The Sonoran Desert

Changing face of the desert keeps communities dynamic

Here, look at this one,” Thomas Van Devender says, holding a 14,000-year-old pack rat midden he found in the Sonoran Desert near the Kofa Mountains in southwestern Arizona. The aromatic fossil midden contains seeds, twigs, and leaves from pinyon pine and juniper trees, as well as traces of dozens of other plants and animals.

Middens are formed when white-throated pack, or wood, rats urinate generation after generation in the same place inside a dry cave or rock shelter near their nest. The sticky middens collect material brought by pack rats and other animals, as well as dust and pollen blown by the wind. By studying their contents, scientists can reconstruct habitat and wildlife community changes over time.

“That area has changed from a pinyon, juniper, and oak woodland to a scrub desert,” says Van Devender, a research scientist at the Arizona-Sonora Desert Museum in Tucson. “That’s what pack rats have shown us. You have to go 2500 feet up the mountains or 100 miles north to find a similar woodland today.”

What particularly interests Van Devender in the middens are small bones from chuckwallas, desert tortoises, and other reptiles today associated with the Sonoran Desert and other dry habitats, “They were living in a forest 14,000 years ago,” he says. “The trees shifted their range [as the area became hotter and drier], but the animals stayed.

“The concept of plant and animal communities tied together by habitat is wrong,” Van Devender concludes. “Different species come together at different times in response to different conditions. Communities are very dynamic.”

Of course, habitat and climate affect wildlife relationships and behavior anywhere. But the desert amplifies many of those relationships, forcing animals to adapt to extremes of heat, rainfall, food availability, and elevation. Studies by Van Devender and others have looked at how animals have adapted to the desert and how the desert affects what animals live there, how they do it, and their ties with each other and their habitat.

Varying Sonoran landscapes

The Sonoran is one of four North American deserts. It covers southwestern Arizona, southeastern California, and northwestern Mexico, including the state of Sonora and most of the Baja Peninsula. In Arizona, the Sonoran extends roughly from east of Tucson and Phoenix northwest to Kingman. The other deserts—the Mojave, Great Basin, and Chihuahuan—reach into Arizona too.

Although often seen as monotonous, the Sonoran Desert varies considerably in habitat and wildlife from east to west, south to north, and bottom to top. The variation depends on differences in rainfall, temperature, and elevation. The desert can also vary from one mountain range or valley to the next.

Rainfall determines which, how many, and what types of plants and animals can survive in different parts of the desert. Around Tucson, on the eastern edge of the Sonoran Desert, rainfall averages 11 inches a year, most falling in summer. But 130 miles west in Ajo it averages 8 inches, and 100 miles farther west near Yuma only 3 inches.

As rain decreases from east to west, the desert changes from a lush, mixed cactus-palo verde tree habitat to one of cactus-mixed scrub and finally to a more barren scrub scene dominated by creosote and bursage. Also, more rain falls on the mountains that cross the Sonoran than on the foothills, bajadas (fan-shaped rises along the sides of mountains made up of rock debris from above), and desert floors below.

As rainfall increases and temperatures drop with higher elevation, habitats change from mixed cactus and scrub to desert grasslands to pinyon, juniper, and oak woodlands. The latter often provide island refuges for species normally not found in the desert.

The Sonoran habitat also changes with latitude. The organ pipe cactus, with its many long arms coming from a base near the ground, is common in Mexico but rare in the United States. The reason: More than a day or two of subfreezing temperatures at night can kill the plant. Similarly, the saguaro cactus that by its height and stately arms dominates the Sonoran flora disappears north of Phoenix except on south-facing slopes. In Mexico, at the southern edge of its range, the saguaro is found only on north-facing slopes.

Warmth and new inhabitants

Freezing nights aside, some wildlife biologists think the Sonoran Desert is becoming warmer. They cite animals once living only in Mexico that

by Jeffrey P. Cohn

BioScience Vol. 46 No. 2
are now common in Arizona. Take javelinas, or collared peccaries, which are piglike animals that range from the southwestern United States to northern Argentina. “Javelinas are recent invaders,” declares Gerald Day, a retired Arizona Game and Fish Department research biologist, who has studied the animals for more than 20 years.

No bones, relics, or art indicating that javelinas were in Arizona have been found that date before 1700, Day says, and the writings of early Spanish missionaries say nothing about javelinas in Arizona. The first records are from nineteenth-century trappers. Native Americans in Arizona, Day adds, took the word javelina from Spanish rather than coined their own to describe the animal.

Today, javelinas are found throughout the Sonoran Desert north almost to the Grand Canyon. They also range from the desert floor up mountain sides and from cactus to chaparral and woodland habitats. “They are a very adaptable species,” Day says.

The expansion of the javelinas’ range was aided by state biologists who brought the animals into northern Arizona in the 1960s and 1970s. Nevertheless, Day thinks the javelinas would have reached northern Arizona sooner or later, in part because they dine on almost anything. They even eat prickly pear cactus, spines and all.

Javelinas were further aided, Day says, by settlers whose cattle overgrazed Arizona’s arid grasslands. Mesquite, prickly pear, and creosote replaced native grasses, spreading the scrub habitat that shelters javelinas from the sun and from predators.

Still, the desert imposes limits. Elsewhere in their range, the animals may travel in herds of up to 50 individuals. But in the Sonoran Desert, herds of 10 to 12 are more common, with only 3 or 4 usually found together west of Ajo. “Group size is determined by food and habitat,” Day says.

Mountain lions like this one were radio collared and tracked to determine where they roamed in the areas in and around the Sonoran Desert. Photo: Matthew Peirce.

Finding animals’ home ranges

Water and habitat determine the ranges of white-tailed and mule deer in the Sonoran Desert, says Paul Krausman, professor of wildlife ecology at the University of Arizona in Tucson. Less well adapted to desert droughts, whitetails require free-standing water more than do mule deer.

Consequently, whitetails live only in the mountains, while mule deer occupy the bajadas and floor virtually throughout the Sonoran Desert. “Pockets of whitetails on the mountain tops are surrounded by a sea of mule deer below,” Krausman says of the two species’ Sonoran distribution in Arizona. Only at elevations of 4500-6000 feet do their ranges overlap.

But others challenge the view that white-tailed deer depend on free-standing water. “The Sonoran Desert is a big place,” says David Brown, an adjunct professor of zoology at Arizona State University in Tempe and a retired game manager for the Arizona Game and Fish Department. “None of the [wildlife] relationships hold everywhere.”

In Mexico, white-tailed deer can be found in mountains with little or no free-standing water. Like mule deer, whitetails can get water from dew and from the plants they eat, especially along the Gulf of California, where humidity levels are higher. The key, Brown says, is reliable summer rains, which keep plants green and moist.

Indeed, white-tailed deer have disappeared from the Tucson, Tortolita, and other mountains during lengthy droughts. Here, they have been replaced by mule deer. “Whitetails can’t get back because the mountains are surrounded by desert and urban sprawl,” Brown says.

White-tailed and mule deer, in turn, determine where mountain lions can live in the Sonoran Desert. Mountain lions in Arizona eat javelina, bighorn sheep, and other fare but rely on deer as a staple. Matthew Peirce has found an average of four to eight deer per square mile in the mountains along the northern and eastern sides of the Sonoran Desert, but only one per square mile on the desert floor.

As a result, says Peirce, an Arizona Game and Fish Department wildlife manager, resident mountain lions inhabit a mountainous arc from Lake Havasu City to Wickenburg, Phoenix, and Tucson. To the south and west, however, in the heart of the desert, mountain lions are usually only transients. Even in the mountains, though, Peirce thinks there are too few deer to support female mountain lions, especially ones with young. Instead, females stay in the higher elevations north and east of the desert, where deer are more numerous.

To confirm his hunch, Peirce has been radio-tracking mountain lions in the Harcuvar and Harquahala Mountains in west-central Arizona. So far, he has found only males, although one track could have been from a female. “This may be marginal lion habitat at best,” Peirce says.

Whether the Sonoran Desert is marginal habitat for another species—the pronghorn—remains an open question for some scientists. Although pronghorn are widespread in the western United States and northwestern Mexico, the Sonoran
subspecies has been listed as endangered by the US Fish and Wildlife Service (USFWS) since 1967.

Smaller, and with a lighter pelage than other pronghorns, the Sonoran subspecies in the United States inhabits Cabeza Prieta National Wildlife Refuge, Organ Pipe Cactus National Monument, and the Barry Goldwater Air Force Bombing Range, all west of Tucson and east of Yuma. The pronghorn are usually found on open ground, where they can use their speed to escape predators.

Until recently, Sonoran pronghorn were little studied. Hard to find in the sprawling desert, they are even tougher to follow, says Robert Schumacher, Cabeza Prieta's refuge manager. Not only are there but a few hundred scattered over hundreds of thousands of acres, but maneuvering even a four-wheel-drive vehicle over the rock-strewn desert floor around saguaros, prickly pear, ocotillo, and other sensitive desert plants and through washes is not easy.

One research effort that has worked involves radio-tracking Sonoran pronghorn from airplanes. Laura Thompson-Olais, a USFWS ecologist at Cabeza Prieta, has been following the animals since 1990. Thompson-Olais' research has produced the first good population estimates for Sonoran pronghorn. She puts their numbers in the United States at 184, based on statistical analysis of 126 actually seen. She also believes that 500 occupy the Mexican Sonoran Desert, based on 220 seen in aerial surveys of one-third their known range south of the border.

"We have no idea whether their numbers are stable or increasing," Thompson-Olais says. "We need to know what factors might limit their population."

By radio-tracking pronghorn, Thompson-Olais and colleagues were able for the first time to videotape the birth of a pronghorn fawn, and they learned that fawns start eating vegetation approximately a month after birth, earlier than previously thought. She also learned that pronghorn often use the low-lying bajadas, which provide more water, more varied forbs, and a better view of the surrounding area than does the desert floor.

However, the findings had a price. Of 22 radio-tagged Sonoran pronghorn, 6 died, 4 within a week of capture. Although one and maybe a second were killed by a mountain lion, Thompson-Olais believes they and the others may have been weakened by capture myopathy. Capture myopathy is a chemical reaction to stress that weakens muscles and damages the kidneys and other organs.

The deaths surprised the scientists, Thompson-Olais says, because a smaller scale capture effort in the mid-1980s resulted in no deaths.
Habitat and subspecies' behavior

Elsewhere, research has shed new light on desert tortoises and found differences between the Sonoran and Mojave subspecies. The latter, found west and north of the Colorado River, has received most scientific and popular attention recently. The Mojave desert tortoise was listed as threatened in 1990 when habitat loss, off-road vehicles, and an upper respiratory disease led to population declines. (The disease does not appear to be common among the tortoises of the Sonoran Desert.)

The Sonoran desert tortoise "is a very different animal" from the Mojave, says Cecil Schwalbe, a National Biological Service research ecologist based at the University of Arizona in Tucson. For one thing, Mojave desert tortoises prefer flat areas, while the Sonoran occupy rocky slopes and foothills, Schwalbe says.

More important, Sonoran females lay just one clutch of eggs a year, while most Mojave females lay two. The difference is due, Schwalbe believes, to water. In most areas, the Sonoran Desert has two rainy seasons a year. Gentle rains fall during winter months, followed by a hot, dry spring and then often-violent thunderstorms in July and August. Rainfall in the Mojave and the Sonoran west of the Colorado River is less predictable from year to year, season to season, and site to site.

Sonoran desert tortoises can count on water at certain times, Schwalbe says, to generate the plant growth their hatchlings will require for food. In the Mojave, less reliable rainfall patterns may explain why the tortoises lay a second clutch. Maybe one clutch will be timed right to get the side benefits of rainfall.

Schwalbe has also found different desert tortoise burrowing behavior in the Sonoran Desert than in areas further north. Burrows in the former are shorter, so short for females that their rear ends often stick out. Farther north, in northern Arizona and Utah, up to 30-40 tortoises may share caves or other deep burrow sites. "We didn't find any sharing south of Phoenix," he says.

Water availability affects the reproductive success of other species as well. Brian Sullivan, a zoologist at Arizona State University West in Phoenix, studies how toads pick mates in the desert's short breeding season. Like the better-known spadefoot toads, Sonoran green toads in Arizona spend most of their lives in burrows avoiding the desert heat and dryness. They emerge only following summer storms to feed and mate.

Previously, Sullivan says, scientists assumed the toads had so little time to mate, for eggs to hatch, and for tadpoles to develop in fast-drying temporary pools that adults were not fussy in choosing a partner. His studies showed that even a few hours were sufficient for toads to select their mates. Indeed, Sullivan says, because of heavy predation, related toads in the Central American tropics also select mates quickly. He believes that related species in Arizona and northern Mexico used the same behavior, keeping it as the area became drier.

Kangaroo rats also time reproduction to match seasonal rainfalls. Rains promote plant growth, especially the seeds kangaroo rats eat, says Yar Petryszyn, associate curator for mammals at the University of Arizona's Department of Ecology and Evolutionary Biology.

Kangaroo rats depend on seeds they eat not only for food but also for water. The animals can extract water from the seeds themselves and can also produce it while metabolizing their food. Kangaroo rats not only survive but thrive during dry years, Petryszyn says. By comparison, white-throated pack rats depend more on green leaves and other plant material for food and moisture. They do better than kangaroo rats in wet years or in riparian areas than on the desert floor.

Turning to another rodent, Russell Davis studies cliff chipmunks in the Santa Catalina and Rincon Mountains north and east of Tucson. There and throughout their range from southern Idaho to Mexico, cliff chipmunks are found at high elevations. But at San Carlos Bay near Guaymas, Mexico, on the Gulf of California, Davis finds cliff chipmunks feeding in the lower intertidal areas at sea level.

"It's very strange to find a mountain chipmunk on the dry desert floor," says Davis, emeritus professor of ecology at the University of Arizona. Cliff chipmunks, he explains, live in both wet and dry mountain habitats. But at San Carlos Bay, there are no other chipmunks or rodent competitors to keep cliff chipmunks from occupying the desert floor as well.

The cliff chipmunks help demonstrate, once again, how dynamic Sonoran Desert community life can be. "You have to look closely at the desert," Petryszyn says. "Things can change very rapidly. This is probably a more dynamic system than the deciduous forests."