Planting and Managing Trees in Engineered Spaces: A SF Bay Area Experience

Nelda Matheny

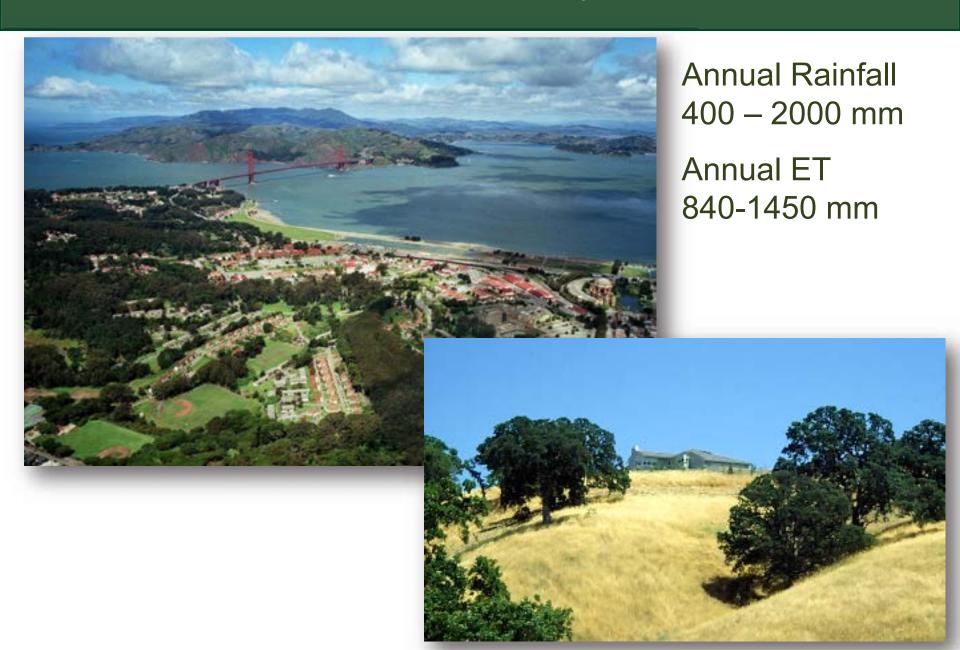
Sept. 11, 2018



San Francisco Bay Area



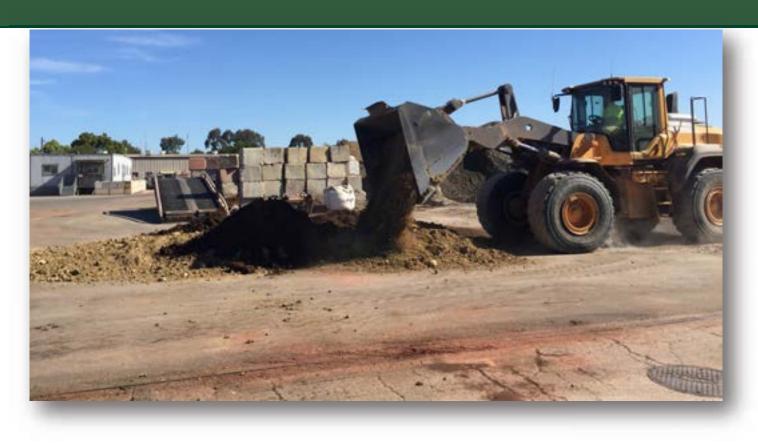
San Francisco Bay Area



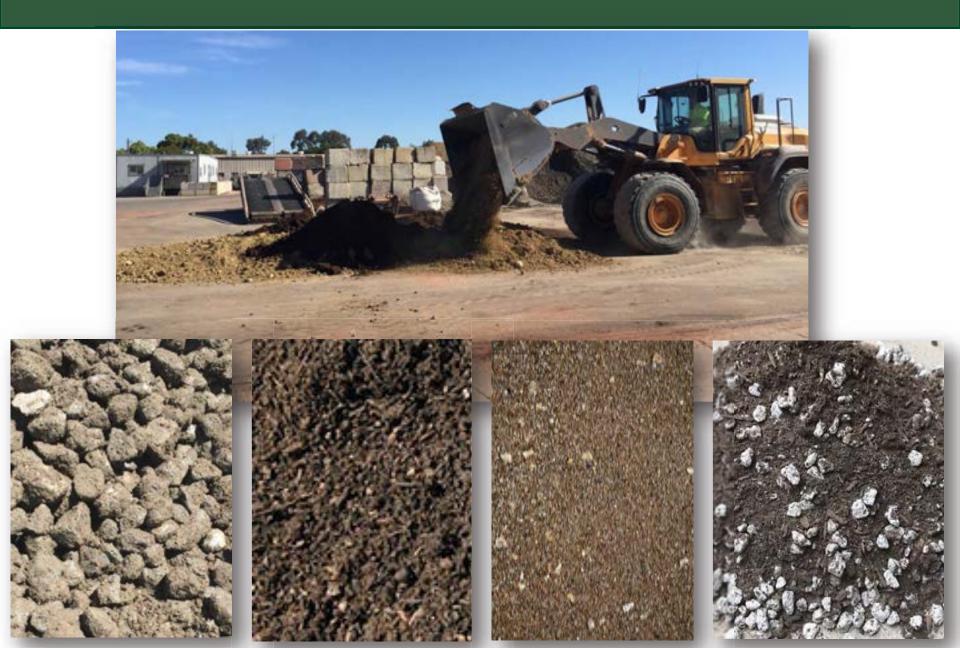
Where have all the good soils gone?



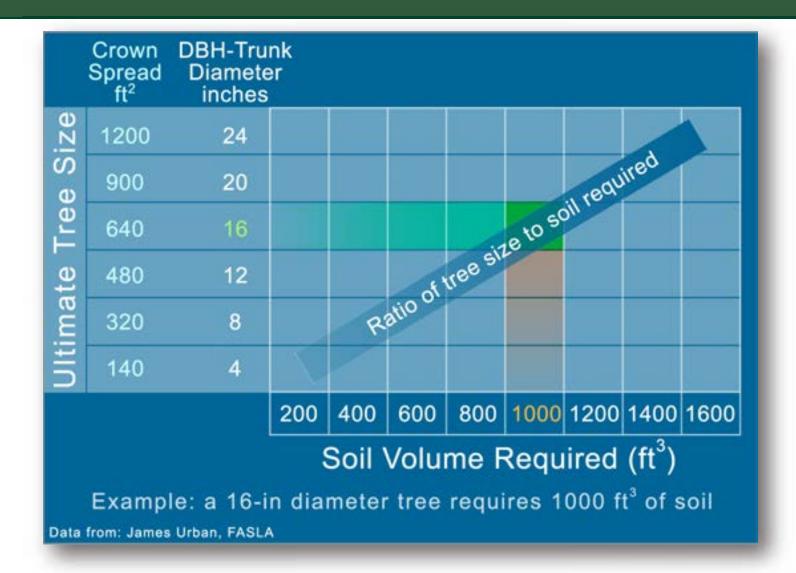
Soil Formation: Urban Style



Soil Formation: Urban Style



Tree soil volume requirements



Lindsey & Bassuk 1991

- A weather-based methodology for adequately sizing soil volumes
- Water is added to the soil mainly through precipitation; rain every 10 days
- Soil is a silty loam

ARBORICULTURE

June 1991 Vol. 17, No. 6

SPECIFYING SOIL VOLUMES TO MEET THE WATER NEEDS OF MATURE URBAN STREET TREES AND TREES IN CONTAINERS

by Patricia Lindsey and Nina Bassuk¹

Abstract. The small volume of soil in a typical street tree pit or container often is not capable of supplying adequate water as the free needs it. As a result, frees can experience severe limitations upon healthy growth and development. Current soil volume estimations fall to address three problems: 1) how to predict whole tree water use, especially for a wide range of prevailing climatic conditions, 2) how to tie this prediction to some easily measured tree parameter, and 3) how to incorporate both of the above into some simple yet accurate means. of estimating soil volume. A weatherbased methodology for adequately sizing soil volumes is presented to address these concerns. This incorporates the findings of a recent study indicating that whole tree water loss can be reasonably predicted with knowledge of evaporation from a U.S. Weather Bureau Class A pan. A soil volume of 220 ft³ for a medium sized tree is then calculated. For use as a general estimate, 2ft³ of soil per 1ft² of crown projection is recommended.

Inadequate soil rooting space can be one of the more important factors in the premature mortality of trees in urban areas (23). Clearly, there is a basic conflict between the biological needs of trees, whose roots systems are generally near the surface and spread laterally, and the small and confined areas they are relegated to in the design

has been no widely applicable method for determining the size of a tree pit or container that is based on a tree's water requirements, it is the intent of this article to provide a knowledgeable framework for both cn._2ally evaluating and effectively using the soil volume methodology presented here.

Current recommendations. Current recommendations detailing appropriate soil volumes for trees have been culled from a variety of sources in the literature and are presented for comparison in Table 1. Many of these estimates are quite high, up to 7000 ft³ and would be next to impossible to achieve in most street tree plantings. Some of these recommendations are either simple rules of thumb, or are based on plant factors other than empirically determined water use rates. Further questions and considerations come readily to mind. Are changing regional climatic conditions accounted for in these estimates and is the amount and timing of rainfall integrated in some

Lindsey & Bassuk 1992

- Model applied to 6 locations in Britain.
- Great deal of similarity among values.
- Generic estimate of 0.15 m² of soil per m² of crown projection.

Arboricultural Journal 1992, Vol 16 pp 25-39

AB Academic Publishers 1992

Printed in Great Britain

REDESIGNING THE URBAN FOREST FROM THE GROUND BELOW: A NEW APPROACH TO SPECIFYING ADEQUATE SOIL VOLUMES FOR STREET TREES

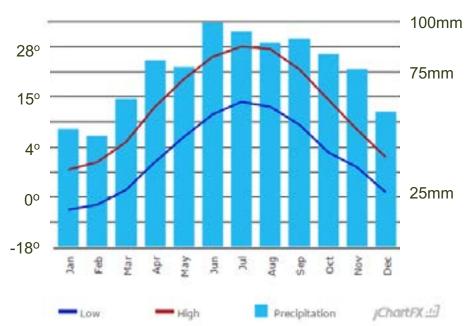
Patricia Lindsey and Nina Bassuk*

Summary

Current surveys have dramatically documented the plight of struggling and dying urban trees. Inadequate soil rooting volume is an important cause of this premature mortality. The soil acts as a vital reservoir, holding and then supplying water as the tree demands it. A weather-based methodology has been developed that enables the arboriculturist to size a tree pit or container based on a tree's daily expected water requirements, thereby reducing or eliminating water stress over a growing season. For use as a general estimate, a soil volume of 5 m³ for a medium sized tree is recommended.

Average monthly rainfall

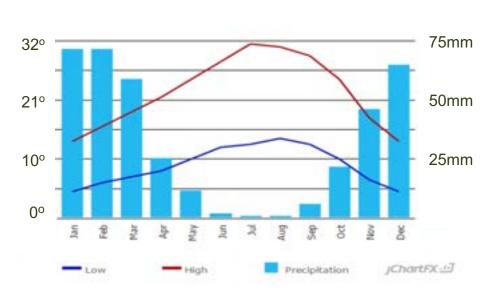




Average Annual Precipitation

890 mm rain 1600 mm snow

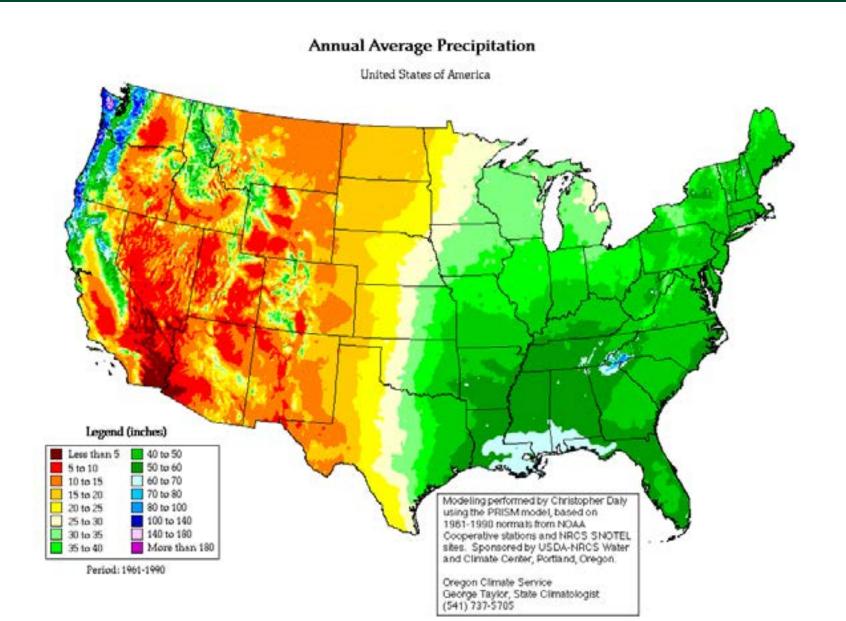
Livermore, CA

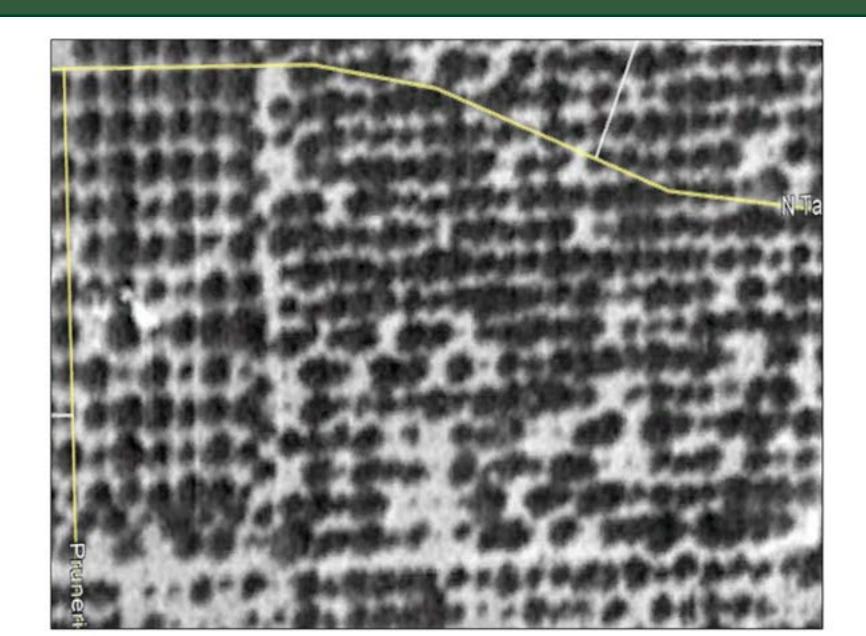


Average Annual Precipitation 380 mm

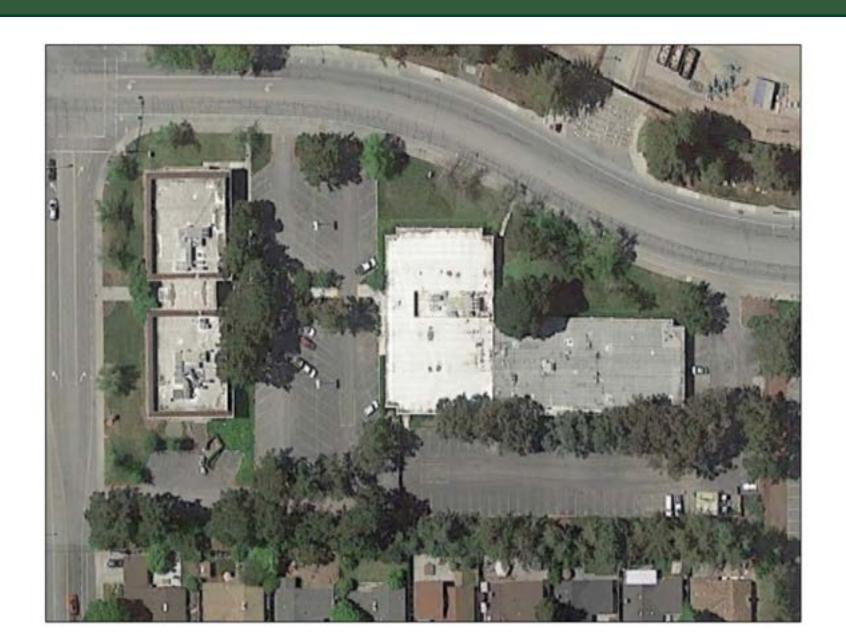
Graphics: www.usclimatedata.com

Environmental conditions make a big difference

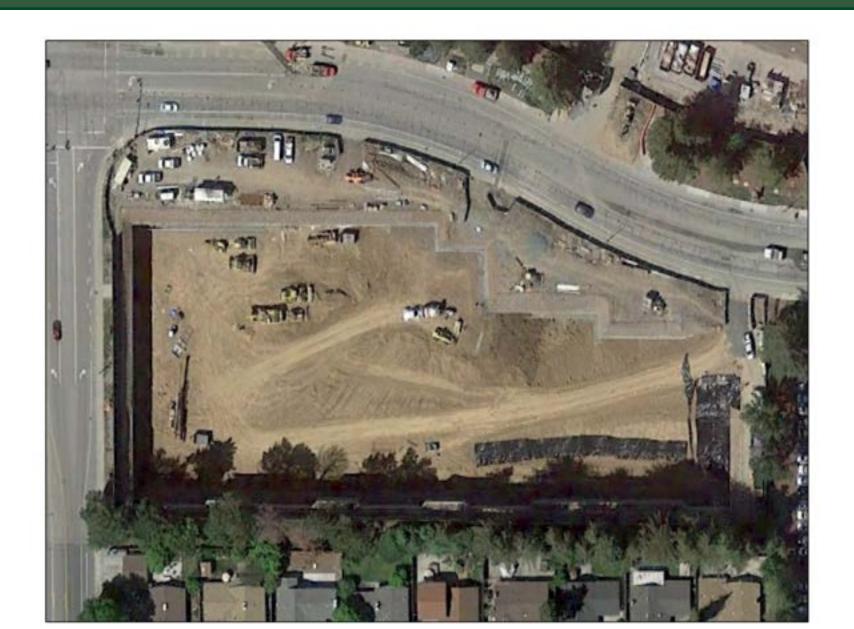




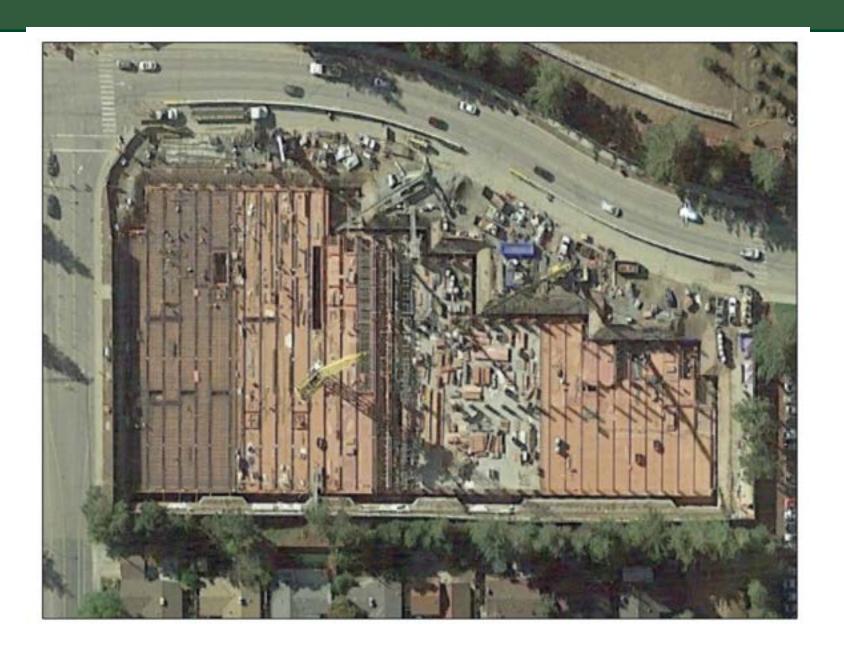
Sometime in the 1980's



April 2016



November 2016



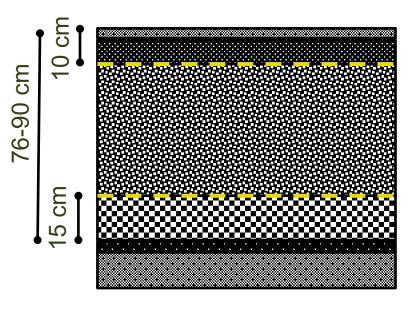
April 2017

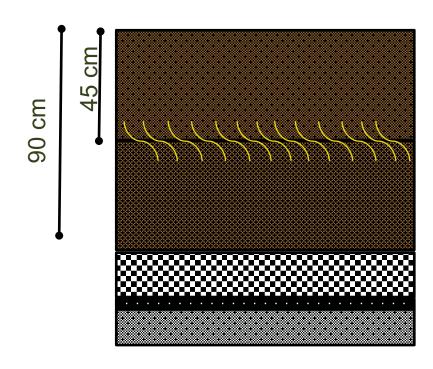


Soil Formation – Urban Style

- 1. Imported "top soil" over compacted site soil
- 2. Imported "top soil" over structure
- 3. CU-Structural soil over compacted site soil
- 4. CU-Structural soil over structure
- 5. Bioretention soil

Soil Profile -- Urban Style

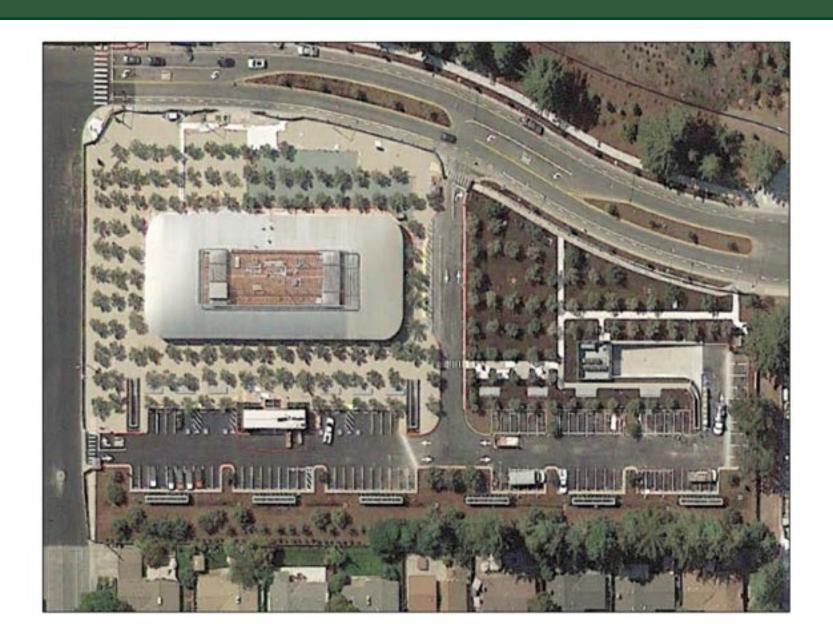




Structural soil over structure

Planting over structure

September 2017









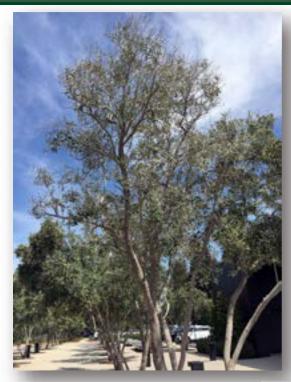


Tree replacement July - November



November 2017

August 2018









Olive tree condition



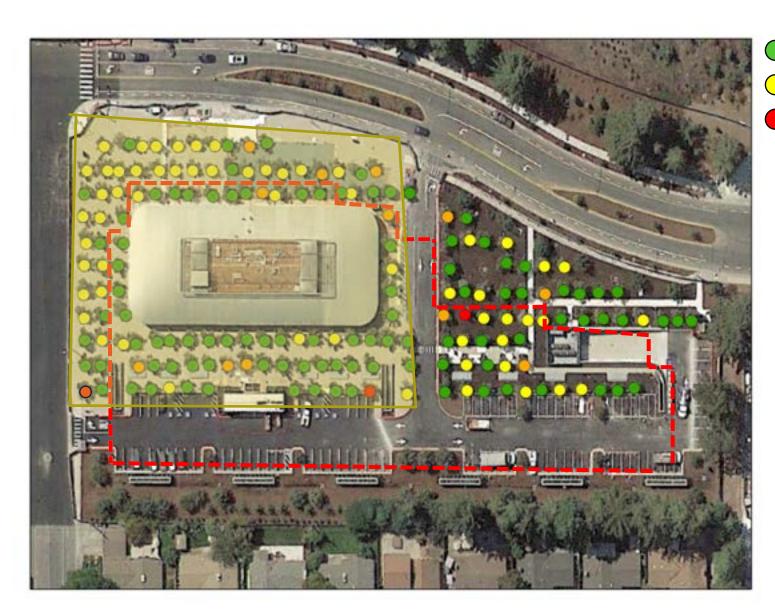
Olive tree condition

Good

Fair

Poor





A closer look at 4 trees

Structural soil over structure



Structural soil over compacted soil





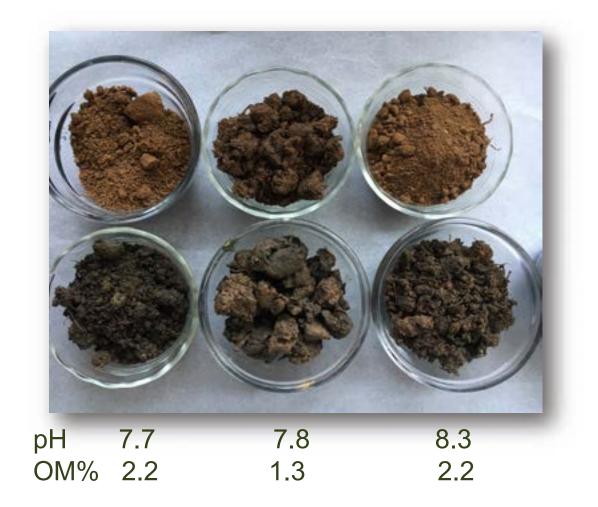
Imported
"top soil"
over site
soil over
compacted
site soil



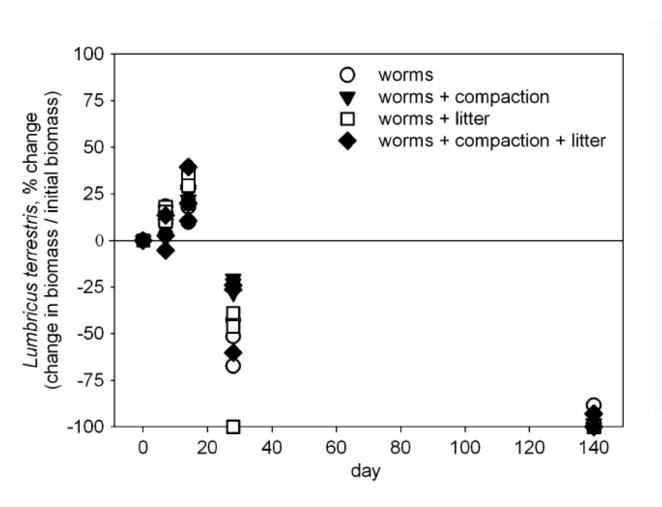
Imported "top soil" over site soil over structure

Soil quality – Give me the numbers

pH 4.8 6.9 5.8 OM% 2.2 1.3 2.4



Biological activity in urban soils

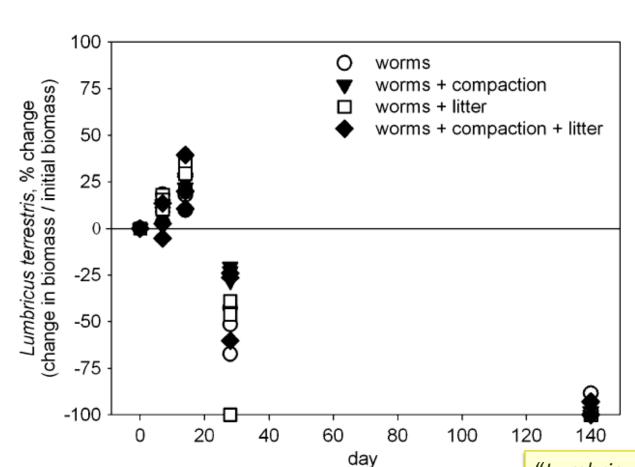




Nigel Cattlin, Science Source

Scharenbroch and Johnston 2011, Urban Ecosystems

Biological activity in urban soils



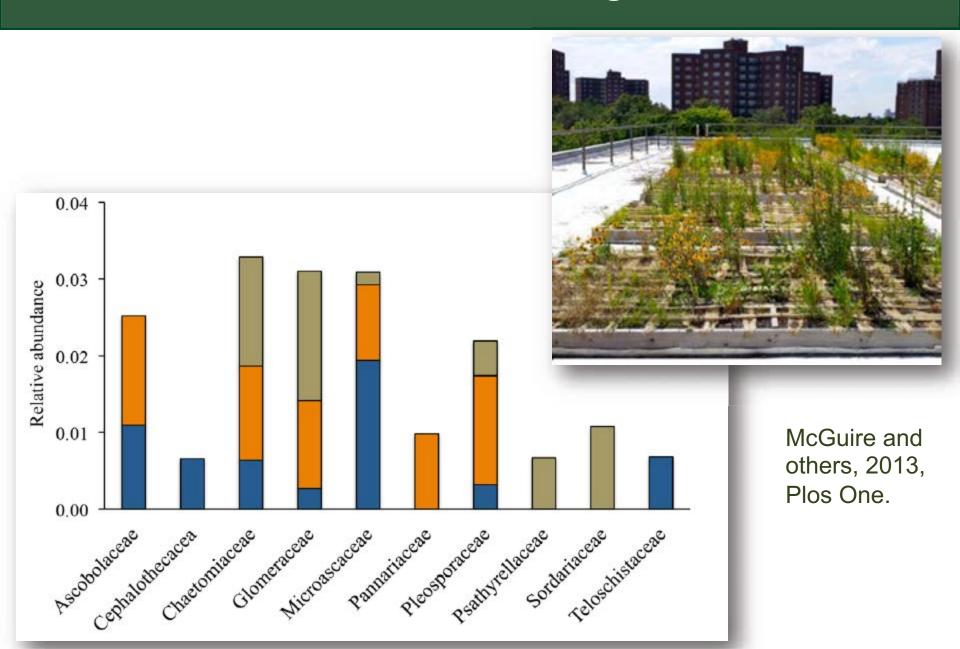


Nigel Cattlin, Science Source

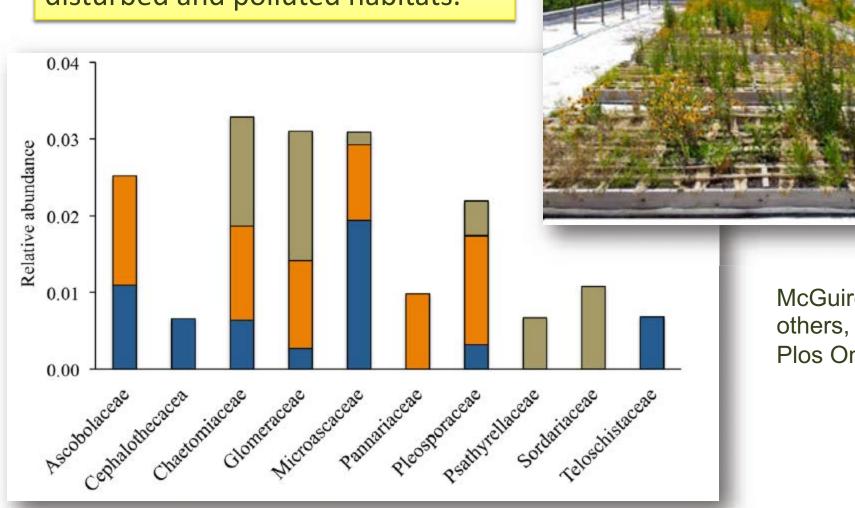
Scharenbroch and Johnston 2011, Urban Ecosystems

"Lumbricus terristris is not suited for habitation in designed urban soils."

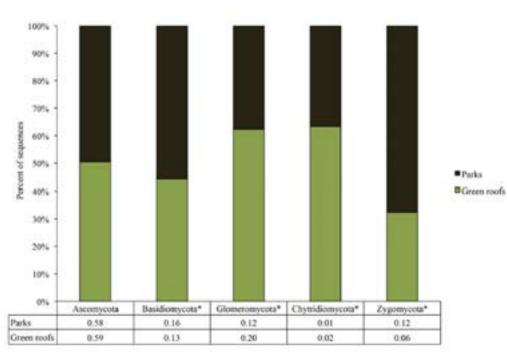
Decline related to physical constraints of CU soil, specifically aggregate abrasion and shallow depth.



Diverse fungal communities...with taxa capable of surviving in disturbed and polluted habitats.



McGuire and others, 2013, Plos One.

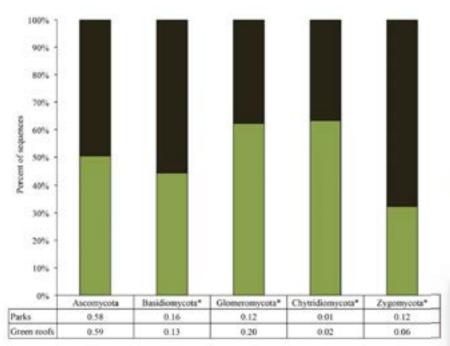


Relative abundance of fungal phyla from green roof substrates and city park soils.

- Only 53% of the green roof taxa were found in nearby city parks.
- Park soils had greater microbial biomass.

McGuire and others, 2013, Plos One.

Green roofs



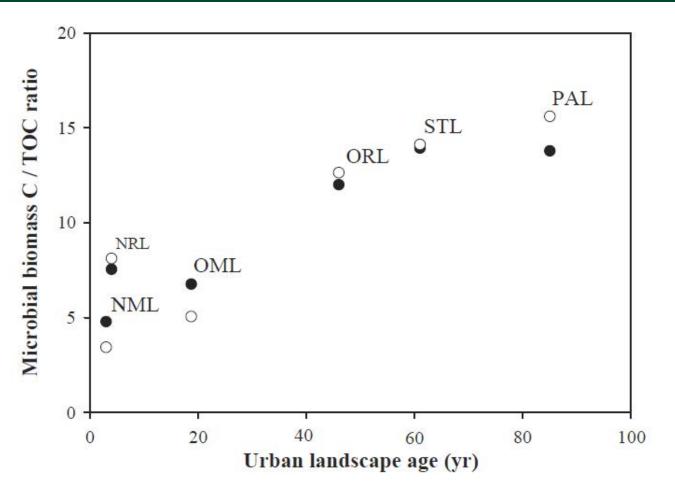
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Time is a factor in urban soil formation, too

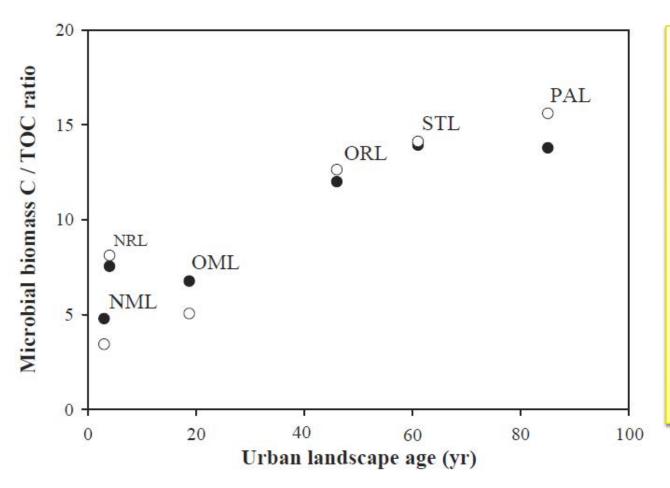


2002, 2003 Moscow ID, Pullman WA

PAL Park
STL Street tree
ORL Old residential
OML Old mulch
NRL New residential
NML New mulch

Sharenbroch, Lloyd and Johnson-Maynard. 2005. Pedo biologia.

Time is a factor in urban soil formation, too



"Of the soil forming factors, time played the most significant role in soil physical, chemical, and biological differences."

Sharenbroch, Lloyd and Johnson-Maynard. 2005. Pedo biologia.

How do we best manage trees in urban landscapes?



- Right tree
- Space
- Water
- Aeration
- Drainage

How do we best manage trees in urban landscapes?



