Examining terrestrial soil invertebrates to understand the impacts of climate change on the red-backed salamander (Plethodon cinereus)

Emily Mausteller, Michelle Gillette, Rachel Snyder and Tanya Matlaga, PhD; Susquehanna University, Department of Biology

INTRODUCTION
Climate change is predicted to cause a 2.8-4.3°C increase in air temperature and reduced snow in the northeast U.S. in the next 100 years. The impacts of climate change are relevant on local and regional scales (Hayhoe et al. 2008). Eastern red-backed salamanders (Plethodon cinereus) are eurythermic, consuming a wide variety of food sources, but in general they prefer herbivores to detritivores and predators (Homyack et al. 2010). There is conflicting evidence regarding the impact salamanders have on invertebrate abundance and ecosystem functioning (Homyack et al. 2010; Hocking and Babbitt 2014).

Snowfall insulates soil in winter, keeping it sufficiently warm for critical aspects of invertebrate life cycles (Templer et al. 2011). Salamanders also utilize insulated soil while burrowing up to 30 cm below the surface in winter (Taub 1961).

Snowfall can lead to changes in the phenology and distribution of animal and plant species. Although invertebrate response to climate change is relatively unstudied, it is predicted that some species will go extinct and new species will evolve (Chown and Tornblanche 2006; Parmesan 2006).

QUESTIONS AND HYPOTHESES
Will a reduced snowpack layer in winter affect soil invertebrate populations in a temperate deciduous forest?
Will certain invertebrate functional groups be more or less prone to population changes as a result of a reduced snowpack layer?
We hypothesize that the overall abundance and diversity of invertebrates in plots where snow has been removed will be reduced in comparison to control plots.

SPARCnet INVOLVEMENT
Our study is a secondary project of SPARCnet (Salamander Population and Adaptation Research Collaboration Network) SPARCnet uses the eastern red-backed salamander (Plethodon cinereus) as a model species to examine how climate change impacts terrestrial salamander populations (http://scaresnet.wix.com/sparcnet).

STUDY SITE
Figure 1. Eastern red-backed salamander (Plethodon cinereus)

EXPERIMENTAL DESIGN
Figure 2. Boy Scout Camp Kardosdninha. Red X’s indicate three study sites, black X’s indicate replicate cover board array plots at each site.

METHODS
• Snow removed from one plot at each site (three plots total) (Fig. 2)
• Three PVC soil samples (Fig. 3) collected June 3, 2015 (spring sample) and October 20, 2015 (fall sample) in each plot
• Samples run through Berlese funnel system (Fig. 4)
• Samples quantified using a dissecting microscope and invertebrates identified to class/order level
• Data assessed for diversity, overall abundance, and abundance in different functional groups using ANOVA
  - Herbivores: Coleoptera larvae, Diptera larvae, Symphyla
  - Detritivores: Collembola, Acari (mites), Coleoptera, Diplopoda
  - Predators: Hymenoptera, Pseudoscorpionida, Araneae, Diptera, Chilopoda

RESULTS
Figure 3. PVC soil sampler
Figure 4. Berlese funnel set-up
Figure 5. Invertebrates: A: Acari, B: Colembola, C: Diptera larva
Figure 6. Gastric lavage equipment
Figure 7. Minimum soil temperatures at 20 cm depth in each plot, recorded daily from 12/13/2014 to 10/22/2015 (control plots in blue and snow removal plots in red).

• Snow events began in January, with the soil temperatures 1-2°C lower in snow removal plots until Mid-April when snow melted (Fig. 7)
• No significant differences in abundance or diversity of invertebrates between control and snow removal plots in spring or fall (Figs. 8 & 9)
• Data indicate seasonal variation in invertebrate abundance (Fig. 8)
• No differences in abundance of different functional groups between control and snow removal plots in spring or fall (Figs. 10 & 11)

REFERENCES

CONCLUSIONS
Soil temperatures were lower during winter in snow removal plots compared to control plots, similar to results found by Templer et al. (2012).

Contrary to our hypothesis and the results of Templer et al. (2012), we found no significant differences in total abundance, abundance of different functional groups or diversity of invertebrates in snow removal compared to control plots on either sampling date.

Invertebrates may not be sensitive to the level of soil temperature change we observed. A larger sample size and more sampling dates are necessary to continue examining our questions.

Invertebrate abundance increased in fall compared to spring, indicating population growth during the summer months.

A long-term study and larger sample size is needed to detect small changes in soil invertebrate populations as a result of climate change (Hayhoe et al. 2008). If additional research finds that invertebrate populations decline with climate change, we expect salamander populations to decline in a similar manner.

ACKNOWLEDGEMENTS
This work was supported by the Nihr Collaboration for Leadership in Applied Health Research and Care for the North East Coast, and the National Institute for Health Research Biomedical Research Centre at the Newcastle upon Tyne Hospitals NHS Foundation Trust. We would like to thank the following for their support and assistance: the staff of the Brean Down Field Station and the Ecology Laboratories at the University of Exeter. This work was conducted under Pennsylvania Fish and Boat Commission permit 010293 (2015).

EXAMINING TERRITORIAL SOIL INVERTEBRATES TO UNDERSTAND THE IMPACTS OF CLIMATE CHANGE ON THE RED-BACKED SALAMANDER (PLETHODON CINEREUS)