

Resource Monitoring Brief

Landscape Dynamics

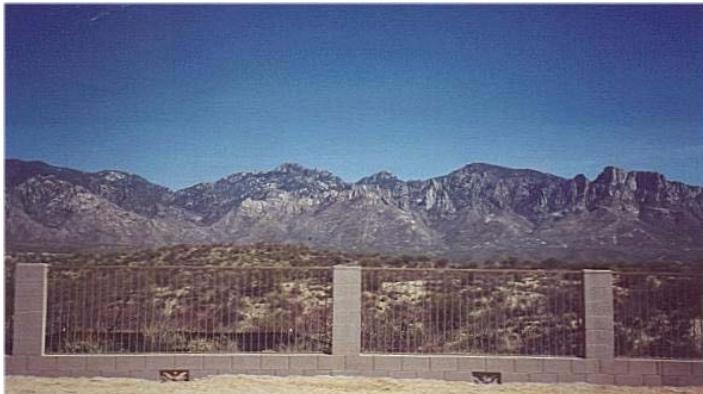
National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science
Inventory and Monitoring Program

Connecting Saguaro National Park to its Surrounding Landscapes

Imagine if people could no longer travel to America's national parks because the lands in between were simply inhospitable. For many species of plants and animals this is not a farfetched possibility – it's actually true when natural habitats around parks are lost to human development. In many places across America our national parks and other protected areas are becoming 'Protected Islands'. These are places where humans have encroached upon and – in some cases – completely surrounded a protected area, thus making it an island of natural habitat in a sea of development. Moving into the 21st century, urban growth around Tucson shows no signs of slowing. Now more than ever it is imperative that Saguaro evaluate human impact in order to develop a sustainable management plan that deals with urban encroachment on the Park.



A common backyard fence like this one can be a serious barrier to wildlife. The only animals crossing it are either small enough to fit through the drains at the base, or large enough to jump over. Photo from <http://easystreet.com>.

Saguaro National Park is threatened by this very issue. Separated by the city of Tucson and surrounding communities, Saguaro's two park districts (Tucson Mountain District to the West and the Rincon Mountain District to the East, Figure 1) struggle to maintain connectivity both with one another and with the broader landscape. The Park is increasingly isolated and disconnected from surrounding areas by human drivers of landscape change, including:

- Roads, which increase mortality in some species (roadkill) and lead to road aversion in others. Dense networks of urban roads and large roads like highways and interstates create the biggest challenges.
- Housing sprawl, where new construction literally bulldozes over natural systems, destroying and fragmenting habitat in the process and interrupting many natural processes.
- Pollution, where atmospheric, water, noise, and light pollution can all erode species' habitats and alter the movements of individuals.

- Water diversions, which reroute waters towards cities/towns and agricultural fields. Diversions reduce the natural availability of water and create obstacles to movement.

Despite these landscape-level impediments, habitat connectivity is critical for sustaining biodiversity inside Saguaro because many species require resources that extend beyond park boundaries. Unfortunately, no park – including Saguaro – can fully protect an entire ecosystem, only a small portion of it. In 1916 when the NPS was established it was believed that simply putting up a fence to keep human influences out would protect park resources. Since then much scientific study has been done that suggests otherwise. We now know that in order for an ecosystem to function its species must be able to move freely through it.

Measuring Human Impact on a Landscape

To fully understand how Saguaro depends on habitat connectivity it is important to evaluate connectivity at different scales. Saguaro's diverse resources depend to varying degrees on habitat connectivity within each district of the Park, between the two districts, and at a larger ecoregional scale (Figure 1).

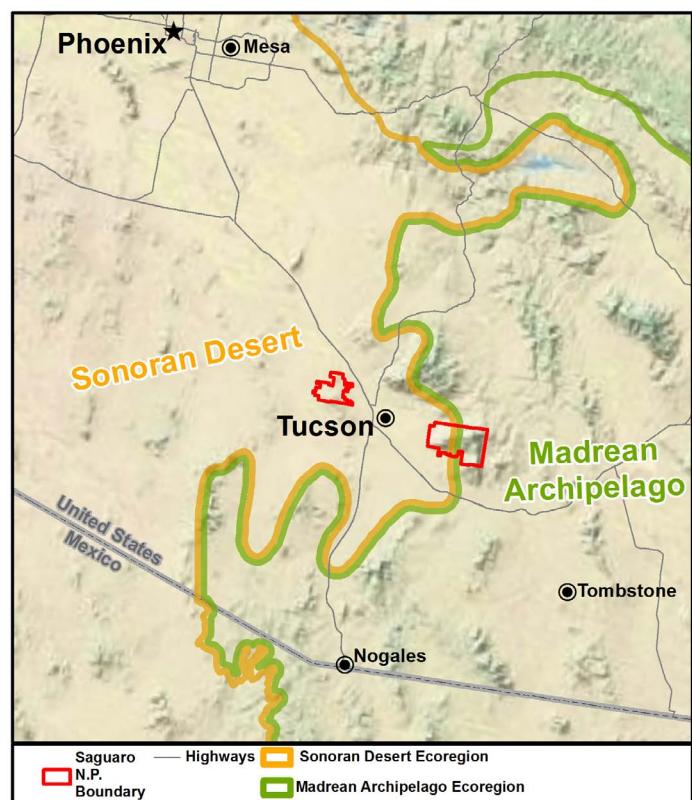


Figure 1. The Tucson Mountain District (West) and Rincon Mountain District (East) of Saguaro National Park, separated by the greater Tucson area and located on the transition between two ecoregions: the Sonoran Desert (West) and the Madrean Archipelago (Sky Islands, East).

Measuring Human Impact on a Landscape

These different spatial scales also vary in terms of the timespans over which species move. For example, small carnivores like the bobcat may move within each district on a daily to weekly basis, between districts on an annual basis, and ecoregionally only over the course of multiple generations. Such movements would undoubtedly be different for a more sedentary species like the desert tortoise, or a migratory bird like the Wilson's warbler. Yet, the three spatial scales (district, park, ecoregion) capture the wide range of areas over which these movements occur.



Bobcat up a saguaro. NPS photo archive.

Connectivity within the Park

Within each district, connectivity differs greatly between the eastern Rincon Mountain District and western Tucson Mountain District of Saguaro. The Rincon Mountain District has only a few miles of roads, which tend to be concentrated on the west side near the Park entrance. Otherwise, the district is accessible only by trail. Animals like mountain lions, diamondback rattlesnakes, and Gila monsters are able to move and access the resources they need.

Meanwhile, the Tucson Mountain District is heavily dissected by roads (Figure 2). Roads can present a significant barrier to species – they scare off many forms of wildlife from up to a kilometer away. Animals that are not deterred by roads and traffic must avoid getting hit. For some species like the desert tortoise, crossing a road is a daunting task that comes with a high likelihood of death. By fragmenting critical habitat, roads further isolate populations of species, thus increasing the likelihood that certain populations will go extinct.



Gila monster. NPS photo archive.

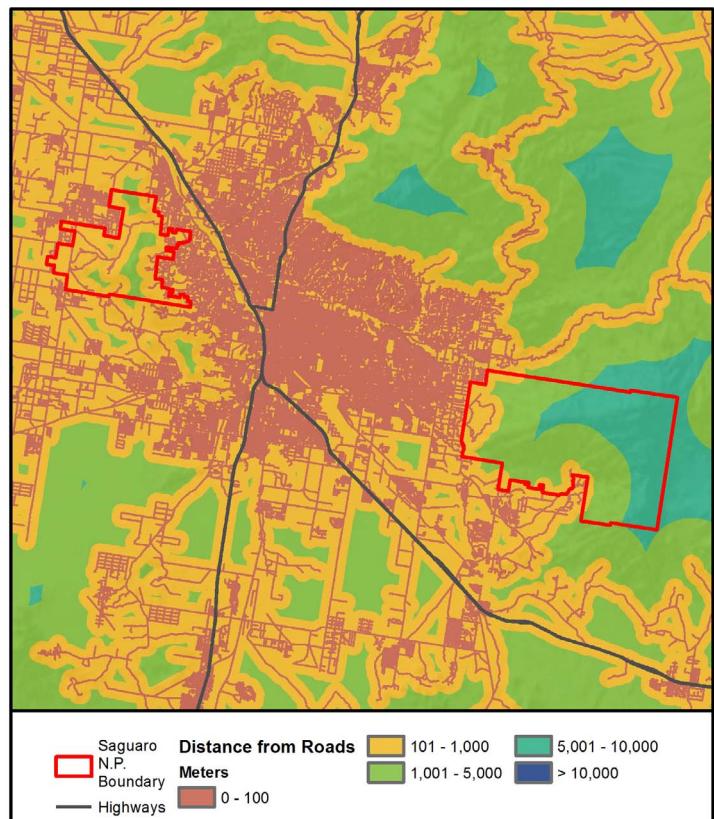


Figure 2. A map of distance from roads clearly shows the road network in metro Tucson. Darker colors indicate areas that are closer to roads. Notice the significant road differences between the east and west districts. The northern portion of the west district is bisected by a major commuter road, Picture Rocks Road.

Despite these challenges, both the Tucson and Rincon Mountain Districts have important natural features that promote connectivity even in the face of human development. By nature of being prone to periodic flooding, washes and riparian areas often remain undeveloped. Hence, they preserve a network of natural corridors both within and outward from Saguaro – a headwaters park. Their value in promoting connectivity is furthered by the fact that water is such a key limiting resource. Additionally, the Tucson and Rincon Mountain Districts contain large tracts of Wilderness, which are mandated to remain free of developments like roads. Hence, most areas of the Park are free from the sorts of direct human influences that tend to degrade natural connectivity.

Linking East and West

It may not seem likely that wildlife could move between the eastern Rincon and western Tucson Mountain Districts of Saguaro because they are separated by the city of Tucson. Yet, ensuring this connectivity is a priority because the two districts provide some of the largest tracts of Wilderness area in the region. This is no easy task: in order to travel directly between the districts – as the crow flies, but on the ground – an animal must cross two freeways and a city of almost 1 million people.

The washes and riparian habitats descending from Saguaro's headwaters – through the desert scrub, and into the more developed foothills and basins below – provide opportunities for urban-adaptable species to move through the city. Animals travel through washes to find water, avoid predators, and seek shade. This makes the urban washes a natural choice for animals moving through the greater Tucson area. Small animals like coyotes, foxes, javelina, and lizards can easily use the tunnels under roads.

The Desert Tortoise

Consider a symbolic Southwestern species that is found in Saguaro, the desert tortoise. Tortoise populations inside the Park appear to be healthy – there is suitable habitat for the species, and that habitat is connected enough to allow populations to be distributed throughout the Park. However, looking to the future, changes in the landscape at a regional scale tend to have effects that we see on a time scale of decades to centuries. This is difficult to envision because we are not talking about specific interactions that we witness (e.g., one tortoise getting run over by a truck). Instead, we are talking about how all of these interactions add up to affect the long-term viability of tortoise populations. At this ecoregional scale, the most prominent interactions are gene flow (genetic connectivity), local extinction, and recolonization. Ensuring a proper balance of these interactions requires protecting landscape-level connectivity for tortoise populations.



The desert tortoise is an iconic southwestern species. Photo from the Red Cliffs Desert Reserve.

Linking East and West

Alternatively, wildlife may move between the east and west districts of Saguaro while circumventing Tucson. Research performed by the Arizona Missing Linkages project showed that looping around the northern side of the city – through the Coronado National Forest and the outskirts of Catalina and Tortolita – would be the most effective route (Figure 3). This route utilizes state trust land to connect the Tucson Mountain District of Saguaro with the Pusch Ridge Wilderness, administered by the US Forest Service



A small bridge over a wash may seem to only serve one purpose, but crossings like these are invaluable to many small to medium sized animals. They can easily use the underpass to cross the busy road, undetected, undisturbed and unharmed. Photo from the Arizona Wildlife Linkages project, 2 foot tall box culverts under a stretch of I-10.

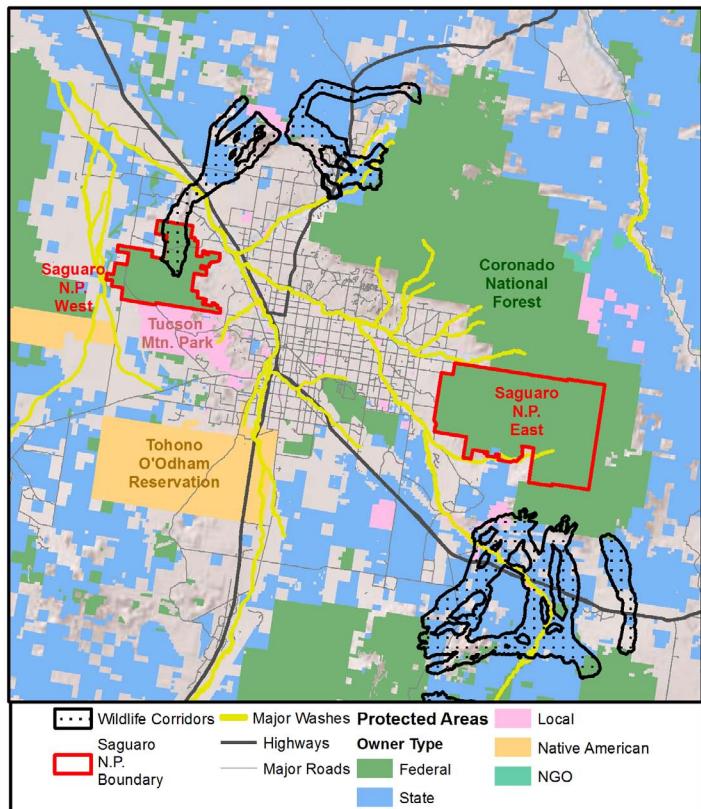
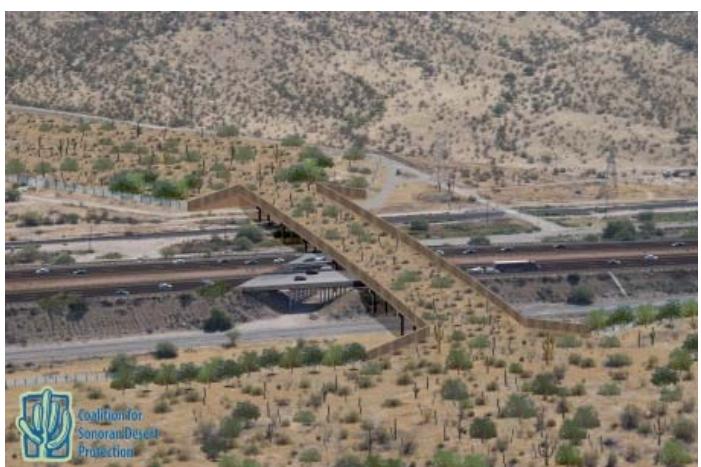


Figure 3. Land ownership and wildlife corridors (Arizona Missing Linkages project) in the Tucson area. Note the importance of the northern corridors for movements between the Tucson and Rincon Mountain Districts of Saguaro. Other protected areas, especially the Coronado National Forest, also help link the east and west districts.

(Coronado National Forest), which is adjacent to Rincon Mountain District. However, in order to make a truly viable corridor for wildlife, crossings of I-10 and state highway 77 need to be constructed. Large overpasses covered in greenery provide an easy crossing for wildlife. With these crossings in place it is possible for even large animals to travel between the two districts.



Overpasses like this simulated one near Tucson can help wildlife cross major roads and promote connectivity.

Taking a Wider View: Saguaro in the Sky Islands and Sonoran Desert

Saguaro and the greater Tucson area are part of something bigger. They lie along the transition between the Madrean Archipelago, also known as the Sky Islands, and the Sonoran Desert: two unique ecoregions whose boundary (ecotone) has given rise to ecosystems that occur nowhere else in America.

An Interesting Situation

A federally designated wilderness area might not seem like a place where you would expect commuter traffic to be a problem for wildlife, but in the Tucson Mountain Wilderness it is. Picture Rocks Road is a high traffic commuter road that runs across the northern portion of Saguaro's Tucson Mountain District. It has had severe and lasting effects on the landscape of the Park. In 2002, Saguaro made an attempt to close most of the road and turn it into a hiking trail, but public objection was high because of its commuter uses, and it has remained open. Studies have shown that about 51,000 vertebrates die each year on Saguaro's 50 miles of roads, with Picture Rocks Road being the biggest culprit. The road brings urban noise, light, pollution, and litter directly into the heart of the Park. Hence, despite its utility to people, the Picture Rocks Road creates challenges for species attempting to move within the Park. These problems are intensified beyond the scope of the current management plan because the road is being used for a purpose that it was never intended for. A new management plan incorporating the needs of both the ecosystem and the human population is needed.



Roadkill javelina. NPS photo archive.

Taking a Wider View: Saguaro in the Sky Islands and Sonoran Desert

The Sky Islands are actually mountains: isolated ranges that rise abruptly from the desert. On a map the mountains seem to dot the desert floor, much like islands in the ocean. These mountains, which include the Tucson and Rincon Mountain Districts, are also islands of refuge for many desert animals. They have higher elevations, cooler temperatures and get more precipitation than the desert below. The mountains are a completely different ecosystem and the wide range of habitats between their arid feet and snowy tips sustain an astonishing array of biodiversity.

At this ecoregional scale, two types of connectivity are important. One is altitudinally, where connectivity between low and high elevations enables species to migrate seasonally both up and down slope. For example, mule deer, mountain lion, and even jaguar can and do live in southern Arizona because of these elevational gradients. Yet, individual animals will often cross the desert to travel between mountains in search of resources, and species adapted to the Sonoran desert also require connectivity among lower elevation habitats. Hence, connectivity among habitats that are similar in elevation is also important. If either of these types of connectivity is disturbed or prevented, populations of plants and animals will become isolated and – over time – more prone to extinction without recolonization.



A view of the sky islands (Santa Rita Mountains) in winter. Photo from Friends of Madera Canyon.

Bringing it Back to Solid Ground

So what does habitat connectivity actually mean to park managers at Saguaro? What role does Saguaro play in ensuring habitat connectivity in the region? And what connectivity does Saguaro need if it is to preserve its plants and animals for future generations?

For starters, the Park is already a highly valued component of the protected areas system. The East and West Saguaro Wildernesses provide crucial habitat for many species, and their protected headwaters contribute important watershed services downstream. When coupled with the Pusch Ridge Wilderness (US Forest Service) north of Tucson, the three large wilderness areas anchor the broader network of protected areas in the region. Collectively, these protected areas are irreplaceable and foundational to maintaining connectivity both now and in the future.

But protected areas by themselves do not guarantee connectivity for Saguaro's plants and animals. One reason why is that they are managed in different and sometimes competing ways for biodiversity, and even if management actions were fully coordinated across boundaries only a fraction of protected areas are physically connected. Hence, without additional assistance, Saguaro's plants and animals must navigate a complex protected areas network comprised of individual management units that are separated in many cases by unprotected non-conservation lands.

Some of this connectivity beyond the protected areas network is facilitated by washes and riparian areas. In addition, newly established over- and underpasses voted in by Tucson area residents in 2006 help animals cross major roads. Saguaro benefits from these features, but the Park is also engaging in landscape-level partnerships in an effort to develop broad regional conservation plans with other federal, state, and local agencies. With strong interagency partnerships and growing public support America's natural wonders can continue to prosper for generations to come.

More Information

Saguaro National Park

<http://www.nps.gov/sagu/index.htm>

Sonoran Desert Inventory and Monitoring Network

<http://science.nature.nps.gov/im/units/sodn/index.cfm>

NPScape - Landscape Dynamics Monitoring

<http://science.nature.nps.gov/im/monitor/npscape/>