Urban Forests and Global Change

The effect of temperature, nitrogen and gastropods on *Thuja plicata* growth and reproduction

Anna O’Brien, Janneke Hille Ris Lambers, & Ailene Kane Ettinger – Department of Biology, University of Washington

**Introduction**

Humans are changing the environment. For example, nitrogen deposition, rising temperatures, and non-native species are influencing plant communities. These changes have and will continue to affect trees. Humans are changing the environment. For example, nitrogen deposition, rising temperatures, and non-native species are influencing plant communities. These changes have and will continue to affect trees. Urban areas already experience higher temperatures, elevated CO$_2$, greater nitrogen levels, and more non-native species compared to rural areas. The response of trees to urban parks therefore used as a proxy for the net effects of global change on trees (Carreiro and Tripler 2005). We investigated the growth and reproduction of *Thuja plicata* trees, a native Pacific Northwest conifer, in both urban and rural forest fragments to understand global change impacts. After observing extremely low conifer germination rates across sites, we concluded that factors such as herbivory might be important. Gastropods have been shown to impact communities through consumption of plants at the seedling stage, and to limit seedling survival of a European conifer (Carreiro and Tripler 2005).

**Hypotheses**

- 1. Trees experience higher temperatures and nitrogen levels at urban fragment edges. Due to higher nutrients and warmer, longer growing seasons caused by the higher nutrient levels and increased temperature, trees are able to grow faster.
- 2. Adult trees experience increased growth at urban fragment edges. Due to higher nutrients and warmer, longer growing seasons caused by the higher nutrient levels and increased temperature, trees are able to grow faster.
- 3. Trees experience decreased reproduction at urban edges. Higher temperatures cause soil moisture and mortality in sensitive germans.
- 4. Gastropods eat tree seedlings. Tree seedlings experience mortality due to gastropod herbivory. Gastropods prefer certain species and nutrient levels of tree seedlings.

**Methods**

The observational field work occurred at 5 forested urban parks and 3 rural parks (Fig. 2). We located study sites near and far from edges of forest fragments. Each study site was centered around a mature *Thuja plicata* tree. Environmental data collected from sites include hourly temperature, soil NO$_3$ N. An increment core was taken from the tree to measure growth, and seedlings were counted 1 m$^2$ quadrats along a 10 m transect from the tree to measure reproduction. (Fig. 1) The data were analyzed for the effect of temperature, nitrogen, and urban edge on growth and reproduction. Tree ring widths from cores were compared to climatic data available for the region, to further understand the influence of climate on tree growth. Results from the field work led us to design and experiment on gastropod herbivory of tree seedlings. The experiment was conducted to investigate gastropod herbivory on *Thuja plicata* seedlings, whether gastropods prefer it over other common tree seedlings, and whether soil moisture and nitrogen of the seedling impact herbivory. *Thuja plicata* seedlings were grown in high or low nitrogen levels and high or low moisture levels (Fig. 3). Seedlings of other tree species (Pseudotsuga menziesii, Tsuga heterophylla, Acer macrophyllum, and *Abies rubra*) were grown with additional *T. plicata* and other species (Fig. 4) to expose seedlings to herbivory by common introduced gastropods (Fig. 5) in a terrarium (Fig. 6). *T. plicata* seedlings from nitrogen and moisture treatments were also exposed to gastropod herbivory in terrariums. Slug herbivory was measured after 5 days. Seedling height was measured both before herbivory, directly after 5 day trials, and two weeks later. Analyses assessed if species or treatment affected herbivory levels. All models are linear mixed effects models and selected by AIC.

**Conclusions**

Our results suggest that urban forest edges resemble future global change conditions of higher temperature and nitrogen. These global change factors appear to be positively influencing tree growth, suggesting that *Thuja plicata* will benefit from future conditions. However, low seedling recruitment may be a concern, because it appears that urban and rural forests are currently failing to regenerate on their own. Introduced gastropods could play a role, as they have the ability to reduce seedling biomass significantly. The relative impacts of invasive slug herbivory and other global change factors on native conifer recruitment should be prioritized in future studies.

**Work Cited**


**Acknowledgments**

In no particular order: Sara Edie, Melissa Wintjen, Irene Wunder, and the Hille Ris Lambers lab; Mary Gary Endowment; Washington NASA Space Grant Program; Pre-Rosen-Keagy, Bevan Memorial Fund; Mac Garrett Hayes; UW Botany Greenhouse; Alan Kolb; Michael Kennedy; Laurie Romoever; Boll Pate; UW Department of Biology; Seattle Parks; Cedar River Watershed; King County Parks; Washington State Parks; Monard; Brian Buchwitz; HHMI Integrative Research Internship Program; Aaron Tilley; UW Biology 472 class of fall 2009 and fall 2010.