

### Project Summary

In 2004, the Cachuma Operations and Maintenance Board (COMB) raised Bradbury Dam (Santa Barbara County, CA) causing the elevation of Cachuma Lake to raise by 3 feet during surcharge events. 879 Coast Live Oak (*Quercus agrifolia*) and Valley Oak (*Quercus lobata*) trees (approximately 90% and 10%, respectively) were drowned by the rising waters, and another 1,122 were at-risk totaling 2,001 trees. At a 2 to 1 mitigation ratio with a 18% mortality rate as determined at the end of the first ten years of the program, 4,722 replacement trees are needed to achieve our mitigation target by 2025 when the planted oak trees need to be self-staining. Described are the mitigation process and success of the program from 2005 through 2017.

### A. Background:

In 2004, U. S. Bureau of Reclamation (USBR) in collaboration with COMB installed 4 foot high flash boards on top of the radial gates of Bradbury Dam to enable surcharging of Lake Cachuma by 3 feet or 9,200 acre-feet of additional water storage to be used in support of the federally listed endangered southern California Steelhead (*Oncorhynchus mykiss*, *O. mykiss*) downstream of the dam. Specifically, the extra storage is used for water releases to the Santa Ynez River and adjacent Hilton Creek in support of the fishery in the Lower Santa Ynez River basin for rearing and fish passage. Higher lake levels impacted the oak trees near the lakeshore resulting in a new program to mitigate for the lost and at-risk oak trees. The Lake Cachuma Oak Tree Restoration Program started in 2005 with mitigation targets set ten years into the program through a Lakeshore Survey which will be completed by 2025.



O. mykiss, Hilton Creek



Lake Cachuma, Santa Barbara County



Bradbury Dam with all four radial gates open and the 4-foot flashboards on top



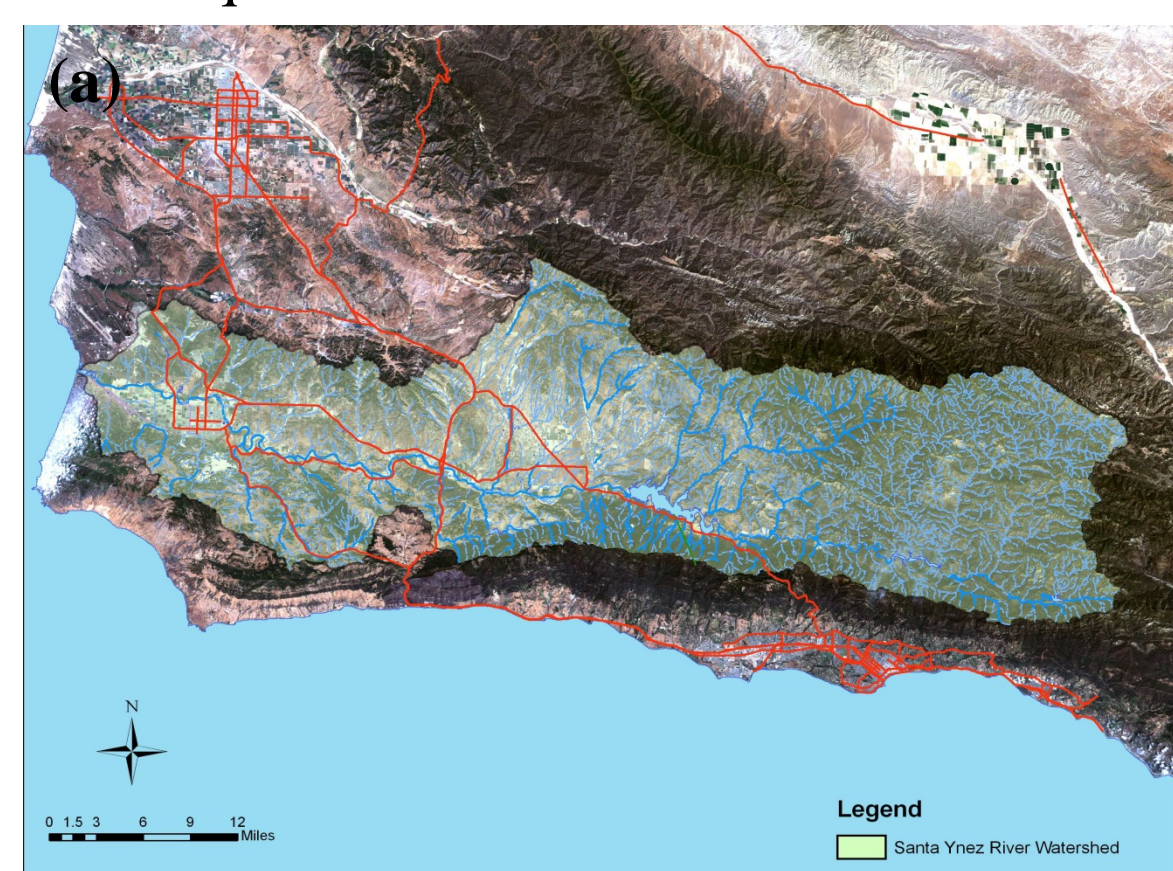
Impacted oak trees on the lakeshore

### B. Project Location:

Cachuma Lake is a water supply reservoir on the Santa Ynez River located in the middle of the watershed (a) in central Santa Barbara County, CA. The USBR built the reservoir in 1953, specifically by the construction of Bradbury Dam, a 201 foot high earthen filled dam. Its surface area covers 3,100 acres. Spatial data and tabular field observations are integrated within a ArcGIS database to create a dynamic, multi-variant analytical tool for mitigation, project management, scientific studies, and policy objectives. Each planted tree has (b) a GPS point and is (c) individually tagged with (d) a unique ID number.

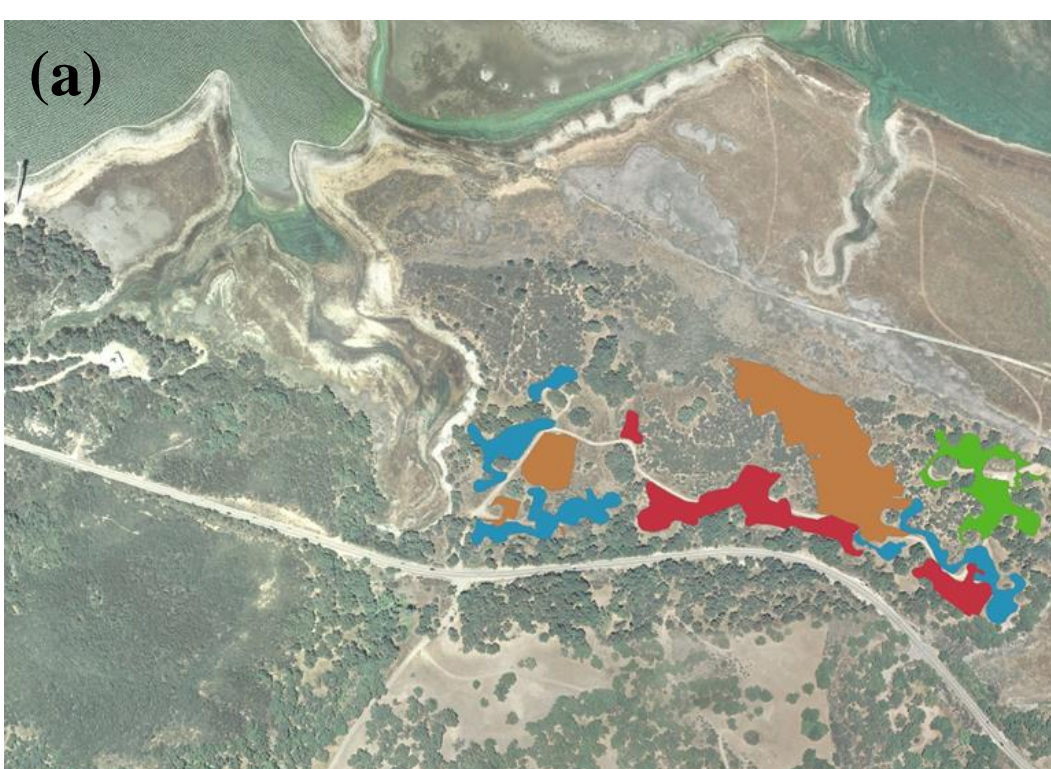


Santa Barbara County



### C. Mitigation and the First 10 Years of the Program:

The National Marine Fisheries Service issued a Biological Opinion to USBR in 2000 to address impacts to *O. mykiss* from the construction and operation of the Cachuma Project (dam and water diversion/supply). A 2004 Environmental Impact Report (EIR) set the terms and mitigation measures for surcharging Lake Cachuma to create water supply for the downstream fishery. In 2005, COMB established the Lake Cachuma Oak Tree Restoration Program and initiated planting of the required mitigation trees in multiple areas around Lake Cachuma. Oak tree planting locations were cataloged by year planted at (a) Storke Flats, (b) Cachuma Lake Recreation Area (County Park), (c) near Bradbury Dam, and (d) Dam Tender (DT) trees.



An initial contractor performed the first six years of oak tree planting and maintenance from 2005 to 2010 totaling 2,250 trees. However, later evaluation of this phase revealed planting design flaws that compromised tree growth and survival. Problems included use of a narrow auger to dig holes for planting in clay rich soils resulting in circular roots in the smooth-sided holes, homemade chicken wire gopher baskets that failed to stop gophers, trees planted 6+ inches below surface level with some trees planted less than 15 feet apart, container grown trees not root pruned, and inadequate protection against browsing deer. COMB staff (Manager and PhD, Tim Robinson) took over the program in 2011 and began working closely with Registered Consulting Arborist (RCA)/Board Certified Master Arborist Ken Knight to implement the remaining plantings, maintain all the planted trees, and assist in the annual inventory and documentation.

Year-ID	Fiscal Year	# Planted Trees
1	2005-2006	375
2	2006-2007	375
3	2007-2008	375
4	2008-2009	375
5	2009-2010	379
6	2010-2011	377
7	2014-2015	909
8	2015-2016	824
9	2016-2017	301
DT	2005-2018	124
<b>Total:</b>		<b>4414</b>



Use of a backhoe to dig rough holes for planting with a professional gopher cage.



Trees planted at least 25 feet apart.



Trees are protected with 5 foot high deer fencing and thoroughly mulched.

### D. Setting the Mitigation Target

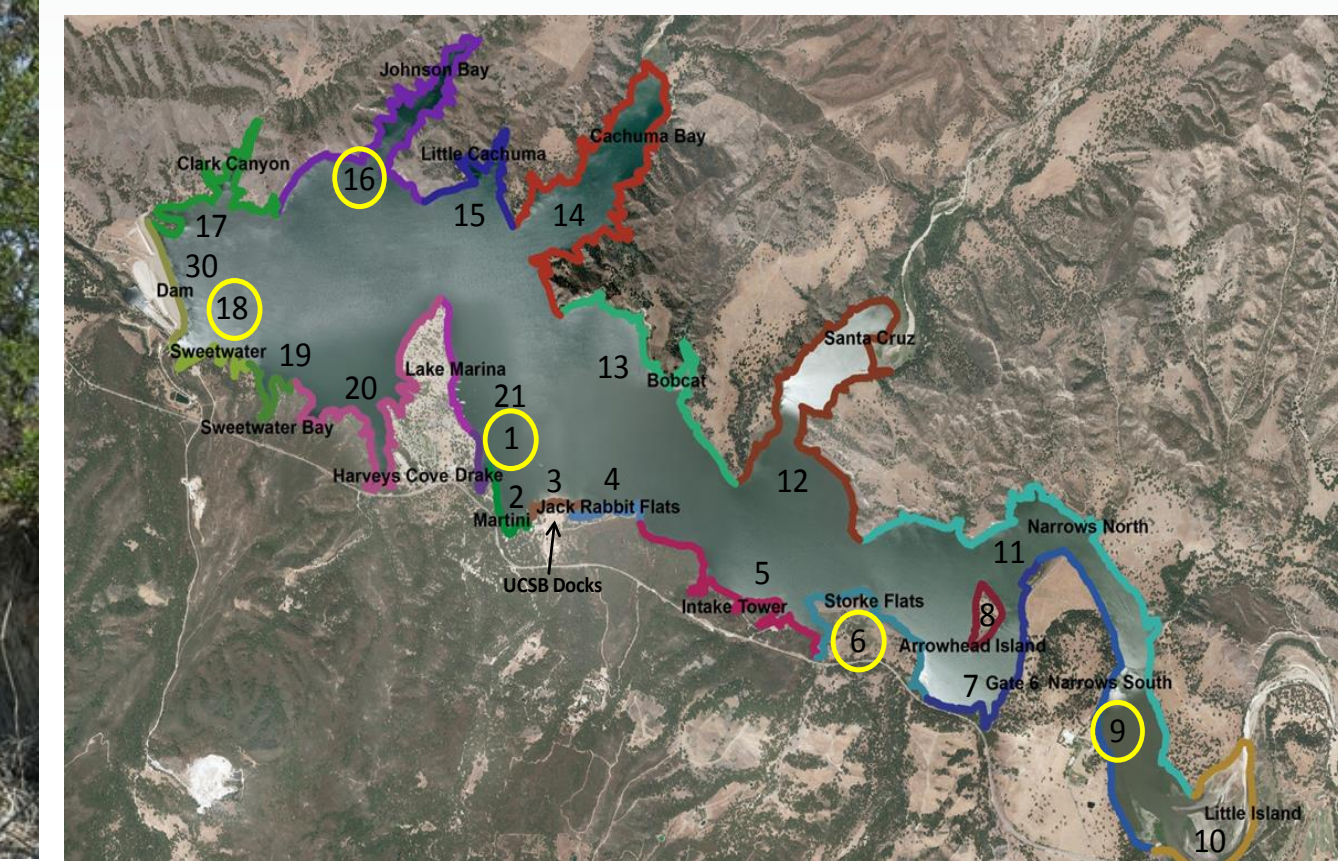
As required by the EIR, COMB conducted a 2015 Lakeshore Survey, 10 years into the program, that determined the final number of dead and at-risk trees from surcharging the lake. The results found 879 dead and 1,122 at-risk trees. This set the mitigation target for 2025 (20 years since the beginning of the program). With a 2:1 mitigation ratio and an estimated 18% mortality rate established after 10 years, 4,722 trees are required to meet the 2025 mitigation requirement.



Lakeshore inventory



Impacted oak tree roots



Identified reaches around Lake Cachuma

- Data Collected to Determine an At-Risk Tree:**
- Tree species: *Quercus agrifolia* or *Quercus lobata*.
  - Tree location: GPS coordinates with a unique ID.
  - Diameter at Breast Height: 54" above the tree base.
  - Critical Root Zone (CRZ): 1" DBH = 1' CRZ Height.
  - (DBH) equals one foot of critical root zone.
  - Critical Root Zone Wake: > 20 % of CRZ impacted.
  - Critical Root Zone Soil: 20 % CRZ with soil washed away >3' below the trunk flare.
  - Tree Health Rating: Good, Fair, Poor or Critical.
  - Photo documentation: Photograph of each tree.

The initial consultant divided the lakeshore into 22 reaches. In 2015, COMB thoroughly evaluated the oak trees within 5 randomly selected reaches of the 22 to determine how many trees were at-risk. The average percentage increase in identified at-risk trees from the initial consultant was used to extrapolate in the not surveyed reaches to determine the total number of at-risk trees around the lake (1,122).

### E. Ongoing Tree Planting and Maintenance

In 2012, COMB hired RCA Ken Knight to provide technical assistance in training staff on the latest tree planting and care techniques. Mr. Knight has since worked with COMB staff on planting locations and techniques, methods for deer and gopher protection, mulching regime, the appropriate watering schedule and amount, formative pruning when appropriate, and weeding. All procedures followed American National Standard Institute tree care standards and International Society of Arboriculture Best Management Practices. Since 2014, COMB staff has planted 2,034 and reclaimed another 124 oaks for a total of 4,414 oaks since program inception. Staff had to contend with six of seven years of extraordinary drought (2012 to 2018, except 2017). Current arboricultural practices were integrated into the tree planting and care methods, although little can be done to correct deficiencies in previously planted trees.



Oak tree planting



Formative pruning training



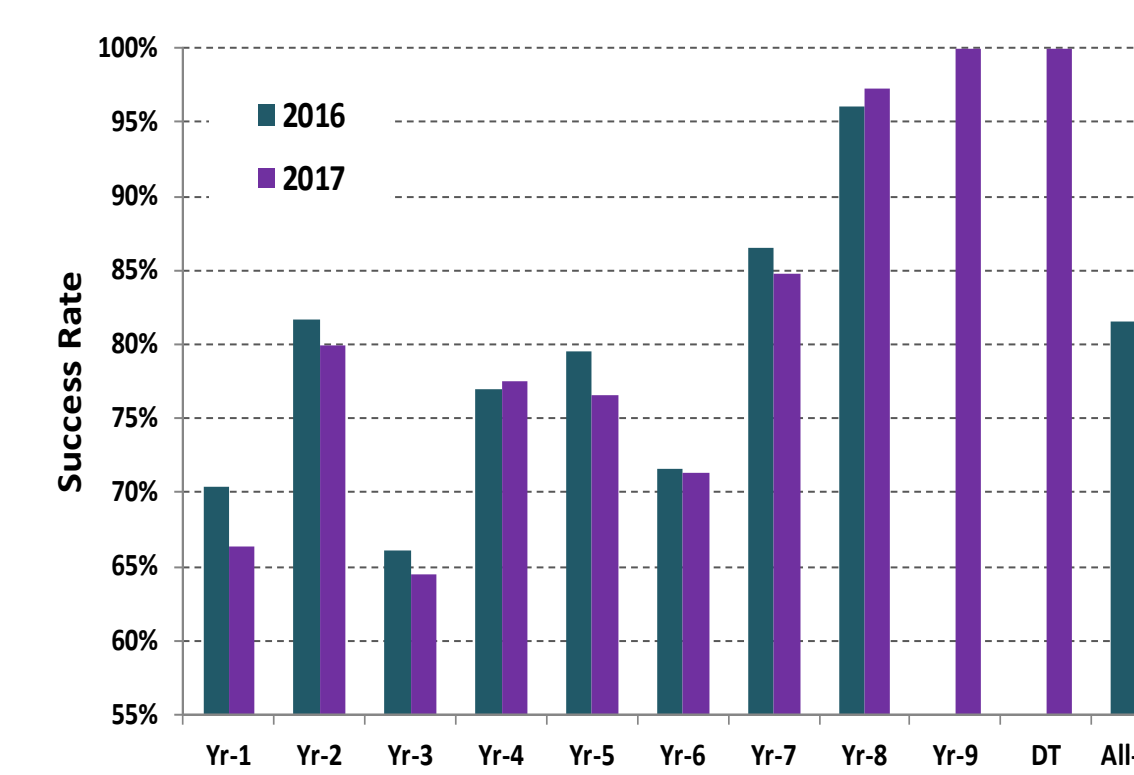
Use of Gro-tubes act as mini-greenhouses and rodent protection



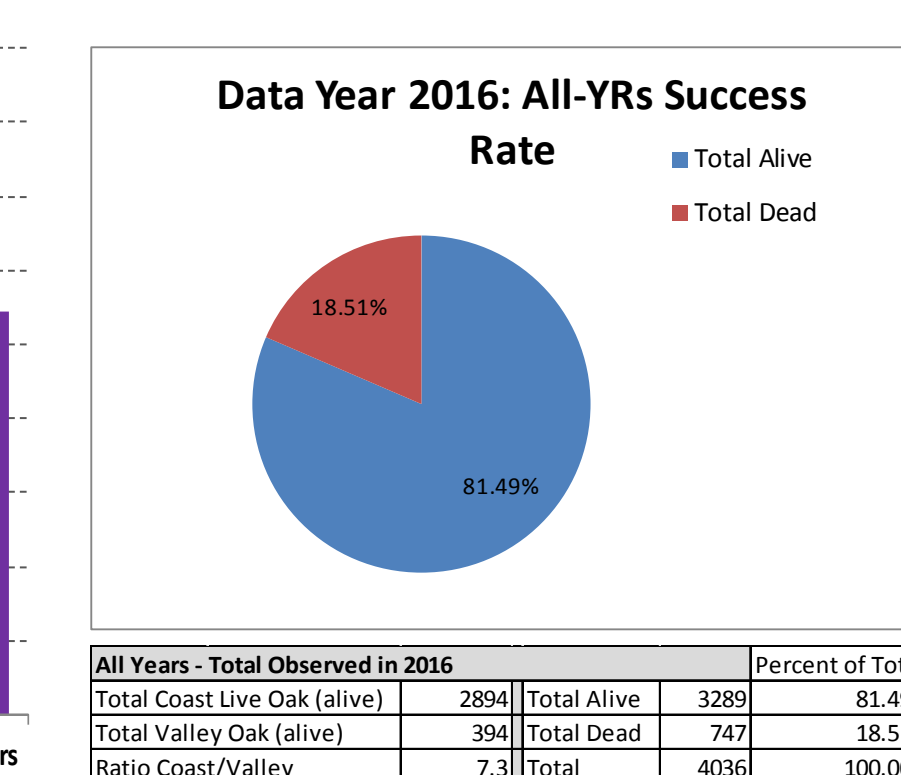
Watering with 1,000 gallon water trailer

### F. Program Results

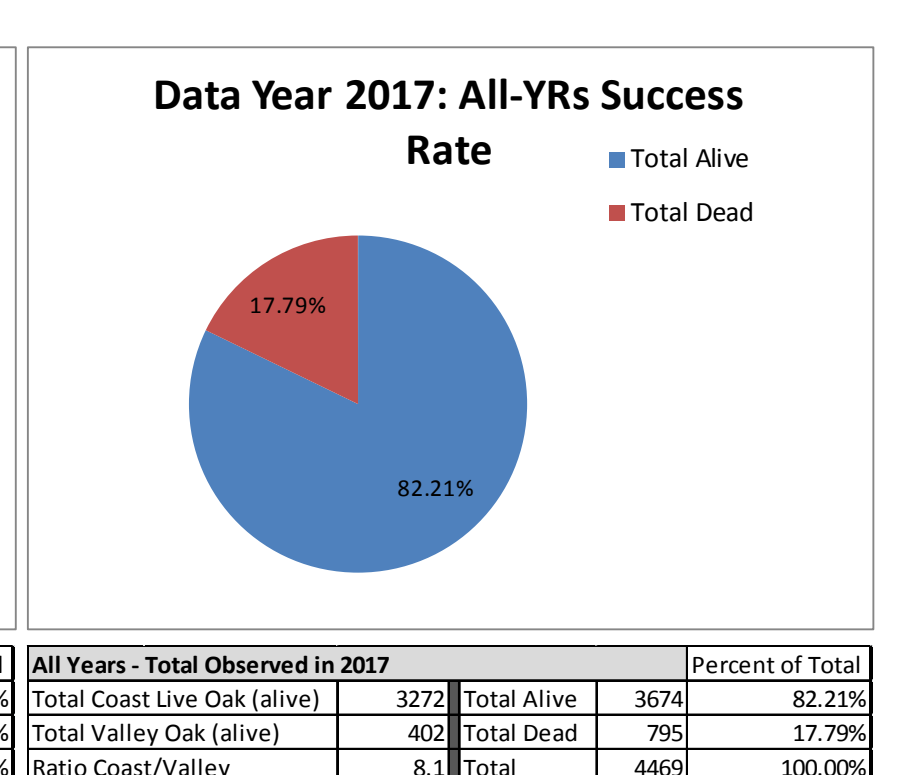
3,674 oak trees are alive as of December 31, 2017, the survival rate is 82.21%, and the remaining 1,047 trees will be planted within the next couple of years.



Success rate comparison from 2016 to 2017 for each and all tree years (Yr)



Result comparison between 2016 and 2017 for all year of planted trees.



# of Years	Fiscal Year	Operator	Year-ID	# Planted Trees	Cost
1	2005-2006	Fournier	1	375	\$116,731
2	2006-2007	Fournier	2	375	\$117,620
3	2007-2008	Fournier	3	375	\$138,786
4	2008-2009	Fournier	4	375	\$137,872
5	2009-2010	Fournier	5	379	\$136,900
6	2010-2011	Fournier	6	377	\$137,878
7	2011-2012	Fournier	-	-	\$79,439
8	2012-2013	COMB	-	-	\$101,431
9	2013-2014	COMB	-	-	\$48,097
10	2014-2015	COMB	7	909	\$134,054
11	2015-2016	COMB	8	824	\$128,241
12	2016-2017	COMB	9	300	\$101,227
13	2017-2018	COMB	DT	124	\$128,752
<b>Total:</b>				<b>4289</b>	<b>\$1,507,029</b>

Project costs since the beginning of the program

### G. Lessons Learned

- Irrigate trees at least once a month during the dry season until the trees are established, necessary for survival.
- During extensive periods of drought, irrigating can be necessary year round.
- Conduct systematic mulching of all trees once a year, particularly newly planted trees for soil enhancement and moisture protection.
- Use 4 or 5 foot welded steel field fencing versus nettings for deer cages to prevent deer browsing and avoid entrapment of snakes.
- Plant trees in professional gopher baskets and maintain them 4 inches above the ground to prevent gophers from going over the top.
- Planting locations for Valley Oaks need careful consideration; hallows and north facing slopes provide a greater success rate.
- Use backhoe dug holes instead of auger dug holes to best allow root spread.
- Use local acorn stock for nursery grown trees; it's best to have program staff collect the acorns for nursery propagation.
- Establish a long-term nursery service contract for multi-year and large scale programs that grow program collected acorns.
- Collect acorns from healthy mature trees in the area where trees will be planted.
- One foot tall nursery established trees have a higher success rate than planted acorns.
- Structurally pruned trees are more likely to survive and thrive than unpruned trees.
- Gro-Tubes provide a localized greenhouse effect for auto-irrigation, protection against surface rodents, and encourage taller, faster oak tree growth.
- Fine mesh cloth wrapped around the bottom of deer cages prohibits rodents from accessing trees.