Young salamanders' movement over land helps stabilize populations

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This is an illustration of the movement ecology of the salamanders in the three stream segments. Each of these arrows illustrates a different movement that a salamander could possibly make. Credit: Photograph: Evan Grant

Amphibians -- frogs, toads, salamanders, and newts -- are disappearing worldwide, but the stream salamanders of the Appalachian Mountains appear to be stable. This region is home to the largest diversity of salamanders in the world (more than 70 species reside here), and scientists want to understand what contributes to the stability of these salamander populations.

In research published in the March 29, 2010 issue of the Proceedings of the National Academy of Sciences, Evan Grant , a research associate in

the University of Maryland Department of Biology and wildlife biologist with the US Geological Survey's Amphibian Research and Monitoring Initiative; along with William Fagan, a professor in the University of Maryland department of biology; and collaborators James Nichols, US Geological Survey (USGS) Patuxent Wildlife Research Center; and Winsor Lowe, University of Montana; describe how two species of stream salamanders find new homes by moving both within streams and over land to adjacent streams during multiple life stages, and how this movement may help to stabilize their populations.

"Scientists tend to be more focused on populations that are declining or threatened," explains Grant, "but it is also important to look at the populations that are doing well, and to understand what makes the population or species more stable. You can apply this to interpret what might be happening with populations that are declining."

The Fagan lab is known for its expertise in combining math and biology to understand the spatial distribution of species to solve real-world conservation problems. They create mathematical models to understand patterns, influences and changes in spatial distribution.

Grant, who is a wildlife biologist with the USGS Patuxent Wildlife Research Center and completed this work as part of his dissertation research, used observations of marked animals to estimate the dispersal probabilities of two species of lungless salamanders (Desmognathus fuscus and Desmognathus monticola) who reside in headwater streams (these salamanders are known to prefer the headwaters, where the stream originates) in Virginia's Shenandoah National Park.

A juvenile salamander (*Desmognathus monticola*) that was marked (note red spots) by researchers travels over land to a new stream. Credit: Photograph : Evan grant

These salamanders are aquatic as larva (a stage which lasts ~9 months), and then become terrestrial as juveniles, when they reabsorb their gills and begin to breathe by diffusing oxygen through their skin. While the stream is the best habitat for the salamanders because of the stable temperatures and humidity, both juvenile and adult salamanders can travel over land to forage for food, and occasionally move from one stream to another.

Over a two year period, Grant and colleagues captured and marked more than 2500 salamanders in three 40 meter segments along the headwater streams using a harmless injectable dye (known as a "visual implant elastomer"). They then released them and tracked their movements by recapturing them during four return visits each year, recording their location each time. This study was the first to track salamanders across all three life stages - larva, juvenile, and adult - because the research team overcame the difficulty in marking the larval salamanders, which

are only a half an inch long. The adult salamanders of these two species grow to a length of almost four inches.

Grant used sophisticated models to estimate the probability of a salamander moving from one segment to another within the same stream either upstream or downstream, and from one stream to another by moving across land. What he found supported his prediction that the salamanders generally prefer to disperse upstream and that those in the juvenile stage were the most likely to change location by moving both upstream and overland to the adjacent stream.

"Marking the larvae was key to figuring out the movement ecology of the species, because once the larva transformed into a juvenile, that is when the dispersal happened," says Grant. "If I hadn't marked the larva and just marked the juveniles, the probability that I would have observed that dispersal would have been very, very slim."

“We went through three stream segments three times per visit, turning over 800-1600 rocks per segment, over the course of 8 visits to locate each salamander and to capture all the data on their movement,” says Grant. Credit: Photograph: Evan Grant

No Stone Left Unturned

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It turns out that this overland movement is very important contributor to population stability. Grant used the observed dispersal probabilities to conduct a computer simulation to show changes in population stability across a range of extinction risk scenarios in the stream networks. He investigated how the combination of dispersal by the three possible movement routes - upstream, downstream, and over land - resulted in changes to predicted extinction times. His modeling showed that when even a small amount of overland movement occurred, it increased the likelihood of salamander population persistence dramatically. This was only the case under low to moderate rates of extinction risk. Under higher extinction probabilities (like we see in stream-breeding frogs in the neotropics), no amount of dispersal could stabilize populations.

No stone left unturned

These results suggest that the specific routes of dispersal play a big role in salamander population stability, and help to explain why we have not seen declines in headwater stream salamander populations. This information can help wildlife biologists, amphibian conservationists, and resource managers in their efforts to maintain or restore salamander habitats to facilitate persistence of the species and prevent extinctions. These data confirm that the terrestrial habitat between streams is important to salamanders and must be maintained and protected.

Provided by University of Maryland