An IPM framework for sustainable urban tree planting and landscape design

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Overview

A foundation of IPM in urban landscapes is to put the right plant in the right place. This reduces plant stress and thus the long term costs of pest management. Many urban trees have more pests than the same tree species in natural areas. This is due in part to the stress created by impervious surfaces such as roads and sidewalks. Impervious surfaces increase air temperature, reduce soil moisture and oxygen, and increase soil compaction. We have found that impervious surface cover is linked to red maple condition and scale insect infestations.

Red maple (*Acer rubrum*)

Maple trees (*Acer spp.*) are the most commonly planted genus of landscape trees in the eastern U.S. The most common maple species planted in southeastern landscapes is red maple (*Acer rubrum*). Red maple is a bottomland species native throughout eastern North America. It has characteristic red petioles, flowers, and brilliant red foliage in the fall.

Gloomy scale (*Melanaspis tenebricosa*)

The most important insect pest of red maples in the southeastern U.S. is the gloomy scale, *Melanaspis tenebricosa* (Hemiptera: Diaspididae). This native armored scale insect is distributed throughout the southeastern and mid Atlantic states. Gloomy scale can feed on many tree species but is most common on red maples. Gloomy scales insert their mouthparts through the bark to feed on fluids within the trunk and branches of trees. These insects are small, obscure, and produce an armored covering that protects them from the environment and most control methods. Therefore, pest management with conventional tactics is difficult and often unsuccessful.

Gloomy scale-infested maple branch. Photo: AG Dale

Effect of urban areas on red maple and gloomy scale

Increasing impervious surface cover around trees makes them hotter and more drought stressed. Research has found that gloomy scales are up to 200 times more abundant on red maple trees in the hottest urban sites of Raleigh, NC than nearby sites just 2-3°C cooler. This is because as temperatures warm and trees become more drought stressed, female scales produce up to 3 times as many offspring, which leads to faster population growth. Other research has shown that the combination of heat, drought stress, and high gloomy scale abundance reduces red maple growth, condition, and the services they provide such as photosynthesis, cooling, and aesthetic enhancement.

Impervious surface thresholds

Average temperature, water availability, and insect pest abundance that reduce tree condition are dynamic and difficult to measure. However, the amount of impervious surface surrounding a tree is static and easy to measure. Impervious surface cover within a 25m radius around a tree or planting site can be used to predict gloomy scale abundance and red maple condition. Arborists rate tree condition as poor, fair, good, or excellent. Impervious surface cover can be measured from satellite images with software such as ArcGIS or by using the Pace to Plant technique described below.

In IPM, thresholds are established points at which management decisions can be made to reduce pest damage and economic loss. Since impervious surface cover is related to scale insect abundance and tree condition, impervious surface thresholds have been developed to guide planting and management decisions. Landscape architects, urban planners, arborists, landscapers, and other tree care professionals can use these impervious surface thresholds to reduce red maple management and replacement costs.

0 – 32% surrounding impervious surface: Suitable red maple planting site

At low levels of surrounding impervious surface cover (0 – 32%), urban red maple trees will most likely be in **good condition**.

33 – 62% surrounding impervious surface: Consider other tree options

At intermediate levels of surrounding impervious surface cover (32 – 62%), urban red maple trees will most likely be in **fair condition**.

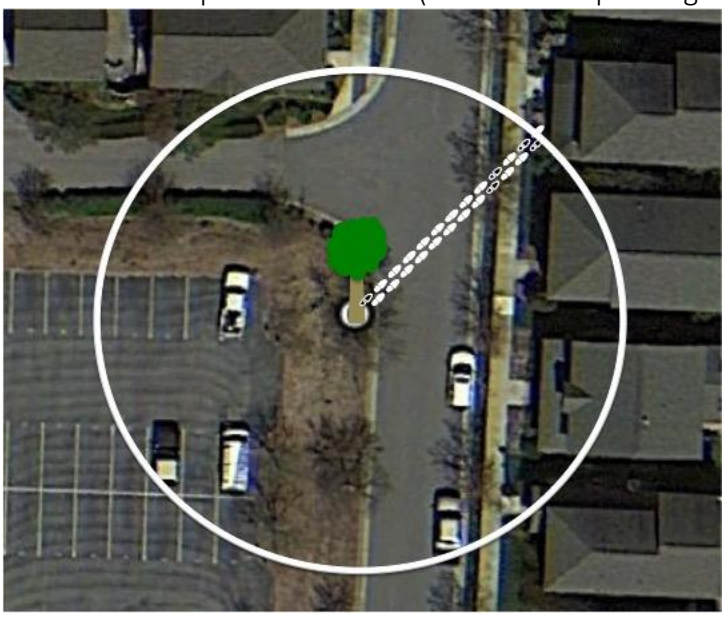
62 – 100% surrounding impervious surface: Do not plant a red maple

At high levels of surrounding impervious surface cover (62% and greater), urban red maple trees will most likely be in **poor condition**.

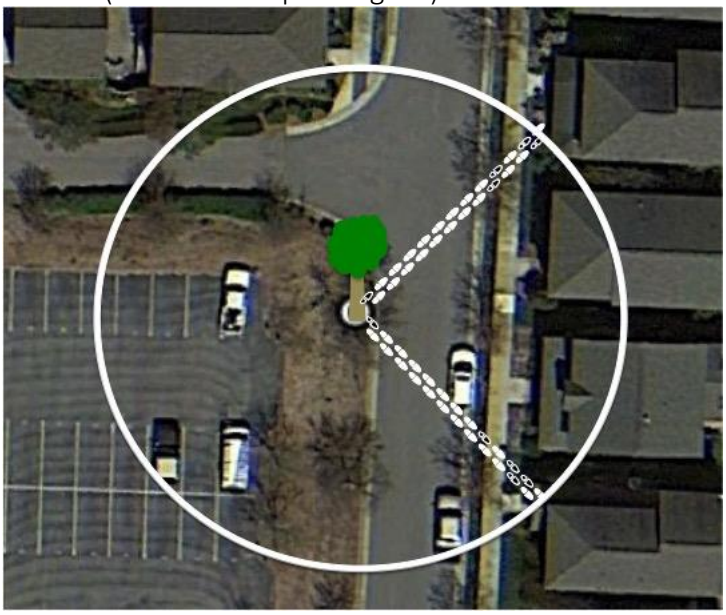
The 'Pace to Plant' technique

Landscape professionals who are installing trees can use these thresholds to increase the likelihood trees will survive and thrive after planting. Since computer software and analysis is not practical for on-the-ground use, a site assessment technique is useful. **The 'Pace to Plant' technique** is a tool for landscape professionals to quickly and accurately quantify the amount of impervious surface surrounding a tree or planting site. Simply follow 5 steps to estimate the percentage of impervious surface area covering the ground around a planting site.

Step 1. Beginning at the planting site, take 25 steps at 45° to the nearest impervious edge, counting the steps that land on impervious surface (white footsteps in figure).



Step 2. Take 25 more steps, 90° to the previous starting point, counting the steps that fall onto impervious surface (white footsteps in figure).



Step 3. Take 25 more steps, 90° to the previous starting point, counting the steps that fall onto impervious surface (white footsteps in figure).

Step 4. Take 25 more steps, 90° to the previous starting point, counting the steps that fall onto impervious surface (white steps in figure). This is the final leg, making an 'X' through the planting site and totaling 100 steps taken.

Step 5. The total number of steps that fall onto impervious surface equals the percentage of the surrounding ground area that is impervious to water. Using the impervious surface thresholds, this percentage can guide tree selection decisions. In the figure above, 66/100 white footsteps landed on impervious surface, meaning that 66% of the area within the circle is impervious.

Summary

As cities expand and habitats transition from natural to urban, landscapes must be designed using guidelines that maximize plant survival and services. Trees that live longer, grow larger, and harbor fewer damaging pests, which cost less to maintain and provide more benefits to people and the environment. Impervious surface thresholds and the 'Pace to Plant' technique are one approach to this informed decision-making. Although these thresholds are specific to red maple trees, they can be expanded to other tree species to provide a more comprehensive landscape design and planting guide for urban trees.

References

Dale, AG and Frank, SD. 2014. Urban warming trumps natural enemy regulation of herbivorous pests. *Ecological Applications*. http://dx.doi.org/10.1890/13-1961.1

Dale, AG and Frank, SD. 2014. The effects of urban warming on herbivore abundance and street tree condition. PLoS One. DOI: 10.1371/journal.pone.0102996

Dale, AG, Youngsteadt, E and Frank, SD. 2016. Forecasting the ffects of heat and pests on urban trees: Impervious surface thresholds and the 'Pace to Plant' technique. *Arboriculture & Urban Forestry* 42(3) 181-191.

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