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City Trees Grow Faster, But Seedlings Struggle to Take Root

By Hannah Waters | January 14, 2013

Despite their name, Western red cedars (Thuja plicata) aren't true cedars--they're in the cypress family. Photo: Evan Leeson

Urban areas are growing in size–and with them, the number of trees influenced by city life. While development often leads to deforestation, there are still a significant number of trees growing in the shadow of cities. According to a report released in 2000, 2.8% of tree canopy cover in the U.S. is in cities, and nearly one-quarter lies in the surrounding metropolitan areas (urban counties).

City trees have to deal with very different growing conditions than trees in more rural areas or old forests. Cities are notorious heat islands: the asphault and dark rooftops absorb enough heat to raise summertime nighttime temperatures by 2-5°F on average–and as much as 22°F on clear nights–compared to the surrounding non-urban areas. Hotter nights mean more evaporation, potentially draining the soil of moisture. Carbon dioxide levels are higher due to greater car exhaust. And the prevalence of cars and fertilizers increases pollution runoff, altering the soil's nutrient availability.

How do trees, adapted to non-urban lifestyles, fare under these circumstances? According to the results of a study published in *Urban Ecosystems*, western red-cedars (*Thuja plicata*), coniferous trees common in the U.S. Pacific Northwest, grow more quickly but produce fewer seedlings, potentially putting these urban forest ecosystems on an unpredictable long-term trajectory.

Western red cedar (Thuja plicata) cones. Photo: Leah Grunzke

Researchers from the Universities of California and Washington compared forest patches within urban Seattle (5,000 to 12,000 people per square mile), in rural areas outside the city (150 to 3,000 people per square mile), and old-growth forest in Mount Rainier National Park (people-free), measuring air temperature and soil nitrogen as a proxy for nutrients. They measured the growth rate of western red cedars by counting tree rings and circumference, and counted seedlings in the three forest types. This species was chosen because it is a late-successional tree that grows even in the relative darkness under a forest canopy.

As expected, the environments in urban and rural forests were distinct: both air temperature and soil nitrogen were higher in the city. But in contrast to a previous long-term study, which attributed increased tree death in the Pacific Northwest to warmer temperatures, city-based western red cedars grew faster than rural ones. The authors speculate that higher temperatures created longer growing seasons, allowing each tree a bit more time to stretch toward the sky, and the excess nitrogen may have acted as a fertilizer.

However, even within a single species, environmental changes won't necessarily benefit seedling growth as they do adult trees. Baby plants are very sensitive to soil moisture, which would be more prone to dehydration because of increased evaporation under warm climates. And the extra shot of nitrogen could overwhelm seedlings, killing them.

Given these predictions, the researchers expected to see a gradient of seedling success, with the fewest seedings spotted in cities, more in rural forests, and the most in old-growth. But they were surprised to see "alarmingly low" numbers of western red-cedar seedlings at both urban and rural sites compared to old growth.

Old growth western red cedar (Thuja plicata) Photo: Miguel Vieira

It's difficult to tease out why seedlings failed to grow in developed areas: it could be caused by increased air temperature and nitrogen–the factors measured by the researchers explicitly–or an indirect effect of these, such as reduced soil moisture. Urban and rural forests receive more human foot traffic, so seedlings in these more disturbed forests may have been trampled to death. It's also possible that trees in urban and rural forests are just too young to produce a lot of seedlings. Old-growth forests have many more mature trees, which produce far more seed-laden cones.

What do these findings mean for urban forests? Combined with the results of earlier papers, increased temperatures and nitrogen–not dissimilar from those expected from global warming–are clearly impacting the growth and reproduction of a variety of tree species in different ways. Ultimately, this could rejigger the typical species compositions we see in regional forests.

In different regions, a fairly predictable list of species will colonize, thrive and become rare as a forest matures, a process known as succession. For example, in the Pacific Northwest, western red-cedar tends to be one of the last to move into a forest, displacing other species that had dominated the ecosystem. If environmental changes prevent it from reproducing successfully, it's possible that it will not longer be a common species in mature urban Pacific Northwest forests, and a species that thrives in the new environment will prevail instead.

This doesn't mean that the forests will fail or disappear–they just might look different than the ones with which we're most familiar.

O'Brien A.M., Ettinger A.K. & HilleRisLambers J. (2012). Conifer growth and reproduction in urban forest fragments: Predictors of future responses to global change?, *Urban Ecosystems, 15* (4) 879-891. DOI: 10.1007/s11252-012-0250-7

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