Meet the Salamanders: *Plethodon welleri*

*Plethodon welleri*, a state-listed species of terrestrial plethodontid salamander, is known to have a limited range and distribution on isolated mountaintops in Western North Carolina. These populations are considered ‘islands’ and are separated by lower elevations that appear to be inhospitable to *P. welleri*, but likely were once part of their range during cooler historical climates. Research on this species might yield valuable data on past climate and ecology of high elevation habitats in the region, as well as provide a basis for future projections of range shifts given various climate models.

**INTRODUCTION**

- Southern Appalachian ecoregion supports the world’s highest diversity of salamanders, well known indicators of environmental change.
- Second most endangered ecoregion in the United States.
- Climate change pushes habitats towards higher elevations, and cloud-immersion on mountaintops is predicted to decline and negatively impact the remaining spruce-fir habitat.
- Both spruce-fir forests and high-elevation salamander species *Plethodon welleri* are confined to ‘sky island’ populations on mountaintops surrounded by uninhabitable lower elevation terrain.
- Range of *P. welleri* is likely associated with spruce-fir forest habitat.
- Terrestrial plethodontid salamanders like *P. welleri* rely heavily on the microhabitats in which they live to provide protection from both environmental threats and predation.
- Microhabitats may be threatened by climate change and pollution, which may result in soil acidification.

**Goals**

- Characterize: Range of *P. welleri* in Western North Carolina.
- Predictive microhabitat characteristics of *P. welleri*.
- Genetic isolation between *P. welleri* populations.

**Predictions**

- *P. welleri* distribution correlates with spruce-fir forest habitat and neutral soil pH.
- Search for previously undocumented populations in WNC.
- Genetically distinct mountaintop populations.

**METHODS**

**Microhabitat Sampling (Fig. 2)**

- Established 25 10x10 m plots along a transect on Unaka Mountain on the North Carolina–Tennessee border between May and August of 2016.
  - Within plots we searched beneath every cover object of reasonable size for a salamander and noted presence or absence of *P. welleri*.
  - We recorded microhabitat characteristics of each cover object and plot:
    - Elevation
    - Soil pH
    - Dominant Tree Species

- We mapped data using R Studio in order to visually assess distribution of *P. welleri* and microhabitat variables.

**Phylogeography (Fig. 4)**

- Sampled 70 individuals of *P. welleri* from the three populations in the Southern Appalachians (Fig. 2).
- Amplified the entire coding region of the mitochondrial ND2 locus using the forward primer (5’-ATTCCCTCTACCTGCAAGGC-3’) and the reverse primer (5’-AAAGTTGGTATGTCATTTA-3’).
- Sequenced the amplified fragments at NCSU, and cleaned, aligned, and analyzed the samples using Geneious™.

**RESULTS**

**Microhabitat (Fig. 3)**

- Several transitions between dominant tree species on elevation gradient up Unaka Mountain.
- Apparent general transition from fairly neutral to more acidic soil.
- *P. welleri* individuals present throughout the entire transect, with a higher concentration of individuals at higher elevations in areas of Spruce and Birch forest.

**Phylogeography (Fig. 4)**

- Confirmed 3 unique lineages of *P. welleri* in North Carolina, Tennessee, and Virginia.
- 3 distinct populations of *P. welleri*, closer evolutionary relationship between NC and Robert Chambliss.

**DISCUSSION**

- *P. welleri* found in Spruce habitat as well as throughout several different forest types and elevations (Fig. 3).
- Greater concentration in Red Spruce habitat.
- pH gradient on Unaka Mountain indicates a positive trend of elevation with acidification (Fig. 3).
- Did not find any novel populations of *P. welleri*.
- Potentially higher risk of species extirpation and extinction.
- Geographically isolated populations of *P. welleri* are genetically distinct.
- Indicates historical geographic isolation (allopatry).

**FUTURE RESEARCH**

- Add additional microhabitat variables to gain a better understanding of *P. welleri’s* relationship with elevation and forest type.
- Fine-scale soil pH data to better assess pH gradients and help understand *P. welleri* persistence when facing acidification due to Earth’s changing atmosphere.
- Use mtDNA sequences to explicitly test for gene flow and estimate divergence times.

**LITERATURE CITED**