Hixon Center for Urban Sustainability

CASE STUDY

Predicting Tree Shade to Reduce Urban Heat

Green City | **Climate Ready City**

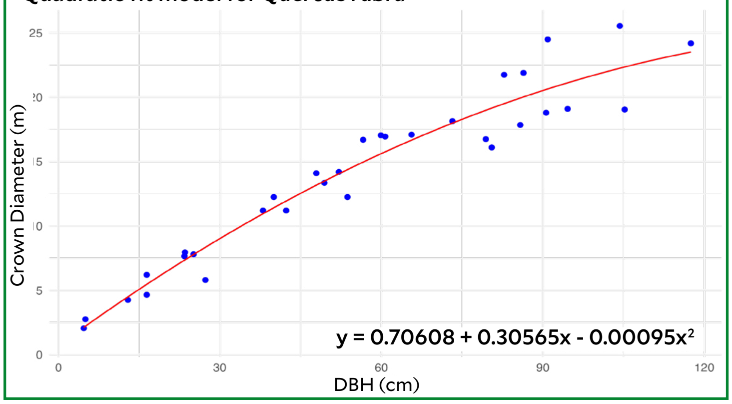
Climate Issue: Urban Heat

- Residents of cities worldwide are increasingly exposed to extreme heat due to the urban heat island (UHI) effect and warmer temperatures caused by climate change.
- Through moisture release, shading, and low heat absorption, trees cool cities. Trees with large, dense crowns contribute greater cooling than those with small or less dense crowns.
- Many cities have tree-planting programs to combat urban heat. Knowing how fast and how large tree species grow can enhance the efficacy of cooling-focused planting efforts.

Allometry: Measuring Tree Growth

- Allometric equations are used to predict tree growth. An equation is developed by measuring many trees and using those measurements to create a growth model through regression analysis.
- Allometric equations can predict the growth of traits such as height, crown diameter, and age. These traits are usually related to diameter at breast height (DBH)—a common way to measure trees. Below is an allometric equation for red oak crown diameter as predicted by DBH.
- Measuring tree height or crown diameter is relatively easy, but confirming tree age is much harder. Accurate planting records can help establish allometric equations for age.
- Most allometric equations are based on trees in forests and are less accurate for urban trees. Thus, it is important to use equations from an urban environment in a similar climate.

Quadratic fit model for *Quercus rubra*



Ranking Shade: Crown Growth Rates and Crown Density

- The table below is drawn from 2024 research on the twelve most common street trees in New Haven, Connecticut. Species are ranked by the rate of crown diameter growth, with the fastest crown growth at the top.
- While crown density varies across species, only honeylocust shows a significantly lower crown density. This suggests that its crown is less effective at providing shade.
- Many factors influence the growth of individual trees, such as access to light and water. However, accurate allometric equations can enable comparison of crown growth across species, showing which trees will provide shade quickly.

Rank by Crown Growth Rate	Species	Common Name	Average Crown Density (%)
1*	*Ulmus parvifolia*	lacebark elm	94
2	*Tilia cordata*	littleleaf linden	96
3	*Zelkova serrata*	Japanese zelkova	96
4*	*Prunus serrulata*	Japanese cherry	90
5	*Ulmus americana*	American elm	93
6	*Acer rubrum*	red maple	90
7	*Platanus x hispanica*	London planetree	92
8	*Quercus rubra*	red oak	93
9	*Gleditsia triacanthos*	honeylocust	87
10	*Quercus palustris*	pin oak	93
11	*Syringa reticulata*	Japanese tree lilac	96
12	*Acer platanoides*	Norway maple	94

*While lacebark elm showed the fastest crown growth, this only reflects growth from smaller sizes because no large trees for this species were present. The growth rate may slow with larger trees.
*Japanese cherry had a relatively high crown growth rate, but the allometric equation for this species was less accurate, so the expected crown growth is less reliable.

WHAT CAN YOUR CITY DO?

WHERE possible, plant trees that will develop large, dense crowns to maximize shade

KEEP clear records of your city's tree-planting, especially date and species, to develop equations specific to your city.

To find out more information on this case study, contact **Jackson Cooper at jackson.cooper@yale.edu**. This research was supported by a Hixon Fellowship.