Million Trees LA: Success and Failure During the Early Years

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Pacific Southwest Research Station
Science that makes a difference

Trees, People and the Built Environment II
University of Birmingham, UK, April 2-3, 2014

Pacific Southwest Research Station

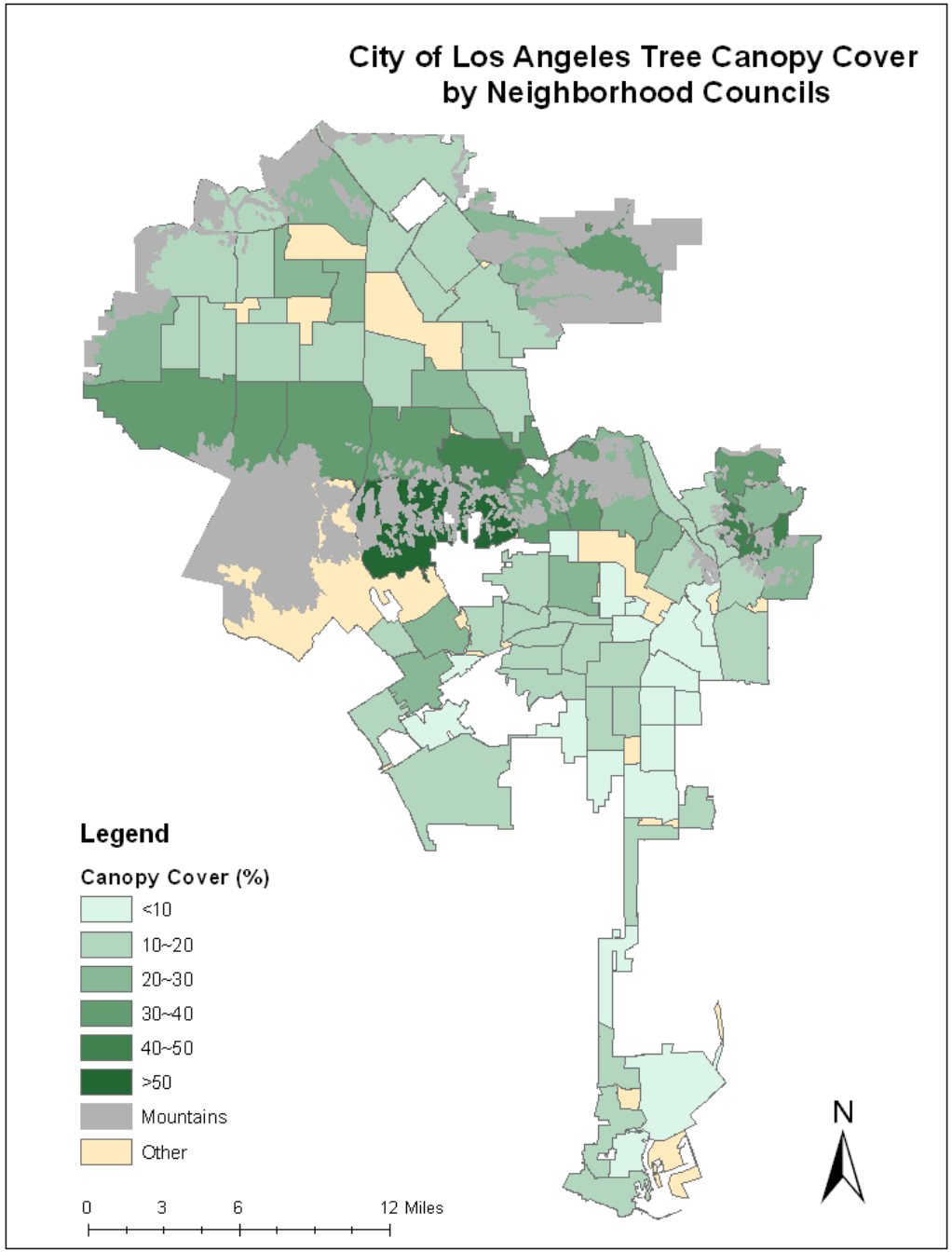
Million Trees LA (MTLA)
Mayor Antonio Villaraigosa
2005-2013

Los Angeles Million Tree Canopy Cover Assessment

- Goals
  - Current tree canopy cover
  - Number and type of potential tree planting sites
  - Value of ecosystem services for 35 yrs

1 Million Trees LA

- 21% UTC
- 11 million trees
- 2.7 million tree sites
- 1 million new trees
  - $1.6-2 billion



MTLA: Function or Fashion ?

GeoJournal (2013) 78:475–493
DOI 10.1007/s10708-012-9446-x

Urban tree planting programs, function or fashion? Los Angeles and urban tree planting campaigns

Stephanie Pincetl · Thomas Gillespie · Diane E. Pataki · Sassan Saatchi · Jean-Daniel Saphores

Published online: 10 February 2012

Abstract Tree planting programs are being implemented in many US cities (most notably New York, Tree planting programs are being implemented in many US cities for their multiple environmental and

CO_2 Sink or Source?

- Not optimizing ecosystem services
  - Science is unsubstantiated
  - No guidance
    - Appropriate species
    - Best locations

Research Questions

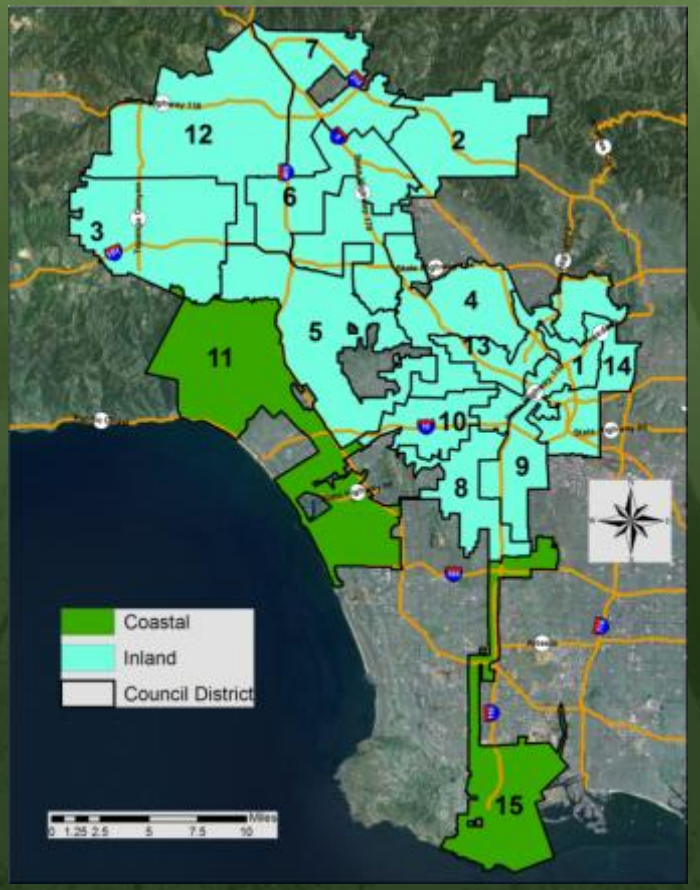
- Modeled Unrealistic Tree Performance?
  - Strategically chosen & located
  - Mature-size of trees planted
  - Survival & growth rates
- Overly Optimistic Benefits?
  - CO_2 stored and avoided emissions
  - Co-benefits: energy, air quality, rain interception
- Compare with MTLA 2008
- Compare with other studies

Methods: Tree Survey

- Tree Planting
  - Interview managers
  - MTLA Database
- Field Survey: Survival and Growth
  - Random sample
    - 98 Street, 225 Park, 96 Yard trees planted 2006-08
    - Survivorship: % surviving to 2011
    - Annual mortality
    - Tree measurements
      - Size
      - Status
      - Location
      - Building

Simulating Future Benefits

- Same methods as before except:
  - Reported planting rates
  - Only one mortality scenario
  - More species growth
  - 40 years

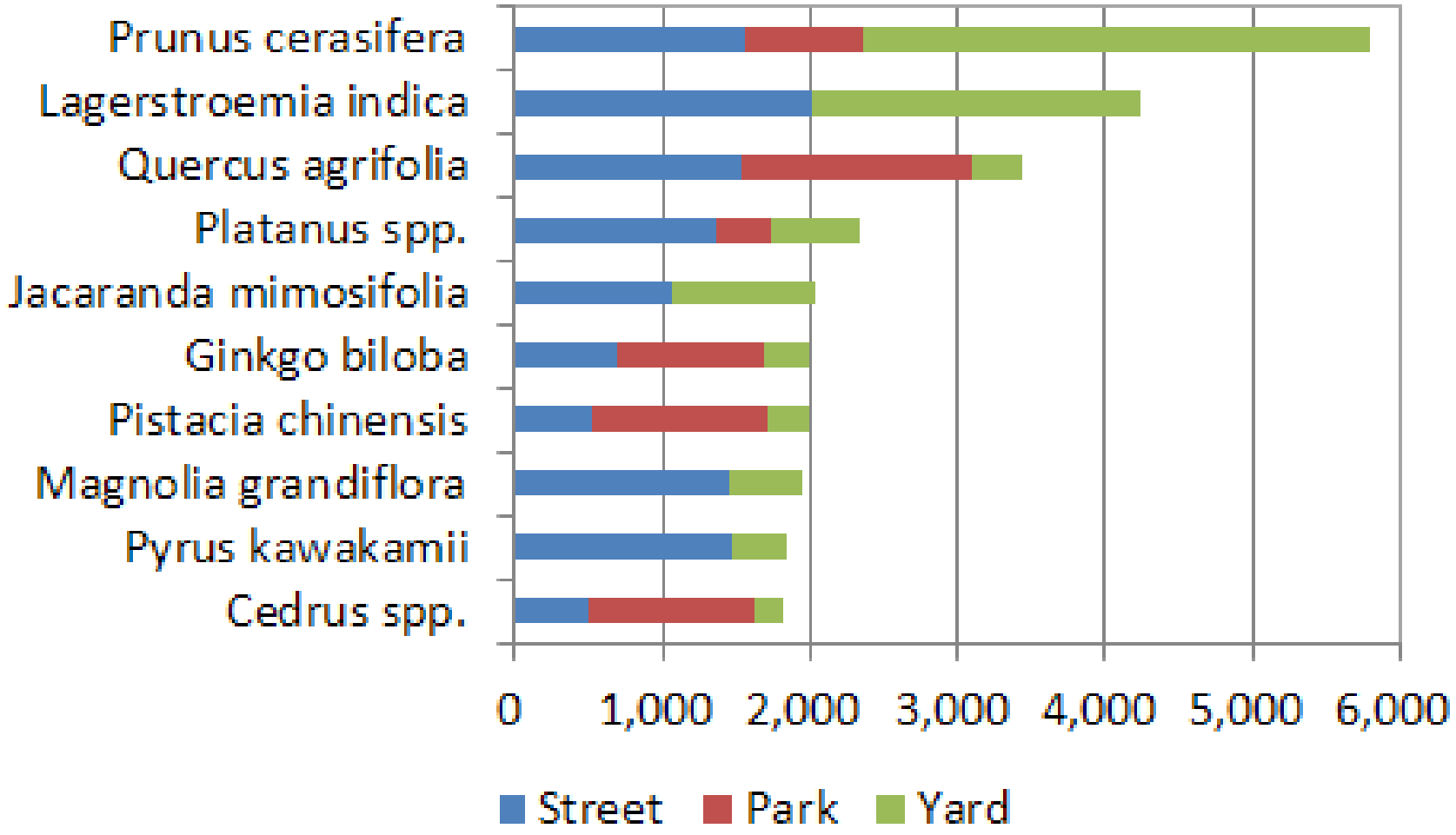


Street Locations

Park Locations

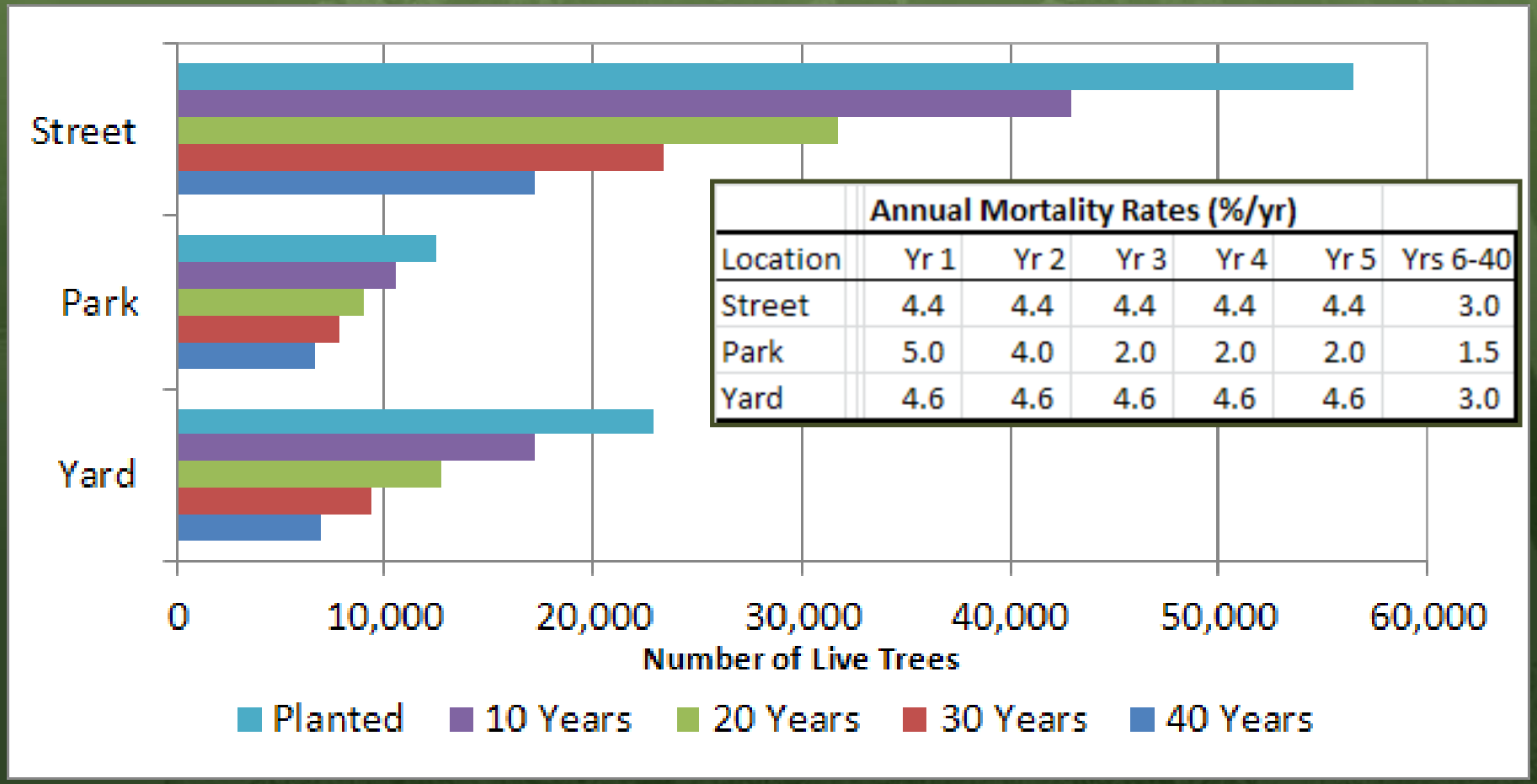
Yard Locations

91,786 Trees Planted 2006-2010



MTLA – Simulated Live Trees

- 33.6% Alive after 40 yrs
  - MTLA 2008: Low Mortality = 82.9%, High = 44.5%



Annual Mortality Rates (%/yr)						
Location	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yrs 6-40
Street	4.4	4.4	4.4	4.4	4.4	3.0
Park	5.0	4.0	2.0	2.0	2.0	1.5
Yard	4.6	4.6	4.6	4.6	4.6	3.0

Mature-Size Percentages

Study	Small	Medium	Large
MTLA 2006	52.3	38.0	9.7
MTLA Sample	27.6	37.5	34.9
MTLA 2011	36.7	33.6	29.7

MTLA – Tree Survival

- MTLA Survivorship (3 to 5 yrs)
  - Street: 79.8%
  - Park: 90.7%
  - Yard: 77.1%

Location	No. years	% loss/yr
MTLA - Street	5	4.4
MTLA - Yard	5	4.6
MTLA - Park	3	3.1
Sacramento	5	6.6
West Oakland	< 7.7 cm	5.6
Baltimore	< 7.7 cm	9.0
Houston	7.7-15.2 cm	12.0
New York City	5	5.5

Tree Growth Comparison

Location	Mean	cm/year
MTLA - Street	6.4	1.10
MTLA - Yard	5.9	0.99
Gainesville[1]	0- 7.7	0.82
Gainesville[2]	7.7-15.2	1.11
Houston[3]	7.7-15.2	1.01

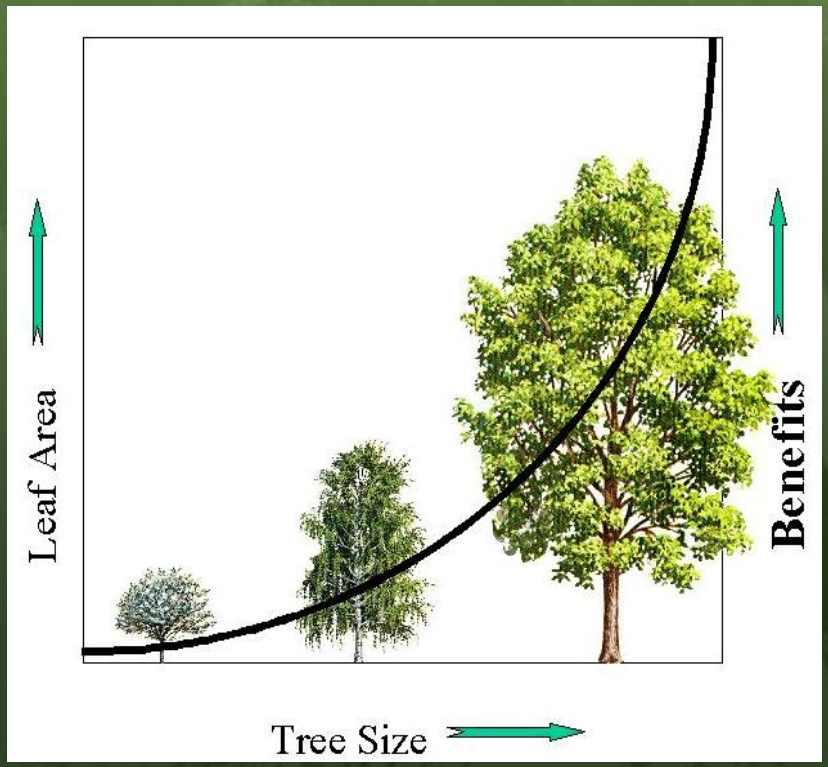
[1]Lawrence et al., 2011

[2]Escobedo, 2010

[3]Staudhammer et al., 2011

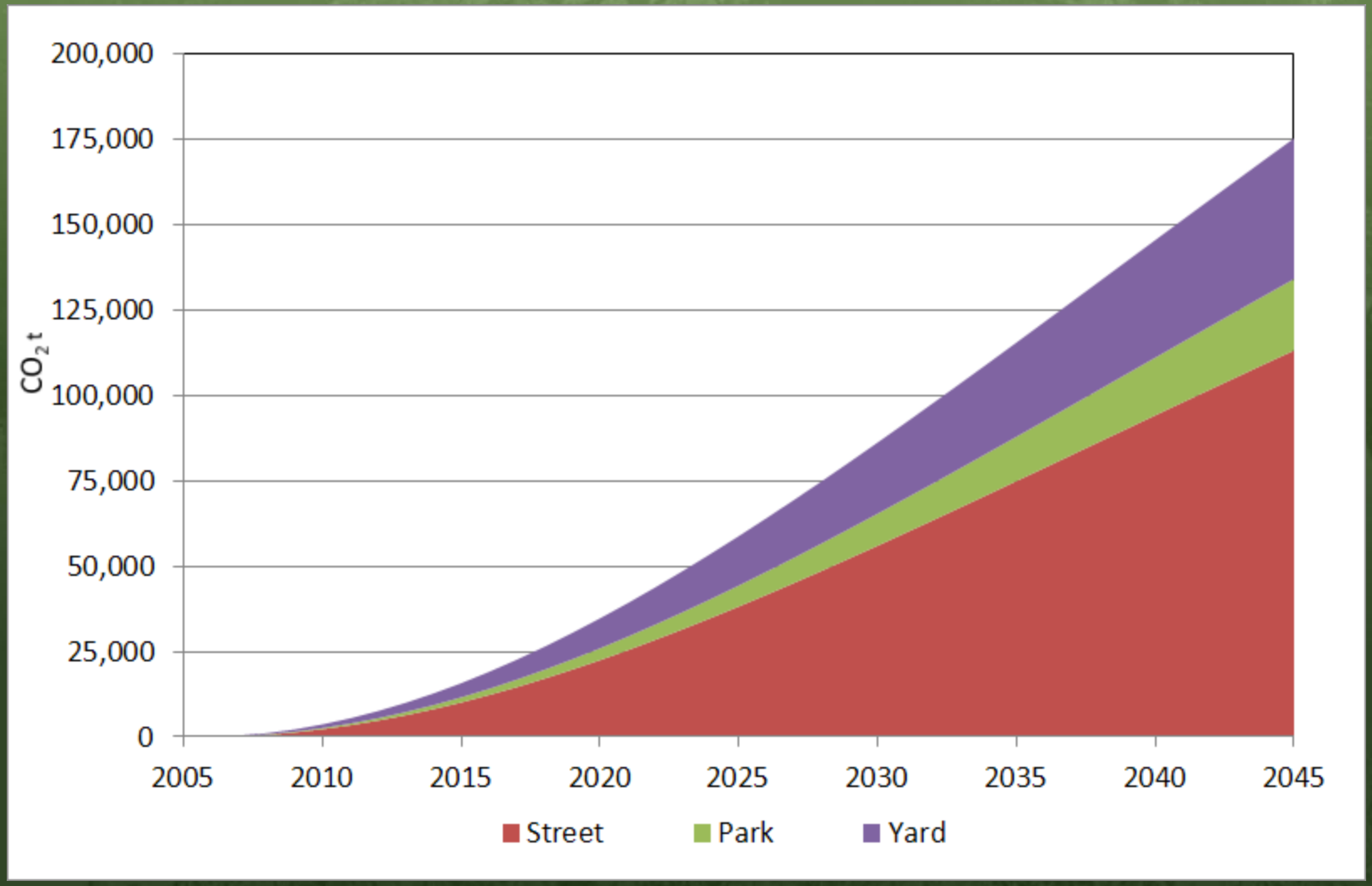
Monitoring Performance Summary

- Mature-size of trees planted
  - More large-stature trees than anticipated
- Survival rates
  - High relative to similar programs
- Growth rates
  - Comparable to others
- Strategically located
  - Street especially for energy



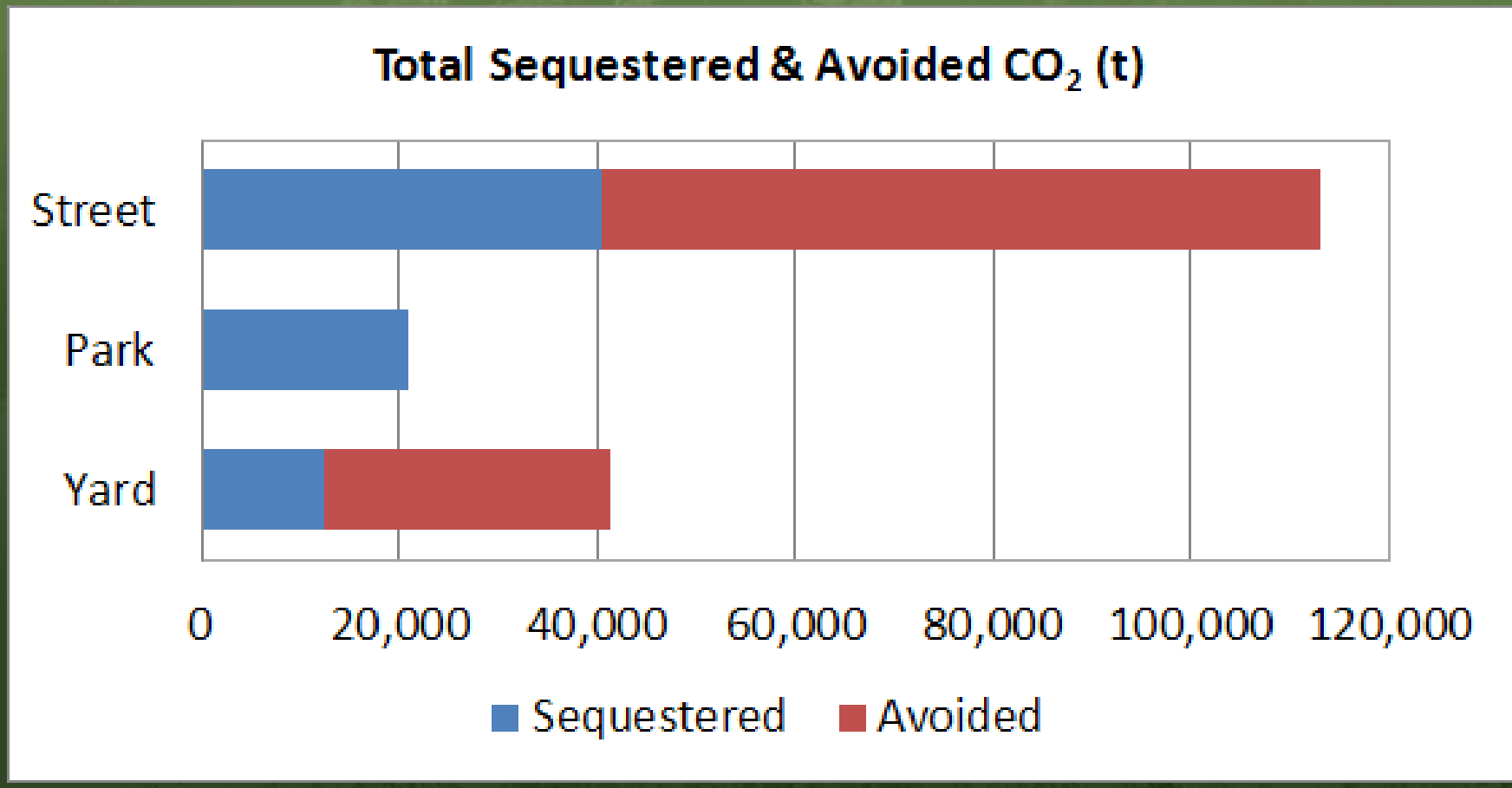
MTLA – CO_2 Sequestered & Avoided

- 175,381 t (47.8 kg/tree planted/yr)



MTLA – CO_2 Sequestered & Avoided

- 58% avoided energy emissions



Carbon Dioxide Comparison

Study	CO2 per tree per year (kg) Sequester	Avoided Emis.	Total
MTLA 2014	20.1	27.7	47.8
MTLA 2008	10.1	12.9	23.0
NYC planetree (Kovacs 2013)	21.3	52.1	73.3
Ft Collins (McHale 2007)	11.2	10.9	22.0
LA (McP 2013)	9.6	9.1	18.8
LA UFORE (Nowak 2010)	11.7	0.5	12.2
Miami-Dade (Escobedo 2010)	28.0	2.3	30.3
Gainesville (Escobedo 2010)	21.2	6.4	27.5

Co-Benefit Comparison

	$ per tree per year		
	MTLA 2014	MTLA 2008	LA UFORE
Cooling	4.74	2.18	2.75
Heating	-0.04	-0.02	-1.05
Air Quality	2.19	1.52	2.37
Interception	2.86	2.78	2.85*
Totals	9.75	6.47	4.07

* Avg. annual 40-year value for Jacaranda from Coastal SoCal Community Tree Guide

Management Implications

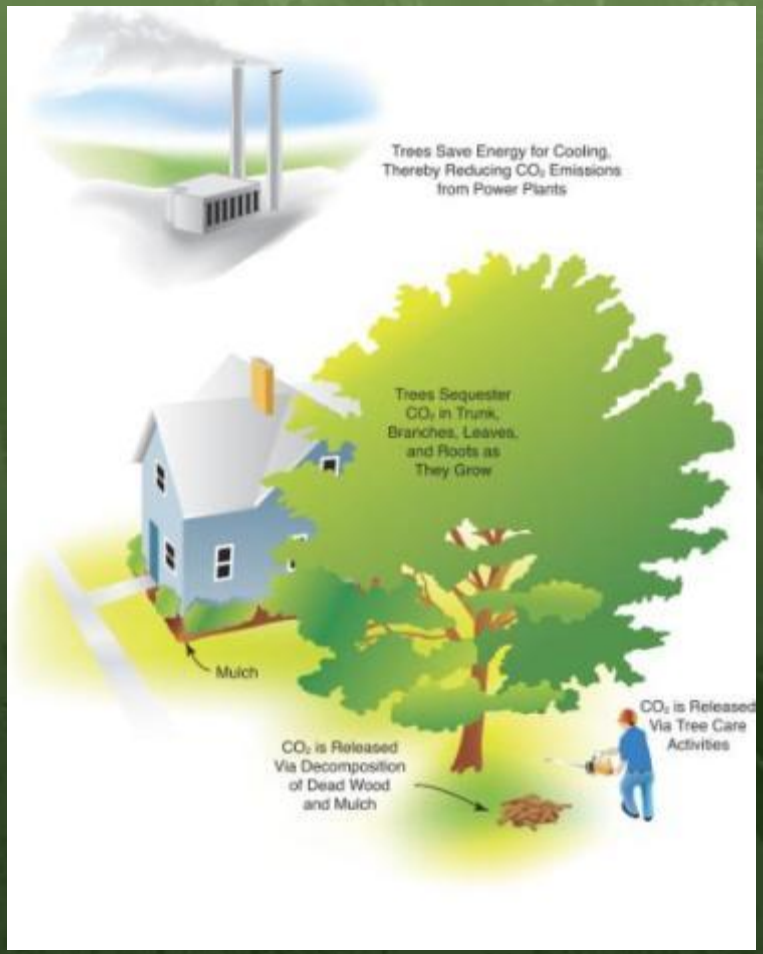
- Park Trees: large-stature, high wood density
- Yard Trees: shade West
- Street Trees: infrastructure conflicts
- Systematic Monitoring:
  - Threats
  - What to plant, not to plant
  - Quantification/Reporting
- CAR/CARB credits
  - 20 kg/tree/yr x 100,000 trees = $300,000/yr

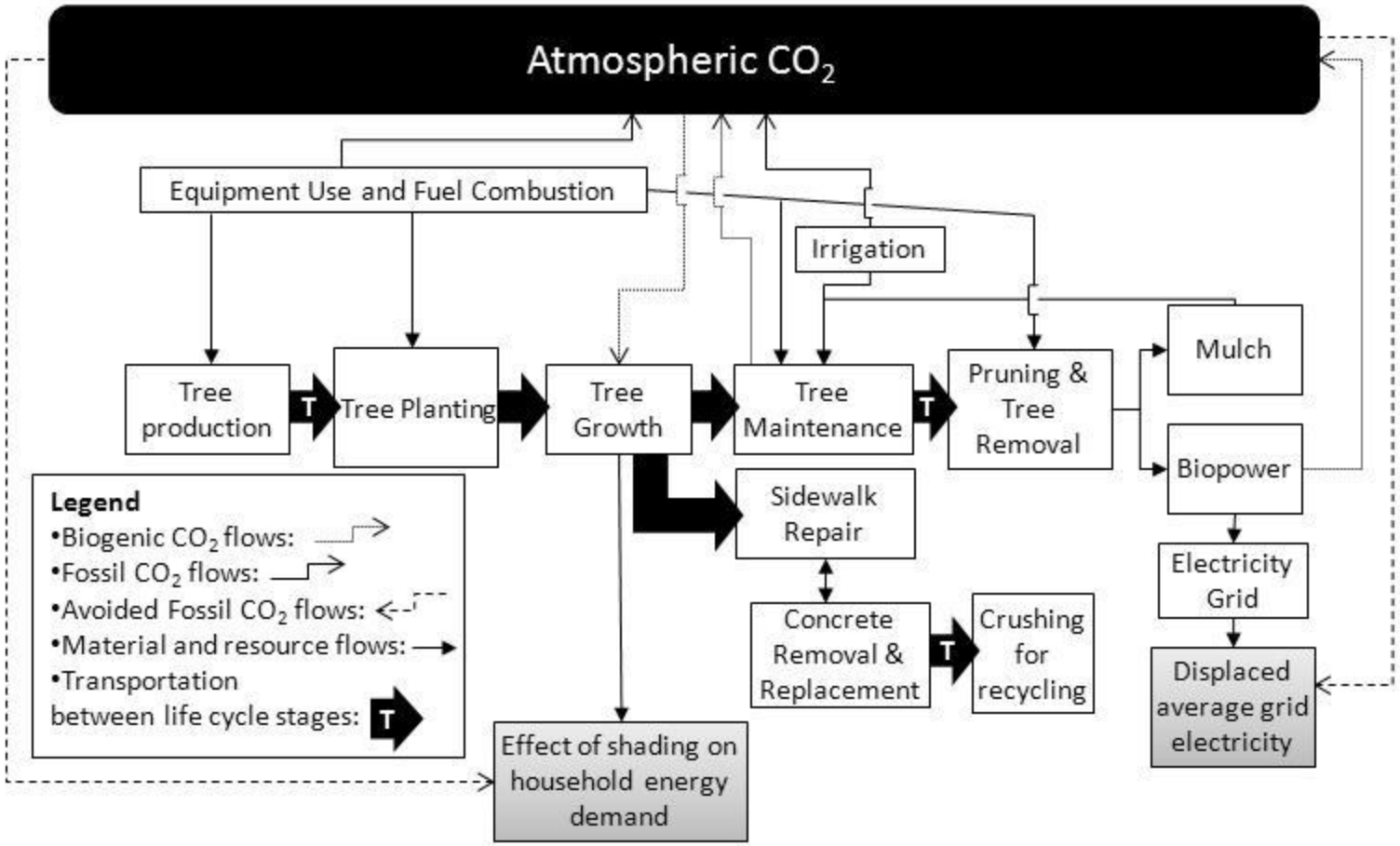
MTLA –Function or Fashion?

- Only 407,000 Planted
- Survival & Growth Good
- CO_2 Performance Good
  - 20 kg/tree/yr seq.
  - 28 kg/tree/yr avoided
- Potential to Improve
  - 100 kg/tree/yr possible
  - Record species planted
- Co-Benefits Increased
  - Selection & Location

MTLA Life Cycle Assessment: Sink or Source?

- Cradle to grave approach
- Expands accounting from previous study
  - Water-energy connections
  - Where are the “hot spots”?
- Benchmarking
  - C stocks and emission trends




Atmospheric CO_2
Equipment Use and Fuel Combustion
Irrigation
Tree production
T
Tree Planting
Tree Growth
Tree Maintenance
T
Pruning & Tree Removal
Mulch
Biopower
Electricity Grid
Displaced average grid electricity
Sidewalk Repair
Concrete Removal & Replacement
T
Crushing for recycling
Effect of shading on household energy demand
Legend
•Biogenic CO_2 flows:
•Fossil CO_2 flows:
•Avoided Fossil CO_2 flows:
•Material and resource flows:
•Transportation between life cycle stages:
T

Vehicles & Equipment

Street - Type	Avg mpg	miles/tree	Fuel	Activities
Prius	40	1.2	gas	IN
Light truck	21	4.6	gas	IN
Light truck	15	5	gas	IN
Hybrid sedan	14	6	CNG	IN
Chevy 2500	15	1.2	gas	PL
Ford F450	11.8	4	gas	PL
Ford F450	11.8	6	gas	PL
Ford F450	11.8	0.6	gas	ES
Chevy C7	8	2.5	gas	PR
Chevy 2500	15	2.5	gas	PR
Chevy C7	8	10	gas	PR, RM
Chevy C7	8	6,500/yr	gas	PR, RM, SW
Kenworth	4	60,000/yr	diesel	PR, RM, SW
Chevy 2500	15	10	gas	RM
Chevy C7	8	1	gas	SW
Chevy 2500	15	1	gas	SW
Chevy C7	8	2 and 3	gas	SW
Chevy 2500	15	2 and 3	gas	SW
Freightliner	5	10	diesel	SW
Park - Type				
Light truck	21	4.6	gas	IN
Medium truck	15	5	gas	IN
Hybrid sedan	14	6	CNG	IN
Ford F350	12	2	gas	PL, ES
GMC C7H042	8	1	diesel	PL, ES
Private vehicles			gas	PL
Private vehicles			gas	ES
Kenworth	4	1600 hr/yr		PR, RM
GMC CC4E042	9	20	gas	PR, RM
GMC C7H042	8	20	diesel	PR, RM
GMC C7H042	8	20	diesel	RM
Yard - Type				
Ford F450	11.8	2.8	gas	PL
Ford F250	13	1.25 and 3.5	gas	PR, RM
Ford F800	6	1.25 and 3.5	diesel	PR, RM
Ford F250	13	8.5	gas	RM

Street - Type	HP	LF	Fuel	Activities
Concrete saw	6.5	0.78	gas	PL
Compressor	12	0.56	gas	PL
Chain saw	2	0.7	gas/oil	PR, RM, SW
Chipper	115	0.43	diesel	PR, RM, SW
Stump grinder	77	0.78	gas	RM
Concrete grinder	6.5	0.78	gas	SW
Generator	12	0.43	gas	SW
Loader	148	0.21	diesel	SW
Root pruner	85	0.43	diesel	SW
Loader	259	1,600 hr/yr	diesel	PL, SW
Screener	265	1,500 hr/yr	diesel	PL, SW
Crusher	300	1,500 hr/yr	diesel	PL, SW
Tub grinder	1000	2,600 hr/yr	diesel	PR, RM, SW
Park - Type				
Chain saw	0.5 and 2	0.7	gas/oil	PR
Chain saw	2 and 3	0.7	gas/oil	RM
Chipper	80	0.43	diesel	PR, RM
Stump grinder	140	0.43	diesel	RM
Tub grinder	1000	2,600 hr/yr	diesel	PR, RM
Yard - Type				
Chain saw	2.1	0.7	gas/oil	PR, RM
Chipper	125	0.43	diesel	PR, RM
Stump grinder	27	0.78	gas	RM
Tub grinder	1000	2,600 hr/yr	diesel	RM

Methods: Equipment Emissions

- $CO_{2\ \text{equip emis}} = \sum_{i=1}^{n} = HRS_i \times LF_i \times HP_i \times EF_i$
- HRS = hours equipment type $_i$ is used per year
- LF = load factor (fraction max. rated HP)
- HP = maximum horsepower
- EF = average CO_2 emissions per hour of use (kg/HP-HR)

Methods: Vehicle Emissions

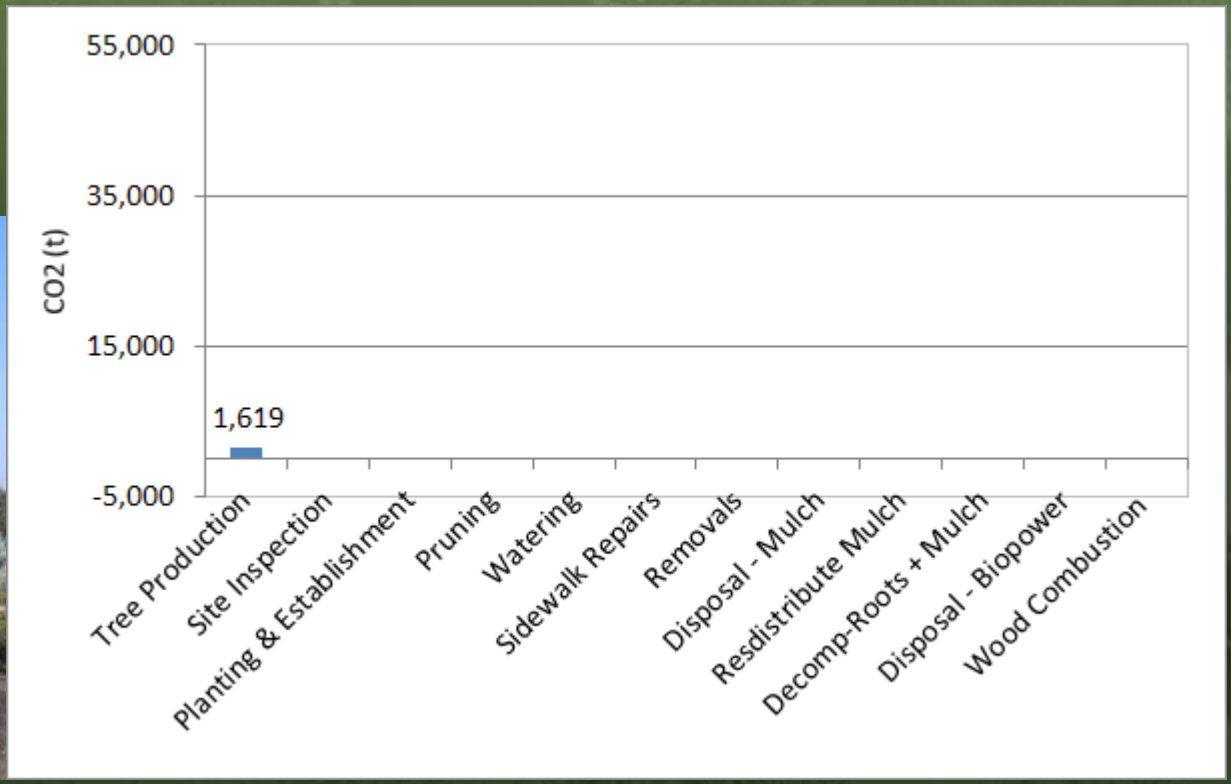
- $CO_{2\ \text{vehicle emis}} = \sum_{i=1}^{n} = TT_{s,z} \times VEC_j$
- TT = Total Trees Visited
- VEC_j = (miles^{-tree} / VFE) x EF
  - VFE = vehicle fuel efficiency (mpg)
  - EF = fuel emission factor (kg CO2/gal)

Methods: Irrigation Emissions WUCOLS

- $IWA = ET_t \times ET_o / IEF$
- $ET_t = k_s \times CPA_s \times 0.62$ gals/ft^2 –inch
  - IWA = irrigation water applied (gals/yr)
  - ET_t = evapotranspiration of the tree
  - ET_o = reference evapotranspiration
  - IEF = irrigation efficiency
  - K_s = species coefficient
  - CPA_s = crown projection area
- LADWP EF = 2.38 lb CO_2/1,000 gals

MTLA – Tree Production

- 15 gal = 15.3 kg/tree
- 24” box = 32.0 kg/tree

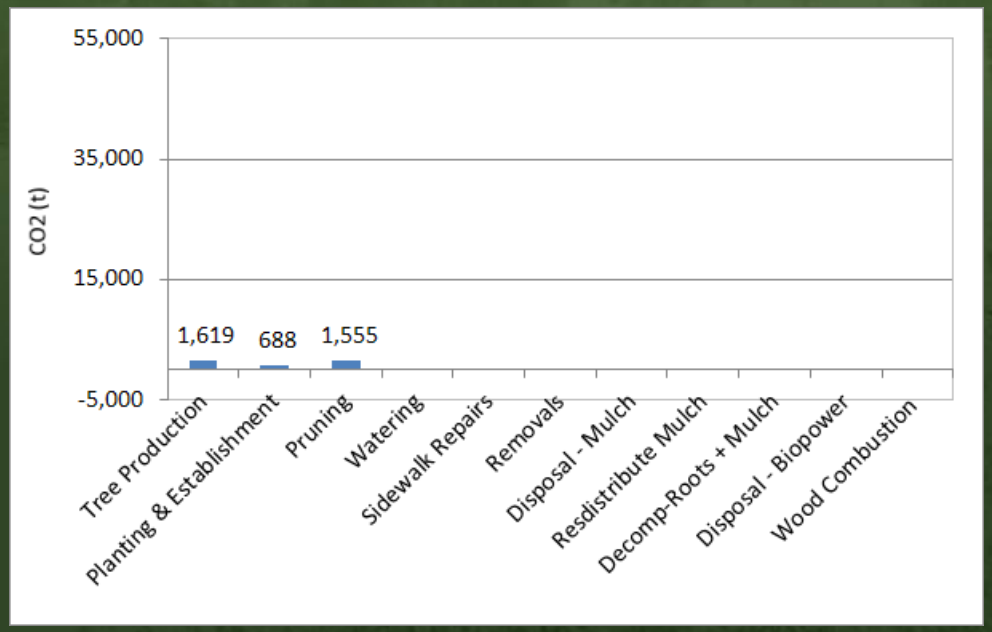


MTLA – Planting

- Street: 56,453
  - Signature/Comm: 27%
    - 1,694 tree wells cut
    - 15 gal water, 2x per mth
  - Residential: 73%
    - 20 gal water per week
- Park: 12,472
  - 6,661 volunteers
  - 45% carpooled
  - No irrigation
- Yard: 22,861
  - WUCOLs

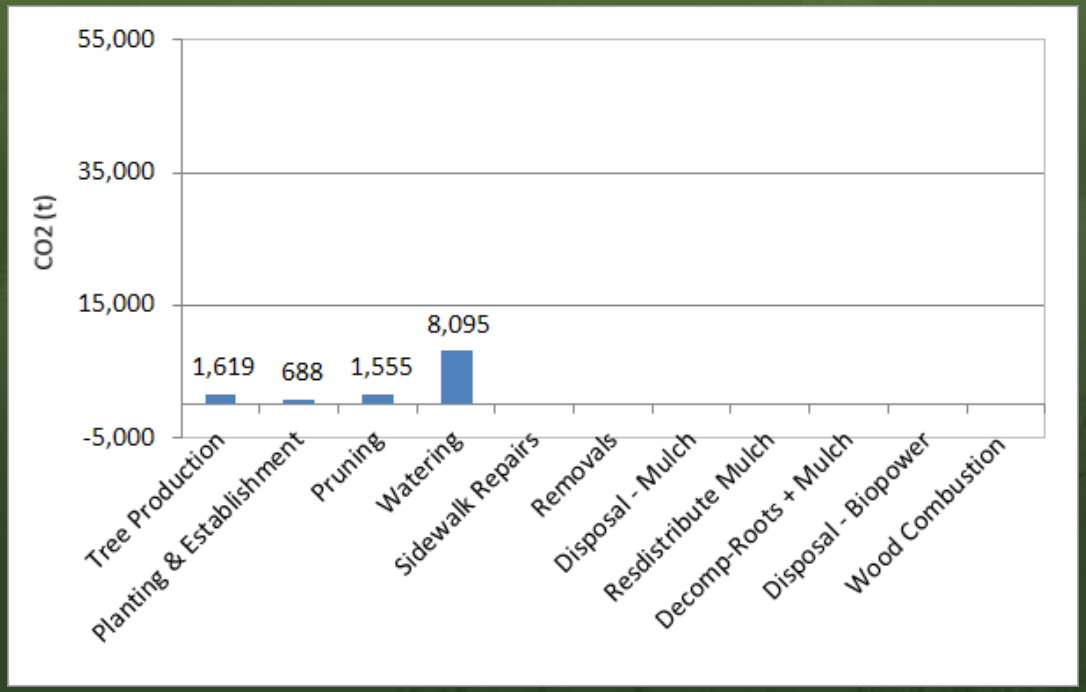
MTLA - Pruning

- Street
  - 40 yr cycle
  - Two trucks, chain saw, chipper (115 hp)
- Park
  - 20 yr cycle
  - Two trucks, chain saw, chipper (80 hp)
- Yard
  - 15% never pruned, 10 yr cycle
  - Two trucks, chain saw, chipper (125 hp)



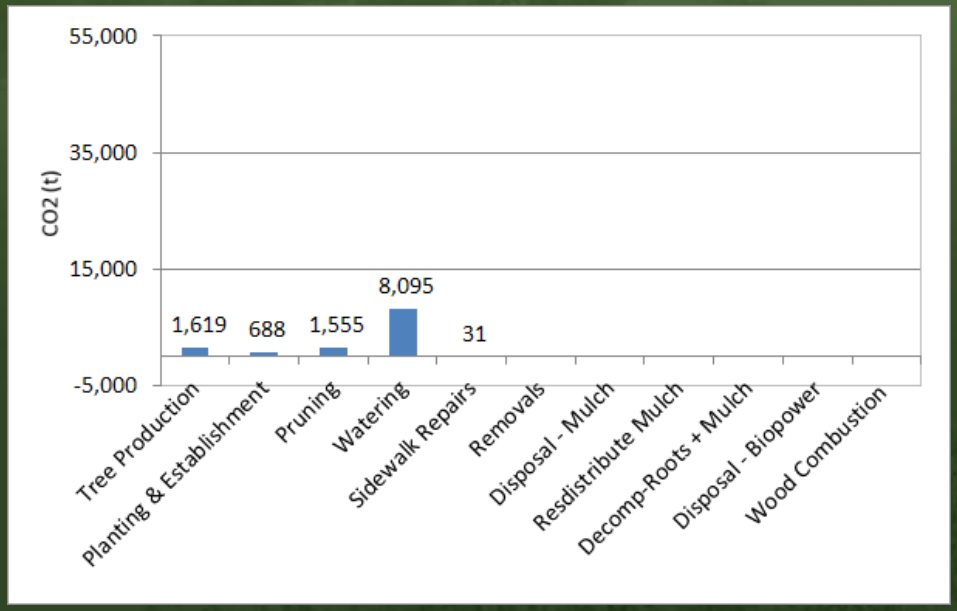
MTLA - Watering

- 7.4 billion gals, 2,300 gal/tree/yr, 9 gals/day
- 74% Street



MTLA – Sidewalk Repair

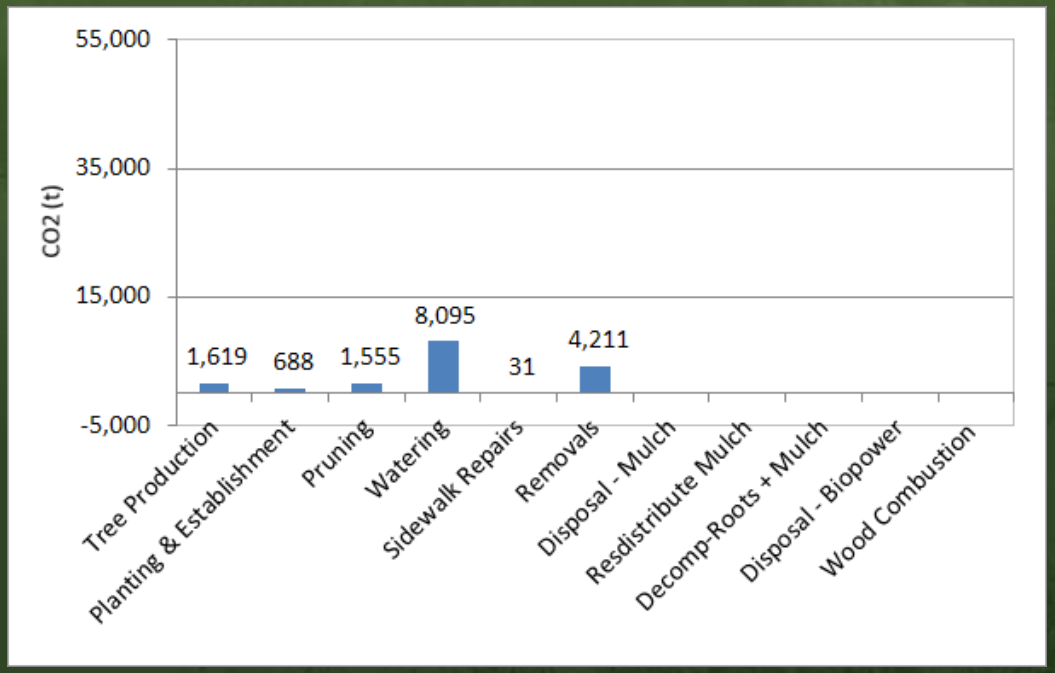
- Species
- Schedule
  - Grind: 10, 25, 40 yr
    - Two trucks, grinder, generator
  - Remove & replace: 15 and 30 yr
    - Prune crown and roots: trucks, chainsaw, cutter, chipper
    - Excavate & repour: loader
    - Haul concrete to recycling: loader, heavy duty truck
    - Crush & screen: wheel loader, crusher, screener



Cedrus spp.
Chitalpa tashkentensis
Cinnamomum camphora
Ginkgo biloba
Jacaranda mimosifolia
Koelreuteria spp.
Magnolia grandiflora
Platanus spp.
Quercus agrifolia
Rhus lancea
Tristania conferta
Ulmus parvifolia

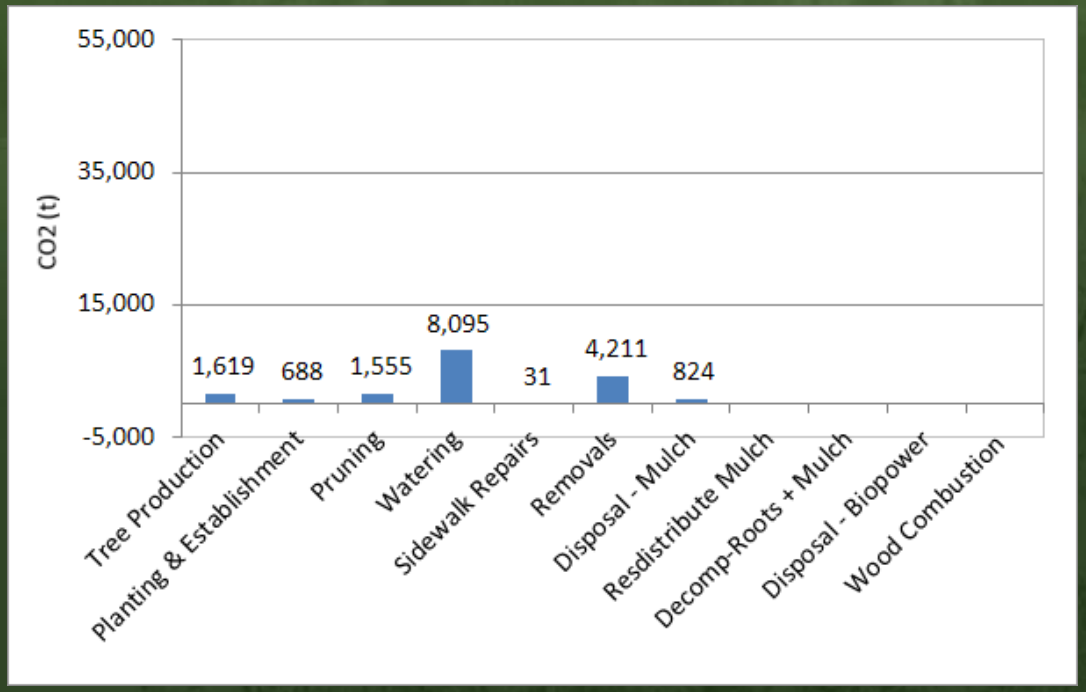
MTLA – Tree Removal & Stump Grinding

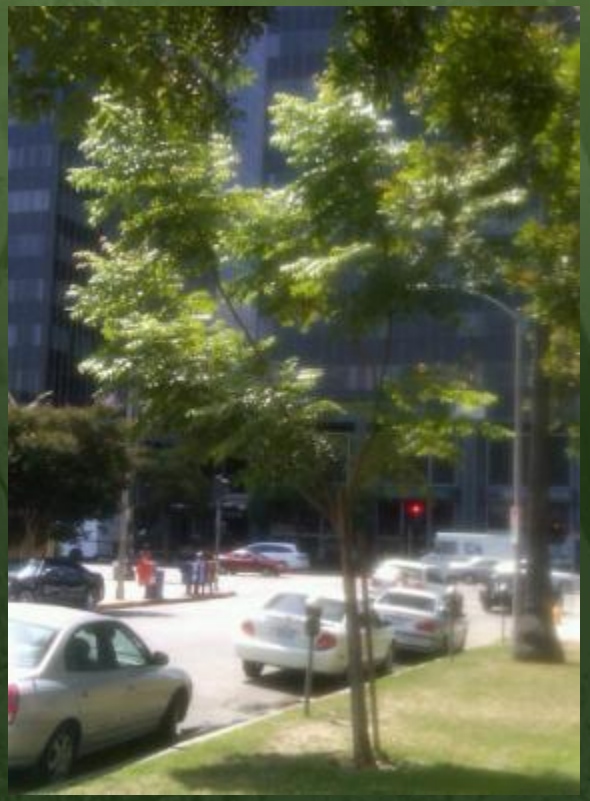
- Street
  - 100% removed and ground
  - Trucks, chainsaw, chipper (115 hp), grinder (77 hp)
- Park
  - 75% removed, 50% ground
  - Trucks, chainsaw, chipper (80 hp), grinder (140 hp)
- Yard
  - 15% never removed, 85% of rest removed, 50% ground
  - Trucks, chainsaw, chipper (125 hp), grinder (27 hp)



MTLA – Biomass Disposal

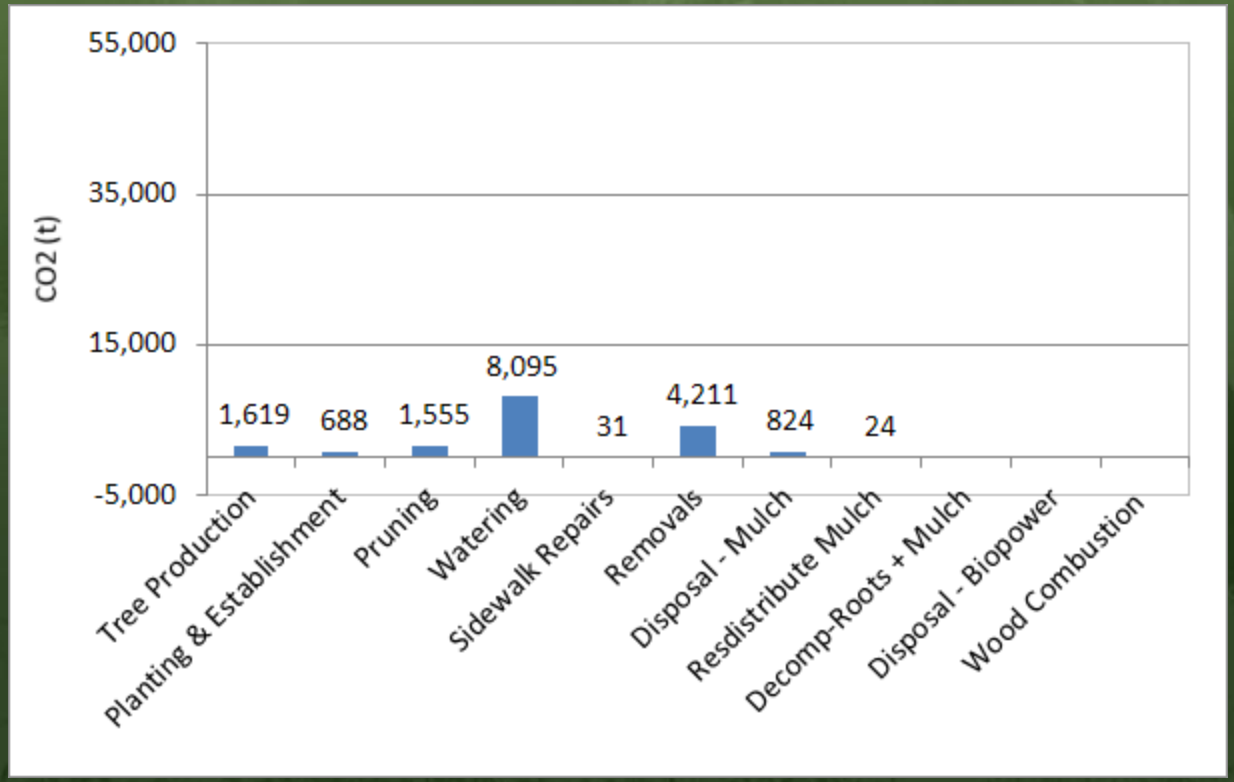
- Street & Park
  - Van Norman & Griffith Park: 77% converted
  - On-site: 2 trucks, tub grinder
  - Constant: 13.5 kg CO_2 per t DW





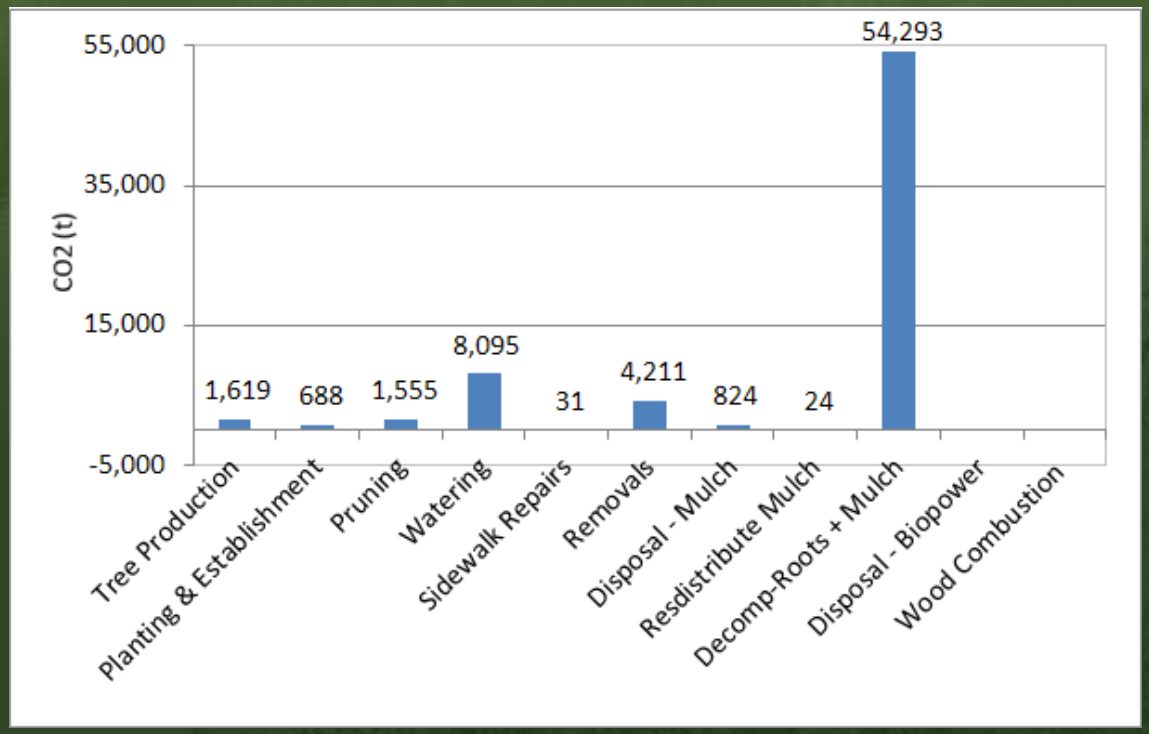
MTLA – Redistribute Mulch

- Street and Park
  - 2 light duty trucks

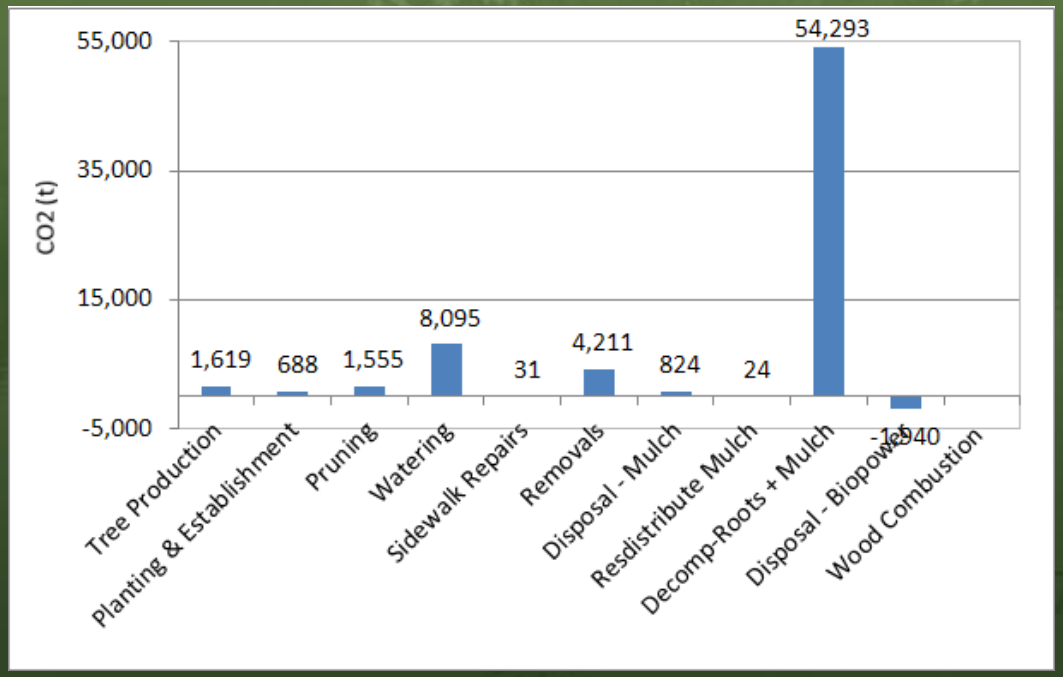


MTLA - Decomposition

- Mulch
  - 100% released immediately
- Root Biomass Dead Trees
  - 22% of total tree biomass
  - 80% released immediately

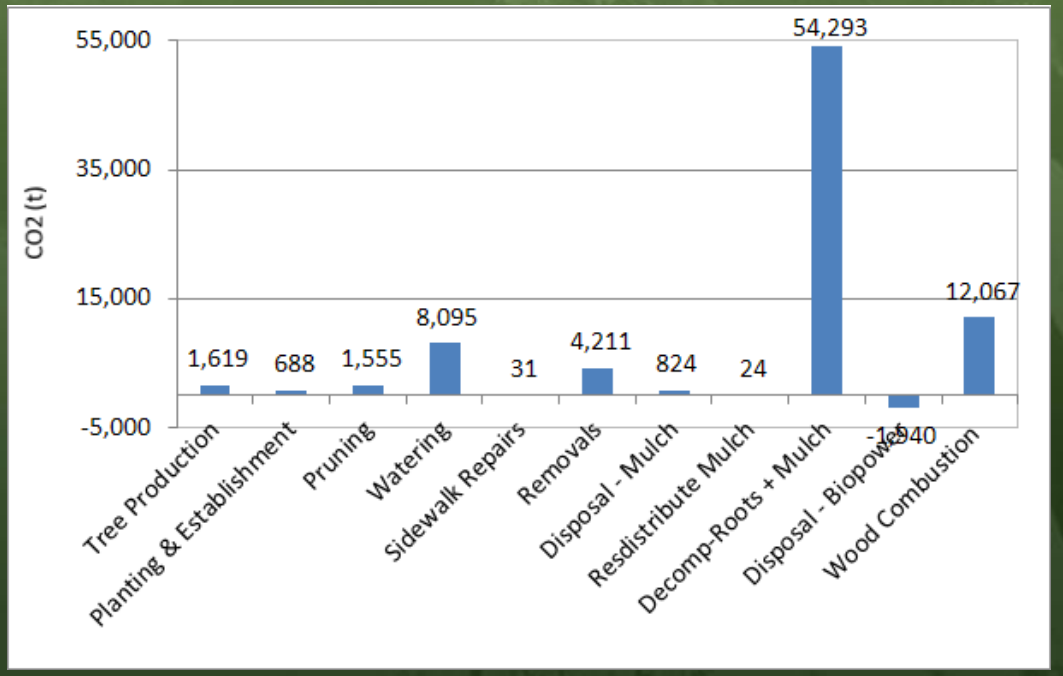


MTLA - Biopower

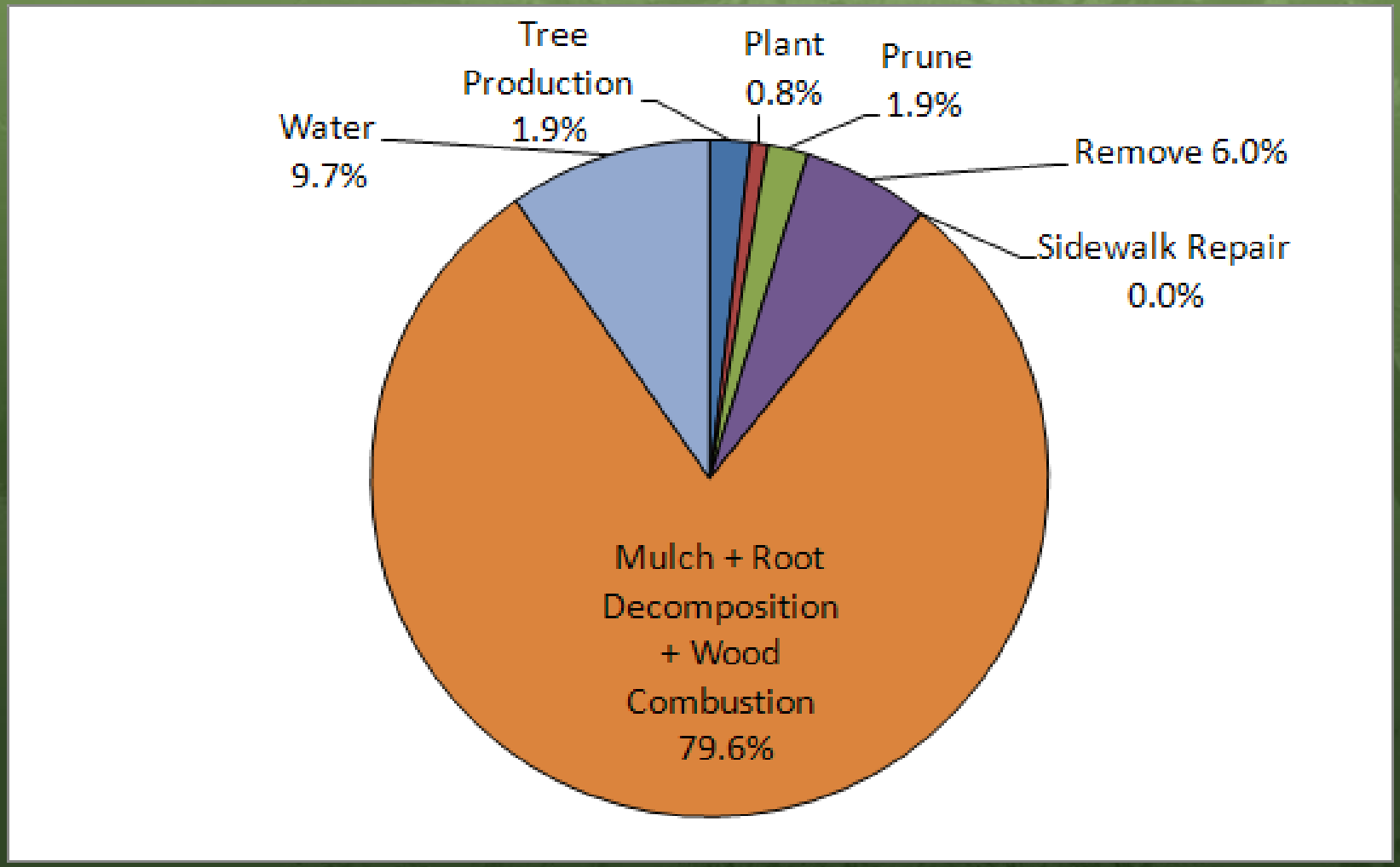


- Yard
  - Crown Disposal trucks to Dinuba (492 km, 600 trips/yr)
  - Dinuba power plant: 70% on, 80,626 t DW fuel/yr
  - Sell electricity to PG&E – Avoided Emissions
  - Constant: 295 kg CO_2 per t DW

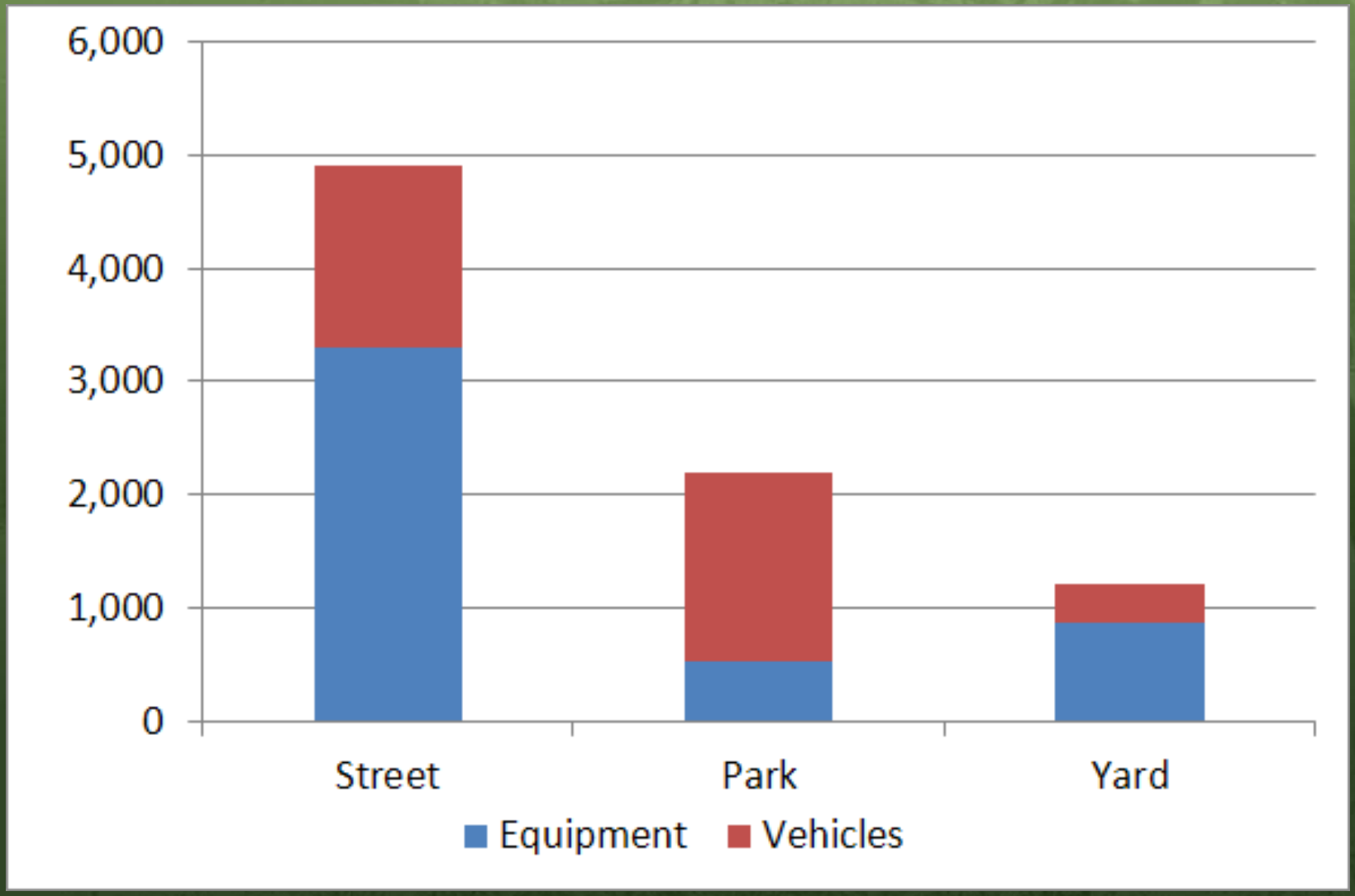
MTLA – Wood Combustion



Emissions Total 40 Years – 83,408 t



Equipment & Vehicle Emissions



MTLA – CO_2 Sink or Source?

- Sink
  - Emissions 46% of Uptake
  - Net Uptake = -98,053 t
  - -26.7 kg/tree/yr

Removal	CO_2 (t)	Release	CO_2 (t)
Stored (Live trees)	-73,703	Equipment	4,704
Stored (Roots)	-4,139	Vehicles	3,602
Avoided (Energy)	-101,679	Water	8,095
Avoided (Biopower)	-1,940	Tree Prod. Mats.	648
		Mulch Decomp.	45,269
		Root Decomp.	9,023
		Wood Combustion	12,067
Total	-181,460	Total	83,408
Net Total	-98,053	Net/tree/yr (kg)	-26.7

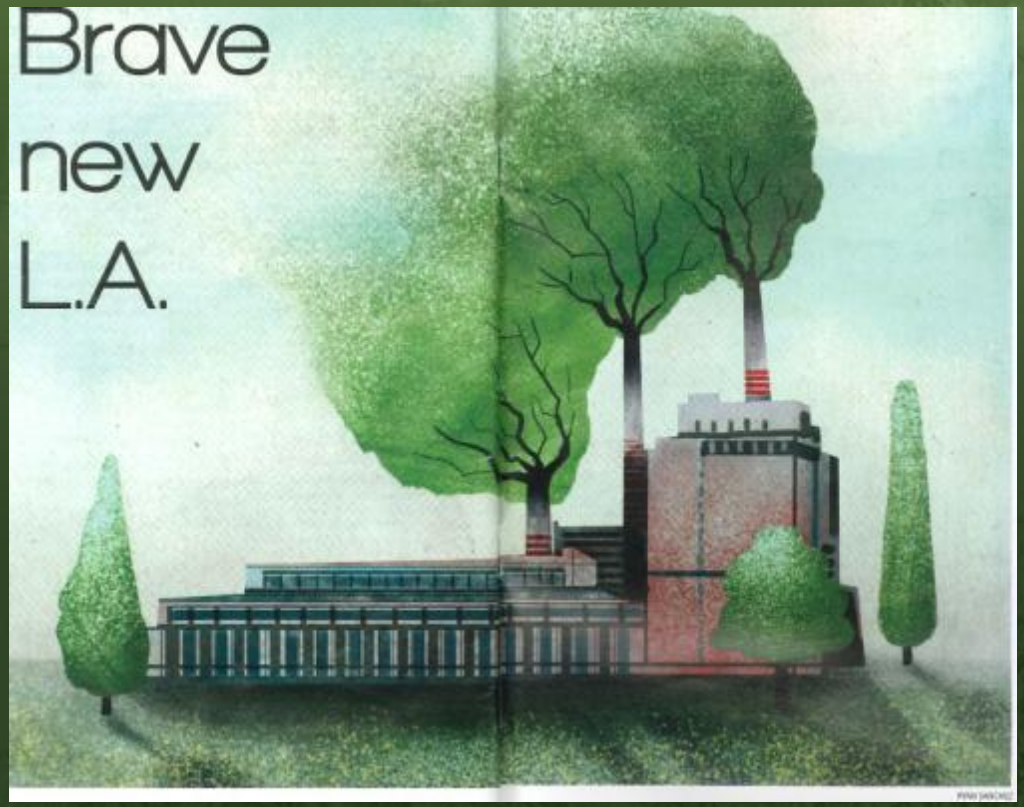
MTLA – Hot Spots?

- Decomposition
  - Wood products
  - Biopower
- Water
  - Species: 9 low, 34 mod water use
  - Soil management
  - Irrigation efficiency & rainwater harvesting
- Mortality & Removal
  - Vehicle & equipment emissions
  - Creates biomass to process & decomposition
  - Reduces uptake by live trees

Conclusions

- Function or Fashion?
- Sink or Source?

- Functional Ecosystem Services Produced!
- Sink: Net CO_2 Uptake!



Reducing Your Carbon Footprint: Vehicles

- Consult on bike
- Aluminum box
- Hybrid fuels

Reducing Your Carbon Footprint: Equipment

- Battery powered: chain saw & blower
  drill & grinder
- Chipper powers generator, charges battery,
  power inverter gives electricity for equip.


STIHL

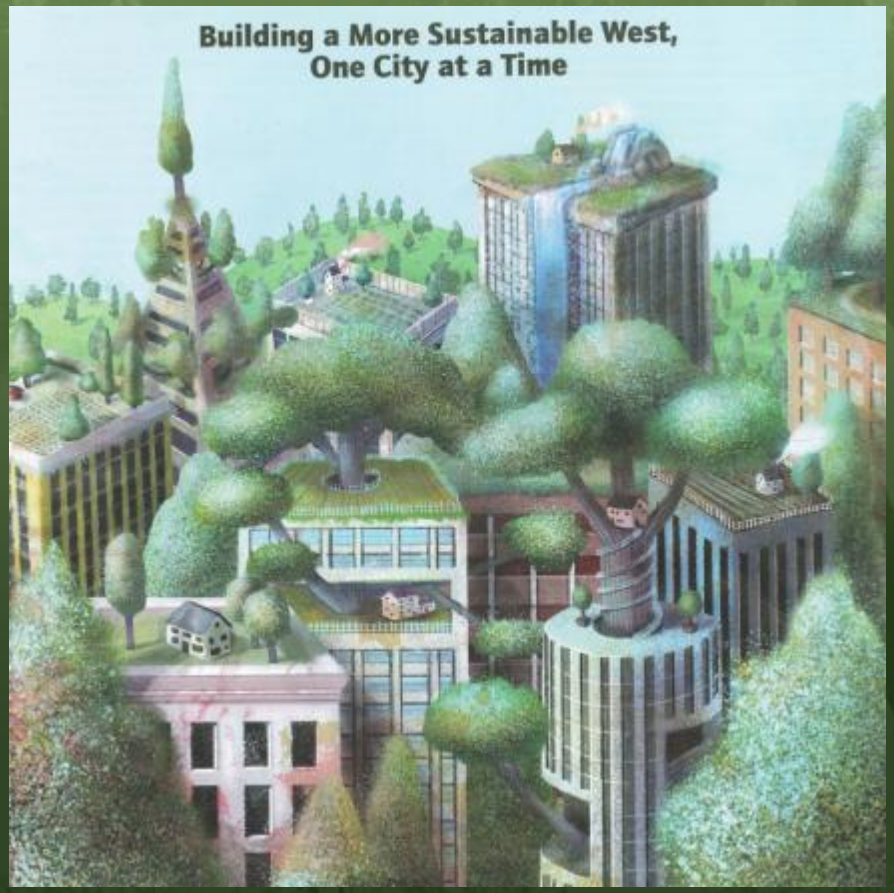

STIHL
BEEVER

Reducing Your Carbon Footprint: Other Practices

- Sterilize hand-tools (STreeDs)
- Biodegradable oil
- Be safe – 15 kg waste/day

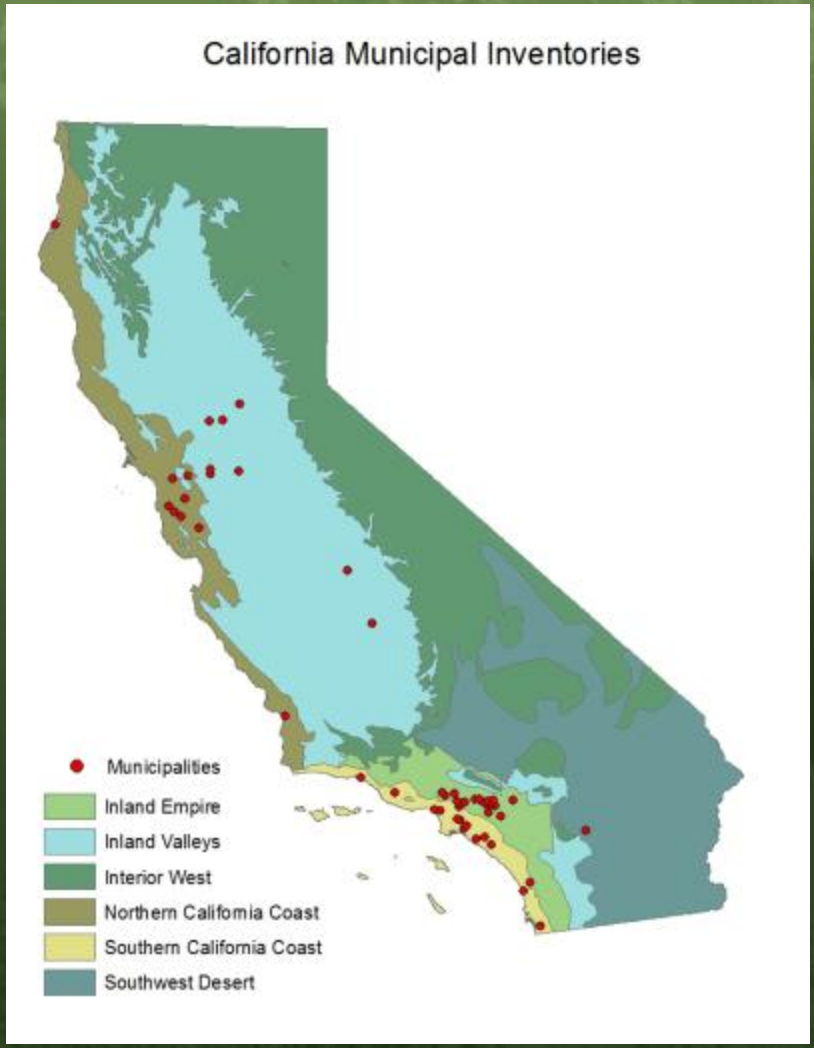
Marketing Green Practices

- You care about the environment
- You care about their neighborhood
- You care about them



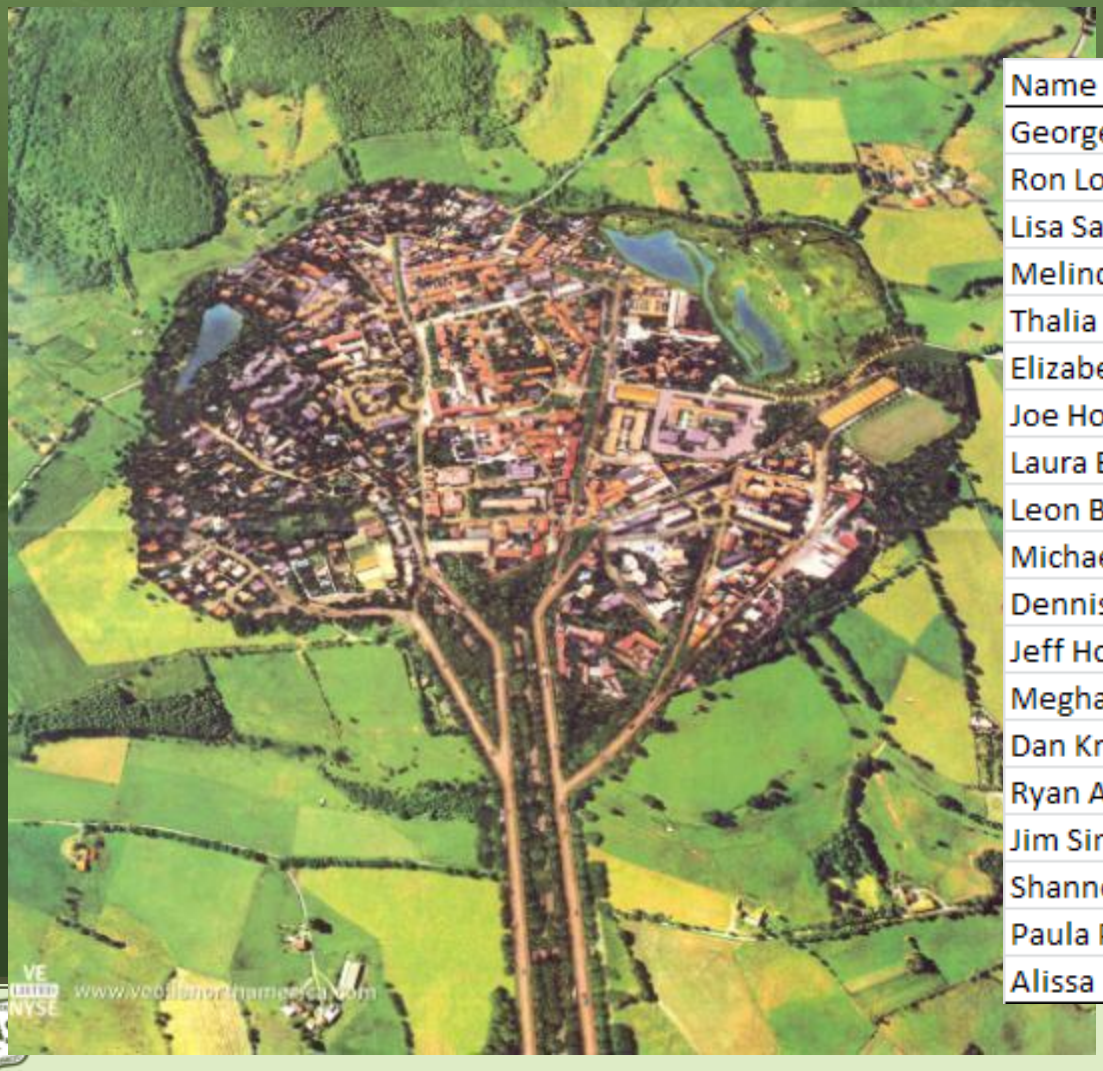
California's Urban Forests Top Down & Bottom Up

- Statewide Inventory of Urban Forest Carbon Stocks
- CAR Urban Forest Protocol Revision
- Testing "Climate-Ready" tree species



Thank You!

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



Name	Organization
George Gonzalez	LA Bureau of Street Services
Ron Lorenzen	LA Bureau of Street Services
Lisa Sarno	MTLA
Melinda Bartlett	MTLA
Thalia Uribe	MTLA
Elizabeth Skrzat	MTLA
Joe Hornbeck	Valley Crest
Laura Baurenfeind	LA Recreation and Parks Dept.
Leon Boroditsky	LA Recreation and Parks Dept.
Michael Kukavina	Utiliquest
Dennis Lord	Southern California Gas Co.
Jeff Hovey	LA Dept. Water & Power
Meghan Shearer	Los Angeles Condervation Corp
Dan Knapp	Los Angeles Condervation Corp
Ryan Allen	TreePeople
Jim Simpson	US Forest Service PSW
Shannon Albers	UC Davis
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Alissa Kendall	UC Davis