Climate-Ready Trees for Near-Roadway Air Quality Mitigation

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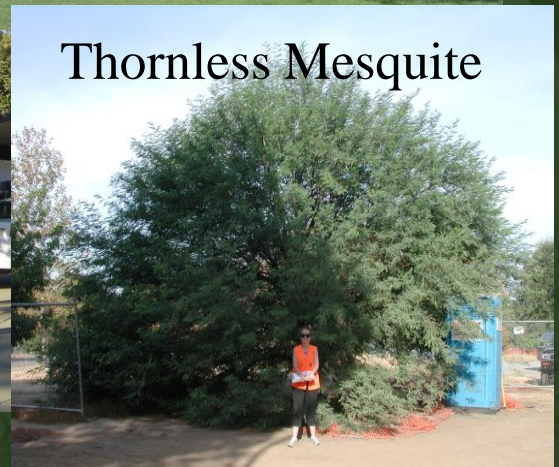Horticulture & Agronomy
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Texas Red Oak
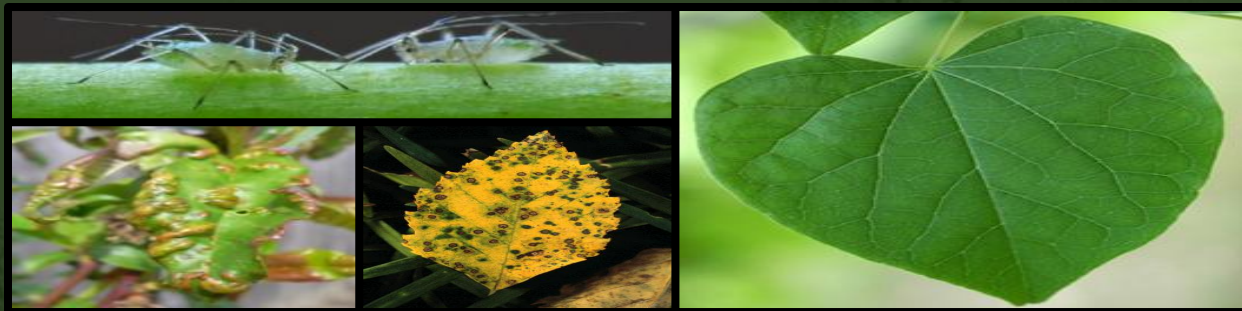
Texas Live Oak

Thornless Mesquite

Goal: Stable, Healthy, Functional Roadside Vegetation

Background

- Risk of tree loss
  - Limited diversity
  - Poorly-adapted species
- Two points of leverage
  - Tree selection
 - Tree maintenance

Goal

- Change tree palette to more resilient species
- 20-year study to test promising cultivars
  - Resilience to climate change
  - Other qualities
- Network of sites and collaborators
- Share performance information

Adaptation

- Exposure – extent?
  - Temperature
  - Precipitation
  - Wind
- Sensitivity – how react?
- Adaptive Capacity – potential to adapt?

TEMPERATURE: DEGREES OF CHANGE MAP

Degrees Changed
9.7 °F
8.5 °F
7.4 °F
6.3 °F
5.1 °F
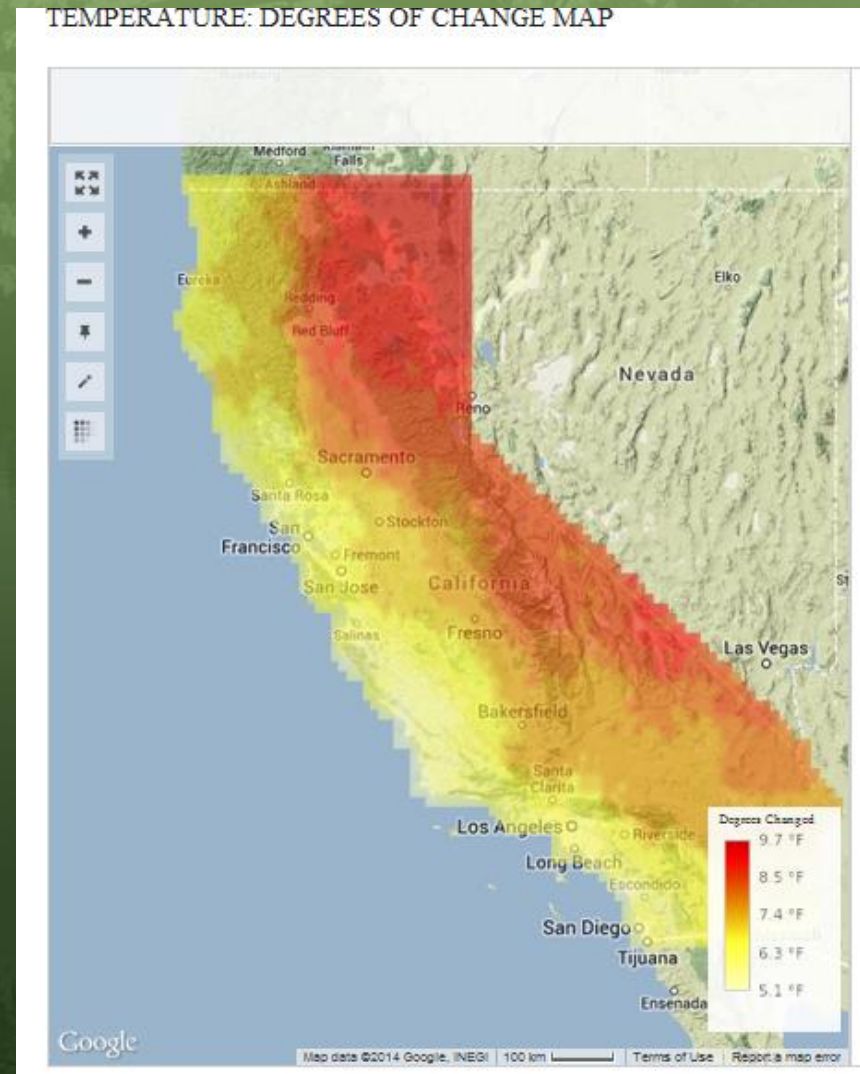
Existing Climate Zones

- USDA Hardiness Zones: average annual minimum temperature

- Inland Valley:

Zones 9A and 9B

California Climate Zones

- Inland Empire
- Inland Valleys
- Interior West
- Northern California Coast
- Southern California Coast
- Southwest Desert

Projected Climate

- Temperature
  - 1½ zone changes
- Precipitation
  - 110% increase
  - More winter, less summer

City	2010-2019 Avg Min Temp (°F)	Current Hardiness Zone	2080-2089 Avg Min Temp (°F)	Predicted Hardiness Zone
Redding	34.1	**9B** ->10A	40.6	10A-> **11A**
Sacramento	36.7	**9B** ->10B	42.4	10B-> **11A**
Merced	33.6	**9A** ->10A	38.9	10A-> **10B**
Fresno	34.6	**9B** ->10A	40.0	10A-> **11A**
Bakersfield	36.3	**9B** ->10B	41.5	10B-> **11A**

Projected Changes in USDA Hardiness Zones

10F to 15F		8a
15F to 20F		8b
20F to 25F		9a
25F to 30F		9b
30F to 35F		10a
35F to 40F		10b
40F to 45F		11

http://cal-adapt.org/tools/

Species Profiles

TRAIT	Source	Description
HABITAT SPECIFICITY		
Soil Moisture	Selec Tree	Soil moisture required by tree species for establishment.
Soil Texture and pH	Selec Tree	Trees species tolerance of a range of soil pH and textures.
Sunlight Exposure	Selec Tree	Tree species tolerance of full sun, shade, and filtered exposure.
PHYSIOLOGY		
Drought Tolerance	WUCOLS	Water needs of tree species: high, moderate, or low water needs.
Wind Tolerance	Selec Tree	Branch strength of tree species: strong, medium, weak.
Salt Tolerance	Selec Tree and Wu and Dodge 2005	Salinity tolerance
Cold Hardiness	USDA Cal-Adapt	Species tolerance of minimum temperatures in Central Valley.
BIOLOGICAL INTERACTIONS		
Invasiveness	Cal-IPC	Potential for species invasiveness: severe, moderate, minor.
Current Pest and Disease Threats	Pest Vulnerability Matrix (PVM)	Current pest and disease threats that pose risk to tree species.
Emerging Pest and Disease Threats	Pest Vulnerability Matrix (PVM)	Emerging pest and disease threats that could pose risk to tree species in the future.

12 Selected Cultivars

Scientific Name	Common Name
Australia	
Acacia aneura	Mulga
Acacia stenophylla	Shoestring Acacia
Eucalyptus papuana	Ghost Gum
Southwest US- Drought Tolerant	
Chilopsis linearis	Desert Willow
Parkinsonia x 'Desert Museum'	Desert Museum Palo Verde
Prosopis glandulosa x 'Maverick'	Thornless Honey Mesquite
Oklahoma-Texas US - Deciduous	
Celtis reticulata	Netleaf Hackberry
Ebenopsis ebano	Texas Ebony
Maclura pomifera 'White Shield'	White Shield Osage Orange
Quercus canbyi	Canby's Oak
Asia	
Dalbergia sissoo	Rosewood
Ulmus propinqua	Emerald Sunshine Elm

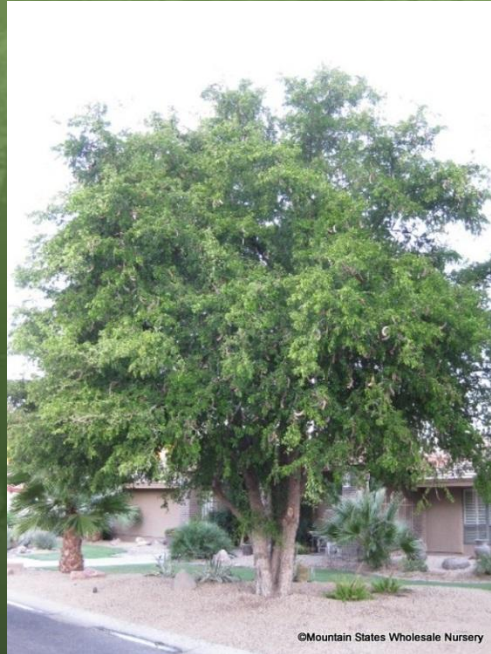# Southwest US

Desert Willow

Honey Mesquite

Palo Verde "Desert Museum"

© J. Frank Schmidt & Son Co.

Osage Orange 30'-50'

©Mountain States Wholesale Nursery

Texas Ebony (thorns, borer)

© Mountain States Wholesale Nursery

Canby Oak – up to 50'

SelecTree

Netleaf Hackberry - up to 80'

Oklahoma, West Texas

Australia

Shoestring acacia

Mulga (*Acacia aneura*)

Ghost gum (*Eucalyptus papuana*), 60' height

Asia

Elm 'Emerald Sunshine'
Ulmus davidiana v *japonica*

35'; DED, elm leaf
beetle resistance

Rosewood (*Dalbergia sissoo*; India)

60', full leafy crown, highly
decay resistant, few pests
(root suckers)

Experimental Design

- Control plot UCD (48)

- 4 Sacramento parks (24 at each)

- Measure
  - Tree size
  - Crown vigor
  - Pruning, pest, disease
  - Soil type, temp, moisture
  - ET, minimum temperatures
  - Leafing out date

- Inland Empire & Coastal SoCal

SPCODE	Scientific	Common_Nam	Size
AA	Acacia aneura	Mulga	#15
AS	Acacia stenophylla	Shoestring acacia	#15
CR	Celtis reticulata	Netleaf Hackberry	#15
CL	Chilopsis linearis 'Bubba'	Desert Willow	#15
DS	Dalbergia sissoo	Rosewood	#15
EE	Ebenopsis ebano	Texas Ebony	24 box
EP	Eucalyptus papuana	Ghost gum	#15
MP	Maclura pomifera 'White Shield'	White Shield Osage Orange	BR
PD	Parkinsonia x 'Desert Museum'	Desert Mueseum Palo Verde	#15
PG	Prosopis glandulosa x Maverick	Thornless Honey Mesquite	24 box
QC	Quercus canbyi	Canby's oak	24 box
UP	Ulmus propinqua	Emerald Sunsine Elm	BR

North Laguna Creek Park

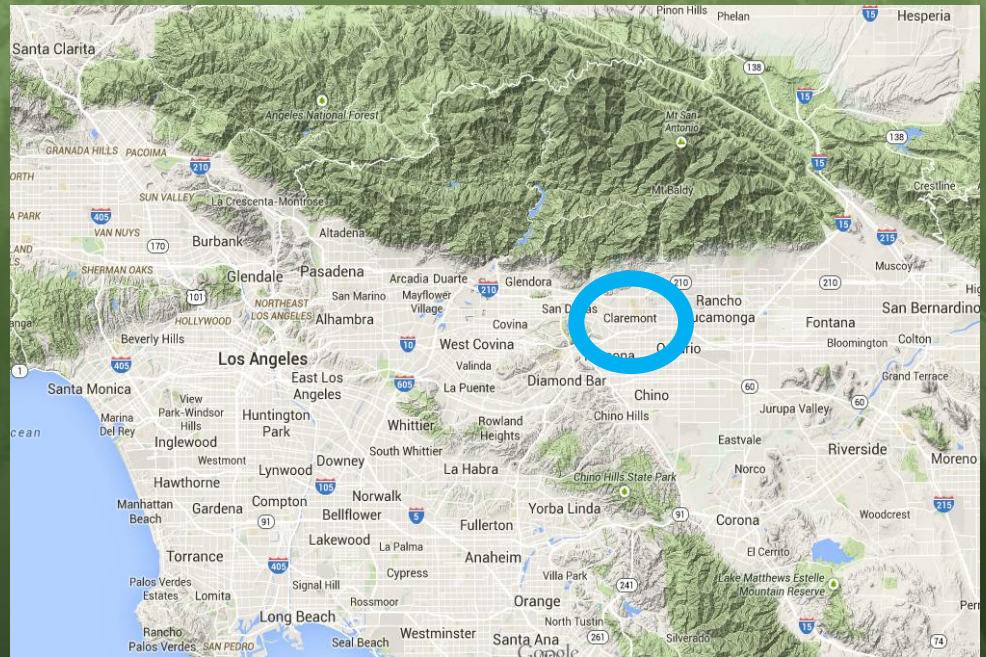Sacramento Tree Foundation

# Remeasurement of Claremont's Street Trees: What Can We Learn 14 Years Later?

Drs. Greg McPherson & Natalie van Doorn
Davis, California

- **Q1: What is the demography of the street tree population?**

- **Q2: Will the Claremont street tree population be resilient to a changing climate?**
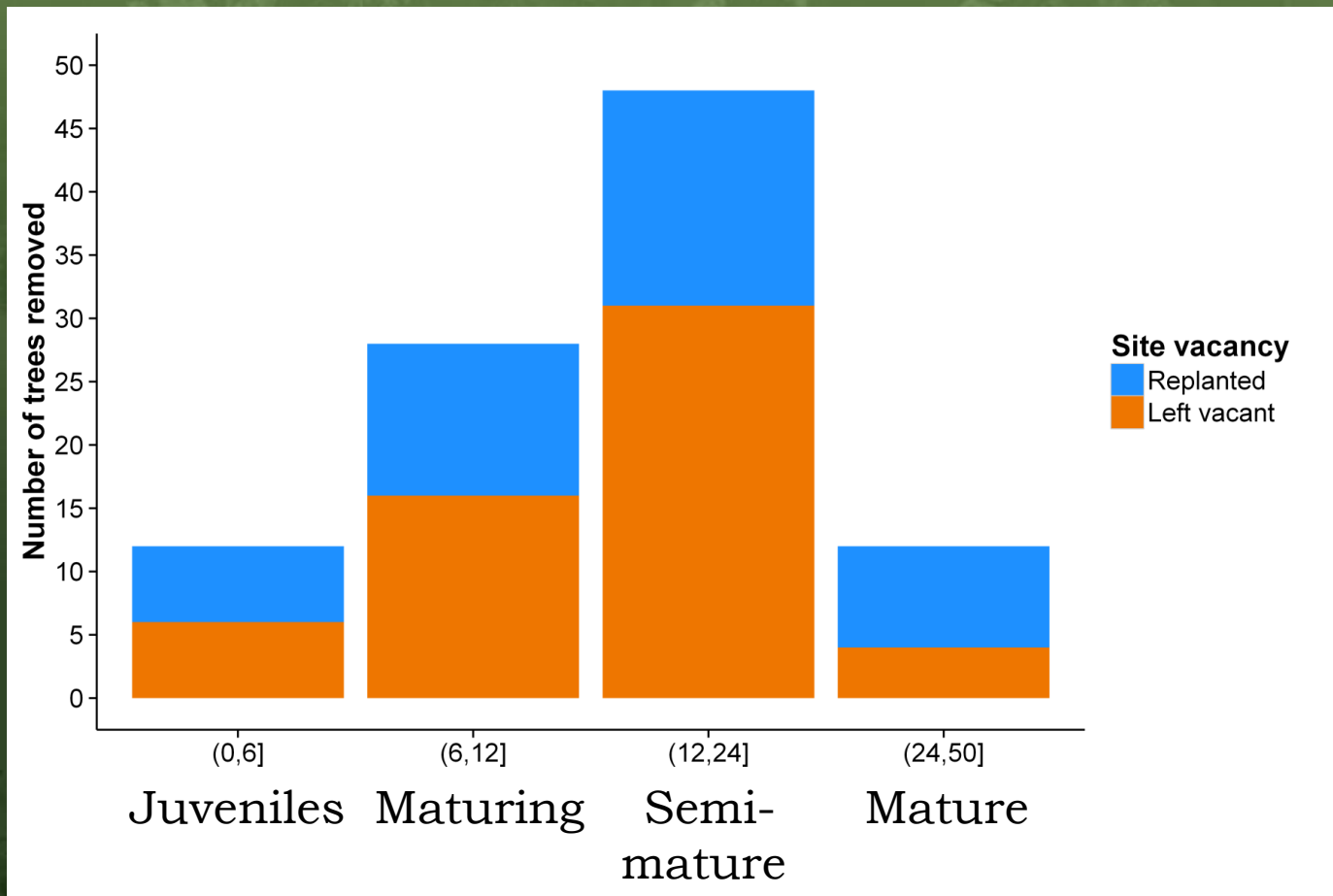
Methods

- 762 sites visited in 2000 & 2014

- 21 most abundant species
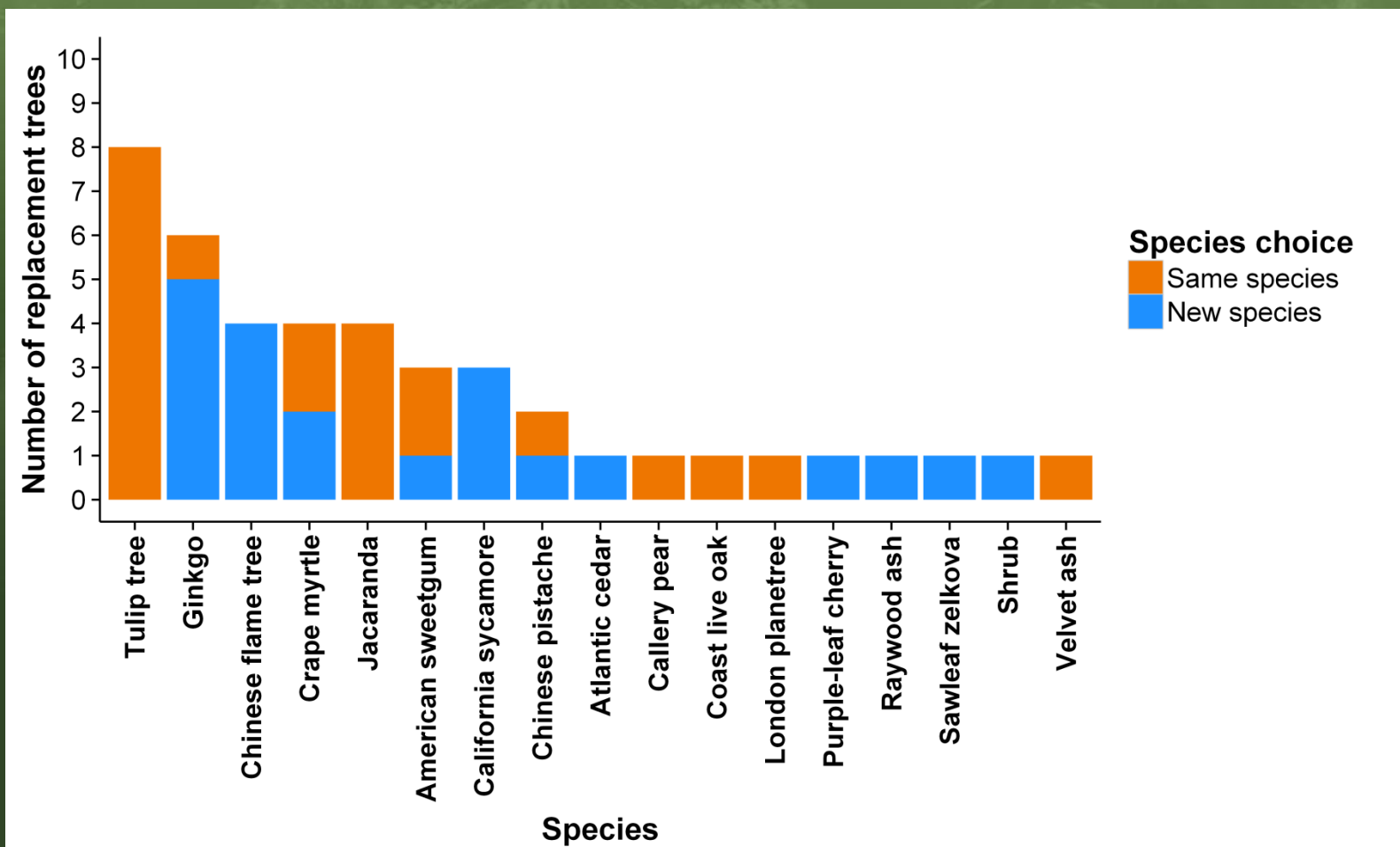
- Random selection stratified by size class
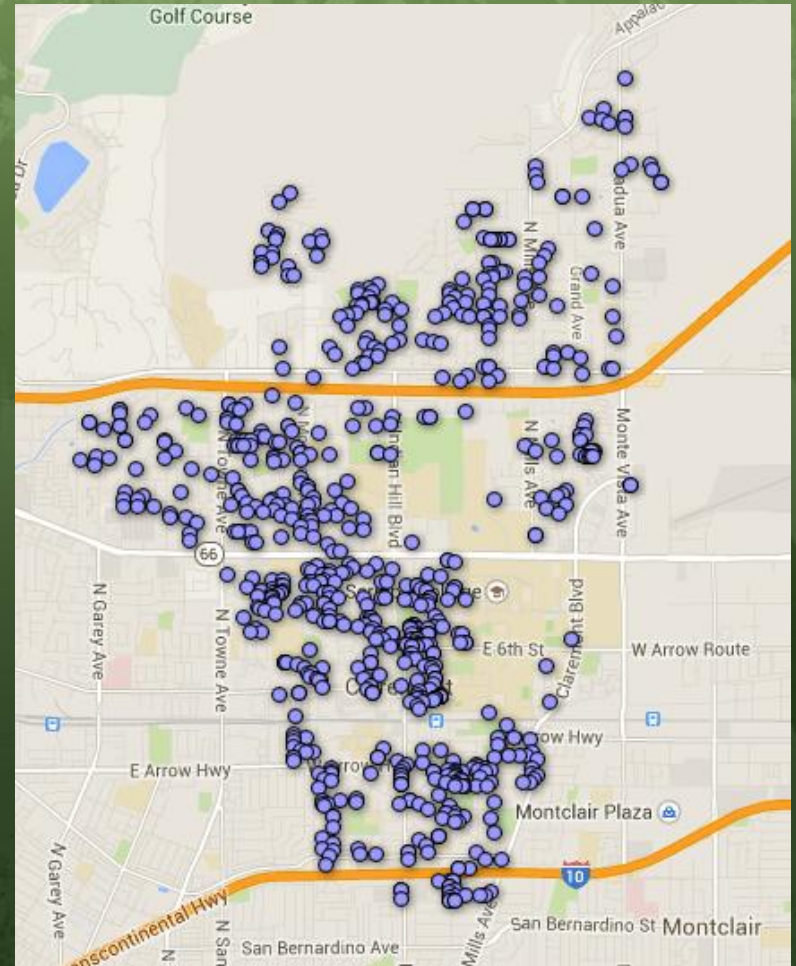
Replaced or left vacant?

- 58% of sites were left vacant
- Highest vacancy in semi-mature class

What are removed trees being replaced with?

GROWTH

MORTALITY

REPLACEMENT

Climate-readiness **+**

Special Features
Biogenic emissions
Shade potential
Longevity
Biodiversity
Aesthetics
Root damage potential
Litter
Native to CA
Carbon storage

Results

	Climate Ready
Pinus brutia	5
Schinus molle	5
Brachychiton populneus	4
Pinus canariensis	3
Pistacia chinensis	3
Schinus terebinthifolius	3
Quercus agrifolia	3
Quercus ilex	3
Ginkgo biloba	3
Eucalyptus sideroxylon	3
Cinnamomum camphora	2
Platanus racemosa	1
Cedrus atlantica 'Glauca'	1
Fraxinus uhdei	1
Platanus x hispanica	1
Fraxinus angustifolia	0
Lagerstroemia indica	0
Koelreuteria bipinnata	0
Pyrus calleryana	0
Zelkova serrata	-1
Jacaranda mimosifolia	-1
Fraxinus velutina	-1
Liquidambar styraciflua	-1
Liriodendron tulipifera	-2
Prunus cerasifera 'Atropurpurea'	-2
Magnolia grandiflora	-2

+

Special Features	GRAND TOTAL	
4	9	Pinus brutia
5	8	Pinus canariensis
2	7	Schinus molle
2	6	Brachychiton populneus
3	6	Pistacia chinensis
5	6	Cedrus atlantica 'Glauca'
2	5	Schinus terebinthifolius
2	5	Quercus agrifolia
2	5	Quercus ilex
4	5	Platanus racemosa
1	4	Ginkgo biloba
2	4	Cinnamomum camphora
0	3	Eucalyptus sideroxylon
3	3	Fraxinus angustifolia
3	2	Zelkova serrata
0	1	Fraxinus uhdei
1	1	Lagerstroemia indica
1	1	Koelreuteria bipinnata
0	0	Pyrus calleryana
1	0	Jacaranda mimosifolia
2	0	Liriodendron tulipifera
-2	-1	Platanus x hispanica
1	-1	Prunus cerasifera 'Atropurpurea'
1	-1	Magnolia grandiflora
-1	-2	Fraxinus velutina
-2	-3	Liquidambar styraciflua

Summary

- Claremont tree replacement
  - 42% is too low
  - 45% species with low resiliency is too low - need more resilient species

- Identifying roadside species for evaluation
  - Score climate-readiness
  - Identify & score other features (evergreen, BVOC, etc.)

- Evaluating performance
  - Experimental design
  - Partnerships and planting
  - Measurements and reporting

Questions?

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