Street Tree Planning and Management: Guiding Principles

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Forest Resources & Environmental Conservation at Virginia Tech

TREES VIRGINIA
Virginia Urban Forest Council

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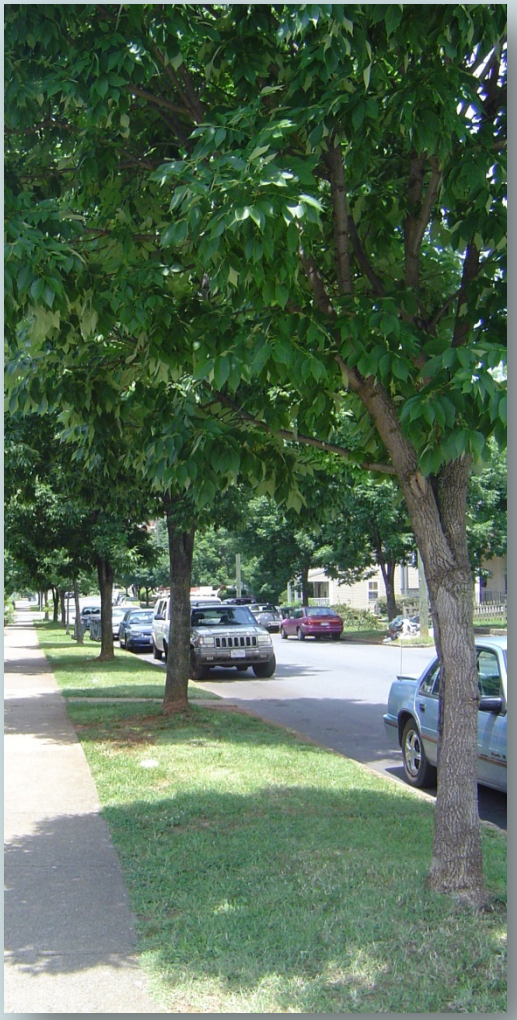
Street Trees in Virginia ~ What We Have, What We Want, & How We Get There

Presentation Overview

- Urban forestry paradigm
- Street tree management model
- Principles of structure
- Principles of function & value
- Take-home messages



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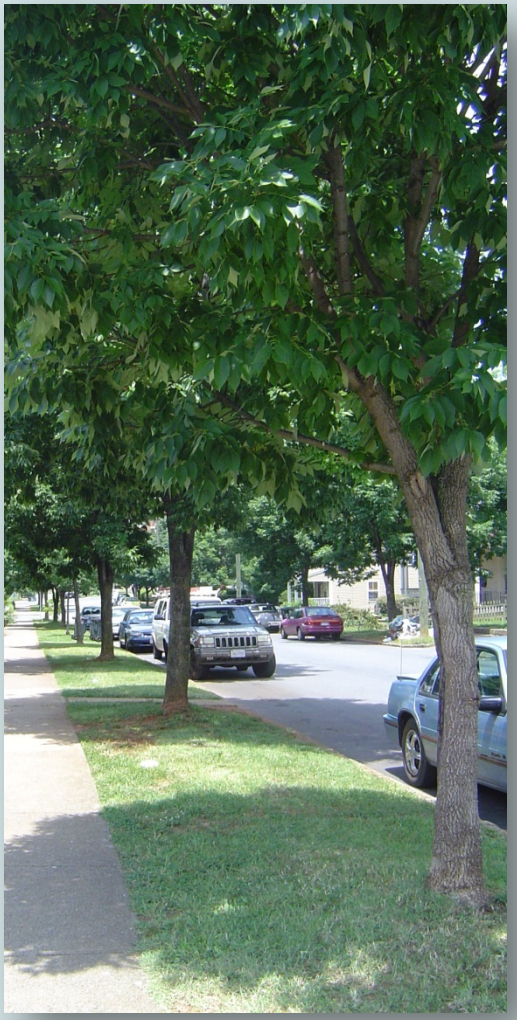
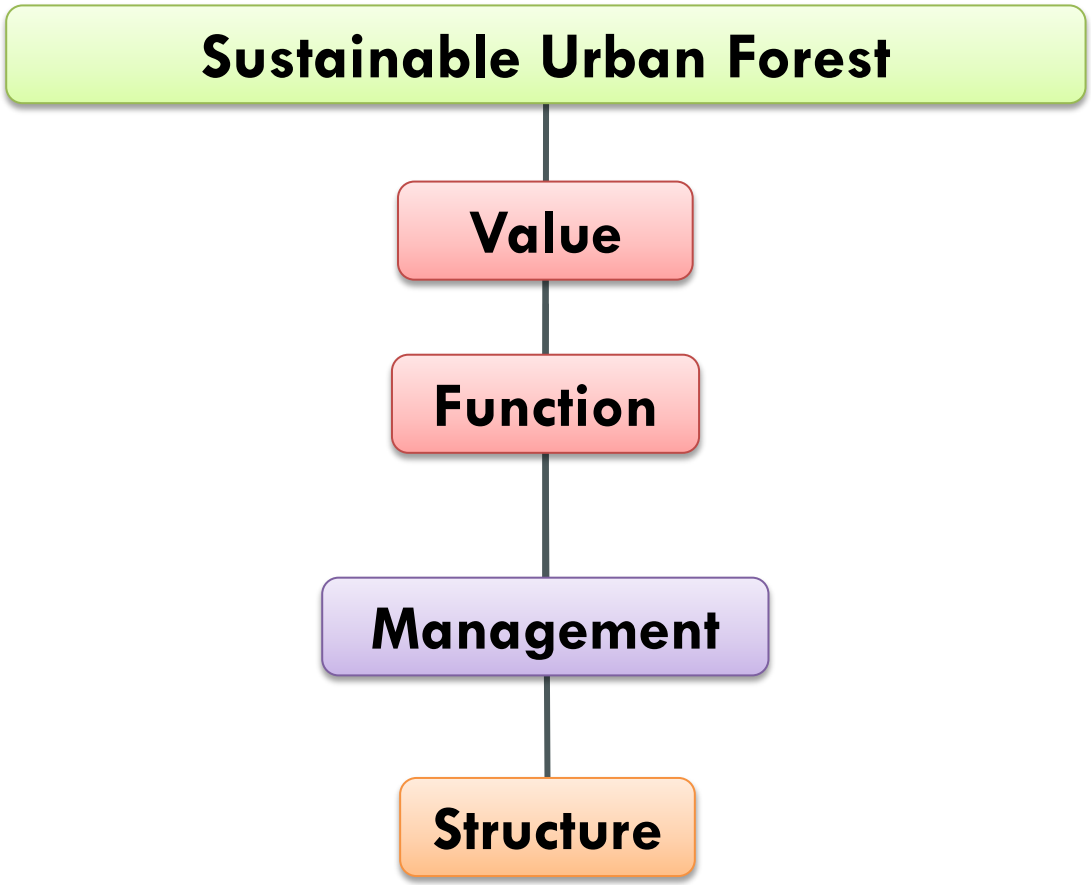


URBAN FORESTRY PARADIGM



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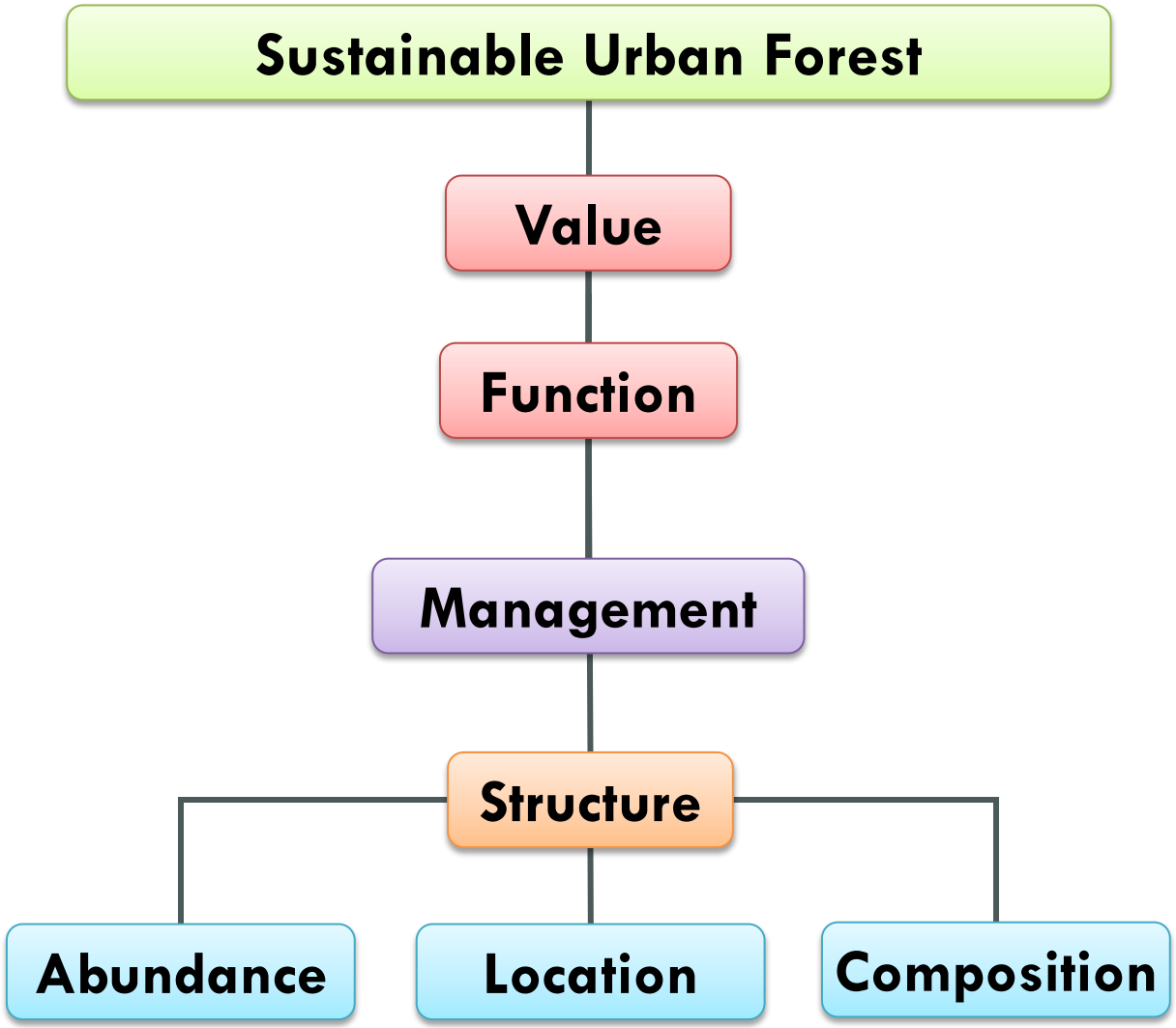

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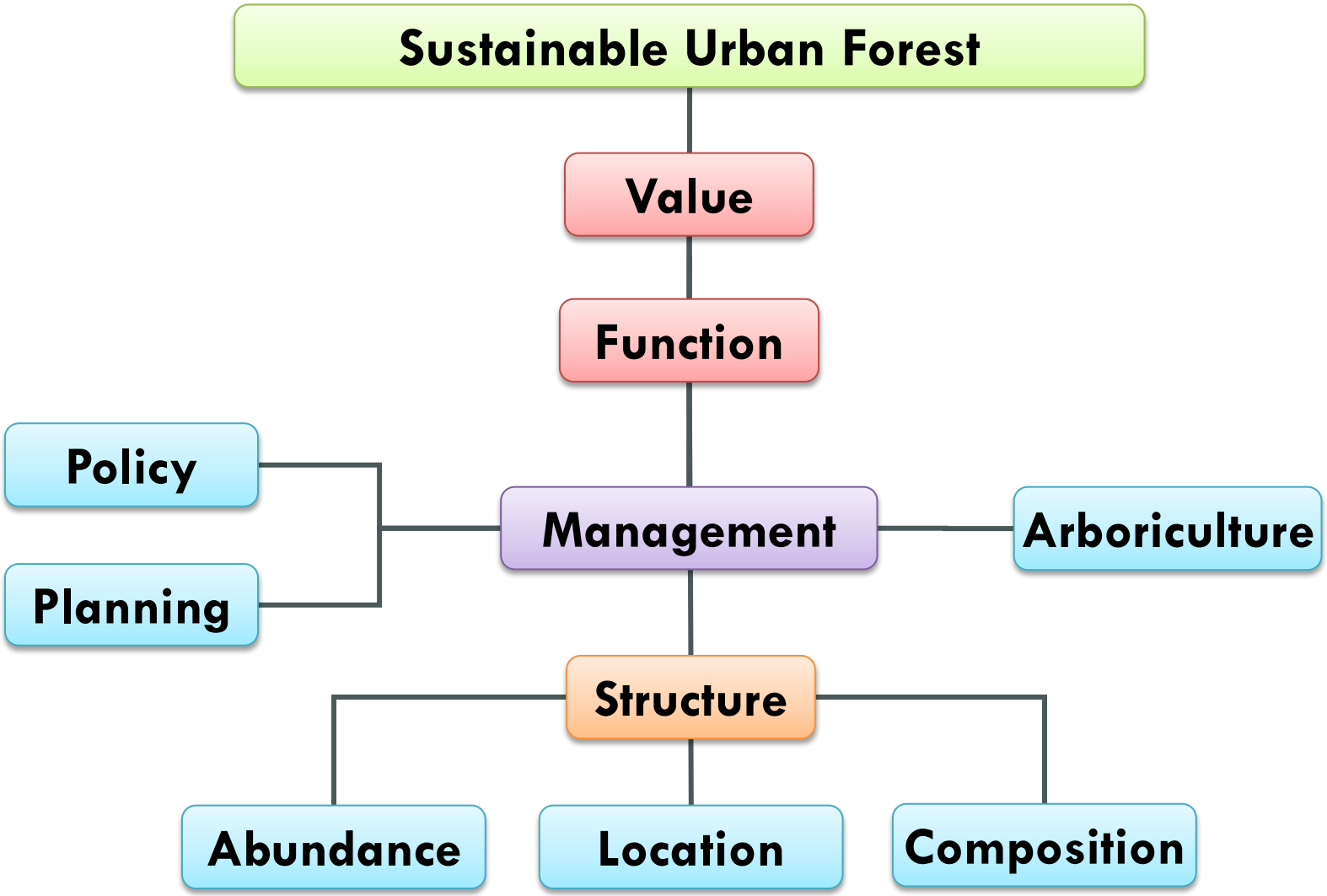

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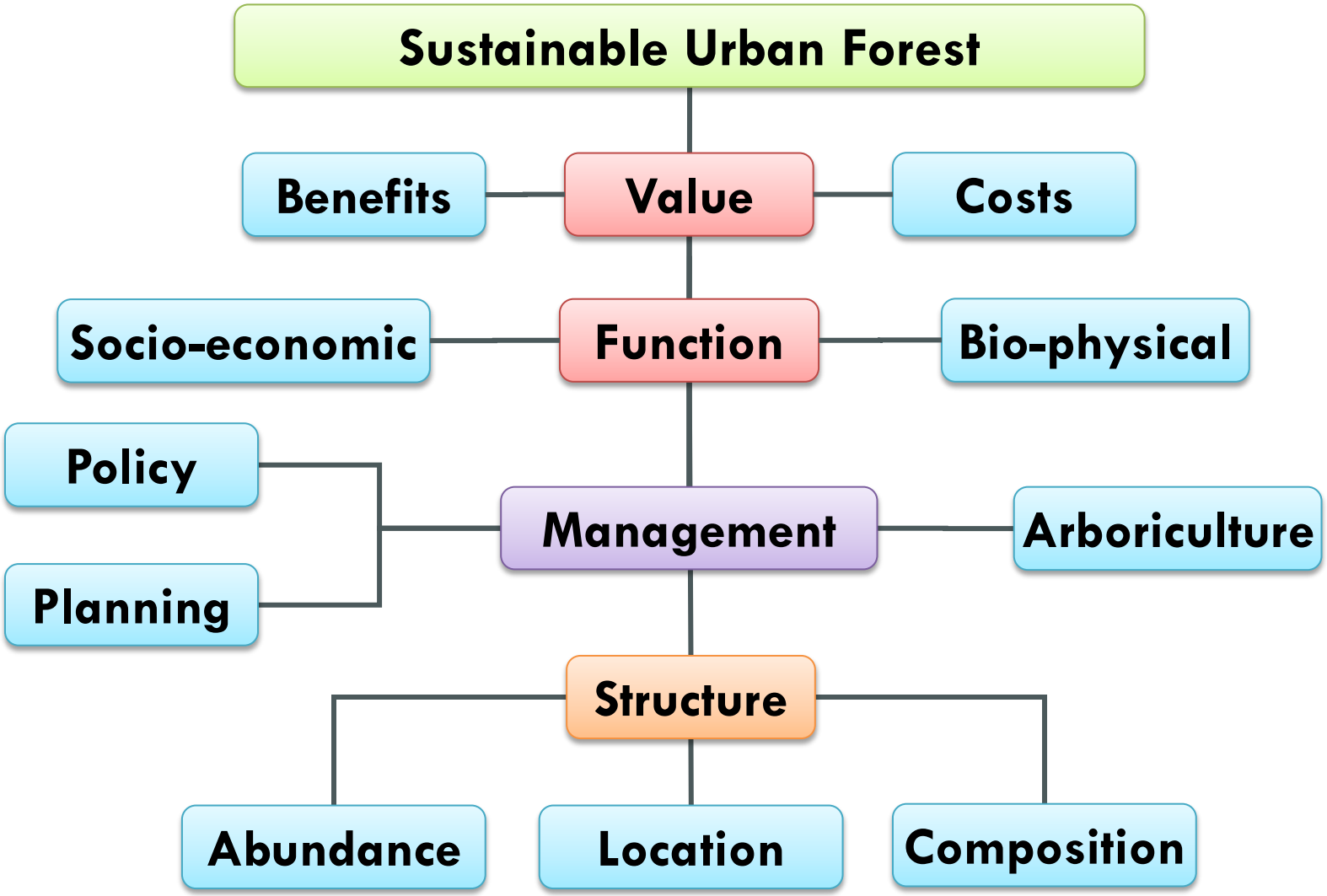

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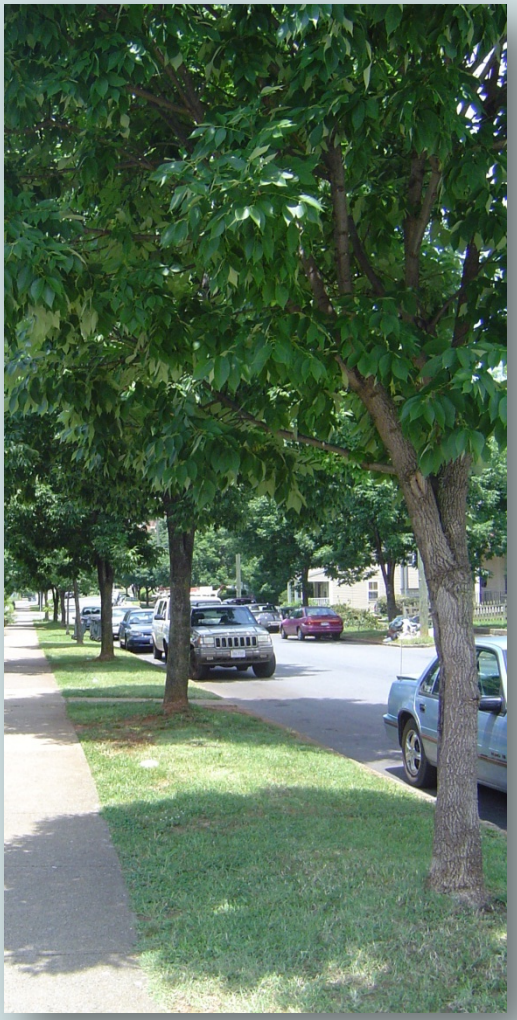

STREET TREE MANAGEMENT MODEL

What Do We Have?

Resource Assessment

What Do We Want?

Management Goals

How Do We Get There?

Management Plans

Are We There Yet?

Re-assess

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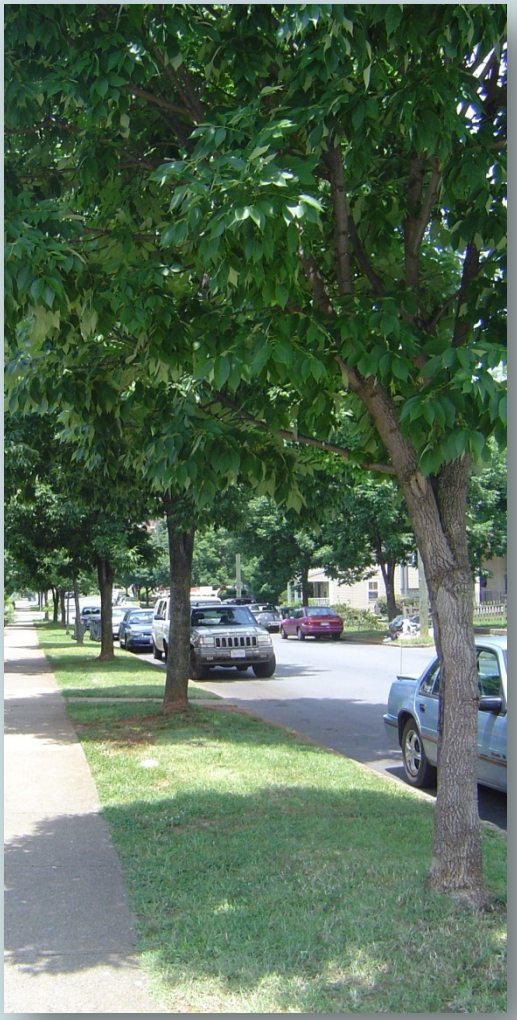


Principles of population structure

- Street Tree Abundance – Stocking

  - Full Stocking
    1 tree every 50’ (Wray & Prestemon 1983)
    45’ | 35’ | 25’ (Various municipalities)
  - Typical Stocking
    46% (Ball et al. 2007)
    38% (McPherson and Rowntree 1989)
    9–66% (McPherson et al. 2005)
  - Optimum Stocking (Miller 1997)
    - Biological capacity
    - Economic capacity
    - Social capacity

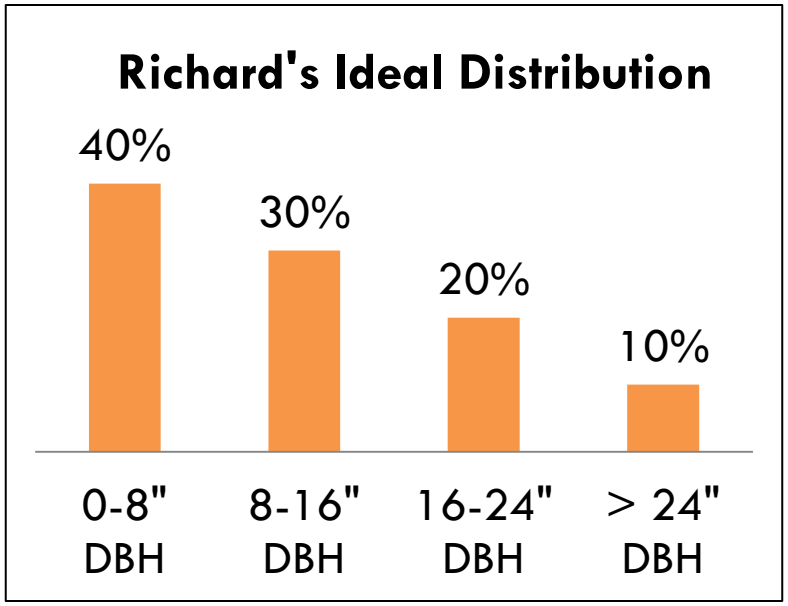
Principles of population structure

- Street Tree Abundance – Stocking

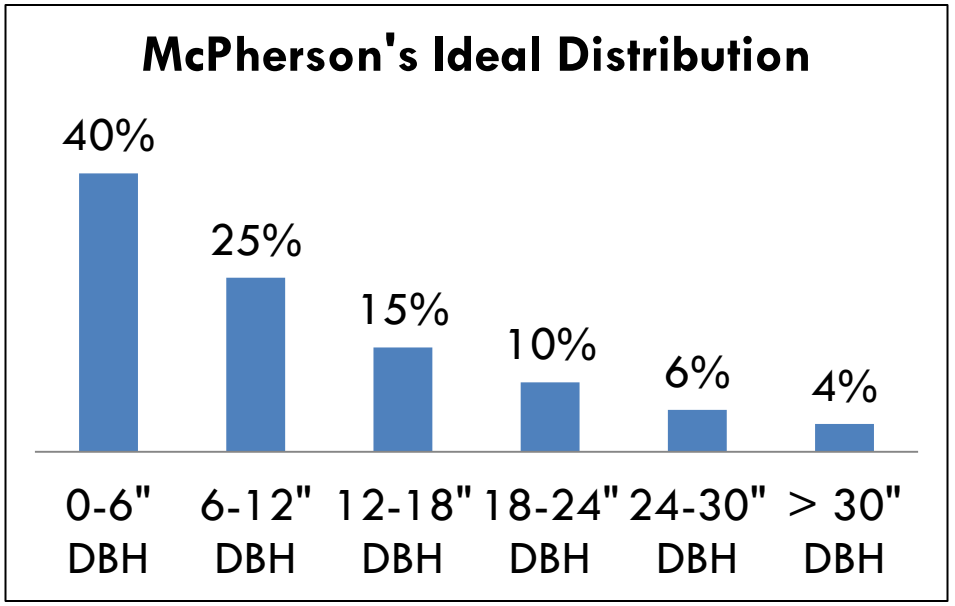
  - Available Planting Spaces
    - Remotely-sensed or field-surveyed
    - As part of a tree inventory
    - Strip/cut-out size; utilities; setbacks

PRINCIPLES OF POPULATION STRUCTURE

- Street Tree Composition – Size Distribution



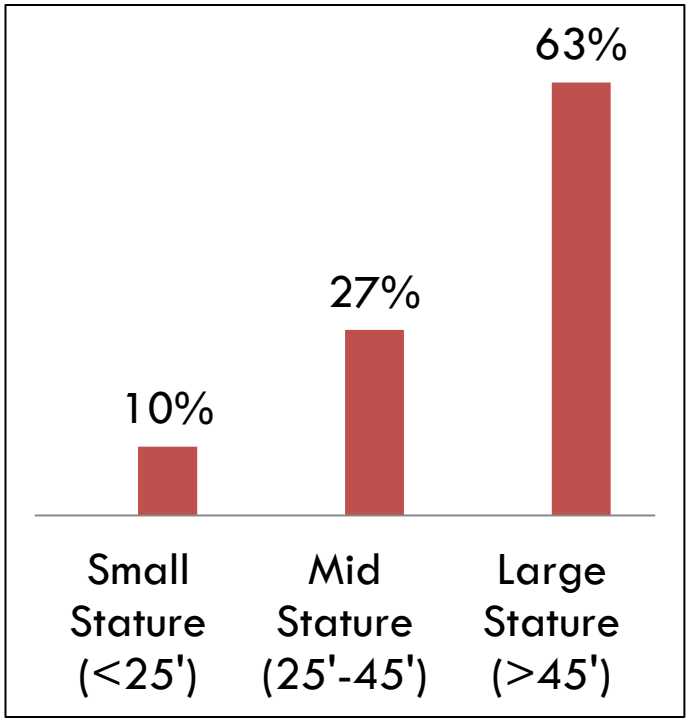
(Richards 1983)



(Soares et al. 2011)

PRINCIPLES OF POPULATION STRUCTURE

- Street Tree Composition – Stature Distribution



(US Forest Service 2004)

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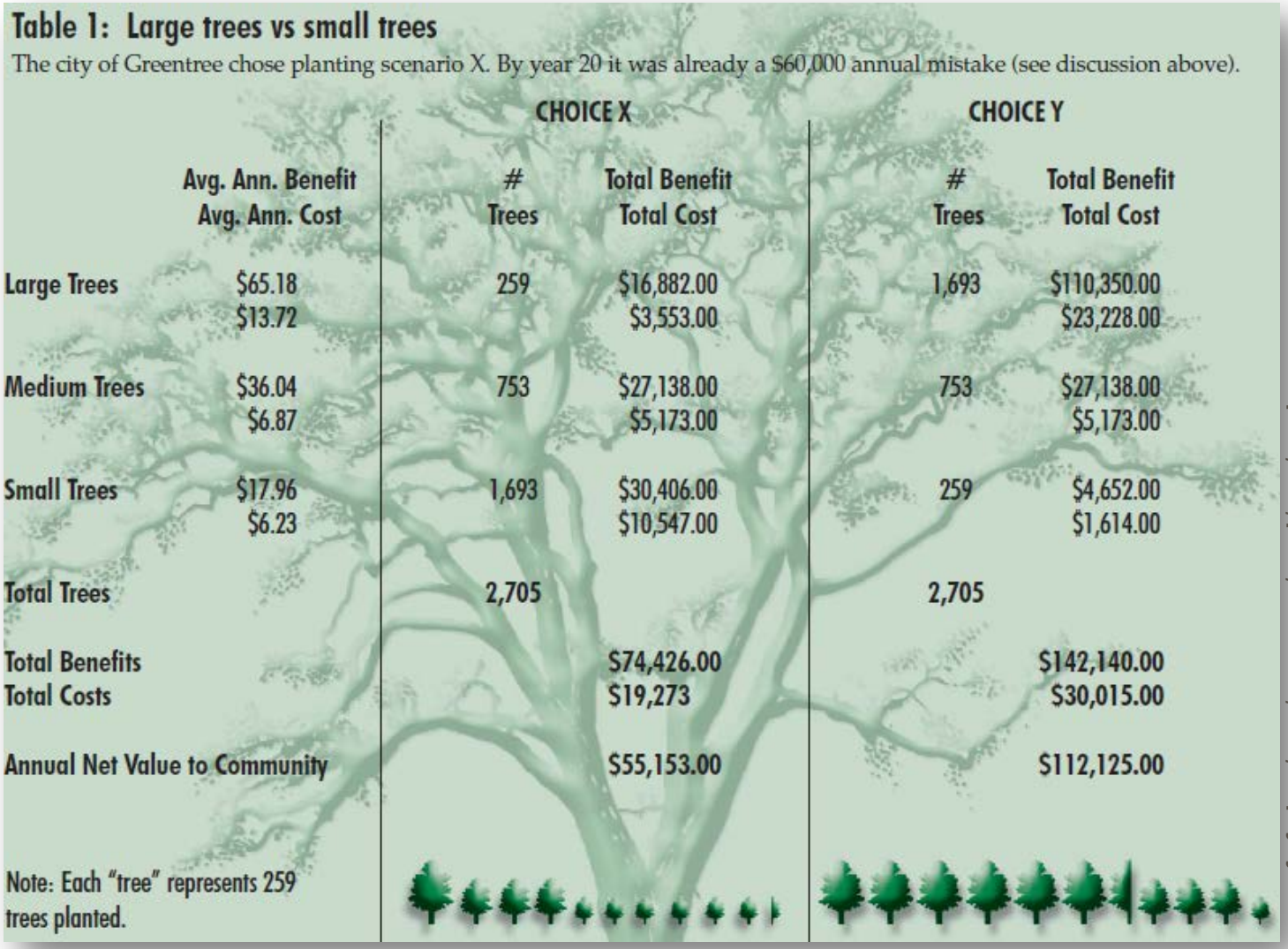


Table 1: Large trees vs small trees

The city of Greentree chose planting scenario X. By year 20 it was already a $60,000 annual mistake (see discussion above).

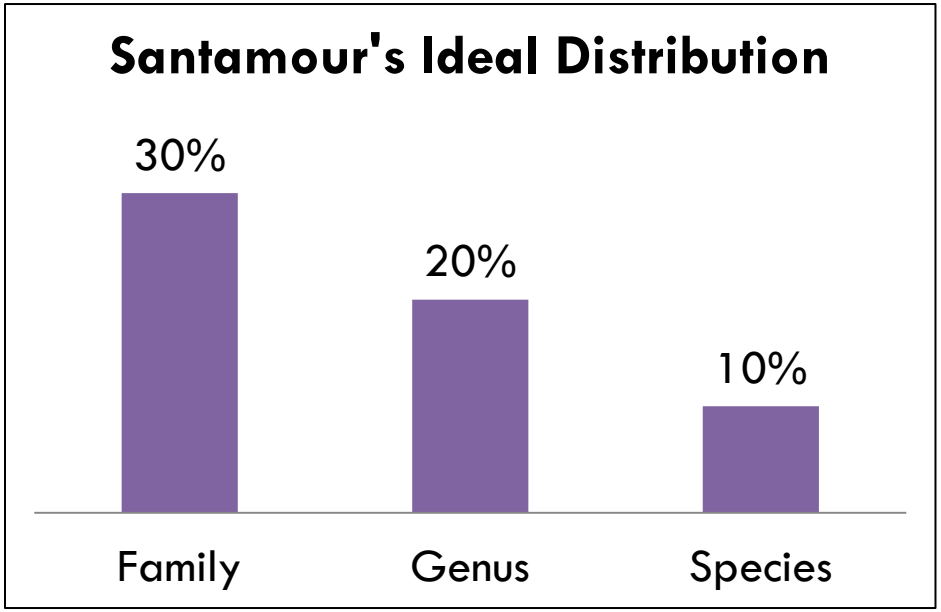
		CHOICE X		CHOICE Y	
	Avg. Ann. Benefit Avg. Ann. Cost	# Trees	Total Benefit Total Cost	# Trees	Total Benefit Total Cost
Large Trees	$65.18 $13.72	259	$16,882.00 $3,553.00	1,693	$110,350.00 $23,228.00
Medium Trees	$36.04 $6.87	753	$27,138.00 $5,173.00	753	$27,138.00 $5,173.00
Small Trees	$17.96 $6.23	1,693	$30,406.00 $10,547.00	259	$4,652.00 $1,614.00
Total Trees		2,705		2,705	
Total Benefits Total Costs			$74,426.00 $19,273		$142,140.00 $30,015.00
Annual Net Value to Community			$55,153.00		$112,125.00

Note: Each "tree" represents 259 trees planted.

www.fs.fed.us/psw/programs/uesd/uep/products

Principles of population structure

- Street Tree Composition – Taxonomic Diversity



(Santamour 1990)

"A community forestry goal of a 10% limit on a single species could give a false indication of stability…. (t)here is probably little concern about the diversity of families used as street trees, but not enough concern on the reliance on a limited number of genera…a 10% limitation on genera may be our best measure of stability." (Ball et al. 2007)

Principles of population structure

- Street Tree Composition – Taxonomic Diversity

  What is holding us back?

  - Ecology (site suitability: soil, space, pests, stress)
  - Social norms (citizens want fast-growing, colorful trees)
  - Design and management norms (symmetry and uniformity)
  - Nursery production (nurseries produce what consumers demand)

PRINCIPLES OF POPULATION STRUCTURE

Arboriculture & Urban Forestry 2011. 37(6): 259–264

Survey of Wholesale Production Nurseries Indicates Need for More Education on the Importance of Plant Species Diversity

Nicole R. Polakowski, Virginia I. Lohr, and Teresa Cerny-Koenig

Abstract. Recent pest outbreaks, such as emerald ash borer and Asian longhorned beetle, have renewed concerns about the lack of genetic and species diversity in landscapes across the United States. However, the level of understanding of these issues by people in the green industry is not known. A survey on the knowledge of plant species diversity issues was distributed to Washington, U.S., wholesale nurseries. Respondents indicated a general awareness of the issue, but they had insufficient understanding of why the lack of species diversity is a problem. Respondents who had learned about plant species diversity in educational settings beyond high school were more likely than others to understand the issues. These results indicate the need for increased, in-depth education on why plant species diversity among landscape plants is important.

Key Words. Biodiversity; Genetic Diversity; Nurseries; Overplanting.

Principles of population structure

- Street Tree Composition – Taxonomic Diversity

  What is holding us back?

  - Ecology (site suitability: soil, space, pests, stress)
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  - Nursery production (nurseries produce what consumers demand)

  What do we do about it?

  - Educate (share results of assessments; websites; social media)
  - Incentivize (tree replacement request preference for diverse spp.)
  - Subsidize (rebate or discount on diverse spp. sales)
  - Regulate (approved/prohibited spp. in policy or ordinance)

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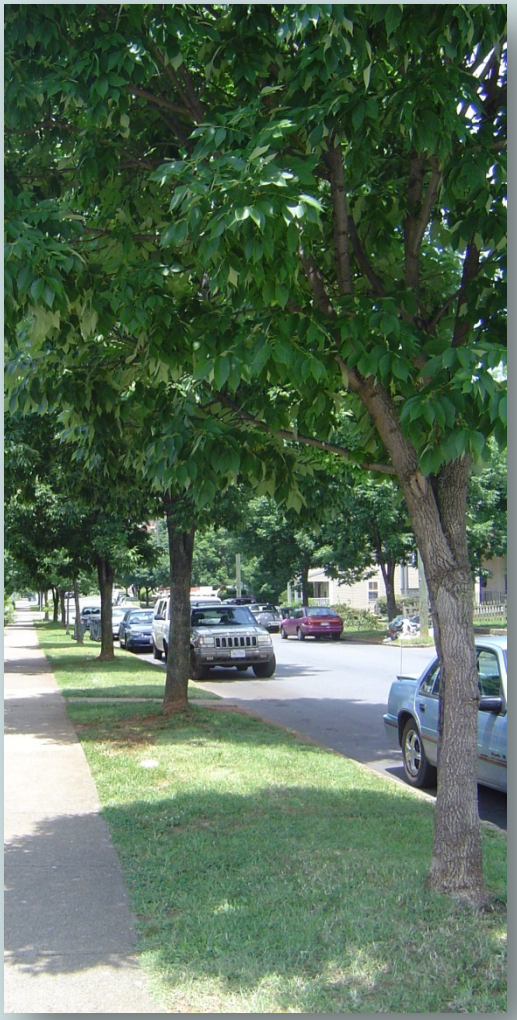
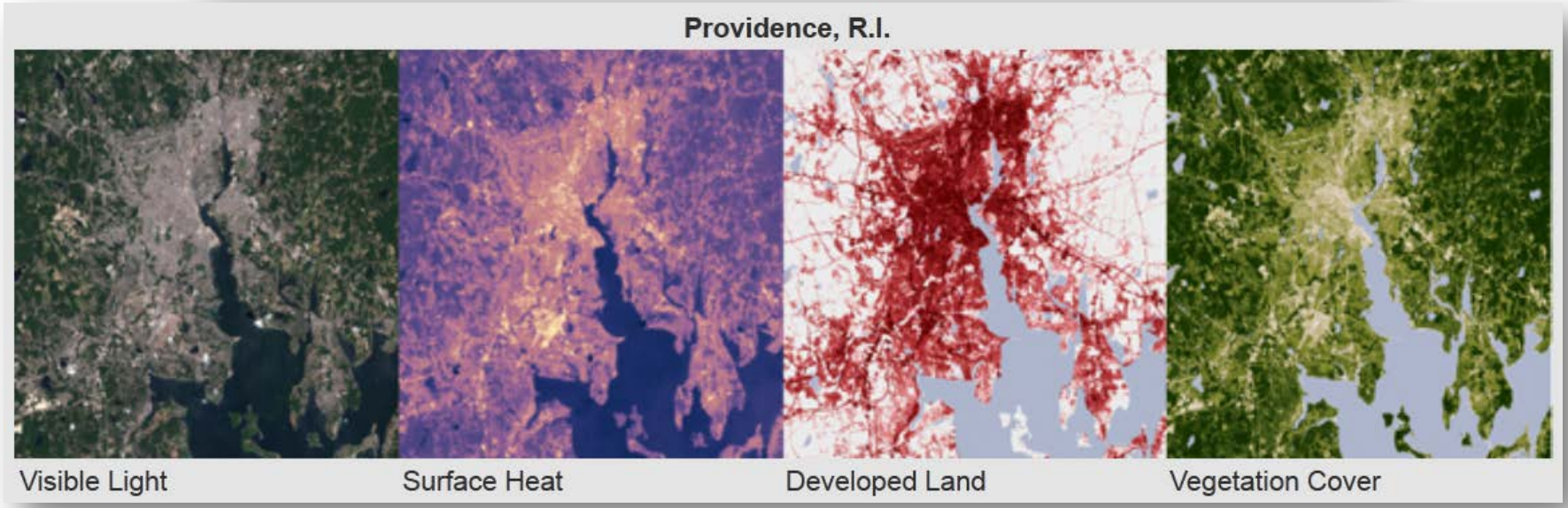


PRINCIPLES OF POPULATION FUNCTION

- Urban heat island and energy conservation



www.nasa.gov/topics/earth/features/heat-island-sprawl.html

PRINCIPLES OF POPULATION FUNCTION

- Urban heat island and energy conservation

	Mature Height	Sunlight Penetration	
		Summer	Winter
Koelreuteria bipinnata	30 ft	6%	66%
Celtis australis	40 ft	9%	56%
Pistacia chinensis	50 ft	11%	30%
Eucalpytus melliodora	50 ft	11%	11%

Thayer/Zanetto/Maeda

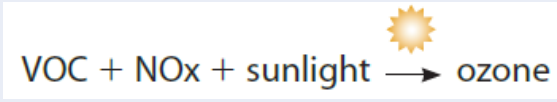
LANDSCAPE JOURNAL, Vol. 2, No. 2, 1983

PRINCIPLES OF POPULATION FUNCTION

- VOCs and ozone-forming potential

Characteristics and Effects of Ozone

- Chemical formula: O_3



- Metastable form of oxygen
- Levels typically found in various locations:
  - *35 to 40 parts per billion (ppb): clean atmosphere, such as found at mid-ocean*
  - *100 to 120 ppb: Central California (summer)*
  - *100 to 140 ppb: Los Angeles, California (summer)*
  - *400+ ppb: Mexico City (summer)*
- Human health effects:
  - *100 ppb: eye irritation*
  - *200 ppb: coughing*
  - *Reduction in pulmonary function and physical performance*
- Damaging to some materials (e.g., rubber)
- Affects plants starting at approximately 60 ppb

anrcatalog.ucdavis.edu/pdf/8484.pdf

Species	BVOC Emissions (lb)	BVOC Emissions ($)	Avg $/tree
Sugar maple	-1,221.6	-7,647	3.91
Willow oak	-16,092.5	-100,739	-15.31
Common crapemyrtle	0.0	0	0.42
Red maple	-812.5	-5,086	2.63
Pin oak	-16,684.3	-104,444	-20.78
Japanese zelkova	-4,417.0	-27,651	-4.19
Winged elm	0.0	0	4.85
Green ash	-3,459.2	-21,655	-9.82
Callery pear	0.0	0	2.69
Hedge maple	-3.8	-24	2.37
American sycamore	-3,026.6	-18,946	-10.24
Ginkgo	-13.3	-83	4.00
Loblolly pine	-2,241.4	-14,031	-6.75
Chinese pistache	-2.4	-15	1.98
Sweetgum	-904.1	-5,660	-4.41
American elm	-4,042.5	-25,306	-21.48
Littleleaf linden	-6.1	-38	3.97
London planetree	-1,170.9	-7,330	-7.48
Norway maple	-517.6	-3,240	-3.07
Silver maple	-78.2	-490	3.94
Kwanzan cherry	0.0	0	1.45
OTHER STREET TREES	-3,509.3	-21,968	0.09
Citywide total	-58,203.4	-364,353	-3.18

PRINCIPLES OF POPULATION VALUE

- Understanding street tree benefits and costs

Benefits	Total ($)	Standard Error	$/tree	Standard Error	$/capita	Standard Error
Energy	359,409	(±13,985)	11.70	(±0.46)	5.60	(±0.22)
CO2	35,171	(±1,369)	1.14	(±0.04)	0.55	(±0.02)
Air Quality	349,758	(±13,609)	11.39	(±0.44)	5.45	(±0.21)
Stormwater	29,161	(±1,135)	0.95	(±0.04)	0.45	(±0.02)
Aesthetic/Other	2,964,686	(±115,359)	96.51	(±3.76)	46.16	(±1.80)
Total Benefits	3,738,185	(±145,457)	121.69	(±4.73)	58.21	(±2.26)
Costs						
Planting	36,000		1.17		0.56	
Contract Pruning	281,500		9.16		4.38	
Pest Management	32,250		1.05		0.50	
Irrigation	9,000		0.29		0.14	
Removal	31,500		1.03		0.49	
Administration	78,750		2.56		1.23	
Inspection/Service	22,500		0.73		0.35	
Infrastructure Repairs	25,000		0.81		0.39	
Litter Clean-up	21,000		0.68		0.33	
Liability/Claims	22,500		0.73		0.35	
Other Costs	0		0.00		0.00	
Total Costs	560,000		18.23		8.72	
Net Benefits	3,178,185	(±145,457)	103.46	(±4.73)	49.49	(±2.26)
Benefit-cost ratio	6.68	(±0.26)				

PRINCIPLES OF POPULATION VALUE

- Understanding street tree benefits and costs

Benefits

	Energy	Air quality	CO_2	Stormwater	Aesthetics	Total
Hackberry	118.30	19.82	7.05	8.23	27.69	181.09
Camphor	54.29	7.62	2.85	6.71	11.29	82.75
Modesto ash	97.83	52.61	7.67	11.19	5.67	174.96
Ginkgo	51.51	2.79	5.43	3.27	35.18	98.18
Sweetgum	79.88	10.16	6.29	5.24	31.38	132.95
Southern magnolia	79.44	2.42	2.81	2.79	6.15	93.61
Pistache	65.31	10.27	2.82	3.34	11.03	92.76
Plane	136.76	25.76	4.80	7.59	11.33	186.24
Pear	34.00	2.98	1.95	1.47	14.19	54.59
Zelkova	89.25	8.26	4.69	3.37	18.47	124.05

Costs

	Prune	Remove	Plant	Root-related	Storm/liability	IPM/other	Total
Hackberry	29.30	1.43	0.01	0.88	0.76	0.29	32.67
Camphor	8.34	1.78	1.05	0.14	—	0.09	11.40
Modesto ash	45.22	0.83	0.01	1.43	0.37	0.93	48.80
Ginkgo	6.56	3.42	2.18	0.75	0.24	0.14	13.28
Sweetgum	49.70	0.90	0.03	2.14	0.62	0.92	54.31
Southern magnolia	17.38	1.13	0.03	0.95	0.70	0.19	20.38
Pistache	25.06	1.54	0.39	0.44	0.19	0.16	27.78
Plane	6.14	0.59	0.51	0.27	0.02	0.13	7.66
Pear	18.55	1.27	0.20	0.53	0.26	0.12	20.94
Zelkova	16.01	2.60	0.78	1.09	0.42	0.24	21.14

McPherson: A Benefit–Cost Analysis of Ten Street Tree Species Journal of Arboriculture 29(1): January 2003

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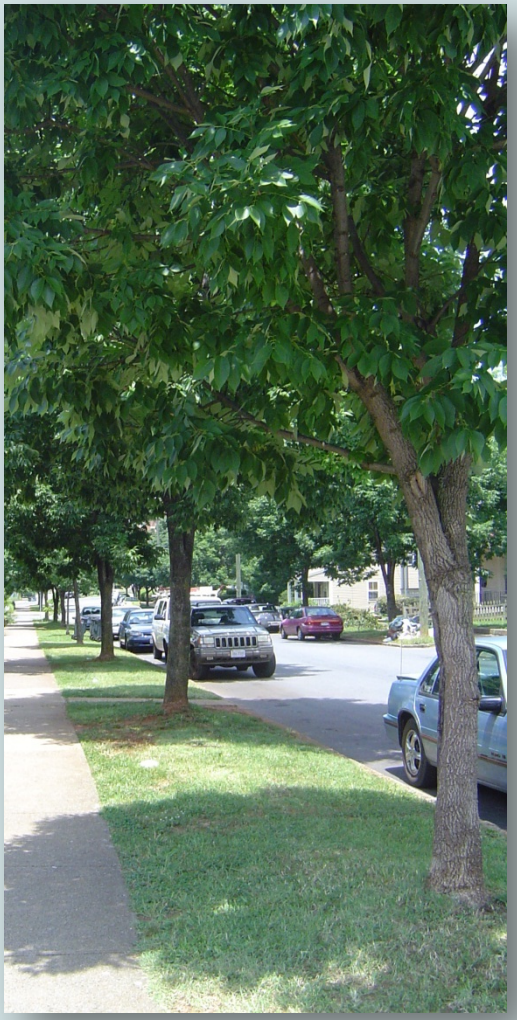

Take-home Messages

- The urban forestry paradigm conceptualizes the interelationships of structure, function, value, & management
- Street tree management is cyclical and is based on resource assessment
- Optimizing structure of street tree populations helps ensure resiliency, stability, and functionality
- High-value street trees are those that provide maximum benefit at minimal cost

Questions?