Urban Sacramento Oak Reforestation: 17 Years and 20,000 Trees[1]

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Abstract

The Sacramento Tree Foundation (Tree Foundation), a nonprofit organization operating in the greater Sacramento California region, has been engaged in planting native oak trees in urban and suburban areas since 1998. Through an effort to provide efficient access to tree mitigation services and support compliance with local tree protection ordinances, more than 20,038 trees have been planted, monitored and cared for. Through developing the program and building hyper-local best practices, Tree Foundation staff has achieved a very high rate of success, growing the program to include a broad variety of reforestation, habitat restoration, habitat creation and urban forestry services. As urbanization continues to spread into our oak woodlands, reforestation and habitat enhancement of disturbed open space, urban edges and waterway corridors will support conservation of habitat and species. Successful methods of managing tree establishment issues will increase project sustainability and maximize the cost effectiveness of this work.

Key words: oak reforestation, Sacramento, tree mitigation, urban forestry

History

The Sacramento Tree Foundation (Tree Foundation) is a 501c3 nonprofit organization operating in Sacramento California since1982. Focused on planting trees and building community, as of 2014 the organization has 25 employees and an annual operating budget of 2.1 million dollars. Though early efforts focused on the urban canopy and city/tree interface issues, today the Tree Foundation operates a variety of programs and services focused on a spectrum of issues from watershed health to public health, energy savings trees to carbon mitigation. In 1998 the Tree Foundation began the operation of the Native Trees in Urban and Rural Environments (NATURE) program, focused on mitigation and planting of native trees. This program has grown and expanded to include a full-service tree mitigation program that operates with a strong commitment to sustainable projects and community involvement.

In 1981 the County of Sacramento California adopted an ordinance to protect and mitigate for the removal of native and landmark trees in circumstances that would otherwise not require action under the California Environmental Quality Act (CEQA). Since its inception, the Tree Preservation Ordinance has required the mitigation of tens of thousands (the total number is unknown as it is not tracked by Sacramento County) of protected trees throughout Sacramento County, with the vast majority of these being native

[1] An abbreviated version of this paper was presented at the Seventh California Oak Symposium: Managing Oak Woodlands in a Dynamic World, November 3-6, 2014, Visalia California.

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trees. Many cities within the Sacramento region have adopted the same or similar ordinances and also require mitigation when impacting or removing specific trees. Working with both public agencies and private developers, the Tree Foundation has received 5.1 million dollars of tree mitigation funding to plant, establish and monitor 19,818 trees due to the enforcement of these local ordinances. With these funds, the Tree Foundation has been able to plant and care for 20,038 trees at 115 locations throughout the greater Sacramento area.

In the beginning of this effort, the Tree Foundation followed the best practices currently in use for urban tree planting to meet these obligations. The very first planting projects were located in traditionally landscaped parks or school yards, often directly within areas of turf grass. Large sized planting materials sourced from traditional nurseries were used. The standard planting materials were native valley oak (*Quercus lobata*) trees in #15 size pots and for several projects ball and burlap trees with 5.1 cm (2 inch) caliper trunks were purchased from nurseries as far away as northern Oregon. Planting protocol followed standard urban methods and trees were staked and pruned to meet standard park landscape shape and function. Follow up irrigation and ongoing tree maintenance was delegated to partner land managers to enact with mixed tree establishment results.

Local tree preservation ordinances all require significant ongoing maintenance and monitoring post planting, with annual reporting to local agency officials. Currently the Tree Foundation undertakes official monitoring with reports submitted once a year. The earliest projects were visited and monitored two times yearly with corrective measures taken once a year in late fall or winter. As planting locations within maintained turf became more challenging to find and secure for plantings with large numbers of trees, the program began to look for non-irrigated park edges, wide street sides and medians, bike paths, open space preserves and other similar areas to plant. As plantings moved to non-irrigated spaces on the urban/wild land interface, tree survival dropped drastically and overall project success was compromised. Though the locations and circumstances had changed, the planting methods and care regime had not. The planting of #15 sized or ball and burlap nursery stock into non-irrigated, un-maintained natural spaces with inconsistent follow up care resulted in 50 to 90 percent mortality on some projects, depending on the specific site, project partner and rainfall during that first project year.

The year 2001 was a banner year for the program. For the previous 3 years the program had serviced one to three native tree mitigation contracts and averaged less than 200 mitigation trees planted each year. In the fall of 2001 a contract for the mitigation of 878 native oak trees was received by the program as well as six other contracts for an annual total of 1,278 mitigation trees. These trees were planted in two different locations with the majority of the native oaks being planted at the Haggin Oaks Golf Course, north of downtown Sacramento and adjacent to the Capital City Freeway. From the start, this project was challenging. A mix of planting materials was sourced from a variety of nurseries and in house from the Tree Foundation Seed to Seedling education program for elementary school students. The native oak

species planted included valley oak (*Quercus lobata*), blue oak (*Quercus douglasii*) and interior live oak (*Quercus wislizeni*).

Haggin Oaks golf course was built in 1957 within the oak woodland surrounding Arcade Creek. By the early 2000s, many of the celebrated oaks were experiencing severe decline and death. Replanting was necessary to keep the oaks at Haggin Oaks. Mitigation trees were planted between the greens in irrigated lawn and along a rolling soil berm that separates the course from a walking trail and the Capital City Freeway. For the first several years the oaks within the irrigated turf areas greatly outperformed the trees on the berm due to the fact that no irrigation was provided to the berm trees. This substantially lowered the rate of berm tree survival for this project. In addition to water stress, the berm trees were also impacted by competition from non-native annual grasses and invasive weeds including tree of heaven (*Ailanthus altissima*), scotch broom (*Cytisus scoparius*) and yellow star thistle (*Centaurea solstitialis*). A third challenge was damage caused by voles (*Microtus californicus*). By the third year of the project, survival rates were not high enough to meet agency requirements. Dead and dying trees were replaced with new seedling trees and a temporary irrigation system was installed to water the 800 trees on the berm. These interventions were successful enough to meet project goals and satisfy the mitigation requirements. Today, both the oaks on the berm and within the golf course are well-established and growing well under the continued care and maintenance of the Haggin Oaks staff.

The years 2002 and 2003 returned to a lower level of planting, with less than 500 new mitigation trees each year. This brief break in contract implementation was the beginning of the transition to program operations better informed by restoration best practices and natural resource management theories rather than urban tree planting programs. Over the last decade, the native tree mitigation program has averaged 15 native tree mitigation contracts every year and has planted an average of 1,530 trees each fall/ winter planting season.

In 2004, the first full-time field maintenance staff was hired to support the native tree mitigation program. This individual would spend the winter and fall working with community volunteers to plant new projects and the rest of the year performing ongoing maintenance and management including regular irrigation, mulching, weed management, pruning and monitoring. With an influx of new contracts, larger numbers of trees and more project sites, a second field maintenance staff member was hired in 2005. At this time, much of the watering was done by hand using 22.7 l (6 gal) blue jugs or hoses and temporary irrigation systems were built using homeowner grade irrigation materials. The evolution to irrigation standardization using professional grade materials and automatic timers has coincided with significant improvement in annual tree survival and long term tree establishment. The change in program staff coincided with a shift to restoration style planting and maintenance practices. Trial and error with these methods within our unique work areas has resulted in the planting and care methods we use today.

Site specific practices and creative management solutions

Beginning with tree propagation and finishing with final reporting, Tree Foundation staff has found the greatest success by bringing all parts of each project in house and under the careful management of the Director of Urban Ecology. A coequal focus of the Tree Foundation's work is education, thus community support and maximizing volunteer involvement are as important as providing the best quality tree mitigation. While many of our colleagues work on restoration, reforestation and tree mitigation projects under wild land environments, the Tree Foundation's Restoration Field Supervisor and her Restoration Field Workers face urban-centric challenges and respond with site specific creative solutions. Planting sites can range from extremely urban including trees in landscaped parks, on school campuses and along roadway planting strips to wild land restoration sites. As project success is measured by our financial supporters and regulating agencies as the number of healthy trees established at the site, this is the primary goal our actions are predicated upon.

All tree planting locations for the program are either publicly owned or managed under some type of easement. This arrangement necessitates a strong partnership with the land manager in order to ensure that tree establishment goals are in line with the long term vision and management strategy of that particular place. After the initial establishment period, land management partners assume the long term responsibility for the trees for the duration of their natural life span. Significant effort is put into developing these strong relationships with schools, parks and open space managers. Due to the history and success of past projects, many of these partners look to the Tree Foundation's tree mitigation program as potential financial support for projects meeting their management goals. An ideal project is one where the tree mitigation funding can be used to leverage a larger habitat creation or restoration project or allow a project partner to divert funds that would be used to pay for trees and their establishment to other unfunded project components.

The cycle of work begins each fall with the acorn harvest, a project that has received strong community support since the inception of the community based harvesting model in 2010. Each August the Restoration Ecologist and several acorn interns begin the process by applying for harvesting permits throughout the six county Tree Foundation service area and recruiting and training volunteer acorn harvesters to follow the very strict self-imposed harvesting guidelines. By working with many individuals who live throughout the service area, small collections of acorns are made from a large number of locations throughout the greater Sacramento region, thus maximizing potential genetic diversity within the tree nursery. Acorns are then either direct seeded into projects November-February or are potted up in the Tree Foundation nursery or with the help of the Seed to Seedling elementary school program. The Tree Foundation's preferred planting stock is deepot seedlings between 12 to 18 months old. When seedlings remain in our nursery past this point, they are transferred to the Rio Cosumnes Correctional Center to be grown into

larger sized trees. These larger trees are used in circumstances where seedlings are not appropriate, such as at school plantings or within park settings. Through experimentation and past failures, we have determined that the planting of seedlings in school and developed park sites do not withstand the pressures of close contact with students and lawn mowers.

The Tree Foundation works with volunteers to plant 100 percent of the native mitigation trees, thus educating and involving the community. As an organization committed to education, the Tree Foundation forges its most lasting connections with citizens through community planting days. However, as an organization that has accepted contracts and funding tied to tree establishment outcomes, it is imperative that the volunteers achieve a high level of quality in their work. Over the last decade, a very controlled method of volunteer planting has evolved that allows all of these goals to be met. Before volunteers are invited out to a planting site, the field crew does significant work to prepare it. This generally includes vegetation management using grazing, mowing, disking or spot clearing with brush cutters, flagging of the site for individual planting locations and species to be planted, and irrigation installation. If conditions are extra dry, the irrigation system may be completely installed and operated prior to planting.

The day of the event, plants and planting materials are staged at each planting site within the field. The amount of work to be done is carefully balanced with the number of volunteers recruited and the number of staff and interns on hand to ensure quality control. Having too few or two many volunteers can greatly impact the quantity and quality of work. In general, we assume each volunteer will plant three seedlings over the course of a 3 hour event. Volunteers arrive, sign waivers, and receive a talk on the project and personal safety before they are split into small groups to work with a planting leader; either a staff member or specially trained intern. In the small groups, every step of the process is demonstrated, from digging the hole to where to put the pot after planting. Following training, volunteers are evaluated on their first attempt and planting leaders spend most of the event checking planting quality and assisting their volunteer team with challenges. Extra equipment is used during volunteer plantings to assist with quality. Squares of burlap are used to deposit and re-apply all soil dug out of a planting spot to ensure seedlings don’t end up planted in a depression. Hammers are handed out to volunteers to avoid the poor quality and danger that occurs when planters try to hammer in the tree shelter stakes using a shovel. Keeping volunteers energized with snacks and fresh fruit as well as having plenty of water and a porta-potty on hand increase the productivity and cheerfulness of the volunteer work crew.

Planting styles used are highly dependent on each unique planting site, though all are a variation of the preferred method. The Tree Foundation prefers to plant native trees as deepot or similar container sized planting materials with 12 to 18 month old stock (from acorns) the preferred age to maximize rooting and shoot growth while minimizing root and shoot overgrowth. A Tubex® brand tree shelter or shrub shelter is used on all

planting materials that it is possible to install one on and pushed into the soil 5.1 to 10.2 cm (2 to 4 inches) deep. A bamboo or similar slender stake is used to secure the tube. Stakes are placed inside the tubes to discourage voles (*Microtus californicus*) from using the stake to gain access to the inside of the tube and are placed on either the north or south side of the tube to best withstand local wind patterns. Insect netting is not used as grasshoppers and other insects do not generally have a significant negative impact on projects in the Sacramento area. On past projects team members have witnessed tube netting tangling the feet of small raptors, becoming dislodged and blowing away as well as disintegrating in the hot summer sun. For Sacramento area projects, the benefit of the netting has not been significant enough to outweigh these negative impacts. In areas with significant mule deer (*Odocoileus hemionus*) or beaver (*Castor canadensis*) populations, a 1.2 m (4 ft) tall hog wire cage secured with t-posts or rebar may also be placed around each tree to provide additional protection. Organic mulch is the preferred ground treatment around new plantings with rice straw most commonly used in open space or wild land settings and wood chip mulch being preferred for developed park and school sites, primarily due to aesthetics and ease of transportation. Irrigation lines and drip emitters are placed on top of the mulch for ease of inspection and repair.

Irrigation is performed on all plantings with the occasional exception for a direct-seeded planting. In open space and wild land settings, drip irrigation lines are placed next to each plant with one or two pressure compensating emitters installed within 30.5 cm (12 inches) of each plant. Irrigation water is obtained in a variety of ways for each site with the most common being a municipal source nearby, use of a trash pump to pull water from a nearby water body, or by way of a fire hydrant hookup nearby. Rarely irrigation may be performed by hand, generally on larger sized trees in park like settings. In these cases, five-gallon “leaky” buckets with holes in the bottom are staged at each tree and filled from a 1,136 l (300 gal) truck bed tank or with hoses and a park facility water connection. In general, trees are irrigated June- October and are given approximately 45.4 to 68.1 l (12 to 18 gal) of water a week the first summer season, 45.4 l (12 gal) ever 2 weeks the second summer season and 45.4 l (12 gal) a month the third summer season. This scheme is altered on a site specific basis depending on soils, infiltration rates and plant growth response. On average to wet water years, third season projects may be irrigated only once or not at all during the third summer. In drier years occasional supplemental water may be provided October through March. Our general observation is that establishing a healthy root system through substantial irrigation during the first growing season leads to trees that are more drought tolerant in future seasons, when compared to trees that did not receive irrigation.

Maintenance is performed at each project site weekly the first season, bi-weekly the second season and on a monthly basis the third season. For project terms of more than three summer seasons, each project is visited and evaluated on a monthly basis. The majority of site maintenance time is spent

on vegetation control, with multiple objectives and benefits. As many Tree Foundation mitigation sites are embedded in highly urban areas, fire is one of the most frequent and costly site impacts to avoid. In certain seasons we have experienced fire at up to 40 percent of our project sites and lost significant irrigation infrastructure and trees. All of the fires at urban interface sites have been started by humans with cigarette butts and other inhalant drug paraphernalia frequently found at the ignition location, with the exception of one fire accidentally started and quickly extinguished by a staff member performing additional late season vegetation control. The Tree Foundation works to minimize fires at sites and the damage caused by fires by evaluating likely areas of fire ignition and mowing or brush-cutting fire breaks. On very high fire potential sites, extra attention is paid to clearing around individual trees and along irrigation transmission areas. With these techniques, trees and irrigation infrastructure can sustain only limited damage even if fire does burn through the project site.

Minimizing herbivory damage is the second main reason intense vegetation control is enacted on project sites, with vole damage being the most destructive in our region. The damage caused by voles fluctuates on a 3 to 5 year cycle with some years being incredibly intense and some years non problematic. Vole damage also varies within a project site, resulting in different treatments for tree management though a relative small project area. In the most intense cases, all mulch is removed from around the base of the tree and surrounding vegetation is mowed as low to the ground as possible to encourage vole predation and discourage further damage to the tree. Installation of perches in sites experiencing significant herbivory is intended to provide roosting for raptors as most of our sites have little to no surrounding vegetation and no place for visual hunters to perch.

Maintenance within established park sites is focused on protecting trees and preventing damage. Within turf areas, the greatest damage to trees comes from line trimmers and mowers operated by park maintenance staff. It is also challenging to keep mulch in place with weekly mowing coming as close to the edge of the tree establishment area as possible. Greatest success is achieved when turf grass is kept at least 1.2 m (4 ft) from the base of the tree, often with a combination of mechanical removal and maintenance with herbicides. Caging is used to discourage close mowing and square turf-free mulched areas around the tree allow complete mowing more efficiently than circular turf-free zones.

Each individual tree is mapped after planting and monitored on a yearly basis. Mapping and ongoing monitoring are facilitated by a customized ArcGIS database and field crews using Ipads and other handheld technologies. Ongoing maintenance communication is facilitated with smart phone apps such as Trello, which supports message boards for needed actions and materials for each project site, keeping everyone on the same page. Required annual reporting focuses on tree survival rates and informs replanting activities each winter. Projects are generally planned with five percent more

trees than necessary to cover expected losses and avoid replanting activities while still meeting contract requirements.

Recovery and reuse of tree planting materials help leave the planting site in a more natural state and can help make planting projects more cost effective. Many well established Sacramento area mitigation and restoration sites still have irrigation materials, tree tubes and woven plastic landscape fabric, even decades after implementation. Tree Foundation staff has witnessed left behind landscape fabric girdling fast growing trees such as Freemont cottonwood (*Populus fremontii*). Because of this, landscape fabric is only used on sites where partner agencies require its use and is the first thing removed as project maintenance terms close. Irrigation line is rolled up and reused if possible, aided by a homemade irrigation spooler designed and built by Sarah McKibbin. Tree tubes may be left on if high levels of herbivory are expected on site as they are designed to come apart when trees outgrow them, as has been witnessed on many of the Tree Foundation's project sites.

Conclusion

Filling Sacramento's urban nooks and crannies with native trees both meets the mitigation intent of local tree protection ordinances and creates valuable habitat for both resident and migratory wildlife. Opportunities to interact with native vegetation; to see the fall acorn crop, to see the spring wildflowers and to experience wildlife, brings our disconnected human population closer to nature while providing local aesthetic, air quality, public health and water quality benefits. Though this approach does not provide complete ecological restoration or necessarily build "natural" habitats, the impacts are significant and positive for people, wildlife and the integrity of the urban forest.

Establishing native trees and vegetation in urban settings is equally challenging when compared to wild land restoration, but with different impacts for which protection is needed. Access to reliable irrigation provides a greater level of success, while the impact of people (sometimes even willfully destructive) can be much harder to control and exceptionally damaging. The Tree Foundation's success in establishing more than 20,000 native trees is based on three key points that can be replicated anywhere: 1) understanding of site-specific challenges and design to accommodate or avoid them, 2) employment of intelligent, knowledgeable, creative people and management styles that allow them to solve problems creatively, and lastly, 3) to actively schedule flexibility. Many agencies and contracts have timelines that must be followed which do not allow flexibility to accommodate natural variations in timing, vagaries of local weather or other impossible to predict situations that directly impact healthy tree establishment. By accepting the flexibility to work with natural opportunities and accept the unpredictability of nature, great success can be achieved in establishing the next generation of native trees.