



City of Phoenix
Tree and Shade
Master Plan



"An investment strategy for creating a healthier, more livable and prosperous Phoenix"

2009

Climate- Proofing Arizona's Urban Forests, One Community at a Time

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US Forest Service, PSW
Davis, California



U.S. Department of Agriculture
**Pacific Southwest
Research Station**
Science that makes a difference

Regional Tree & Shade Summit, Phoenix, AZ
March 9, 2016



Traditional Zoos



Wild Animal Park



Habitat for Humans?



Urban Forests Don't Happen by Chance

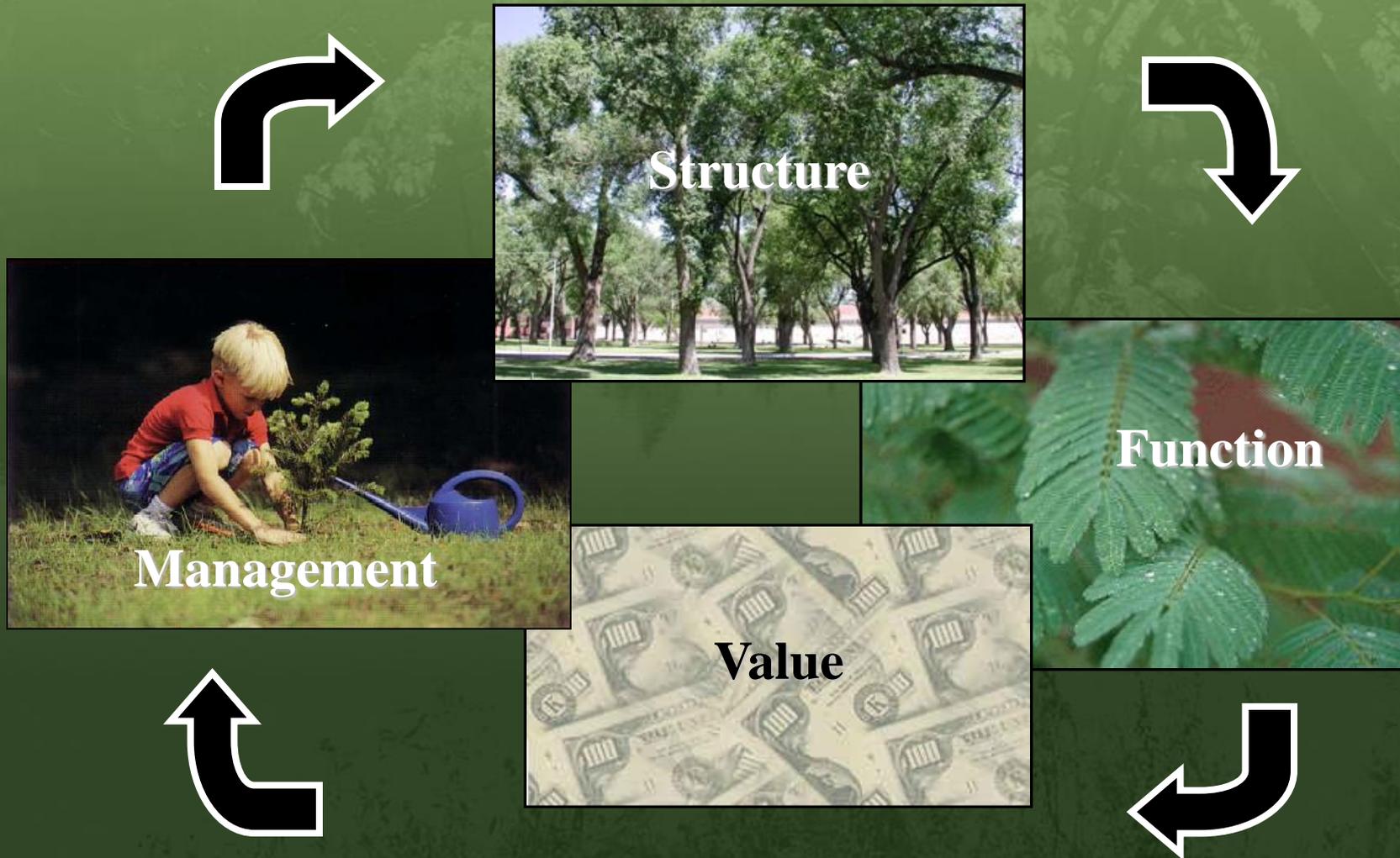


Today

- Urban Forest Structure & Services
- Threats
- What Do Climate-Proof Urban Forests Look Like?
- Lessons Learned



Benefit-Based Approach



Glendale, AZ Reference City (2003)

- Measured 21 species, 827 trees
- Analyzed growth rates and dimensions
- Estimated magnitude of annual benefits
- Priced benefits
- Priced tree care costs
- Calculated net annual benefits, benefit-cost ratios



Products

<http://www.fs.fed.us/psw/programs/uesd/uep/>



PLANTING THE SEEDS OF SUCCESS.



Trees in Our City



- Municipal Forest Resource Assessment
- Community Tree Guide
 - Benefits And Costs for Tree Planting Projects
 - Examples
 - Guidelines For Selecting And Placing Trees
 - Trees in Our City PPT
- i-Tree Streets data

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ARID ZONE TREES, QUEEN CREEK, AZ





We've just installed 2,500 air conditioners.

Conserving Energy



Conserving Energy

- Mesquite, 20 years, Opposite west wall
 - Save AC: 388 kWh, \$37/yr
 - Heating costs: - \$1/yr
 - Save \$36/yr total

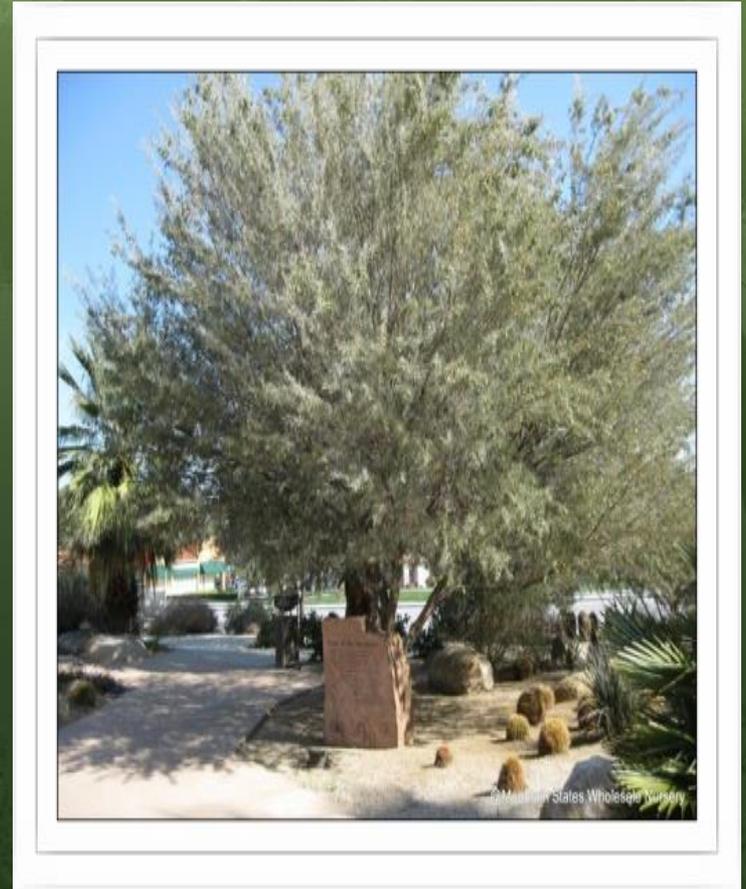


Plant Strategically Summer Shade

- West is the best
- Closer is better
- Large, dense crown



Choose Species Wisely: Bigger is Better



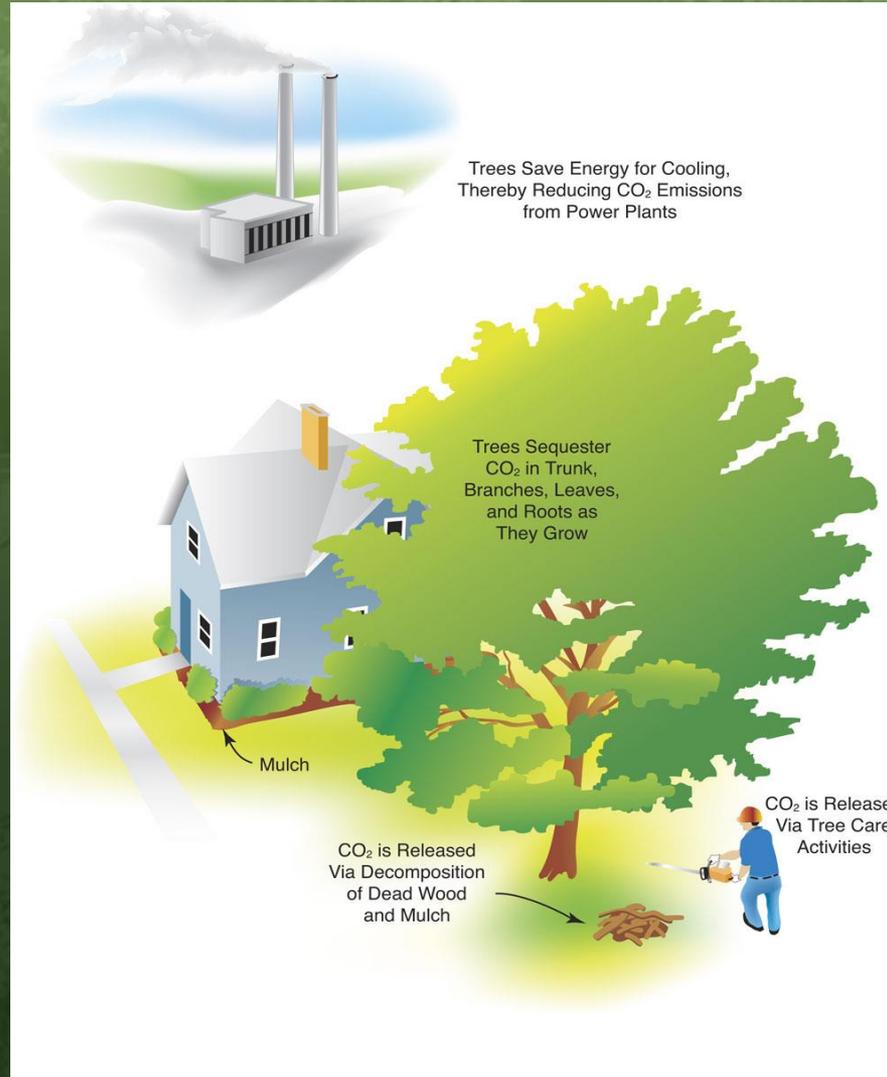
Plant Lots of Trees



Shade Paved Surfaces



Reducing Atmospheric Carbon Dioxide



Reducing CO₂

- Mesquite, 20 years, Opposite west wall
 - Total Net = 155 kg
 - Total Value = \$3



Choose Species Wisely



Small and short-lived



Large and long-lived

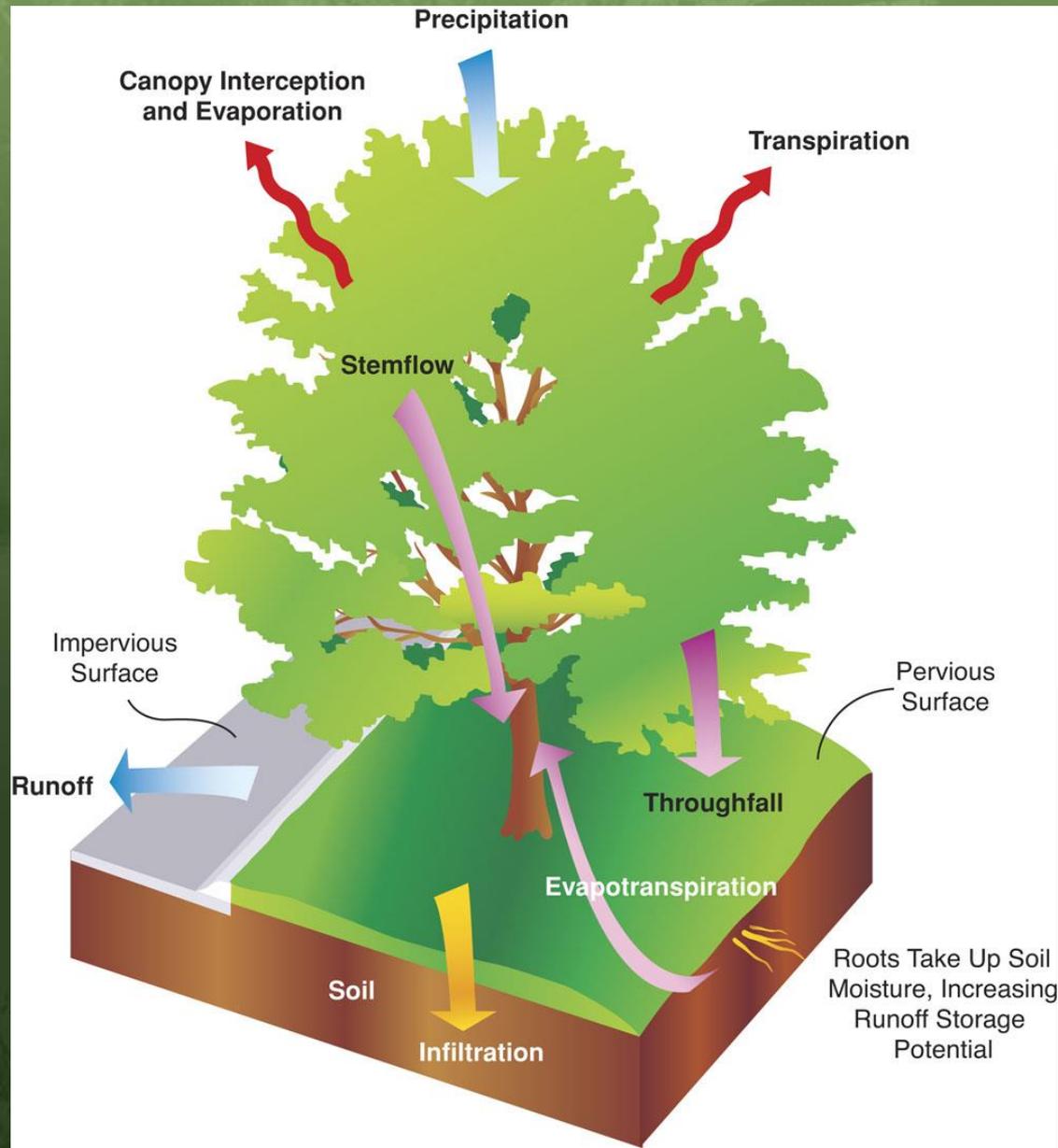
Plant and Maintain More Trees



Make Use of Wood



Reducing Stormwater Runoff



Intercepting Rainfall & Reducing Runoff

- Mesquite, 20 years
 - Intercepted = 1,604 gal
 - Value = \$8



Choose Trees Wisely



Little leaf & stem surface



Lots of surface area, wide crown

Choose Trees Wisely



Complex structure, rough surface

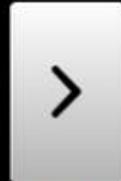
Evergreen foliage

Locate Trees Wisely





PREV



NEXT



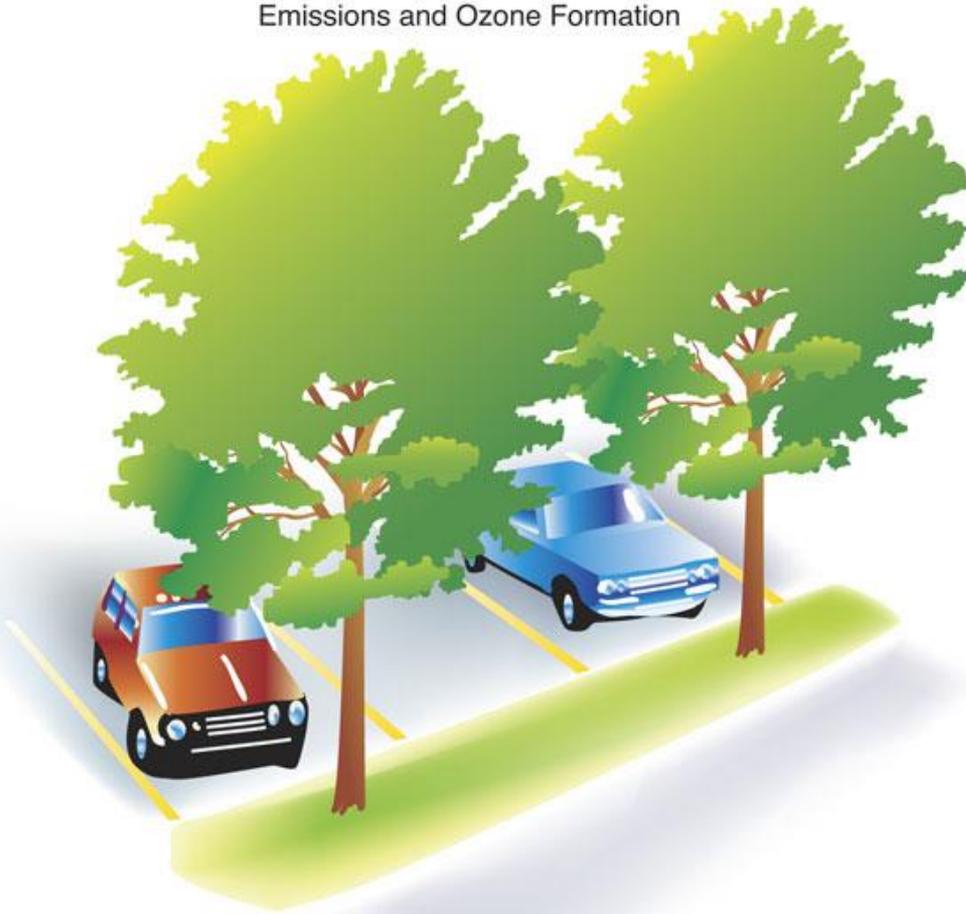
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America
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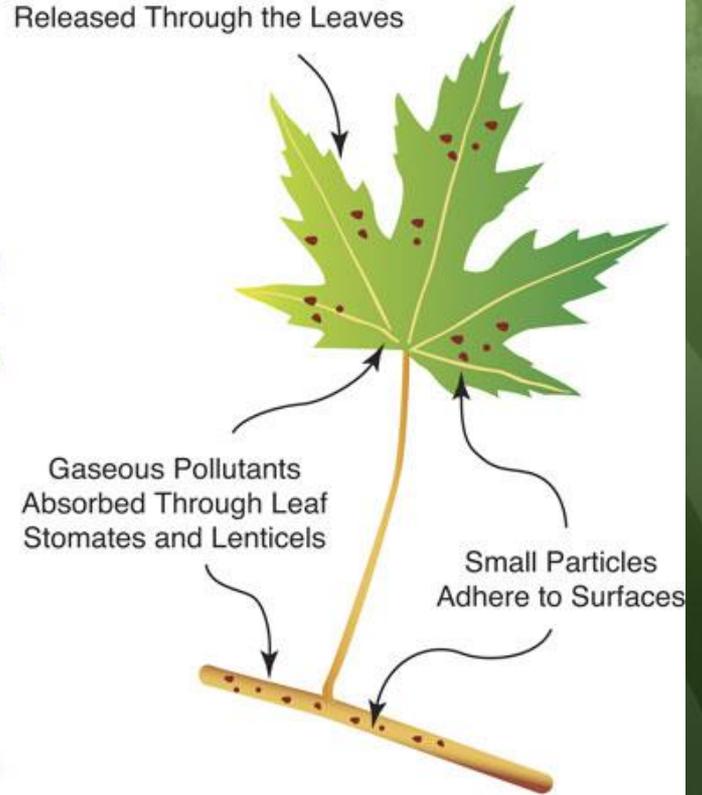
git
problem
from May
or in the

Improving Air Quality

Shade on Paved
Surfaces and Parked Cars
Reduces Evaporative Hydrocarbon
Emissions and Ozone Formation



Oxygen and Volatile Organic Compounds
Released Through the Leaves



Improving Air Quality

- Mesquite, 20 years, Facing West Wall (kg)
 - NO_2 = 0.31, \$2.75
 - SO_2 = 0.21, \$7.23
 - PM_{10} = 0.19, \$2.54
 - Ozone = 0.14, \$1.23
 - VOCs = 0.04, \$0.33
 - BVOCs = -0.85, -\$7.53
 - Net Value = 0.03, \$6.54



Choose Trees Wisely



Large and tolerant to pollutants



Evergreens for particulates

Others Things Trees Do



Trees are Vital to Human Health

- Tree-filled neighborhoods:
 - Lower levels of domestic violence
 - Are safer and more sociable
- Tree-filled landscapes reduce stress
- Trees decrease need for medication and speed recovery times



The image is a screenshot of the ScienceDaily website. At the top left, the logo "ScienceDaily" is displayed in blue and red, with the tagline "Your source for the latest research news" below it. To the right of the logo is a navigation menu with buttons for "News", "Articles", "Videos", "Images", and "Books". Below this menu are several category tabs: "Health & Medicine", "Mind & Brain", "Plants & Animals", "Earth & Climate", "Space & Time", and "Matters". The main content area features a "Science News" section with a prominent article titled "A Walk In The Park Improves Attention In Children With ADHD" in red text. The article's text begins with "ScienceDaily (Oct. 15, 2008) — For children with Attention Deficit Hyperactivity Disorder (ADHD) tasks that require concentration such as doing homework or taking a test can be very difficult. A simple, inexpensive remedy may be a 'dose of nature.'" To the right of the article is an advertisement for "ADHD Treatment for Adults" with the text "ADHD - not just a childhood disorder Learn about ADHD in adults. More..." and the URL "www.adhd-treatmentforadults.com".

Trees Sell Houses. (At higher prices)



- Each large front yard tree adds 1% to sales price
- Large specimen trees can add 10%, or more, to property values.

Trees Mean Better Business



In tree-lined commercial districts...

- More frequent shopping
- Longer shopping trips
- Shoppers spend more for parking
- Shoppers spend 12% more for goods



TWO OLD
CROWS
LIVE HERE!

Aesthetic and Other Benefits

- Mesquite, 20 years
 - \$9/yr



Benefit-Cost Analysis 20-Year Old Mesquite

Benefits	\$/tree	Costs	\$/tree
Energy	\$ 35.63	Planting (\$330)	\$ 16.50
Carbon	\$ 2.56	Pruning	\$ 3.96
Air Quality	\$ 6.54	Removals	\$ 2.88
Rain Interception	\$ 7.70	Irrigation	\$ 1.85
Property Values	\$ 9.37	Other	\$ 0.07
Total	\$ 61.80		\$ 25.26

- Benefit-Cost Ratio = 2.45

Phoenix Urban Forest

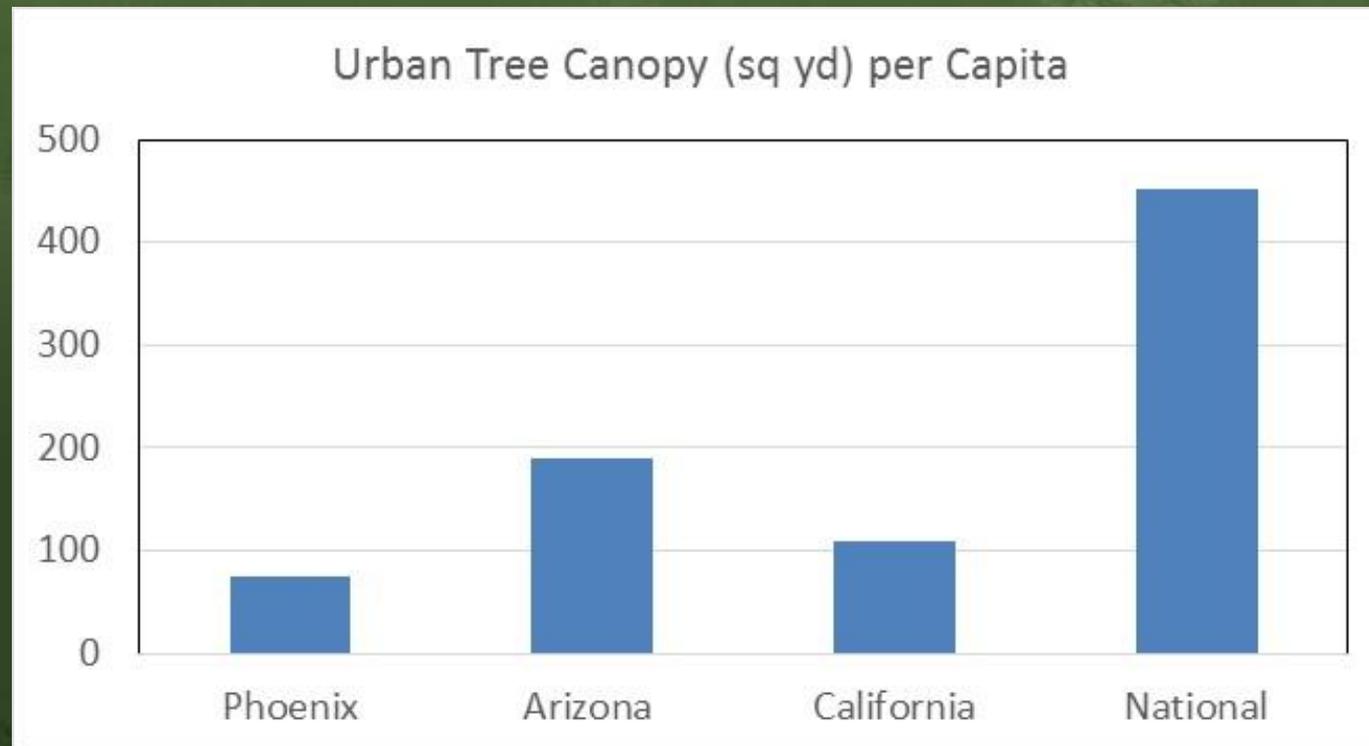
i-Tree Eco Plot Data

- 204 plots (1/10th acre)



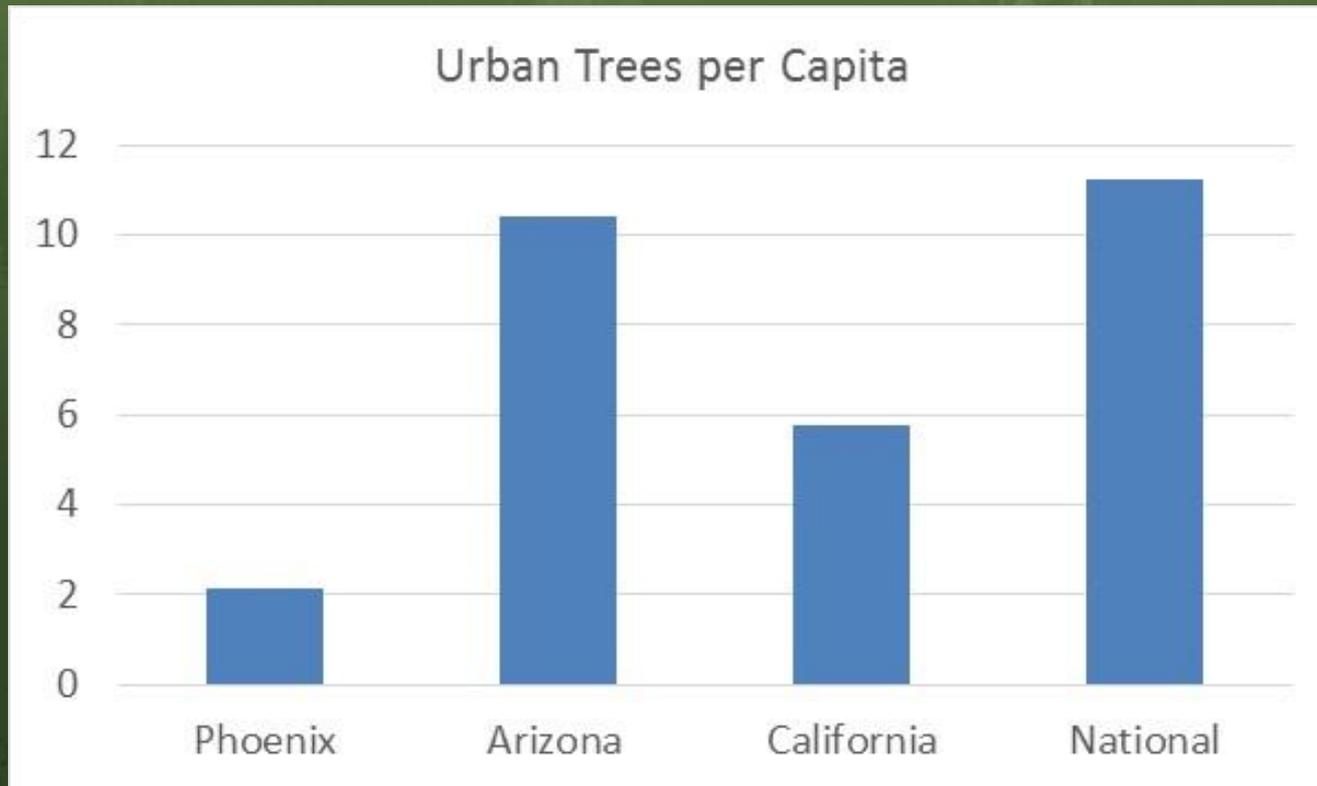
Phoenix's Urban Tree Canopy (9%)

- 34.6 sq miles UTC
- 73 sq yds/capita (US avg 451 s.y.)

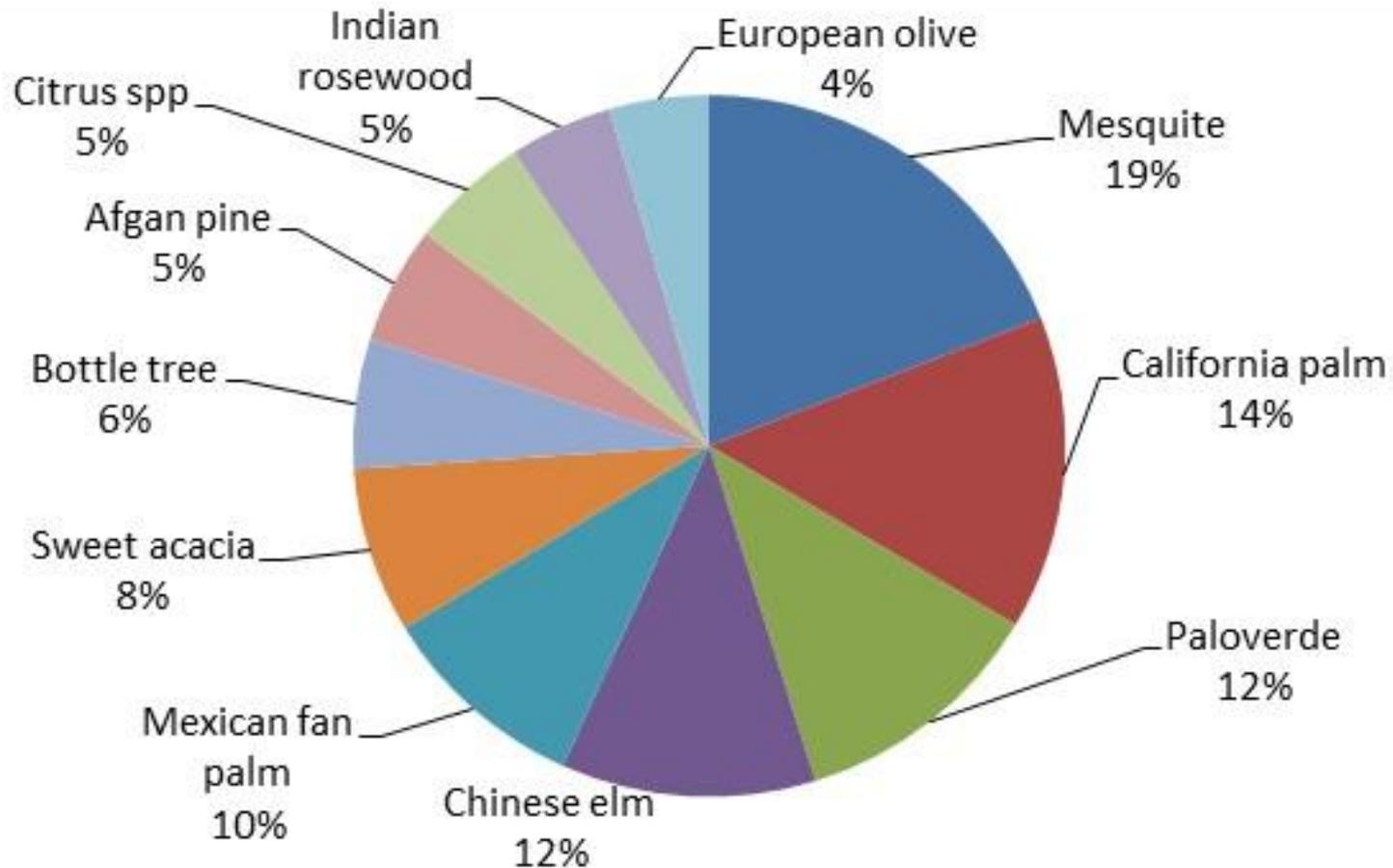


Tree Numbers

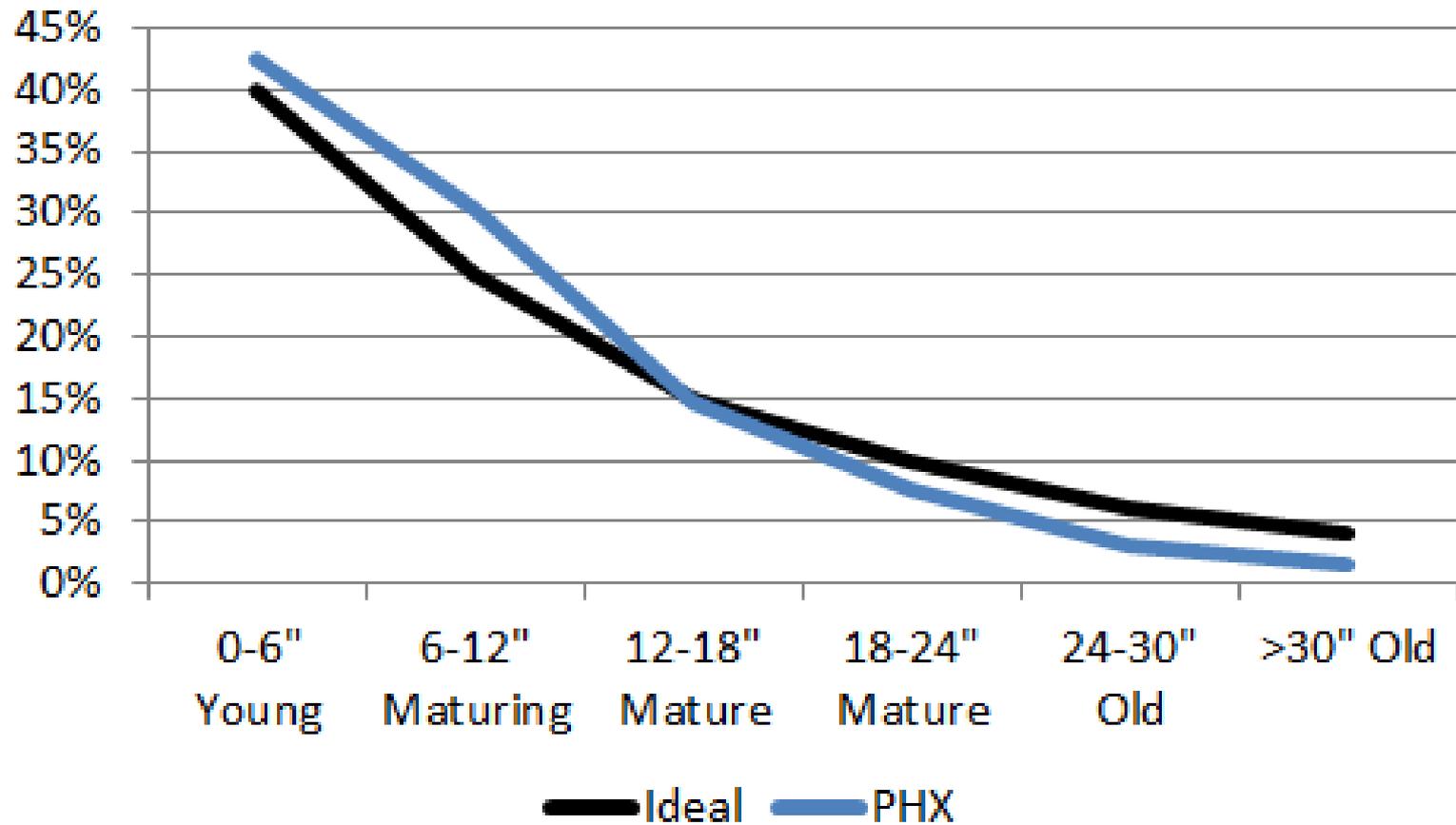
- 60 species
- 3.2 million trees (77% Resid.)
- 2.26/capita



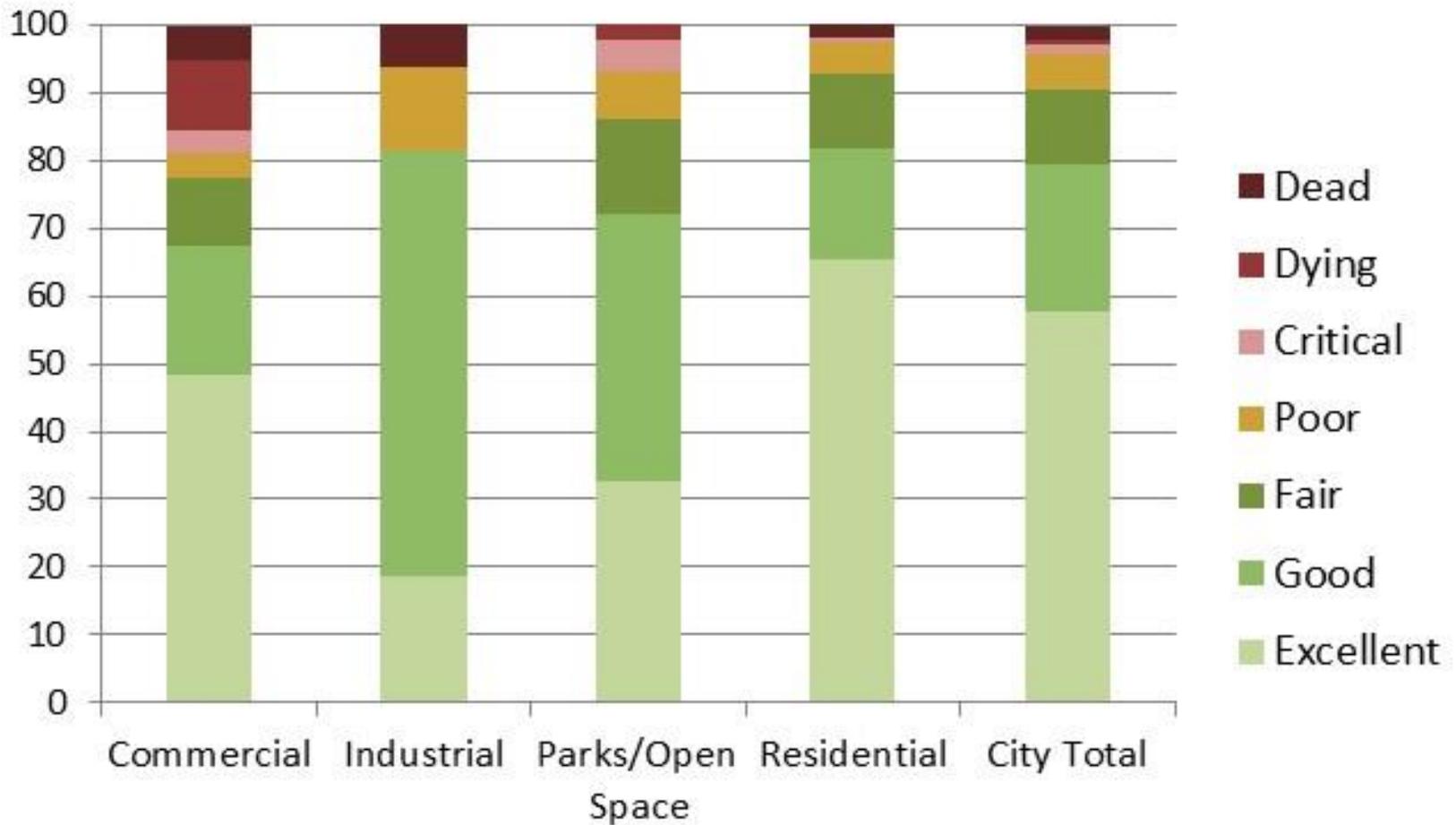
Dominance (Number+Leaf Area)



Age Diversity

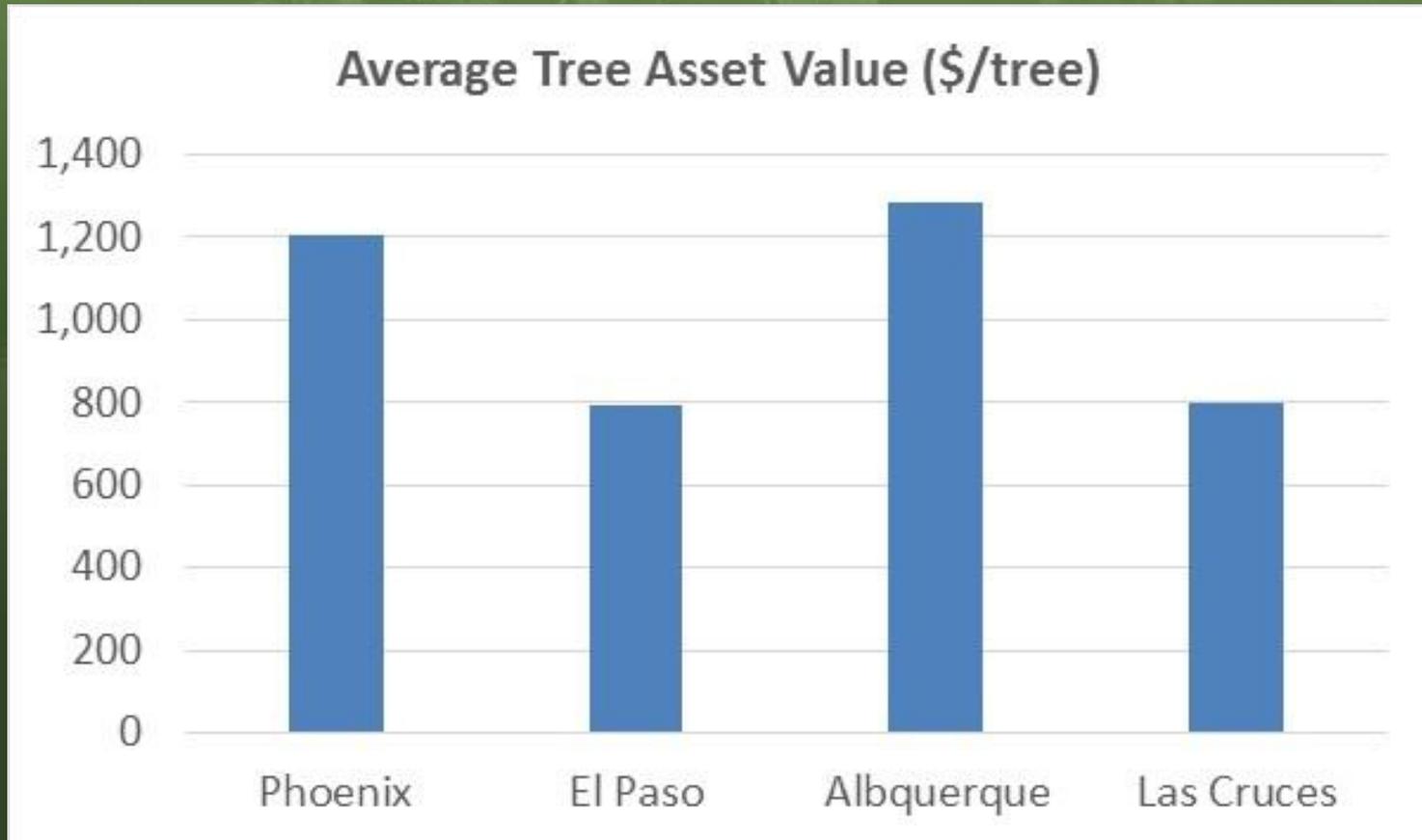


Tree Condition (%)

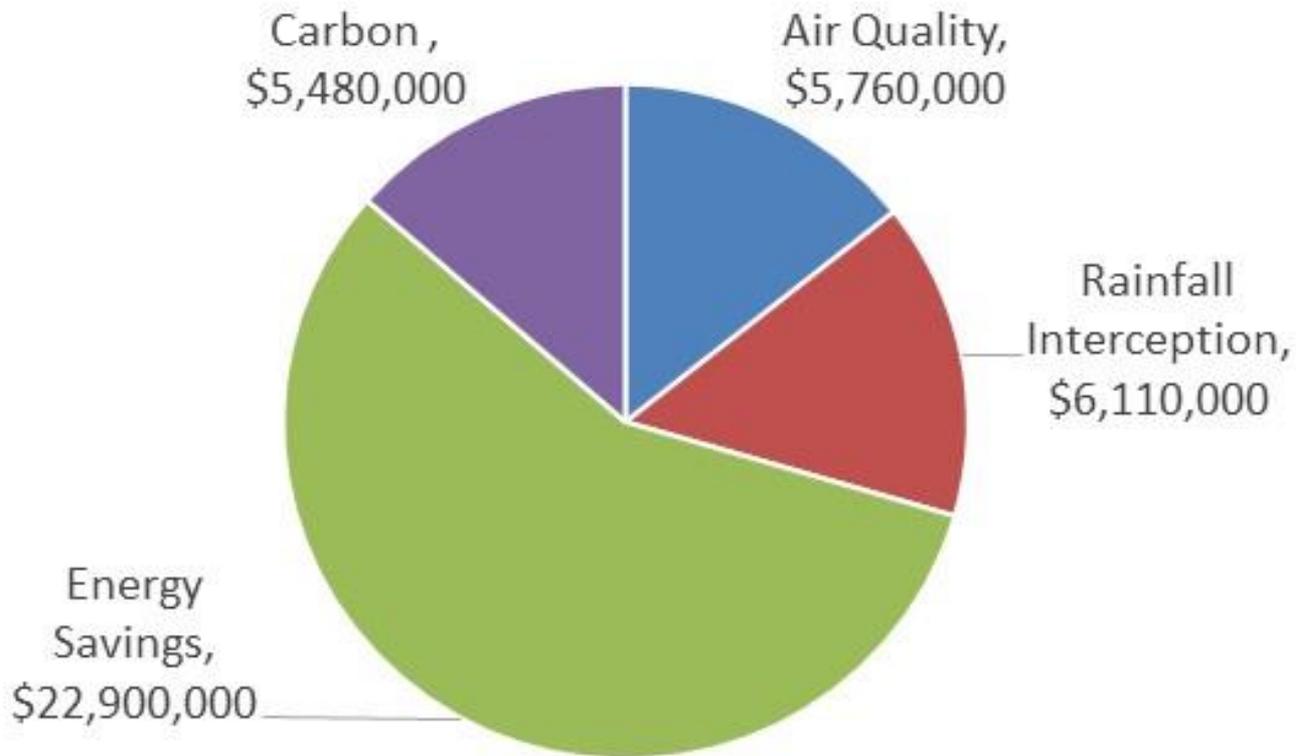


Asset or Replacement Value

- \$3.82 billion (\$1,207/tree)

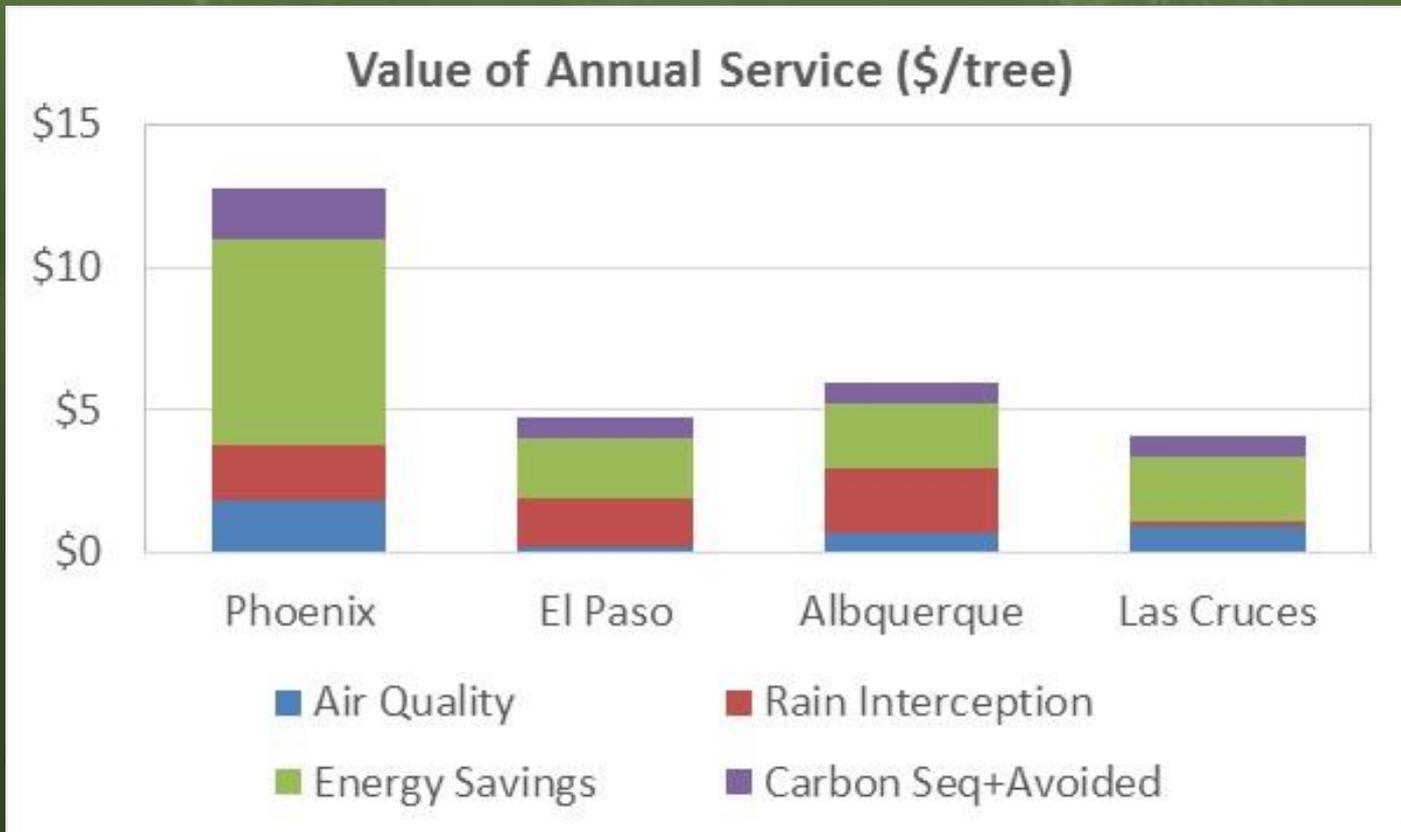


Phoenix's Urban Forest Value of Annual Services (\$40 million)



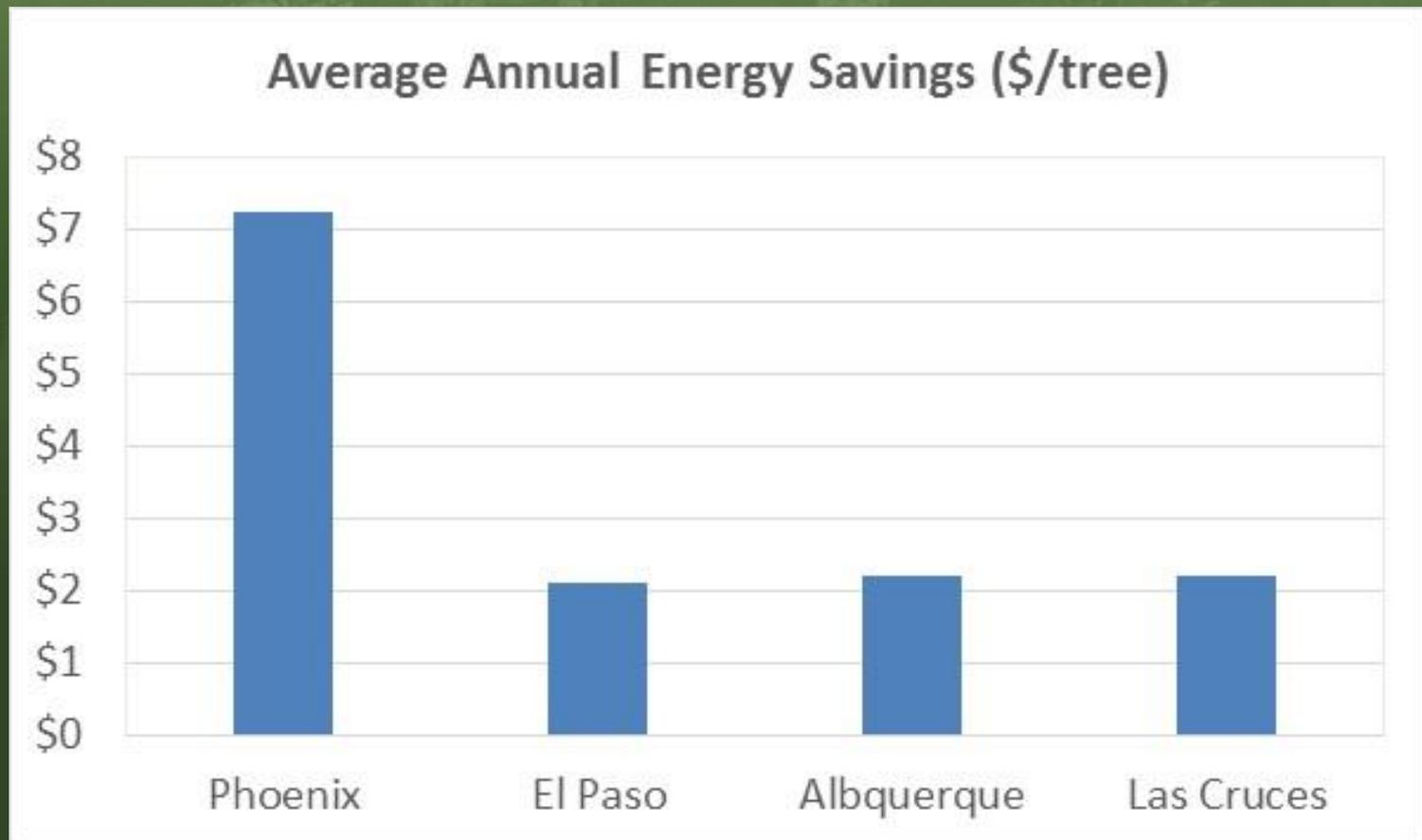
Value of Annual Services

- \$27.84/capita
- \$12.71/tree



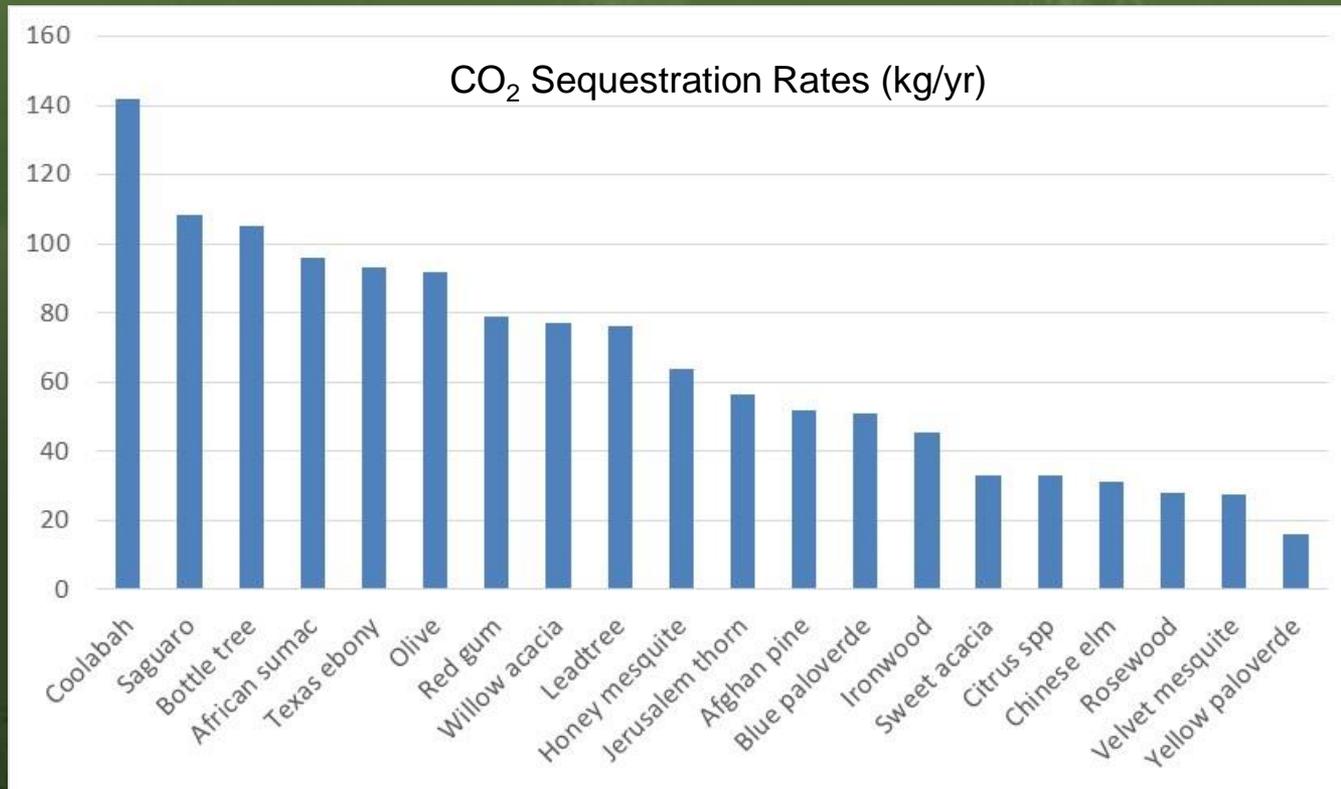
Value of Annual Energy Services

- 215,470 MWh = \$22.9 million (net)
- AC use 40,000 households (7% 600k)



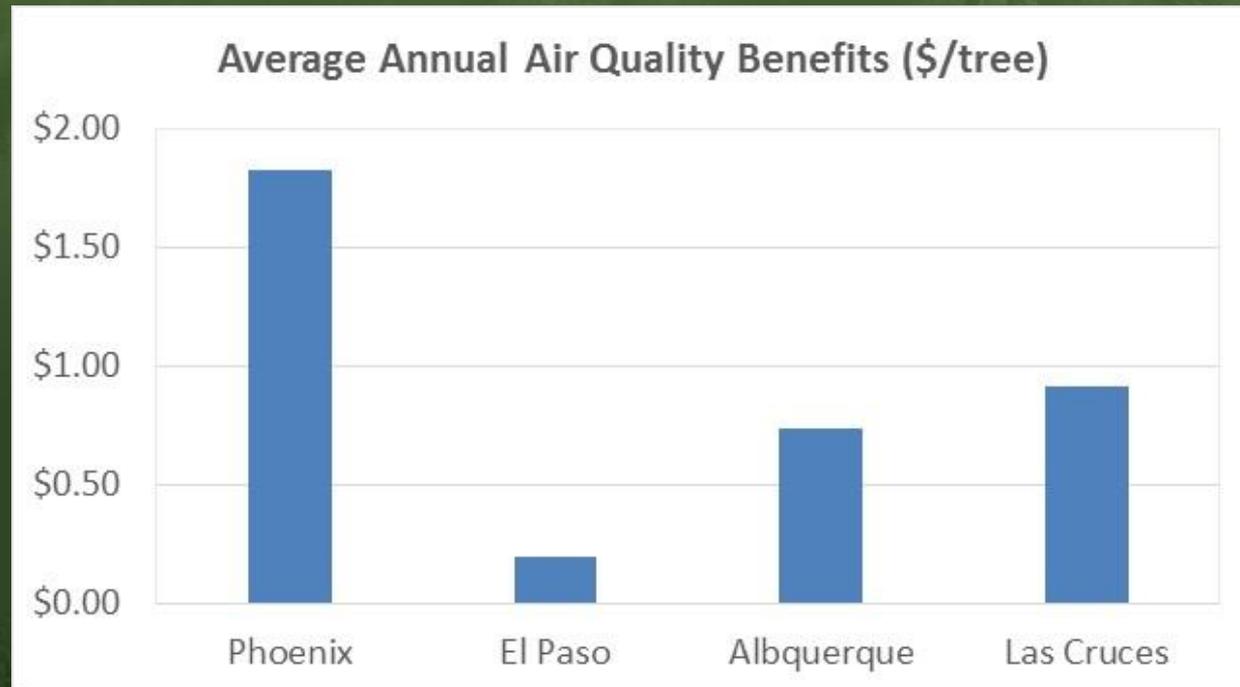
Value of Annual CO₂ Services

- 256,245 MT = \$5.46 Million (56% avoided)
- Offsets emissions from 54,520 vehicles



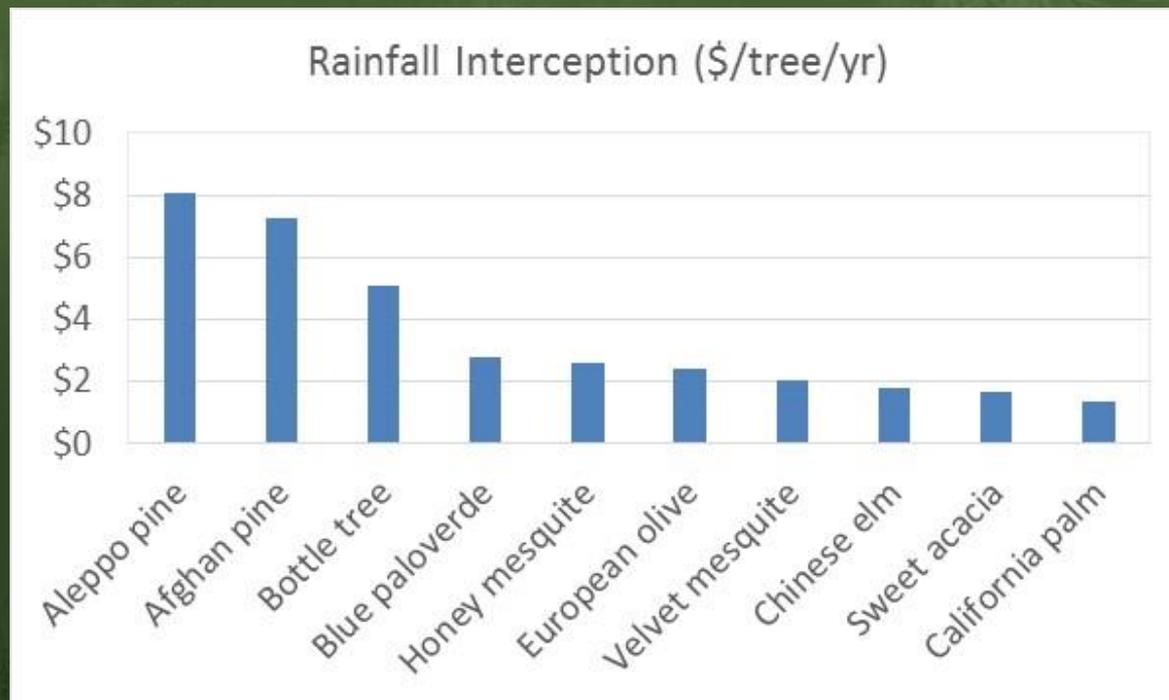
Value of Annual Air Quality Services

- 1,600 t = \$5.8 million (80% PM₁₀)
- NO₂ uptake offsets emissions of 14,400 vehicles (25%)



Value of Annual Rainfall Interception Services

- 686 Million gals = \$6.1 Million
- equals potable water used in 7,700 households (1.3%)



Threats & Challenges

- Climate Change

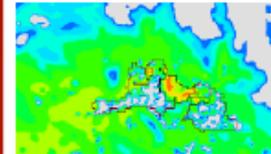
Phoenix's URBAN HEAT ISLAND

As Phoenix has developed, significant changes have been made to the natural landscape. Buildings, roads, and other infrastructure replaced natural desert and farmland. Surfaces that were once permeable and moist have become impermeable and dry.

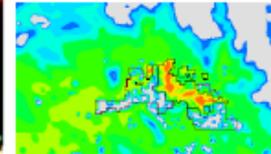


These changes have caused Phoenix to become warmer than the surrounding rural and desert areas, forming an "island" of higher temperatures in the landscape ([Environmental Protection Agency](#)). Phoenix's urban heat island (UHI) typically occurs after sundown as heat built up in cement, asphalt and other material during the day is slowly released back into the environment ([NASA](#)). The Phoenix area has seen its nighttime temperatures rise dramatically, resulting in Phoenix being up to 15 degrees warmer than the adjacent desert and farmland ([@Golden and Kaloush](#)).

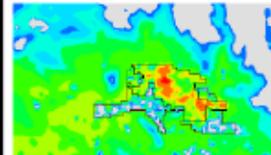
1973



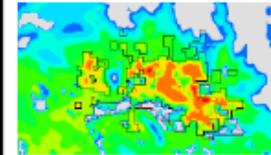
1985



1998



2006



Images provided by: Susanne Grossman-Clarke from the Global Institute of Sustainability, Arizona State University.

Phoenix Heat Island
These images show how the expansion of the urban environment has contributed to an increase in air temperatures. The images demonstrate that if the City does not change its current course, temperatures will continue to increase. The images were generated using computer model simulations based on weather conditions on July 14, 2003, during a heat wave period.

Each plot presents simulated 2 mile air temperatures using land use data from 1973, 1985, 1998 and 2006, respectively.

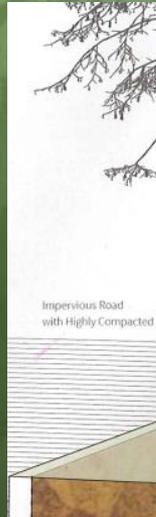
Threats & Challenges

- Climate Change
- Water
- Air Quality



Threats & Challenges

- Climate Change
- Air Quality
- Water
- Infrastructure, Infill & Funding



National Average **\$\$\$\$\$\$\$\$\$** \$7.65
Per Capita

Phoenix **\$\$\$\$** \$3.48
Per Capita

Summary

- Phoenix's urban forest 3.2 million trees, \$3.8 billion asset
- \$40 million annual services
- 9% UTC, low per capita
- Relatively sparse & fragile resource
- Threats: drought, root space, \$
- Call to Action
 - increase canopy, education, and funding for tree planning and care

What Does A Climate-Proof Urban Forest Look Like?

- Resilient Resource
 - Delivering high level of services
- Mindful Management
 - Applying science and best practices in support of a resilient resource
- Civic Connections
 - Embedding tree literacy and activism in all aspects of civic life

Phoenix Tree & Shade Plan

- Vision – 25% UTC
- Goals
 - Educate
 - Preserve, Protect & Increase
 - Sustainable & Maintainable Infrastructure

Goals of the Tree and Shade Master Plan

The following goals and recommendations apply to all areas of the urban forest. Actions for each recommendation are provided in further detail within the plan.



Raise Awareness (Educate)

- Recommendations
 - Establish Partnerships.
 - Educate the Public and Staff through Programs, Publicity and Media
 - Lead By Example



Preserve, Protect and Increase

- Recommendations
 - Create an Urban Forest Infrastructure Team
 - Conduct a Tree Inventory
 - Develop and Adopt Best Management Practices
 - Research and Develop Dedicated Revenue Streams



Sustainable Maintainable Infrastructure

- Recommendations
 - Revise City Ordinances
 - Items for further review and possible inclusion:
 - Engineered Shade Standards
 - Streamlined Permitting for Engineered Shade
 - Tree Permitting
 - Tree Protection on Construction Sites
 - Incentives and Alternatives
 - Planting and Irrigation Standards
 - Landscape Standards based on the concepts of Right Tree, Right Place

Resilient Resource

- Abundance
 - UTC targets sustained
 - Fully stocked streets & parks
- Species Composition & Age Structure
 - Diverse mix of climate-ready species
 - Juvenile and maturing trees dominate
- Health
 - Excellent and good health dominate
 - Monitoring in-place
 - Capable of rapid response to threats



**A Resilient Resource
Doesn't Happen by Chance**

Continued Commitment

Mindful Management

- UTC Campaigns
 - Integrate with policy
 - Ordinances to protect & expand
 - Funding
- Master Plans
 - Prioritize
 - Protect veteran trees
 - Planting
 - Young tree care
 - Removal and reuse
 - Optimize benefits, minimize costs





**Mindful Management
Doesn't Happen by Chance**

Continued Commitment

Civic Connections

- Informed and active citizenry
 - NGOs and advocacy groups
- Youth education
- Skilled workforce and quality products
 - Landscape professionals
 - Jobs and career opportunities



Volunteers and tree advocates are transforming concrete into green space in many underserved and low-income neighborhoods across Oakland, Calif.



**Civic Connections Don't
Happen by Chance**

Continued Commitment

Green Infrastructure

- Available
- Effective
- Economical
- Sustainable



Incremental Implementation

“[S]mall, piecemeal patches created by individual developers rather than an integrated effort by the whole community...”

(Cities of the Future, 2007)

Grey to Green

The next five years

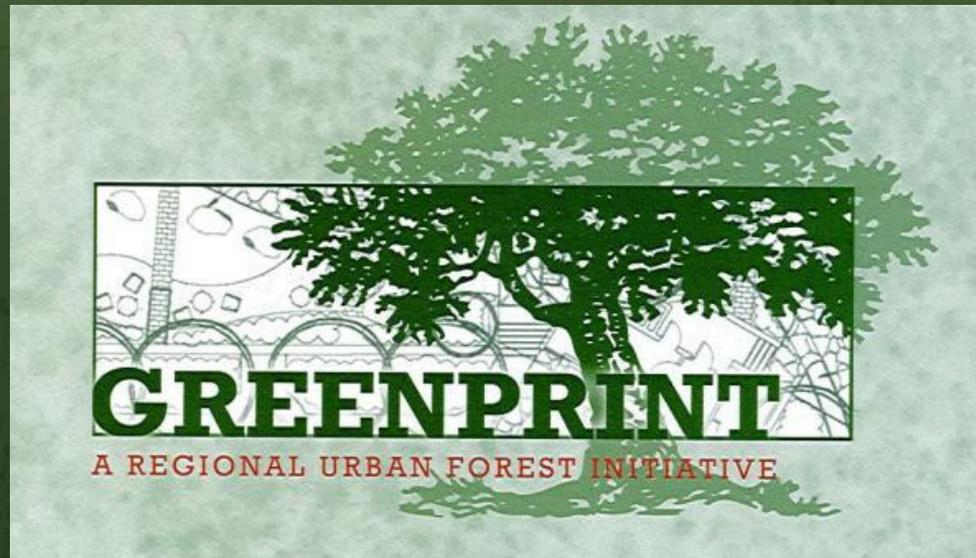
\$50 million for...

- 43 acres of ecoroof
- 920 green streets
- 83,000 trees
- 419 acres purchased
- 8 culverts replaced



Lessons Learned

- Tree Planting Initiatives
 - 9 of 12 largest US cities
 - 20 million trees
- Sacramento Greenprint
 - National Greenprint Workshop



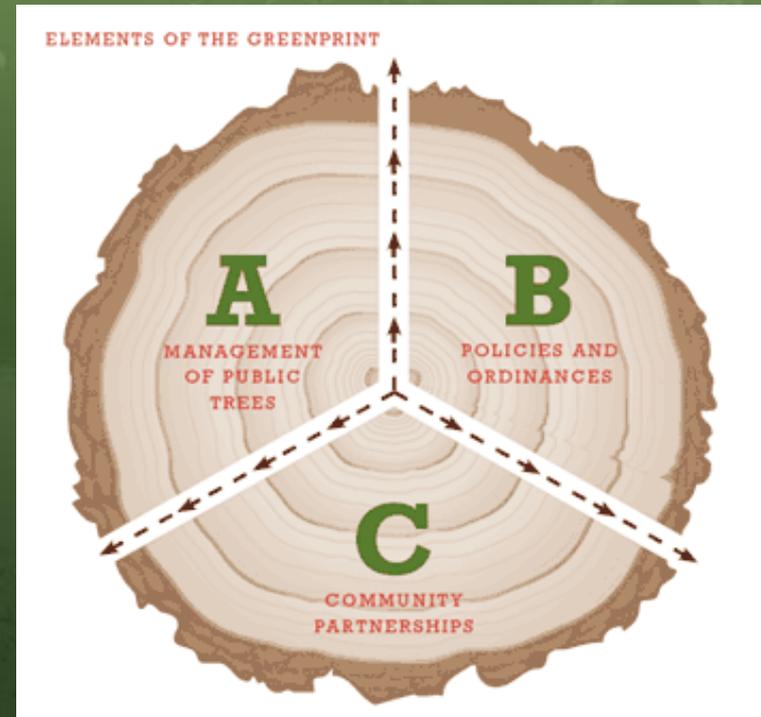
Greenprint Lessons Learned

- Engage public officials
 - Credibility: Proven partnerships & science
 - Steering committee – meet regularly
- Use your Board of Directors
 - Build bridges to key groups
- Celebrate your volunteers



Greenprint Lessons Learned

- Be leaders
 - Take risks, benefits will come
- Be visible
 - Tell your story
 - Use symbols to inspire action & report progress
- Be patient
 - Perseverance pays off



TPIs: Initial Conclusions

- Beautification or GI?
 - Presence of overarching goals
 - Collaborative constituencies
- Effective planning?
 - Some approaches work
 - Science-based planning
- TPIs mainstreamed?



BMPs

Executive Management

- Set realistic goals
- Champion TPI with public & politicians
- Demand interdepartmental coordination
- Lead fund-raising effort



BMPs

Management Team

- Create early successes
- Establish strategic partnerships
 - planting/stewardship
 - public relations
 - funding
- Develop a plan
- Report TPI accomplishments





Regional Greenprints Don't Happen by Chance

Continued Commitment

Summary



A photograph of a wooden treehouse built high up in a dense forest of tall trees. The treehouse has a balcony and is surrounded by thick tree trunks and lush green foliage. The scene is brightly lit, suggesting a sunny day.

Summary

- Trees are **PRICELESS**
- Urban Forests Don't Happen by Chance: See the Future, Be the Future
- Lessons Learned: Continued Commitment is Required
- More Treehouses: Tell the Stories

The tree in front of my home is a **word**



The trees on my street are
a **sentence**



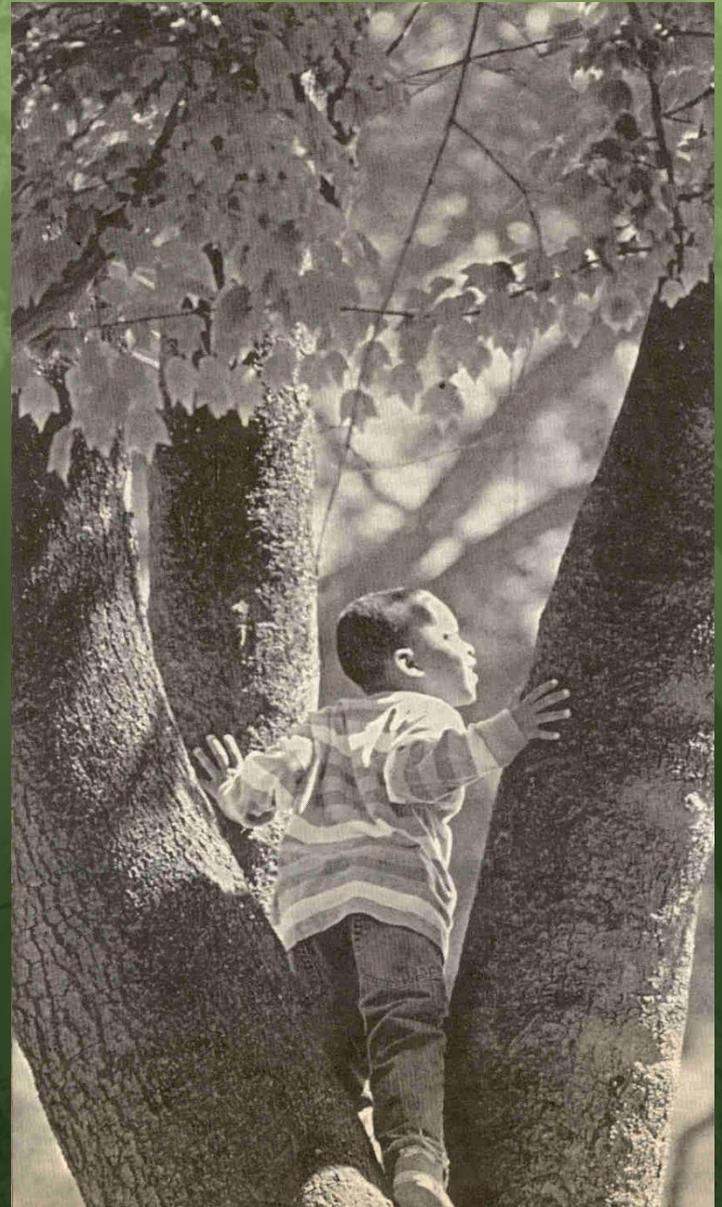
The trees in my neighborhood
are a **paragraph**



All the trees in my community
are a **story**



This story tells us
about our
relationship to
nature past and
present. The next
chapter is ours to
write. Our challenge
is to reveal the
connections between
my trees and **my
forest.**



Questions?

