

PLANTING THE SEEDS OF SUCCESS.



Benefit-Based Tree Appraisal

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USDA Forest Service, PSW Research Station
Midwest Chapter ISA Annual Conference



Center for Urban Forest Research

Today

- Tree valuation
- Yard tree comparison
- Street trees example
- Tree Effects Calculator
- Other Research & Tools

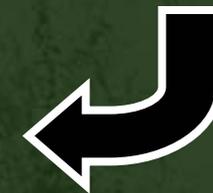


Tree Valuation Approaches

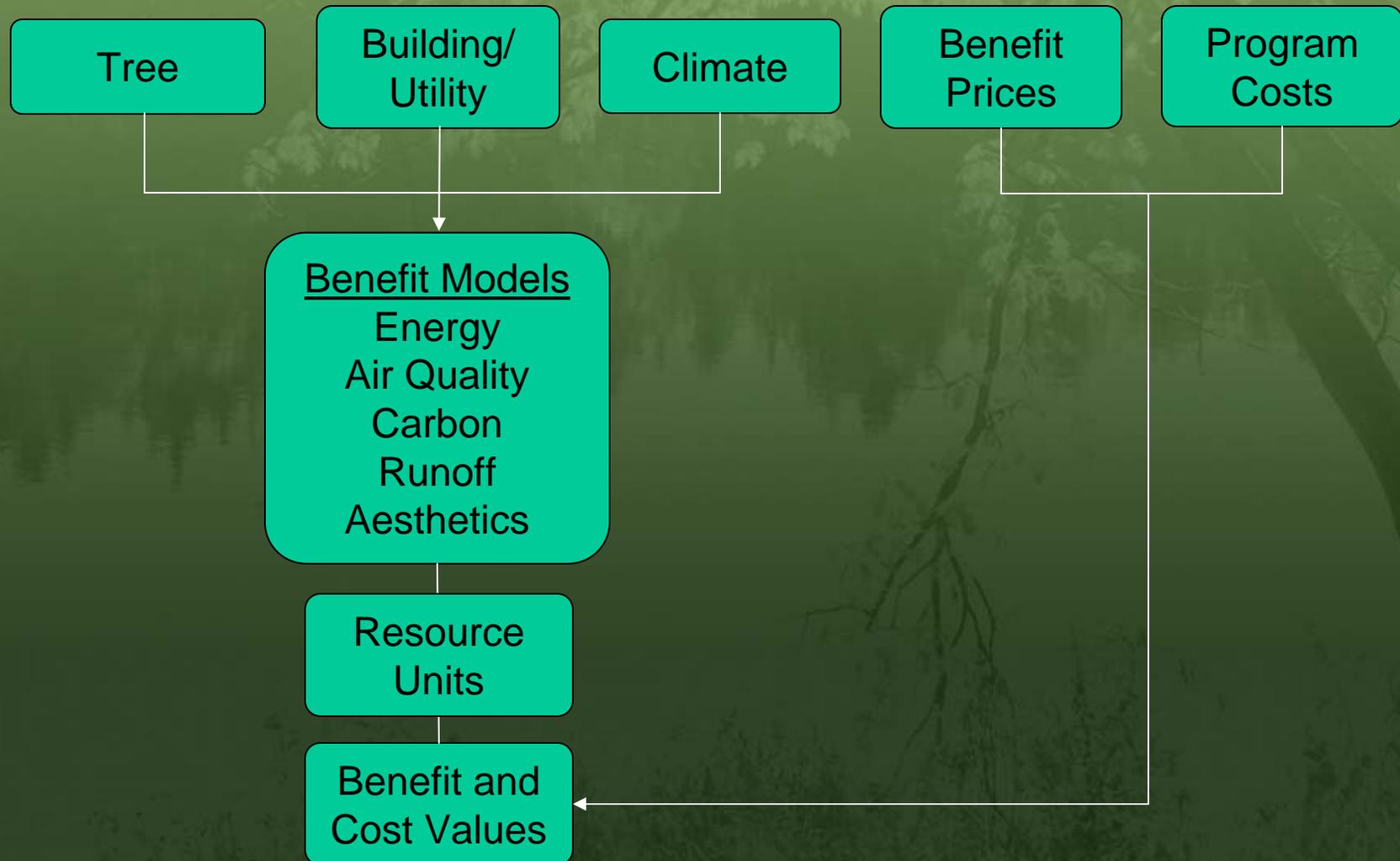
- Cost Value
- Income Value
- Market Value



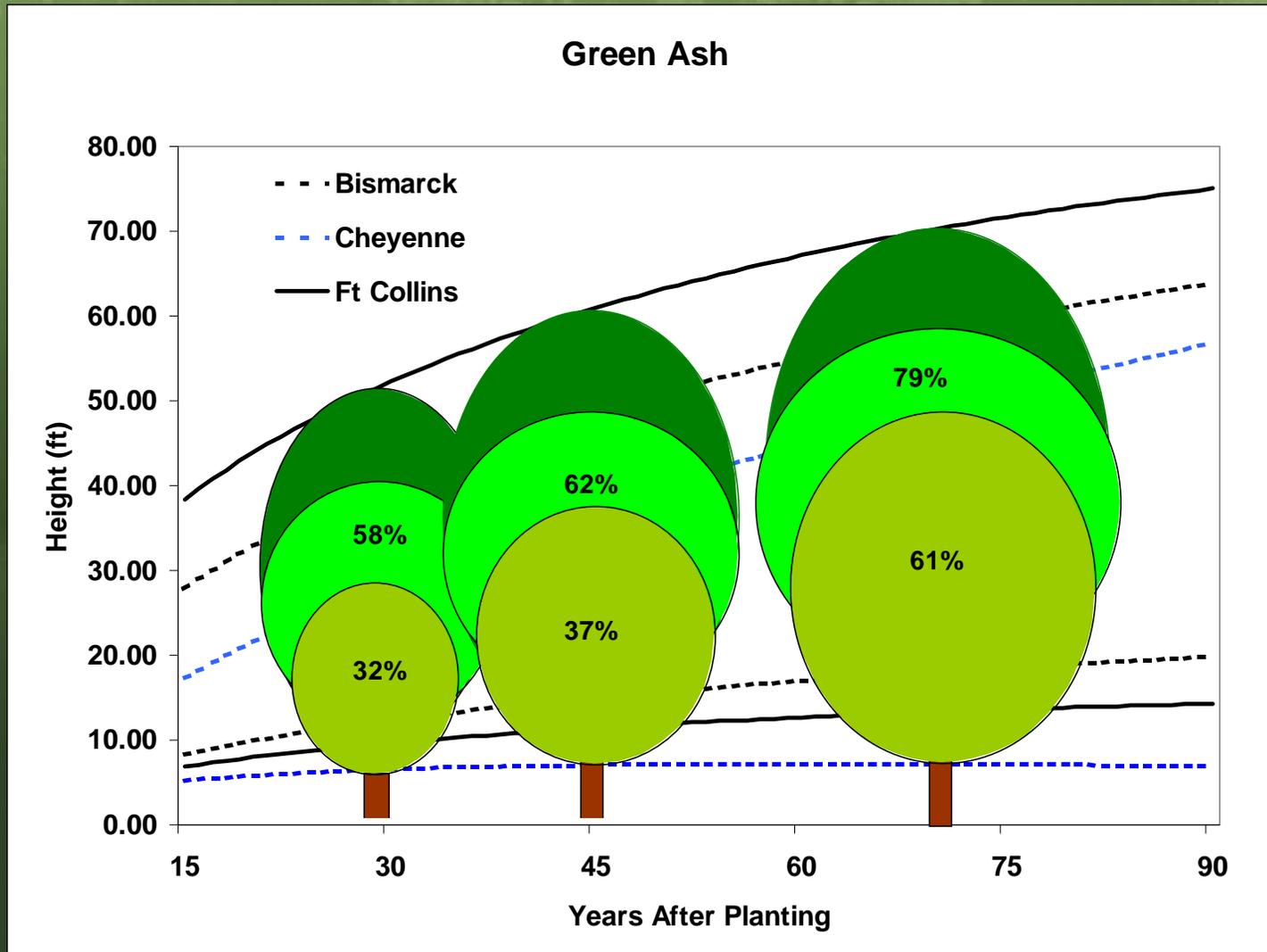
Benefit-Based Approach



Benefit-Cost Modeling



Fraxinus pennsylvanica





Bismarck



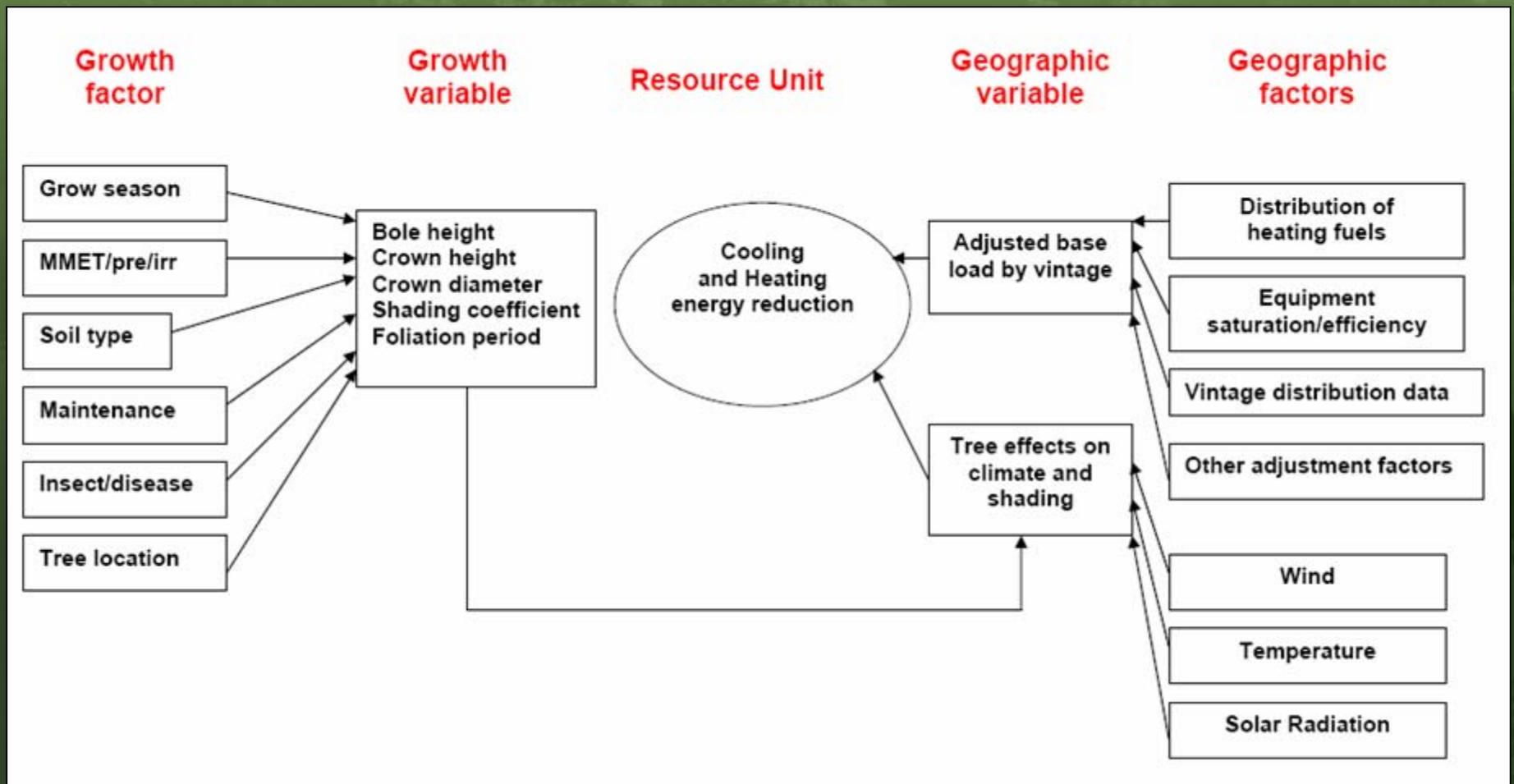
Fort Collins



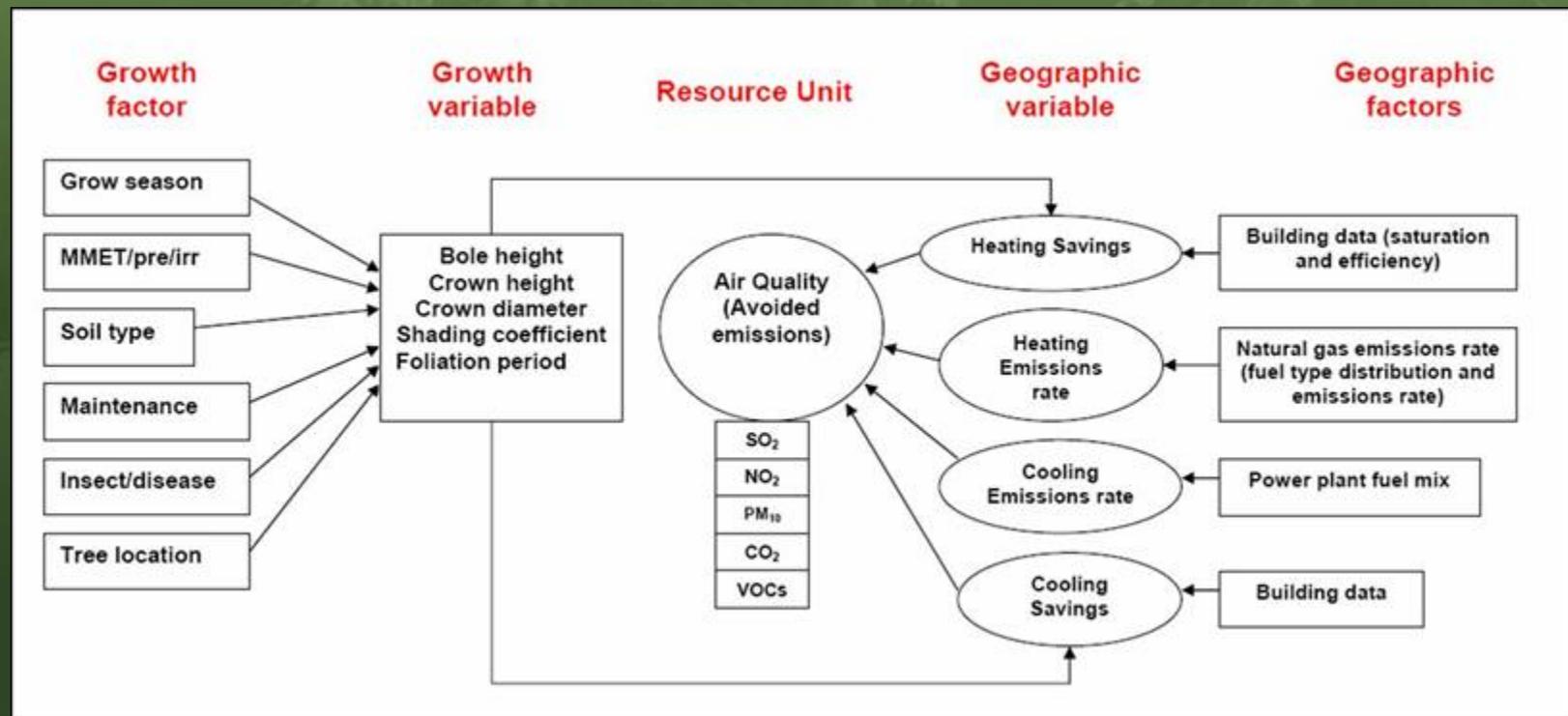
Cheyenne

30 year old
green ash

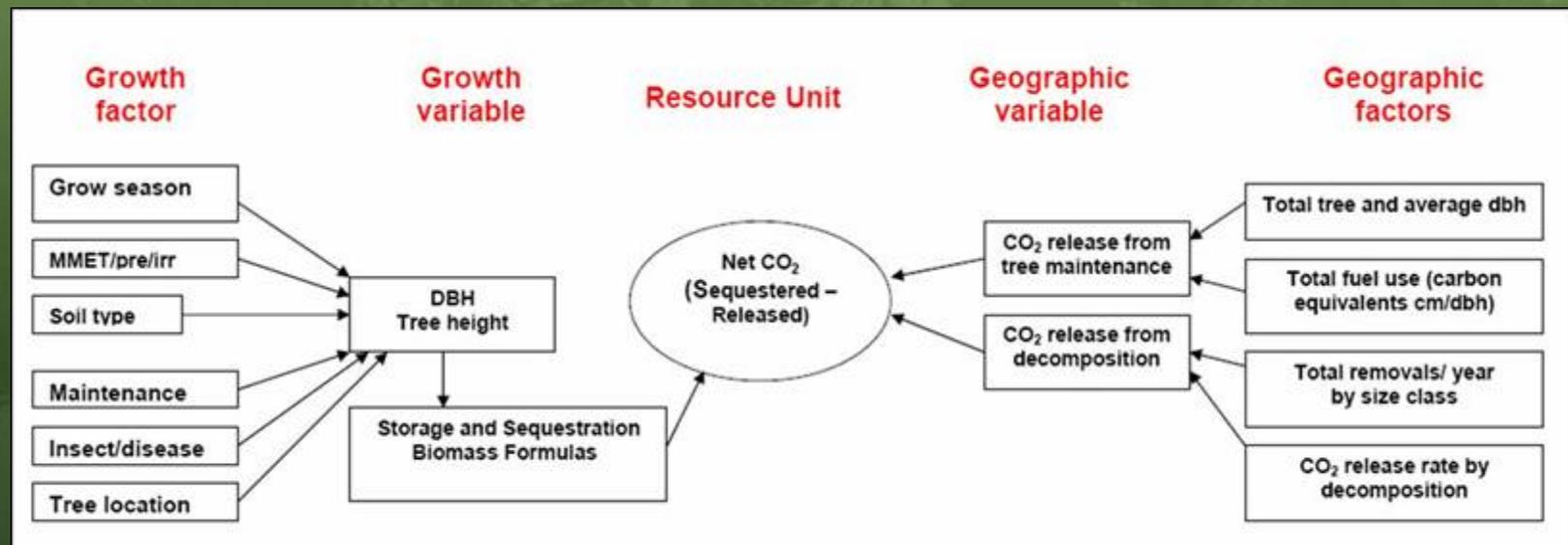
Cooling and Heating Energy Savings



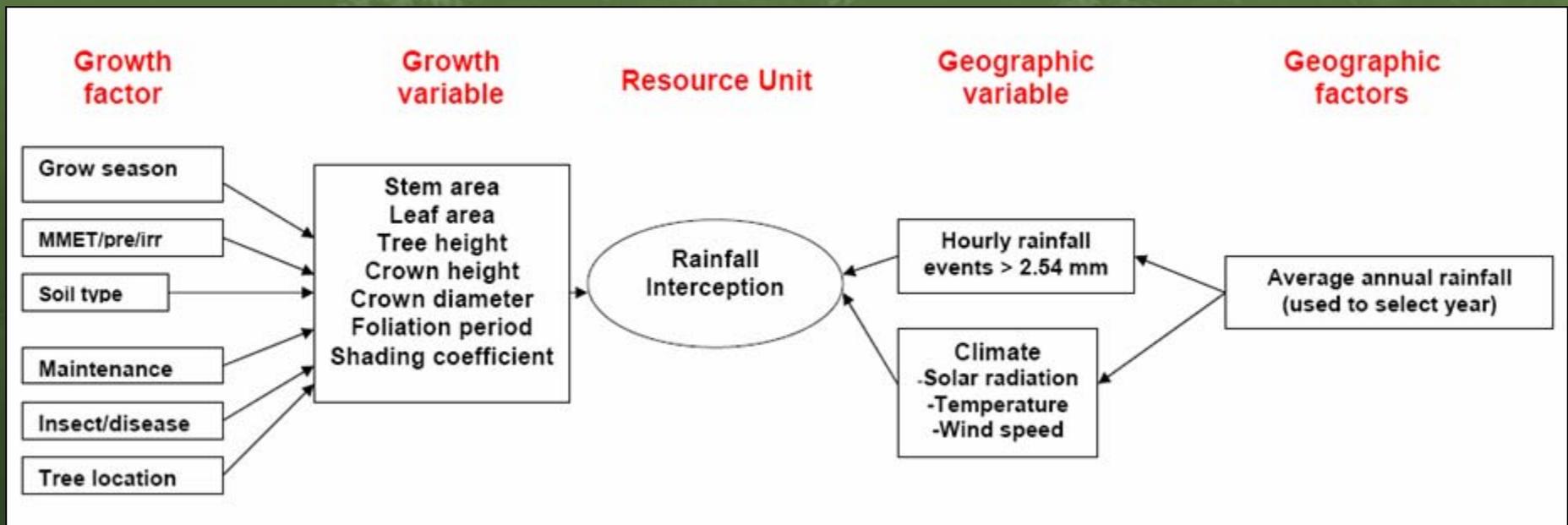
Avoided Emissions



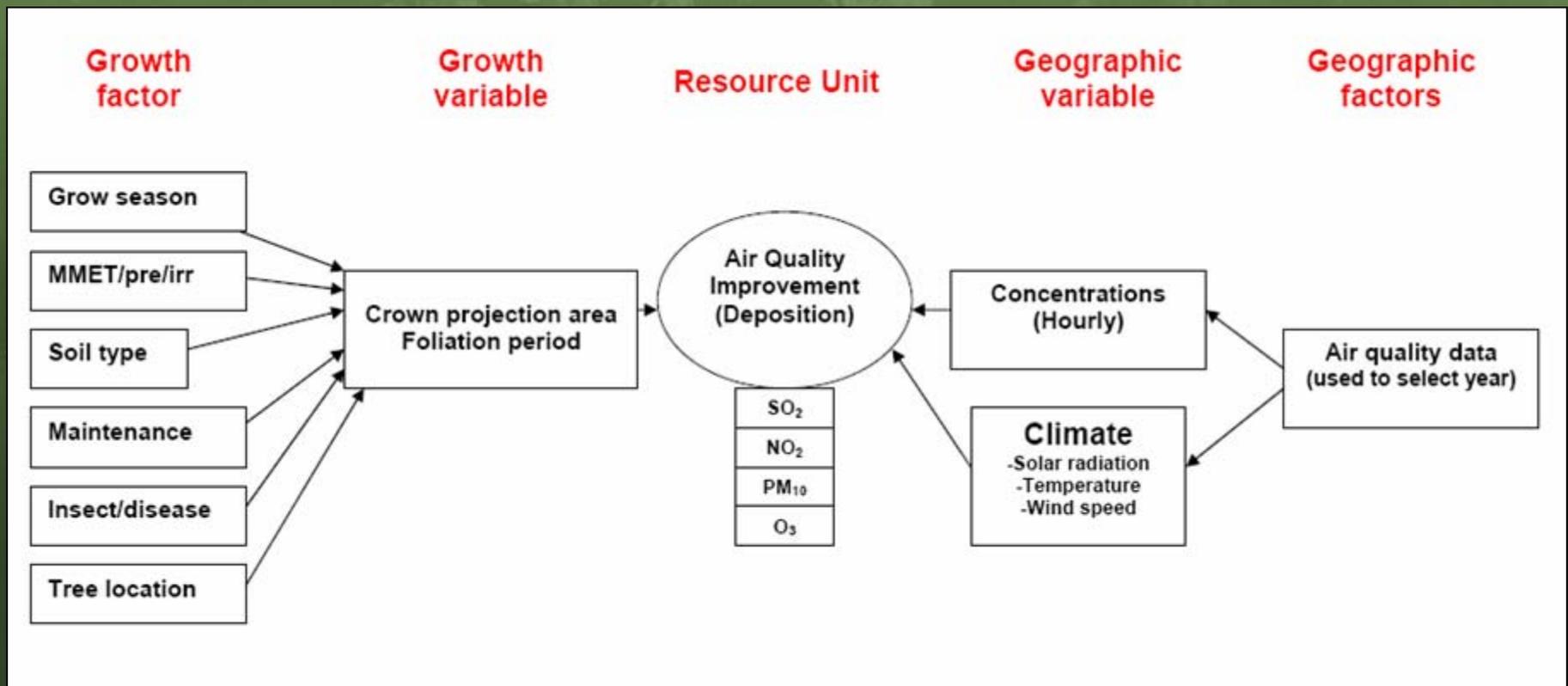
Carbon Dioxide



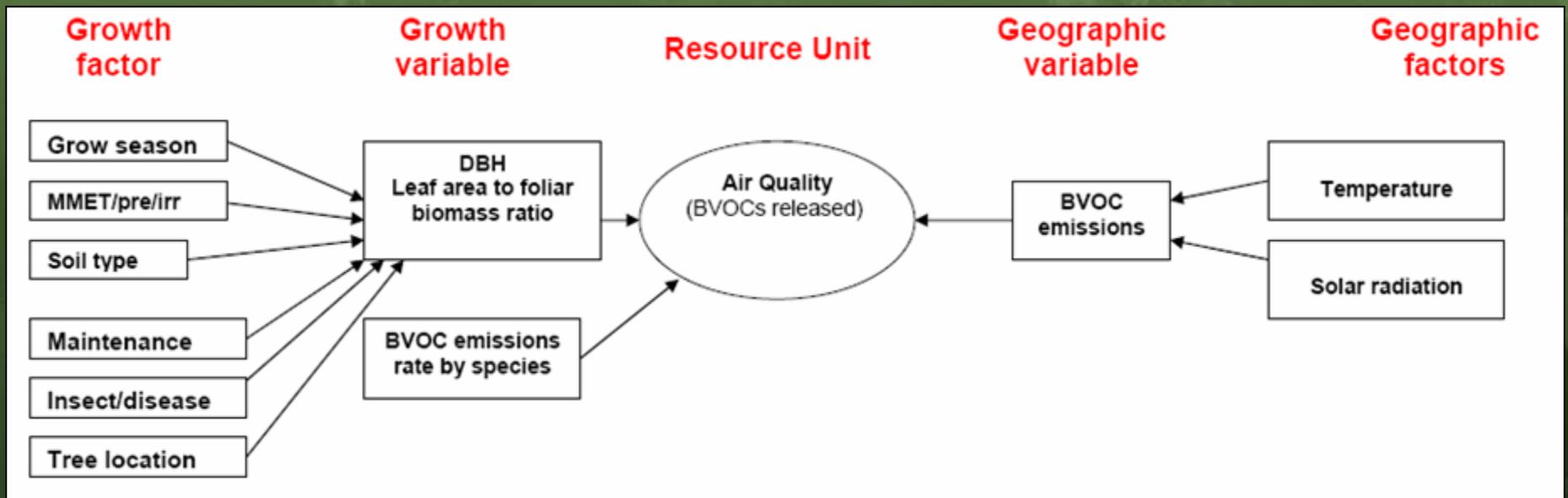
Rainfall Interception



Air Pollutant Uptake



Biogenic Volatile Organic Compounds Release

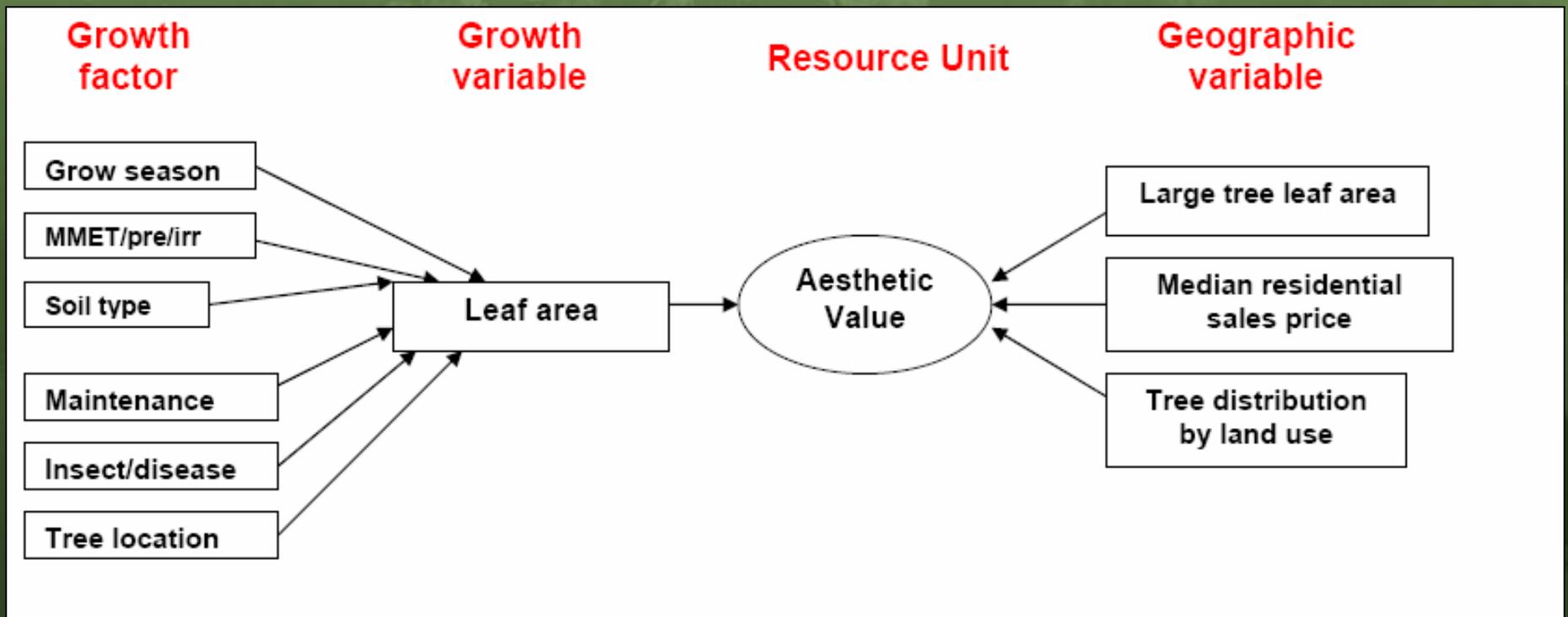


Aesthetic and Other Benefits

- 844 home sales, Athens, GA
- Large front yard tree adds 0.9%
- $A = L \times ((T \times C) / M)$
 - L = Leaf area increase
 - T = Sales price increase by large tree = (0.9% x median home sales price)
 - C = Location reduction
 - M = Large tree leaf area



Aesthetic and Other Benefits



Yard Tree Comparison

- Green ash, Fort Collins
- Front yard, west side
- 40 years
 - Cost Approach (Replacement value)
 - Income Approach
 - Cumulative annual benefits (Ft Collins)
 - Cumulative annual benefits (Boulder)

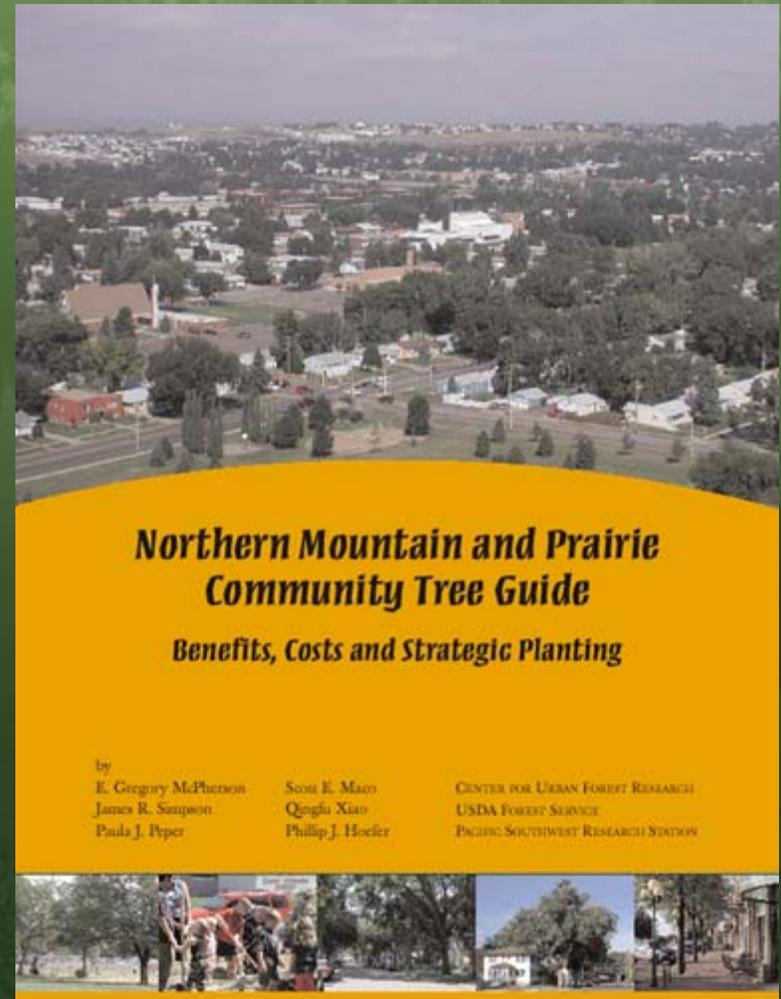
Yard Tree Comparison

- Value = Basic Value x
Cond x Loc
Basic Value = Replacement
Cost + (Basic Price x [TAa -
TAr] x Species)
- Replacement Cost = \$671
- Basic Price = \$49/sq inch
- Species = 60%
- Condition = 70%
- Location = 70%



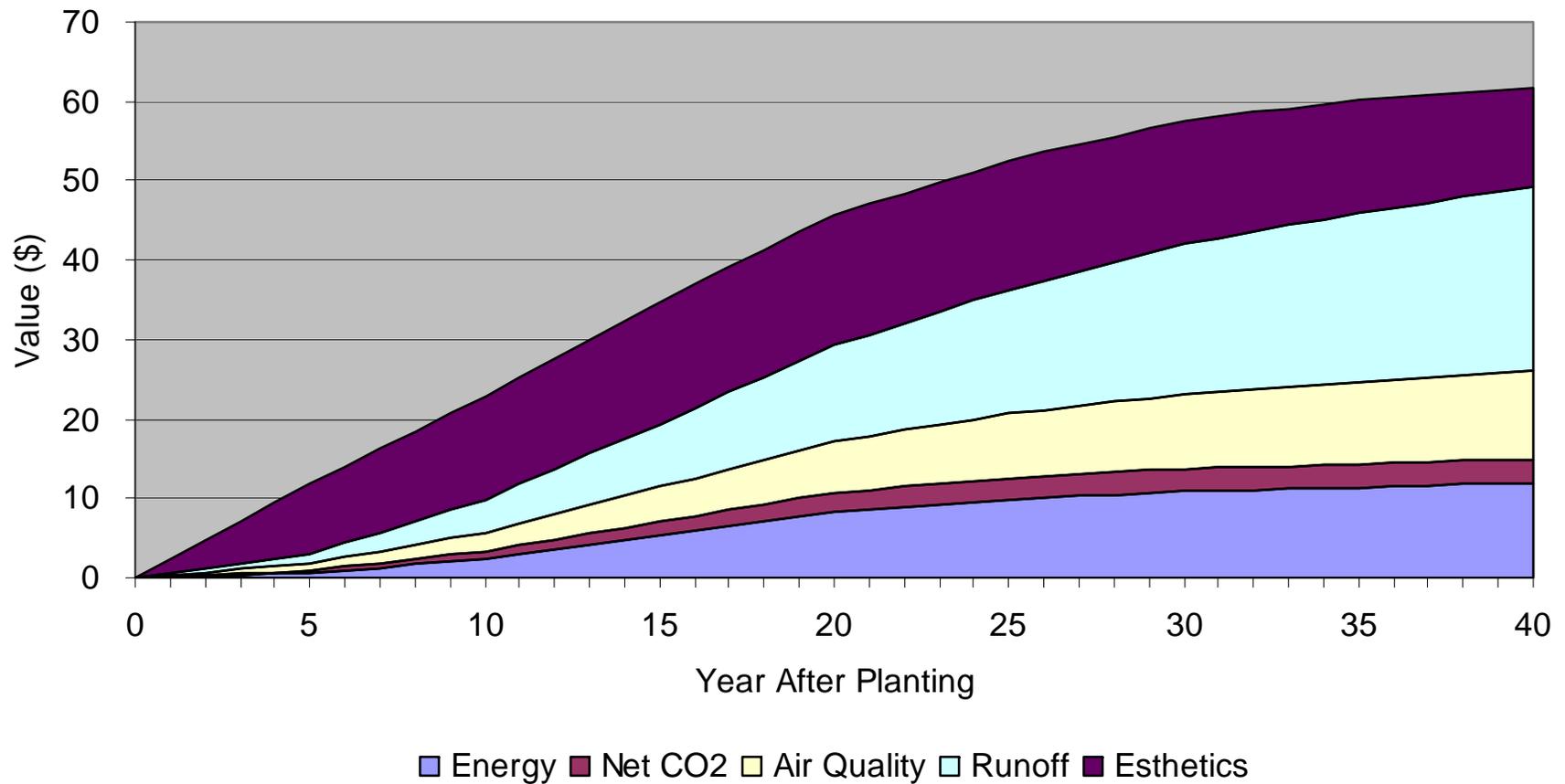
Benefit Valuation

- Energy prices
 - Electricity (\$0.78/kWh)
 - Natural gas (\$0.0072/kBtu)
- CO₂ reduction
 - \$15/ton - CO2e.com
- Pollutant uptake
 - Control costs (Wang and Santini 1995)
 - NO₂ & O₃ = \$3.07/lb
 - SO₂ = \$7.13/lb
 - PM₁₀ = \$5.13/lb
 - VOC = \$4.85/lb
- Rainfall interception
 - Control costs based on construction and operation costs of detention/retention basin in Fort Collins (\$0.01/gal)
- Aesthetic and Other
 - Median residential sales price
 - Ft Collins = \$212,000
 - Boulder = \$413,000

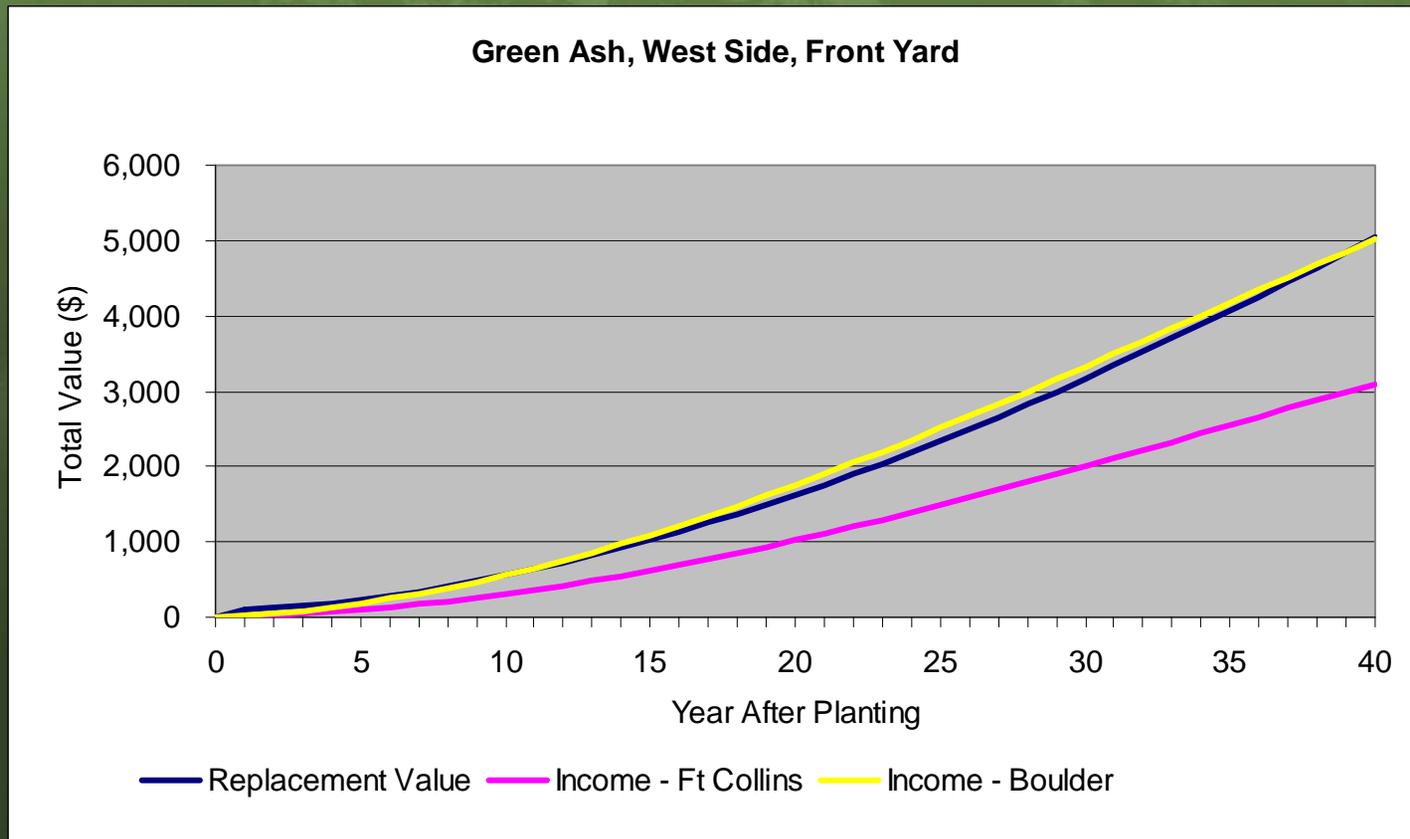


Yard Tree Comparison

Green Ash, West Side, Yard, Ft. Collins, CO



Yard Tree Comparison



Yard Tree Comparison Summary

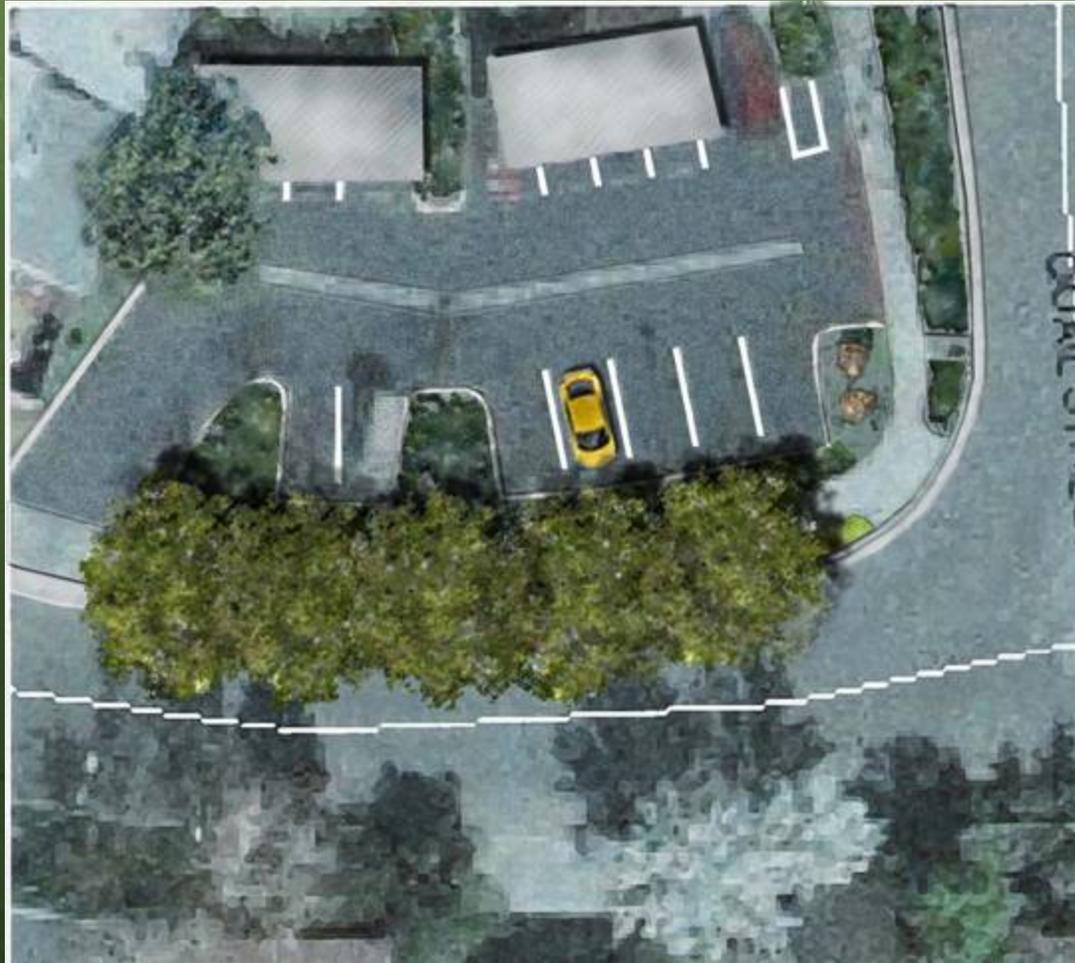
- Replacement Value exceeds Income
 - Costs not included
- Income Value
 - Relative importance of each benefit
 - Very sensitive to property values
 - Sensitive to place
 - Tree condition not included



Street Trees Example

- 5 Pistache planted 15 years ago
- Compare Current Value
 - Replacement value
 - Net present value of benefits for next 25 years
 - Discount rates: 4%, 7%, 10%
- Retain or remove and replace?
 - Remove Pistache and replace with Planes
- Amount saved from optimal planting?

Example in Davis, CA

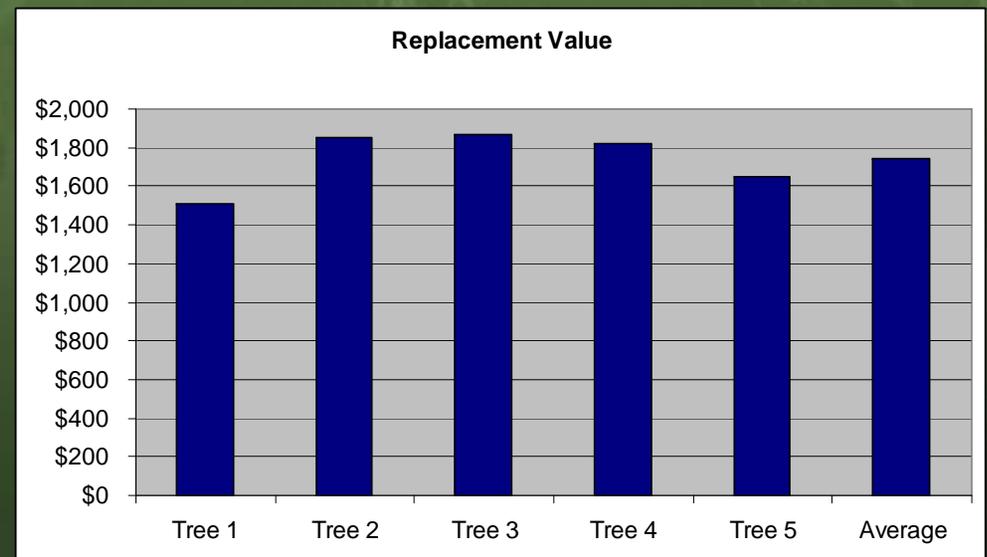


Current Situation



Compare Current Value

- Trunk formula
 - Avg dbh = 9"
 - Avg condition = 57%
 - Avg location = 67%
 - Site = 80%
 - Contribution = 70%
 - Placement = 50%
 - Species rating = 90%
 - Basic price = \$56.50/sq inch
- Replacement Value
 - \$1,751 avg/tree
 - (\$1,451 to \$1,913)



Background

- Modesto tree growth & benefit data for Pistache & Plane
- Davis tree care costs and sidewalk repair schedule

Activity	Unit Cost	\$/tree
Plant pistache		75
Plant plane (adds \$50 for site prep of shrub bed)		125
Prune small tree (4-yr cycle)		36
Prune 6-12" dbh (8-yr cycle)		113
Prune 12-18" dbh (8-yr cycle)		163
Prune 18-24" dbh (8-yr cycle)		225
Remove pistache 6-12" dbh (at 15 years)		150
Remove pistache 12-18" dbh (at 40 years)		250
Grind sidewalk (5 squares, at yrs 10, 15, 30, & 35)	\$20/4-ft square	20
Root prune (at years 20, 25, and 40)		30
Remove & replace sidewalk (at yrs 20 and 40)	12/sq ft, 3 sq/tree (48 sq ft)	576
Remove & replace curb/gutter (at yrs 25 and 40)	\$50/linear ft, 12 ft/tree	600

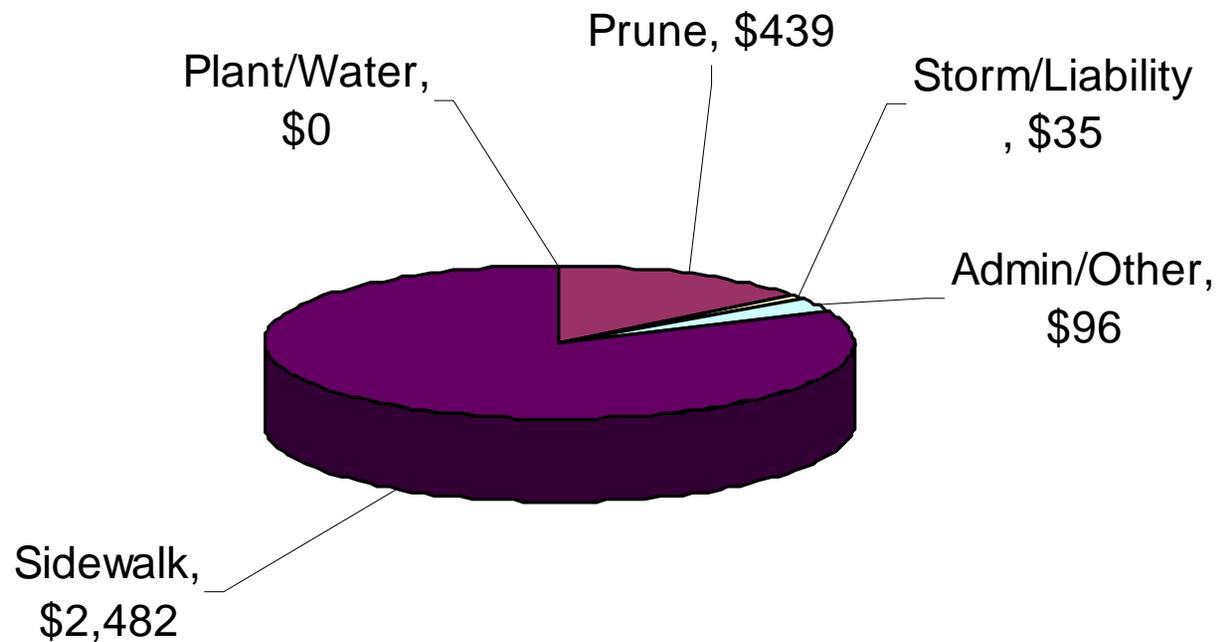
Davis Benefit Valuation

- Energy prices
 - Electricity (\$0.116/kWh)
 - Natural gas (\$0.0064/kBtu)
- CO₂ reduction
 - \$30/ton
- Pollutant uptake
 - Emission reduction credits
 - NO₂ & O₃ = \$3.85/lb
 - PM₁₀ = \$4.47/lb
 - VOC = \$1.51/lb
- Rainfall interception
 - Annualized capital cost and operations and maintenance (\$0.0017/gal)
- Aesthetic and Other
 - Median residential sales price
 - \$273,518 in 1999-2000



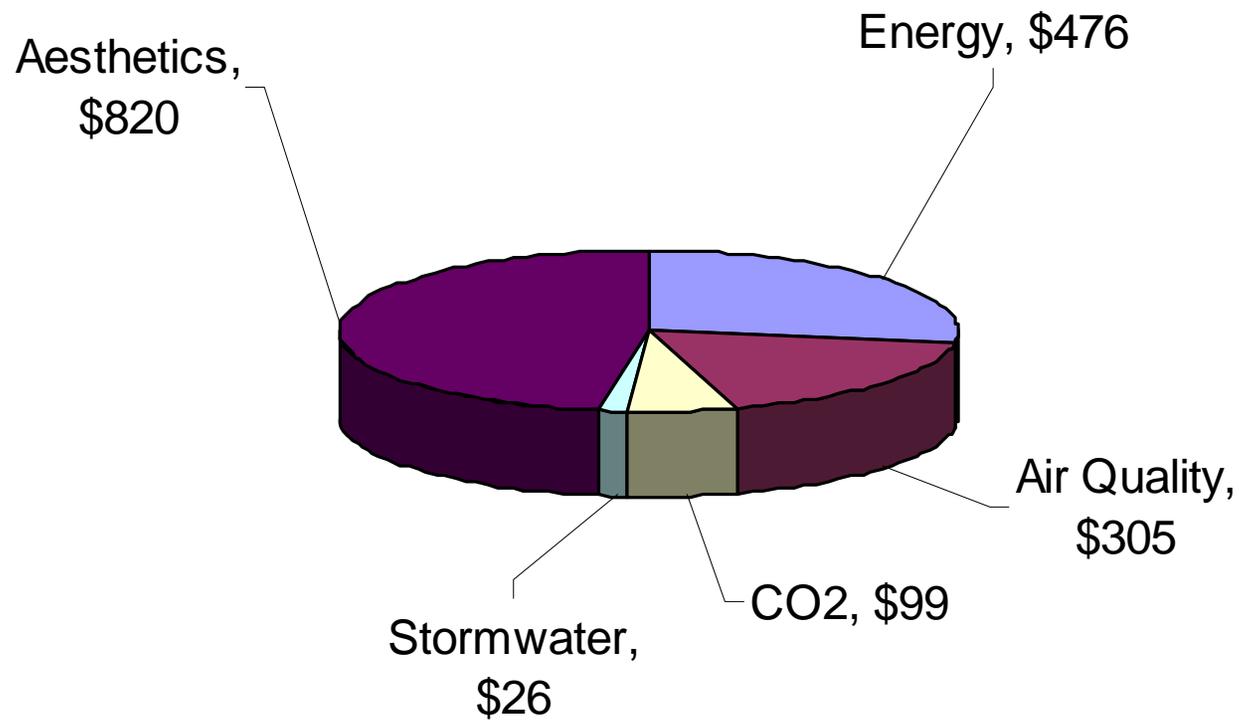
Compare Current Value - Costs

Expenditure per Pistache = \$3,052 (Years 16-40)



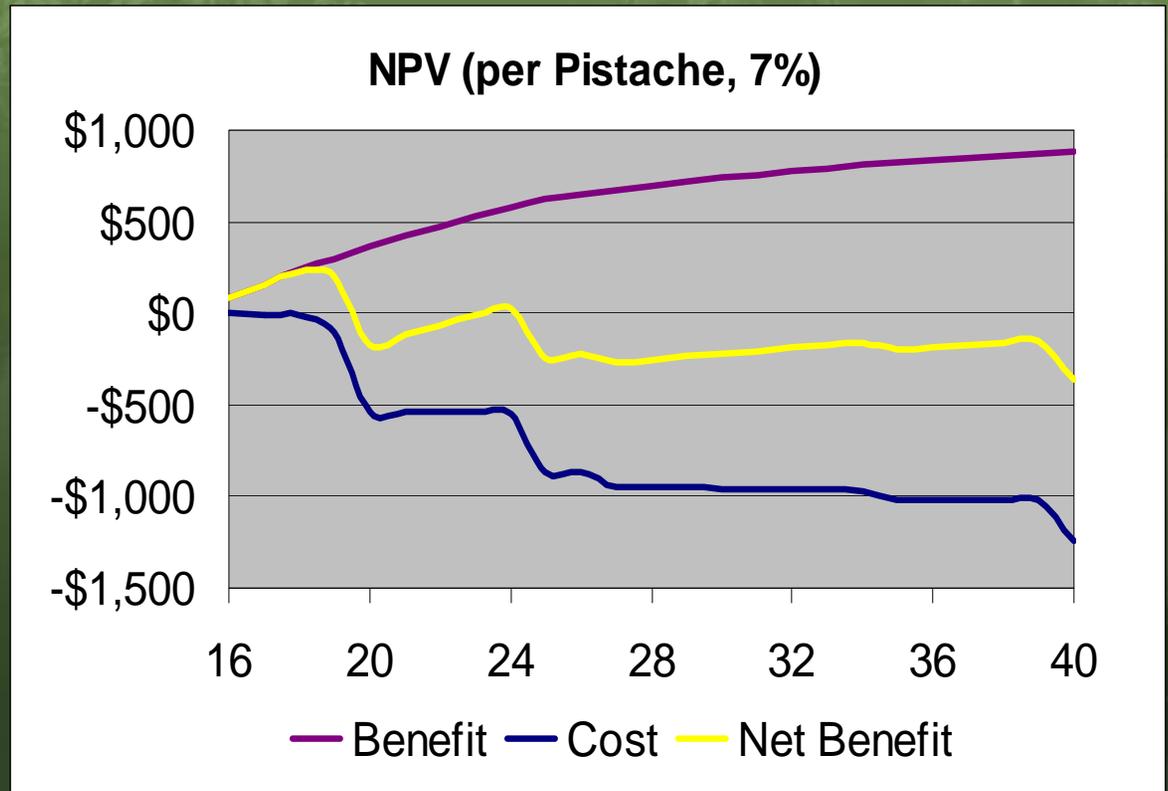
Compare Current Value - Benefits

Benefit per Pistache = \$1,726 (Years 16-40)



Compare Current Value

- NPV Yr 16-40
 - 0% = \$-1,296
 - 4% = \$-608
 - 7% = \$-363
 - 10% = \$-226
- Replacement Value
 - \$1,751

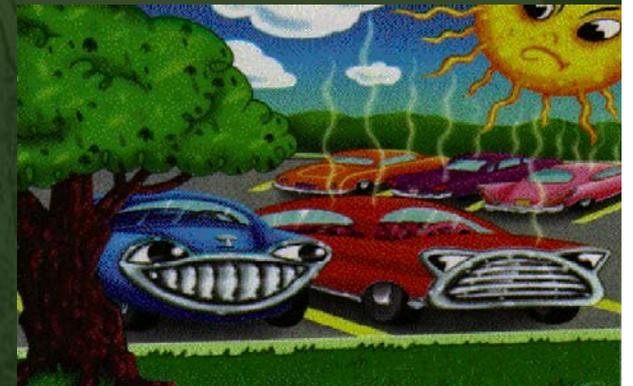


Replant With Plane in Shrub Bed

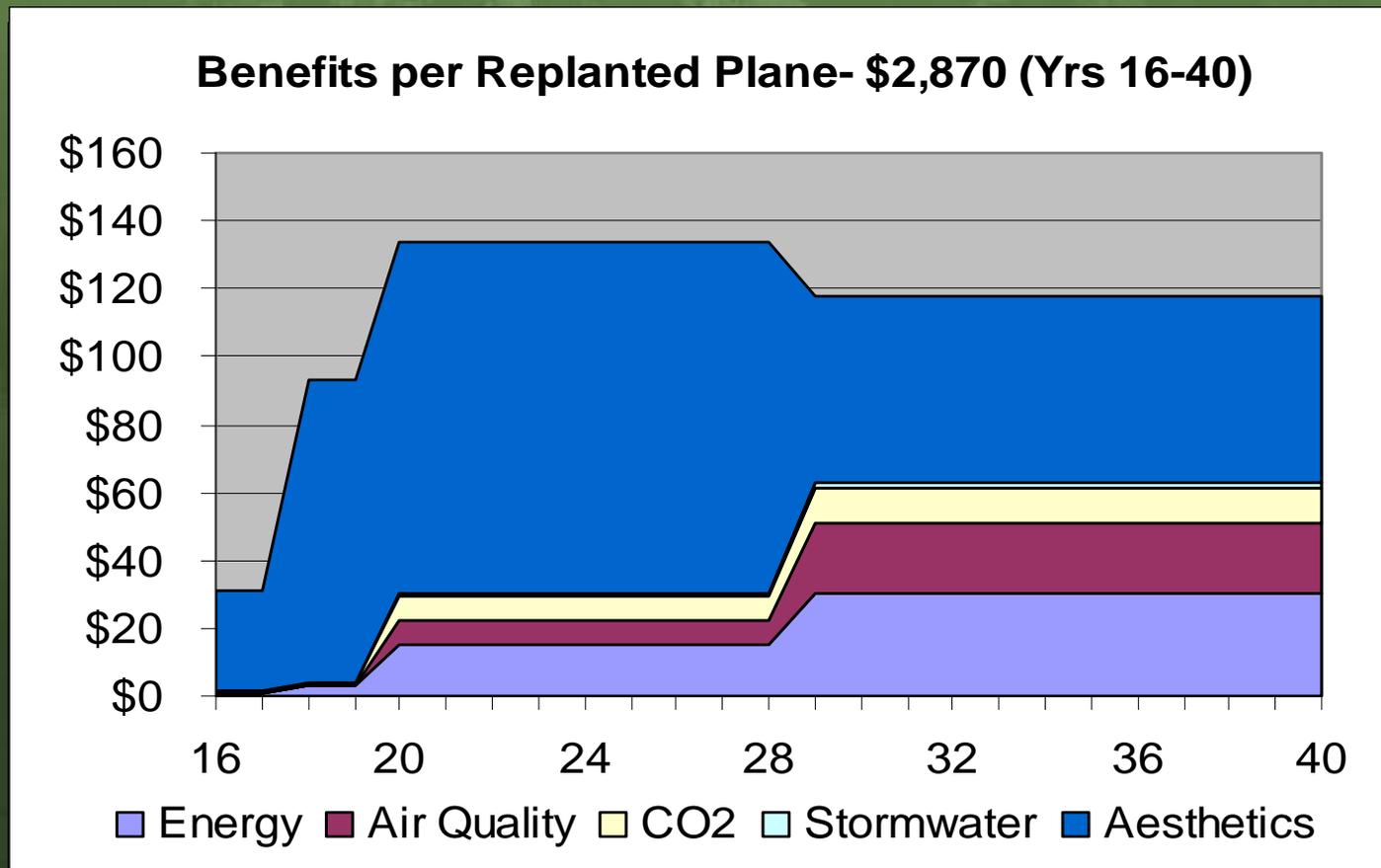


Cost-Effective to Remove and Replace Pistache?

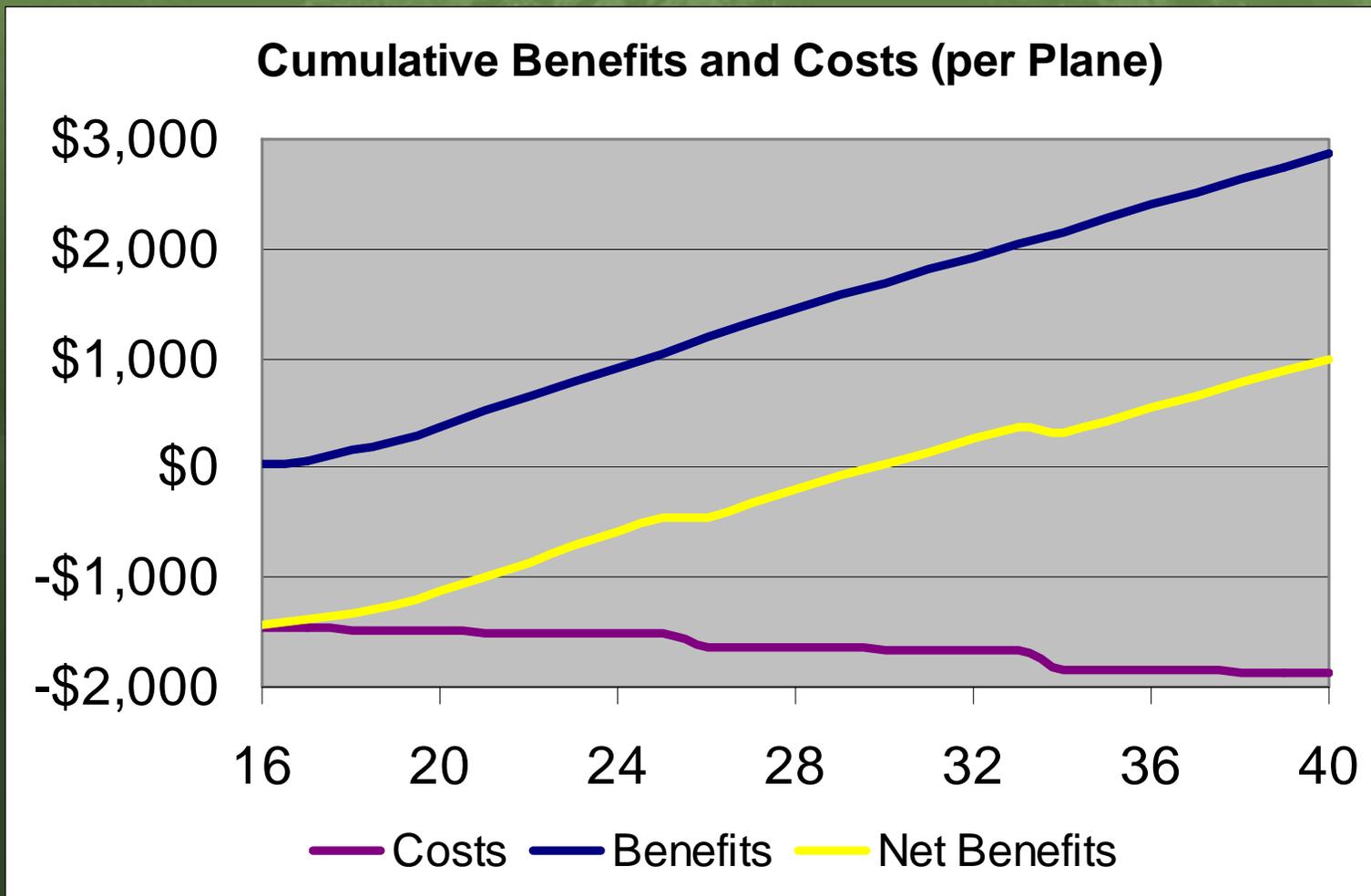
- Removal and replacement costs
 - \$150 remove, \$125 plant = \$275/tree
 - Remove & replace sidewalk/curb & gutter = \$1,176/tree
- Reduced benefits from smaller trees
- Increased air quality benefit (VOCs)
- Reduced costs for tree care and sidewalk repair
- Greatest NPV of benefits



Benefits and Costs for Replacing

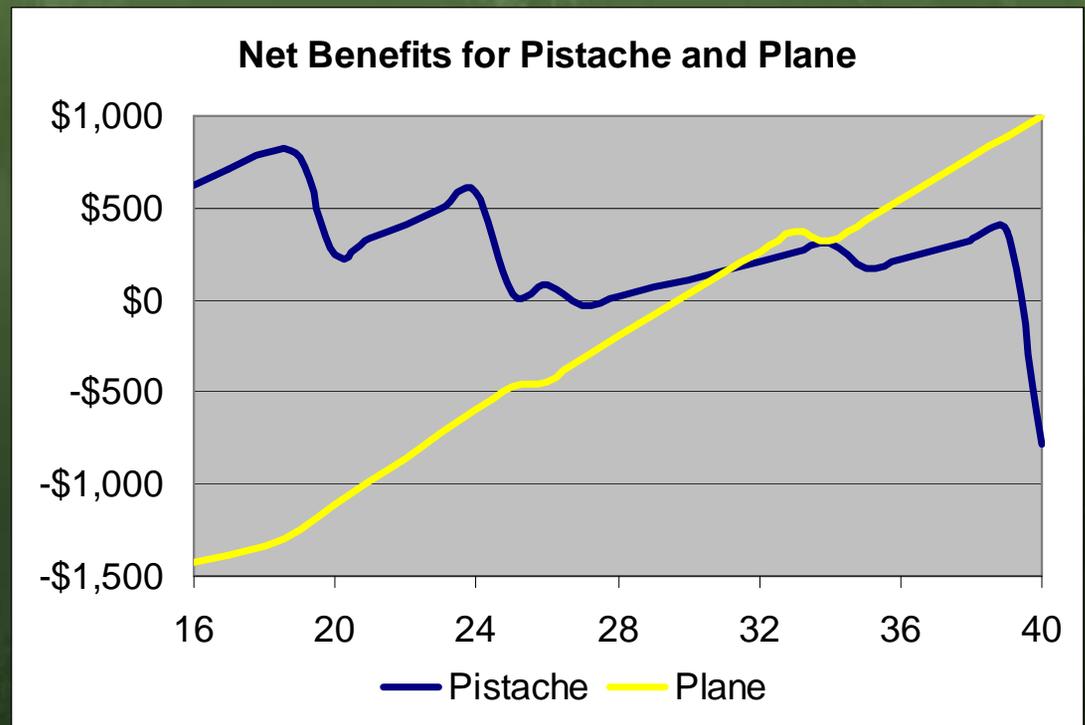


Benefits and Costs for Replacing



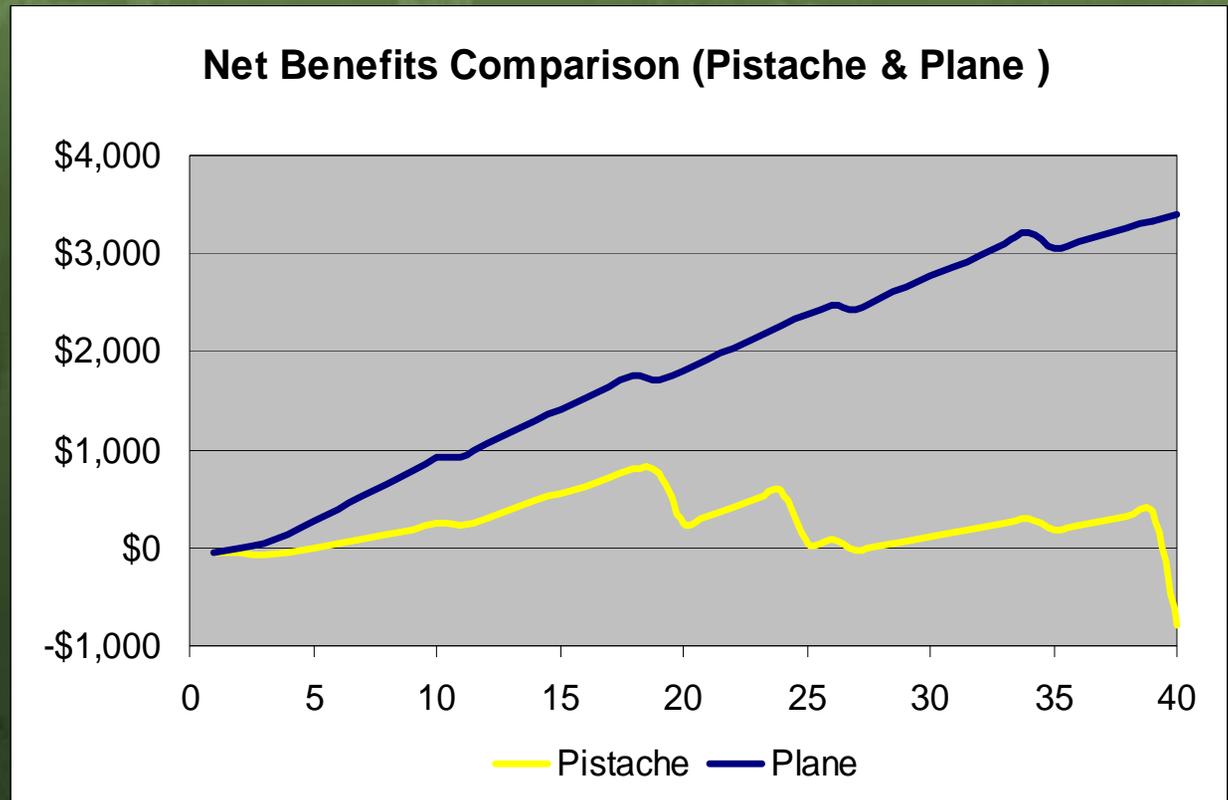
Cost-Effective to Remove Pistache and Replace?

- Net Present Value of Benefits per tree (Yrs 16-40)
- NPV Benefit (0%)
 - Retain Pistache \$-1,326
 - Replace w/ Plane \$994
- NPV (7%)
 - Retain Pistache \$-363
 - Replace w/Plane \$-270
- Remove-Replace cost-effective at lower discount rates



Amount Saved With Optimal Layout for 40 Years

- NPV Benefits (0%)
 - Pistache \$-783
 - Plane \$3,409
- Amount saved:
 - \$4,192/tree
- Decision effects future value



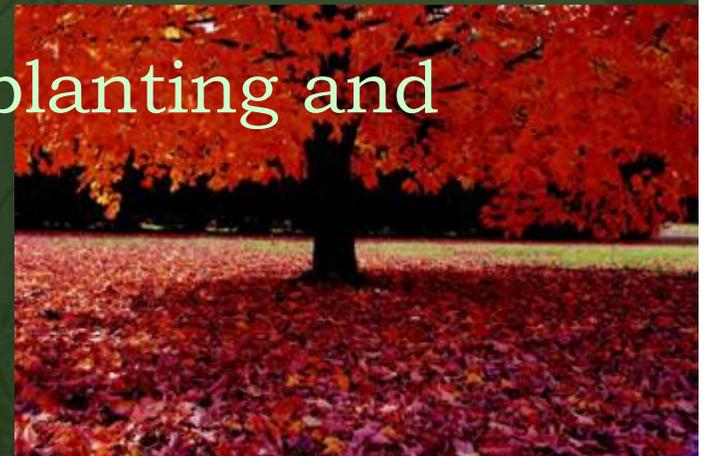
Summary

- Compare Current Value Pistache
 - Replacement Value > Benefit-based
 - Future sidewalk repair costs
- Retain or Remove & Replace?
 - Depends on discount rate
 - Retain more cost-effective at higher rates
 - Decision-support tool
- Amount Saved with Optimal Planting (40 yrs)
 - \$4,192/tree



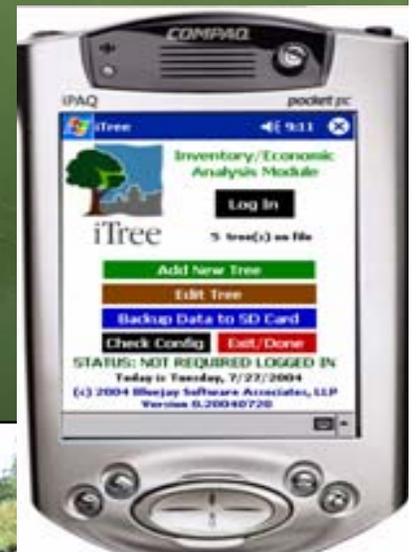
Benefit-Based Approach

- Considers future stream of costs & benefits
- Breaks out specific benefits
- Unsuitable for tree appraisal now
 - specific tree species, size, location, condition, longevity
- Principles can inform contribution and placement ratings
- Long-term implications of planting and management



Tree Effects Calculator

- Enter Region
- Enter Tree Data
- Enter Site Data
- Calculate Replacement Value
- Calculate Value of Current Benefits
- Calculate Value of Future Benefits



U&CF Tipping Point

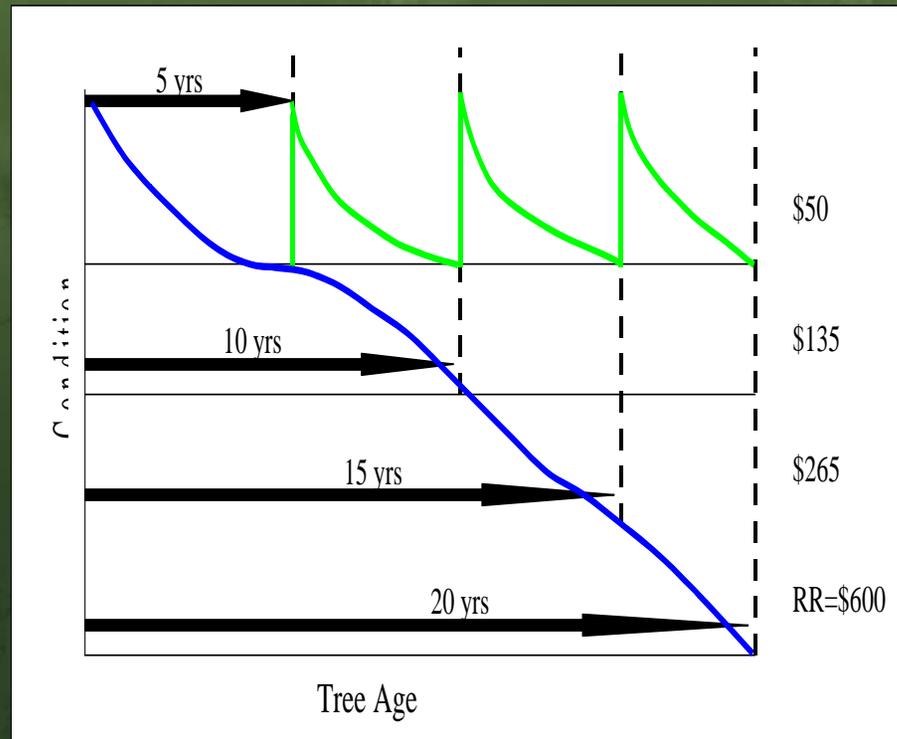
- New Leadership & Awareness
 - At the Top
 - Grass Roots
- New Investment & Responsibility
 - Los Angeles
 - Sacramento: Energy & Air Quality
 - Green Streets & Carbon
 - Making it Pay!
- New Tools for Project Planning, Budgeting, & Monitoring



Street Tree Simulator

User Interface Design

DeVine Consulting



September 19, 2006

Global Inputs

Button for importing data from STRATUM.

Dropdown region selection. This can be made a graphical selection if necessary.

The screenshot shows the 'Street Tree Simulator' application window. The title bar includes the application name and standard window controls. The menu bar contains 'File', 'Global Inputs', 'Schedules', 'Reports', 'Simulation', and 'About'. A blue button labeled 'Import Values from STRATUM' is located at the top left of the main content area. The interface is divided into several sections:

- Background Identification:** Includes text input fields for 'User Name' (Bob), 'Project Name' (Demo Project), and 'Project Location'. It also features a date dropdown menu set to 'Friday, September 15, 2006' and a 'STRATUM Region' dropdown menu set to 'Pacific Northwest'.
- City Information:** Includes text input fields for 'City Name' (Davis), 'Total Municipal Budget (\$)', 'Population', and 'Total Land Area (sq mi)'. It also features three more text input fields for 'Avg. Street Width (ft)', 'Avg. Sidewalk Width (ft)', and 'Total Street Miles (mi)'.
- Analysis and Economics:** Includes a text input field for 'Analysis Period (yrs)', and several radio button options for 'Include costs in analysis?', 'Carry over budget surplus or deficit?', 'Include inflation adjustment?', and 'Include random events?'. A percentage input field is also present for 'Percentage inflation adjustment?'.
- Benefit Prices:** Includes text input fields for 'Electricity (\$/kWh)', 'Natural Gas (\$/Therm)', 'CO2 (\$/lb)', and 'PM10 (\$/lb)'. It also features text input fields for 'NO2 (\$/lb)', 'SO2 (\$/lb)', 'VOC (\$/lb)', 'O3 (\$/lb)', 'Stormwater Interception (\$/gal)', and 'Average Home Resale Value (\$)'.

Adjust DBH Values

Street Tree Simulator

File Global Inputs Schedules Reports Simulation About

Adjust DBH Values

All values shown indicate boundaries between DBH size classes. The largest size class is assumed to go from the number specified to infinity. Size classes must be input in order with the smallest size at the top.

Remove a Size Class

Add a Size Class

0	<input type="checkbox"/>	Large Size Class
3	<input type="checkbox"/>	Large Size Class
6	<input checked="" type="checkbox"/>	Large Size Class
12	<input checked="" type="checkbox"/>	Large Size Class
18	<input checked="" type="checkbox"/>	Large Size Class
24	<input checked="" type="checkbox"/>	Large Size Class
30	<input checked="" type="checkbox"/>	Large Size Class
36	<input checked="" type="checkbox"/>	Large Size Class
42	<input checked="" type="checkbox"/>	Large Size Class

Buttons for adding and removing inputs for additional size classes.

User enters boundaries between size class and checks those that are considered large DBH classes.

Adjust Default LOS

The screenshot shows a software window titled "Street Tree Simulator" with a menu bar containing "File", "Global Inputs", "Schedules", "Reports", "Simulation", and "About". The main content area is titled "Adjust Default Levels of Service" and contains a table for configuring service levels.

Program Area	Minimal LOS 1	Standard LOS 2	Excellent LOS 3	Optimal LOS 4
Planting (% full stocking)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Small Tree Care (# yrs between visits)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Large Tree Care (# yrs between visits)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Removals (% dead or dying)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Infrastructure Conflicts (% conflicts)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Administration/Other (\$/tree)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Unit Cost Schedules

Street Tree Simulator

File Global Inputs Schedules Reports Simulation About

Unit Cost Schedules

Planting Cost

Type							Totals
Cost/Tree (\$)							
# Trees							
Total \$/yr							

Irrigation and Establishment

DBH Classes	0 - 3	3 - 6	6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	42+	Totals
Cost/Tree (\$)										
# Trees										
Total \$/yr										

Inspect/Prune Small Trees

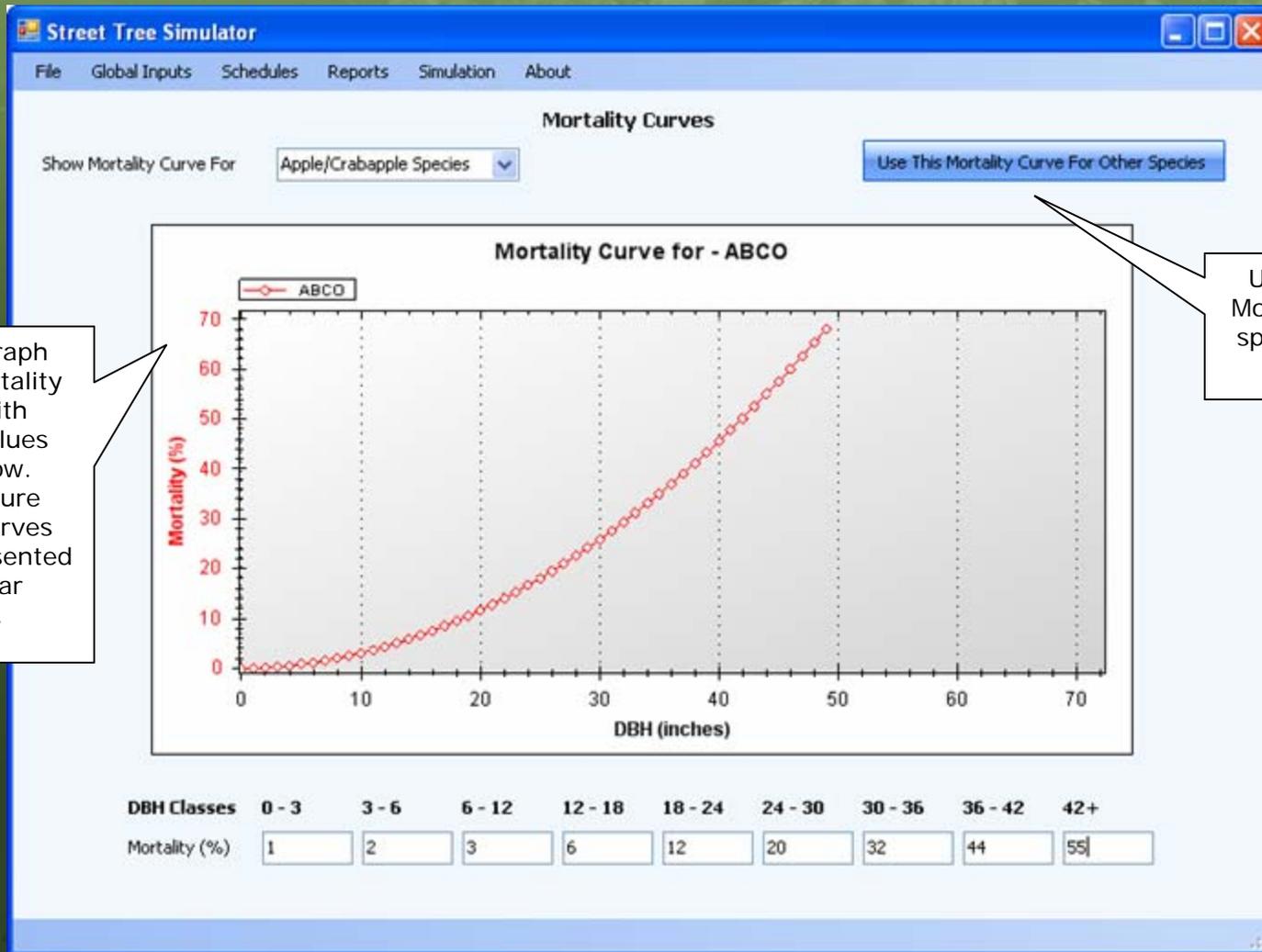
DBH Classes	0 - 3	3 - 6	Totals
Cost/Tree (\$)			
# Trees			
Total \$/yr			

Inspect/Prune Large Trees

DBH Classes	6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	42+	Totals
Cost/Tree (\$)								

All program areas included on scrollable (and resizable) window.

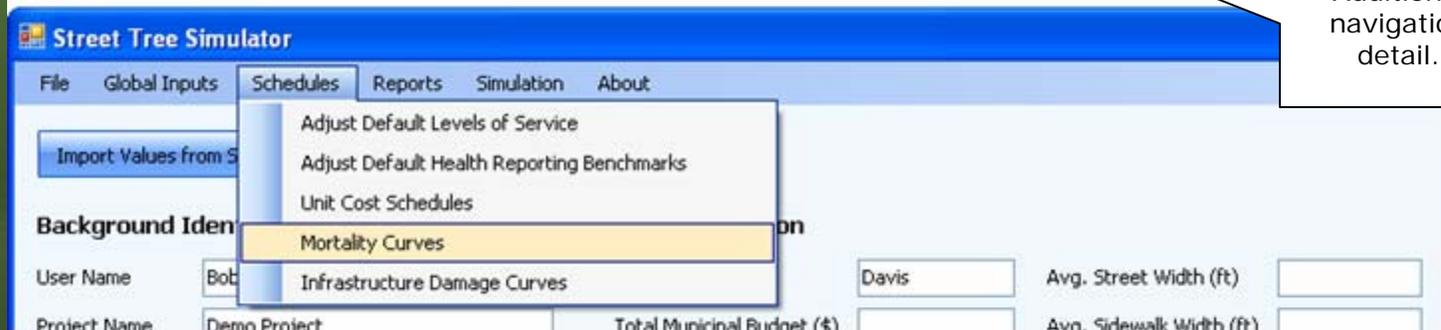
Mortality Curves



Dynamic graph displays Mortality Curves with numeric values listed below. Infrastructure Damage Curves will be represented in a similar fashion.

Users can adjust Mortality Curves by species or use one curve for all.

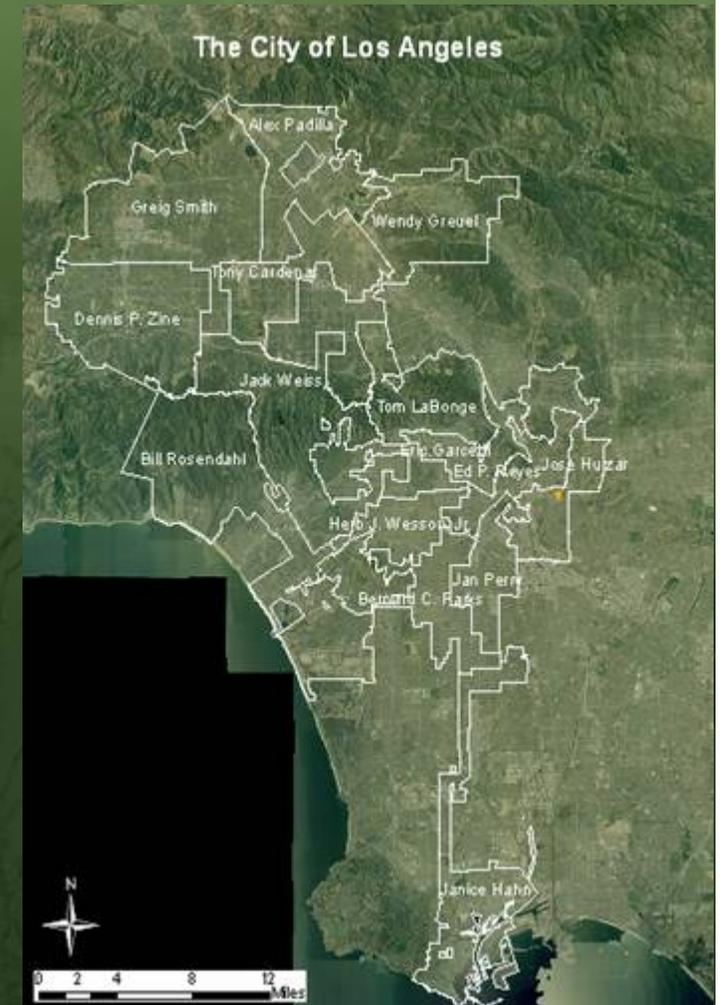
Navigation Detail



Additional navigation detail.

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



Remote Sensing and GIS Data

- QuickBird Imagery (2002-2005)
- Digital Aerial Imagery (2000 & 2006)
- Digital Land Use Maps
- Base Maps
 - Council districts & Neighborhoods
 - Census data
 - Highways, major streets

Method for Existing Canopy

- Masking
 - Mountains
- Classification
 - Non-vegetation (paving, buildings, rock, water)
 - Vegetation
 - Tree/shrub
 - Irrigated turf
 - Un-irrigated grass/herbs
- Accuracy Assessment (9% overestimate)



Results – Existing Canopy

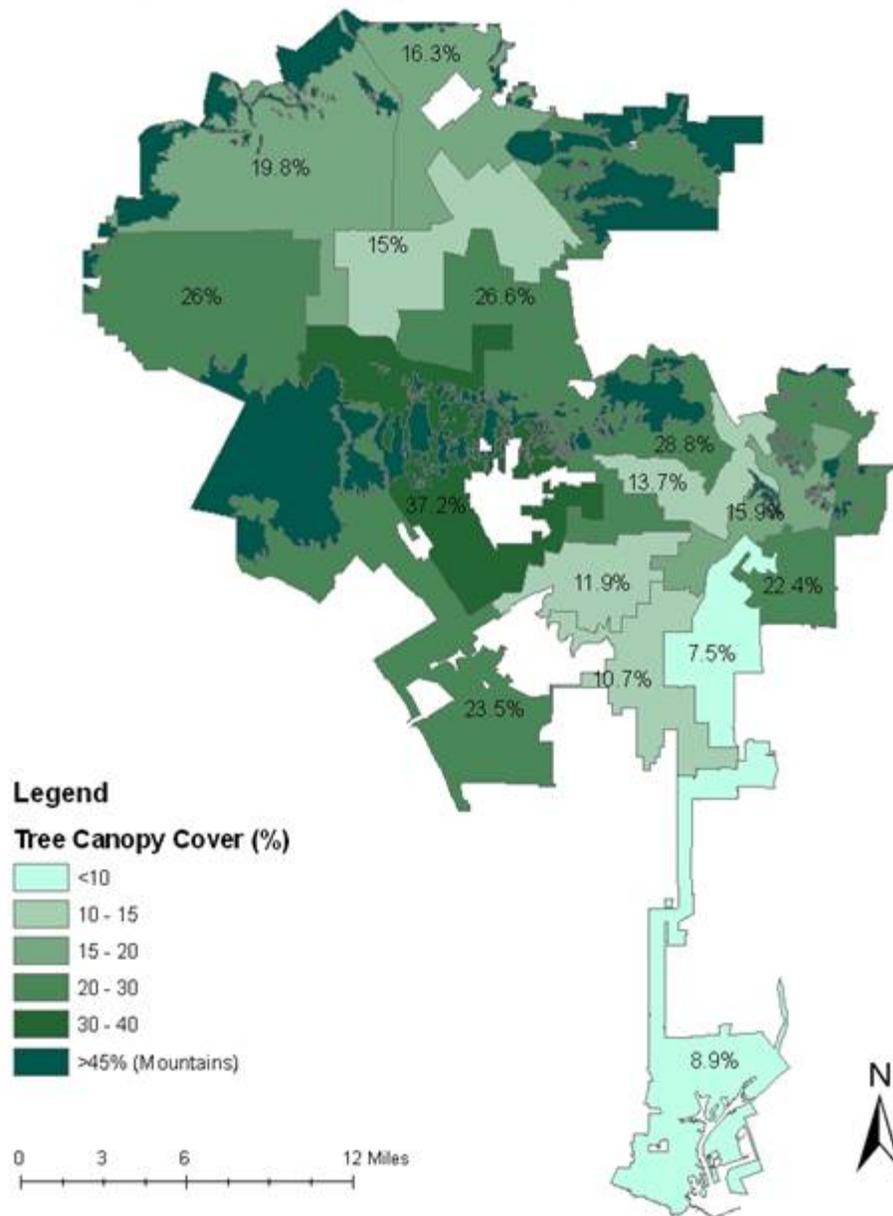
–21%

–10.7

million
trees

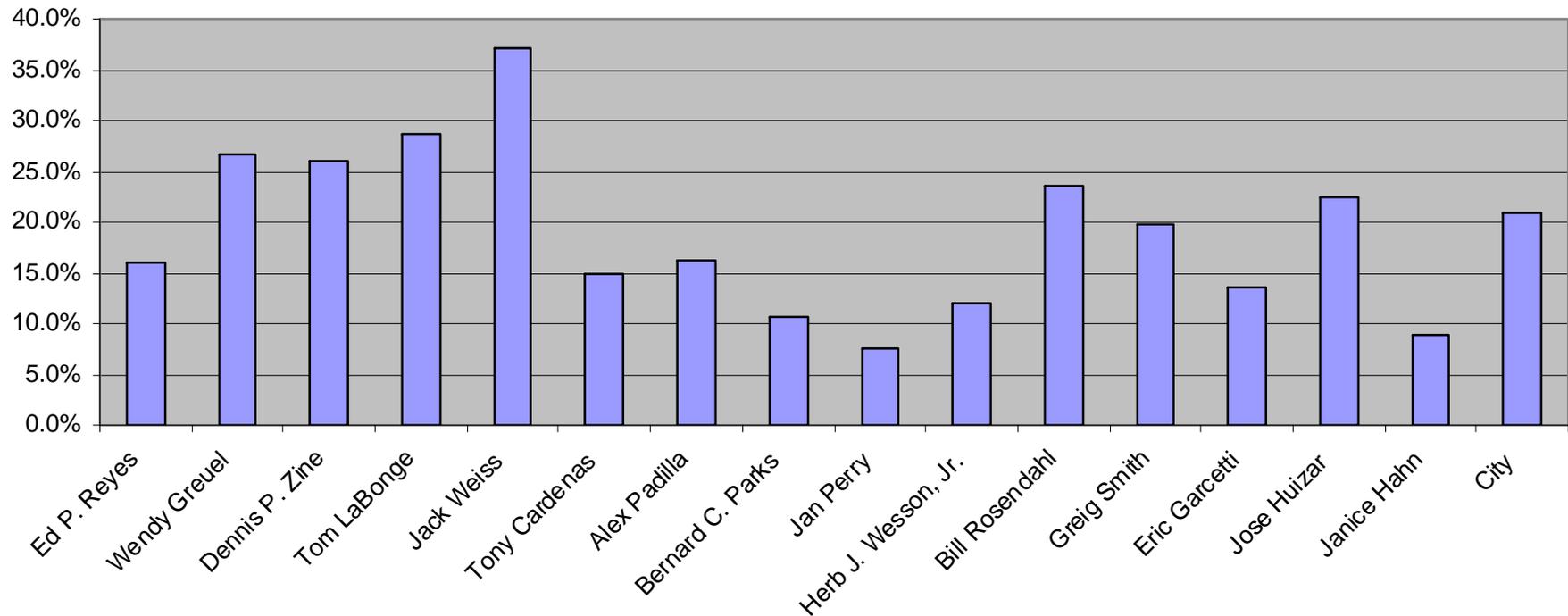
– 8%-37%

LA City Tree Canopy Cover by Council District



Results – Existing Canopy

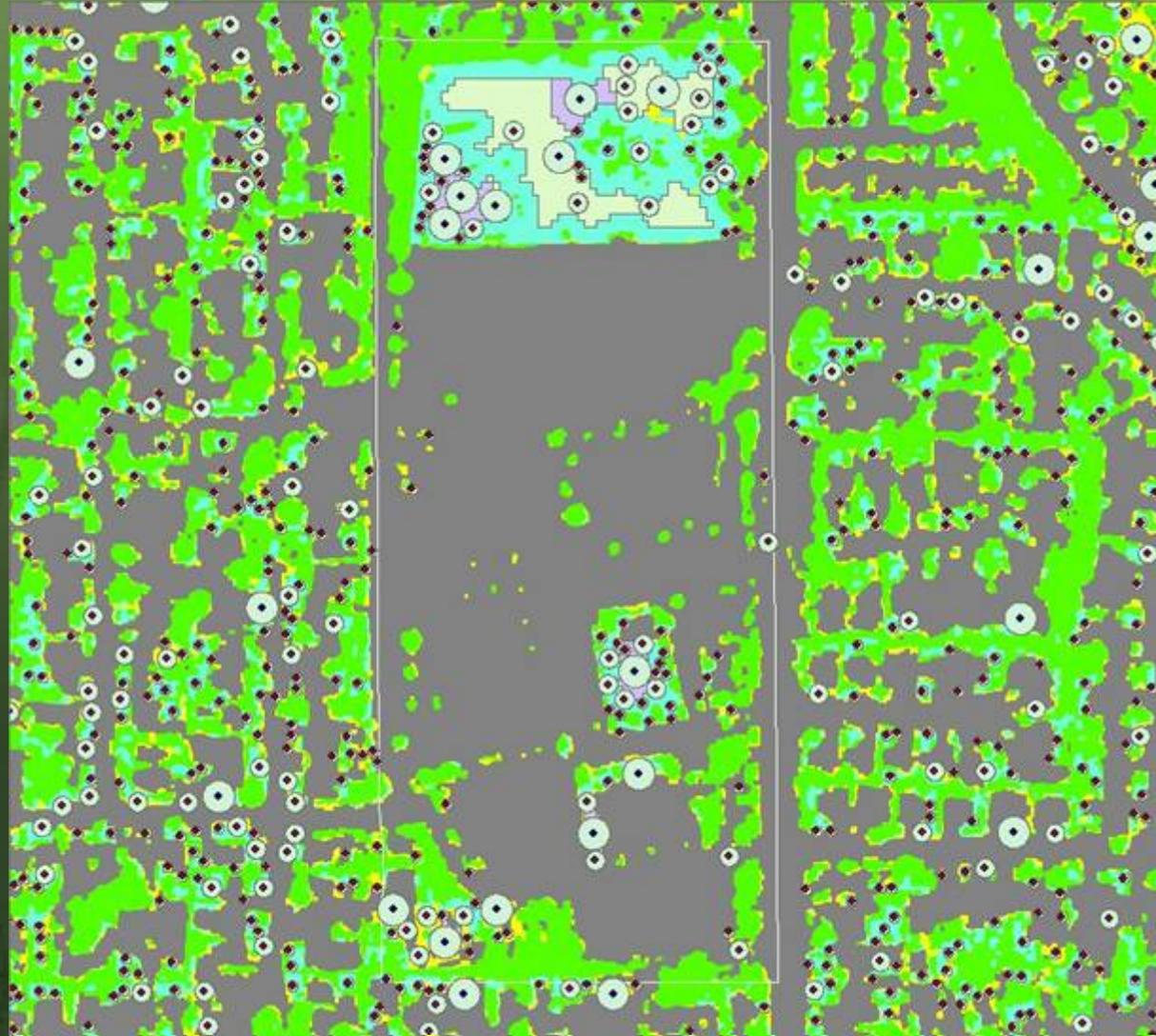
Existing Tree Canopy Cover by Council District



Method for Potential TCC

- Potential Tree Canopy Cover
 - Grass area without tree canopy
 - Tree trunk 2-ft min from paving & building
 - Tree crowns don't overlap
 - Largest stature trees first
 - Reiterate for each tree type
- Mature Tree Crown Diameters
 - 50 ft, 30 ft, 15 ft
- Large Parking Lots (Ind, Comm, Institutional)
 - Sample % area paved in each Council District by Land Use
 - Assume 25% TCC for Industrial (30' Crown Diameter)
 - Assume 50% TCC for Others
- Accuracy Assessment
 - 50 sample plots
 - Ground Truthing

Method for Potential TCC

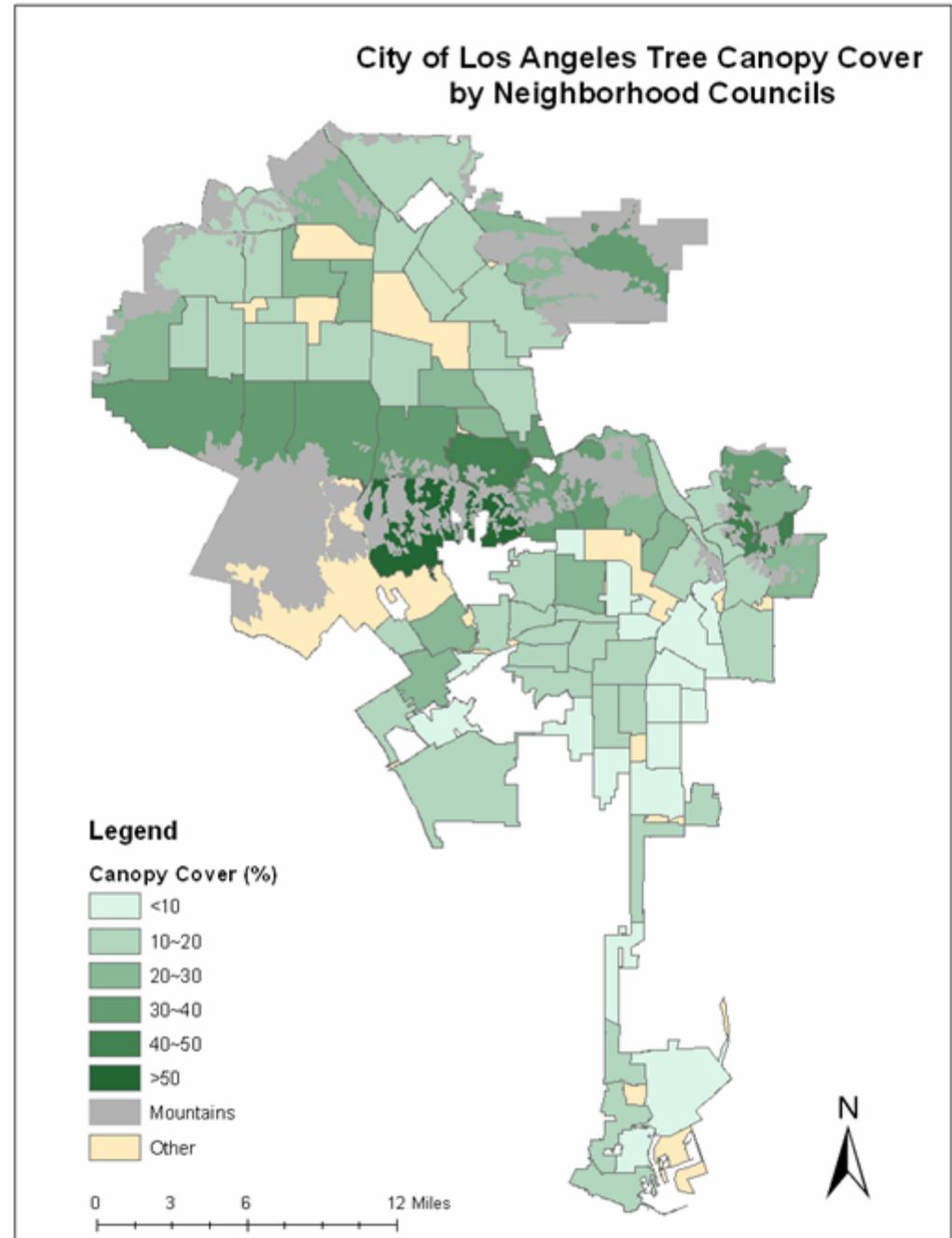


Ground-Truthing

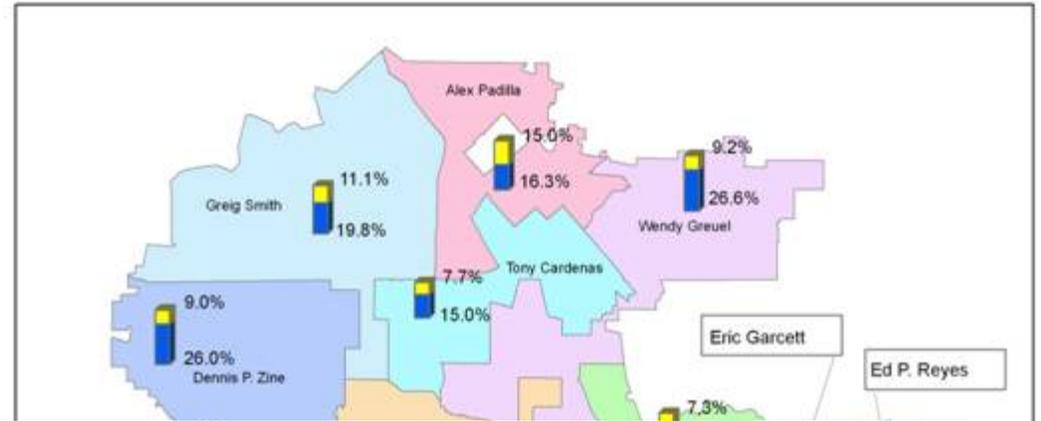


Results – Potential Canopy

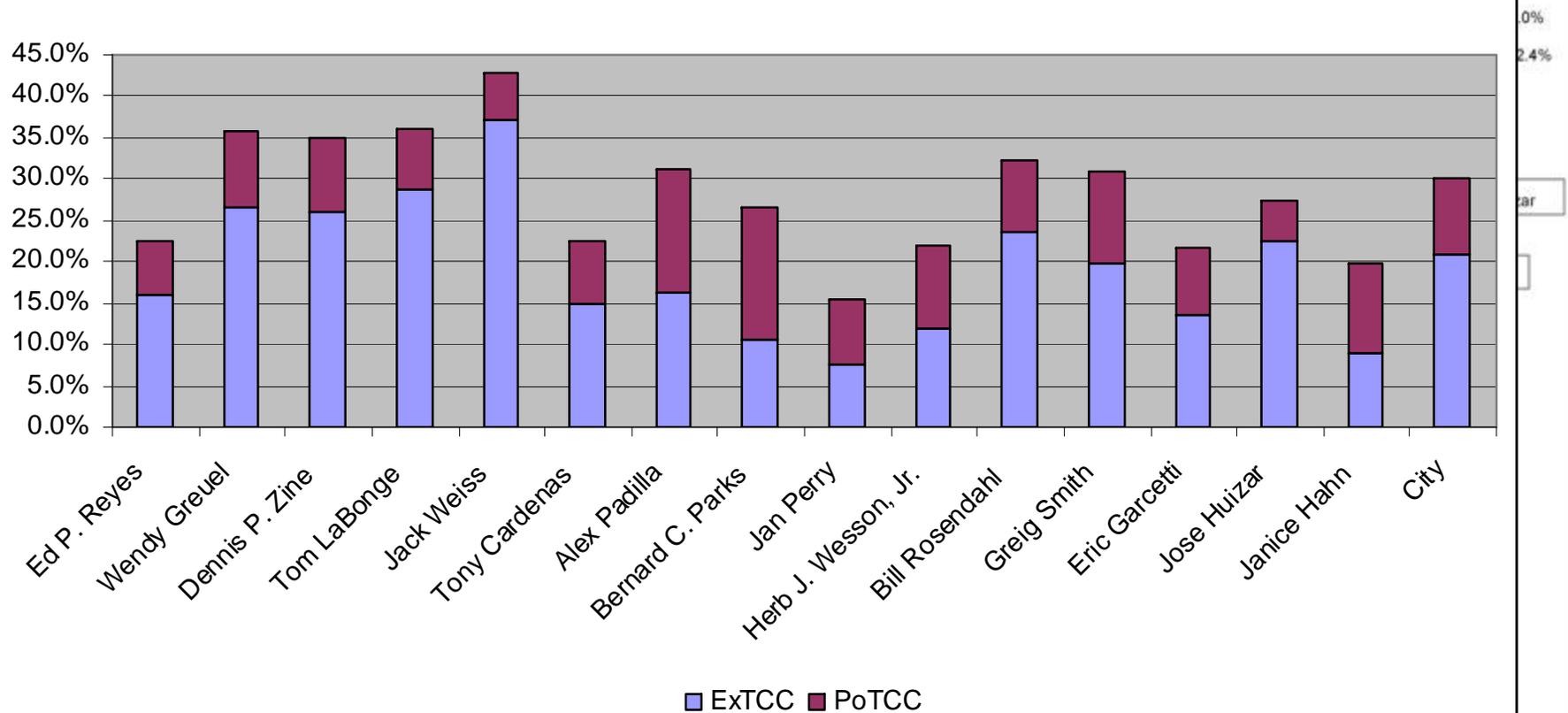
- 9.2%
Citywide
 - 23,244 ac
- 2.7 million
trees
 - 73% small
 - 20% medium
 - 7% large



Results – Potential TCC

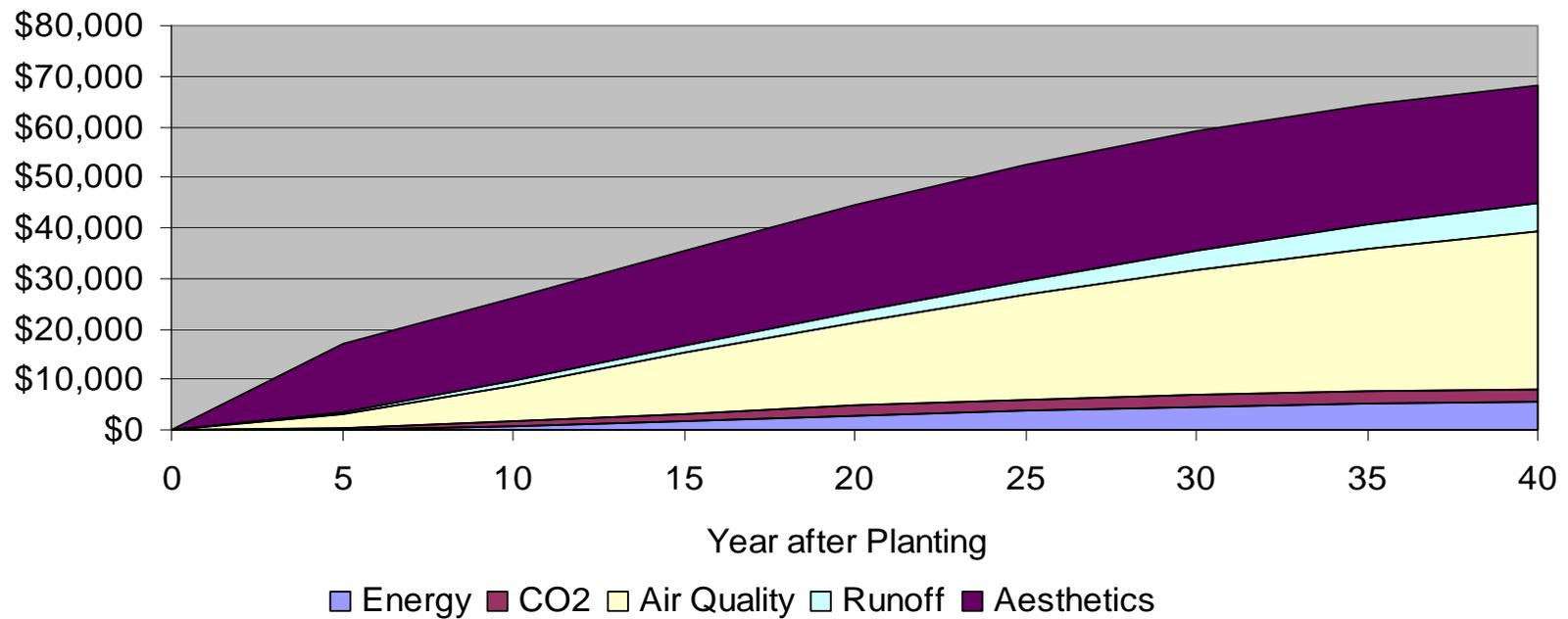


Existing and Potential Tree Canopy Cover by Council District



Project Future Benefits

Benefits from Planting 160 Trees in Hazard Park, Los Angeles

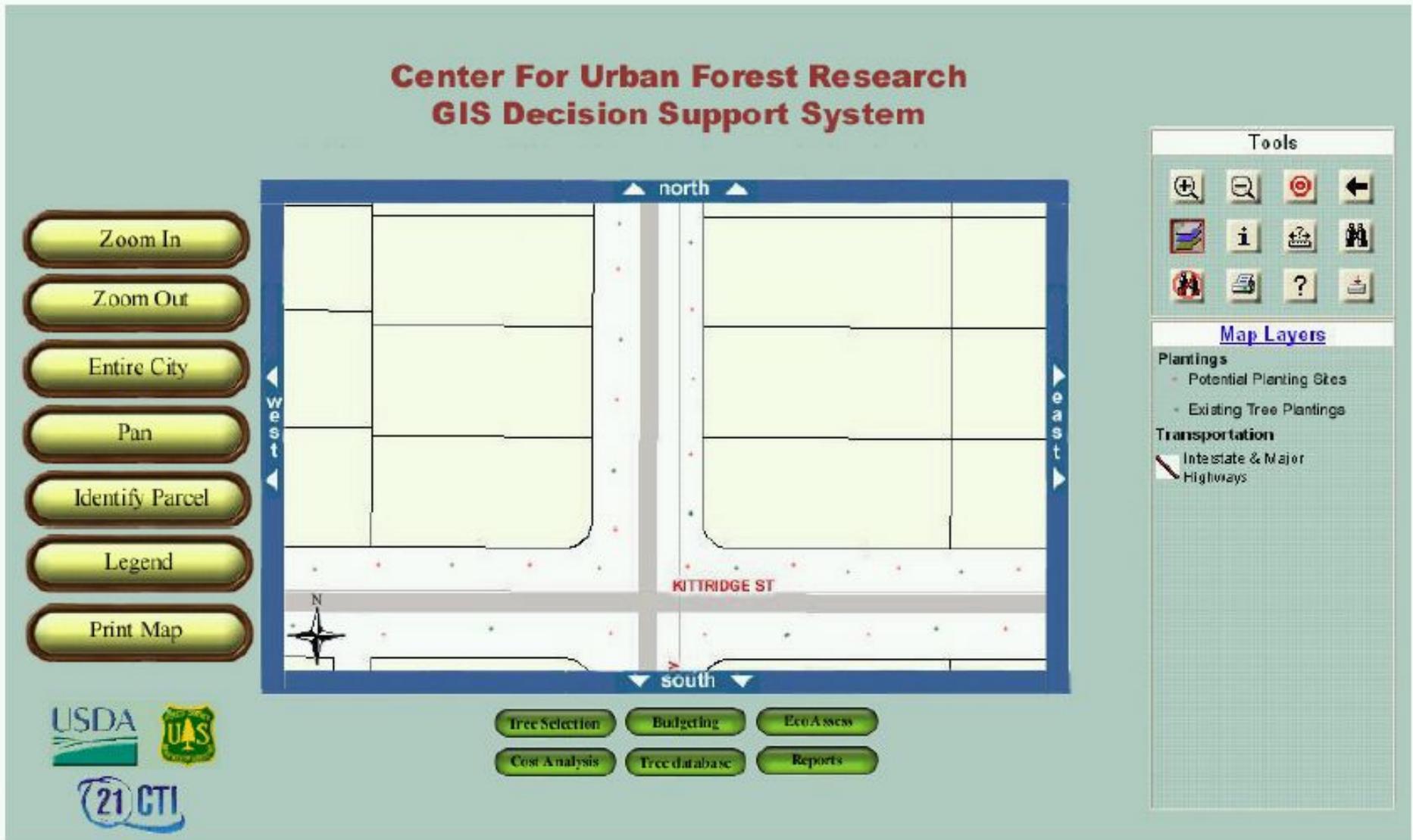


GIS Decision Support System



Conceptual Image of GDSS Main Screen

GIS Decision Support System



Conceptual Image of GDSS Parcel Screen

Questions?

