LT
Bird	*Aimophila botterii*	Botteri's sparrow	G4	
	Ammodramus bairdii	Baird's sparrow	G4	
	Asturina nitida maxima	Northern gray hawk	G3	
	Callipepla squamata	Scaled quail	G5	
	Chloroceryle americana	Green kingfisher	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Colinus virginianus ridgwayi	Masked bobwhite	G1	LE
	Glaucidium brasilianum cactorum	Cactus ferruginous pygmy-owl	G3	LE
Mammal	*Antilocapra americana*	Pronghorn	G5	
	Macrotus californicus	California leaf-nosed bat	G4	
	Myotis velifer	Cave myotis	G5	
	Plecotus townsendii pallescens	Pale Townsend's big-eared bat	G4	
	Sigmodon ochrognathus	Yellow-nosed cotton rat	G4	
Reptile	*Thamnophis eques megalops*	Mexican garter snake	G3	
Vascular plant	*Agave parviflora* ssp *parviflora*	Santa Cruz striped agave	G3	
	Coryphantha scheeri var *robustispina*	Pima pineapple cactus	G2	LE
	Heterotheca rutteri	Huachuca golden aster	G2	

Conservation Area **64 Big Hatchet Mountains** Total Conservation Targets **6**
Site size (hectares): 10,500 (acres): 25,946

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Chihuahuan Desert Scrub	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
Mollusk	*Ashmunella hebardi*	Hacheta Grande woodlandsnail	G1	
	Radiocentrum hachetana	Hacheta mountainsnail	G1	

Conservation Area **65 Atascosa/ Pajarito Mountains** Total Conservation Targets **53**
Site size (hectares): 107,000 (acres): 264,397

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A&B	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Cienega point	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Madrean Encinal	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Eleutherodactylus augusti*	Western barking frog	G3	
Amphibian	*Gastrophryne olivacea*	Great Plains narrowmouth toad	G5	
	Rana chiricahuensis	Chiricahua leopard frog	G3	LT
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Aimophila botterii*	Botteri's sparrow	G4	
	Aimophila carpalis	Rufous-winged sparrow	G4	
	Asturina nitida maxima	Northern gray hawk	G3	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Empidonax traillii extimus	Southwestern willow flycatcher	G2	LE
	Falco peregrinus anatum	American peregrine falcon	G3	
	Glaucidium brasilianum cactorum	Cactus ferruginous pygmy-owl	G3	LE
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
	Trogon elegans	Elegant trogon	G5	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus insignis	Sonora sucker	G3	
	Gila ditaenia	Sonora chub	G2	LT
	Poeciliopsis occidentalis	Gila topminnow	G3	LE
Insect	*Abedus herberti*	Giant water bug	GU	

	Calephelis arizonensis	Arizona metalmark	G3	
Mammal	*Antilocapra americana*	Pronghorn	G5	
	Myotis velifer	Cave myotis	G5	
	Panthera onca	Jaguar	G3	LE
	Plecotus townsendii pallescens	Pale Townsend's big-eared bat	G4	
	Sigmodon ochrognathus	Yellow-nosed cotton rat	G4	
	Ursus americanus	Black bear	G5	
Reptile	*Cnemidophorus burti*	Giant spotted whiptail	G3	
	Eumeces callicephalus	Mountain skink	G5	
Vascular plant	*Agave parviflora* ssp *flexiflora*	Maguey	G3	
	Agave parviflora ssp *parviflora*	Santa Cruz striped agave	G3	
	Amsonia grandiflora	Large-flowered blue star	G2	
	Carex ultra	Arizona giant sedge	G3	
	Choisya mollis	Santa Cruz star leaf	G2	
	Coryphantha scheeri var *robustispina*	Pima pineapple cactus	G2	LE
	Dalea tentaculoides	Gentry indigo bush	G1	
	Erigeron arisolius	Erigeron arisolius	G2	
	Graptopetalum bartramii	Bartram stonecrop	G3	
	Hedeoma dentatum	Mock pennyroyal	G3	
	Macroptilium supinum	Supine bean	G2	
	Metastelma mexicanum	Wiggins milkweed vine	G3	
	Notholaena lemmonii	Lemmon cloak fern	G3	
	Pectis imberbis	Beardless chinch weed	G3	
	Penstemon discolor	Catalina beardtongue	G2	
	Penstemon superbus	Superb beardtongue	G2	
	Physalis latiphysa	Broad-leaf ground-cherry	G1	

Conservation Area **66 Huachuca Mountains Grassland Valley Complex** Total Conservation Targets **119**
Site size (hectares): 569,000 (acres): 1,405,999

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class A&B	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Grassland and Savanna Condition Class C	GU	
		Apachean Grassland and Savanna Condition Class D	GU	
		Apachean Shrubland	GU	
		Chihuahuan Desert Scrub	GU	
		Cienega point	GU	
Ecological System		Cienega polygon	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Desert Wash	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Mixed-Conifer Forest	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Pinyon-Juniper Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Ambystoma tigrinum stebbinsi*	Sonoran tiger salamander	G1	LE
	Eleutherodactylus augusti	Western barking frog	G3	
	Hyla eximia	Mountain treefrog	G4	
	Rana chiricahuensis	Chiricahua leopard frog	G3	LT
	Rana pipiens	Northern leopard frog	G5	
	Rana subaquavocalis	Ramsey Canyon leopard frog	G1	
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Aimophila botterii	Botteri's sparrow	G4	
	Ammodramus bairdii	Baird's sparrow	G4	
	Asturina nitida maxima	Northern gray hawk	G3	
	Athene cunicularia hypugaea	Western burrowing owl	G4	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
	Callipepla squamata	Scaled quail	G5	
	Ceryle alcyon	Belted kingfisher	G5	
	Chloroceryle americana	Green kingfisher	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Cyrtonyx montezumae	Montezuma quail	G4	

	Empidonax traillii extimus	Southwestern willow flycatcher	G2	LE
	Falco femoralis septentrionalis	Northern aplomado falcon	G2	LE
	Falco peregrinus anatum	American peregrine falcon	G3	
	Glaucidium brasilianum cactorum	Cactus ferruginous pygmy-owl	G3	LE
	Haliaeetus leucocephalus	Bald eagle	G4	LT
	Pipilo aberti	Abert's towhee	G3	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
	Trogon elegans	Elegant trogon	G5	
Crustacean	*Stygobromus arizonensis*	Arizona cave amphipod	G2	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Catostomus clarki	Desert sucker	G3	
	Catostomus insignis	Sonora sucker	G3	
	Catostomus wigginsii	Matalote opata	G3	
	Cyprinodon macularius	Desert pupfish	G1	LE
	Gila intermedia	Gila chub	G2	C
	Poeciliopsis occidentalis	Gila topminnow	G3	LE
	Rhinichthys osculus	Speckled dace	G5	
Insect	*Abedus herberti*	Giant water bug	GU	
	Agathymus evansi	Huachuca giant-skipper	G2	
	Calephelis arizonensis	Arizona metalmark	G3	
	Heterelmis stephani	Stephan's heterelmis riffle beetle	G2	C
Mammal	*Antilocapra americana*	Pronghorn	G5	
	Cynomys ludovicianus	Black-tailed prairie dog	G4	C
	Leptonycteris curasoae	Lesser long-nosed bat	G3	LE
	Macrotus californicus	California leaf-nosed bat	G4	
	Myotis ciliolabrum	Western small-footed myotis	G5	
	Myotis thysanodes	Fringed myotis	G4	
	Myotis velifer	Cave myotis	G5	
Mammal	*Panthera onca*	Jaguar	G3	LE
	Plecotus townsendii pallescens	Pale Townsend's big-eared bat	G4	
	Sciurus arizonensis	Arizona tree squirrel	G4	
	Sigmodon ochrognathus	Yellow-nosed cotton rat	G4	
	Sorex arizonae	Arizona shrew	G3	
	Ursus americanus	Black bear	G5	
Mollusk	*Pyrgulopsis thompsoni*	Huachuca springsnail	G2	C
Reptile	*Cnemidophorus burti*	Giant spotted whiptail	G3	
	Cnemidophorus opatae	Huico de oputo	G1	
	Crotalus pricei	Twin-spotted rattlesnake	G5	
	Crotalus willardi willardi	Arizona ridgenose rattlesnake	G3	
	Eumeces callicephalus	Mountain skink	G5	
	Phrynosoma cornutum	Texas horned lizard	G4	
	Sceloporus slevini	Bunch grass lizard	G4	
	Terrapene ornata luteola	Desert box turtle	G4	
	Thamnophis eques megalops	Mexican garter snake	G3	
Vascular plant	*Agave parviflora* ssp *parviflora*	Santa Cruz striped agave	G3	
	Amoreuxia gonzalezii	Saiya	G1	
	Amsonia grandiflora	Large-flowered blue star	G2	
	Arabis tricornuta	Chiricahua rock cress	G1	
	Asclepias uncialis	Greene milkweed	G3	
	Aster potosinus	Lemmon's aster	G2	
	Astragalus hypoxylus	Huachuca milk-vetch	G1	
	Browallia eludens	Elusive new browallia species	G2	
	Carex ultra	Arizona giant sedge	G3	
	Coryphantha scheeri var *robustispina*	Pima pineapple cactus	G2	LE
	Dryopteris patula var *rossii*	Mexican shield fern	G1	
	Echinomastus erectocentrus var *erectocentrus*	Needle-spined pineapple cactus	G3	
	Erigeron arisolius	Erigeron arisolius	G2	
	Erigeron lemmonii	Lemmon fleabane	G1	C
	Erigeron pringlei	Pringle's fleabane	G2	
	Euphorbia macropus	Woodland spurge	G4	
	Graptopetalum bartramii	Bartram stonecrop	G3	
	Hedeoma dentatum	Mock pennyroyal	G3	
	Heterotheca rutteri	Huachuca golden aster	G2	
	Hexalectris revoluta	Chisos coral-root	G1	
	Hexalectris warnockii	Texas purple spike	G2	
	Hieracium pringlei	Pringle hawkweed	G2	
	Hieracium rusbyi	Rusby hawkweed	G2	
	Lilaeopsis schaffneriana var *recurva*	Huachuca water umbel	G2	LE

	Lilium parryi	Lemmon lily	G3	
	Lupinus huachucanus	Huachuca mountain lupine	G2	
	Macroptilium supinum	Supine bean	G2	
	Metastelma mexicanum	Wiggins milkweed vine	G3	
	Muhlenbergia dubioides	Box Canyon muhly	G1	
	Pectis imberbis	Beardless chinch weed	G3	
	Penstemon superbus	Superb beardtongue	G2	
	Psilactis gentryi	Mexican bare-ray-aster	G2	
	Rumex orthoneurus	Blumer's dock	G3	
	Samolus vagans	Chiricahua mountain brookweed	G2	
	Senecio huachucanus	Huachuca groundsel	G2	
	Spiranthes delitescens	Madrean ladies'-tresses	G1	LE
	Talinum humile	Pinos Altos flame flower	G2	
	Talinum marginatum	Tepic flame flower	G2	

Conservation Area **67 Sierra San Luis/ Peloncillo Mountains** Total Conservation Targets **71**
Site size (hectares): 757,500 (acres): 1,871,783

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Grassland and Savanna Condition Class A&B	GU	
		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Grassland and Savanna Condition Class C	GU	
		Apachean Grassland and Savanna Condition Class D	GU	
		Apachean Shrubland	GU	
		Chihuahuan Desert Scrub	GU	
		Cienega point	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Montane Riparian Woodland and Shrubland	GU	
		Playa	GU	
		Ponderosa Pine Forest and Woodland	GU	
Amphibian	*Rana blairi*	Plains leopard frog	G5	
	Rana chiricahuensis	Chiricahua leopard frog	G3	LT
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Aimophila botterii	Botteri's sparrow	G4	
	Ammodramus bairdii	Baird's sparrow	G4	
	Asturina nitida maxima	Northern gray hawk	G3	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
	Callipepla squamata	Scaled quail	G5	
	Ceryle alcyon	Belted kingfisher	G5	
	Chloroceryle americana	Green kingfisher	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Falco femoralis septentrionalis	Northern aplomado falcon	G2	LE
	Haliaeetus leucocephalus	Bald eagle	G4	LT
	Pipilo aberti	Abert's towhee	G3	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
	Trogon elegans	Elegant trogon	G5	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Campostoma ornatum	Mexican stoneroller	G3	
	Catostomus bernardini	Yaqui sucker	G4	
	Cyprinella formosa	Beautiful shiner	G2	LT
	Gila intermedia	Gila chub	G2	C
	Gila purpurea	Yaqui chub	G1	LE
	Gila robusta	Roundtail chub	G2	
	Ictalurus pricei	Yaqui catfish	G2	LT
	Poeciliopsis occidentalis	Yaqui topminnow	G3	LE
Mammal	*Antilocapra americana*	Pronghorn	G5	
	Cynomys ludovicianus	Black-tailed prairie dog	G4	C
	Leptonycteris curasoae	Lesser long-nosed bat	G3	LE
	Lepus callotis	White-sided jack rabbit	G3	
	Myotis velifer	Cave myotis	G5	
	Panthera onca	Jaguar	G3	LE
	Sigmodon ochrognathus	Yellow-nosed cotton rat	G4	

	Sorex arizonae	Arizona shrew	G3	
	Thomomys umbrinus	Southern pocket gopher	G5	
	Ursus americanus	Black bear	G5	
Mollusk	*Ashmunella animasensis*	Animas Peak woodlandsnail	G1	
	Pyrgulopsis bernardina	San Bernardino springsnail	G1	
	Sonorella animasensis	Animas talussnail	G1	
Reptile	*Crotalus willardi obscurus*	New Mexico ridgenose rattlesnake	G1	LT
	Phrynosoma cornutum	Texas horned lizard	G4	
	Sceloporus slevini	Bunch grass lizard	G4	
	Sceloporus virgatus	Striped plateau lizard	G4	
	Sistrurus catenatus edwardsii	Desert massasauga	G3	
	Terrapene ornata luteola	Desert box turtle	G4	
	Thamnophis eques megalops	Mexican garter snake	G3	
Vascular plant	*Astragalus cobrensis* var *maguirei*	Coppermine milk-vetch	G2	
	Carex ultra	Arizona giant sedge	G3	
	Cleome multicaulis	Playa spider plant	G2	
	Coryphantha robbinsorum	Cochise pincushion cactus	G1	LT
	Hymenoxys ambigens var *ambigens*	Pinaleno mountain plummera	G1	
	Lilaeopsis schaffneriana var *recurva*	Huachuca water umbel	G2	LE
	Penstemon superbus	Superb beardtongue	G2	
	Physalis latiphysa	Broad-leaf ground-cherry	G1	
	Vauquelinia californica ssp *pauciflora*	Limestone Arizona rosewood	G3	

Conservation Area **68 Patagonia Mountains** Total Conservation Targets **12**
Site size (hectares): 5,500 (acres): 13,591

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Madrean Encinal	GU	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Falco peregrinus anatum	American peregrine falcon	G3	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
Mammal	*Sciurus arizonensis*	Arizona tree squirrel	G4	
	Sigmodon ochrognathus	Yellow-nosed cotton rat	G4	
	Ursus americanus	Black bear	G5	
Reptile	*Crotalus willardi willardi*	Arizona ridgenose rattlesnake	G3	
Vascular plant	*Astragalus hypoxylus*	Huachuca milk-vetch	G1	
	Euphorbia macropus	Woodland spurge	G4	
	Pectis imberbis	Beardless chinch weed	G3	

Conservation Area **69 El Fresnal Arroyo** Total Conservation Targets **3**
Site size (hectares): 4,000 (acres): 9,884

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Bird	*Callipepla squamata*	Scaled quail	G5	

Conservation Area **70 Arroyo la Cienega** Total Conservation Targets **7**
Site size (hectares): 2,000 (acres): 4,942

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Cienega point	GU	
		Madrean Encinal	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Bird	*Asturina nitida maxima*	Northern gray hawk	G3	
	Ceryle alcyon	Belted kingfisher	G5	
	Cyrtonyx montezumae	Montezuma quail	G4	

Conservation Area **71 Sierra Cibuta/ Sierra Pinito** Total Conservation Targets **19**
Site size (hectares): 45,500 (acres): 112,431

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Cienega point	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Pinyon-Juniper Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Ambystoma rosaceum*	Salamandra	GU	
	Rana pipiens	Northern leopard frog	G5	
	Rana tarahumarae	Tarahumara frog	G3	
Bird	*Aimophila carpalis*	Rufous-winged sparrow	G4	
	Asturina nitida maxima	Northern gray hawk	G3	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
	Chloroceryle americana	Green kingfisher	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Cyrtonyx montezumae	Montezuma quail	G4	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
	Trogon elegans	Elegant trogon	G5	
Reptile	*Thamnophis eques megalops*	Mexican garter snake	G3	

Conservation Area **72 Sierra Cibuta/ Punta de Agua** Total Conservation Targets **2**
Site size (hectares): 7,000 (acres): 17,297

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Madrean Encinal	GU	

Conservation Area **73 Sierra los Azules/ Arroyo los Azules Grassland** Total Conservation Targets **9**
Site size (hectares): 37,000 (acres): 91,427

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class A	GU	
		Apachean Shrubland	GU	
		Chihuahuan Desert Scrub	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Playa	GU	
Bird	*Athene cunicularia hypugaea*	Western burrowing owl	G4	
	Empidonax traillii extimus	Southwestern willow flycatcher	G2	LE
Mammal	*Cynomys ludovicianus*	Black-tailed prairie dog	G4	C

Conservation Area **74 Cañon el Pulpito** Total Conservation Targets **5**
Site size (hectares): 5,500 (acres): 13,591

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Madrean Encinal	GU	
Amphibian	*Rana tarahumarae*	Tarahumara frog	G3	
Bird	*Buteogallus anthracinus*	Common black-hawk	G4	
Mammal	*Sciurus nayaritensis chiricahuae*	Chiricahua fox squirrel	G1	

Conservation Area **75 Arroyo Bambuto/ Rio Magdalena** Total Conservation Targets **10**
Site size (hectares): 9,500 (acres): 23,475

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Madrean Encinal	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	

Bird	*Coccyzus americanus occidentalis*	Western yellow-billed cuckoo	G3	C
	Empidonax traillii extimus	Southwestern willow flycatcher	G2	LE
Fish	*Gila ditaenia*	Sonora chub	G2	LT
Reptile	*Terrapene ornata luteola*	Desert box turtle	G4	
	Thamnophis eques megalops	Mexican garter snake	G3	
Vascular plant	*Abutilon thurberi*	Thurber indian mallow	G2	
	Lilaeopsis schaffneriana var *recurva*	Huachuca water umbel	G2	LE

Conservation Area **76 Sierra Buenos Aires** Total Conservation Targets **4**
Site size (hectares): 4,500 (acres): 11,120

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Cienega point	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	

Conservation Area **77 Cerro el Picacho/ Upper Rio Sonora** Total Conservation Targets **20**
Site size (hectares): 51,000 (acres): 126,021

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Madrean Encinal	GU	
		Pinyon-Juniper Woodland	GU	
Bird	*Aimophila botterii*	Botteri's sparrow	G4	
	Aimophila carpalis	Rufous-winged sparrow	G4	
	Asturina nitida maxima	Northern gray hawk	G3	
	Ceryle alcyon	Belted kingfisher	G5	
	Chloroceryle americana	Green kingfisher	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Cyrtonyx montezumae	Montezuma quail	G4	
	Trogon elegans	Elegant trogon	G5	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Campostoma ornatum	Mexican stoneroller	G3	
	Catostomus wigginsii	Matalote opata	G3	
	Gila eremica	Desert chub	G4	
	Poeciliopsis occidentalis	Yaqui topminnow	G3	LE
Reptile	*Phrynosoma ditmarsi*	Rock horned lizard	G1	
Vascular plant	*Amsonia grandiflora*	Large-flowered blue star	G2	
	Dalea tentaculoides	Gentry indigo bush	G1	

Conservation Area **78 Sierra la Madera** Total Conservation Targets **5**
Site size (hectares): 10,500 (acres): 25,946

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Madrean Encinal	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana tarahumarae*	Tarahumara frog	G3	
Bird	*Strix occidentalis lucida*	Mexican spotted owl	G3	LT

Conservation Area **79 Sierra Azul** Total Conservation Targets **6**
Site size (hectares): 32,500 (acres): 80,308

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Pinyon-Juniper Woodland	GU	
Bird	*Strix occidentalis lucida*	Mexican spotted owl	G3	LT
Mammal	*Ursus americanus*	Black bear	G5	

Conservation Area **80 Mesa las Guacamayas/ Sierra el Palomo** Total Conservation Targets **4**
Site size (hectares): 18,500 (acres): 45,714

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	

Conservation Area **81 Cañon la Palma** Total Conservation Targets **4**
Site size (hectares): 8,000 (acres): 19,768

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Madrean Encinal	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Vascular plant	*Brahea nitida*	Palma lisa	G1	

Conservation Area **82 Sierra el Tigre/ Rio Bavispe Watershed** Total Conservation Targets **57**
Site size (hectares): 381,000 (acres): 941,451

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Cienega point	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Interior Chaparral	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Pinyon-Juniper Woodland	GU	
		Sinaloan Thornscrub	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
		Sonoran Short Tree / Desert Scrub	GU	
Amphibian	*Ambystoma rosaceum*	Salamandra	GU	
	Ambystoma tigrinum stebbinsi	Sonoran tiger salamander	G1	LE
	Bufo microscaphus microscaphus	Arizona toad	G3	
	Gastrophryne olivacea	Great Plains narrowmouth toad	G5	
	Rana chiricahuensis	Chiricahua leopard frog	G3	LT
	Rana pipiens	Northern leopard frog	G5	
	Rana tarahumarae	Tarahumara frog	G3	
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Accipiter gentilis*	Northern goshawk	G5	
	Aimophila botterii	Botteri's sparrow	G4	
	Aimophila carpalis	Rufous-winged sparrow	G4	
	Asturina nitida maxima	Northern gray hawk	G3	
	Buteo albonotatus	Zone-tailed hawk	G4	
Bird	*Buteogallus anthracinus*	Common black-hawk	G4	
	Callipepla squamata	Scaled quail	G5	
	Ceryle alcyon	Belted kingfisher	G5	
	Chloroceryle americana	Green kingfisher	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Cyrtonyx montezumae	Montezuma quail	G4	
	Empidonax traillii extimus	Southwestern willow flycatcher	G2	LE
	Falco peregrinus anatum	American peregrine falcon	G3	
	Haliaeetus leucocephalus	Bald eagle	G4	LT
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
	Trogon elegans	Elegant trogon	G5	
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Campostoma ornatum	Mexican stoneroller	G3	
	Catostomus bernardini	Yaqui sucker	G4	
	Cyprinella formosa	Beautiful shiner	G2	LT
	Gila eremica	Desert chub	G4	
	Gila robusta	Roundtail chub	G2	
	Ictalurus pricei	Yaqui catfish	G2	LT
	Poeciliopsis occidentalis	Yaqui topminnow	G3	LE
Mammal	*Eumops perotis californicus*	Greater western mastiff bat	G4	

	Macrotus californicus	California leaf-nosed bat	G4
	Myotis velifer	Cave myotis	G5
	Myotis yumanensis	Yuma myotis	G5
	Plecotus townsendii pallescens	Pale Townsend's big-eared bat	G4
	Ursus americanus	Black bear	G5
Reptile	*Cnemidophorus burti*	Giant spotted whiptail	G3
	Cnemidophorus opatae	Huico de oputo	G1
	Thamnophis eques megalops	Mexican garter snake	G3
Vascular plant	*Agave parviflora* ssp *flexiflora*	Maguey	G3
	Asplenium dalhousiae	Asplenium dalhousiae	G3
	Aster potosinus	Lemmon's aster	G2
	Bernardia myricaefolia	Bernardia myricaefolia	G2
	Carex ultra	Arizona giant sedge	G3
	Dalea tentaculoides	Gentry indigo bush	G1

Conservation Area **83 Rio Fronteras** Total Conservation Targets **23**
Site size (hectares): 123,500 (acres): 305,169

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Grassland and Savanna Condition Class B	GU	
		Apachean Shrubland	GU	
		Chihuahuan Desert Scrub	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Madrean Encinal	GU	
		Madrean Oak-Pine Woodland	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana pipiens*	Northern leopard frog	G5	
Bird	*Aimophila carpalis*	Rufous-winged sparrow	G4	
	Asturina nitida maxima	Northern gray hawk	G3	
	Buteogallus anthracinus	Common black-hawk	G4	
	Ceryle alcyon	Belted kingfisher	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Cyrtonyx montezumae	Montezuma quail	G4	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
Fish	*Agosia chrysogaster*	Longfin dace	G4	
	Campostoma ornatum	Mexican stoneroller	G3	
	Catostomus bernardini	Yaqui sucker	G4	
Fish	*Cyprinella formosa*	Beautiful shiner	G2	LT
	Poeciliopsis occidentalis	Yaqui topminnow	G3	LE
Reptile	*Crotalus willardi willardi*	Arizona ridgenose rattlesnake	G3	
	Phrynosoma cornutum	Texas horned lizard	G4	
Vascular plant	*Agave parviflora* ssp *flexiflora*	Maguey	G3	

Conservation Area **84 Arroyo Agua Caliente/ Sierra Jucaral** Total Conservation Targets **24**
Site size (hectares): 55,000 (acres): 135,905

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Desert Riparian Woodland and Shrubland	GU	
		Madrean Encinal	GU	
		Sinaloan Thornscrub	GU	
		Sonoran Paloverde-Mixed Cacti Desert Scrub	GU	
Amphibian	*Rana pipiens*	Northern leopard frog	G5	
Bird	*Aimophila botterii*	Botteri's sparrow	G4	
	Aimophila carpalis	Rufous-winged sparrow	G4	
	Asturina nitida maxima	Northern gray hawk	G3	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Buteogallus anthracinus	Common black-hawk	G4	
	Ceryle alcyon	Belted kingfisher	G5	
	Chloroceryle americana	Green kingfisher	G5	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Cyrtonyx montezumae	Montezuma quail	G4	
	Empidonax traillii extimus	Southwestern willow flycatcher	G2	LE
	Falco peregrinus anatum	American peregrine falcon	G3	
	Trogon elegans	Elegant trogon	G5	
Fish	*Campostoma ornatum*	Mexican stoneroller	G3	

	Catostomus wigginsii	Matalote opata	G3	
Reptile	*Terrapene ornata luteola*	Desert box turtle	G4	
	Thamnophis eques megalops	Mexican garter snake	G3	
Vascular plant	*Amsonia grandiflora*	Large-flowered blue star	G2	
	Carex ultra	Arizona giant sedge	G3	

Conservation Area **85 Sierra el Carmen** Total Conservation Targets **2**
Site size (hectares): 25,000 (acres): 61,775

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Madrean Encinal	GU	

Conservation Area **86 Arroyo la Sauceda/ Cerro Caloso** Total Conservation Targets **5**
Site size (hectares): 9,000 (acres): 22,239

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Madrean Encinal	GU	
Amphibian	*Rana chiricahuensis*	Chiricahua leopard frog	G3	LT
	Rana tarahumarae	Tarahumara frog	G3	
	Rana yavapaiensis	Lowland leopard frog	G4	

Conservation Area **87 Sierra la Sandia/ Sierra la Madera** Total Conservation Targets **4**
Site size (hectares): 19,000 (acres): 46,949

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Madrean Encinal	GU	
Ecological System		Madrean Oak-Pine Woodland	GU	
		Sinaloan Thornscrub	GU	

Conservation Area **88 Cordon el Alamo** Total Conservation Targets Targets **6**
Site size (hectares): 3,500 (acres): 8,649

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Sinaloan Thornscrub	GU	
		Sonoran Short Tree / Desert Scrub	GU	
Bird	*Aimophila carpalis*	Rufous-winged sparrow	G4	
	Buteo albonotatus	Zone-tailed hawk	G4	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C

Conservation Area **89 Sierra el Oso/ Sierra Verde** Total Conservation Targets Targets **5**
Site size (hectares): 24,000 (acres): 59,304

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Madrean Encinal	GU	
		Sinaloan Thornscrub	GU	
Amphibian	*Rana pipiens*	Northern leopard frog	G5	
Reptile	*Phrynosoma ditmarsi*	Rock horned lizard	G1	

Conservation Area **90 Sierra Aconchi** Total Conservation Targets **14**
Site size (hectares): 37,000 (acres): 91,427

Taxonomic Group	Scientific Name	Common Name	Global Rank	ESA Status
Ecological System		Apachean Shrubland	GU	
		Madrean Encinal	GU	
		Sinaloan Thornscrub	GU	

Amphibian	*Ambystoma rosaceum*	Salamandra	GU	
	Rana tarahumarae	Tarahumara frog	G3	
	Rana yavapaiensis	Lowland leopard frog	G4	
Bird	*Aimophila carpalis*	Rufous-winged sparrow	G4	
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	G3	C
	Cyrtonyx montezumae	Montezuma quail	G4	
	Strix occidentalis lucida	Mexican spotted owl	G3	LT
	Trogon elegans	Elegant trogon	G5	
Mammal	*Ursus americanus*	Black bear	G5	
Reptile	*Cnemidophorus burti*	Giant spotted whiptail	G3	
Vascular plant	*Agave parviflora* ssp *flexiflora*	Maguey	G3	

Conservation Area **91 Sierra del Jaralito** Total Conservation Targets **3**

Site size (hectares): 4,500 (acres): 11,120

Taxonomic Group	**Scientific Name**	**Common Name**	**Global Rank**	**ESA Status**
Ecological System		Madrean Encinal	GU	
		Sinaloan Thornscrub	GU	
Bird	*Ceryle alcyon*	Belted kingfisher	G5	