Sycamore Genetics and Propagation Study

Presented by

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Ecological Consultants

Santa Clara Valley Water District

Loma Prieta Resource Conservation District

California Sycamore (*Platanus racemosa*)

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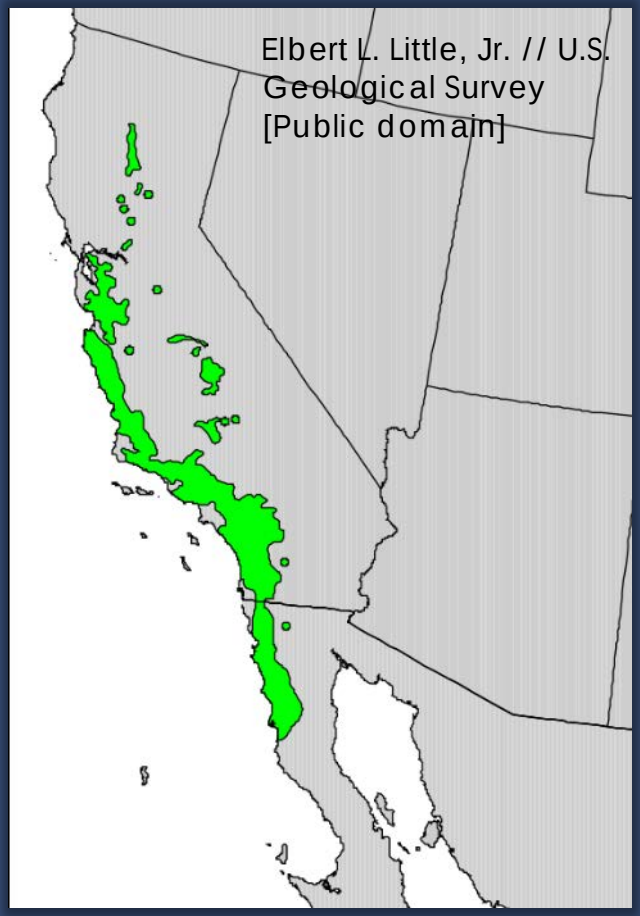
California Sycamores and Sycamore Alluvial Woodlands



California sycamore range

Sycamore alluvial woodland (SAW)

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California Sycamore Wildlife Habitat

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Current Concerns Regarding California Sycamores

- Lack of recruitment from seed
- Hybridization with non-native landscaping tree

Lack of Recruitment from Seed

- **Limited Natural Hydrologic and Geomorphic Processes**
  - Lack of high intensity floods
    - Little freshly deposited alluvium
    - Strong competition with riparian forbs and shrubs
    - Altered surface and groundwater hydrographs
- **Plant pathogens**
  - Anthracnose (*Gnomonia platani*)
  - Others

Hybridization: The Players

Native California sycamore
(*Platanus racemosa*)

Non-native London planetree
(*Platanus ×hispanica*)

Hybridization with London Planetree

London planetree in Gilroy

- London planetree is one of the most common street trees
- London planetree introduced to California in late 1800's
- California sycamore and London planetree readily hybridize (Whitlock 2003; Johnson et al. 2016)
- Produce viable offspring

Threats from Hybridization

London planetree in Morgan Hill

- Dilute native genetics/intrinsic value of native species
- Lead to outbreeding depression
- May lead to increased invasiveness of non-natives
- Potential reduction in habitat value (lack of cavities)

Statewide Need for Restoring and Conserving SAW

- **1990's CDFW study:**
  - 17 stands greater than 10 acres
  - Pacheco Creek in Santa Clara County is one of largest remaining stands

- **SCVHA VHP goals:**
  - 14 acres of SAW restoration
  - 40 acres of SAW acquisition/ conservation

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Challenges Restoring California Sycamores

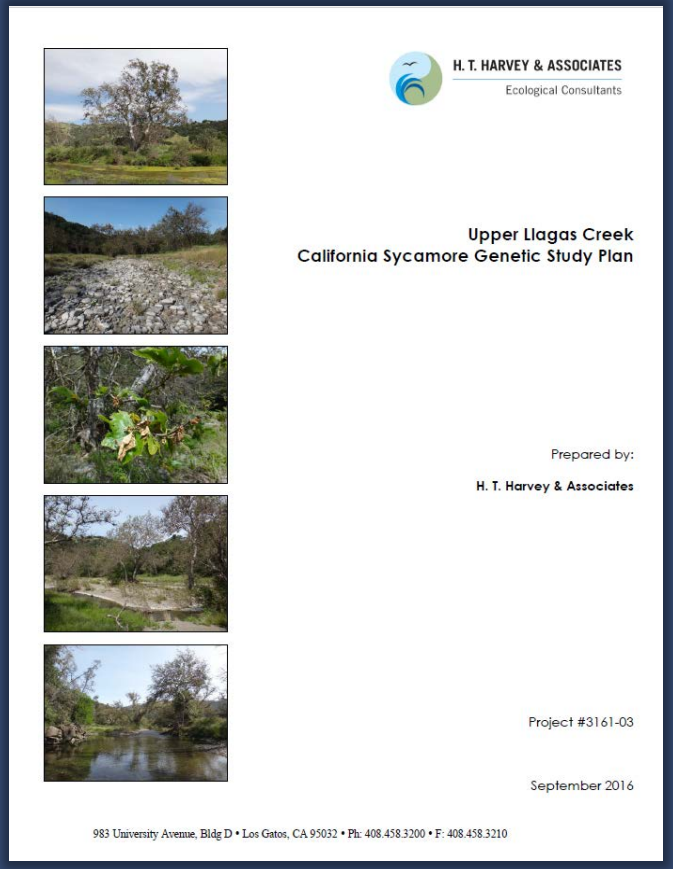
- Propagules from wild-collected seed may be hybrid
- Low survival of cuttings
- Cannot visually identify natives versus hybrids
- Lack of research and funding

Santa Clara Valley Water District
Upper Llagas Creek Flood Protection Project
LSAA Measure 3.4

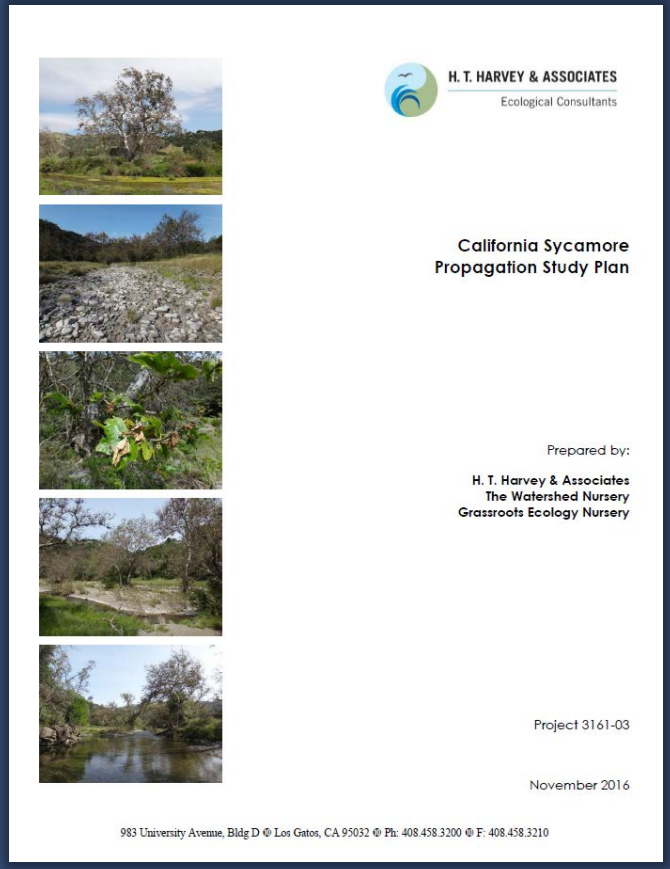
Sycamore Tree Mitigation. *In consideration of the dominance of the hybridization of native sycamore trees with the non-native London plane (Platanus x hispanica) trees in the South Bay, and the challenges of establishing successful, pure genetic stands of replacement sycamores due to soil and hydrologic limitations, loss of sycamore trees within the project area shall be compensated by a combination of in-kind, on-site sycamore planting and* ***out-of-kind mitigation in the form of a propagation and genetic study****.*

California Sycamore Genetic and Propagation Study Plans

Genetic Study Plan



Propagation Study Plan



Genetics Study Objectives

- **Objective 1.** Examine the degree of hybridization present in southern Santa Clara County, and compare the results of this study with those of previous hybridization studies conducted in the northern Sacramento Valley to determine the relative degree of hybridization in the regions.

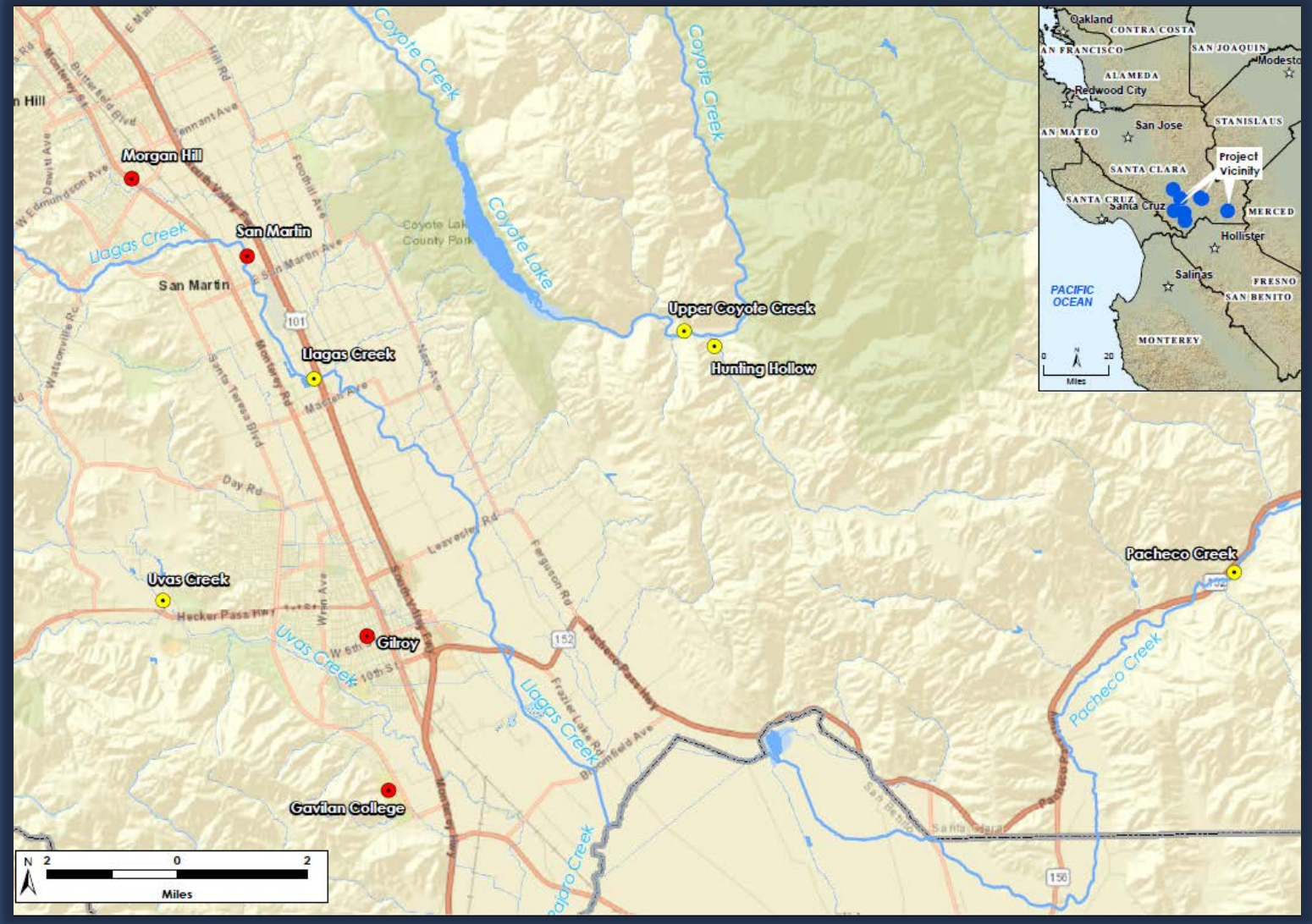
Genetics Study Objectives

- **Objective 2.** Use tree coring and the genetic analysis to determine approximately when hybridization began to occur in southern Santa Clara County. If a point in time can be identified before which hybridization did not occur, then we will identify the minimum tree size (diameter at breast height) that can be used as a “rule of thumb” to select pure California sycamore trees as source materials for propagation. Such a short cut would be a significant advantage for future sycamore restoration projects.

Genetics Study Objectives

- **Objective 3.** Identify genetically pure California sycamore "mother" trees for use in the propagation study associated with this project and for use in future habitat restoration projects.

Sampling Locations



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Leaf Sampling

- Collected leaves from 384 trees.
- Trees selected using generalized random-tessellation stratified sampling design
- Measured size (DBH) of each tree

Genetic Testing

- **Leaf samples taken to genetics lab at University of California, Davis**

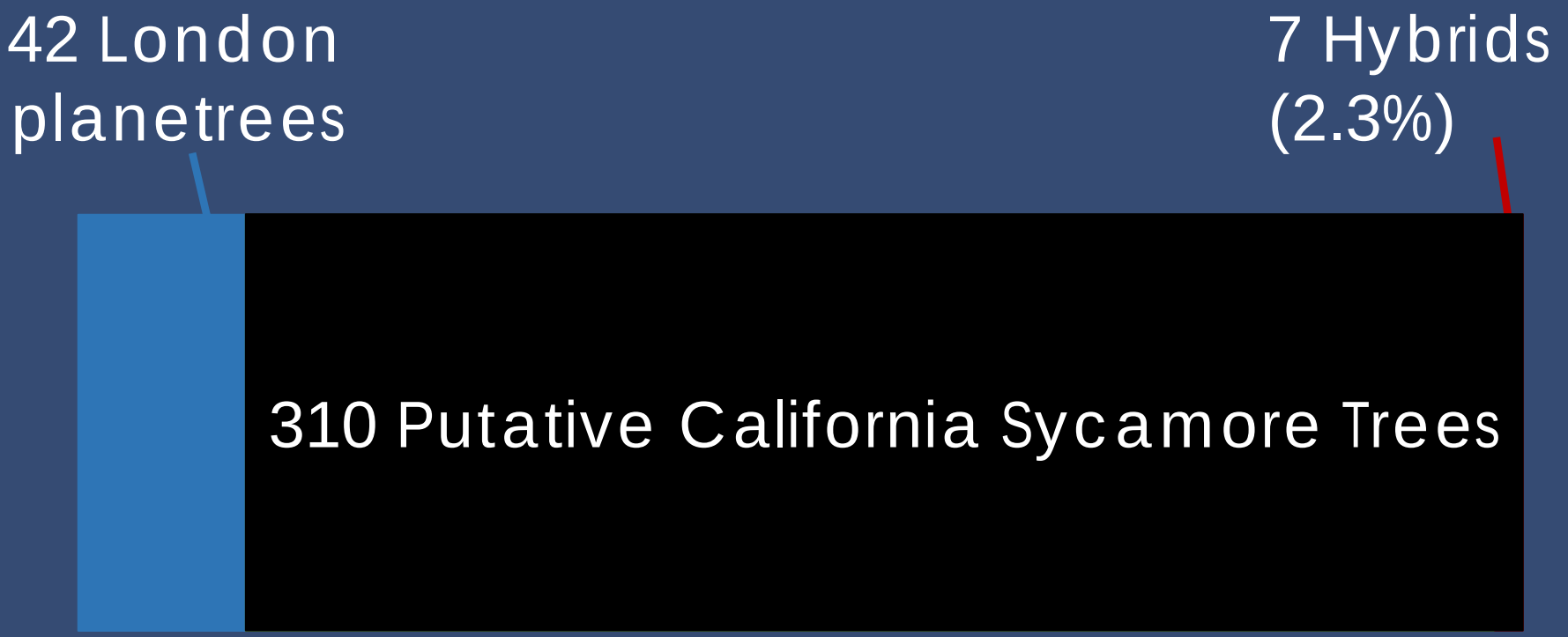
- **Sequenced each tree's DNA**
  - Restricted site associated DNA sequencing (RAD)

- **Compared to reference sequences**
  - Principle component analyses
  - Admixture analyses

Genetic Results

42 London planetrees

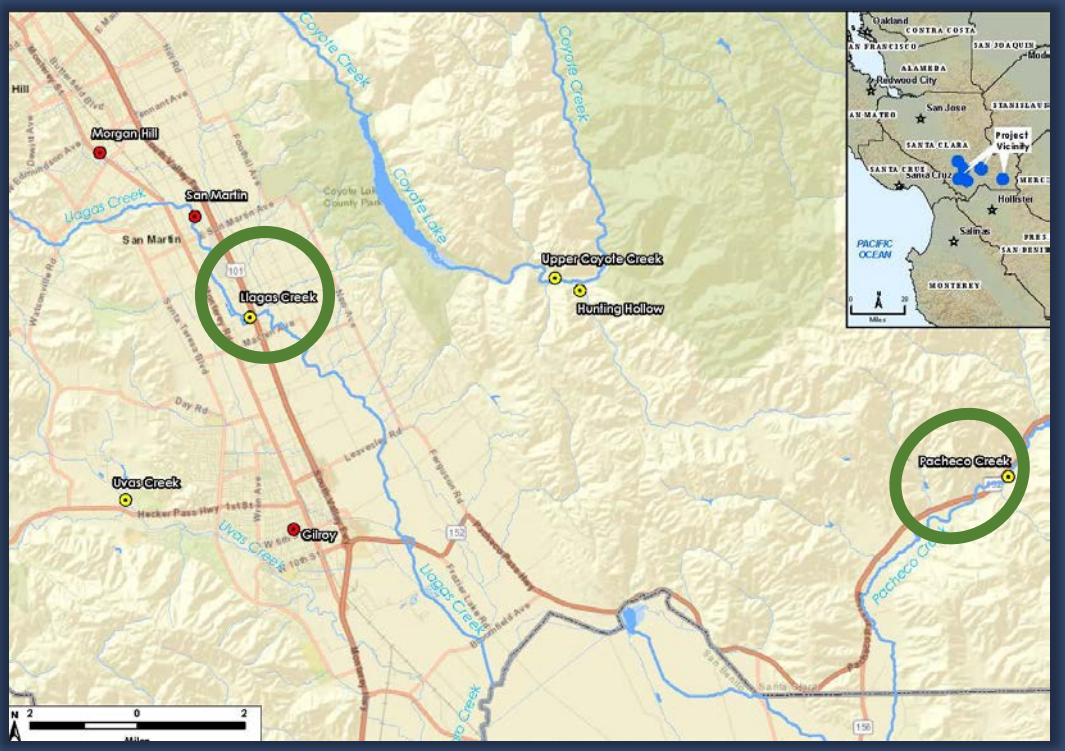
Genetic Results



Hybrids

Hybrid sycamores:

- **5 at Pacheco Creek, 2 at Llagas Creek**
- **Mean dbh of 6.4 inches**
- **Max dbh of 9.7 inches**



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Objective 1—Degree of Hybridization in Southern Santa Clara County

- **Hybrids may be uncommon in Santa Clara County (2.3% of sycamore sample)**
- **Along the Sacramento River had 15% hybridization**

Objective 2—Minimum Tree Size to Identify 100% Native California Sycamores

- Seven sampled hybrids in Santa Clara County were small
- Sample size too small to identify a minimum size for native sycamores
- Along Sacramento River, hybrids were common across age classes and present above 59 inch DBH

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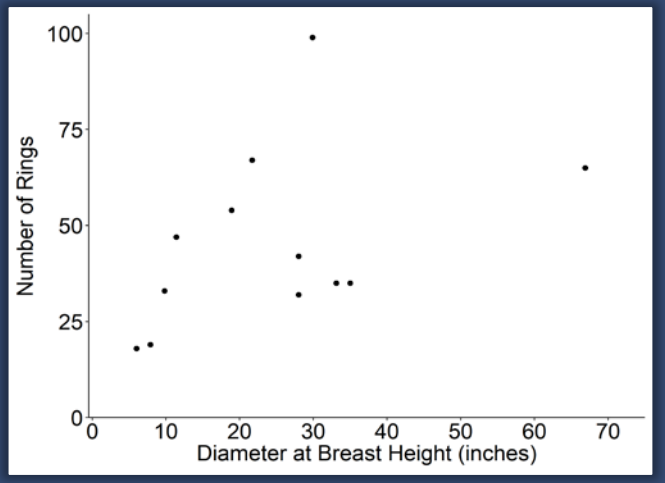
Tree Coring

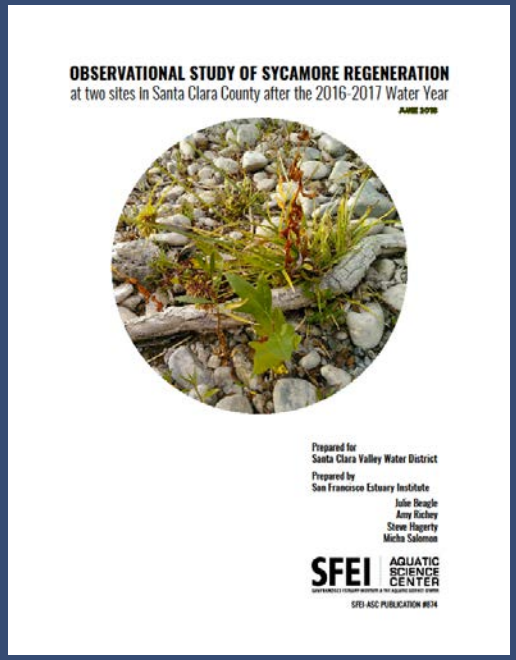
- **2016: 9 trees cored at Pacheco Creek and Upper Coyote Creek**

- **2017: 4 trees cored at Pacheco Creek and Upper Coyote Creek**

Tree Coring Results

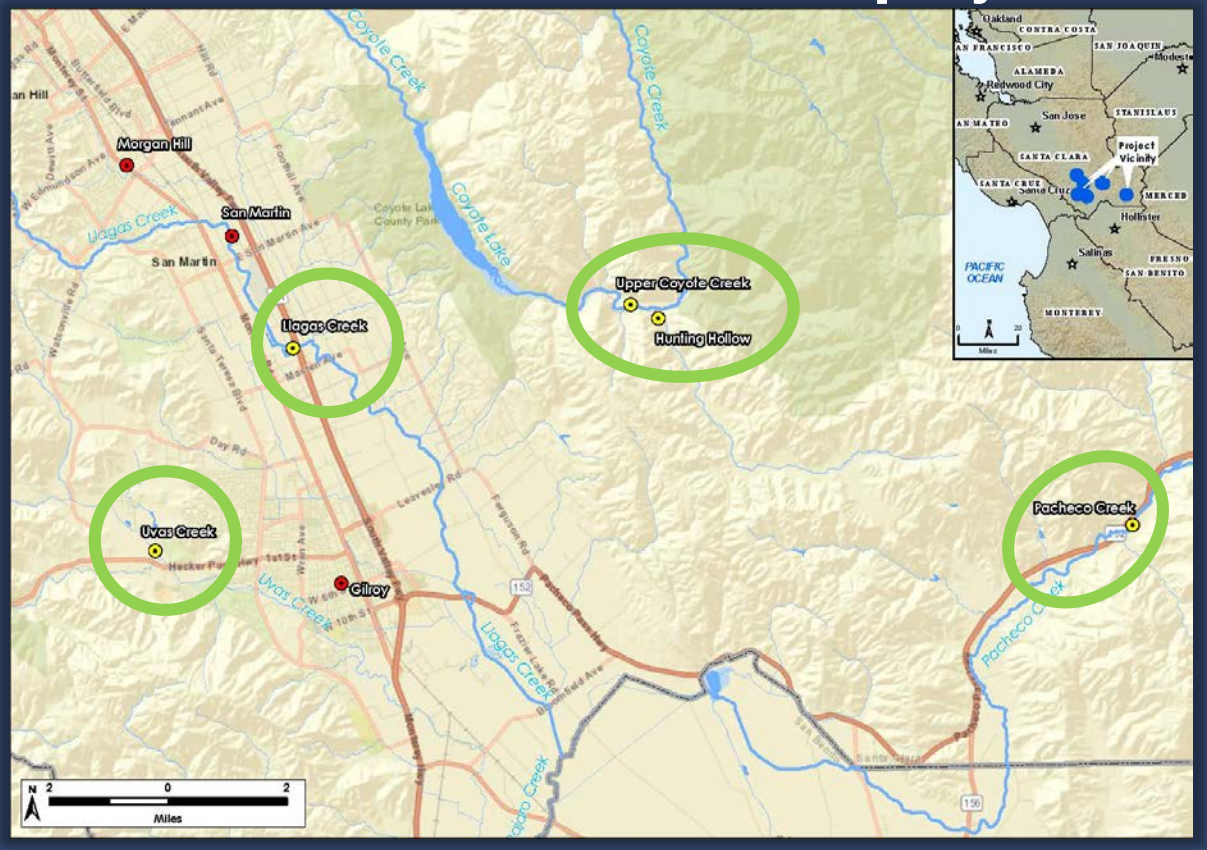
- **Many trees with heart rot**
- **Tree coring did not have clear results**
  - no patterns were found between age and size
- **SFEI Observational Study of Sycamore Regeneration**





Objective 3—Locations of 100% Native California Sycamores

- 303 verified native California sycamore trees
- Used in the propagation study
- Can be used for future restoration projects



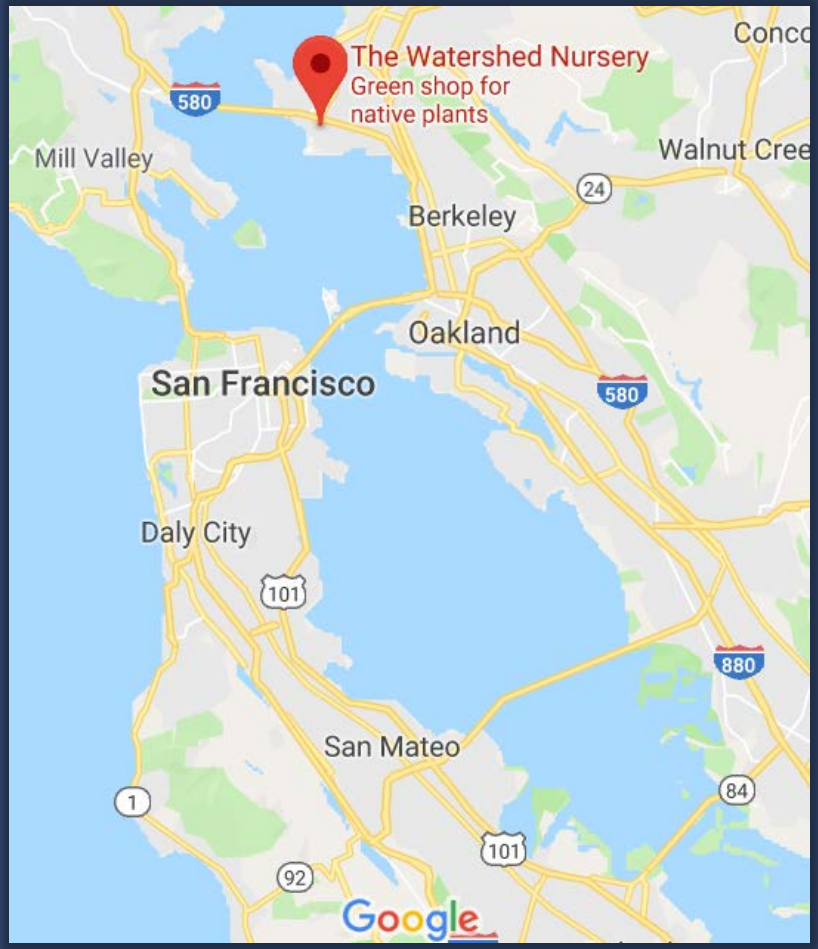
Propagation Study Objectives

- **Objective 1.** Advance the science of vegetative propagation of California sycamore
- **Objective 2.** Improve the cost-effectiveness of vegetative propagation of California sycamore
- **Objective 3.** Determine future studies that could be employed to build off the propagation study and further advance the science and efficiency of vegetative propagation of California sycamore.

Native Plant Nurseries

GRASSROOTS ECOLOGY

The Watershed Nursery



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THE WATERSHED NURSERY

Grassroots Ecology Nursery

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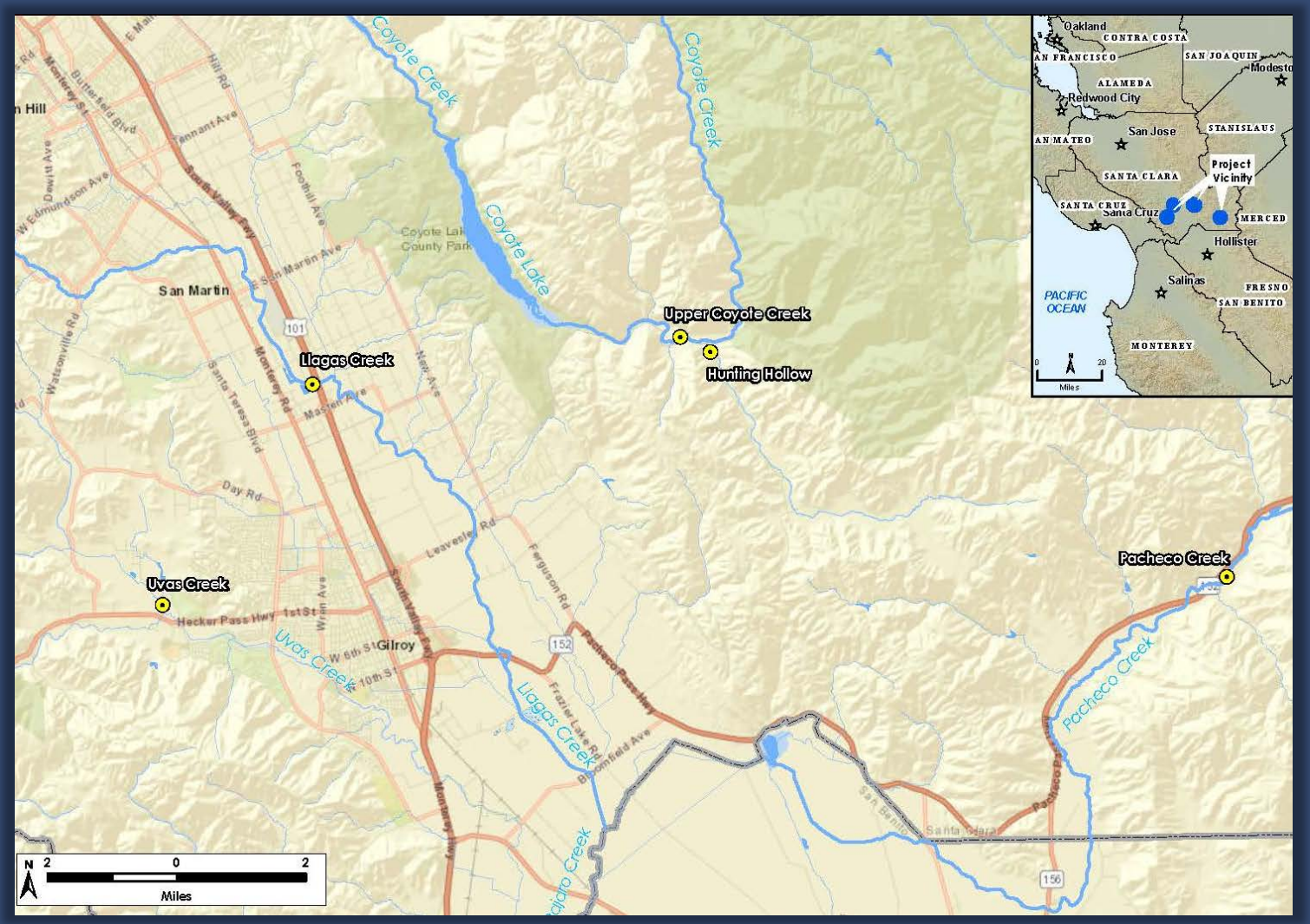
GRASSROOTS ECOLOGY

Collection Procedures

- Collected from genetically verified California sycamore trees
- Collected cuttings with minimal signs of disease
- Systemically disinfected all cuttings before bringing into a nursery and followed best management practices to limit the spread of plant pathogens

Collection Locations



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Treatments

- Season of collection
- Cutting material
- Cutting preparation
- Presoak type
- Rooting media type

Season of collection

Spring 2017:

Winter 2018:

Cutting Material

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Cutting Preparation

Simple Cut:

Heal Cut:

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Presoak Type

Willow Water

Tap Water

Rooting Media Type

Rockwool

Perlite

Cutting Propagation Steps

Rooting Media

Treebands

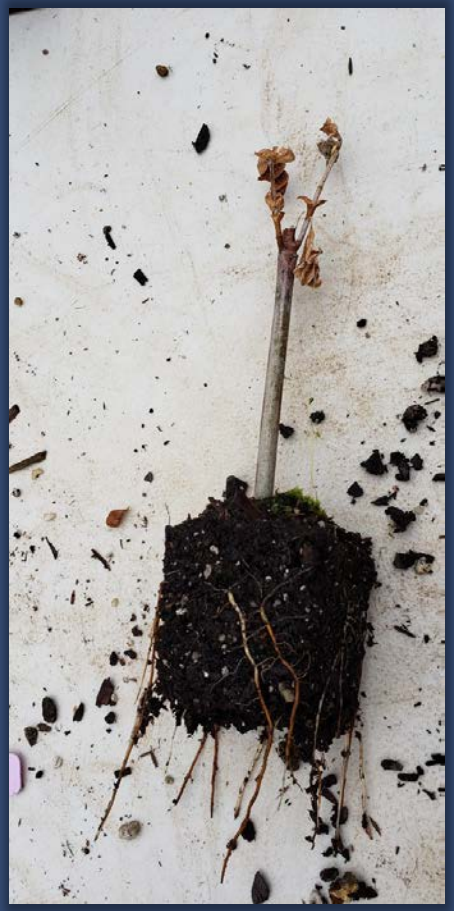
Treepots

Response Variables

- Survival (each transplanting)
- Initial Vigor (first transplanting)
- Ongoing Vigor (second transplanting)
- Growth Rate

Survival

Alive



Dead

Initial Vigor

Ranking = 1

Ranking = 3

Ongoing Vigor

Ranking = 1

Ranking = 3

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Growth Rate

Height at First Transplanting

Height at Second Transplanting

Statistical Analyses

- **Conducted in R Statistical Software**
- **Conducted independently by nursery**
- **Used generalized linear models (glm)**
  - Example: Survival ~ cut location * cut type * presoak * rooting media
  - Used AIC to choose best model

Effects of Season

- **Spring: <1% survival**
  - Only 1 of 713 cuttings survived
- **Winter: 24.2% survival**
  - 296 California sycamores for Upper Llagas Creek
  - Similar survival rates between the nurseries

Grassroots Ecology Nursery

Spring 2017 Collections

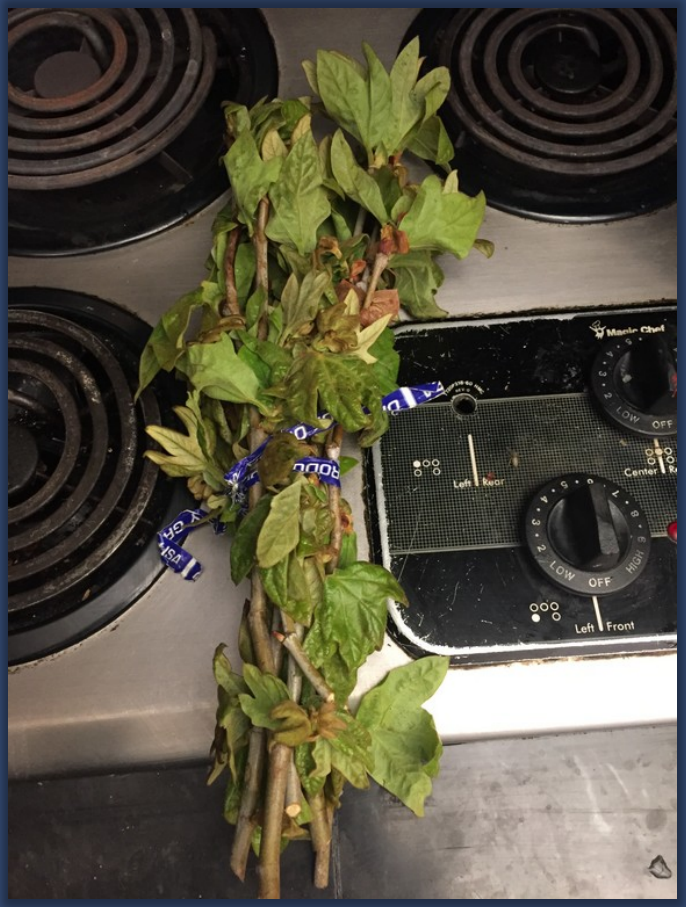
Anthracnose and *Phytophthora*

- **Ted Swiecki provided direction**
- **Original plan:**
  - **Bleach soak**
    - Kills pathogens superficially
- **Recommended and implemented plan:**
  - hot water bath
    - Kills pathogens on and inside plant

Disinfecting Hot Water Bath

Spring 2017 Collections

Pre-hot water bath

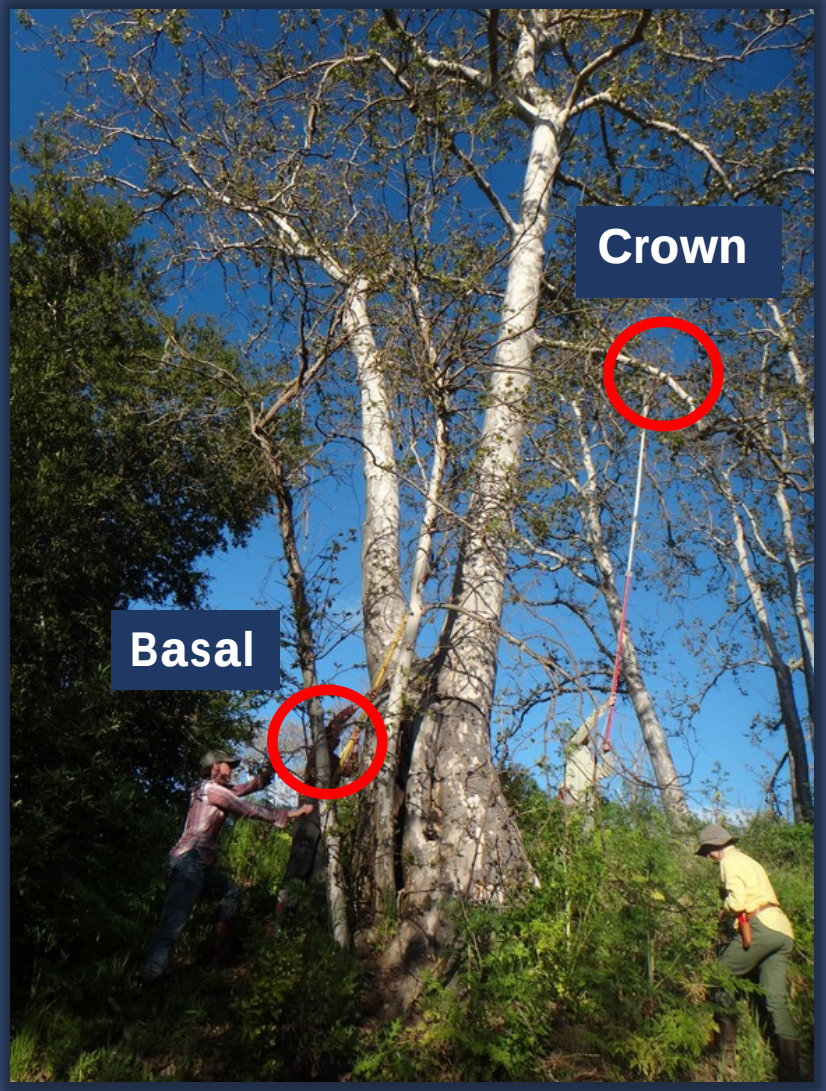


Post-hot water bath

Winter 2018 Collections

Effects of Cutting Material

- **No statistically significant results**
- **Nursery practitioners' anecdotes:**
  - Basal cuttings less prone to disease
  - Basal cuttings easier to collect



Effects of Cutting Preparation

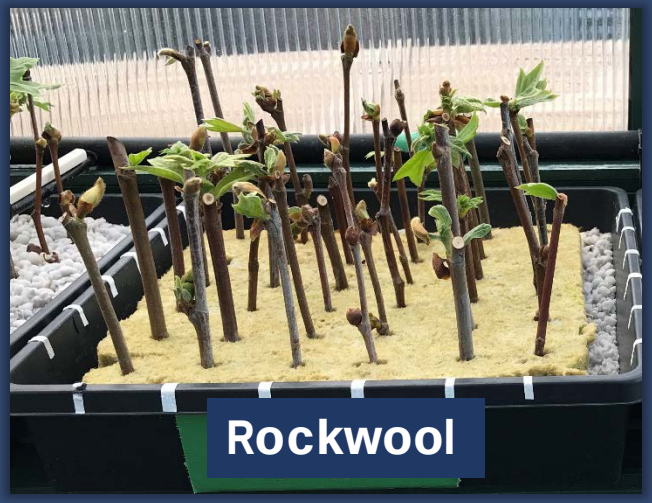
- **The Watershed Nursery:**
  - Simple cuts outperformed heal cuts in ongoing vigor and growth rate
- **Nursery practitioners' anecdotes:**
  - Simple cuts easier to collect

Effects of Presoak Type

- **No statistically significant main effects**
  - Grassroots Ecology Nursery: For basal cuttings, willow water increased survival and ongoing vigor

Effects of Rooting Media

- **Both Nurseries:**
  - Perlite increased initial vigor
- **Grassroots Ecology Nursery:**
  - Rockwool increased growth rate
- **The Watershed Nursery:**
  - Perlite increased survival
    - 100% mortality of rockwool rooted cuttings



Rockwool Irrigation

- **The Watershed Nursery:**
  - Driplines watered 4x a day for 3 minutes
- **Grassroots Ecology Nursey:**
  - Hand watered every 2-3 days

Nursery Practitioner Anecdotes

- Basal cuttings were easier to collect, seemed more vigorous, and had less anthracnose than crown cuttings
- Cuttings from younger trees seemed more vigorous
- Locations to make simple cuts were more common and easier to make than heal cuts
- Moisture was easier to control in perlite than rockwool

Objective 1. Advance the science of vegetative propagation of California sycamore.

The Watershed Nursery

Treatment		Survival at First Transplanting	Survival at Second Transplanting	Average Initial Vigor	Average Ongoing Vigor	Average Growth Rate (inches/day)
Cutting material	Basal	32.0%	22.7%	1.9	2.8	0.079
	Crown	35.6%	20.0%	1.8	2.8	0.077
	p-value	*0.08*	0.77	0.6	0.43	0.78
Cutting preparation	Simple	35.0%	21.0%	1.9	2.9	0.083
	Heal	33.1%	20.2%	1.6	2.5	0.064
	p-value	0.19	0.72	*0.06*	**<0.0005**	<**0.05**
Willow water presoak	Tap Water	36.8%	20.8%	1.8	2.8	0.078
	Willow Water	31.9%	21.1%	1.9	2.8	0.078
	p-value	0.34	0.68	0.54	0.79	0.62
Rooting media	Perlite	62.7%	41.5%	1.9	2.8	0.5
	Rockwool	6.0%	0.0%	1.2	NA	NA
	p-value	**<0.0001**	**<0.0001**	**<0.001**	NA	NA

Grassroots Ecology Nursery

Treatment		Survival at First Transplanting	Survival at Second Transplanting	Average Initial Vigor	Average Ongoing Vigor	Average Growth Rate (inches/day)
Cutting material	Basal	37.8%	28.8%	1.7	1.4	0.047
	Crown	32.3%	25.3%	1.8	1.5	0.042
	p-value	0.22	0.2	**<0.01**	0.46	0.72
Cutting preparation	Simple	35.0%	26.3%	1.8	1.4	0.046
	Heal	32.3%	26.8%	1.8	1.5	0.039
	p-value	1	0.43	0.21	0.78	0.16
Willow water presoak	Tap Water	34.7%	25.8%	1.4	1.4	0.047
	Willow Water	33.4%	27.1%	1.5	1.5	0.041
	p-value	0.74	0.69	0.81	*0.06*	0.1
Rooting media	Perlite	35.5%	27.2%	1.9	1.5	0.040
	Rockwool	32.6%	25.7%	1.7	1.4	0.048
	p-value	0.42	0.64	**<0.05**	0.46	**<0.05**
Cutting material* willow water/tap water soak	Basal + Tap Water	33.0%	22.7%	1.8	1.2	NA
	Basal + Willow Water	42.7%	34.9%	1.6	1.5	NA
	p-value	**<0.05**	**<0.05**	*0.09* (p=0.65*)	*0.06* (**<0.05***)	NA

Objective 2. Improve the cost-effectiveness of vegetative propagation of California sycamore

- Collect cuttings during winter, when trees are dormant
- Target collection of basal cuttings
- Target making simple cuts
- Use perlite rather than rockwool as the rooting medium

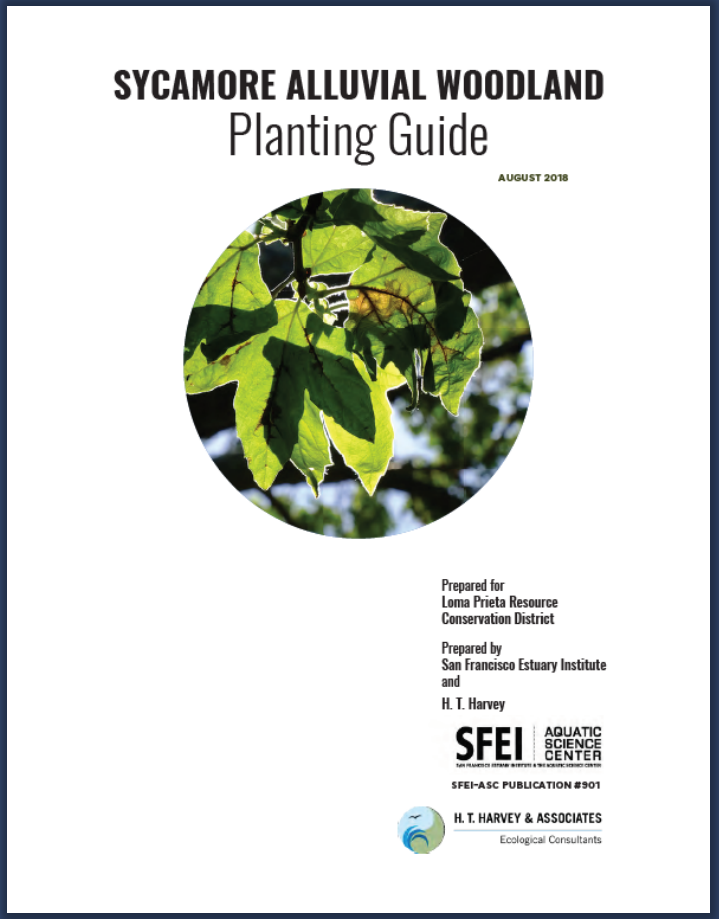
Objective 3. Determine future studies to build off the propagation study

- Assess the degree of hybridization by testing seed
- Assess the effect of source tree size and age on cutting survival and performance
- Replicate treatments in this study that only had significant effects at one of the two nurseries
- Continue genetics work to expand the database of genetically verified California sycamores, hybrids, and London planetrees

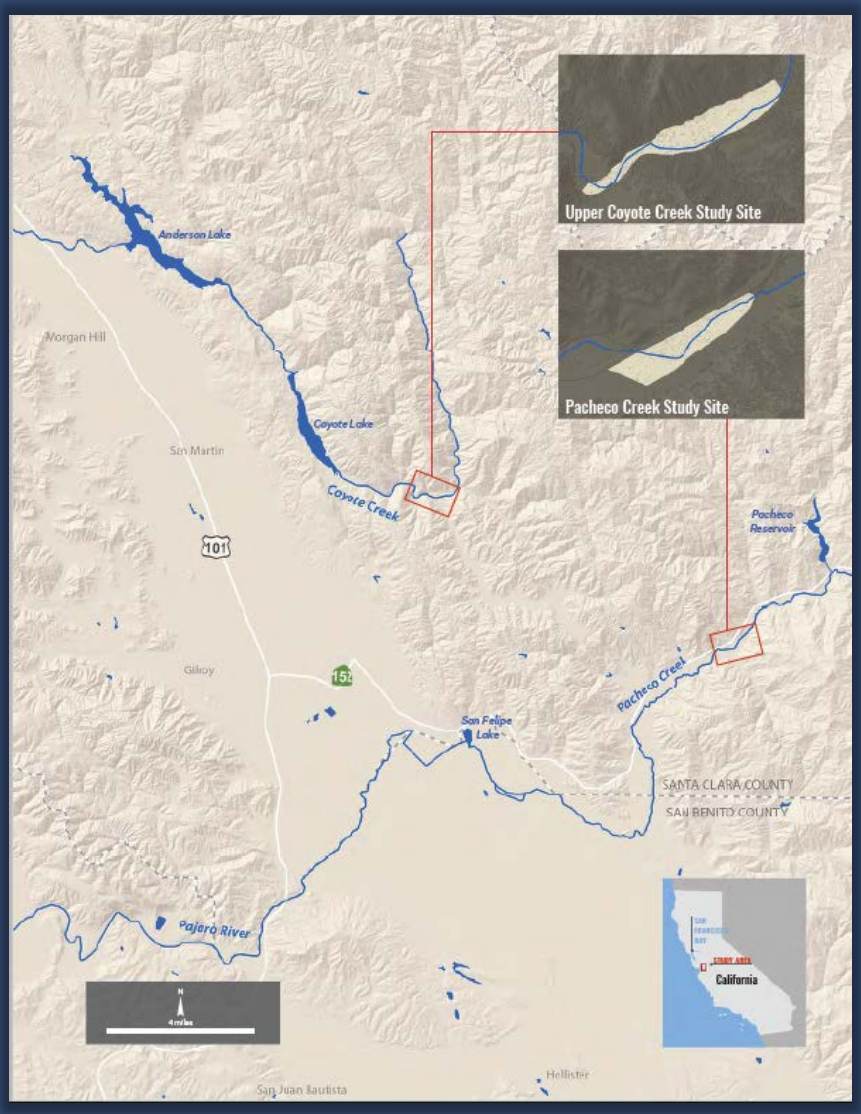
Pilot Planting Guide

- **Goal:**
  - Provide guidelines for active and passive Sycamore Alluvial Woodland restoration

Photo from Flickr by NatureShutterbug



Site Locations



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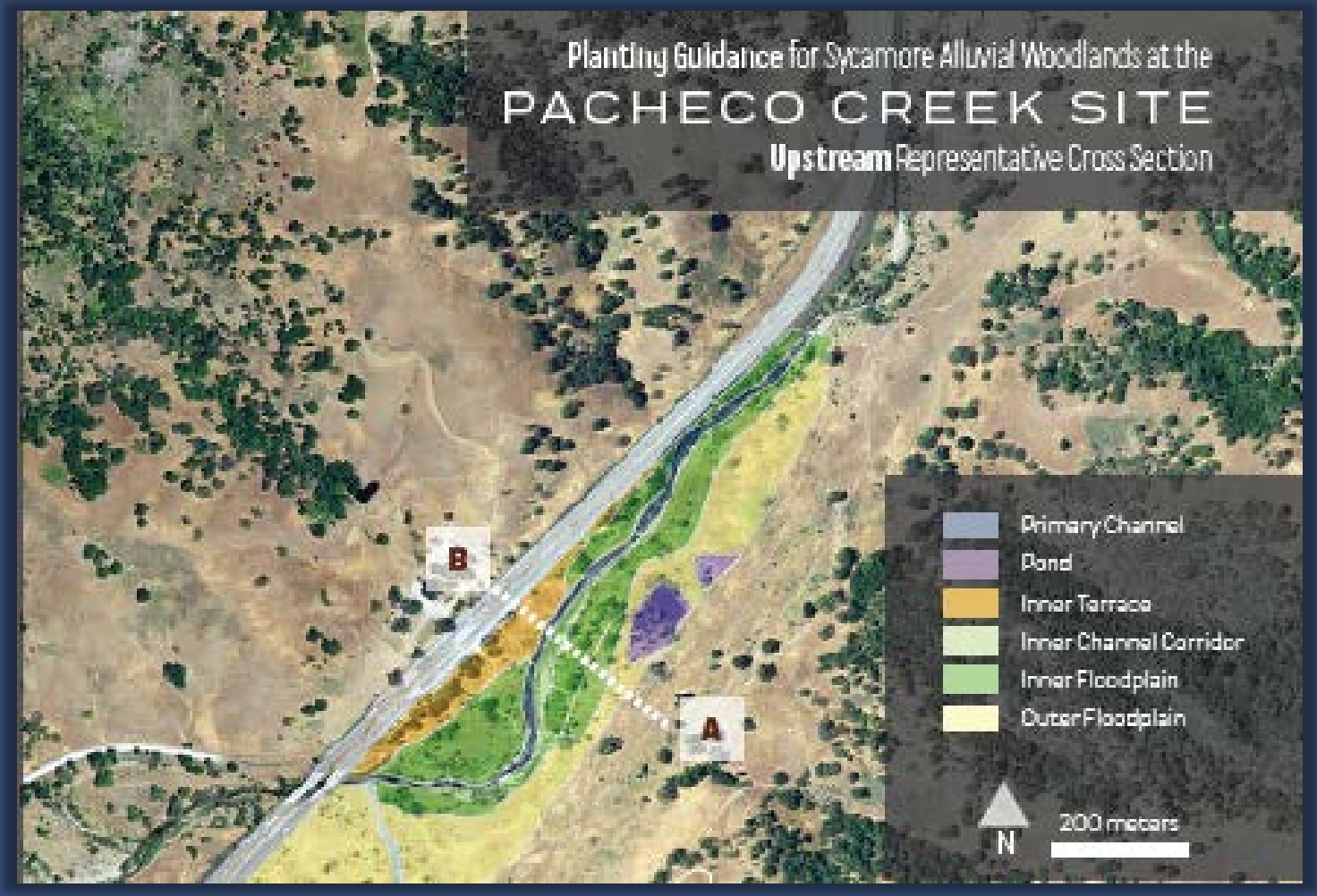
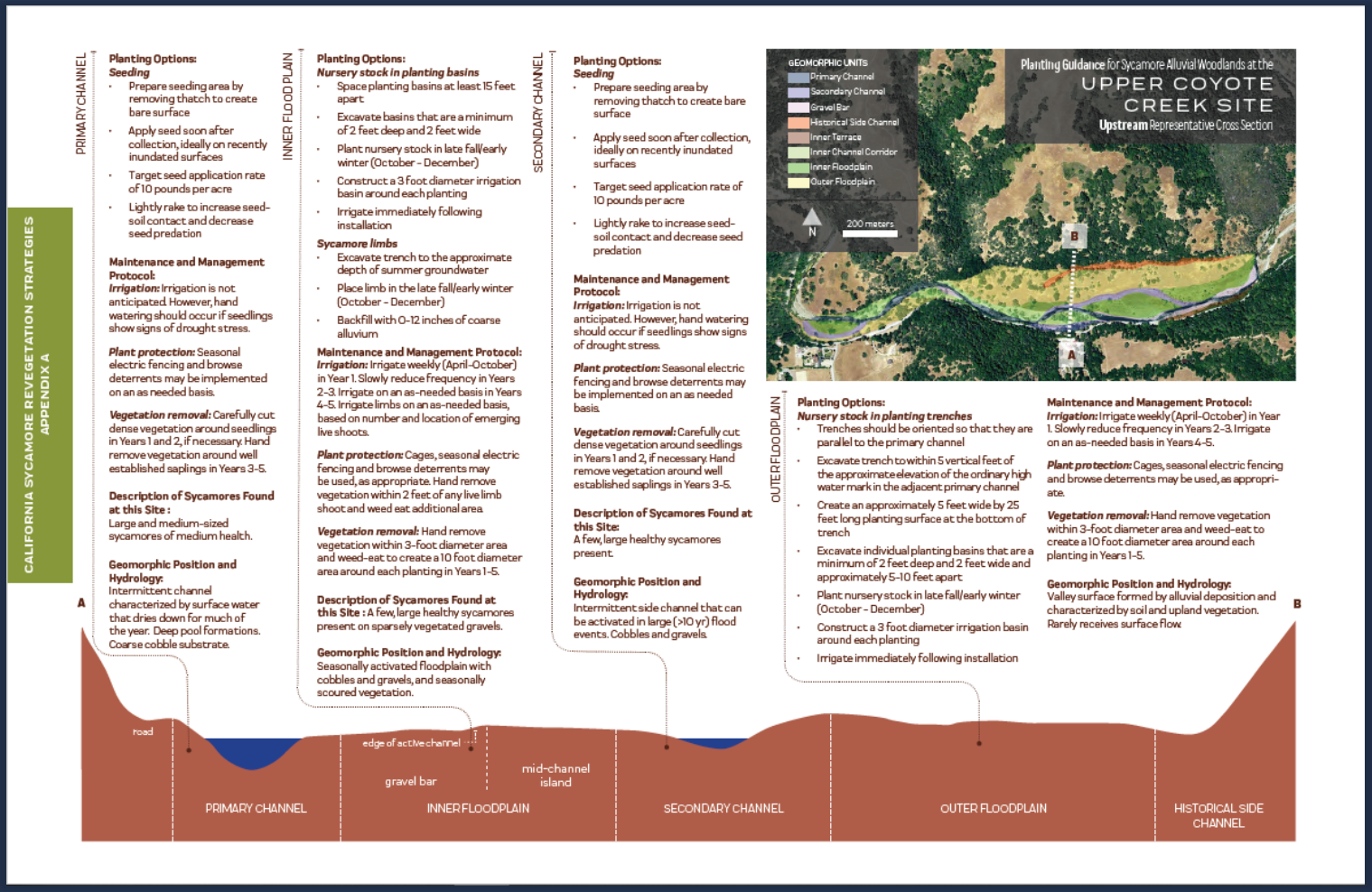
Geomorphic Settings



Planting Recommendations



Questions

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The University of California Davis

The Watershed Nursery