Design & Management for Longevity

Sacramento, CA

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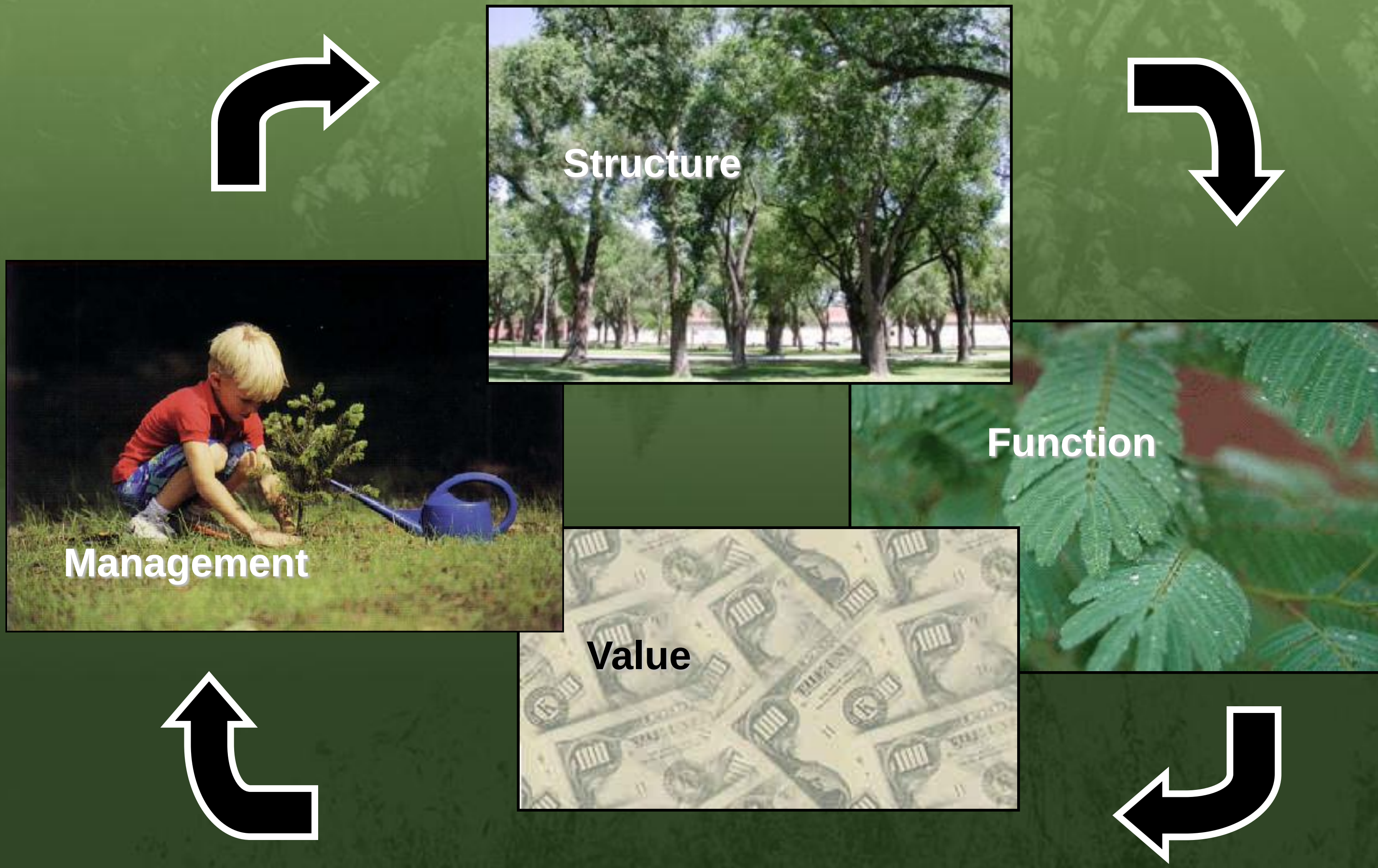
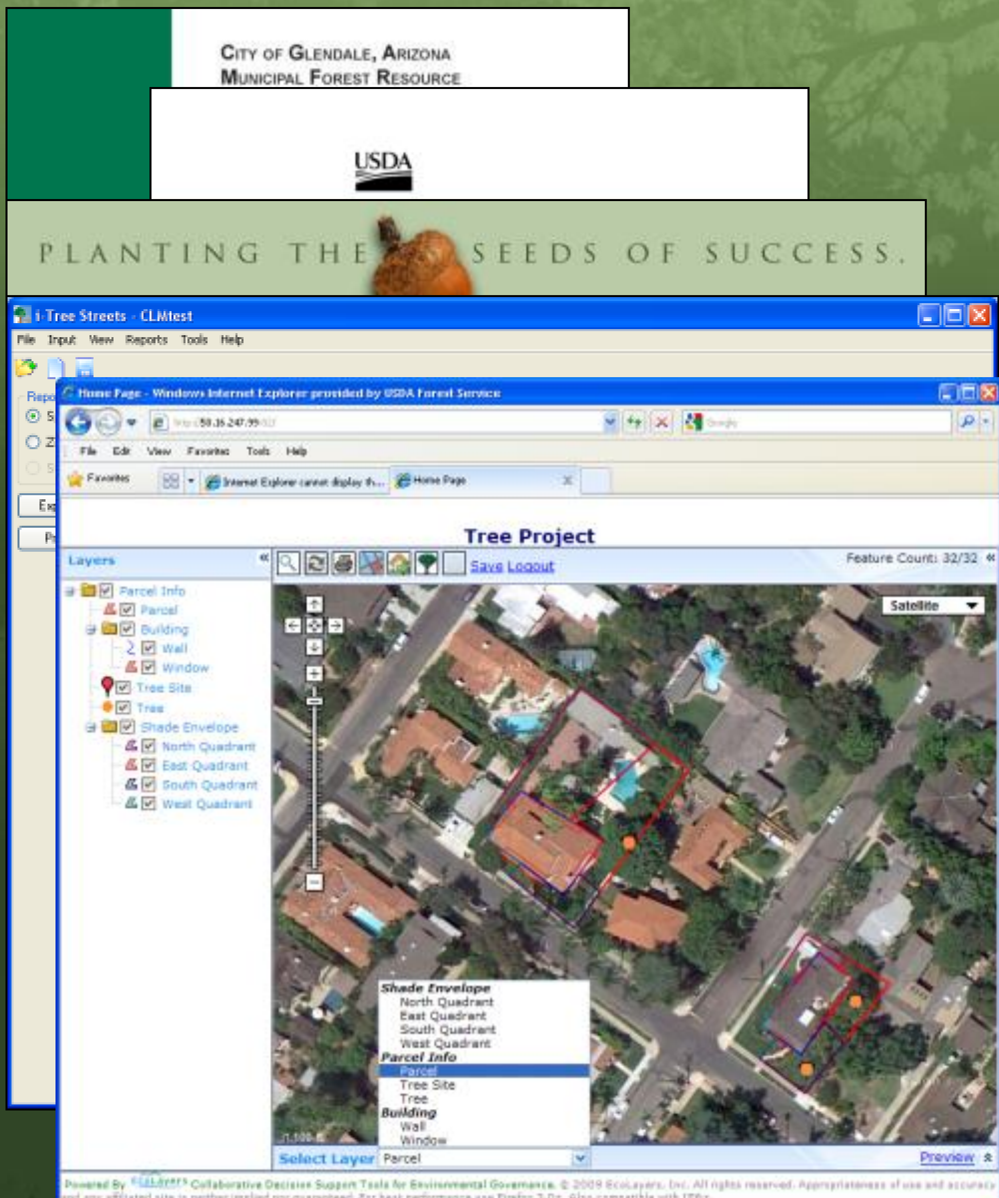
Demonstrate new ways that trees add value - quality of life - to communities.

We convert research results into financial terms to stimulate community investment in trees.

Benefit-Based Approach



Products



- Municipal Forest Resource Assessments
- Community Tree Guides
  - Benefits And Costs for Tree Planting Projects
  - Examples
  - Guidelines For Selecting And Placing Trees
- Trees in Our City PPTs
- i-Tree STREETS data
- Tree Carbon Calculator

Tree Quiz

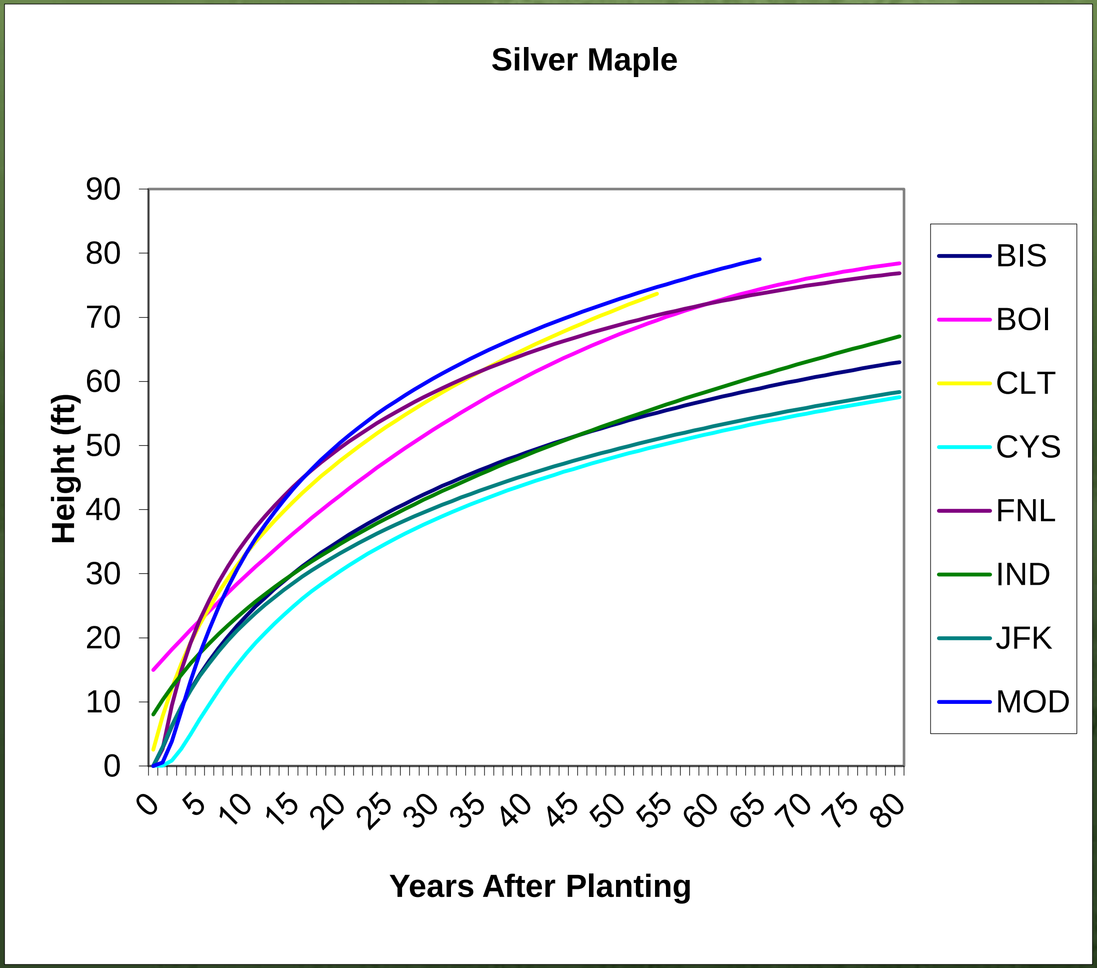
- Bradford Pear
- 9 years old
- 9 inch dbh
- 28 ft. tall
- 19 ft. spread

- Number of leaves 88,908
- Total leaf area 3,846 sq ft
- H_2O retainment capacity 55 gal

Street Tree Growth in U.S.

- Started in 1998
- Completed 2010
- Over 17,000
- 171 species
- Species overlap

Comparisons and trends

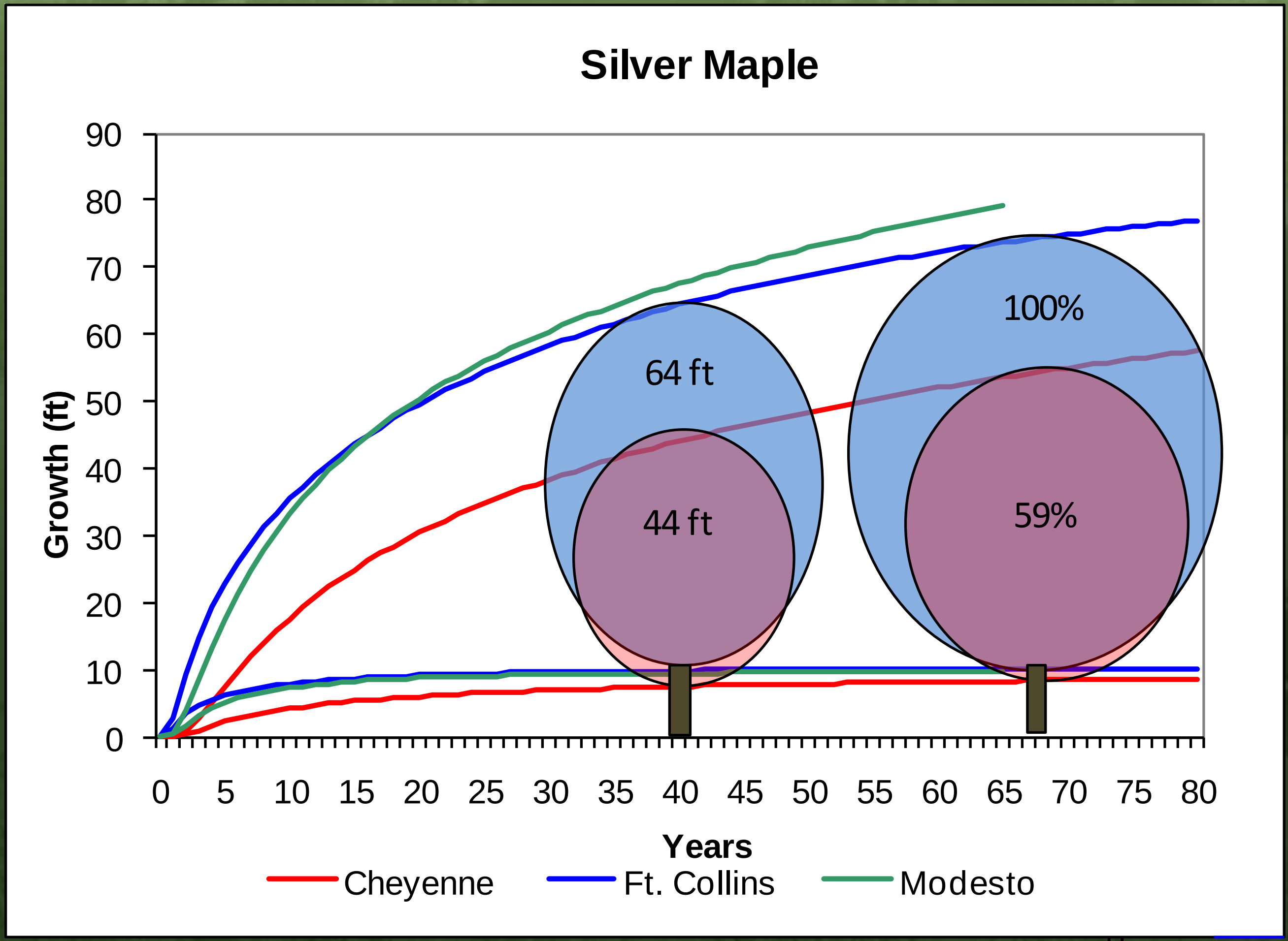


- Overlap
  - Sweetgum 10
  - Honeylocust 10
  - Silver maple 9
  - Callery pear 9
  - Green ash 8

What affects growth

Effect on longevity & benefits

Cheyenne vs. Ft. Collins



Benefits ($) from 100 Maples over 40 Years

City	Energy	CO2	Air Quality	Storm-water	Total Services
Ft. Collins	92	13	90	27	222
Cheyenne	58	7	52	14	131
units in $1000s					

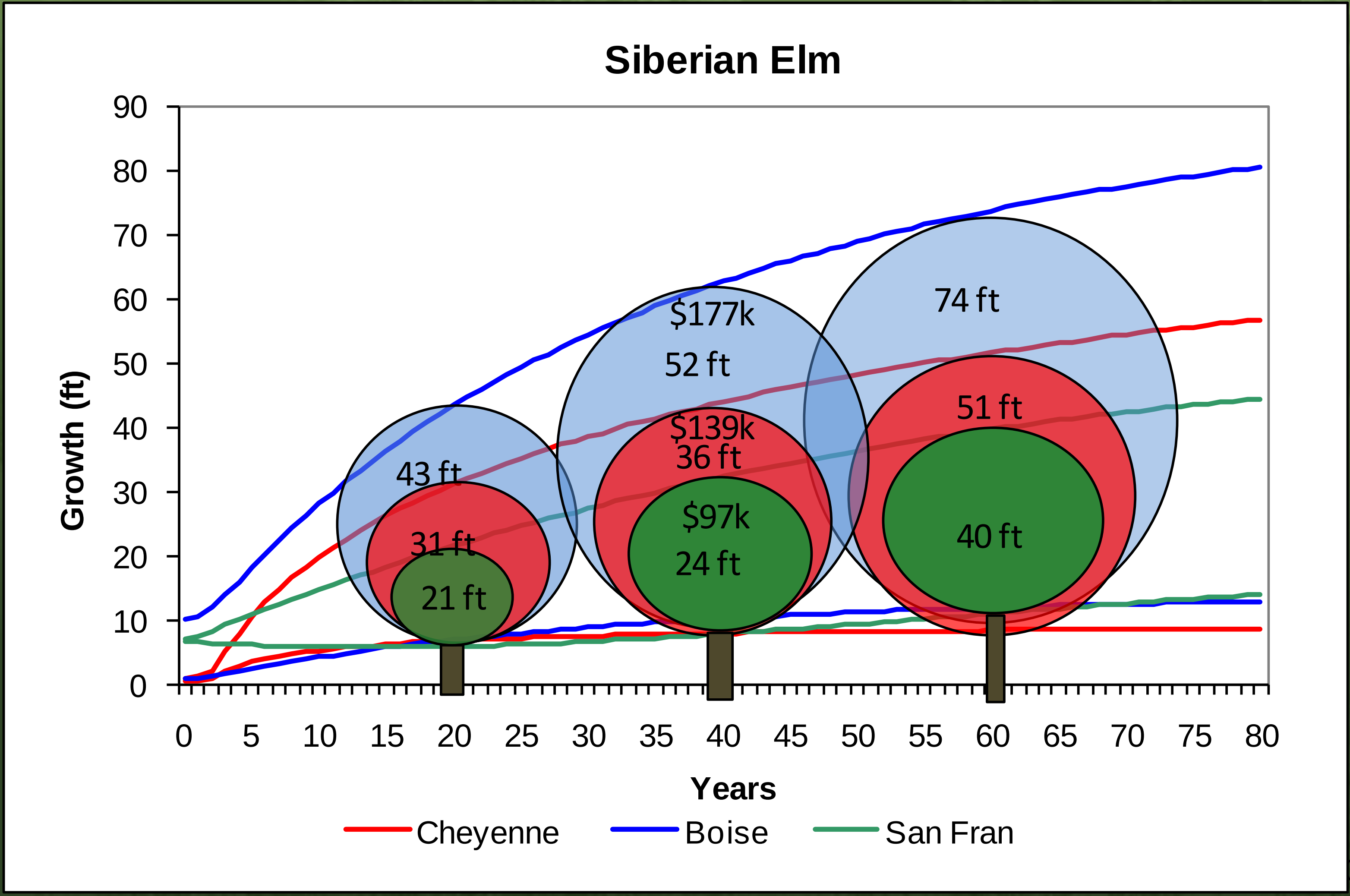
Wyoming: Not for lightweights

These growth variations often happen within the same city

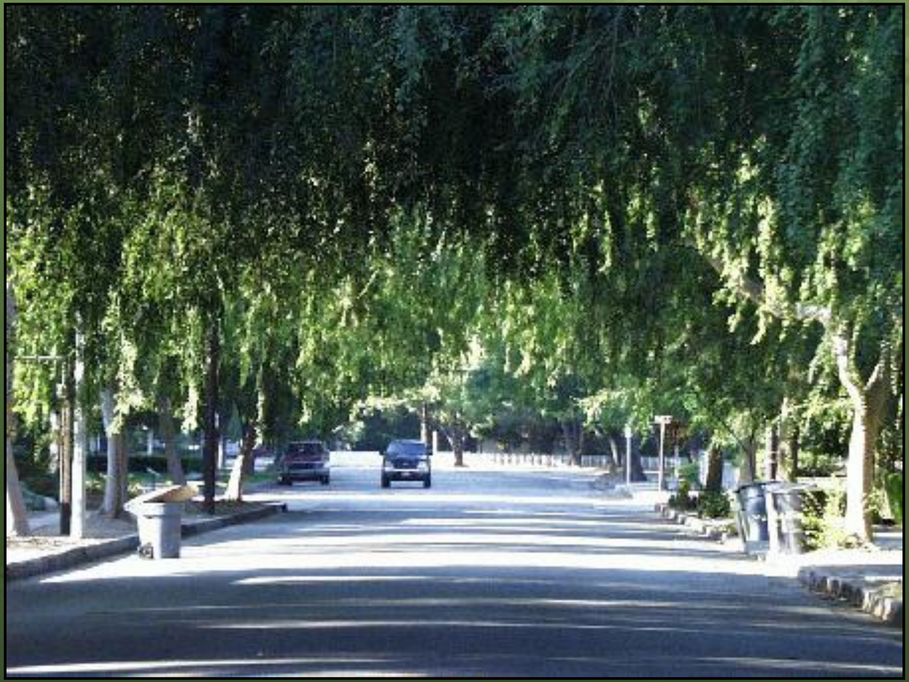
Center f

Pruning Effect on Benefits

(100 Trees over 40 Years)



Pruning Effects on Benefits



- Increases maintenance cost
- Turns large trees into small
- Decreases life expectancy

Large
$213/tree

Small
$44/tree

Tree Foliage

- Intercept air pollution and particulates
- Intercept rainfall
- Process carbon dioxide
- Shade –heat island and energy

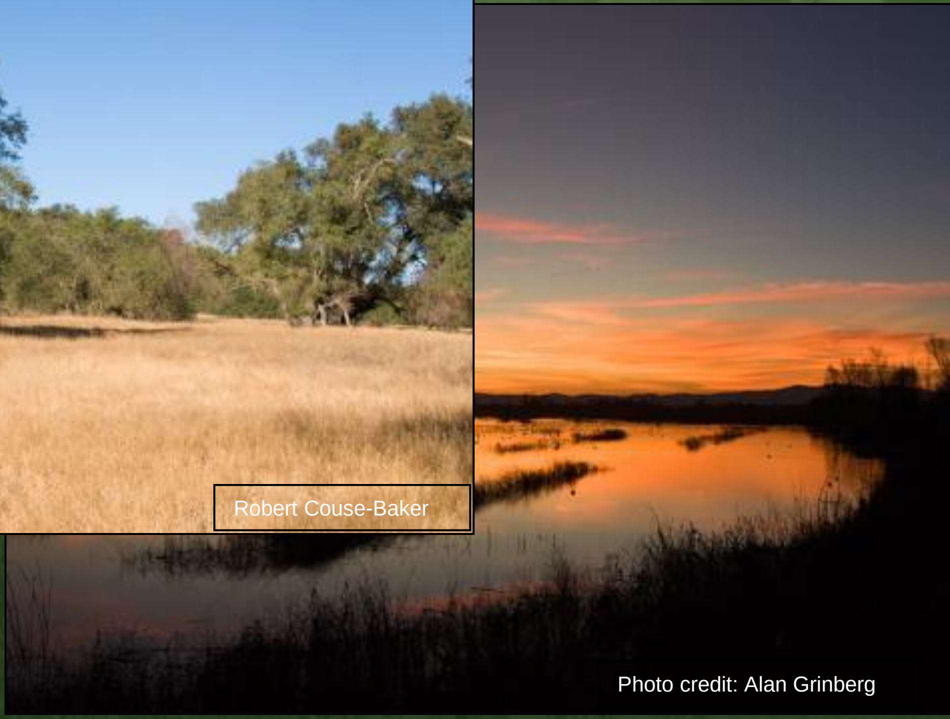
Factors that inhibit growth & longevity

- Climate
- Cultural influences
- Pruning
- Planning /designing landscapes without proper site assessment and species knowledge
- Soils
- Poor stock, water, improper planting, etc.

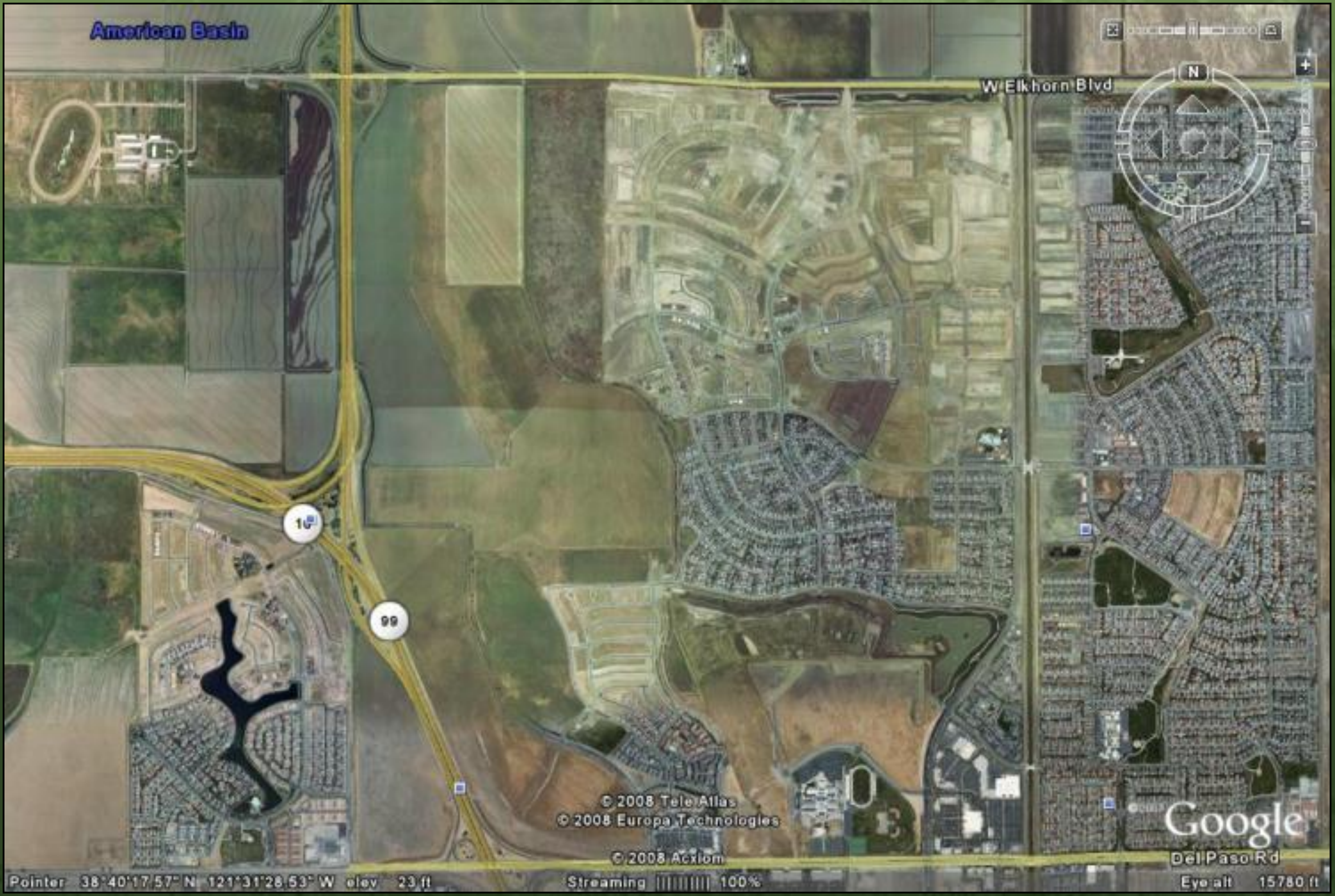
Planning and Design Mantra

The site where a tree is placed determines its mature size, longevity, and often, maintenance requirements

We Impose Ourselves on the Landscape



“Man is a geologic agent”



Still in Transition…

Sustainability Planning: Optimizing Tree Services

- Trees become integral component of infrastructure
- Masterplanning and design processes incorporate the trees' needs for the services desired

Planning and Design Considerations

- Where and how to place for best services while minimizing present and future costs
- What species to plant for these services
- Design to meet mature trees' needs
- Clarity on what constitutes "natives species"

Planners, Arborists, Landscape Architects --Site Assessment: 3-Step Approach

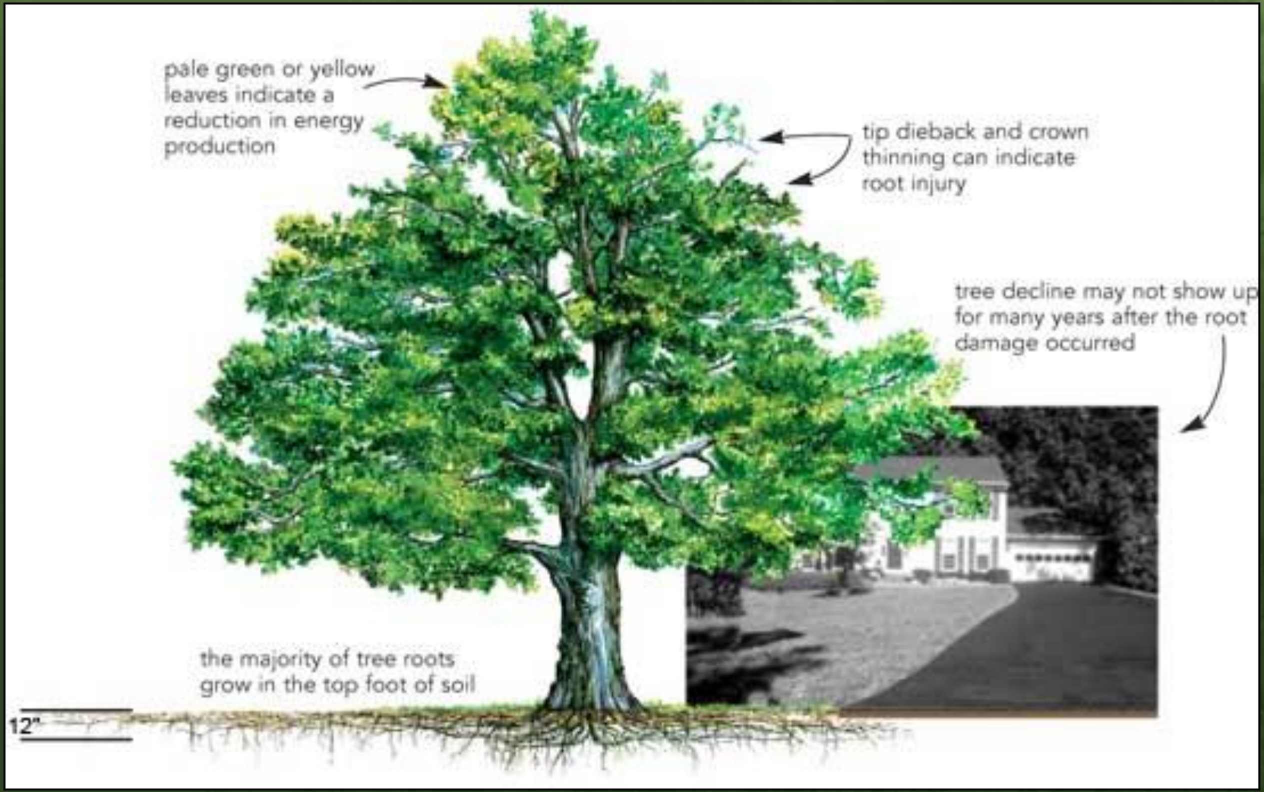
- Assess the site above ground
- Assess the site below ground
- Select the best tree for that site (what does the tree need?)

Right Tree + Right Place

The Right Place

The Right Place

- Aboveground
- Belowground

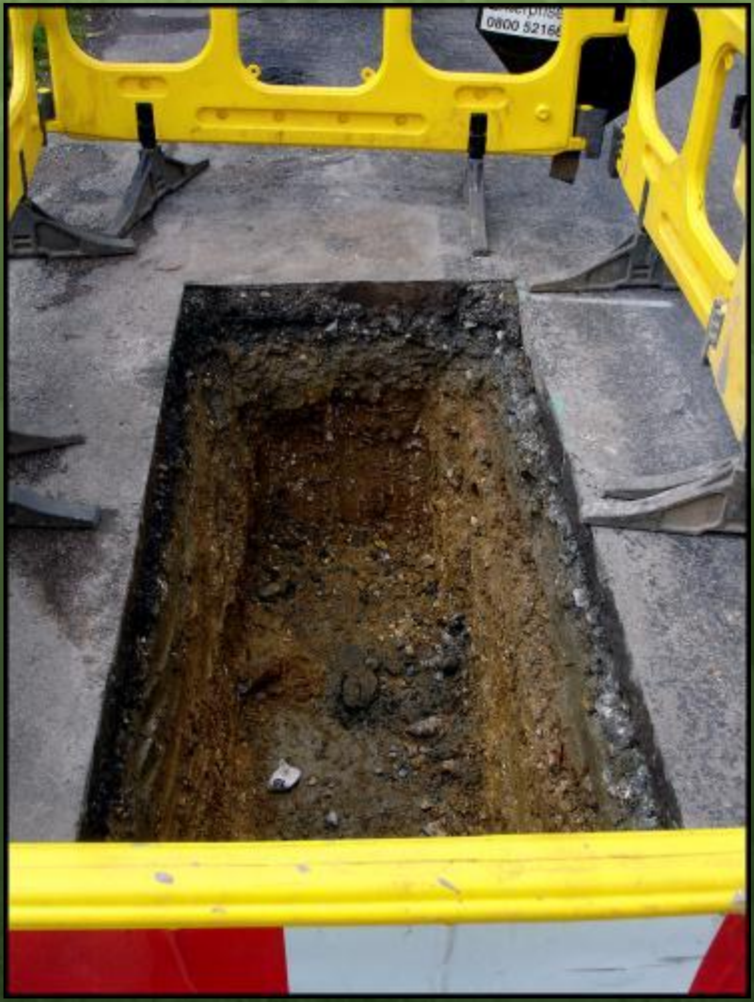


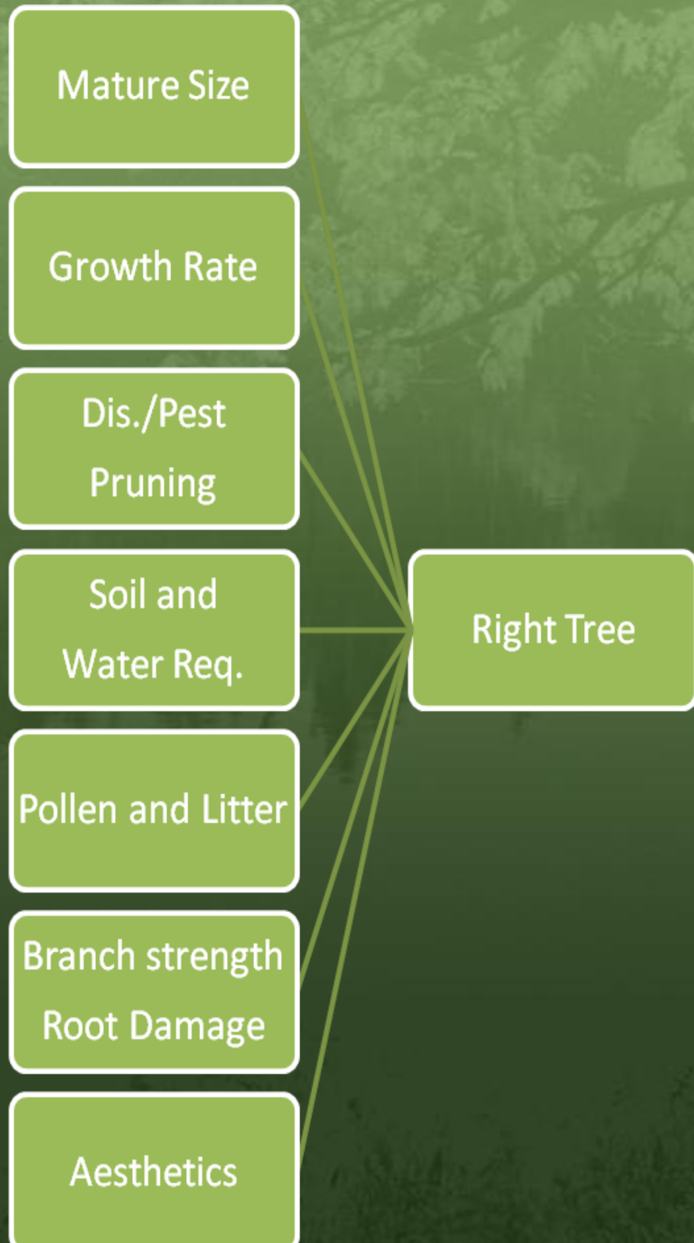
Space for successful trees

- Above ground
  - Light and slope
  - Wind, salt
  - Wires, lights
  - Buildings, signs
  - Trees
  - Vandalism
  - Regulations

Space for Successful Trees

- Below ground
  - Soil ph and texture
  - Compaction, drainage
  - Salinity, contaminants
  - Soil depth, rooting space
  - Utilities
  - Water access





Develop Species Area Specific Species Profiles

Match Site Conditions & Requirements at Local Level

Don’t Generalize --Localize

Know local conditions and how trees respond to those conditions

Put the right tree in the right city…and the right place in that city

Plan for the mature tree

Local Tree Matrix

- Climate adapted

Footnote	a	b	c	d	e	f	g	h	I	j	k	l	m	
Weighting	5	5	5	3	3	3	3	3	3	1	1	1	1	
Species	Climate Adapted	Dis./Pest Susceptib	Soil tolerance	Degree of litter	Water Needs	Pruning Needs	Branch Strength	Root Damage	Longevity	Availability	BVOC Emission	Pollen Emission	Aesthetic Value	Average
Ulmus parvifolia	3	1	3	3	2	1	1	2	2	3	3	1	2	5.92
Cinnamomum camphora	3	1	2	2	2	3	2	1	3	3	3	2	2	6.08
Magnolia soulangiana	2	3	2	2	2	2	2	3	2	3	2	1	2	6.31
Acer buergerianum	3	3	2	2	3	1	2	3	2	2	2	2	2	6.69
Acer rubrum	3	2	2	2	2	1	2	2	3	3	2	1	3	6.15
Cedrus deodara	3	3	3	3	2	3	2	2	3	3	3	3	2	7.77
Ginkgo biloba	3	3	2	2	2	3	3	2	3	3	3	2	2	7.31
Lagerstroemia indica	3	2	2	2	3	3	2	3	2	3	3	2	3	7.00
Laurus nobilis	3	2	3	3	3	2	2	2	2	2	3	1	1	6.85
Liriodendron tulipifera	3	1	2	2	2	3	1	2	3	3	1	2	3	6.00
Magnolia grandiflora	3	3	2	1	2	3	2	1	3	3	2	3	2	6.62
Pinus canariensis	2	3	3	3	3	3	2	2	3	3	2	2	1	7.38
Pinus halepensis	3	2	2	2	3	2	3	2	3	3	3	2	1	6.85
Pinus pinea	3	3	1	1	3	1	1	2	2	2	3	2	1	5.62
Pistacia chinensis	3	3	2	3	3	1	3	2	2	3	2	1	2	6.92
Pterocarya stenoptera	3	3	3	2	2	1	2	1	3	1	-	2	2	6.38
Pyrus calleryana	3	2	3	2	2	1	2	2	2	3	3	2	3	6.46
Pyrus kawakamii	3	1	3	3	2	2	2	3	2	3	3	2	2	6.69
Quercus agrifolia	3	3	3	2	3	1	3	2	3	3	1	1	2	7.23
Quercus douglassii	3	3	3	2	3	1	3	3	3	2	2	1	2	7.46
Quercus ilex	3	3	3	2	3	3	3	3	3	2	1	1	1	7.77
Quercus lobata	3	3	2	1	3	3	2	2	3	3	2	1	2	6.92
Quercus rubra	3	2	2	2	2	3	3	2	3	3	1	1	1	6.62

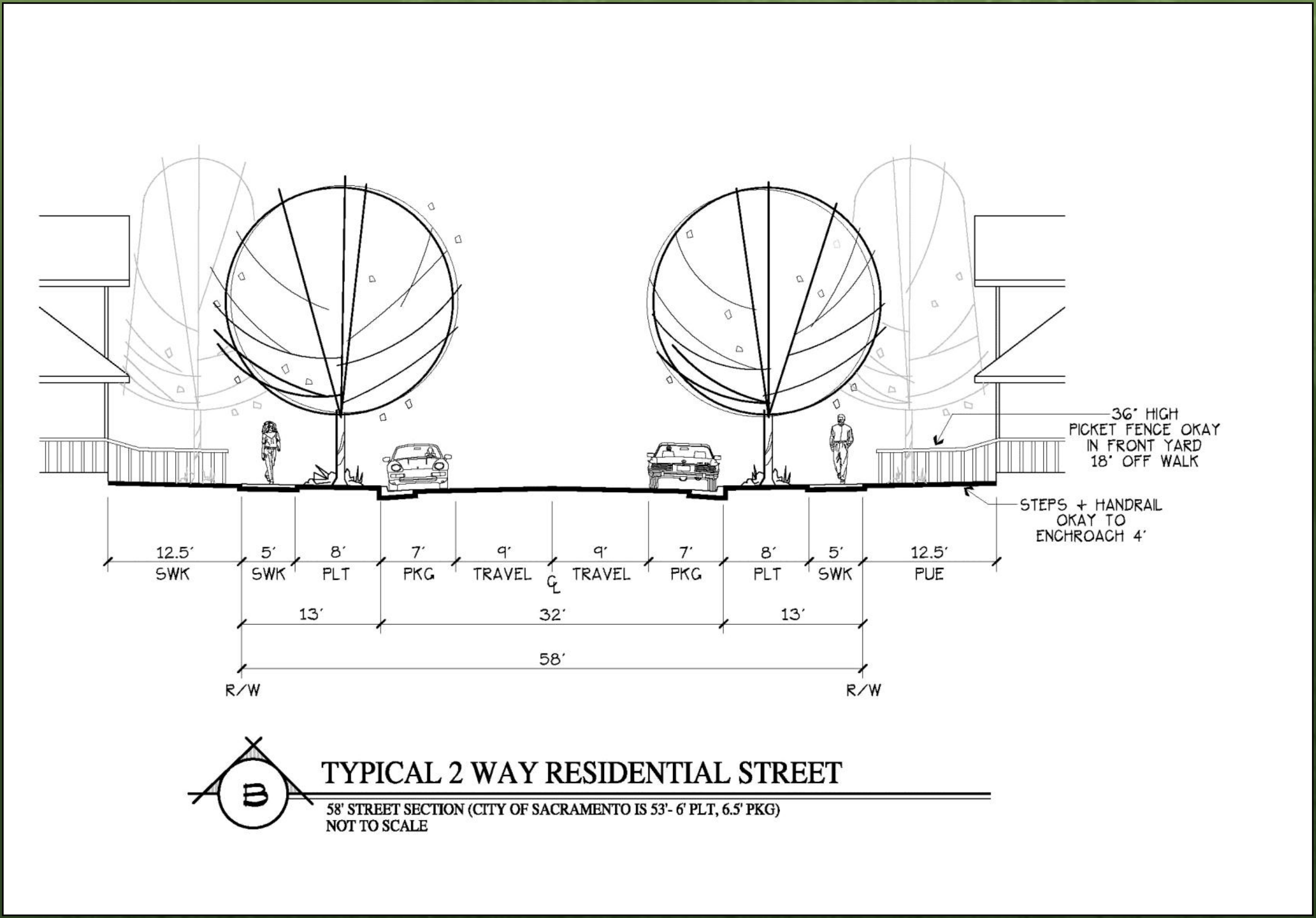
- Availability
- BVOC emissions
- Aesthetic Value

If Longevity is the Goal?

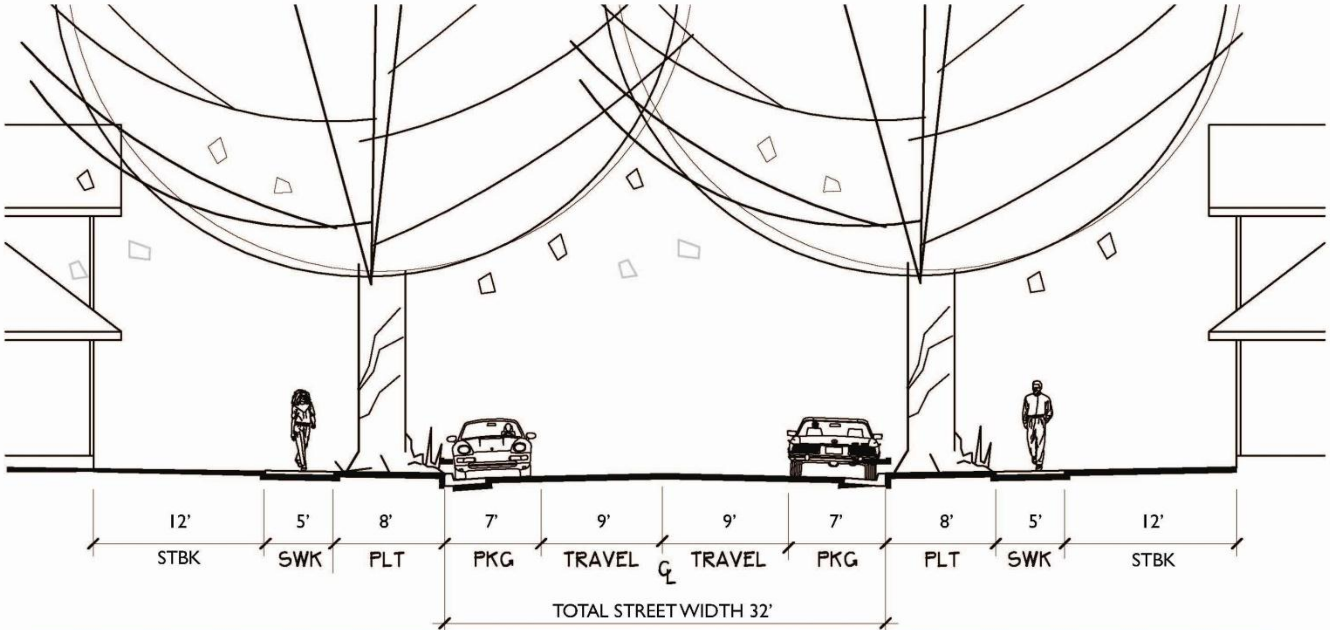
- Oops!
- Understand maintenance requirements
- Design to maximize ecosystem services and minimize costs

Plan Space Correctly

Recent plans for 2-way residential street



Actual Two-way Streets



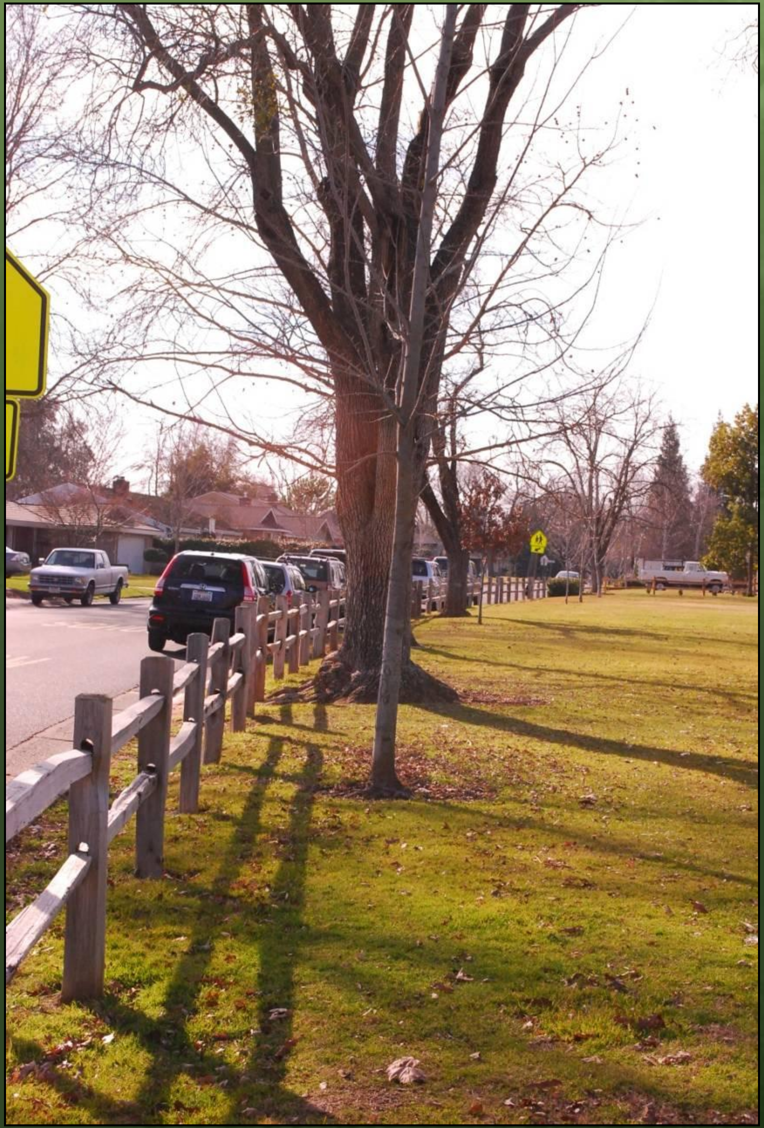
Planting strip												
			Section							Tree		
Neighborhood	Street	Between	PUE	SWK	PLT	Total street width	PLT	SWK	PUE	DBH	Height	Crown diameter
Curtis Park	Donner, N side		15.5	4.5	5	33	5	4.5	15.5	24	53	41
Curtis Park	Portola		12.5	5	5	41	5	5	12.5	22	50	43
Land Park	5th	17th and 19th	24.5	4	9	30	9	4	24.5	25	69	49
McKinley	D	33rd and Alhambra	19	6	15	33	15	6	19	30	85	57.5
McKinley	37th	H and F	21	4	5	31	5	4	21	26	67	54
Oak Park	1st Ave	34th and 35th	12.5	6	9.5	49	9.5	6	12.5	14	33	28
East Sacramento	38th	Folsom and R	36.5	4	7.5	37/58	7.5	4	36.5	34	54	68

Fig. 1—"Typical" treescape conditions for the studied streets with planting strips. Drawing, including tree height, crown, and diameter, is to scale and represents a potential future scenario that can be compared with dimensions on existing streets

Research

Park Space

Park Space

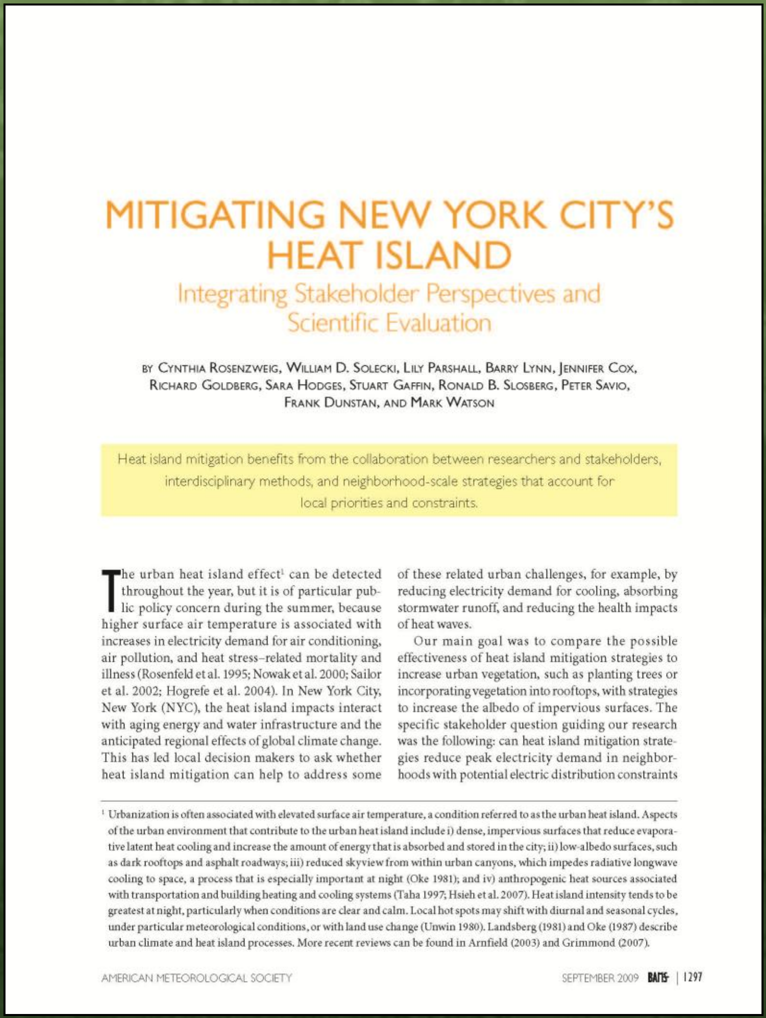


Ecosystem Services – Heat Islands

"Street trees have the largest cooling potential…followed by living roofs, light colored surfaces, and open space planting."

Reduction in heat

Reduction in evapotranspiration



MITIGATING NEW YORK CITY'S HEAT ISLAND

Integrating Stakeholder Perspectives and Scientific Evaluation

BY CYNTHIA ROSENZWEIG, WILLIAM D. SOLECKI, LILY PARSHALL, BARRY LYNN, JENNIFER COX, RICHARD GOLDBERG, SARA HODGES, STUART GAFFIN, RONALD B. SLOSBERG, PETER SAVIO, FRANK DUNSTAN, AND MARK WATSON

Heat island mitigation benefits from the collaboration between researchers and stakeholders, interdisciplinary methods, and neighborhood-scale strategies that account for local priorities and constraints.

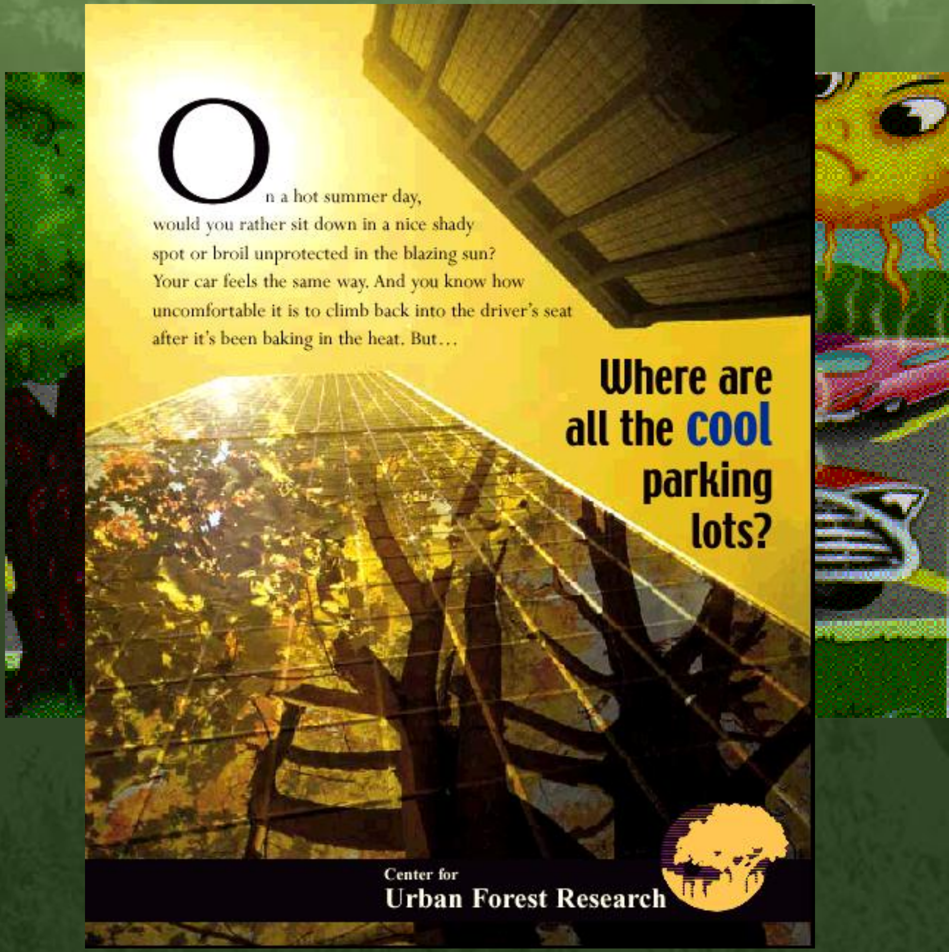
The urban heat island effect[1] can be detected throughout the year, but it is of particular public policy concern during the summer, because higher surface air temperature is associated with increases in electricity demand for air conditioning, air pollution, and heat stress–related mortality and illness (Rosenfeld et al. 1995; Nowak et al. 2000; Sailor et al. 2002; Hogrefe et al. 2004). In New York City, New York (NYC), the heat island impacts interact with aging energy and water infrastructure and the anticipated regional effects of global climate change. This has led local decision makers to ask whether heat island mitigation can help to address some of these related urban challenges, for example, by reducing electricity demand for cooling, absorbing stormwater runoff, and reducing the health impacts of heat waves.

Our main goal was to compare the possible effectiveness of heat island mitigation strategies to increase urban vegetation, such as planting trees or incorporating vegetation into rooftops, with strategies to increase the albedo of impervious surfaces. The specific stakeholder question guiding our research was the following: can heat island mitigation strategies reduce peak electricity demand in neighborhoods with potential electric distribution constraints

[1] Urbanization is often associated with elevated surface air temperature, a condition referred to as the urban heat island. Aspects of the urban environment that contribute to the urban heat island include i) dense, impervious surfaces that reduce evaporative latent heat cooling and increase the amount of energy that is absorbed and stored in the city; ii) low-albedo surfaces, such as dark rooftops and asphalt roadways; iii) reduced skyview from within urban canyons, which impedes radiative longwave cooling to space, a process that is especially important at night (Oke 1981); and iv) anthropogenic heat sources associated with transportation and building heating and cooling systems (Taha 1997; Hsieh et al. 2007). Heat island intensity tends to be greatest at night, particularly when conditions are clear and calm. Local hot spots may shift with diurnal and seasonal cycles, under particular meteorological conditions, or with land use change (Unwin 1980). Landsberg (1981) and Oke (1987) describe urban climate and heat island processes. More recent reviews can be found in Arnfield (2003) and Grimmond (2007).

Shading Paved Surfaces Reduces Heat Island Effect

- Lots 3 F degrees cooler
- Cabin 40-50 degrees cooler
- Gas temp 4-8 degrees cooler
- Reduce VOC 1ton/day



Trees Improve Pavement Performance for Roads and Parking Lots

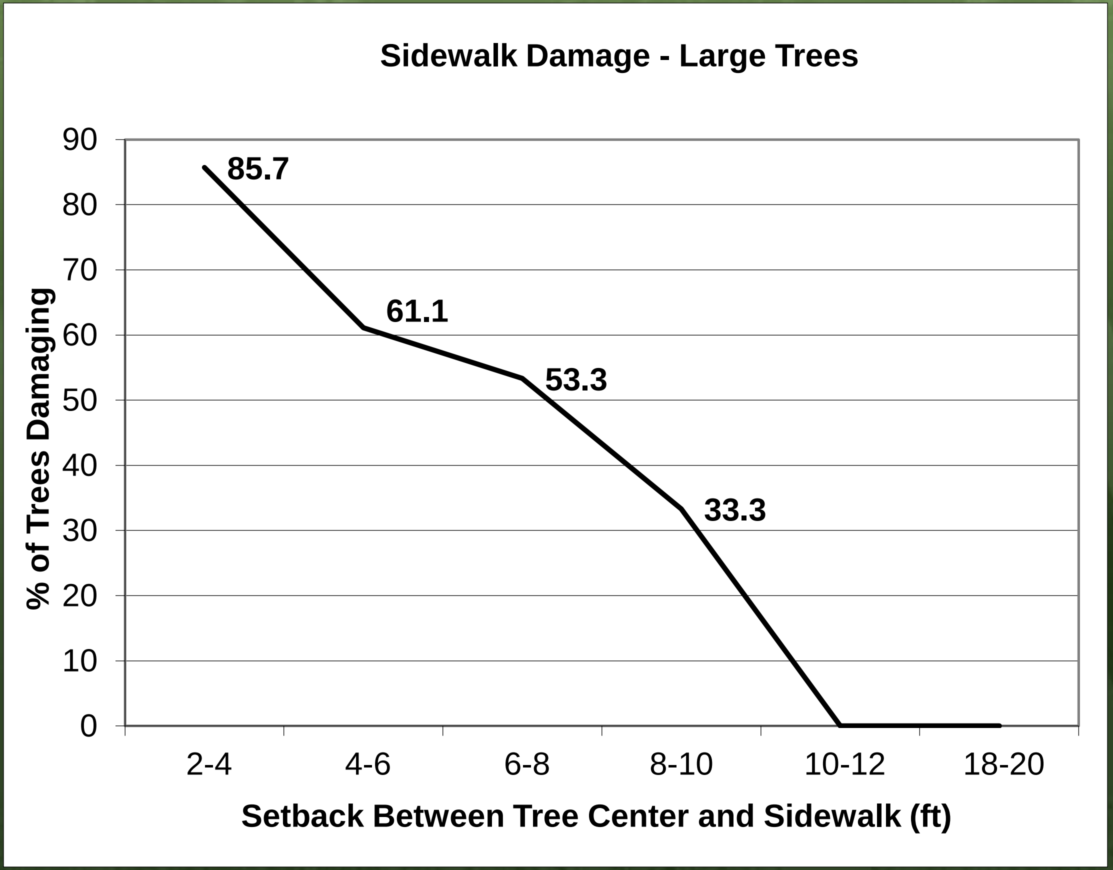
More shade means more time between repaving.

20% shade improves pavement condition by 11%. 60% savings for resurfacing in 30 years

Parks: Heat Island Mitigation

Plant

- Along parking lot perimeters
- Within parking lots
- Near roadways and sidewalks
    - 12 ft away
- Park trees en masse can reduce air temp



Buildings in Parks: Plant Strategically for Energy Savings

- West is the best
- Closer is better
- Large, dense crown
- Solar friendly
- Park windbreaks benefit neighborhoods

Plant Strategically: Solar Friendly to South

- Avoid trees to south
- Open winter crown, dense summer shade
- Foliage early to drop, late to leaf-out

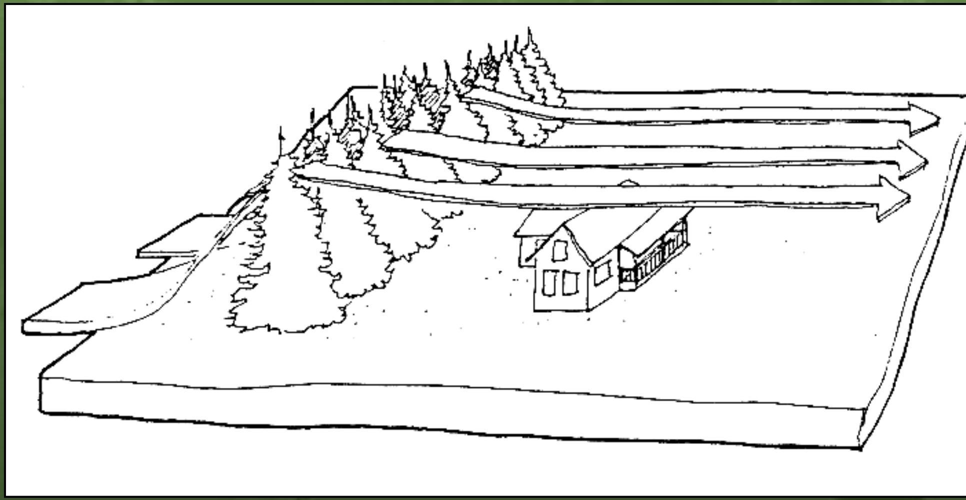
Improving Air Quality
Choose Trees Wisely

Large and tolerant to pollutants

Evergreens for particulates

Locate Trees Wisely

- Pollution barriers
  - Along transportation corridors
  - Near schools
  - Multi-row if possible



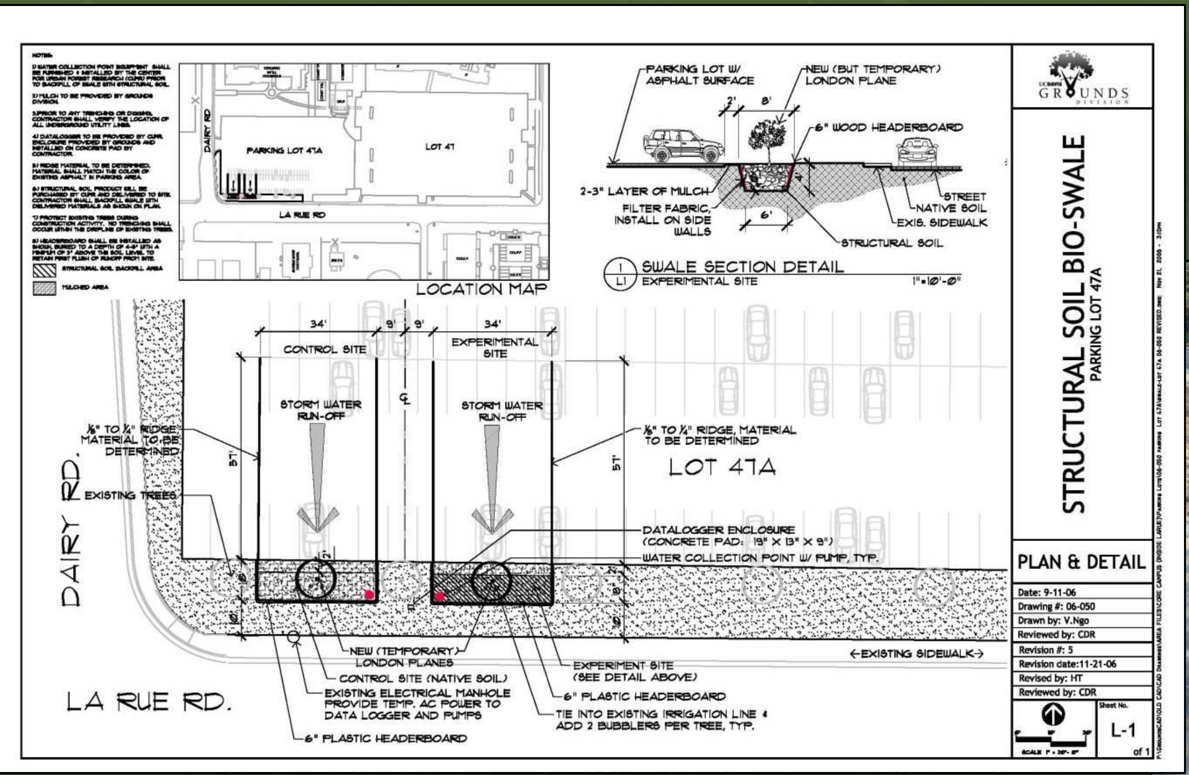
- Surrounding and within parks
- Along pedestrian corridors, particularly near roadways

Stormwater Benefits

- Reduce runoff volume, peak flow, and flow duration
- Slow down the flow to increase time of concentration and promote infiltration and evapotranspiration
- Improve groundwater recharge
- Water quality improvement/reduced treatment costs
- Reduce incidence of combined sewer overflow (CSOs)
- Reduce thermal pollution
- Reduce erosion –natural areas

Stormwater Benefits

- Adjacent to hardscapes
- Use trees with swales, engineered soils, porous pavements



Choose Trees Wisely

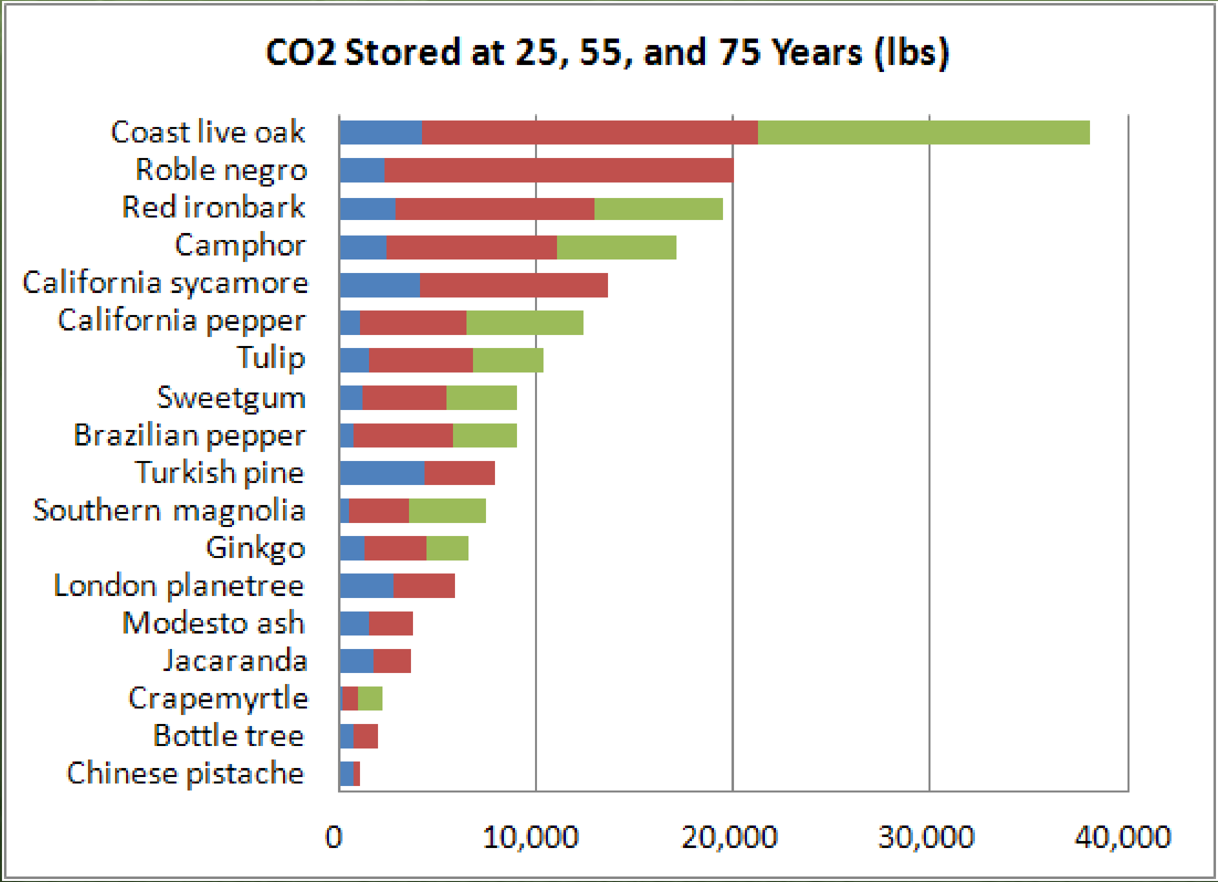
Complex structure, rough surface

Evergreen foliage

Use Parks as Carbon Sinks

- Plan permanent sites
- Park sites less likely to be impacted by development
- 100 year

reporting horizon



Choose Species Wisely

Small and short-lived

Large and long-lived

Planning

- Avoid fast-growers
  - e.g. ornamental pears, some of the new elms

  Low water use, high water capture
- Species diversity
  - Think beyond Platanus sp.
  - Low emission mix (oaks are higher emitters)
- Age diversity
- Minimum 50 year horizon

Managers: When Planners/Designers Have Left the Scene

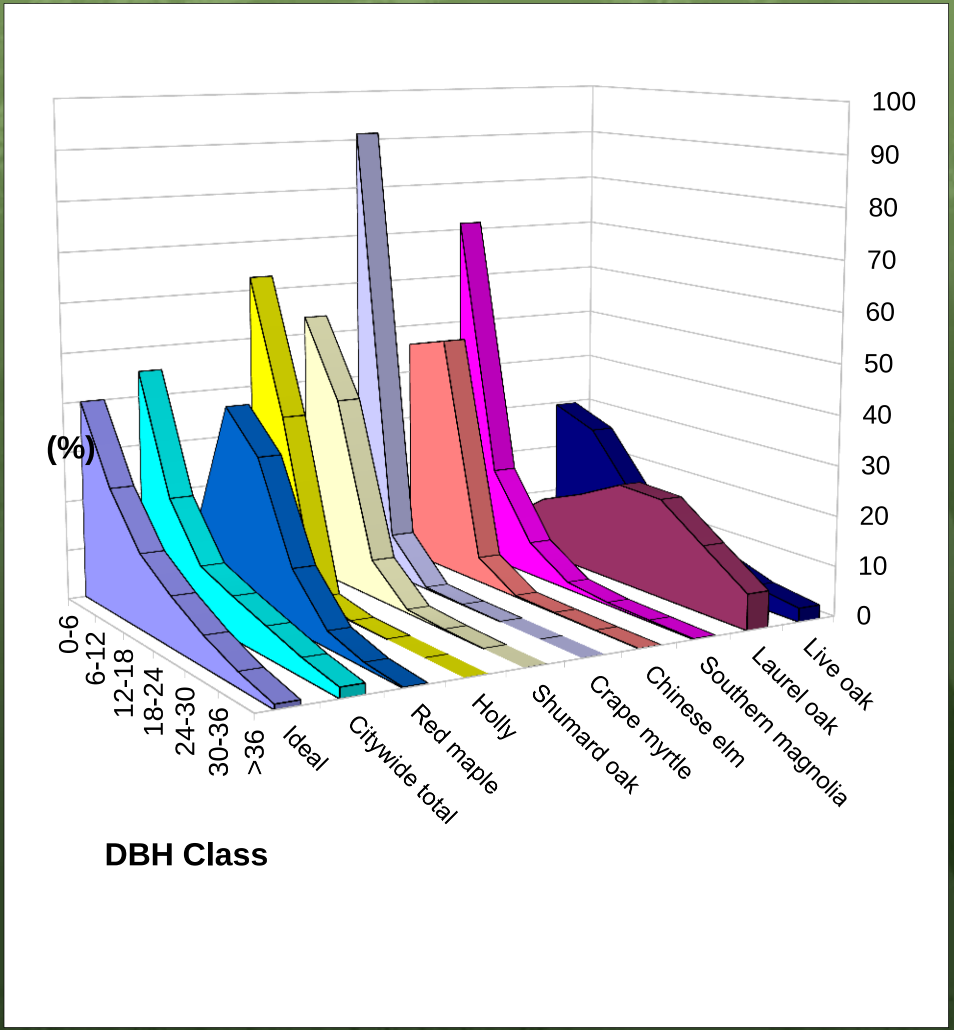
- Handling the results of planning—the good, bad, and the ugly
- Maintenance
- Replacement issues
- Liability
- How to shorten the life of the city forester?
  - Say you're going to plant 30,000 trees in 30 days

Tree Management

- Planning, Design, Management should be integrated
- Managing trees as a resource
  - Forest diversity—species and age
  - Ideal is no more than 10% of any one species
  - 40% young
- Inventory and management plan

Management Plans

- Develop goals
- Pruning cycles
- Irrigation requirements
- Replacement plan
- Root issues and resolution
- Cross-departmental pollination



Cycle of Failure

- Plant trees
- They grow up
- Bad things happen
- We don't like those trees anymore
- Time passes
- Same "bad" trees planted in same places again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95/124/1695

"Leaners" on 17th street. Day after the storm. Feb. 10th, 1938.

85/24/1698

85/24/1698

Northwest corner of 17th & M street.
Feburary 10th,1938.

Causes

- Improper planting - space
- Improper pruning
- Roots cut with street and sidewalk development
- Began systematic removals 35-50 ft spacing (until $$ ran out)


Today

Coast Redwoods

Coast Redwoods

Drainage

What Went Wrong?

- No historical knowledge
- Site assessment?
  - Heavy clays
  - Reduced irrigation needs
  - Competition, stunting, creating disease vectors
- No local species knowledge
- Lost powers of observation?
- County/city planning dept?
- Designer/landscape architect?

Urban forest sustainability

involves many players

Most of us seldom

Permitting authorities

Ecologists

City planners

Landscape crews/cert land. tech

Tree crews/cert. arborists

Landscape architects

Growers

Nursery Retailers

Homeowners Associations

Sustainable urban forests

communicate

Sustainability

- Frequent interdepartmental communication – understand and educate each other
- Understand local tree performance/needs/limitations
- Plant for quality not quantity
- Prune to ANSI standards – with benefits in mind
- Educate, educate, educate

If trees can grow in New York City….

- Forestry chief signs off on all new development and retrofits
- Interdepartmental communication
- Conduct research
- Apply new science
- Education programs
- Volunteers
- $5.60 in benefits