Considering the Green Infrastructure: Benefits & Costs

Paula Peper, Ecologist
Center for Urban Forest Research, US Forest Service

Center for Urban Forest Research

USDA Forest Service
PSW Research Station
Davis, CA

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.

Today

- Overview of tree functions
- Benefit – Cost Approach
  - Comparison of 4 RM region cities
- All trees are not equal
  - Climate
  - Management
- Green planning in other cities
- Tools for managers

Areas of Research

Investment Value

Benefits *and Costs*

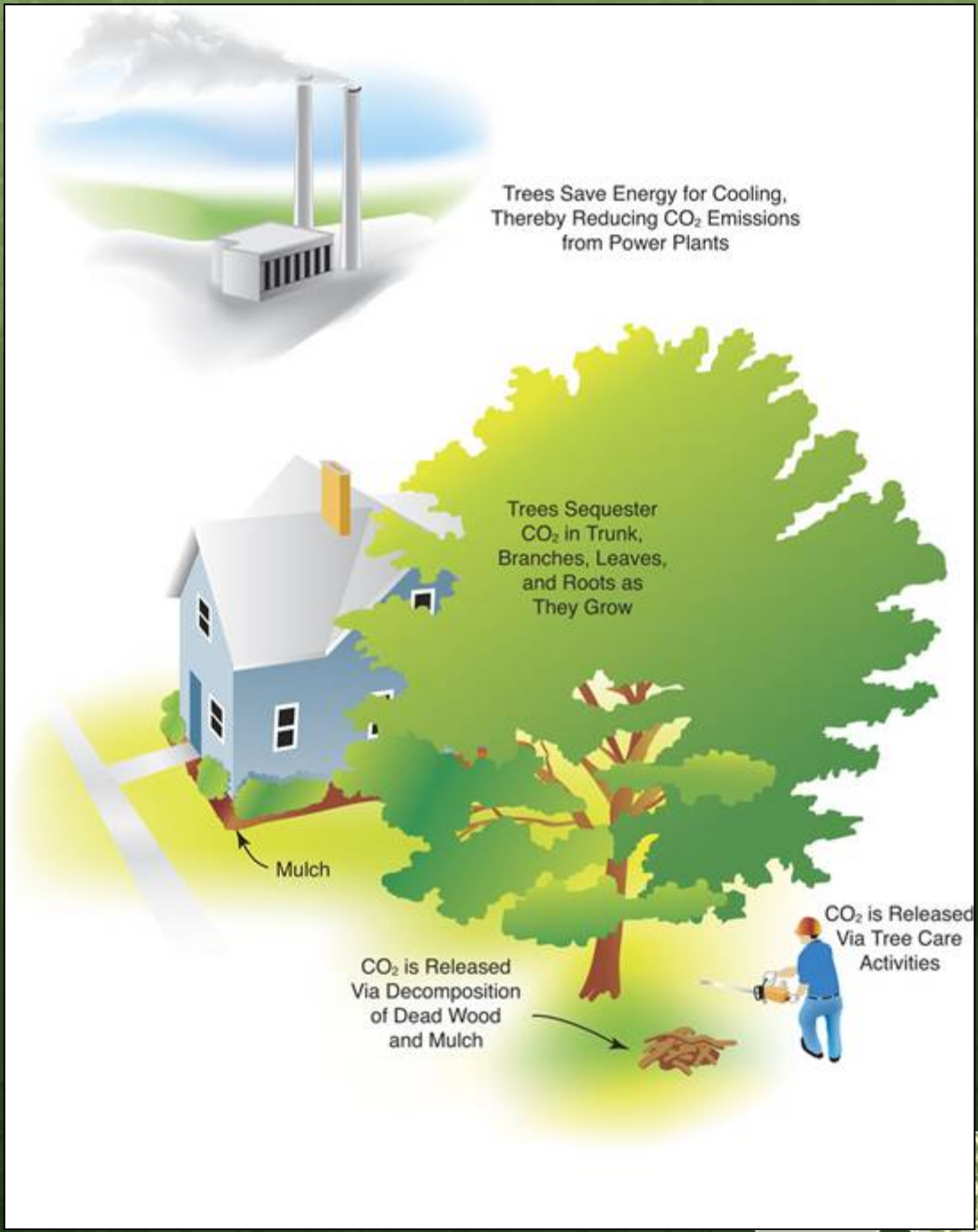
- Benefits
  - Air quality
  - Carbon
  - Stormwater interception
  - Energy savings
  - Property value
- Costs
  - Planting
  - Care & Maintenance
  - Infrastructure damage
  - Liability
  - Pest control

Benefit-Based Approach

Conserving Energy

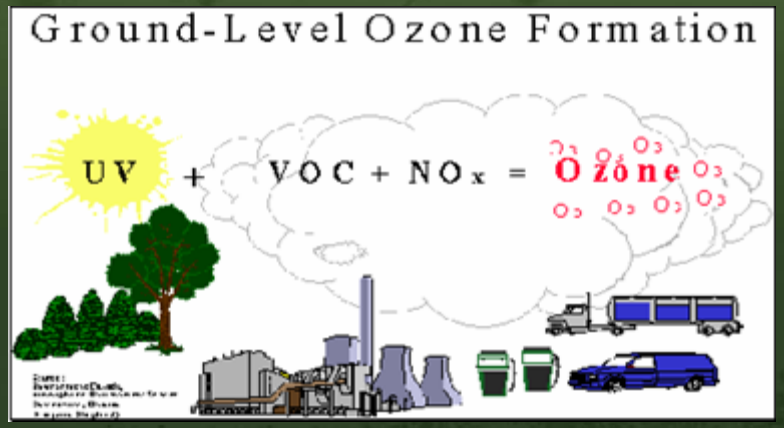
Reducing Atmospheric Carbon Dioxide

- Green ash
  - Average 161 lbs/year
  - 3.2 tons at age 40



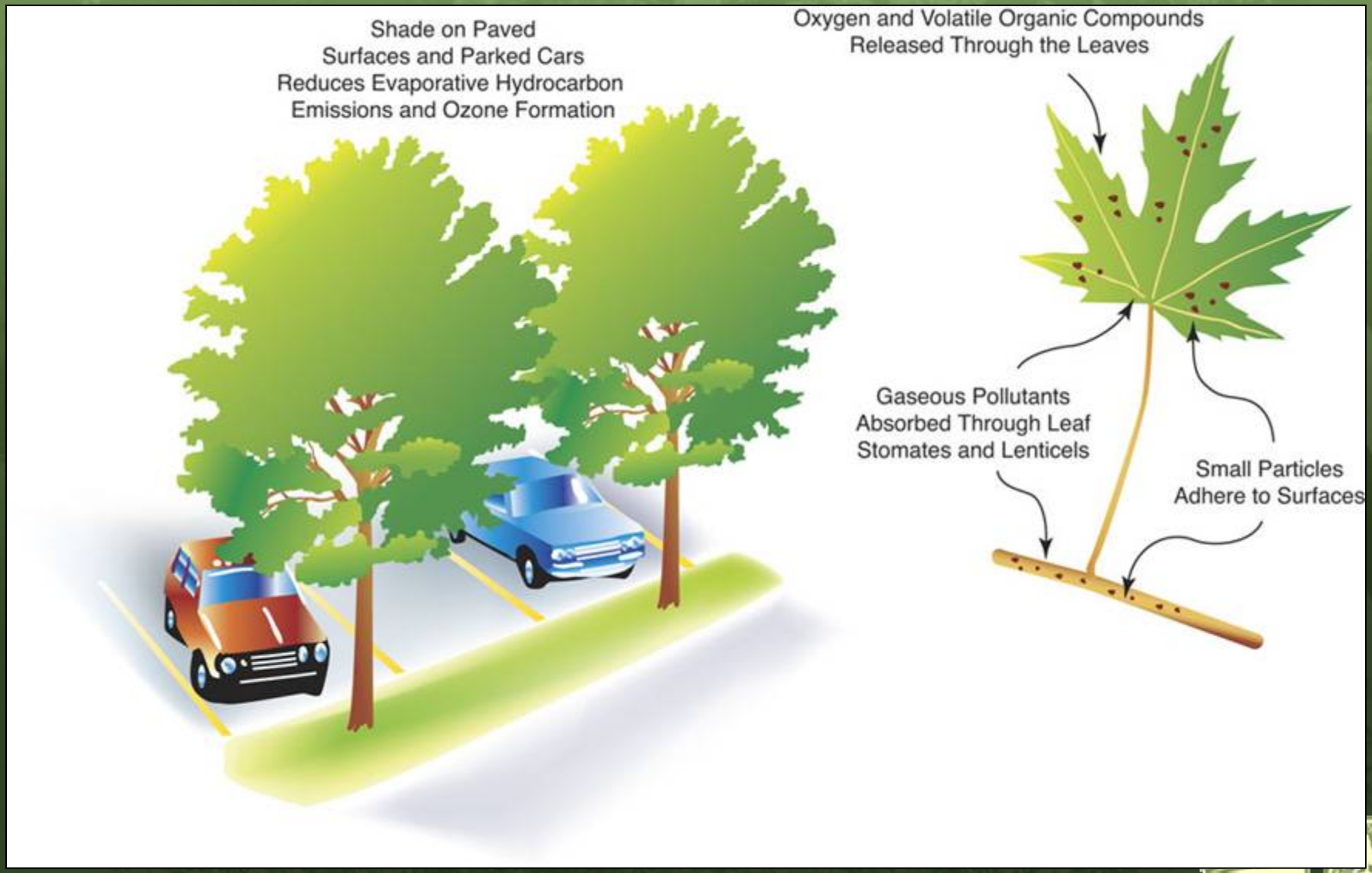
Improving Air Quality

- Ozone: 160 million people
- Particulates: 100 million people



- Green ash
  - 1.5 lbs/year

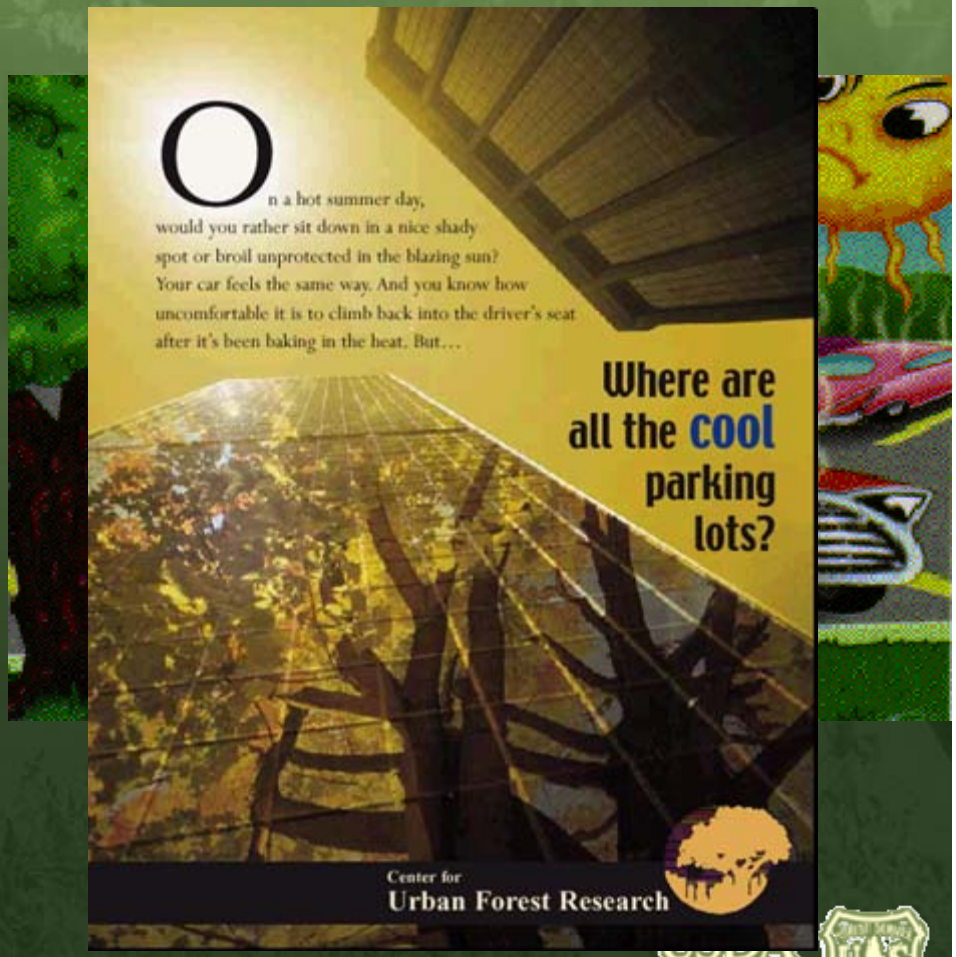
Improving Air Quality



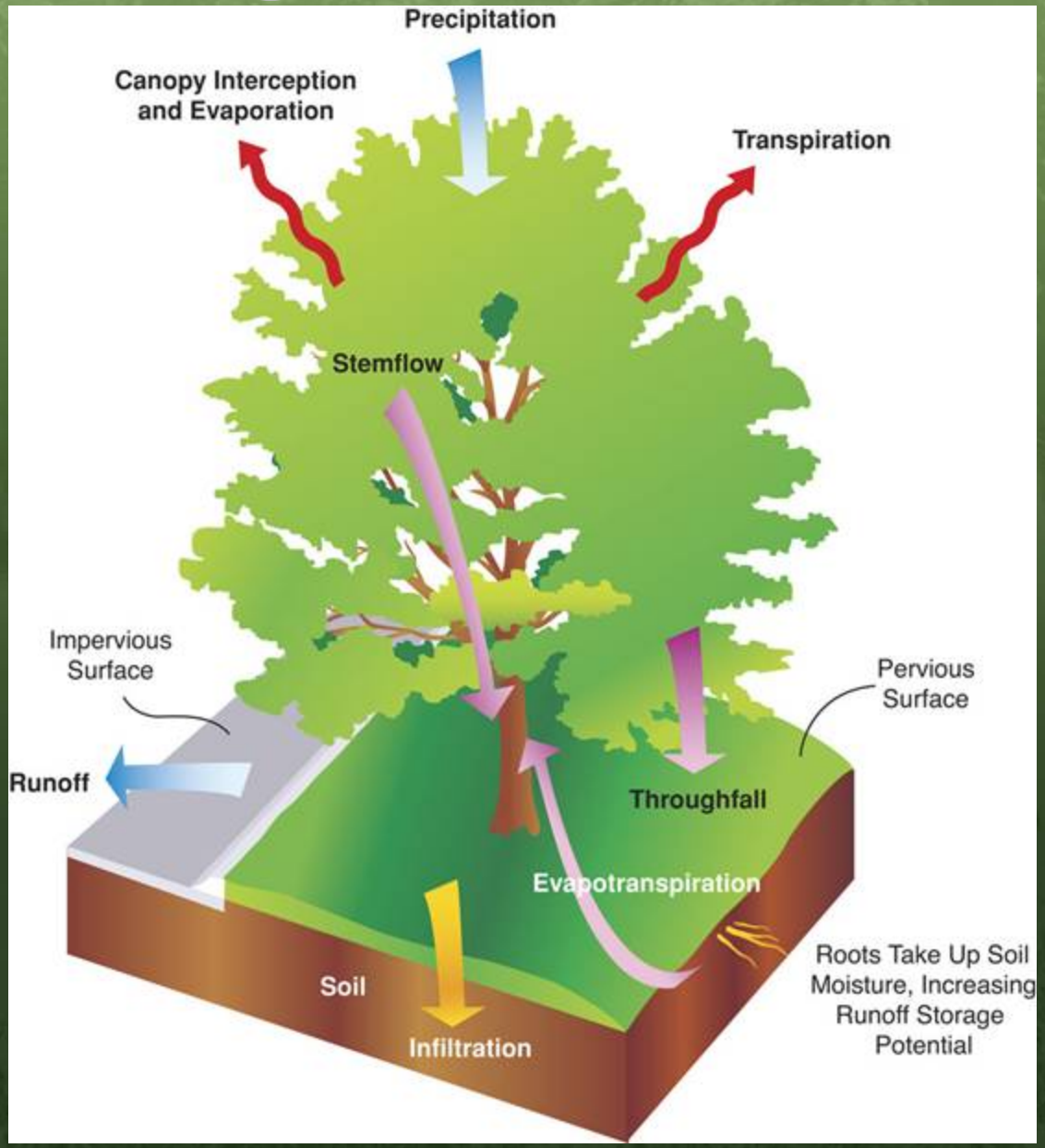
Improving Air Quality

Parking Lots

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



Reducing Stormwater Runoff



Tree Expenditures

- Planting, pruning, maintenance

Infrastructure Damage

Compendium of Strategies to Reduce Infrastructure Damage

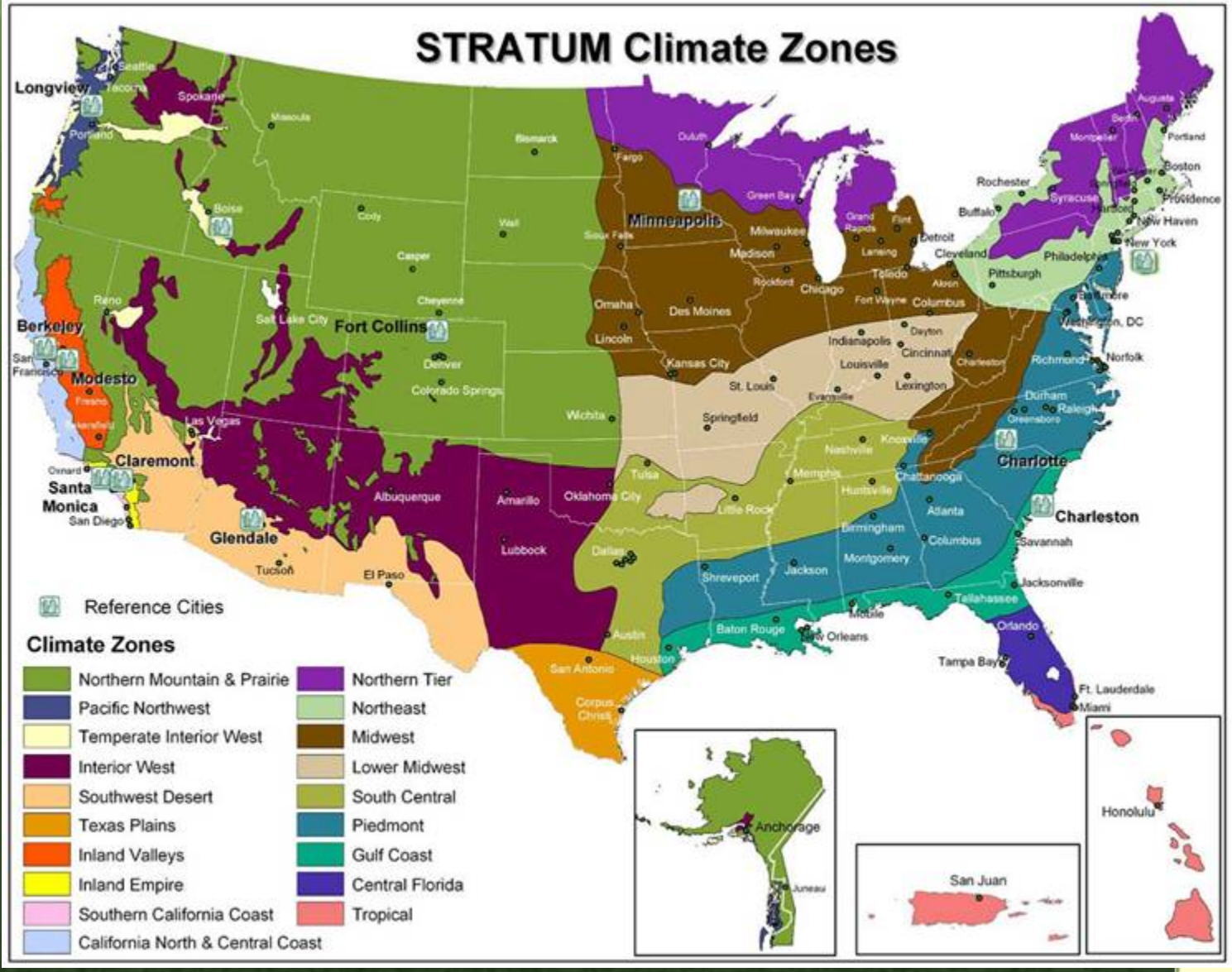
Other costs

- Sewer
- Pest control
- Liability – trip and fall, storm damage, vehicle accidents
- Catastrophic tree loss

Extensive Regional Differences

- Tree level
- Cost of resources
  - NYC electricity example
- Air quality monitoring
- Building vintages/climate
- Infrastructure/repair costs
- Liability issues
- Employee costs

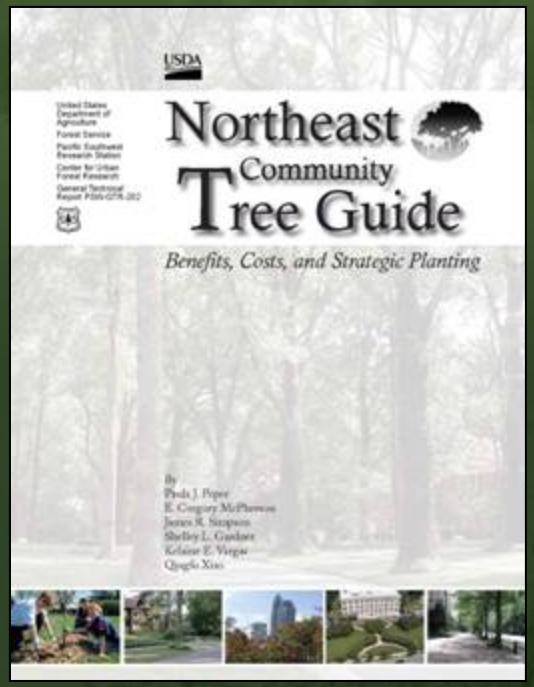
Reference Cities

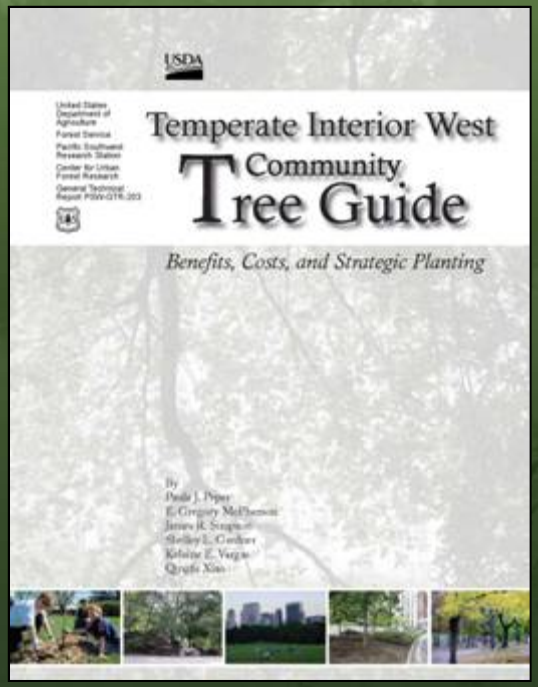


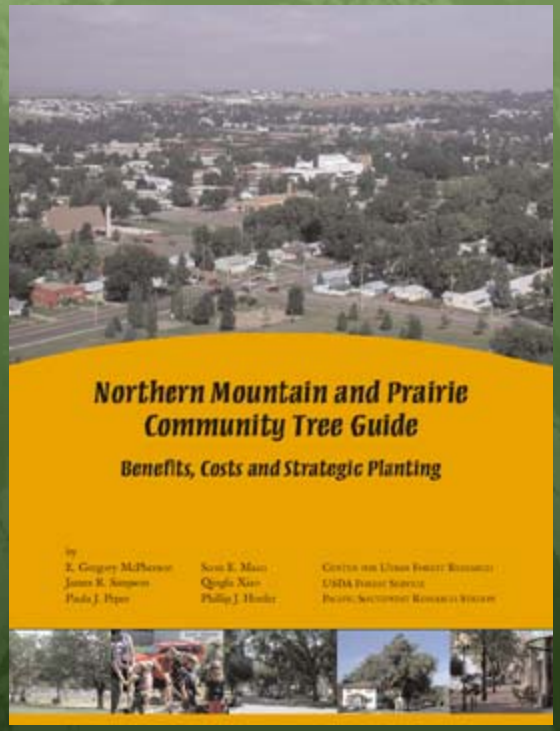
National Application

To provide tree managers with tools to:

- increase public awareness and support for trees.



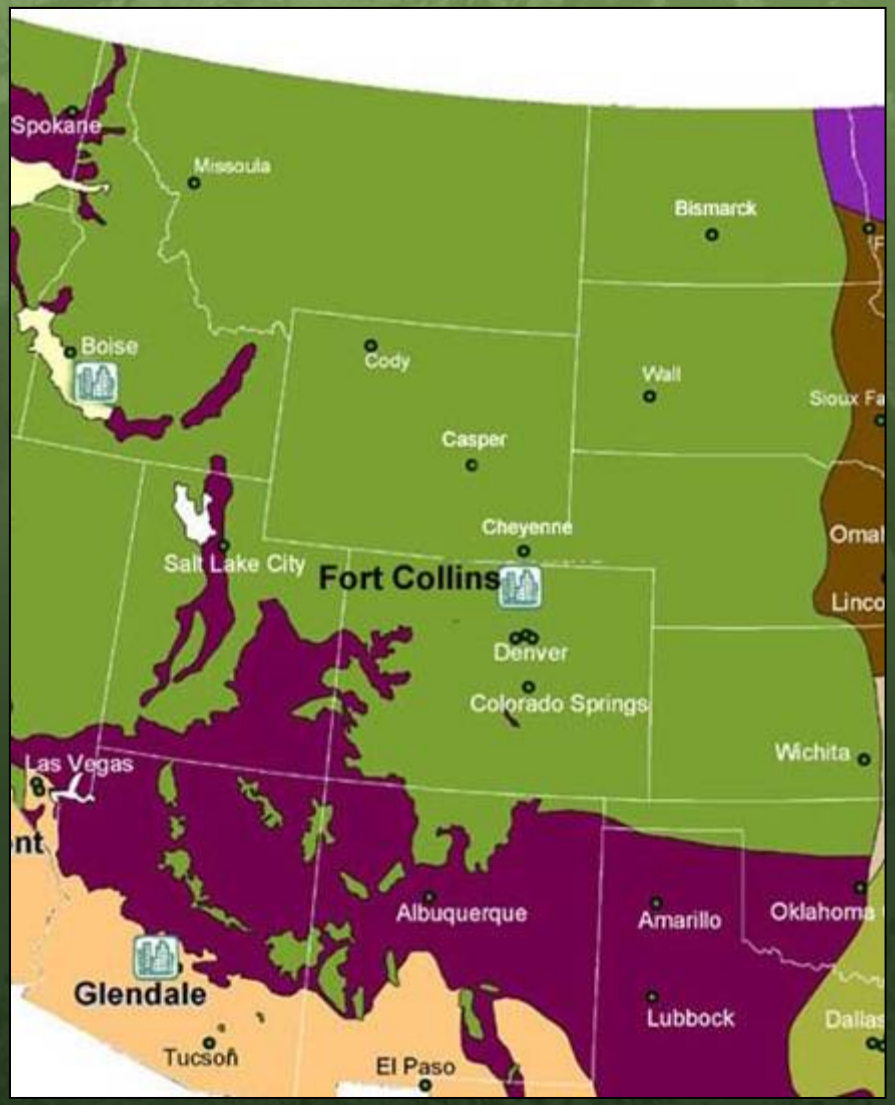




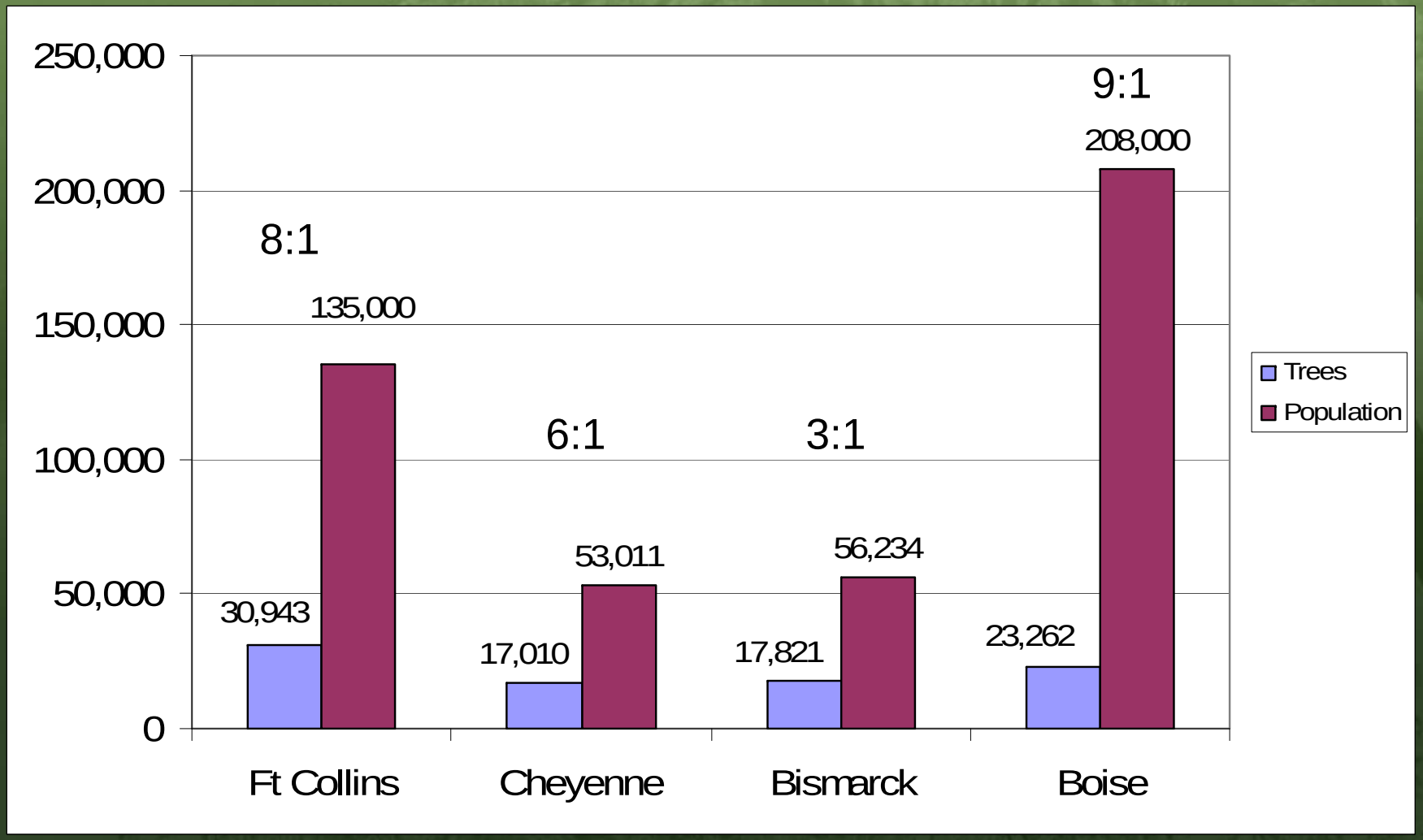
- assess structure, function, value of tree populations
- develop and evaluate BMPs

Reference City Research

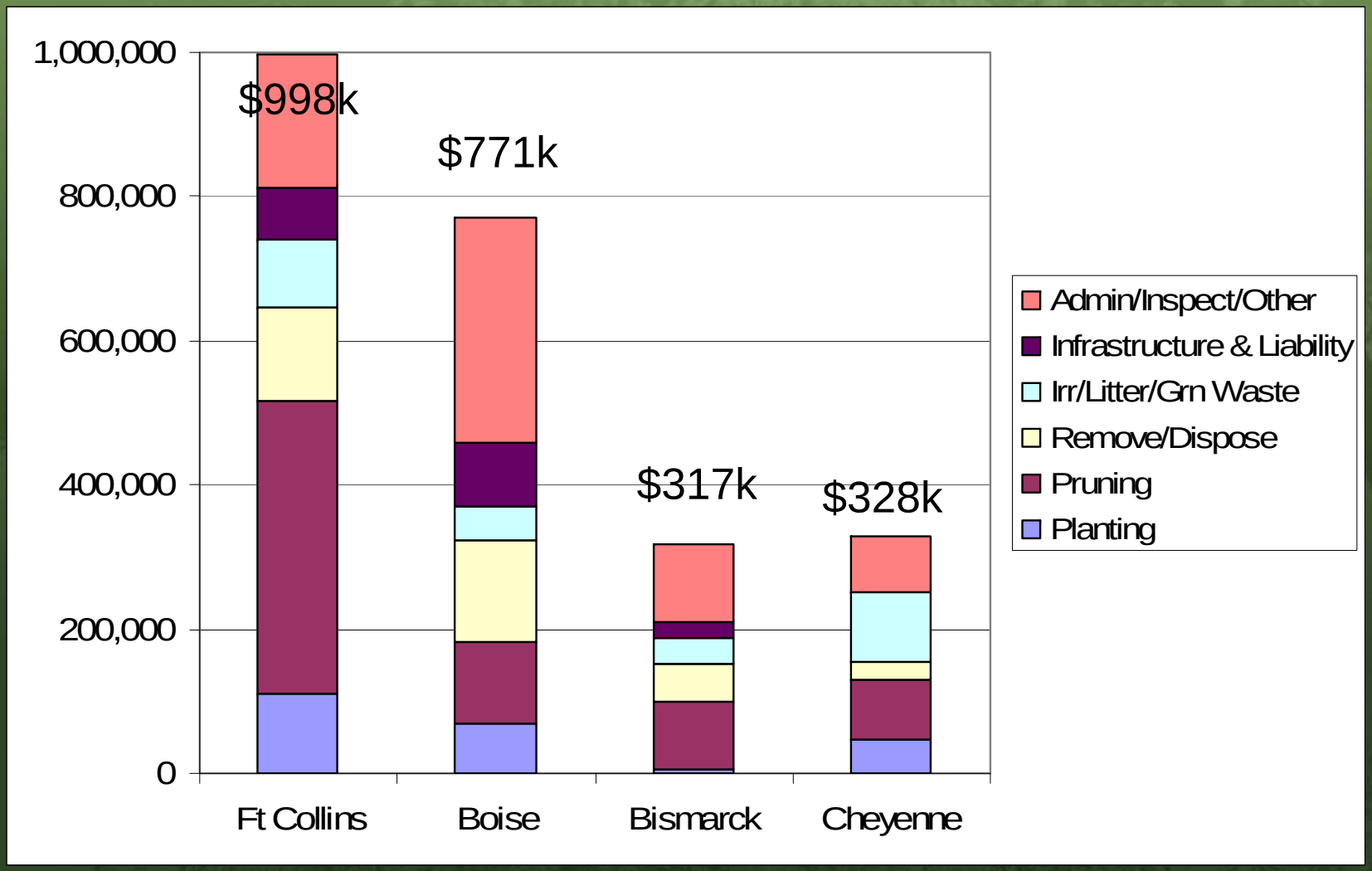
- Collect data – reference city street and park trees
- Analyze growth rates and dimensions
- Estimate magnitude of annual benefits
- Price benefits
- Price tree care costs
- Calculate net annual benefits, benefit-cost ratios



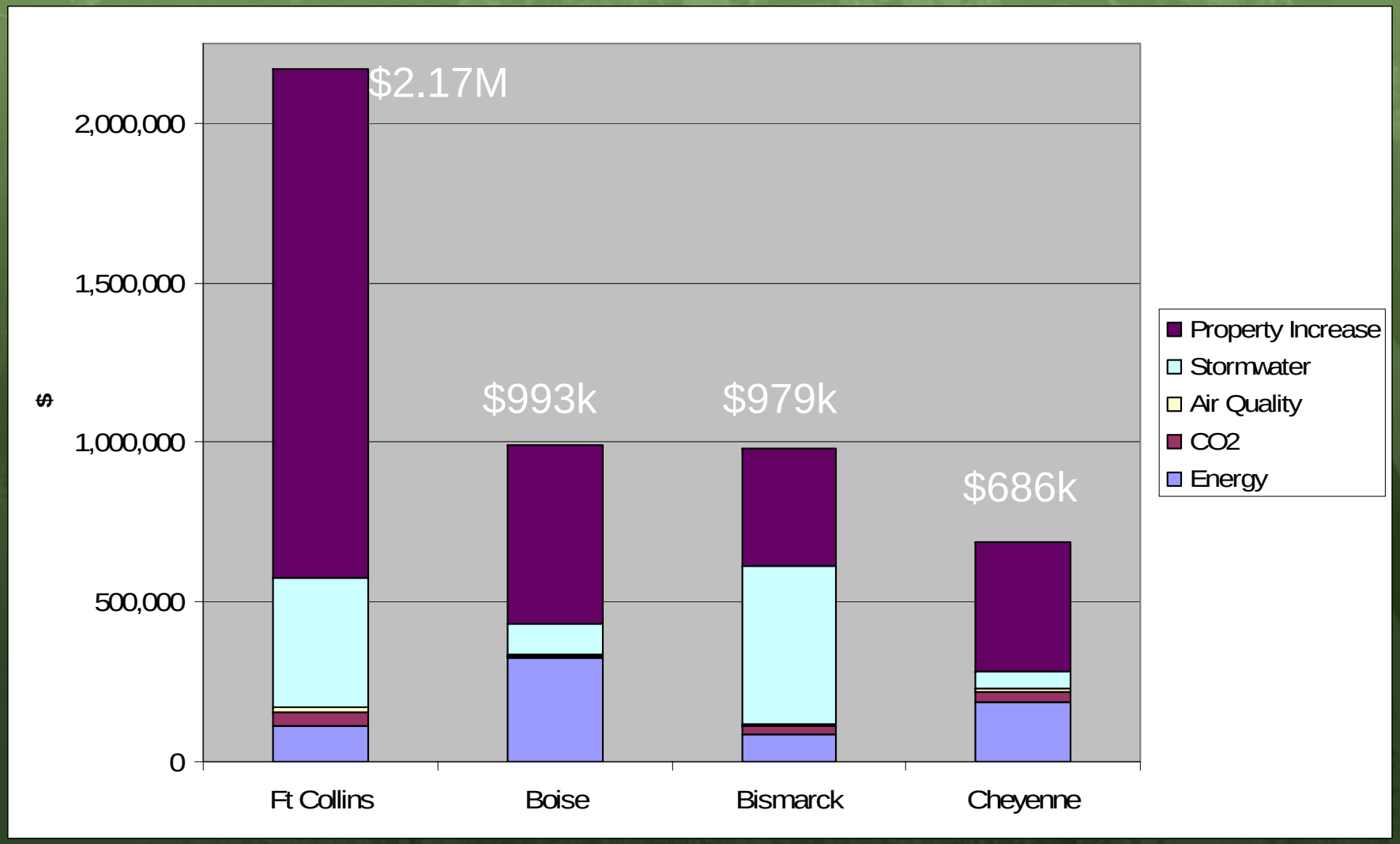
Tree & People Populations



Expenditures ($)



Benefits


$2.17M
$993k
$979k
$686k
2,000,000
1,500,000
1,000,000
500,000
0
$
Ft Collins
Boise
Bismarck
Cheyenne
Property Increase
Stormwater
Air Quality
CO2
Energy

Comparison (?) per Tree

	Ft Collins	Cheyenne	Bismarck	Boise
Benefits	$70.15	$40.33	$54.94	$42.70
Costs	$32.24	$19.28	$17.77	$33.13
B/C Ratio	2.18	2.09	3.09	1.29

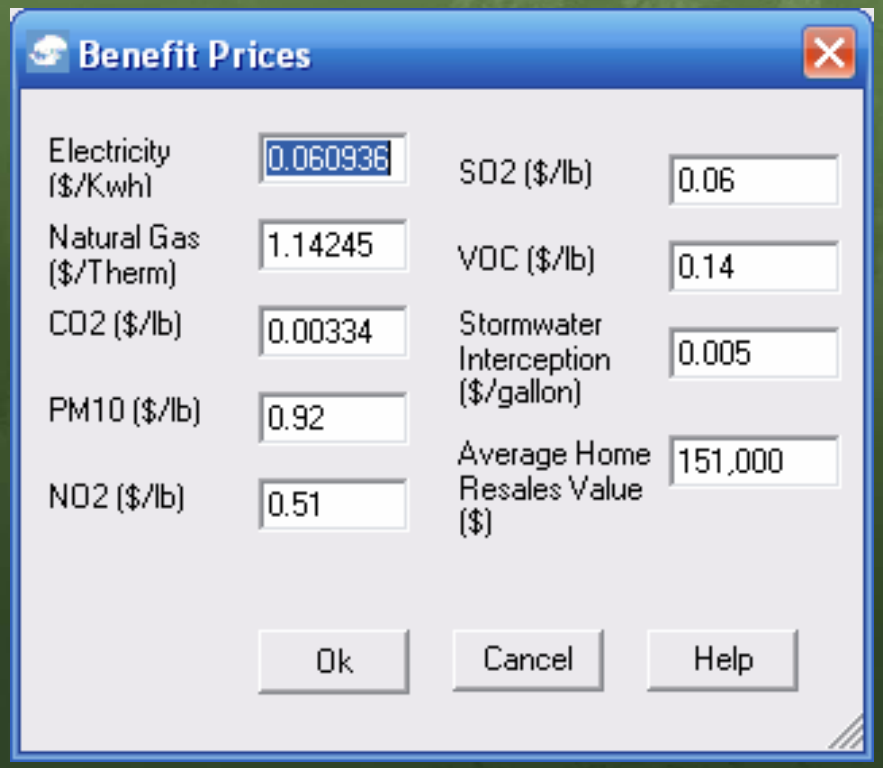
1st Place Bismarck
2nd Place Ft Collins
3rd Place Cheyenne
4th Place Boise

New York City
5.60

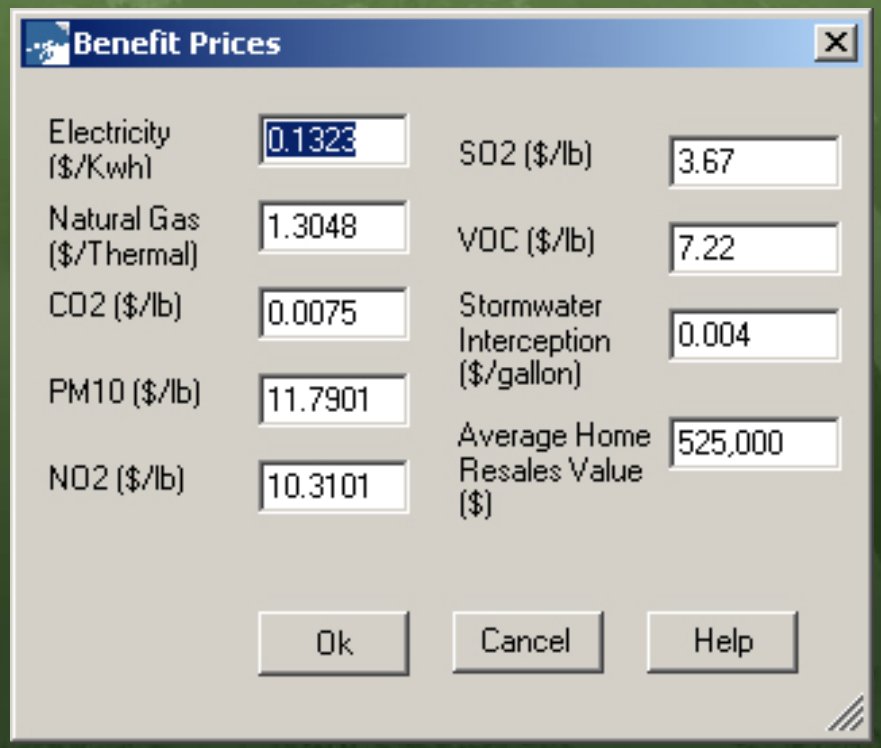
Regional Variation

- Tree age distribution
- Tree location
- Size counts
- Local cost of living – benefit prices
- Building vintages
- Etc.

Environmental Service Price Differences

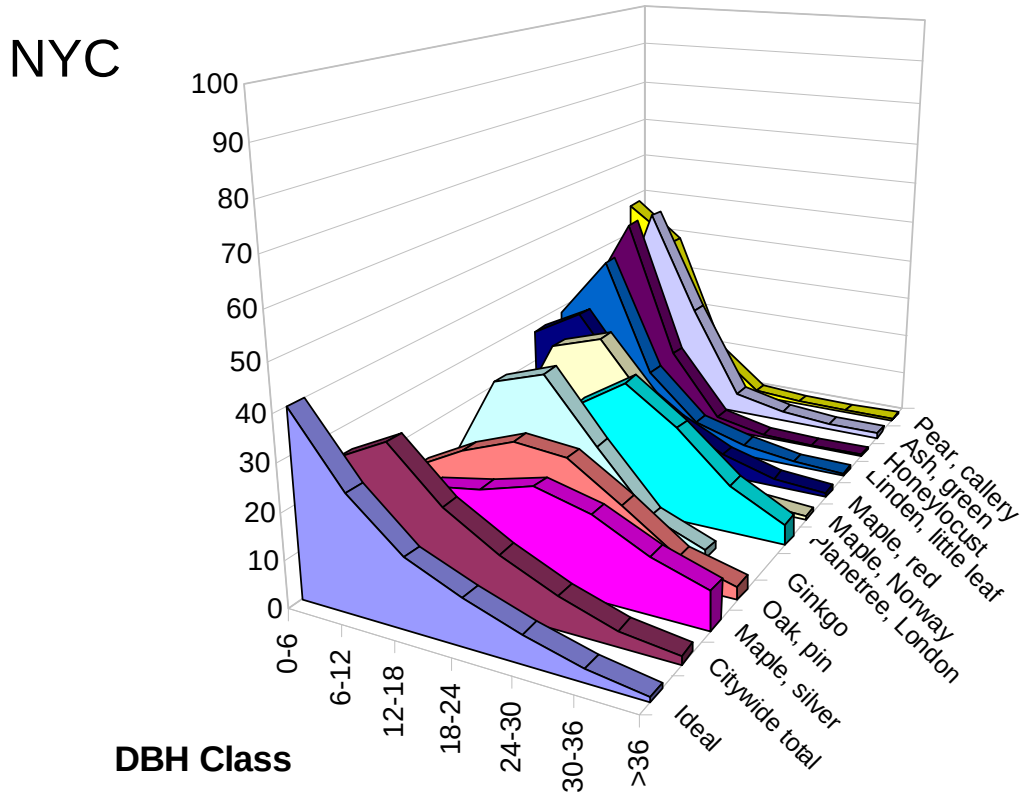


Boise



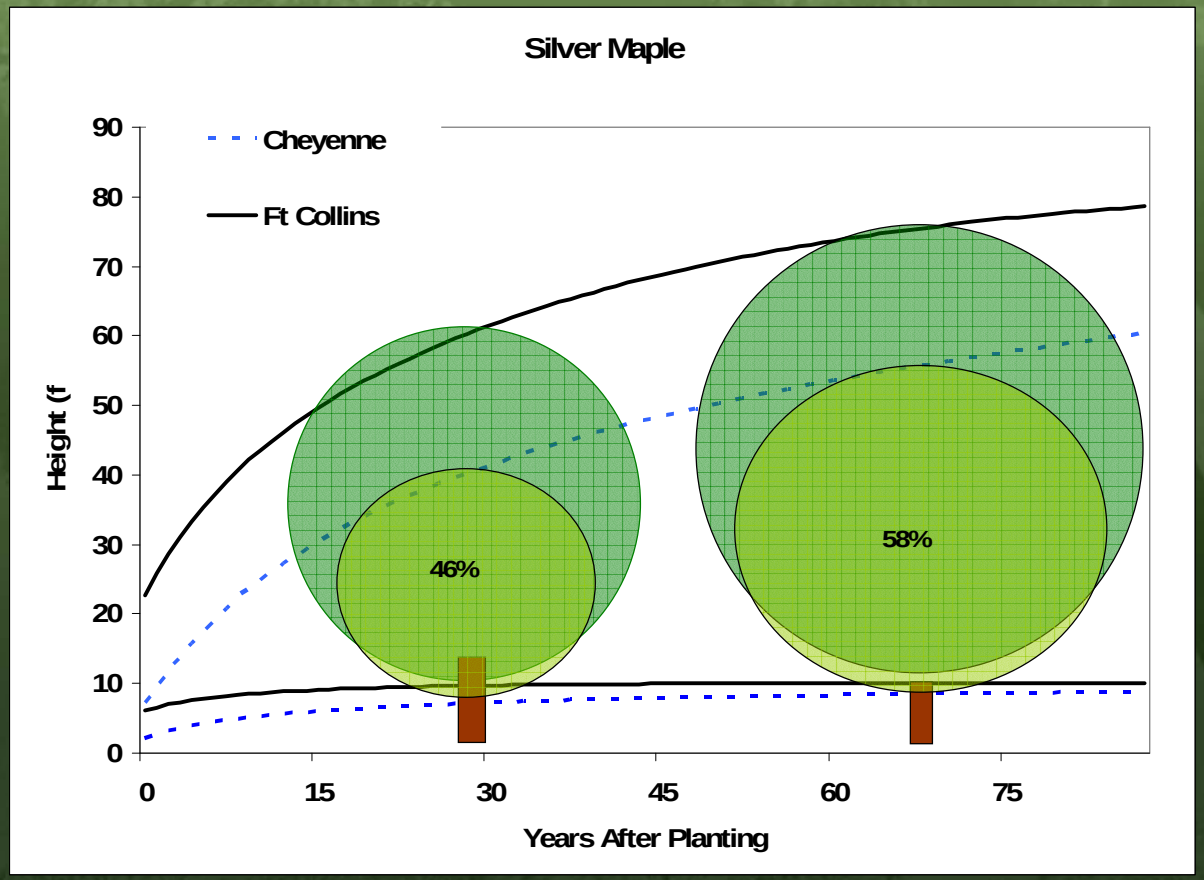
New York City

Relative Age Distribution

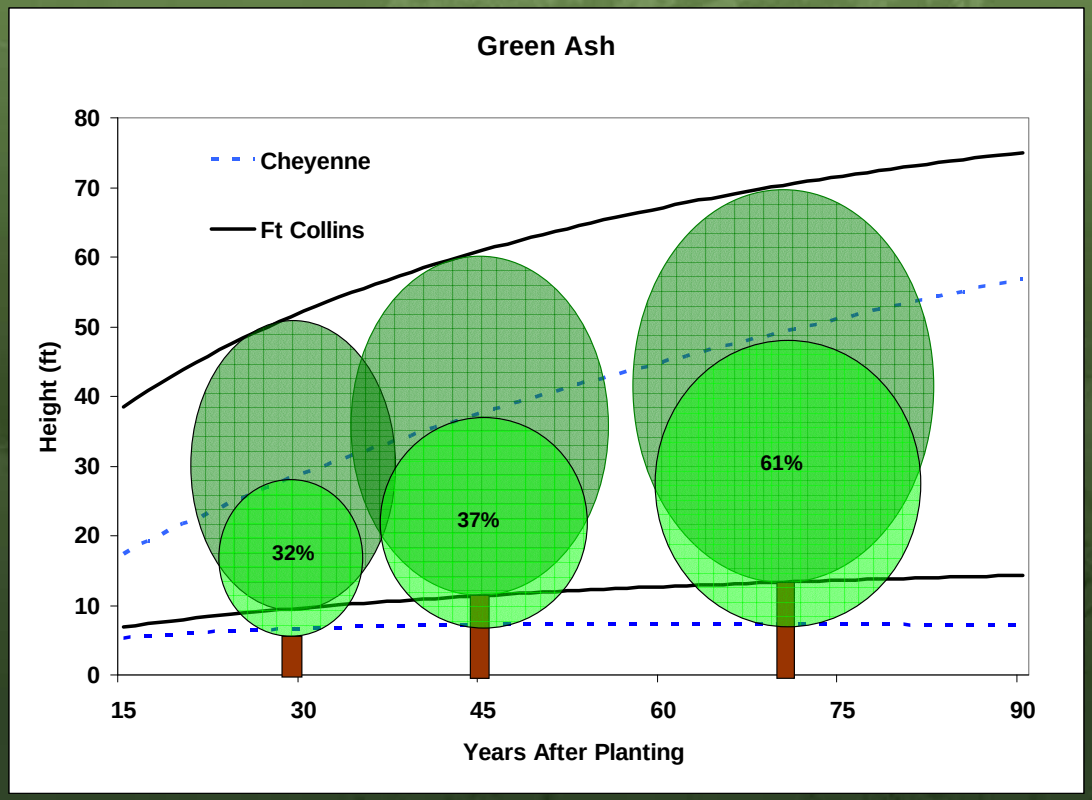


Tree Size & Location

Climate Affects Tree Size and Growth



Fraxinus pennsylvanica



Accounting for Growth Differences

Cheyenne Climate and Environmental Factors

- Weather:
  - 4th windiest city
  - Highest incidence of hailstorms
  - Average 14.4 inches precipitation annually
  - Low humidity and higher altitude (6138 ft)
- Soils:
  - Alkaline
  - Low water-holding capacity

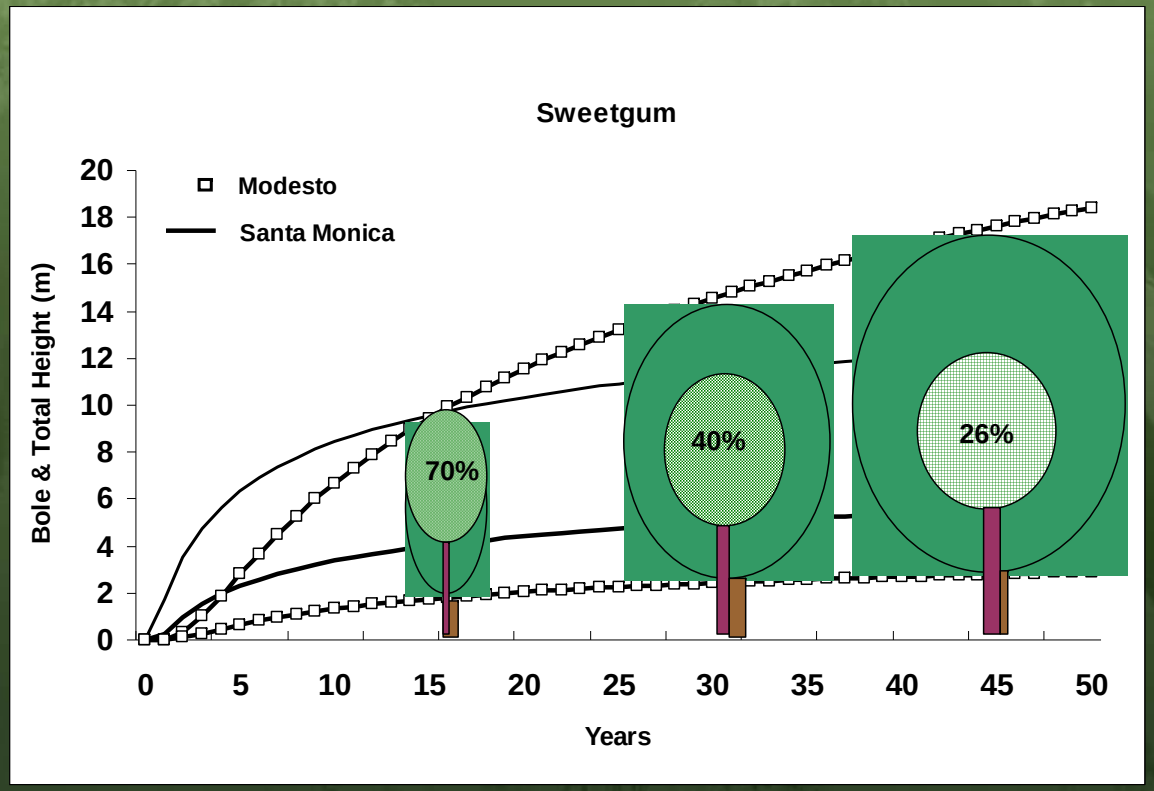
Cheyenne Trees

- Compared to like-aged trees
  - Shorter
  - Smaller dbh
  - Smaller crown diameter
  - Less leaf area

Dust cloud approaches during the 'Dust Bowl'

Municipal Forests: Planning + Tenacity =Benefits

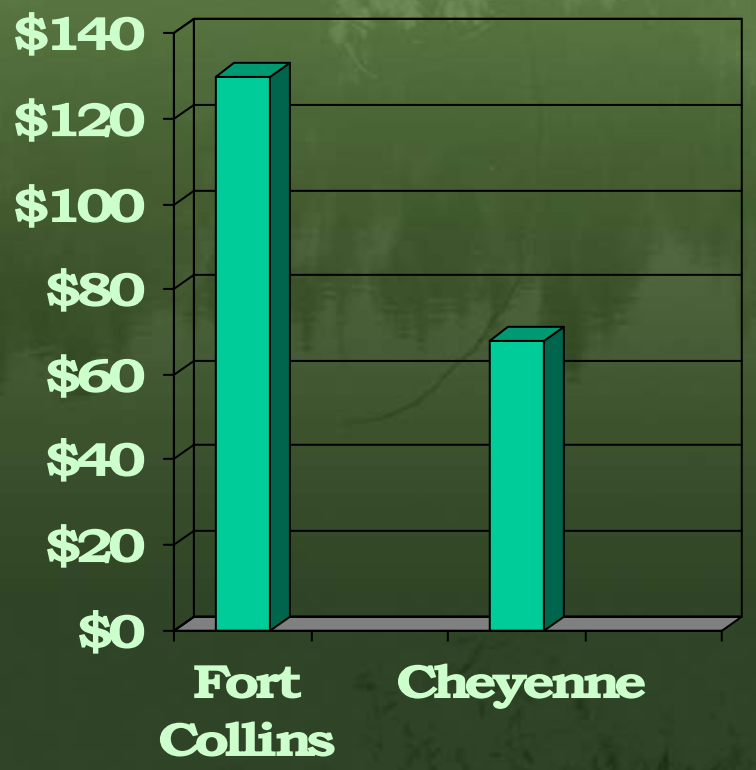
Care Affects Tree Size and Growth

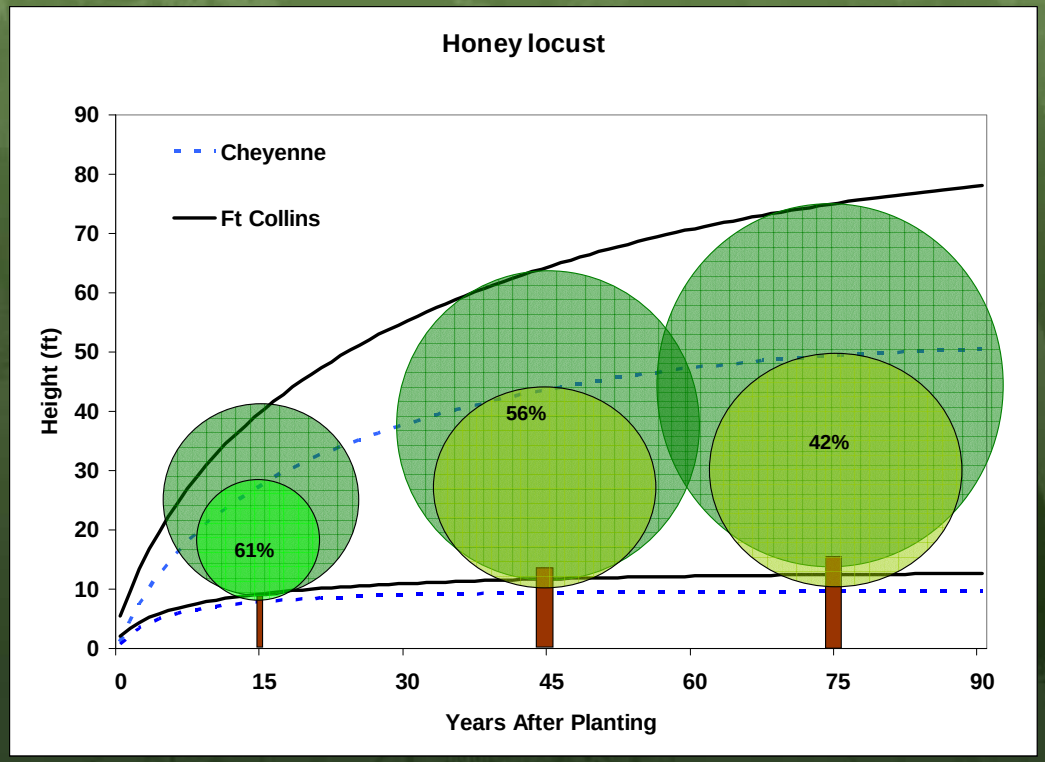


Are your pruning cycles

pruning dollars off of trees?

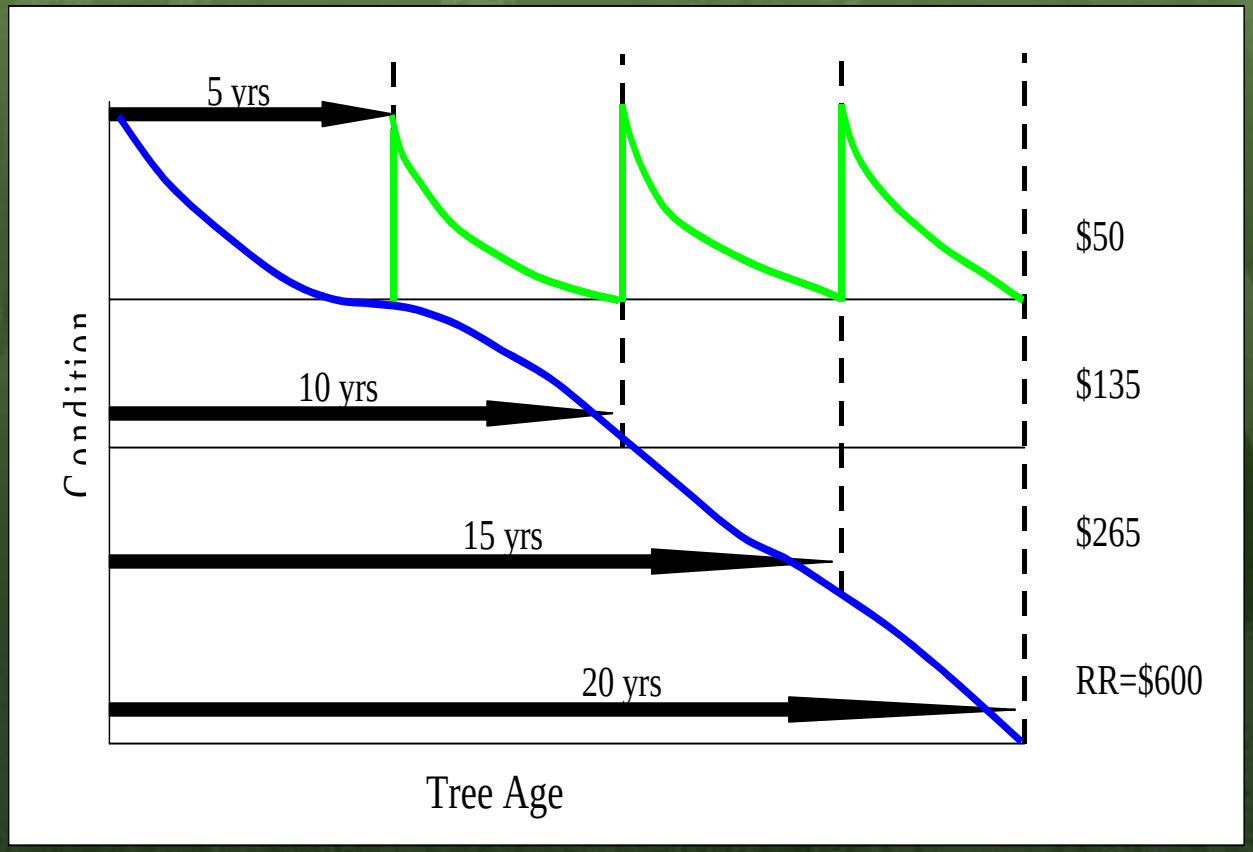
Tree Size and Benefits



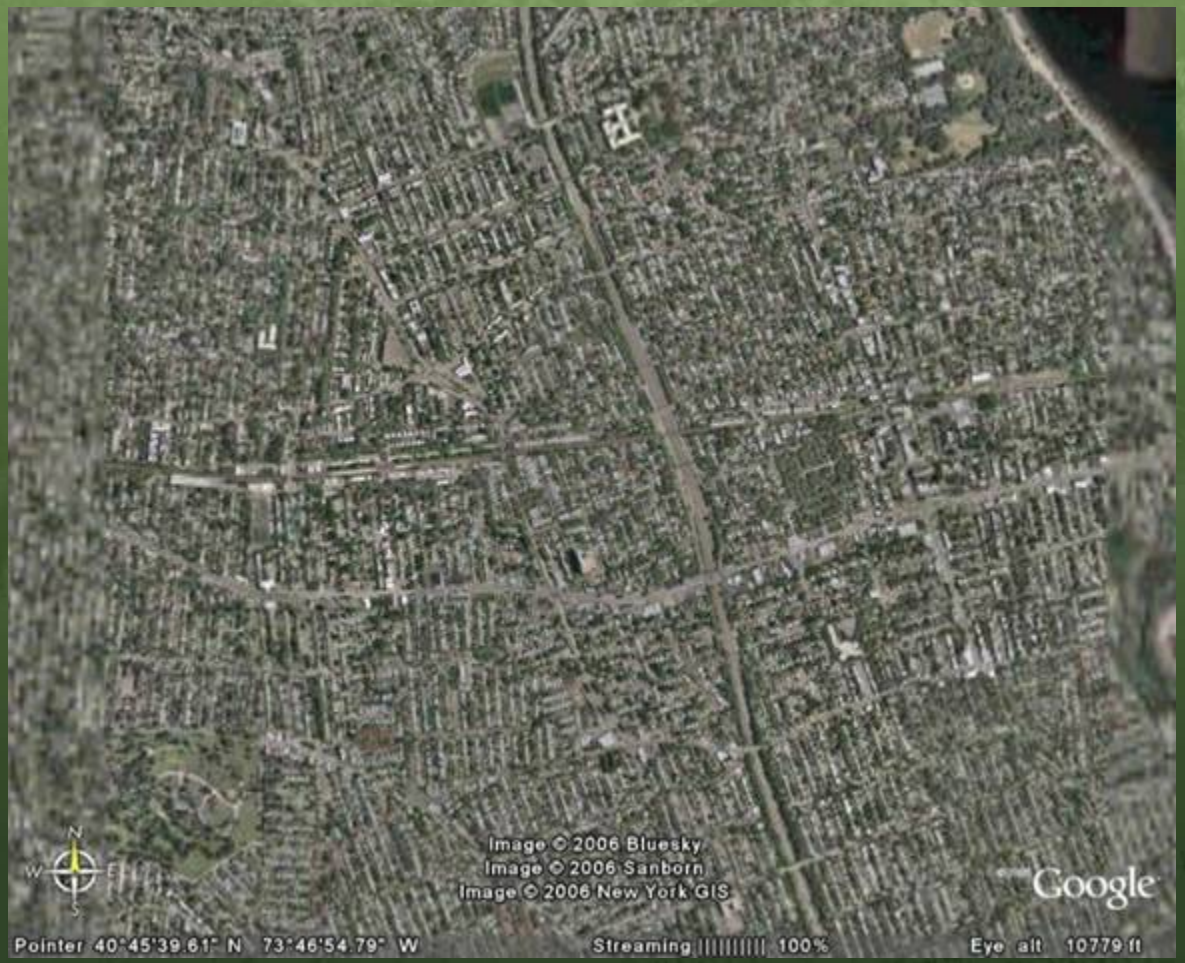


Cost-effective and healthy pruning

- Change in tree condition & function with different levels of management
- Value of investment in preventative maintenance



Planning Green Infrastructure



City expansion → Greater economic services obtainable from trees

Sacramento Valley

REGIONAL MAP

The

GREENPRINT

PURPOSE

To guide cities and counties of the Sacramento Area Council of Governments region in developing urban forest initiatives.

GOALS

- To optimize the benefits of trees throughout our region.
- To create sustainable urban forests.
- To build community-wide appreciation for our urban forests.

ELEMENTS

A successful urban forest program requires attention in three key elements:

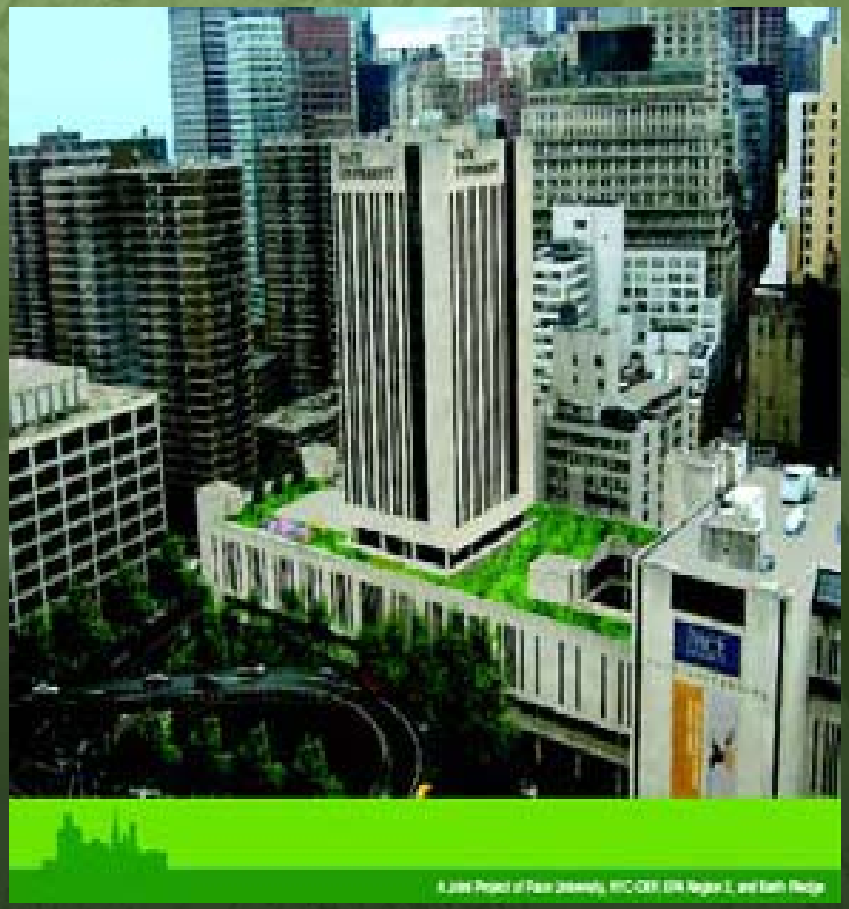
A *Management of Public Trees*

B *Policies and Ordinances*

C *Community Partnerships*

Greenprint Cities

Green Roof Programs



How to Develop a Stormwater Plan With Trees

For further information: US Environmental Protection Agency (EPA)
For information on NPDES Phase II:
http://cfpub.epa.gov/npdes/stormwater/swfinal.cfm

City of Casper, Stormwater Site
We all live downstream...

Reducing Runoff in the Temperate West and NM & Prairie

- White ash, 20 years
  - Intercepted = 993 gal (BOI)

- Green ash, 20 years
  - 1,116 gal (FTC)

Oakland Watershed Restoration & Protection Project

- Measure and model benefits
- Side-by-Side: with and without trees
  - Curbside runoff
  - Soil moisture
- Mature Tree: deciduous and evergreen
  - Interception
  - Pollutant washoff

Los Angeles One Million Trees Initiative Canopy Cover Assessment

- Study Goals
  - Current tree canopy cover
  - Number and type of potential tree planting sites
  - Value of ecosystem services for 40 yrs
- Final Products
  - Report (results by city and council district)
  - GIS database

Dash to Plant

If you plan to plant trees for increased canopy…

…plan to manage and care for the trees.

Planning tools for manager, foresters, designers, landscape architects

i-Tree

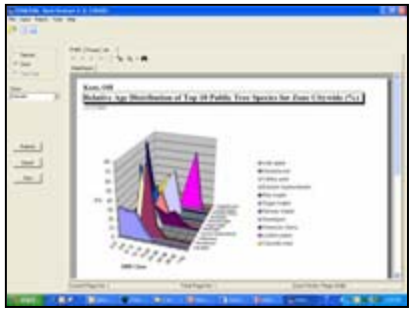
USDA Forest Service
Center for Urban Forest Research
Davis, CA

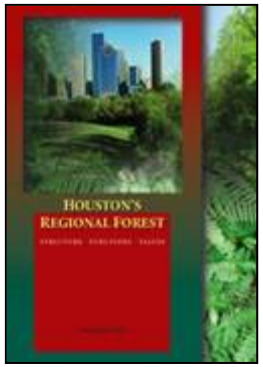
Public/Private Partnership

- USDA Forest Service
  - ✓Research and Development
  - ✓State and Private Forestry
- Davey Tree Expert Co.
- National Arbor Day Foundation
- Society of Municipal Arborists

What's Included?

- Two urban forest assessment tools:
  - ✓Assessing street tree populations
  - ✓Assessing urban ecosystems
- Multiple Utilities:
  - ✓Data collection & transfer
  - ✓Inventory management
  - ✓Storm damage assessment





How is i-Tree Different?

- Public domain software = free
- Information on structure, function, value & management needs
- Scaled analyses: Tree→Neighborhood→Community
- Results provided at species & tree level
- Local field inventory data required!
- Free technical support

Assessing Urban Ecosystems

- **UFORE** assesses:
  - ✓ Structure
  - ✓ Function
    - Energy
    - Air pollution
    - Carbon
  - ✓ Value
  - ✓ Management
    - Health
    - Pest impacts

Assessing Street Tree Populations

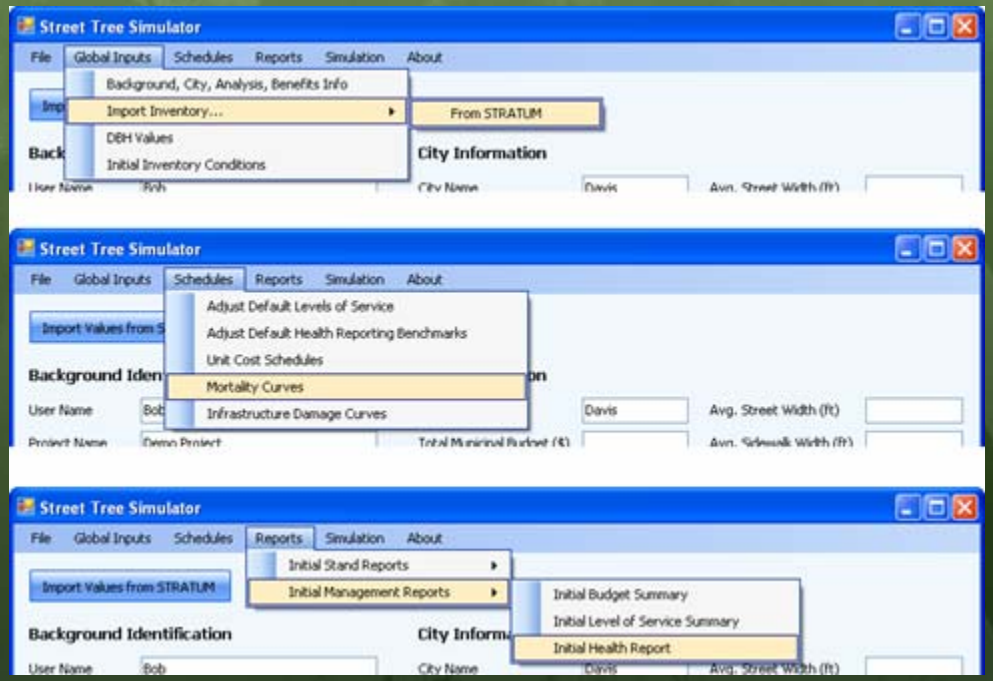
STRATUM assesses:

- ✓ Structure
- ✓ Function
  - Energy
  - Air pollution
  - Stormwater
  - Carbon
  - Property Value
- ✓ Value
- ✓ Management needs

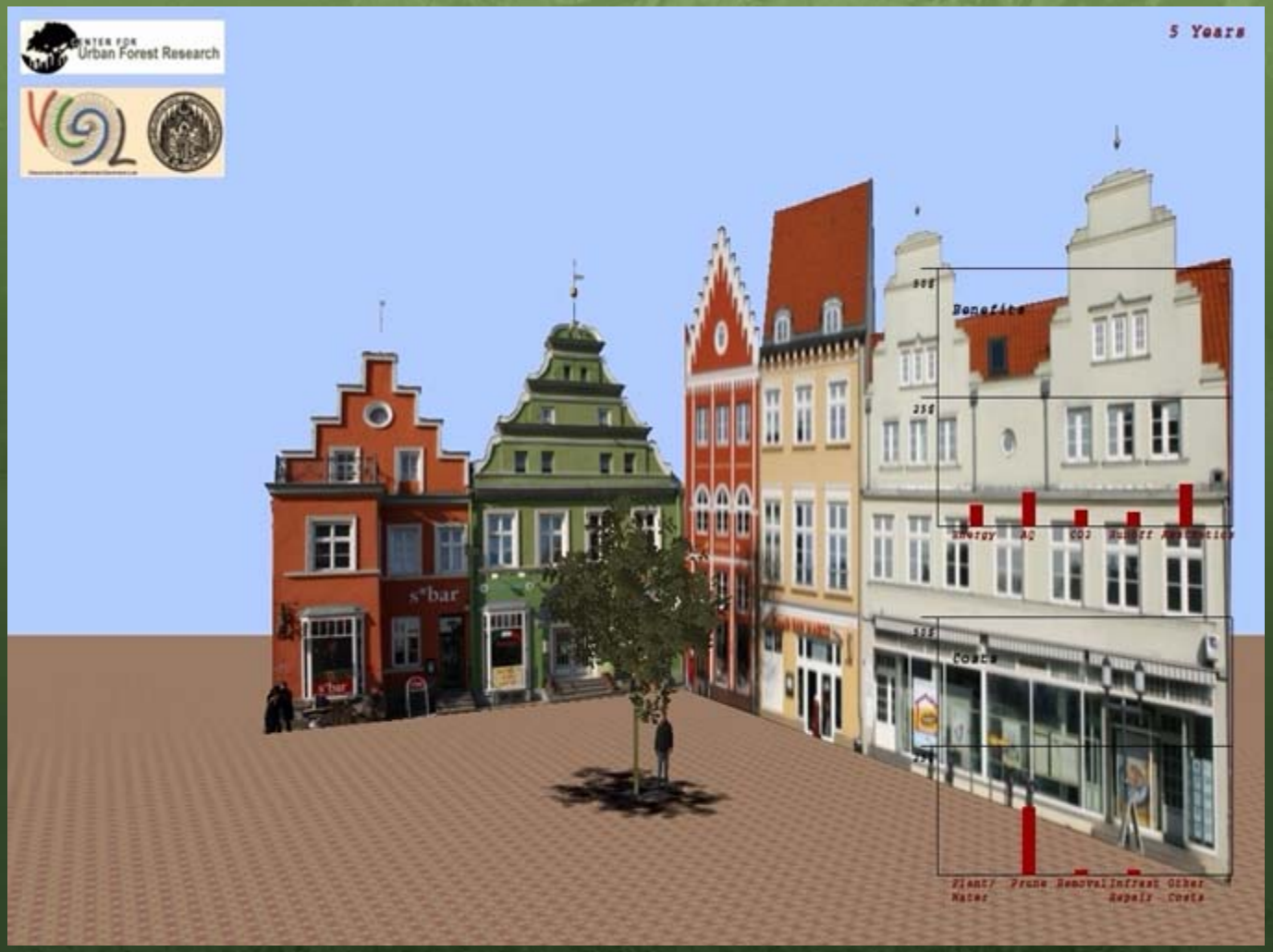
	Total ($)	$/capita	$/tree
Benefit	501,064	11.31	93.64
Cost	94,000	2.12	17.57
Net Benefits	407,064	9.19	76.07
Benefit-Cost Ratio	5.33	5.33	5.33

Street Tree Simulator

- Stream of future benefits
- Level of service analysis
- Adjustments for mortality, infrastructure damage, etc. by species and city



Tree Visualization



Key elements for profitable municipal & urban forests

- Inventory
  - Trees
  - Assessment of available space
- Planting and young tree program
  - Maximize space, large trees, diversity
- Maintenance – levels of service
  - Care for large and old tree population
- Sustainability
- Work across departments
  - Educate one another regarding issues, costs, benefits over time

Visit our Websites

Center for Urban Forest Research

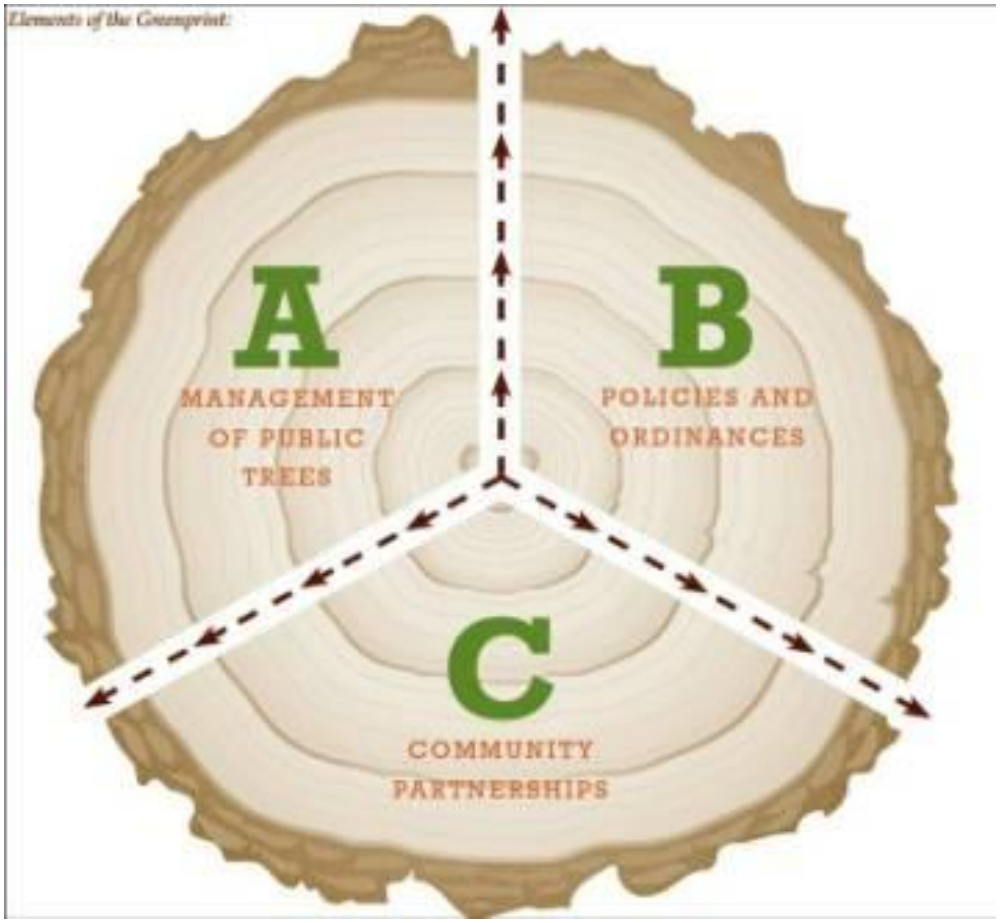
http://www.fs.fed.us/psw/programs/cufr/

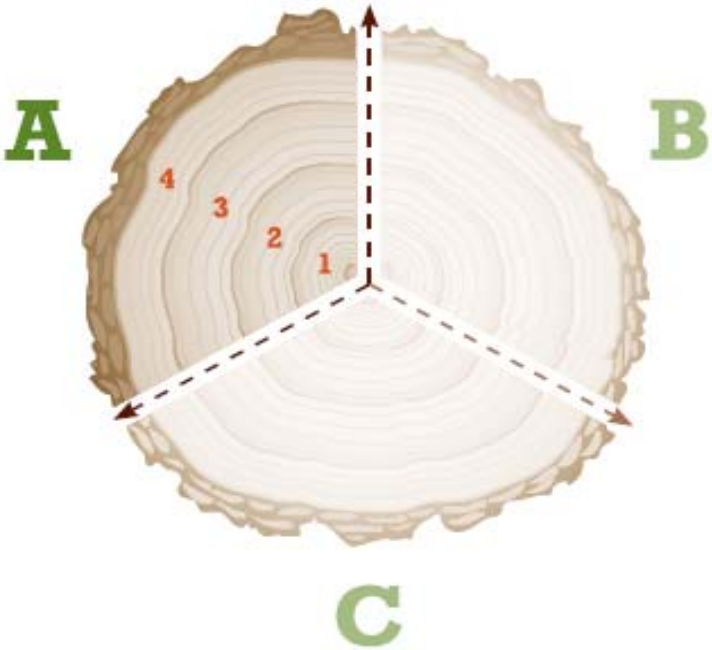
i-Tree STRATUM

http://www.itreetools.org/

ppeper@fs.fed.us

The Campaign





ELEMENT A: *Management of*

PUBLIC TREES

GROWTH RING 1

- Maintain public trees on an emergency basis
- Become a Greenprint participant

GROWTH RING 2

- Assign a liaison to the Greenprint Clearinghouse
- Conduct an urban forest value assessment[7]
- Convene interdepartmental urban forest stakeholder working group
- Develop stage 1 of urban reforestation program components[8]

GROWTH RING 3

- Develop stage 2 of urban reforestation program components[9]
- Adopt an urban forest master plan
- Adopt staff education and certification guidelines

GROWTH RING 4

- Form an urban forest department/hire an urban forest coordinator
- Conduct biannual urban forest department evaluations
- Publish a state of the urban forest report on 5-year intervals