**Plant Hardiness in the Built Environment**

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An ASHS HortIM peer-reviewed instructional material

**What Is Plant Hardiness?**

*Plant Hardiness* = ability of a given genotype to survive, grow, and fulfill its intended use in the landscape in a given geographic location

- Involves many interactions among genotype, environment, cultural practices, and intended use
- Critical concept for sustainable designs

**Changes In USDA Plant Hardiness Zone Map**

Derived from 1990 version  
http://www.usna.usda.gov/Hardzone/ushzmap.html

Derived from 2012 version  

True changes in climate versus changes in sample period?  
Urban impacts at some measurement sites?  
Natural cyclical variation versus human caused variation?

**Cold Temperatures**

- A key factor for perennial plants, little meaning for summer annuals
- USDA Hardiness Zone Map
  - Based on *average annual minimum low temperature*
  - Says nothing about:
    - 100 or 1000 year low temperature
    - Duration or frequency of low temperatures
    - Fluctuations from low to growing temperatures
    - Fall acclimation / spring deacclimation conditions
    - Variation between measurement & planting sites
**Cold Temperatures**

**Latitude versus altitude**
- Temperature varies inversely with altitude & latitude
- Implications with global climate change

**Maritime and Lake Effects**
- Moderate seasonal fluctuations
- Depends on size, prevailing winds, and currents

**Continental Effects**
- Accentuate seasonal fluctuations

**Topographical Variations**
- Diversion of prevailing winds
- Trapping of air masses in depressions

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**Drought**

**Year-Round Deficits**
- Desert & semi-arid regions

**Seasonal Deficits**
- Summer, winter, cold / drought interactions

**Soil moisture versus atmospheric humidity**
- Significant water demand even at high relative humidity
- Interactions among wind, relative humidity, and soil moisture

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**Drought & Topographic Features**

Local wind patterns and topographic features influence moisture as well as temperature
(Wet versus dry sides of Island of Maui, HA)
**Excess Moisture**

Flooding
- Anoxia / hypoxia is problem, not excess H₂O
- Poor surface drainage = temporary flooding
- Monsoon rains
- Permanently wet soils
  - Swamps, bogs, etc.
  - Seasonal wetlands
  - Poor internal soil drainage is a major urban limitation

**Heat**

Daily maximum temperatures
- High night temperatures
  - Major limitation in southern USA
  - Respiration is more temperature dependent than photosynthesis
    - Some genotypes essentially starve with long term high night temperatures

Reflected heat in built envirn.
High root zone temperatures
- Special concern in above ground planters

**Elevated Soil Temperatures**

- Major challenges in some settings
- Often combined with reflected heat and high night temperature conditions

**Masonry Surfaces May Exacerbate High Soil Temperatures**
**Misc. Soil & Atmospheric Factors**

Seashore conditions
- Soil salts &/or salt spray
- Smog / air pollutants
- Saline or alkaline soils

Coastal challenges are substantial

Smog in Dallas, TX

Shallow alkaline soil

**Quality of irrigation water**
- Method of application

**Soil fertility**
- Interactions with various physiological processes

**Soil compaction**

Compaction during construction

Fertility affects leaf mass

**Soil And Foliar Salt Exposure**

High levels of soil salts arise from:
- Soils containing high salts
- Irrigation with salty water
- Excess fertilizer applications
- Drift or runoff from salted roads, parking lots, &/or pedestrian walkways
- Coastal salt spray
- Evaporative salt deposition

**Urban / Suburban Soil Challenges**

- High pH is a frequent challenge
  - Massive quantities of structures with calcium carbonate
  - Soil fertility & pH intimately intertwined

Mn chlorosis on *Acer rubrum*
Low Soil Oxygen

Compaction & poor drainage = lethal combination

Compaction mediated dieback on Catalpa speciosa

Drainage lines must exit at lower elevation

Construction damage!

Bathtub effect!

Other Urban Soil Challenges

• Lack of soil structure
• Limited volume of root zone
• High bulk density soils
• Poor fertility subsoil
• Imbedded foreign objects
• Low mycorrhizal inoculum

An alternative solution to urban soil problems is to use containers of various sizes

Informal setting, incorporate edibles

Formal setting

Any season
Urban Heat Islands - Large Scale Implications

Micro Climates
Small scale lake, river, stream effects
Shelter by buildings and other plants
Exposure to prevailing wind
Reflected heat
Restricted root zones
Road-side salts and pollution
Air drainage patterns
Buried utility lines
Heated discharge water
High traffic areas

Microsite Implications Of Urban Heat Islands

Hardiness Can Be An Issue Even In Interiorscapes
- Light (irradiance) levels
- Air movement patterns
- Low humidity levels
Disease, Pest, and Environmental Interactions

- Unfavorable environments predisposes plants to diseases and pest infestations
- Diseases and pest infestations increase susceptibility to environmental stresses

Questions / Comments?

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