Urban warming slows tree growth, photosynthesis

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Willow oak near the Capitol building in Washington, DC. Credit: North Carolina State University

New research from North Carolina State University finds that urban warming reduces growth and photosynthesis in city trees. The

researchers found that insect pests are part of the problem, but that heat itself plays a more significant role.

"Earlier studies have shown that urban warming increases pest abundance in street trees," says Emily Meineke, lead author of a paper describing the work. "We wanted to know how urban warming and pest abundance affect tree growth, since trees pull carbon out of the atmosphere and convert it into biomass. This is important, because we know that high levels of atmospheric carbon play a role in climate change." Meineke did the work while a Ph.D. student at NC State. She is now a postdoctoral researcher at Harvard.

To explore this issue, researchers went to 20 pairs of willow oak trees (Quercus phellos) across Raleigh, North Carolina. At each site, one tree was treated with an oil that kills insect pests, and the second tree was left untreated. The sites were located across a variety of different urban temperatures, and air temperature was monitored at each site over the course of the experiment.

The researchers tracked the growth of all 40 trees for two years. Growth was assessed in two ways: by measuring the circumference of each tree's trunk, and by measuring how much specific branches grew on each tree. The researchers also measured each tree's photosynthesis, which is how trees capture carbon from the atmosphere and is a key marker of tree health.

The researchers found that scale insects and spider mites – well known tree pests – were more abundant at hotter sites. Specifically, they found that spider mite populations more than doubled when a site's average temperature crossed a threshold of 16.4 degrees Celsius (61.5 degrees Fahrenheit). Scale insects, however, showed a linear relationship with temperature. In other words, the hotter it got, the more scale insects there were.

The researchers also found that warming negatively affected tree photosynthesis and growth, regardless of whether pests were present.

"Trees that didn't have pests had more branch growth than trees with pests," Meineke says. "But trees at warmer sites had less trunk growth, which accounts for more tree biomass, regardless of pests."

The researchers then plugged these results into a model to determine the extent to which urban warming impacted carbon storage for all of the willow oaks in Raleigh.

"We found that urban warming reduced carbon storage by all of Raleigh's willow oaks by 12 percent, or 27 metric tons per year," Meineke says.

"We think the findings are generalizable to other tree species and other cities, especially hotter cities like Atlanta, but additional work needs to be done to determine whether that's the case," Meineke says.

More information: Emily Meineke et al. Urban warming reduces aboveground carbon storage, *Proceedings of the Royal Society B: Biological Sciences* (2016). DOI: 10.1098/rspb.2016.1574

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