New paper: Urban warming reduces aboveground carbon storage

This is a guest post from our former student (now postdoc at Harvard) [Emily Meineke](#).

Through years of studying urban trees and the insects that eat them, we, the Frank lab, have discovered that warming in cities leads to more pests. We also know how: where it's warmer, insects survive and reproduce better, and the effects of their natural enemies are diminished. In most conversations we have about this work, explaining these discoveries leads to the question: but what does this mean for the trees?

Street trees perform essential services like removing pollutants from air. Photo: EK Meineke

I tackled this question with the help of Elsa Youngsteadt by studying how warming and pests affect tree drought stress and functions like photosynthesis and stomatal conductance. Of course, as in my previous work, I studied the charmless but interesting oak lecanium scale on willow oaks which are among the largest and most common street trees in Southeastern cities.

Oak lecanium scales on willow oak. Photo: EK Meineke

Over three years we took hundreds of tedious measurements (thanks Elsa!) to figure out how fast our trees were growing and thus how much carbon they were removing from the air and storing in their tissue. This is called carbon sequestration and is a critical way trees reduce carbon pollution and global warming.

Elsa measuring photosynthesis. Photo: EK Meineke

In a new paper, we show that the urban heat island effect significantly reduces street tree growth. This is because trees in warmer urban areas photosynthesize less. When these effects were scaled up to all the willow oak street trees in Raleigh, warming reduced citywide carbon sequestration by 12%. However, insect pests like scales and spider mites had minor effects on tree growth compared to warming, at least in the short term.

Oak spider mites damage leaf cells and reduce photosynthesis. Photo: EK Meineke and A Ernst

These results lead to several recommendations for urban forest management. First, because urban and global warming are becoming more intense, urban trees will store even less carbon in the future. However, managers may be able to reduce these effects by planting trees that are more tolerant of hot urban conditions. This highlights the need for research to identify what trees are appropriate to plant in hot urban environments. In general, this research makes us excited about science that will help landscape designers tailor green infrastructure for resilience to climate change and intensifying urbanization.

Our results also highlight the utility of cities as large-scale natural climate experiments, in which sessile organisms, such as trees and many insect herbivores, are confined to different thermal environments in close proximity. The range of urban warming they experience parallels the extent of global warming expected regionally, outside the city, over the next several decades. Therefore, cities can serve as experiments that allow scientists to address questions that are otherwise difficult or impossible to approach, such as the effects of warming on mature trees.

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