



Genetic restoration in the eastern collared lizard under prescribed woodland burning

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In this study, authors demonstrate the impact of landscape-scale prescribed fire on a reintroduced species. They summarize findings of a 22-year project in which fire reestablished habitat for collared lizards (*Crotaphytus collaris collaris*) within glades and woodlands in the Ozark Highlands of southeast Missouri, USA. DNA was collected from nearly two thousand lizards to document the population's dispersal, reproduction, and new glade colonization during three distinct land management periods: Phase 1 - fire suppression in woodlands that surround and connect fire-maintained glades; Phase 2 - initiation of prescribed fire in these woodlands and shortly thereafter; and Phase 3 - continuous, periodic woodland prescribed fire.

The study site was located on Stegall Mountain, within the 9300-hectare Peck Ranch Conservation Area, owned by the Missouri Department of Conservation (MDC). Here, collared lizards historically inhabited scattered igneous glades embedded within a fire-maintained woodland matrix. A top predator adapted to the open, dry, rocky glades in the Ozarks, collared lizards are considered a



Gravid female collared lizard on a Stegall Mountain glade. (Photo: Alan Templeton)

MANAGEMENT IMPLICATIONS

- Landscape level restoration reversed declines in genetic diversity and population levels of collared lizards on Stegall Mountain in southeast Missouri, USA.
- Prescribed fire perpetuated vegetative conditions that promoted collared lizard dispersal and the colonization of new glades, resulting in a stable metapopulation.

sensitive indicator of glade ecosystem function.

Effective fire suppression in the study area began in 1945, which led to the invasion of glades and surrounding woodlands by fire-sensitive eastern red cedar (*Juniperus virginiana*) and other shrub and tree species. Glade habitat was reduced, and a dense woody understory blocked collared lizards' travel through the woodlands separating glades. About 75 percent of these populations had disappeared in the eastern Ozarks by the 1980s, including those on Stegall Mountain and surrounding areas. To improve habitat, MDC initiated prescribed burning in 1982 within glades, but not in the surrounding woodlands. See [Templeton et al. 2011](#) for additional history about the study site and this long-term research project.

Starting in 1984, a total of 29 wild collared lizards from outside the area were released on three separate glades on Stegall Mountain over a five-year period. To ensure initial high levels of genetic diversity in the new populations, lizards were caught on four or five different source glades, and then uniformly mixed together on each of the three glades. Thus, starting conditions on the three reinvaded glades were similar; each glade was stocked with about the same number (9 or 10) of genetically diverse

lizards.

Throughout the study period, collared lizards were captured annually. They were marked with a toe-clip number and a blood sample or toe clipping was collected for genetic analysis, and then they were released. Commercial DNA technology was used to track gene flow and colonization throughout the three phases of land management.

Phase 1, from 1984–1989, began after the initial lizard releases. Although burning of the glades began in 1982, fire was suppressed in the surrounding woodland during this phase, and lizards did not move freely between glades. On the first glade, where 10 lizards were released in 1984, the population stabilized at 11 individuals after an early decline. In 1987, nine more were released on a second glade of similar habitat, about 50 meters from the first. This group dwindled to an estimated annual average of just 3.4 individuals. On a third glade, about 1700 meters distant from the first, lizards were not introduced until 1989, and its initial population of 10 grew to an annual average of 37 adults and yearlings by 1993.

During this first management phase, only two lizards were known to move between glades (none to new glades), indicating that each glade's lizard population was effectively isolated. On all

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three glades, expected signs of population fragmentation developed, particularly on the sparsely-populated second glade, where genetic diversity dropped dramatically. The other two glades' populations also became less diverse, with decreases in the number of genetic markers. Genetic differentiation between the three groups increased significantly.

Phase 2, from 1994 to 1999, immediately followed the initiation of prescribed fire within the woodland matrix. In 1994 about half the mountain was burned, and the fires were later expanded to the entire mountain. Fire reduced the understory vegetation in the woodlands, facilitating collared lizard movement between glades. This stimulated a colonization phase during which all ages and genders, but particularly hatchlings and yearlings, moved between glades, including into 'new' glades, where no lizards had been released. Newly colonized glades were generally founded by just a few lizards and dispersal was generally limited to glades in close proximity to the original glades.

Overall, population grew during this period. Lizard population on the first glade grew modestly, from 11 to an annual average of 17.6 individuals. The population on the second glade rebounded from an average of 3.4 to 19.8 lizards. Although the area around the third glade was not burned until later, its population grew from an average of 21.4 to 47.8 individuals. By 1999, the collared lizard population on the mountain had grown from 29 to 143.

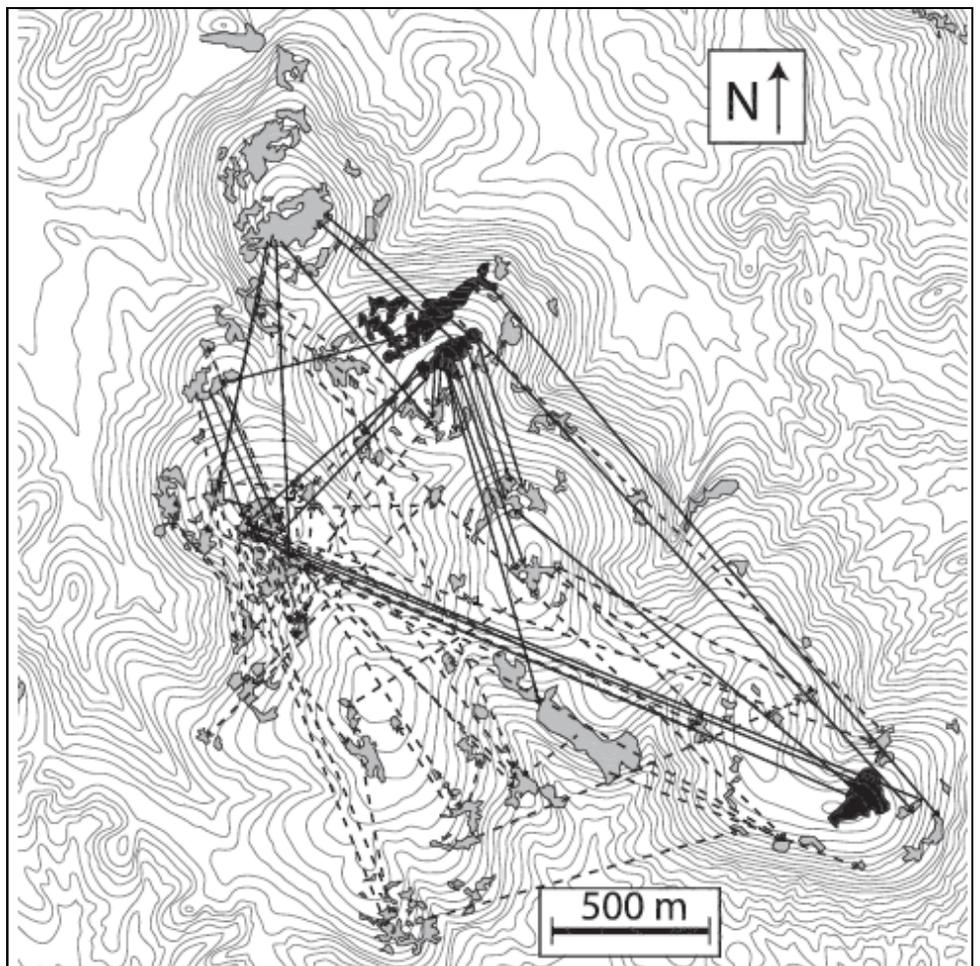
Colonization increased genetic mixing, halting the loss of genetic diversity that dominated the first phase. On 22 glades colonized between 1994 and 2000, colonists came from at least two source glades. On many glades, every newcomer originated

from a different source glade. Even on the three original glades, incoming lizards stabilized genetic diversity.

During **Phase 3**, from 2000 to the study's end in 2006, all the woodlands surrounding and connecting glades were burned periodically. The year 2000 marked the beginning of a demographically stable collared lizard metapopulation that has continued beyond the end of the study period, with a mountain-wide population in equilibrium averaging 372 annually. Between 44 and 55 glades were occupied at any given time, with a balance between glade extinctions and recolonizations. Hatchling dispersal increased significantly, and travel distances increased. However, despite evidence of a few movements over long

distances and even to new mountains in an expanded burn area, the lizards typically dispersed to adjacent glades. During this period, genetic mixing became so widespread that researchers were not always able to use DNA markers to identify a colonist's source glade.

Authors concluded that managing small patches of suitable habitat (i.e., individual glades) did not create adequate conditions for collared lizards to repopulate Stegall Mountain and was not sufficient to protect this vulnerable species from genetic degradation. Managing woodland habitats with prescribed fire at the landscape level facilitated collared lizard population dispersal and recolonization, thus reversing genetic degradation and leading to a stable metapopulation.



A map of Stegall Mountain showing the inferred movements of colonists of new glades between 1994 and 2000. Solid arrows show movements between 1994 and 1998, and dashed arrows movements in 1999 and 2000 after the entire mountain was under fire management.

FOR FURTHER READING

[Templeton, A. Brazeal, H. Neuwald, J.L. \(2011\). The transition from isolated patches to a metapopulation in the eastern collared in response to prescribed fires. *Ecology*, 92, 1736-1747](#)

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