Restoration as science: case of the collared lizard

August 22 2011, By Diana Lutz

Male collared lizard struts his stuff in an Ozark glade. The males have bigger bodies and heads than the females and bulkier jaw muscles. The orange throat is also a male trait. Males display their throats when they are being aggressive toward other males or when they are attempting to attract females. (ALAN R. TEMPLETON)

In a time when a five-year grant is considered a long-term grant, Alan R. Templeton, PhD, a professor of biology in Arts & Sciences at Washington University in St. Louis, has managed to follow some of the species he studies for 10, 20 or even 30 years.

Early in his career he studied parthenogenesis, or virgin birth, in fruit fly populations at a dump and in cactus patches in Hawaii.

"Drosophilia have fast generation times," he says, "but I studied them for 12 years. And because I followed them for 12 years, I saw patterns I wouldn't otherwise have seen. In fact, had I not stuck with it so long, I often would have made incorrect conclusions."

But the fruitfly study is a sprint compared to his lizard work, described in the cover story of the September 2011 issue of *Ecology*. The *Ecology* article covers more than 20 years of a 30-year followup monitoring the reintroduction of collared lizards on Ozark glades in 1984. (For the story in pictures, see the slideshow to the right.)

During this time, 1,662 lizards living on 139 glades on three mountains were captured or recaptured 4,545 times. The acknowledgements section of the paper thanks more than 20 people for their help in capturing lizards.

The major revelation of the work was that burning entire mountains and valleys, called landscape-level burning, undid ecological damage that was slowed but not stopped by smaller prescribed burns.

In fact, it allowed the lizards to undertake their own expanded restoration effort without the assistance of worried biologists.

Moreover, burning benefited many species besides the lizards, including a rare fen orchid and fen dragonfly, that were flying under the radar and would probably never have commanded labor intensive restoration efforts on their own.

In short, fire turned restoration from a time-consuming labor-intensive process to one that ran pretty much on its own.

The Ozark glades

To many people, the word glade suggests a grassy sun-dappled forest clearing like those in Longfellow's poetry or Hawthorne's stories. The Ozark glades, however, are nothing like these literary glades.

Instead, they are areas of exposed bedrock in the Ozark woodlands that create their own hot, dry, desert-like microclimates. Among the species that live in the Ozark glades are tarantulas, scorpions, prickly pear cactus —- and lizards.

The subject of Templeton's research is the startling eastern collared lizard (Crotaphytus collaris collaris), so called for the darkly pigmented bands around its neck.

Missouri is at the eastern end of the collared lizards range, which includes much of the southwestern United States and northern Mexico.

Odd as a lizard in the woods might seem, the collared lizard is just one of the larger and more visible of the many beautiful and rare species that live in the Ozarks.

The Ozarks are in fact highlands that were uplifted when the South American plate collided with the North American plate to create the Ouachita Mountains south of the Ozarks 300 million years ago.

Because the Ozark highland terrain was higher than the regions that surround it, it was not inundated by seas nor scoured by glaciers like the rest of the continent. It is, Templeton says, the oldest land in North America that has continuously existed as land.

And because life has steadily evolved in the Ozarks for 250 million years, it is a center of endemism, or species uniquely adapted to a

particular site, one of the very few centers of endemism in a temperate rather than a tropical region.

The Ozarks are home to more than 200 species found nowhere else on the planet, including the federally endangered snakemouth orchid.

The collared lizard is not endemic to the Ozarks, but its existence is entwined with that of many endemic species, as Templeton was to discover.

Witness to extinction

Templeton's acquaintance with the lizard began when he was 13. He was hiking with his Boy Scout troop near Mina Sauk Falls in the Ozarks when they happened upon a glade, and he saw his first collared lizard.

"I'd never seen anything like it in Missouri. It was big, it was colorful and it got up on its hind legs and took off running. I just fell in love with them." Later as a nature counselor at Camp Taum Sauk, he led kids on popular collared lizard hikes.

But then he went off to get his PhD in Michigan and to do research in Hawaii and at the University of Texas. After this sojourn, he returned to Washington University, where he is currently the Charles Rebstock Professor of Biology in Arts & Sciences.

After he returned, Owen Sexton, PhD, a WUSTL ecologist who was studying the life history of collared lizards, told him he was having trouble finding his study subjects.

"I said I'd take him down to this area and show him all these collared lizard populations," Templeton says. "So I went down there and in glade after glade after glade that had collared lizards when I was a teenager,

now they're not there. I was shocked and very concerned. So I started looking into it."

In 1982, after a rigorous survey of the Missouri glades, Templeton and his colleagues estimated that at least 75 percent of the lizard populations had gone extinct. In some areas of the Ozarks, the lizards had vanished entirely.

The red cedar lag

What had happened? The answer turned out to be firefighting,

"In the Ozarks, you really didn't have effective fire suppression until after World War II," Templeton says. "That's when all the fire towers and lookout towers went in, and the forest service began to fight wildfires." (Smokey the Bear, the forest service's mascot, dates from 1944.)

Glades no longer swept by fire were invaded by Eastern red cedar (Juniperus virginiana). "Before fire suppression, the red cedar was actually a very rare tree," Templeton says. "When they're young, they're full of resin, so they're not fire resistant. In fact, they candle, they almost literally explode in a fire."

"Before fire suppression, the red cedars were basically confined to cliff and bluff faces where the fire couldn't reach. Now they're just all over the place."

But why were the glades still healthy when Templeton was young? "Typically in the harsh glade environment, the red cedars are slow growing," Templeton says. "So there is a 30- or 40-year lag before the consequences of fire suppression catch up to you.

"Then, suddenly, the red cedars are big enough to start shading out the glade and the whole glade community collapses.

"When I was a teenager, I was on the good side of that curve," he says. "The red cedars were coming in but the glades were basically in very good shape. But when I returned to Washington University as an associate professor, I was on the wrong side of the curve and the glades were in terrible shape."

A chance encounter One area Templeton visited when he was surveying Missouri for lizards was the Peck Ranch Conservation Area.

The Peck Ranch was a large tract of land bought by a Chicago businessman in the early part of the 20th century as an investment. He clearcut the second-growth forests on the ranch to fuel the blast furnaces at an iron foundry known as Midco that was right next to his property.

When Midco collapsed, in part because of the deadly 1918 flu, the businessman abandoned the land. It was purchased in 1945 by the Missouri Department of Conservation for wild turkey management.

Wild turkeys, once too numerous to count, had been driven nearly to extinction in Missouri, much to the consternation of hunters.

By the time Templeton came by looking for lizards in 1982, there were no lizards left at the Peck Ranch. "The ranch manager at the time was a man named Scott McWilliams," Templeton says. "His mandate was to manage for deer and turkey," Templeton says, "but he really liked glades; he thought they were beautiful. So when we found that the glades were in rough shape, he said 'Let's start restoring some.' And I said, 'Sounds good to me.' "

At first, Templeton tried local restoration. People were hired to cut the

red cedar and burn the glades.

"It didn't take long to get the glades back into shape, at least from a botanical point of view," he says. "Most of the plants adapted to glades put their biomass below the ground because historically the glades burned frequently and anything above the surface was destroyed. The big root systems can survive for decades and once we opened the glade to the sun again, the plant life came back remarkably fast."

Having restored the glades, Templeton wanted to restore the lizards. He reintroduced lizards to three glades on Stegall Mountain in the Peck Ranch in 1984, 1987 and 1989.

By 1993, however, it was clear that something was wrong. All three populations still existed but the lizards were not recolonizing other glades and no dispersal was taking place between the different populations.

As a population biologist, he knew that these small (often 10 or fewer), isolated lizard populations were not stable and would eventually hit a bump and crash again.

A fire fight The problem, Templeton suspected, was that the lizards were trapped on the glades by the dense understory of the woodlands surrounding them, which had not been touched by fire for a long time.

In 1992, a Biodiversity Task Force, of which Templeton was a member, recommended landscape-level burning.

"We'd been burning prairies and glades for a long time, and everybody liked that," Templeton says, "but what we were saying was we're going to burn an entire landscape, including glades and prairies but also woodland and fens. Everything. Because that's the way fires used to be."

The proposal raised a firestorm of protest. Foresters didn't like it because it flouted the Smokey the Bear tradition and environmentalists didn't like it because they regarded it as yet another attempt by people to manipulate nature.

"Believe you me," Templeton says, "both groups were adamantly opposed. The only thing they could agree on was that what we were trying to do was bad."

After two years of infighting, the first burn was held in spring 1994. That burn encompassed two of the three glades with reintroduced lizards. In 1999, the burn management area was expanded to include all of Stegall Mountain and the third lizard population, as well as several adjacent mountains and the interlaying valleys.

The transformative power of fire "We did the burn and to tell the truth, I wasn't really very optimistic about it," Templeton says. "I thought it was more really to reduce the fuel load, but I was stunned by what it did. Just one burn totally changed the environment. All of us were just shocked at how beneficial it was.

"The fire mainly got rid of the woody understory and thick mats of leaf litter, but it didn't destroy the canopy trees. In fact, with the woody understory gone, the canopy trees grew better, so the forestry people were happy.

"The woody understory was mostly exotics, little shrubby trees that came from elsewhere. Once they were gone, the nutrients were released into the soil, and the soil was exposed to more sunlight, the endemics came back. All these endemic herbaceous plants came out of the forest floor and with them came a very abundant insect community. So the environmentalists were happy, too."

Even the hunters were happy, he says, because the grasshopper populations exploded — as Templeton proved by counting grasshoppers — and wild turkeys populations boomed, fattened on grasshoppers.

"And we were happy," Templeton says, "because the lizards started to move about. The burn was in early April and by May and June of that year, the lizards were already beginning to disperse and colonize new glades."

Having reoccupied the Stegall glades, they went to Thorny Mountain, starting to colonize glades there in 2000. Thorny is a long mountain that comes very close to Mill Mountain at its far end.

"We had an initial colonization on Mill in 2004, but it didn't take. A couple of years later there was a female on Mill Mountain, but no other lizard and we never found her again. Then a third time we found some lizards and since then that glade has consistently had lizards and the population is steadily growing.

"Moreover, you can tell they're exploring; not yet colonizing, but visiting other glades," Templeton says.

The *Ecology* paper celebrates the fact that on Stegall Mountain, the first mountain to be recolonized, the metapopulation of lizards living on interconnected glades had been stable since 2000.

"The glades only support a dozen lizards or so," Templeton says, "so you always have this problem that just by chance one population might go extinct. And if you're in a situation where the glade can't be recolonized, that's it, you're done.

"After 1994, we still had Stegall glades going extinct, but now they'd be extinct for one or two years and then they'd be recolonized because the

woodland has this more open habitat form and the lizards can move through it.

"The Stegall metapopulation is very dynamic," he says. "Local components of it blink on and off, but at the global level it is very stable.

"But the important point is we no longer have to transport lizards. Instead, we've created the ecological conditions that let them get there on their own four legs. I put them on three glades on those mountains, and on their own they've colonized another 140.

"So our work shows that if you manage at the landscape level and restore fundamental ecological processes, that's the best way of doing species conservation, because we just don't have the time and resources to save a species one by one.

On the lizard's coattails

Moreover, Templeton says, if you manage at the landscape level you support not only charismatic species like the collared lizards but also many equally endangered but less glamorous species that otherwise might perish unnoticed

In the case of the collared lizards, the coattail riders included two endemic fen species: the snakemouth orchid and Hine's emerald dragonfly.

Most of the fens in North America are in the Great Lakes region and Canada, but there are also teeny tiny fens (waterlogged areas with a low pH) in the Ozarks.

"Because the fens are wet, you wouldn't expect them to burn," Templeton says. "But I went to one of the fens during a burn and there

was a wall of fire 20 feet high traveling across the fen.

"As soon as the top layer of the fen burned, all these old species popped up, including the snakemouth orchid, an orchid that grows only in fens in the Ozarks and that was known from only a handful of locations.

The Ozarks are also home to an endangered dragonfly called the Hine's emerald dragonfly for its bulbous emerald-green eyes. The Hine's dragonfly can hybridize with a sister species that's adapted to the forest. Because the forest species is very abundant and the forests were encroaching on the fens, hybridization was wiping out the fen dragonfly genetically.

"When we burned, we separated the species a bit — it didn't take much — and that helped the dragonfly," Templeton says.

"When I first started doing this," Templeton says, "I didn't think about the fens, to tell the truth, and we burned the fens because they were part of the landscape and suddenly all this stuff started appearing.

"In conservation biology," Templeton says, "you're always forced into a position where you have to act on incomplete knowledge because if you wait, the species you are trying to conserve may become extinct.

"You never know what you are going to find, so the constant theme of all this work is the need to regard every conservation program as an experiment. The real work starts after you've done the restoration."

Provided by Washington University in St. Louis