

Sycamore Genetics and Propagation Study



Presented by
Matt Quinn | Senior Associate Restoration Ecologist
February 13, 2019



H. T. HARVEY & ASSOCIATES

Ecological Consultants

Santa Clara Valley Water District



California Sycamore (*Platanus racemosa*)



Photo from Flickr by [Tracie Hall](#)



H. T. HARVEY & ASSOCIATES

Ecological Consultants

California Sycamores and Sycamore Alluvial Woodlands



California sycamore range



Sycamore alluvial woodland (SAW)

California Sycamore Wildlife Habitat

Photo from Flickr by [David Baron](#)



Photo from Flickr by [Frank Vassen](#)



H. T. HARVEY & ASSOCIATES

Ecological Consultants

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



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

H. T. HARVEY & ASSOCIATES
Ecological Consultants

**Upper Llagas Creek
California Sycamore Genetic Study Plan**

Prepared by:
H. T. Harvey & Associates

Project #3161-03

September 2016

983 University Avenue, Bldg D • Los Gatos, CA 95032 • Ph: 408.458.3200 • F: 408.458.3210

Propagation Study Plan

H. T. HARVEY & ASSOCIATES
Ecological Consultants

**California Sycamore
Propagation Study Plan**

Prepared by:
**H. T. Harvey & Associates
The Watershed Nursery
Grassroots Ecology Nursery**

Project 3161-03

November 2016

983 University Avenue, Bldg D • Los Gatos, CA 95032 • Ph: 408.458.3200 • F: 408.458.3210



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.

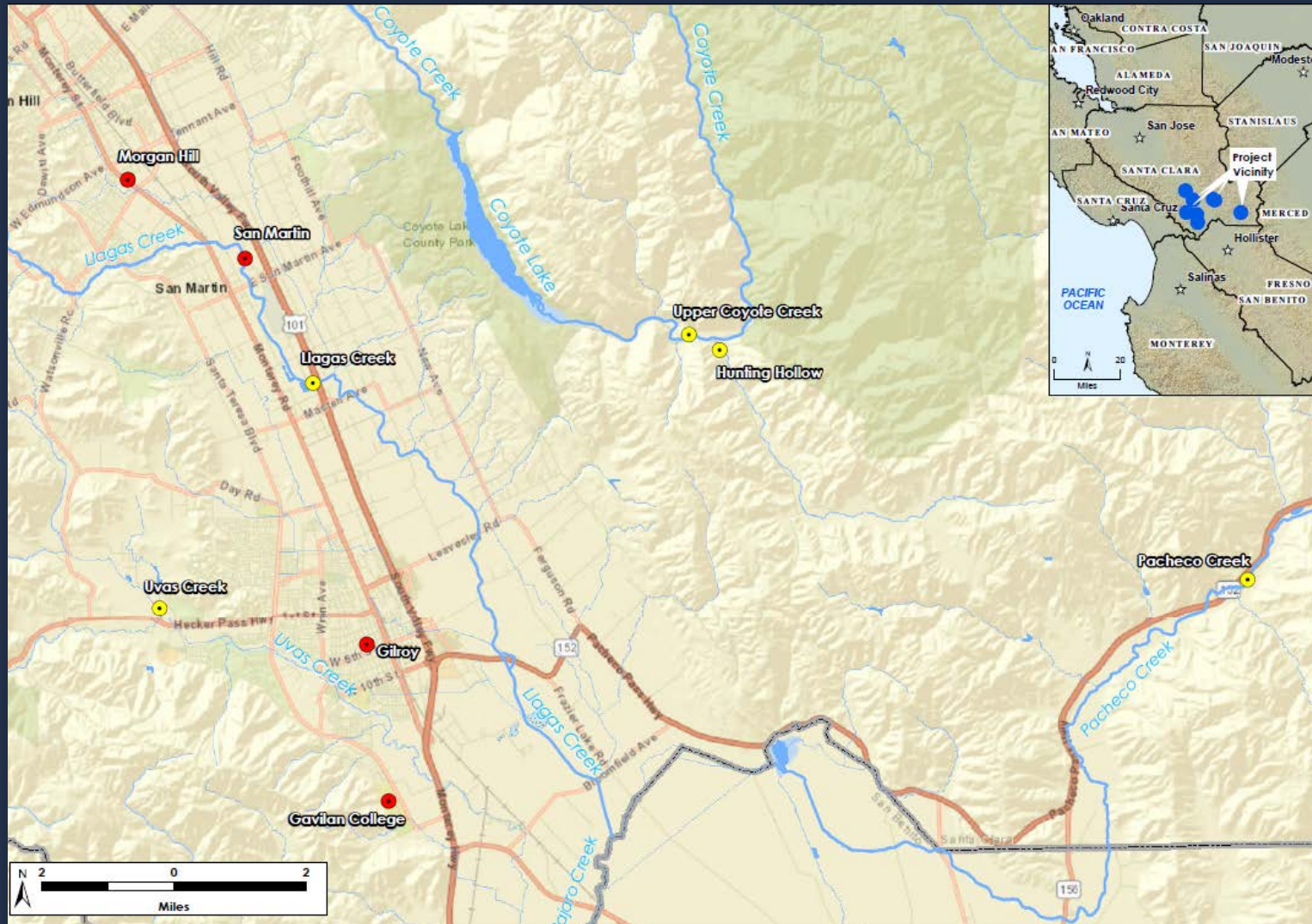


Genetics Study Objectives

- **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



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

352 Sampled Trees



Genetic Results

42 London
planetrees

7 Hybrids
(2.3%)

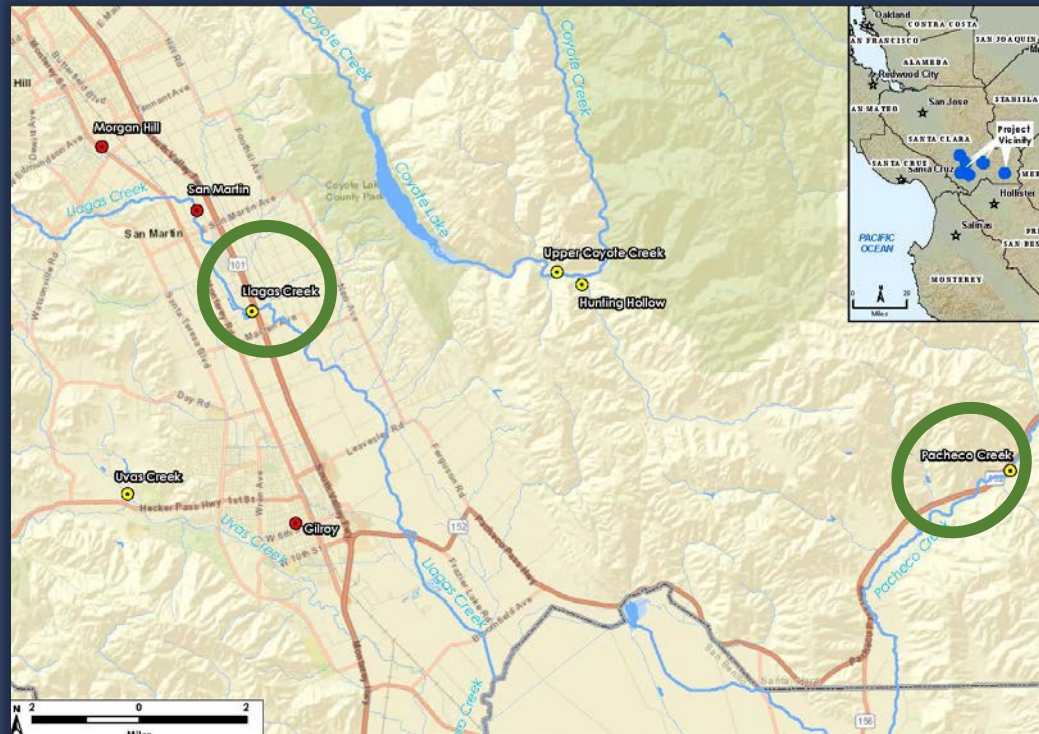
310 Putative California Sycamore Trees



Hybrids

Hybrid sycamores:

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



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



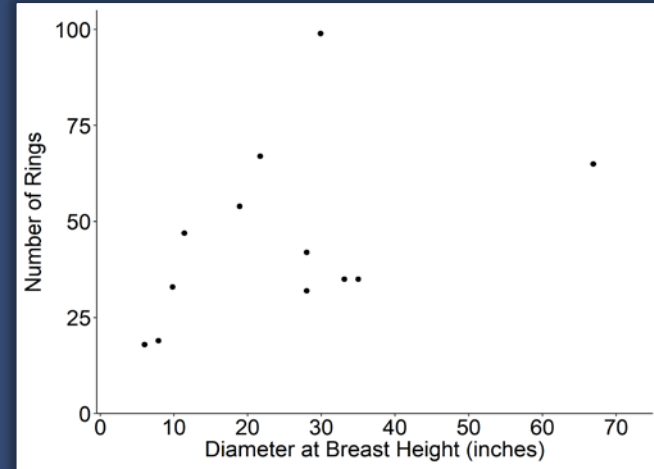
Tree Coring

- 2016: 9 trees cored at Pacheco Creek and Upper Coyote Creek
- 2017: 4 trees cored at Pacheco Creek and Upper Coyote Creek



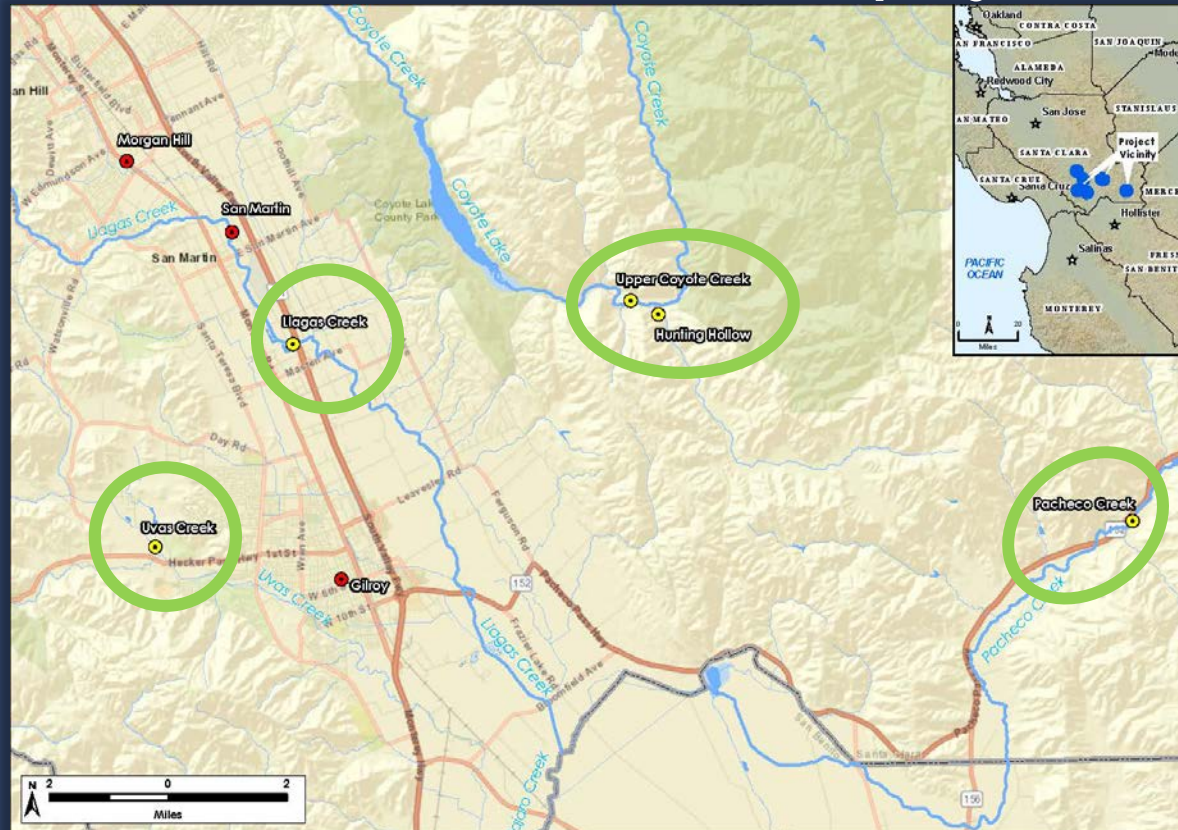
Tree Coring Results

- 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



H. T. HARVEY & ASSOCIATES

Ecological Consultants

The Watershed Nursery



H. T. HARVEY & ASSOCIATES
Ecological Consultants



Grassroots Ecology Nursery

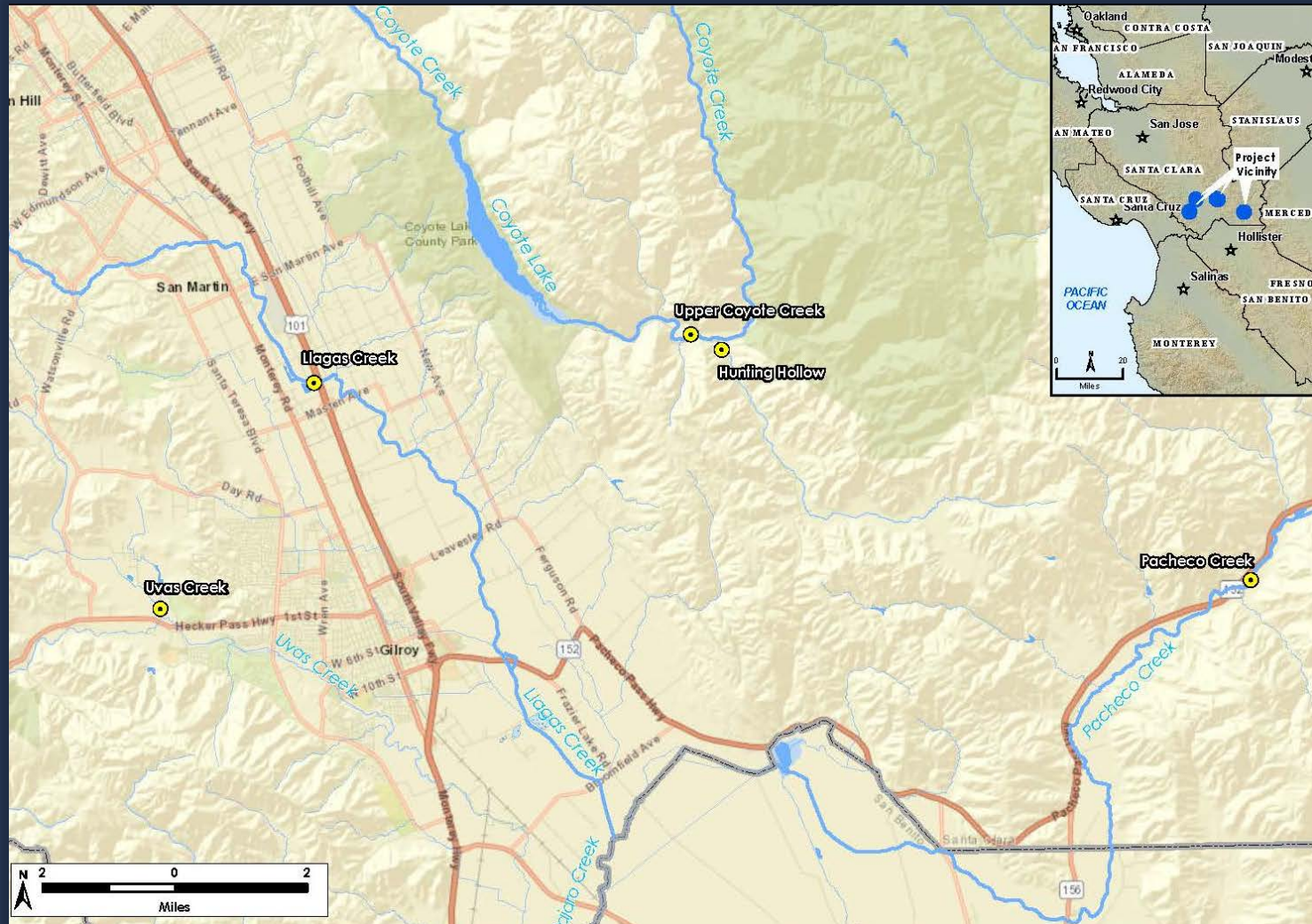


Collection Procedures

- 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



Treatments

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



Season of collection

Spring 2017:



Winter 2018:



Cutting Material



Cutting Preparation

Simple Cut:



Heal Cut:



H. T. HARVEY & ASSOCIATES

Ecological Consultants

Presoak Type

Willow Water

Tap Water



H. T. HARVEY & ASSOCIATES

Ecological Consultants

Rooting Media Type

Rockwool



Perlite



Cutting Propagation Steps



Rooting Media



Treebands



Treepots



Response Variables

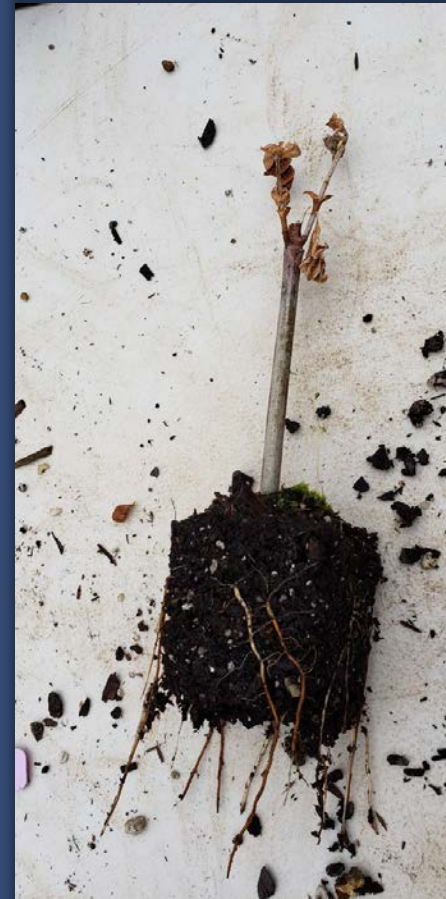
- Survival (each transplanting)
- Initial Vigor (first transplanting)
- Ongoing Vigor (second transplanting)
- Growth Rate



Survival



Alive



Dead



Initial Vigor



Ranking = 1



Ranking = 3



Ongoing Vigor



Ranking = 1



Ranking = 3



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: $\text{Survival} \sim \text{cut location} * \text{cut type} * \text{presoak} * \text{rooting media}$
 - 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



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

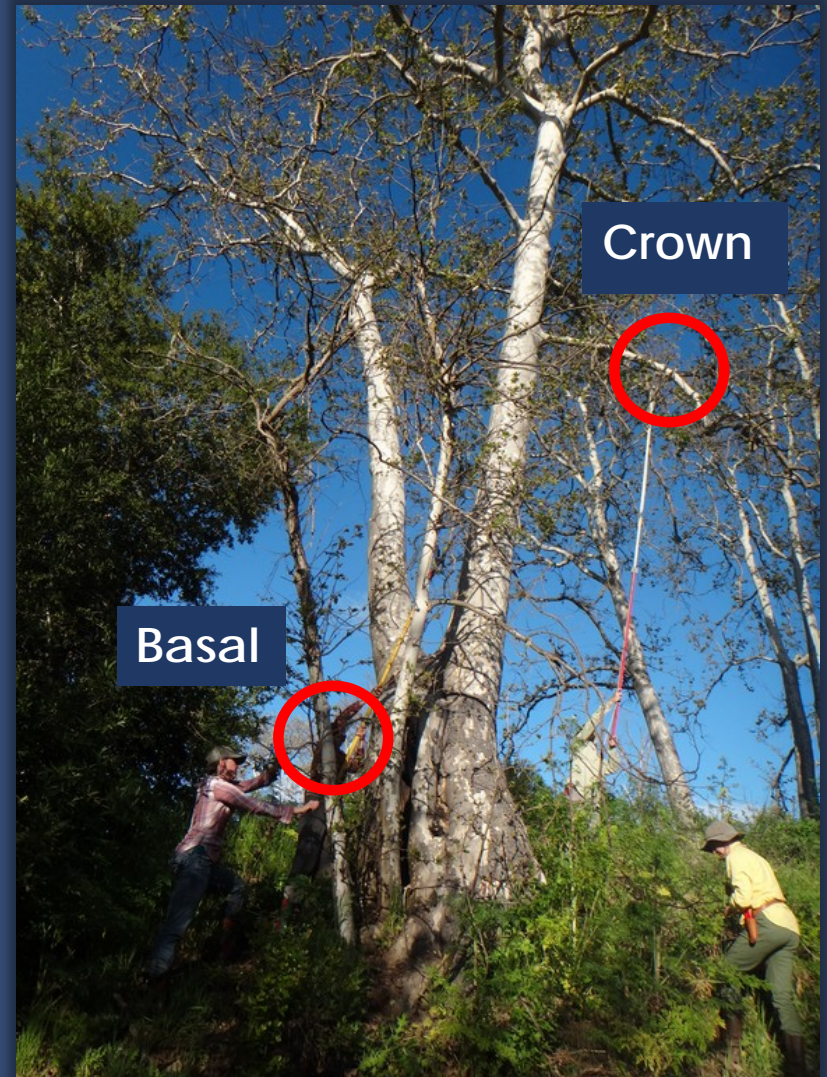


H. T. HARVEY & ASSOCIATES

Ecological Consultants

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

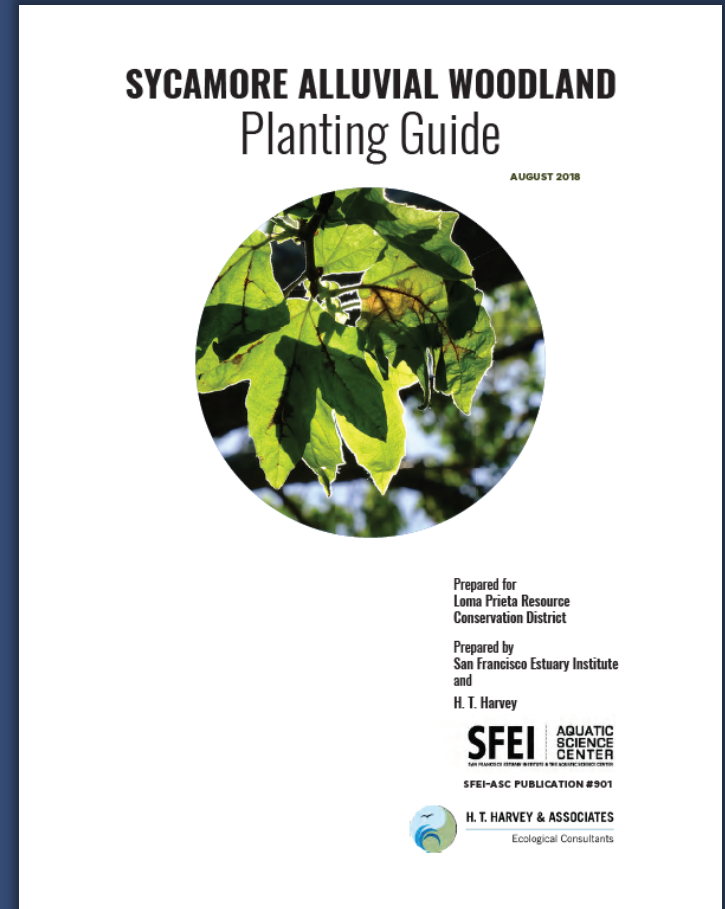


Pilot Planting Guide

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



Photo from Flickr by [NatureShutterbug](#)



H. T. HARVEY & ASSOCIATES

Ecological Consultants

Site Locations



H. T. HARVEY & ASSOCIATES

Ecological Consultants

Geomorphic Settings



Planting Recommendations

PRIMARY CHANNEL

Planting Options:

Seeding

- Prepare seeding area by removing thatch to create bare surface
- Apply seed soon after collection, ideally on recently inundated surfaces
- Target seed application rate of 10 pounds per acre
- Lightly rake to increase seed-soil contact and decrease seed predation

Maintenance and Management Protocol:

Irrigation: Irrigation is not anticipated. However, hand watering should occur if seedlings show signs of drought stress.

Plant protection: Seasonal electric fencing and browse deterrents may be implemented on an as-needed basis.

Vegetation removal: Carefully cut dense vegetation around seedlings in Years 1 and 2, if necessary. Hand remove vegetation around well established saplings in Years 3-5.

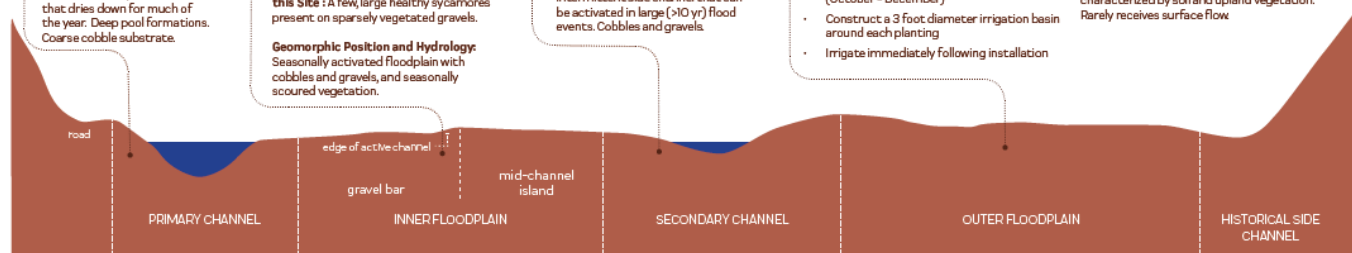
Description of Sycamores Found at this Site:

Large and medium-sized sycamores of medium health.

Geomorphic Position and Hydrology:

Intermittent channel characterized by surface water that dries down for much of the year. Deep pool formations. Coarse cobble substrate.

A



INNER FLOODPLAIN

Planting Options:

Nursery stock in planting basins

- Space planting basins at least 15 feet apart
- Excavate basins that are a minimum of 2 feet deep and 2 feet wide
- Plant nursery stock in late fall/early winter (October - December)
- Construct a 3 foot diameter irrigation basin around each planting
- Irrigate immediately following installation

Sycamore limbs

- Excavate trench to the approximate depth of summer groundwater
- Place limb in the late fall/early winter (October - December)
- Backfill with 0-12 inches of coarse alluvium

Maintenance and Management Protocol:

Irrigation: Irrigate weekly (April-October) in Year 1. Slowly reduce frequency in Years 2-3. Irrigate on an as-needed basis, based on number and location of emerging live shoots.

Plant protection: Cages, seasonal electric fencing and browse deterrents may be used, as appropriate. Hand remove vegetation within 2 feet of any live limb shoot and weed eat additional area.

Vegetation removal: Hand remove vegetation within 3-foot diameter area and weed-eat to create a 10 foot diameter area around each planting in Years 1-5.

Description of Sycamores Found at this Site:

A few, large healthy sycamores present on sparsely vegetated gravel.

Geomorphic Position and Hydrology: Seasonally activated floodplain with cobbles and gravels, and seasonally scoured vegetation.

SECONDARY CHANNEL

Planting Options:

Seeding

- Prepare seeding area by removing thatch to create bare surface
- Apply seed soon after collection, ideally on recently inundated surfaces
- Target seed application rate of 10 pounds per acre
- Lightly rake to increase seed-soil contact and decrease seed predation

Maintenance and Management Protocol:

Irrigation: Irrigation is not anticipated. However, hand watering should occur if seedlings show signs of drought stress.

Plant protection: Seasonal electric fencing and browse deterrents may be implemented on an as-needed basis.

Vegetation removal: Carefully cut dense vegetation around seedlings in Years 1 and 2, if necessary. Hand remove vegetation around well established saplings in Years 3-5.

Description of Sycamores Found at this Site:

A few, large healthy sycamores present.

Geomorphic Position and Hydrology:

Intermittent side channel that can be activated in large (>10 yr) flood events. Cobbles and gravels.



OUTER FLOODPLAIN

Planting Options:

Nursery stock in planting trenches

- Trenches should be oriented so that they are parallel to the primary channel
- Excavate trench to within 5 vertical feet of the approximate elevation of the ordinary high water mark in the adjacent primary channel
- Create an approximately 5 feet wide by 25 feet long planting surface at the bottom of trench
- Excavate individual planting basins that are a minimum of 2 feet deep and 2 feet wide and approximately 5-10 feet apart
- Plant nursery stock in late fall/early winter (October - December)
- Construct a 3 foot diameter irrigation basin around each planting
- Irrigate immediately following installation

Maintenance and Management Protocol:

Irrigation: Irrigate weekly (April-October) in Year 1. Slowly reduce frequency in Years 2-3. Irrigate on an as-needed basis in Years 4-5.

Plant protection: Cages, seasonal electric fencing and browse deterrents may be used, as appropriate.

Vegetation removal: Hand remove vegetation within 3-foot diameter area and weed-eat to create a 10 foot diameter area around each planting in Years 1-5.

Geomorphic Position and Hydrology:

Valley surface formed by alluvial deposition and characterized by soil and upland vegetation. Rarely receives surface flow

B



Questions



H. T. HARVEY & ASSOCIATES

Ecological Consultants

Santa Clara Valley Water District 



