Assessing Capacity and Benefits of Native Plant Nurseries in the Los Angeles Region to Support Restoration of the Los Angeles River

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ABSTRACT

The Los Angeles River (LA River) is a waterway that flows approximately 51 miles through Southern California, and is characterized by extreme environmental degradation since its channelization in the 1960's. Once an alluvial river rich with biodiversity, known for its meandering flow and frequent flooding, the LA River caused destruction to urban settlements located on its floodplains.[1] The City of Los Angeles (City of LA), the National Park Service (NPS), and the United States Army Corps of Engineers (USACE), along with a host of several organizations, institutions, and individuals have recognized the tremendous ecological, financial, social and aesthetic value that a revitalized river could provide the City. These entities are working to restore the river's riparian ecology by reintroducing native plants adjacent to, inside of, and alongside the river. This revitalization project hinges on the availability of native plants. It also opens up a dialogue that examines the best sourcing methods for a native plant restoration. Millions of plants will be needed over the next several years (up to 20 years for the USACE Alternative with Restoration Benefits and Opportunities for Revitalization (ARBOR) Study alone). Although several local native plant nurseries exist, establishing a network of locally-sourced, locally-grown satellite nurseries could help ensure a sustainable supply of local native plants and provide social benefits to surrounding communities, supplement the existing nurseries, and reduce carbon emissions ("local" in this case refers to plants native to and grown within the LA region's watershed). Based on interviews with managers of established native plant nurseries in Los Angeles County, Orange County, and Ventura County, as well as a cost-benefit analysis comparing the establishment of a Los Angeles-based network of nurseries versus utilizing existing nurseries outside of the Los Angeles basin, existing nurseries have the capacity, expertise and willingness to expand land and production to support the river's restoration needs. The advantages of establishing a network of nurseries include helping to preserve the genetic purity of local native plants, equipping students with environmental education and vocational training, providing green jobs to local citizens, and reducing carbon emissions associated with plant transportation. This information, along with a compilation of best management practices and Geographic Information Systems (GIS) maps that showcase projected City of LA five-year priority projects for river revitalization efforts, projected ARBOR Study Alternate 20 sites, available city parcels along the river, the associated plant counts for these projects, and suitable Los Angeles Unified School District (LAUSD) schools for nursery establishment, will provide the City of LA and NPS with data to determine how to proceed with the supply of plant material to the future restoration/revitalization projects planned for the LA River.

[1] History of the Los Angeles River. (n.d.). Retrieved May 26, 2016, from http://ladpw.org/wmd/watershed/LA/history.cfm

INTRODUCTION

The Los Angeles River (LA River) is a 51-mile waterway flowing from the western San Fernando Valley through the City of Los Angeles, and out to its mouth in Long Beach. While it once flowed freely and provided abundant habitat for diverse local flora and fauna, its frequent flooding and unpredictable flow resulted in human casualties and property damage; this damage culminated after two major flooding events in the 1930's. It flows through 85 cities, with the first 32 miles within the City of Los Angeles. The complex politics eventually led to the river's channelization by the US Army Corps of Engineers, an effort undertaken in 1938, and completed by 1960.[2] Though the river is fixed by concrete and controlled, its predictability has come at the cost of significantly disturbed surrounding ecology and marginalized adjacent communities. The habitat in and around the river has largely decreased over the past century of increased urbanization.[3]

A great number of agencies, organizations, and individuals (including stakeholders, City of Los Angeles and National Park Service) realize the tremendous ecological, economic, and social potential that the LA River holds, and have supported efforts to revitalize it for decades. The LA River Revitalization refers to a large-scale, long-term effort to "celebrate neighborhoods, protect wildlife, promote the river's health, and leverage economic development while maintaining flood protection and safety," according to the Mayor's Fund for Los Angeles.[4] In 2007, the LA River Revitalization Master Plan was published as a result of collaboration among environmental groups, elected officials, community leaders, and concerned individuals and organizations. It includes plans to remove some of the river's concrete banks and reintroduce native plant species adjacent to, inside of, and alongside the river.[5] Furthermore, in 2013, the City of Los Angeles, in conjunction with the United States Army Corps of Engineers (USACE), completed the LA River's Alternative with Restoration Benefits and Opportunities for Revitalization Study (ARBOR Study) and Integrated Feasibility Report (IFR), which aims to restore an 11-mile stretch of the LA River's riparian habitat.

The plant material needed for such a large scale revitalization project is intuitively very substantial. By virtue of the large scale and wide visibility of the LA River, and the diverse array

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[2] History of the Los Angeles River. (n.d.). Retrieved May 26, 2016, from http://ladpw.org/wmd/watershed/LA/history.cfm

[3] US Army Corps of Engineers. (2015). Los Angeles River ecosystem restoration integrated feasibility report: Final feasibility report and environmental impact statement/environment impact report: Volume 1: Integrated feasibility report: Los Angeles County, California [Data file]. Retrieved from http://cdm16021.contentdm.oclc.org/cdm/ref/collection/p16021coll7/id/2339

[4] LA River: Revitalization for Stronger Communities. (2015) Retrieved from https://mayorsfundla.org/program/la-river-revitalization-for-stronger-communities/

[5] US Army Corps of Engineers. (2015). Los Angeles River ecosystem restoration integrated feasibility report: Final feasibility report and environmental impact statement/environment impact report: Volume 1: Integrated feasibility report: Los Angeles County, California [Data file]. Retrieved from http://cdm16021.contentdm.oclc.org/cdm/ref/collection/p16021coll7/id/2339

of stakeholders and projects associated with its revitalization, a dialogue that considers the most appropriate sourcing of required native plant material has been introduced.[6] A result of this dialogue is the consideration and proposal for a means of sourcing local seeds and producing plants locally in order to address a potential deficiency in plant supply, while also securing a viable, local source for native plant restoration efforts into the future (Jao, 2015). Such locally sourced, locally grown plant material is suggested to preserve local genetic stock and to stimulate local communities.

This paper estimates the annual plant count requirements associated with the LA River Revitalization, and comments on the perceived need for new nursery establishment in order to meet future demands. Further, a cost-benefit analysis exploring the social, environmental, educational, and economic implications of the proposed local network is outlined, as are best management practices compiled from interviews with industry professionals. Essentially, the feasibility, viability, and necessity of a network of locally sourced, locally grown native plants is discussed.

METHODS

Plant Counts

The LA River Revitalization is a large-scale, long-term plan comprised of many different projects; therefore, it is necessary to determine the acreage of its many planned projects. An estimate for the annual need of native plants was accomplished by combining the plant demands per acre for each project. Using a five-year priority project list provided by Melissa Guerrero of the Los Angeles Mayor's Office, which included projects' acreage, in combination with the 720 acres of the ARBOR Alternate 20, plant totals were summed.

Correspondences with Bob Sussman of Matilija Nursery, in addition to figures provided on Las Pilitas Nursery's website, informed the standard number of plants needed per acre of restoration (B. Sussman, personal communication, March 4, 2016).[7] Further, accounting for a potential high attrition rate of fifty percent, an upper bound of required plants per acre was determined (S. Landregan, personal communication, March 2016). In order to glean the number of plants needed per acre for a given project, the estimated range of plants needed (which is 4,000 to 6,000 plants) was multiplied by the number of acres of the given project scope.

Interview Process

[6] Jao, C. (2015). Imagining a Network of Native Plant Nurseries for the L.A. River. Retrieved from https://www.kcet.org/confluence/imagining-a-network-of-native-plant-nurseries-for-the-la-river
[7] Wilson, B. (2013). Restoration of a California Native Plant Community. Las Pilitas Nursery. Retrieved from http://www.laspilitas.com/advanced/advrevegetation.htm

During the interview phase of the project, the team visited seven nurseries, all of varying operation size and model, including for-profit retail and non-profit educational nurseries. The following native plant nursery managers were interviewed: Cody Chappel (TreePeople), Joey Algiers (NPS), Bob Sussman (Matilija Nursery), Mike Evans (Tree of Life Nursery), and Tim Becker (Theodore Payne Foundation). Each visit consisted of nursery managers answering questions about plant production, the costs of operating native plant nurseries, the nurseries' ability to meet potential plant counts associated with the Los Angeles River Revitalization project, the environmental education initiatives at each nursery, and the impediments associated with contract-growing locally sourced seed (from the Los Angeles basin, for example). At each of these meetings, group members took notes and compiled information (Appendix B-1). Further, founder and co-owner of former (now closed) Nopalito Nursery, Antonio Sanchez, was interviewed via conference call. The meeting with Sanchez consisted of discussing obstacles the nursery encountered during its operation and as it was about to close. This information helped to inform Best Management Practices, plant counts, nursery operation and set up, and final recommendations.

Additionally, in order to compile information on leading environmental education outlets, the research group contacted the following environmental education program managers: Tim Brick (Arroyo Seco Foundation), Meghan Steinharter and Brian Tseng (Parks Conservancy), Allison Brown (Rio Vista Middle School), and Stephen Majia (Friends of the Los Angeles River). The information from nursery visits and email correspondences was used during the Best Management Practices compilation.

Assessing Nurseries' Capacities

Existing (Outside of Los Angeles Watershed)

In order to determine the outputs of existing nurseries, the group compiled and added available plant counts from the following nurseries' websites: Matilija Nursery, Theodore Payne Foundation, Las Pilitas Nursery, and Tree of Life. Tree of Life Nursery's website included some data that was presented in a range; in order to achieve Tree of Life's plant count, the median number was selected per range in plants.

In addition, the group sent a survey to all of the visited nurseries in order to assess their current availabilities of sixteen randomly selected native plants (plants taken from two sources, the Los Angeles Revitalization Planting Guide[8]). This plant availability data can be found in Appendix C-4.1.

Also included with the above information in Appendix B is a directory of nurseries, detailing contact information and general notes about nurseries in California; this was provided

[8] Los Angeles Department of Public Works. (2004). Los Angeles River Master Plan Landscaping Guidelines and Plant Palettes

by Kat Superfisky and serves as a great resource for native plant sourcing. See Appendix B-3 for this data.

Proposed (Local, Within Los Angeles Watershed)

In examining the potential capacity and plant production capabilities for proposed start-up native plant nurseries within the LA watershed, only one existing model was identified and analyzed: the Los Nogales Nursery, located in Deb's Park and operated by the National Park Service and the Audubon Society. Justin Yee, the nursery's manager, provided material cost estimates as well as plant counts and capacity estimates as of February, 2016. See Appendix C-3 for these estimates. With only one model to analyze, the group presents the information found, but is unable to accurately extrapolate potential capacities for future start-ups.

Site Selection

LAUSD Schools: Existing Infrastructure

Using data indicating all Los Angeles Unified School District (LAUSD) schools with existing infrastructure (greenhouses, growing areas, etc.) suitable for seed propagation and plant production, a list of schools was prioritized for future nursery, seed bank, and environmental education projects. This data was provided by Kat Superfisky, designer at Mia Lehrer and Associates and Executive Director of Grown in LA, a nonprofit dedicated to implementing a means of locally sourcing and growing native plants in Los Angeles. Using the geocoding function of ArcGIS, a Geospatial Information Systems (GIS) program, these K-12 schools were plotted on a map.

In an attempt to address the current disparities in access to environmental jobs and education,[9] schools were analyzed based on their communities' disadvantaged designation by the Environmental Protection Agency (EPA) as well as the diversity and income (free/reduced eligibility) of their student populations (data was gathered for each school via the National Center for Education Statistics (NCES)).[10]

Sites are prioritized based on their available infrastructure, for intuitive cost-saving purposes. But further decisions regarding site selection may benefit from analyzing sites' proximity to the river and surrounding communities' disadvantaged designation (which indicates "areas with concentrations of people that are of low income, high unemployment, low levels of homeownership, high rent burden, sensitive populations, or low levels of educational attainment" *and* "disproportionately affected by environmental pollution and other hazards that can lead to

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[9] Taylor, D. E. (2004). *The State of Diversity in Environmental Organizations.* University of Michigan, School of Natural Resources & Environment Ann Arbor, Michigan

[10] Search for Public Schools. (n.d.). Retrieved 2016, from https://nces.ed.gov/ccd/schoolsearch/

negative public health effects, exposure, or environmental degradation").[11] See Appendices D-1 through D-3 for this data.

Public Parcels

Geospatial data provided by Melissa Guerrero of the LA Mayor's Office illustrates all of the publicly-owned and city-owned public parcels along the LA River. Parcels owned by the city and by the public are labelled separately. Parcels with area less than one acre have been screened out, and the acreage of the remaining parcels was calculated using ArcGIS's "calculate geometry" field. From here, for both ownership types, the total number of parcels, the average parcel acreage, and the summed parcel acreage was retrieved from ArcGIS's summary statistics function. See appendices D-4 and D-5 for this data.

Best Management Practices

Best management practices were compiled when reviewing relevant literature, and from suggestions offered by experts in the fields of nursery management, restoration, and education. These practices have been arranged in an order that addresses different aspects of restoration efforts, such as what type of seeds to collect, when to grow plants, etc.

Cost-Benefit Analysis

The cost-benefit analysis examines monetary and environmental costs, as well as social, economic, and environmental benefits associated with two native plant-sourcing strategies: (1) investing in LAUSD-based native plant sources, (2) public parcel-based satellite nurseries intended for plant storage and acclimatization, (3) well-funded nurseries with abundant resources, and alternatives which include investing in purchasing (A) 1-gallon plants or (B) 4-inch pots. Benefits and costs quantified in monetary terms include green job creation (statistics from transportation cost reduction, plant purchasing costs, and nursery start-up costs.

Transportation

One cost associated with remote sourcing, as opposed to sourcing from within the LA watershed, would be that of transportation. Transportation costs include dollars spent for diesel fuel and deleterious environmental impacts--namely carbon emissions.

Distances from each of the five main nurseries (Tree People, Matilija, Tree of Life, S&S Seeds, and Theodore Payne) to the LA River were mapped using Google Maps, and were found to be 17, 19, 72, 81, and 30 miles from a central point in Los Angeles River, respectively. Additionally, more distant nurseries from San Diego (RECON Native Plants), Watsonville

[11] EPA (2014) DESIGNATION OF DISADVANTAGED COMMUNITIES PURSUANT TO SENATE BILL 535 (DE LEÓN)

(Suncrest Nurseries), and the Bay Area (Yerba Buena Nursery) were also mapped to the river. The assumption was made that diesel trucks would be used to transport seed, and EIA data provided that the diesel cost is $2.20/gallon, and that 22.4 pounds of carbon dioxide is released for every gallon of diesel burned.[12]

Green Job Creation

"Bare bones" nurseries like Los Nogales, a National Park Service nursery, are able to operate with only one hired staff person, as they rely heavily on volunteer labor. However, as nurseries become more complex with environmental education programming and demonstration gardens, for example, they require more staff.

Start-Up Costs vs. Alternatives

Using cost estimates for infrastructure materials, like fence, lumber, and pea gravel, provided by Justin Yee of the National Park Service's Los Nogales Nursery, initial investments were determined for scenarios (1) and (2). Additional material costs, accounting for soil, fertilizer, and conetainers, inform yearly expenses. The cost of paying one full-time nursery manager is also counted as a cost for these two scenarios. Scenario (3) is a hypothetical nursery that comes at a higher cost, due to its more advanced infrastructure and greater access to resources and staff. The figures included are theoretical estimates assuming significant investment. See Appendix C-3 for calculations and cost estimates.

In order to determine alternatives (A and B), the overall costs of these three different scenarios are divided by the cost of 1-gallon plants: $4.00 (Landregan, S. Personal Communication). This indicates an alternative use of funds: purchasing plants instead of investing in local nurseries. Weighing this alternative purchasing potential against the overall need for native plants over the next five years (an estimated 3 million plants--see Appendix A-1).

RESULTS

Plant Counts

The Los Angeles River Priority Project List for the next five years includes 487 acres of river-adjacent revitalization. Estimates provided from several reliable sources state that four to six thousand plants are needed per acre of revitalization, resulting in a figure of between two and three million plants needed over the next five years for thirty-two miles of LA (Municipal) River Revitalization (J, Algiers, personal communication, January 30,2016; B. Sussma, personal communication, March 9, 2016; T. Becker, personal communication, March 11, 2016). This translates to between 40,000 and 60,000 native plants needed per year (Appendix A-1).

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[12] "How much carbon dioxide is produced by burning gasoline and diesel fuel?" (n.d.). Retrieved June 09, 2016, from http://www.eia.gov/tools/faqs/faq.cfm?id=307

The ARBOR Study, another long-term restoration effort, will require between 2,880,000 to 4,320,000 native plants for its 719 acres of restoration. Led by the US Army Corps of Engineers, planting for the 20-year ARBOR study will likely take 5 years to start, solidifying plant demands for 25 years.

Assessing Nurseries' Capacities

Existing

The determined current plant outputs for Matilija Nursery, Theodore Payne Foundation, Las Pilitas, and Tree of Life are: 12,797[13]; 9,154[14]; 23,669 (14,429 in production and 9,240 for purchase)[15]; and 74,350[16] respectively.

Proposed

Los Nogales Nursery is the only nursery startup model available to examine the efficiency and/or effectiveness of the production scale of new nurseries. An interview with Justin Yee, NPS restoration technician and manager at Los Nogales Nursery, revealed that the nursery has 7,682 plants and 23 species in an area equivalent to 0.027 acres. This information was current as of February 2016.

Site Recommendations

LAUSD Schools: Existing Infrastructure

The team deduced that environmental education was among the most impactful of nursery network uses. Therefore, it was proposed that satellite nurseries be hosted on LAUSD school with the appropriate infrastructure already in place for such facilities (ie. greenhouses and agricultural classroom buildings). In incorporating these currently underutilized facilities into the proposed network of nurseries, start-up costs will be minimized, and access to nurseries will be placed on students' campuses (eliminating the need to travel long distances for environmental education opportunities).

Once the forty-one LAUSD schools with existing nursery infrastructure were identified, they were labelled and sorted by their communities' level of "disadvantage," as designated by

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13 *California Native Plant & Non-native Iris Availability | Matilija Nursery – California Native Plant and Iris Nursery*. (2016). *Matilija Nursery*. Retrieved 3 June 2016, from http://www.matilijanursery.com/california-native-plant-availability/

14 Theodore Payne Nursery Inventory – Plants for sale as of June 3rd, 2016. (n.d.). Retrieved June, 2016, from http://theodorepayne.org/nursery/inventory/

15 Santa Margarita Store - Printable Plant Product Listing. (n.d.). Retrieved June, 2016, from http://www.laspilitas.com/stores/santa-margarita/plant-products/listing

16 Evans, D. (2016). *Tree of Life Nursery California Native Plants - Tree of Life Nursery Native Plant Catalog*. *Californianativeplants.com*. Retrieved 3 June 2016, from http://www.californianativeplants.com/index.php/plants/plant-catalog

the US EPA (see Appendices D-1 and D-2 for a table on schools' EPA designation and demography; see Appendix D-3 for a map). Of the forty-one schools with suitable infrastructure for nursery establishment, twenty-seven are located in census tracts ranked among the 25th percentile of disadvantaged communities; in other words, they have the highest degrees of environmental and social burdens, including significant environmental degradation and pollution, and high concentrations of people with low income, high unemployment, and low education attainment, to name a few factors.[17]

Public Parcels

Along the LA River, there exist a total of 1,738 publicly-owned parcels larger than one acre. The average size of these public parcels is approximately 9 acres, and the total available acreage of public parcels is 16,045 acres (See Appendices D-4 and D-5 for public parcel data). High availability of public land, coupled with generally low annual costs to lease--for example, $1 per year, for a ten year lease (S. Landregan, March, 2016)--points to an opportunity for expanding the proposed nursery network to include public parcels.

Cost-Benefit Analysis

Transportation

For the twelve nurseries examined, the cost of fuel for a one-way trip to the LA River ranges from $2.38 to $55.15, depending on the nursery. Carbon emissions range from 11.5 kilograms to 252.5 kilograms of CO_2. The values for these transportation-associated costs can be found in Appendix C-1. Realistically, during the process of a restoration project, multiple trips will be required, which will multiply the fuel costs and carbon emissions.

Green Job Creation

Appendix C-2 outlines the average salaries for nursery managers ($43,825), horticulturists ($38,480), nursery technicians ($26,000), environmental educators ($58,060) and sales associates ($24,000).

Start-Up Costs vs. Alternatives

Appendix C-3 details the costs and benefits (over three years) for three different options: (1) utilizing LAUSD's existing infrastructure to establish native plant facilities intended for plant-growing or -acclimatizing; (2) establishing a "bare bones" satellite nursery on a public parcel intended for plant-growing or -acclimatizing; and (3) investing in a nursery better-equipped for environmental education, demonstration gardens, and increased plant production.

[17] EPA (2014) DESIGNATION OF DISADVANTAGED COMMUNITIES PURSUANT TO SENATE BILL 535 (DE LEÓN)

The total costs over a three-year period, not accounting for time-value or opportunity *costs*, for each option are as follows: (1) $156,512, (2) $159,839, and (3) $1,541,676. Their calculated monetary *benefits* are the following: (1) $121,884, (2) $121,884, (3) $167,000. Assumptions used to calculate these figures are detailed in the appendix (C-3), and limitations will be addressed later in the discussion section.

Two of the most viable alternatives to investing in local native plant facilities are instead (A) purchasing one-gallon plants (approximately $4.00 each) or (B) purchasing four-inch pots (approximately $1.50 each) for revitalization and restoration purposes. For the first option, alternatives to (option 1) investment yield 39,128 one-gallon plants, or 104,342 four-inch pots. The second option's alternative yields 54,313 one-gallon plants, or 144,835 four-inch pots. Finally, the third option's alternative yields 385,419 one-gallon plants and 1,027,785 four-inch pots. Calculated as a percentage of total native plants (3,000,000) needed in the foreseeable future, alternative A yields (1) 1.30%, (2) 1.81%, and (3) 12.85%, respectively, of the total need.

DISCUSSION

Assessing Existing Nurseries' Capacities

Due to a small sample of nurseries, a final conclusion cannot be made about the capacity of existing nurseries. With a variety of different metrics coming from different sources, it is difficult to arrive at nurseries' standard production rates per unit area. However, combining nurseries' efforts, the expected number of plants needed for the restoration should be met. Each nursery manager interviewed expressed enthusiasm for the revitalization, and also indicated an ability to provide sufficient plant material. S&S Seeds even offered to donate seed to the effort.

The only inhibiting factors in these nurseries' abilities have to do with space. Bob Sussman of Matilija Nursery mentioned his, the possibility of expanding, renting additional land and scaling up his resources to help meet the revitalization demand. This eagerness to deliver makes sense; such a large scale project is attractive to business owners, as it theoretically provides a steady stream of business and has wide visibility. Another issue expressed by several nursery managers dealt with plant maintenance. When contracted to work with government agencies specifically, nurseries are occasionally faced with shifting project timelines, and plant shipment is often delayed due to issues with funding, for example (B. Sussman, Personal Communication, 2016). Having to store plants for indefinite periods of time can be costly and is an inefficient use of land. Occupying space and requiring attention and water, these plants-in-waiting slow down further production, incurring an opportunity cost for nurseries.

Establishing river-adjacent satellite nurseries, both on LAUSD school grounds (with existing infrastructure) and on the city's public land parcels, can address this storage issue. Satellite nurseries provide the space and infrastructure needed to store plants as they grow, and they also enable plants to "harden off" in their new environment, before being planted on-site. This is a more cost-efficient solution, and it allows for better acclimatization of plants.

Assessing Proposed Nurseries' Capacities

Los Nogales Nursery in Debs Park is a promising example of a successful startup nursery. There are a few factors worth considering when determining its scalability and success, though. First, with plant production near 7,700 plants per 0.027 acres, it seems to be producing very efficiently (compared to Bob Sussman's estimate of 20,000 one-gallon plants per acre). But it should be noted that Los Nogales' plants are likely not all at the one-gallon stage (recommended for restoration). Intuitively, this will change with time as plants grow and nursery operations improve further. While Los Nogales is a successful model to study, it is the only one of its kind in Los Angeles; as more start-up nurseries come online, the scalability and success of of these facilities will be better understood.

Due to the complex logistics of establishing a nursery and process of propagating a wide range of native species, a full-production nursery is not advised[18] [19]. As mentioned previously, the proposed satellite nursery will be a holding space to store plants as they grow and "harden off." Existing nurseries will be able to maximize shipping load by delivering plants in 2-inch pots, a stage where plants are at a stage to grow with a higher success rate (M. Evans, personal communication, February 20, 2016).

Site Selection

Underutilized infrastructure and land proliferate Los Angeles. Vacant, public space exists in excess of sixteen thousand acres, and at least forty-one schools have nursery infrastructure that is currently not being used. From a cost-effectiveness standpoint, integrating these underutilized resources into the nursery network model is recommended. However, the team was not able to visit potential sites to evaluate utility adjacencies, security, and other site assessments needed in order to comment on which city properties would be best suited. But benefits extend beyond cost-savings; plant survivorship is likely to increase if satellite nurseries are established, as plants will be introduced to their new environments more gradually. [20] Further, LAUSD and public parcel satellite nurseries have the potential to serve as learning environments, fit for project-based learning, environmental education, and science curriculum integration. By virtue

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[18] Dumroese, R. Kasten, Tara Luna, Thomas D. Landis (2009). *Nursery manual for native plants: A guide for tribal nurseries, Vol. 1: Nursery Management*. Washington, D.C.: U.S. Department of Agriculture, Forest Service.
[19] Kyriazis, Stephanie. "How to start a nursery". National Park Service.
[20] *Hardening Off*. (n.d.). North Dakota State University Extension Service. Retrieved from https://www.ag.ndsu.edu/richlandcountyextension/horticulture/information-images/The sq. footer#6.pdf.

of their location (within river communities), these nurseries can serve to bridge communities and their river, engaging them in the process of its revitalization.

Community Engagement

Continued community partnership and engagement throughout the entire process of the River's Revitalization is essential for its success. In engaging community members throughout the course of the project--beyond just the initial public process--knowledge will continue to disseminate, and engaged participants will help to promote local issue awareness with their families, friends, and neighbors. Through this exchange, people with different skillsets can be expected to come together to address their community's needs (J. Saunders, personal communication, June 1, 2016). This creates room for innovation, and opportunities for creative solutions ((J. Saunders, personal communication, June 1, 2016). Outlets that connect individuals to the revitalization of the LA River will give them the tools they need to become stewards of the river--both now, and into the future. In this manner, the significance of the river may be understood, and shared by Angelenos. Sites for these outlets should best serve the communities most affected by its revitalization.

It is paramount to focus on the communities located proximal to the LA river, as their lives and histories are deeply integrated with the river, and environmental gentrification (the increase in property values as a result of greening projects, which tends to drive out the original residents[21]) is too often a byproduct of good intentions. As seen in Appendices D-1 through D-3, Los Angeles has many disadvantaged communities; river-adjacent communities in particular are marked by severe environmental and social issues. "Disadvantaged" designations are set by the EPA, and are based on the amount of social and environmental obstacles a community faces.[22] An effect of these qualities is that resources such as education are not equitably provided across Los Angeles County. However, for the LA River Revitalization to be a success in river-adjacent communities, community members must understand how a project like the revitalization of the LA River can not only benefit their ecosystem health, but also improve their current statuses of economic and social capital--that they will not be forgotten. Plans for such large-scale environmental initiatives set by the city must be coupled with eagerness to involve local communities. In this manner, members may become invested in the river and its future, and a bridge between Angelenos and the LA River may be created.

According to experts in the field of restoration, education should be provided to promote community involvement in projects like the LA River's revitalization (A. Sanchez, personal communication, March 30, 2016). As LA is certain to face plenty of environmental challenges in the future, it is crucial to encourage stewardship and environmental education in the youth.

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[21] Daigneau, E. (n.d.). Just Green Enough. Retrieved June 09, 2016, from http://www.governing.com/topics/transportation-infrastructure/gov-green-gentrification-series.html

[22] Rodriguez, M. (2014). *Designation of Disadvantaged Communities*. Retrieved from California Environmental Protection Agency: http://www.calepa.ca.gov/EnvJustice/GHGinvest/Documents/SB535DesCom.pdf.

Environmental Education

Eighty-eight percent of the United States' population may be considered "environmentally illiterate," according to a ten year study published by the National Environmental Education and Training Foundation[23]. The study found that although most individuals believe they are knowledgeable about the environment, they do not have a comprehensive understanding of environmental science, and the sustainable solutions--including composting and other household solutions--that are practiced in order to address environmental issues. As a result, samaritans are often misguided in their attempts to make environmentally-conscious decisions. These actions can ultimately result in negative contributions to their communities and local ecosystems, and highlight an issue that students and educators face today--the lack of environmental education (EE) that is available to the public. EE's positive contributions include promoting individual growth, opportunities for job training, and improvements to ecosystem health. If native plants are sourced from sites in which EE practices are extensively implemented, it is possible to create communities of environmentally-aware and literate individuals that will support the revitalization of the LA River and a healthy city. By forging relationships between the citizens of Los Angeles and the land, EE will help to shape attitudes and promote sustainable practices.

The Environment as an Integrating Context for Learning Model (EIC) is one model for environmental education that stimulates individual growth in students.[24] A study of 40 schools that follow EIC shows that when the environment is used as an educational tool, students perform better on standardized tests, are more disciplined and manageable, are more engaged, and are more likely to feel accomplished.[25] These trends are not limited to students that receive environmental education through EIC. Reading, math, science, and social studies skills notably improve in students that receive any environmental-based education.[26] Due to the real-world and hands-on applications that EE provides, students are additionally more likely to address environmental issues that their communities face.[27] Environmental action by youth has been documented in the following ways: physical environmental improvements, community education, inquiry, public issue analysis and advocacy for policy change, and products or services contributing to community development.[28] Through contributions to their communities,

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[23] Coyle, K. (September 2005). *Environmental Literacy in California*. Retrieved from http://files.eric.ed.gov/fulltext/ED522820.pdf.

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[26] Mann, L., & Hensley, E. (2002). *Education and the Environment: Strategic Initiatives for Enhancing Education in California*. Retrieved from http://resources.spaces3.com/fd939d06-a0c3-489f-8858-1f04455f1538.pdf

[27] Mann, L., & Hensley, E. (2002). *Education and the Environment: Strategic Initiatives for Enhancing Education in California*. Retrieved from http://resources.spaces3.com/fd939d06-a0c3-489f-8858-1f04455f1538.pdf

[28] Krasny, Marianne E., Monroe, & Martha C. (2015). *Across the Spectrum.* Retrieved from

students that receive EE are seen to be more active, invested, and responsible citizens.[29] EE shapes individuals in a way that benefits both the environment and the public.

Green employment in California has expanded by 109% since 1995, while the state's overall employment has only increased by 12%.[30] This growth must be met by the industry's next generation of workers, and further highlights the need for adequate EE programming to be provided to the youth. However, LAUSD educators today are limited in their ability to integrate EE into curriculums. Since Common Core Standards were adopted by the school district, teachers have participated less in extracurricular activities, like field trips (C. Russell, personal communication, April 7, 2016). For this reason and due to other travel restrictions subjected by the school district, students may be best served with outlets for EE that occur on their school's campus. Stimulated by a $15 million grant from the state's Department of Education, LAUSD has invested in Linked Learning--a program designed to foster relationships between students, local businesses and community colleges in an effort to provide clear career pathways and a more enriched learning experience.[31] Benefits of Linked Learning include a 10% higher increase in high school graduation, and a 9% increase in post-secondary enrollment.[32] Each high school participating in Linked Learning offers advanced education in a certain sector, and provides vocational training to individuals so they may actualize their desires to work in the field. The following high schools are Linked Learning schools that focus on applications of EE: Environmental and Social Justice at Fremont High School; Los Angeles River School at Sonia Sotomayor Learning Academies; Environmental Science, Engineering and Technology at Carson High School; and Academy of Environmental and Social Policy at Lincoln High School; and Ornamental Horticulture/Service, Sales and Marketing at Jack London High School.[33]

It is critical to note that these green-focused Linked Learning programs constitute only five of the forty-one high schools in the program (with programs in urban agriculture, among other subjects). The revitalization of the LA River is unique for an urban project as it provides opportunities for EE in communities. In conjunction with this project, Linked Learning and similar, project-based EE platforms can be expanded to incorporate education through local, native plant sourcing methods.

Network Model

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https://naaee.org/sites/default/files/eepro/resource/files/acrossthespectrum_su15_final_spreads.pdf

[29] Hungerford, H.R., & Volk, T.L.(1990). *Changing Learner Behavior Through Environmental Education, The Journal of Environmental Education*. Retrieved from http://dx.doi.org/10.1080/00958964.1990.10753743

[30]Melville, J., Brown, C., Harutyunyan, A., & Held, K. (2012). *Seven Growth Factors Driving California's Clean and Efficient Economy*. Environmental Defense Fund.

[31] Waldman, Tom. "LAUSD Awarded Grant to Create Career Pathways for Students" Los Angeles Unified School District. LAUSD, 30 May 2014. Retrieved from http://home.lausd.net/apps/news/article/383389

[32] The James Irvine Foundation: Linked Learning. (n.d.). Retrieved June 09, 2016, from http://interactives.irvine.org/linkedlearning2016/evidence/research

[33] LAUSD Linked Learning Pathways by Industry Sector. (n.d.). Retrieved from http://achieve.lausd.net/Page/8076

Establishing a network of locally grown and locally collected plants will help to engage communities in the transformation of their region and revitalization of their river (K. Superfisky, personal communication, May 17, 2016). It will provide a platform for fostering the connection of people to their environment by opening up educational, environmental, and green job opportunities. Native plant sourcing methods, such as local seed collection, propagation, and other nursery tasks can be used in future to foster an environmental education curriculum for high school students, such as the aforementioned Linked Learning, that lead to green career pathways. Other opportunities obtained through establishing a nursery network include providing vocational training programs for youth corps, veterans, and the homeless through nursery-related activities (K. Superfisky, personal communication, May 17, 2016).

Grown in LA (GiLA) is an example of a nonprofit that seeks to provide a multi-faceted solution for transforming Los Angeles and its River by simultaneously addressing the environmental, social, and economic systems inherently connected to the Los Angeles metropolitan region through the creation of a nursery network (K. Superfisky, personal communication, May 17, 2016). GiLA hopes to streamline communication and collaboration among existing growers and connect them to upcoming projects, and is also helping to establish new nurseries on underutilized land in Los Angeles (K. Superfisky, personal communication, May 17, 2016).

Kat Superfisky, designer at Mia Lehrer and Associates and Executive Director of Grown in LA, provided data of LAUSD schools with existing nursery infrastructure and Melissa Guerrero, from the City of LA, provided public parcels data on the LA river, which were used to determine potential locations for nursery establishment. The nursery models for these future potential nurseries are discussed in appendix D-6. From the data of LAUSD schools with sufficient nursery infrastructure, the team focused on the schools in designated disadvantaged zones near the river.

Genetics and Ecological Restoration

A clear definition of “ecological restoration” must be established before undertaking any such project. The National Research Council committee defines restoration as “the return of an ecosystem to a close approximation of its condition prior to disturbance”[34] while the Society of Ecological Restoration (US EPA, 2016) defines it as “the intentional alteration of a site to establish a defined, indigenous, historic ecosystem. The goal of this process is to emulate the structure, functioning, diversity, and dynamics of the specified ecosystem” (US EPA, 2016). One important factor that has been often overlooked when striving to achieve said restoration goals is

[34] *Wetlands Restoration Definitions and Distinctions | Wetlands Protection and Restoration | US EPA*. (2016). *Epa.gov*. Retrieved 2 June 2016, from https://www.epa.gov/wetlands/wetlands-restoration-definitions-and-distinctions

the genetics of the introduced stock[35]. Careful consideration of the genetic material introduced is key in achieving historical ecological conditions.[36]

An important consideration is choosing the source material for a restoration project. Most restorationists understand the negative effects inappropriate plant stock can have on the restoration site[37]. Some of these negative effects include genetic swamping, outbreeding depression, genetic pollution, bottleneck effect, etc. [38] [39] . These processes can reduce genetic variation. Although the introduction of the nonlocal stock may be well intentioned, these effects can be devastating to the already fragile native ecosystem. Another concern when introducing non local native plants comes from the idea of local adaptation. Even plants within the same species may differ genetically due to subtle changes in their respective environment. Many times, only distance from the restoration site is considered when collecting source material. This might not always be appropriate. Other factors including elevation, slope, temperature, soil pH, etc. must be taken into account as well. Introducing plants that are maladapted to a particular environment may end up in crop failures, resulting in a failed restoration project.[40]

There is debate within the ecological restoration community regarding what is the best method in carrying out restorations (Longcore et al. 2000). Restoration projects can be distinguished between a concentration in diversity or a concentration in function. Some literature suggests that restorationists can imitate natural systems instead of copying them by creating communities that resemble natural systems but actually differ in species composition[41]. Longcore et al. believes that ecological restoration should be historically accurate and complete in order to qualify as a "restoration." Restoration should have as its goal "the preservation of biodiversity in a system that requires minimal human management" with biodiversity including not only plants but also insects, birds, mammals, and cryptobiotic crusts (Longcore et al. 1997). Although a restoration may seem successful due to healthy flora, many times the effects on fauna are overlooked. Vandegehuchte *et al.* studied the effects of nonlocal plant genotypes on associated invertebrate community. Their results suggested that "non-local genotypes of this

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[35] Millar, C. I., & Libby, W. J. (1989). Restoration: Disneyland or a native ecosystem? A question of genetics. Ecological Restoration.

[36] Longcore, T., Mattoni, R., Pratt, G., & Rich, C. (2000). On the perils of ecological restoration: lessons from the El Segundo blue butterfly. 2nd Interface Between Ecology and Land Development in California, 281–286.

[37] McKay, J. K., Christian, C. E., Harrison, S., & Rice, K. J. (2005). "How Local Is Local?"A Review of Practical and Conceptual Issues in the Genetics of Restoration. Restoration Ecology, 13(3), 432–440. http://doi.org/10.1111/j.1526-100X.2005.00058.x

[38] Mijangos, J. L., Pacioni, C., Spencer, P. B. S., & Craig, M. D. (2014). Contribution of genetics to ecological restoration. Molecular Ecology, 24(1), 22–37. http://doi.org/10.1111/mec.12995

[39] Hufford, K. M., & Mazer, S. J. (2003). Plant ecotypes: Genetic differentiation in the age of ecological restoration. Trends in Ecology and Evolution, 18(3), 147–155. http://doi.org/10.1016/S0169-5347(03)00002-8

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[41] Jordan, William R., III. & Steven Packard. 1987. Just a few oddball species: restoration practice and ecological theory. Pp. 18–26 in Buckley, G.P. ed. Biological habitat reconstruction. Belhaven Press, New York

grass, even at small geographical scales, can have negative impacts on the associated invertebrate community."[42]

In a disturbed ecosystem, the development of plant material may pose a significant challenge. Although local genotypes maybe the best place to start, it may not be the best place to finish (Jones, 2013). Due to the limited amount of source material to work with, choosing from a "hyper local" location may not be ideal. This is due to the limited genetic variation available from the local sources.[43] As expressed previously, limited genetic variation can cause a plant population to fail. Disturbed ecosystems also have significant conditions that local native plants are not adapted to handle (Jones, 2013). A more "ecologically appropriate" source selection as defined by Jones, 2013 maybe a more viable option for a restorationist.

Implications of Urban Park VS. Restoration

An important distinction must be made when completing any sort of restoration, revitalization, or regeneration project. This distinction is this - the project would either aim for a complete ecological restoration of the LA River, or it would focus on an urban parks project approach. A restoration project emphasizes rehabilitation of an area's natural habitat, as close as possible to its original state (original state here meaning before anthropogenic development occurred in the region).

When designing habitat restoration in an urban environment, many factors must be considered. Habitat restoration can mean many things to many people, thus it is important to define what is wanted for this habitat restoration. The Society of Ecological Restoration (SER) defines restoration as "the intentional alteration of a site to establish a defined, indigenous, historic ecosystem. The goal of this process is to emulate the structure, functioning, diversity, and dynamics of the specified ecosystem." [44] One of the major difficulties with this definition of restoration is that often it is difficult if not impossible to determine what exactly these indigenous ecosystems looked like, and what species to include (Aronson et al, 1993). This is particularly true in highly urbanized areas like Los Angeles.

Rehabilitation is the repair of damaged ecosystem functions, with the primary goal of increasing ecosystem productivity for the benefit of the local community (Aronson et al, 1993.) Ecosystem services provided by restored/rehabilitated urban areas are increasingly gaining interest. As urban areas continue to expand, benefits provided by green (parks, urban forests) and blue (streams, lakes, ponds) infrastructure may be crucial to the long term resilience of such

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[42] Vandegehuchte, M. L., De La Peña, E., Breyne, P., & Bonte, D. (2012). Non-local genotypes of a resident grass species reduce invertebrate species richness. Insect Conservation and Diversity, 5(6), 453–460. http://doi.org/10.1111/j.1752-4598.2011.00181.x

[43] Jones, T. (2013). Ecologically Appropriate Plant Materials for Restoration Applications. BioScience, 63(3), 211–219. http://doi.org/10.1525/bio.2013.63.3.9

[44] Aronson, J., Floret, C., Floc'h, E., Ovalle, C., Pontanier, R., Aronsod, J., … Ode, C. (1993). Restoration and rehabilitation of degraded ecosystems in arid and semi-arid lands. I. A view from the South. Restoration Ecology, 1(1), 8–17. http://doi.org/10.1111/j.1526-100X.1993.tb00004.x

urban areas in the face of climate change.[45] Some monetary benefits include pollution and air quality regulation, carbon sequestration, etc. Non-monetary benefits include health, social cohesion and education (Elmqvist et al. 2015). These benefits can be included under the "Human Factor." When assessing ecosystem benefits, many times the "Human Factor" is largely understudied. Increasing the attention on the "Human Factor can increase the participatory stakeholder involvement.[46]

In an urban park setting, one danger is the "museumification process" that tends to develop in urban park restoration. Museumification is the process in which everyday objects and places are removed and transformed as if placed within a museum.[47] In this case, nature experiences provided by the urban parks seem to limit rather than increase those experiences. This happens through limiting the park use by changing and reducing "acceptable behaviors" in order to reduce degradation of this now fragile environment (Gobster, 2007). One particular concern are city children, especially those with little to no nature exposure. City children will not be able to fully explore the park due to restrictions put in place (Gobster, 2007). Limiting urban children from a full natural experience in the exact place meant for such would defeat the purpose of an urban park (Gobster, 2007).

A political concern is that wild habitats are unsightly in an urban context. Some people are attracted to the aesthetic beauty nature can provide. In an urban setting, this can be greatly improved through a more carefully-designed landscape approach, rather than a restoration approach. Thus an ecological park can be most successful if it incorporates human values related to the experience of nature as much as it does to ecological values (Gobster, 2007). People are more likely to care for landscapes that they admire therefore ensuring the survival and success of an urban park. The Los Angeles River Revitalization has proposed one of its major goals is to provide much needed green space and access to nature to traditionally underserved communities often located along the river[48] Revitalization of the Los Angeles River can not only improve habitat for local flora and fauna, but also provide many social and economic benefits for those communities that need it the most.

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[45] Elmqvist, T., Setala, H., Handel, S. N., van der Ploeg, S., Aronson, J., Blignaut, J. N., … de Groot, R. (2015). Benefits of restoring ecosystem services in urban areas. Current Opinion in Environmental Sustainability, 14, 101–108. http://doi.org/10.1016/j.cosust.2015.05.001

[46] Turner, K. G., Anderson, S., Gonzales-Chang, M., Costanza, R., Courville, S., Dalgaard, T., … Wratten, S. (2015). A review of methods, data, and models to assess changes in the value of ecosystem services from land degradation and restoration. Ecological Modelling, 319, 190–207. http://doi.org/10.1016/j.ecolmodel.2015.07.017

[47] Gobster, P. H. (2007). Urban Park Restoration and the "Museumification" of Nature. Nature & Culture, 2(2), 95–114. http://doi.org/10.3167/nc2007.020201

[48] *LA River RMP - Community Outreach*. (2016). *Boe.lacity.org*. Retrieved 2 June 2016, from http://boe.lacity.org/lariverrmp/CommunityOutreach/masterplan_download.htm

Cost-Benefit Analysis

The cost-benefit analysis was performed to compare the potential costs of either investing in a network of native plant nurseries, or using that money to simply buy plants from existing nurseries. For the LAUSD scenario, volunteer labor and plant production combined yield a monetary gain of $121,884 over the course of three years. This figure does not account for the positive externalities associated with environmental education (examined earlier in our environmental education discussion). Alternatively, if the three-year investment of $156,512.75 were devoted to purchasing 1-gallon plants instead, a total of 39,128 plants could be purchased. When divided by the 3,000,000 plants needed over the next five years of the River's revitalization, this alternative accounts for 1.30% of the total (upcoming) demand (see Appendix C-3).

While this cost-benefit analysis has its limitations, it does illustrate the relative weight of these two investment strategies: (1) investing in a long-term program that extends project-based learning, environmental education, and an opportunity to engage with nature to youth in EPA-designated Disadvantaged Communities, whose relationship to their River has long-been severed by the environmental degradation imposed by a single-minded 'solution' imposed eighty years ago, or (2) buying 39,128 one-gallon pots of plants. Also, assuming similar production rates to the Los Nogales model, the former investment will yield 23,046 plants over the course of 3 years anyway.

Costs associated with sourcing from existing nurseries pertain to transportation: fuel costs from diesel-burning trucks, and their carbon emissions (See Appendix C-1). Transportation costs are relatively insignificant, ranging from less than three dollars, to around fifty-five, depending on the nursery. Realistically, multiple trips would be needed between each nursery and the LA River, which would amplify fuel costs and carbon emissions. However, even after accounting for multiple trips, fuel costs still end up being a fraction of the cost required to start up even the most barebones nursery ($50,000, according to Kat Superfisky). Carbon emissions also fall relatively low, as the 250 kg emitted by a one way trip from Yerba Buena to the LA River translated to metric tons ends up being around 0.25 metric tons. For comparison, the average U.S citizen's annual CO_2 emissions are around 17.0 metric tons, as of 2011.[49]

Limitations

A primary limiting factor within the project is the fact that native seeds themselves have seasonal limitations. The amount of seeds suitable for collection is viability - the attrition rate for seeds is estimated to be very high (around 50%). Since different nurseries have their own sources for seeds, having a reliable source for seed collection is another challenge.

[49] The World Bank. (2016). United States Data. Retrieved from http://data.worldbank.org/country/united-states

A limiting factor in the team's research is the fact that contradicting and often biased information stemmed from various different sources. For example, the issue of genetic purity within a restoration context is highly contested--how local is local enough? Individuals are often very polarized on either side of this debate, and it becomes difficult sometimes to tangle philosophical, emotional, and scientific reasoning. The group struggled with this issue for much of the project, finally deciding that there is not one definitive answer to the issue of locality. Another example of bias in the group's interviews stems from that fact that nurseries are businesses; their eagerness to supply for River's Revitalization may be influenced by the promise of the project's large scale, steady demand, and public visibility.

Recommendations

The team has a number of recommendations regarding the proposed local network of native plant sources. First, vacant public parcels provide a unique opportunity. They are affordable to lease, they are located along the river, and they can serve as overflow, holding locations for plants in need of acclimatization. By forging partnerships with existing nurseries, nonprofits and government agencies can serve the needs of the communities *and* the LA River Revitalization. Interviews with different nurseries managers indicated a pain point that nurseries face: they are willing to serve the large demands of the Revitalization, but doing so might require expanding their operations.

The second recommendation includes using LAUSD's existing, underutilized nursery infrastructure as a source for growing, storing and hardening off native plants (M. Evans, personal communication, February 20, 2016). These plants can be sourced from established nurseries, since newly-established school nurseries will not have the resources nor experience to produce viable native plants for restoration. In addition to providing storage and care to current growers' plants, these LAUSD-based nurseries should offer their students environmental education and project-based learning environments.

These interagency partnerships will ensure a shared investment between the city, the existing nurseries, and community members alike.

CONCLUSION

Reasons to establish a local network of native plant nurseries are rooted deeper than simply 'not having enough plants to supply the LA River Revitalization.' Many native plant nurseries that have committed themselves to collecting native seed, growing native plants, and supplying for native plant restorations exist throughout California. These nurseries have the stock and proven reliability that will be critical in actualizing the LA River Revitalization.

The argument for local nurseries runs deeper. River communities are among the most heavily impacted by environmental and social issues--unemployment, low income, environmental hazards, pollution, and low education attainment. Just as invasive interventions from outside sources are damaging to communities of people, they do not work with the Los Angeles River. The community needs to be engaged, or the process will not work.[50]

The City of Los Angeles has the resources to make this happen. LAUSD schools have the necessary land and infrastructure, and established nurseries are eager to contribute their expertise. It will take time and serious effort, but it is time to forge partnerships, and to create a network of local native plant sources that honors the long-standing efforts of existing native plant nurseries, and inspires the next generation of Angeleno stewards.

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APPENDICES: Contents

Appendix A-1: Five Year Priority Project List

LA RiverWorks: Draft 02/24/2016

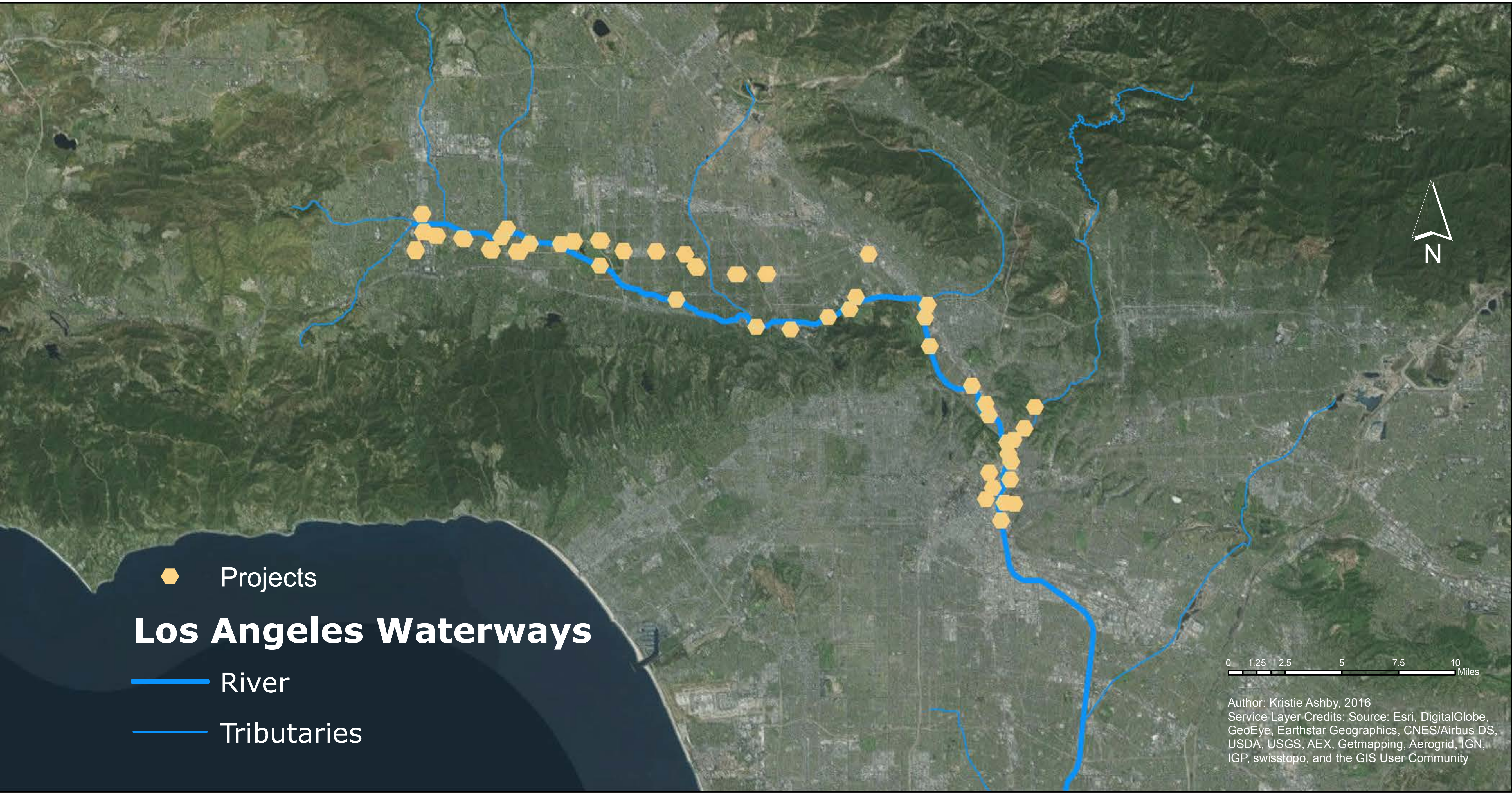
#	ARBOR	Status	Lead	Approx. Total Acres	Project Type
1	x	Confidential		41	Wetland or In-Channel Restoration
2	x	Pre-design	LARiverWorks		Wetland or In-Channel Restoration
3		Design	LARiverWorks	8.73	Greenway
4	x	Planning	LARiverWorks	118	Wetland or In-Channel Restoration
5	x	Planning	LARiverWorks	68	Wetland or In-Channel Restoration
6	x	Planning	LARiverWorks	59	Wetland or In-Channel Restoration
7	x	Planning	LARiverWorks	59	Wetland or In-Channel Restoration
8	x	Planning	City	120	Wetland or In-Channel Restoration
9		Unknown		12	Wetland or In-Channel Restoration
10		Permitting	City / River Revitalization Corporation (Also, BOE, ML+A part of design team)	0.1	Greenway
11		Design-Schematic	City	0	NA
12		Design-Concept	Trust for Public Land, Robin Marks	?	Greenway
13		Design-Concept	Mountains Recreation and Conservation Authority,Gabriella Golik <gabriella.golik@mrca.ca.gov>	1.5	Park / Wetland or In-Channel Restoration
14		Design-Concept	Northeast Trees, Mark Kenyon	5.6	Park / Greenway
15		Planning	LA Conservation Corps, Larry Smith	2	Park / Greenway
16	x	Planning	LARiverWorks	2.9	Greenway
17		Planning	LARiverWorks	0.95	Greenway

Approximate TOTAL Acres = 498.8

498.8 Acres x (4,000 - 6,000 plants/acre) = **1,995,200 to 2,992,800**
plants needed for the next 5 years

* Range accounts for attrition rate (up to 50%)

Appendix 1.2: Five Year Priority Projects: LA RiverWorks



Appendix A-2: ARBOR Study

ARBOR Study Acreage: Approximately 720 acres of restored habitat

720 acres x (4,000 - 6,000) plants per acre =

2,880,000 to 4,320,000 plants needed

Over a ~ 20 year period

Alternative 20

Alternative 20 restores 719 acres of habitat along the 11 mile study reach.

Table 7-1 Approximate Acres Restored By Reach

Reach	Alt 13v Acres	Alt 20 RIVER Acres
1	82	82
2	39	59
3	50	80
4	59	59
5	41	68
6	159	159
7	59	59
8	109	153
Total	598	719

The acreages provided in this table are based on conceptual drawings and GIS. The resolution of these estimates is at a feasibility level for planning purposes. The Real Estate Plan used individual parcel information based on County records for greater accuracy for future acquisition purposes.

Source:

United States Army Corps of Engineers. (n.d.). *Los Angeles River Ecosystem Restoration Integrated Feasibility Report* (Vol. 1) [PDF].
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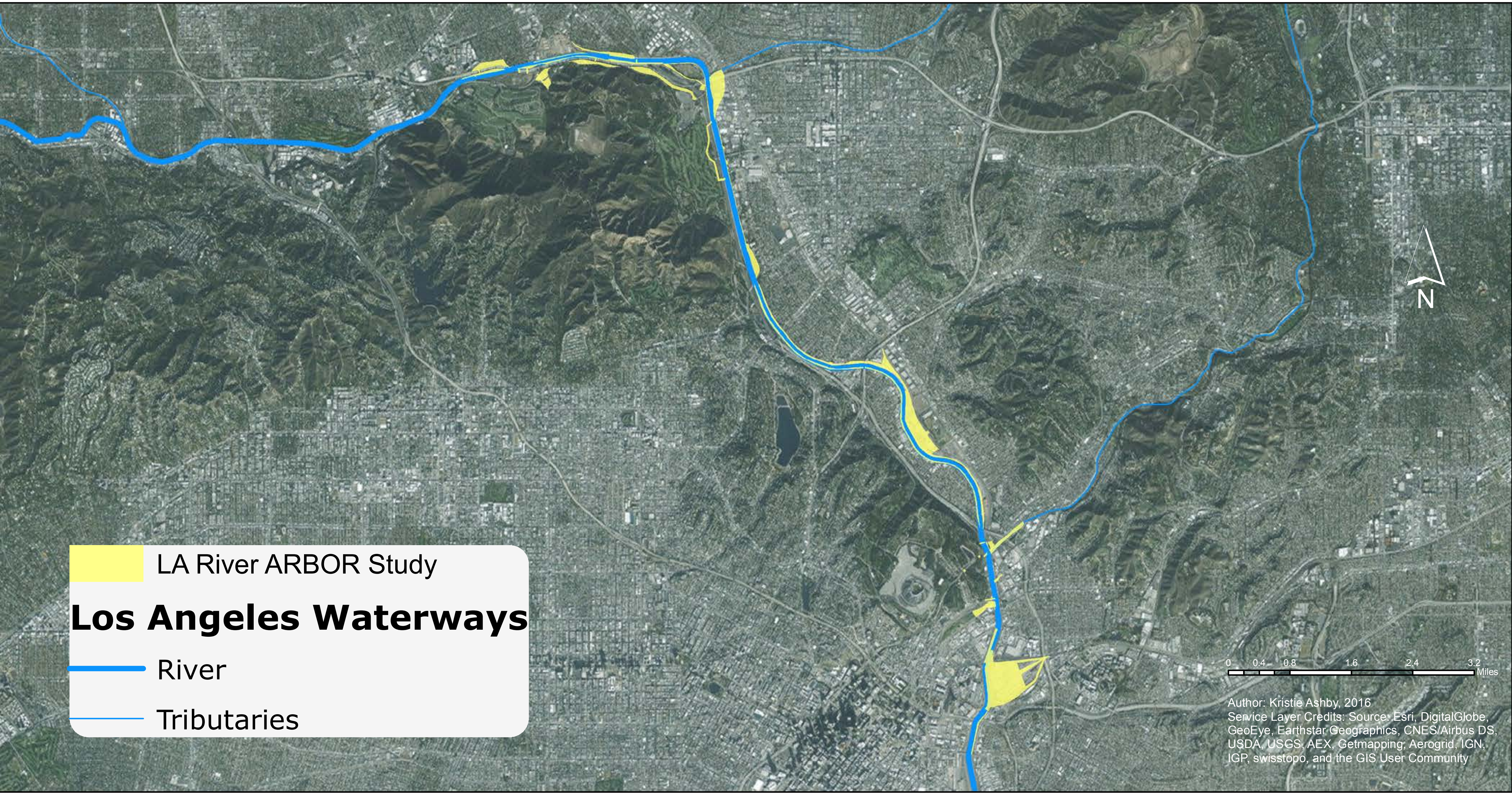
Appendix 2.2: ARBOR Study



Appendix B-1: Interview Material

A. Tree People Visit

    01/20/2016 - Cody Chappel

B. National Park Service's Rancho Sierra Vista Nursery (RSV)

    01/ 30/2016 - Joseph Algiers

C. Matilija Nursery

    01/30/2016 - Bob Sussman

D. Matilija Nursery

    03/08/2016 - Bob Sussman (Email Correspondence)

E. Theodore Payne Foundation

    03/03/2016 - Tim Becker

F. Theodore Payne Foundation

    03/11/2016 - Tim Becker (Email Correspondence)

On January 20, 2016, the Native Plants team visited the TreePeople in Beverly Hills, California, to meet with the nursery manager, Cody Chappel. As our first meeting with a nursery, we sought to understand the general operations of a nursery onsite. (C. Chappel, personal communication, January 20, 2016)

- EcoTours - K-12 learn about natural systems
- TreePeople nurseries: randomly places, poor sunlight, ad hoc/symbolic, greenhouse, no overhead irrigation, shade cloths, planting storages in nursery
- Nursery necessities: (overhead) irrigation, sunlight, rodent prevention, planting storages
- RCD Antelope Valley
- contracts are important!!! people cannot back out
- protection against rodents especially on site -- keeping it human only
- investing in a quality nursery: time vs. money
- electricity: heating, nocturnal propagation
- seedling to transplant success: depends on species
    - know characteristics of planting
    - might have to deal with germinating
    - who's working with the nursery?
    - TreePeople has been pretty successful with volunteers + employees
- site: history, what it went through, life, pre-existing conditions
- seeds/plants: "watershed" specific, covariance -- let nature take its course, stick to geological barriers
- existing plant pallette
    - anything will be an improvement for project, hard to find resources (SMM, SGM)
- LA River pocket parks -- not really riparian landscape
    - landscape architecture features vs. riparian restoration
- LA river stream comes from municipal water
    - "river of the Angeles" converted to a flood control channel
- benefits of environmental education -- for teachers: Generation Earth, EcoTours, HS visits, EcoClub for school projects
- TreePeople responsible for LA recycling -- kids convinced parents to vote for recycling in 80s
    - purpose to love the forest
- effects of biodiversity - where do these plants come from to feed animals
- San Pedro nurseries -- good to check out (near oil refinery, Navy property)

Visiting sites:

- biodiversity: natural history?
- April Road nursery near Malibu Creek & Paramount

On January 30, 2016, the Native Plants team visited National Park Service's Rancho Sierra Vista Nursery (RSV) located in Newbury Park, California, to meet with nursery manager, Joseph (Joey) Algiers. As one of our first meetings with nurseries, we sought to understand the general operations of a nursery onsite. (J. Algiers, personal communication, January 30, 2016)

Q: How do you collect seeds?

- Seeds are self-collected and sorted by coastal and inland species
  - Collection sites are recorded to prevent over collection and for future references
- S&S Seeds are seed collectors with about a 2-year (season) turnaround
  - They are contractors to propagate

Q: What is the maximum capacity of this nursery?

- About 25,000 plants maximum for 26 acres of restoration on a 10-acre nursery was the biggest operation the nursery has seen (pretty doable operation)
  - Seeds from S&S Seeds were returned due to lack in quality
  - ⅓ of the seeds successfully propagated
  - 300 seeds per square meter

Q: What are some tips for propagating?

- Enter everything into a database for inventory, label plants by projects
- Anticipate the weather and collect seeds periodically
- Only collect about 5-15% of seeds at a site

Q: Are there volunteers?

- The nursery is heavily influenced by Congress since NPS is a federal agency
  - Volunteers stay for about 6 months, mainly local retires
  - There are some student hires
  - There are some interns; however there are short turnovers for interns

Q: How long does it take to start up a nursery?

- An example of an NPS nursery that has recently started is an LA nursery in Debs Park
  - Started in February and March 2015, propagated in summer
  - everything potted recently
  - had to depend on RSV nursery (50 miles)
  - LA does not have many seed collection spots
- Seeding room
  - Seeds go from flats → cones → gallon pots → yards
  - Soil composes of native soil into soil mix
  - Not much seed treatment necessary
  - Beware of herbivory problem (mice)
  - Each flat has 90-100 seeds per species
  - Mountains Restoration Trust (MRT) uses NPS for restoration
  - Summer propagation are good by first rain (around February)
  - Weed control: Milestone vs. roundup treatment
  - Harden off plants before putting them into the yard

    - Diversity means less competition at site

Q: What are some educational programs RSV has been a part of?

- SAMO Youth is for high school seniors and juniors (16-18 year olds) planting program
- SHRUBs program for 5th graders and school visits

Q: What are some operational obstacles?

- The nursery is currently watering by hand, which takes 3 to 4 hours to water
    - Drop irrigation system is set up but not efficient
- Locations and communities should be considered

On January 20, 2016, the Native Plants team visited Matilija Nursery in Moorpark, California, to meet with the owner, Bob Sussman. As one of our first meetings with nurseries, we sought to understand the general operations of a nursery onsite. (B. Sussman, personal communication, January 20, 2016)

Q: How long does it take to start up an average nursery?

- It takes about 1.5 year with an experienced nursery team
  - Space and capacity should not be an issue; renting land is an option to expand
  - Basic needs of a nursery include: space, irrigation system, structures, water, electricity, sanitation for staff and equipment
  - Consider the upfront cost of construction and equipment (potting)
  - Water comes from wells

Q: Do you have volunteers?

- No, paid staff only
  - Volunteers are not permanent
  - Paid internships are slightly better, but still run the risk of workman compensation insurance

Q: What are costs to consider in a planting plan?

- Plant quantity and timeline of the plan should be made clearly in the contract
  - Deposits tend to be higher than normal for rare plants and flakey customers
    - Typically ⅓ down payment
  - Best offered difference, cash return if planting plan is not met
  - Beware of some bureaucratic issues
  - Maintenance fees apply if nursery has to hold on to plants
- Bidding of list
  - If a certain amount of a certain species cannot be grown, the customers need to be informed so a compensation can be made (substitution for another plant)

Q: What are your opinions on the importance seed collection and seed sourcing locally?

- Seed collection can be flexible geographically bounded plants
  - Seed collection can be costly to restrict plants geographically
  - Seed collection can come from customers
  - Local genetics can be a little broader
    - 25-50-mile radius; coastal - coastal, inland-inland

Q: What is the capacity of one truck delivery?

- A trucking can fit up to about 1200 plants
  - The smaller the orders are, the bigger the delivery cost will be
  - The closer the nursery, the better the advantage (quick demand and flexible)

Q: How would you plan a 600-acre restoration project?

- Pathways need to have sun/shade, bathroom

- Plant grass along the walkway and parks (easy, short, low)
- Know when plants go dormant
    - Summer and fall plants are easy to plant
- For educational purposes:
    - Nectar and milkweed should be in a grouping with milkweed off trail and nectar in front
    - Design a wild “urban” kingdom
- The best time to plant is during the fall going into winter then plan backwards from there

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On March 8, 2016, the team contacted Bob via e-mail to ask questions about metrics to determine a nursery’s capacity to produce plants per acreage and a restoration site’s capacity to install plants. (B. Sussman, personal communication, March 9, 2016)

On Tue, Mar 8, 2016 at 3:57 PM, MINDY PHAM <minpham@ucla.edu> wrote:
Hi Bob,

Our class is working on the cost benefit analysis with the nursery capacity. You mentioned during our tour about the capacity our Matilija. How did you estimate the amount of plants produced per acreage in a nursery? What is your estimate on the capacity of plants per acreage in a restoration site and/or an urban park setting? What is an estimate turnover of plant sales to maintain a nursery?

Thanks,
Mindy

On Wed, Mar 9, 2016 at 5:47 AM, Matilija Bob <matilijanurseryweb@gmail.com> wrote:
The plants that can be produced per acre is actually is situation where supply is meeting projected demand. Think of it the same as a warehouse, if there is open space in the warehouse and we think we can fill it with something we can sell - begin to work on filling the space. We can fit/per acre about 20,000 1-gallon plants. That amounts to 1/2 the space for plants and the other half of the space for production facilities-production facility defined as space needed to produce the product/deliver the product as opposed to space needed to warehouse the plants themselves.

2nd question? What I think you mean- not sure but it largely depends on the design. If the design requires lots of oak trees then the plants per "restored" acre are going to be less- grasses would be more. For the area of a park/restoration site - not the recreation or walk areas or parking area but planted resorted areas- maybe 1plant / 15sqft- very rough very average. This can depend on so many things.

Estimated plant sales to maintain the nursery- again not sure so you can call or email me but - if you're asking from a profit/loss point of view- that would be a minimum of just under 1x per year. As you got below 1x per year - that would indicate you have too much space devoted to finished inventory at you'd max out at about 2x per year. As you try to go much past 2x per year - that might indicate that the plants really are not "finished" and ready to be planted. From a viability standpoint - the plants/inventory start going non-viable after sitting for more that 6 or 7 months. This depends very much on the individual plant but after 6 or 7 months some things need to be tossed.

Ok, hope this helps.
Good luck,
Bob

On Thursday, the Native Plants team visited Theodore Payne Foundation. After the initial meeting, the team exchanged emails with Theodore Payne Foundation's nursery manager Tim Becker. (T. Becker, personal communication, March 11, 2016). The email is as followed:

From: MINDY PHAM [mailto:minpham@ucla.edu]
Sent: Tuesday, March 8, 2016 12:54 PM
To: Tim Becker <tim@theodorepayne.org>
Subject: Re: UCLA Native Plant Practicum

Hi Tim,

As we are working on our cost benefit analysis, we came up with some more questions. You mentioned during our tour about the capacity of the nursery, how did you estimate the amount of plants produced per acreage? Another question we have was what is an estimate turnover of plant sales to maintain a nursery?

Thanks,
Mindy

On Fri, Mar 11, 2016 at 11:46 AM, Tim Becker <tim@theodorepayne.org> wrote:

Amount of plants produced per acre is a pretty simple formula of surface area that a plant takes up (including paths). By my estimate a 1 gallon pot with paths included in the equation gives you about .43 square feet per plant so a 43560 (1 acre plot) would yield ~100,000 if you only had one crop cycle and were only growing one gallons. Your second question is very much business operation question…you need to sell enough plants to make up for expenses. This is a very complex issue and would require having a solid business model before creating turnover estimates. Hope this helps,

Tim Becker
Director of Horticulture
Theodore Payne Foundation
For Wild Flowers and Native Plants, Inc.
10459 Tuxford Street
Sun Valley, CA 91352
818-768-1802 x19 | www.theodorepayne.org

Appendix B-2: Best Management Practices

Based on the information gleaned from in-person interviews and email correspondences, the team compiled a list of best management practices for future work with the restoration efforts. These practices are based on recommendations provided by Kat Superfisky, senior ecologist Ellen Mackey, and managers from various native plant nurseries.

From Seed to Plant

According to Kat Superfisky, there must be increased collaboration between various government and private entities to create a regional Los Angeles native plant seed bank. These entities include city government, NPS, and the various native plant nurseries in the Los Angeles region.

Ellen Mackey, senior ecologist with the Metropolitan Water District of Southern California, gave several suggestions for the project. These include to collect seed samples from all types of native plants, not just big and robust ones; to grow perennials instead of annuals, as annuals require more maintenance and waste that must be removed (perennials live for at least two years, while annuals live for only one); and that a dependency on schools for plant propagation is not ideal given high student turnover, for example.

From Plant to Site

Ellen Mackey noted that the ideal time to plant would be in the late fall to early winter (the months of November to January), when the soil is cool and moisture is better retained. However, many nursery managers recommend that the best time to plant would be the summer. Jody Miller of S&S seeds stated that succession planting (planting a second plant in the same space as the first after the latter has been harvested) would prevent hindrances, like shade, from affecting propagation. Mackey, as well as Mike Evans from Tree of Life and Tim Becker from Theodore Payne Foundation, all recommend utilizing one-gallon plants, as they are cost-effective, easy to transport, are ideal for retail, and provide more room for additional plants. As for genetic purity, the University of California, Davis, states that choosing local ecotypes ensures the highest rates of seed success, and that the genetic purity of the seed stock must be equivalent or greater than the required genetic purity of the final product.

Miscellaneous Nursery Items

Antonio Sanchez, manager of the now-closed Nopalito nursery, warned that growing too many plants too quickly is a problem in and of itself. He pointed out that it is the landscape, not the plants themselves, that inspires locals, and as such recommended plants such as sage, penstemon, and other plants that are not too wild-looking. Sanchez argued that neighborhood landscapers must be inspired by native plants, and this can be done most effectively by through appealing landscapes. He also indicated that having plants with no site to plant them on was a common problem, and that this coordination was crucial to a successful nursery.

General Notes

After visiting several nurseries, it became clear that each nursery manager was committed to aiding the LA River Revitalization. S&S Seeds even expressed willingness to donate seeds to the Revitalization effort. These nurseries and seed banks have existed for years, and in some cases, decades, learning through trial and error the techniques and practices essential for success. Additionally, accounting for the unique propagation methods required of different species of native plants (like those whose germination is fire-activated, for example), it is unlikely to assume that new, start-up nurseries will be able to provide these specific services. So, forming partnerships with knowledgeable organizations with proven track records in native plant production will be crucial as the Revitalization progresses.

Appendix B-3: Nursery Directory (by Kat Superfisky)

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Private Brokers							
	Larry Hawes			949-456-6531	lhawes.lh@gmail.com		

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Nursery Broker							
	Bamboo Pipeline	Nicole	321 N. Aviador St. #201 Camarillo, CA 93010	805-764-2600	sales@bamboopipeline.com	www.bamboopipeline.com	
	F.K. Nursery	Dave	2027 Colby Ave. Los Angeles, CA 90025	310-473-2104	No email	No website	
	Village Nurseries	Deborah	mulitple locations in Orange County	714-998-8751	ddoyle@villagenurseries.com	villagenurseries.com	

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Gen. Wholesale							
	Boething Treeland	Douglas	multiple locations	818-316-2057	DHenderson@boethingtreeland.com	www.boethingtreeland.com	
	El Nativo		200 S. Peckham Rd. Azusa, CA 91702	626-969-8449	sales@elnativogrowers.com	elnativogrowers.com	Drought Tolerant Plants
	Kobata Growers		17622 Van Ness Ave. Torrance, CA 90503	310-323-0662		www.kobatagrowers.com	Some indoor and outdoor
	Monrovia Nursery		817 E. Monrovia Pl. Azusa, CA 91702	626-334-9321		monrovia.com	
	Monterey Bay Nursery		748 San Miguel Canyon Rd. Royal Oaks, CA 95076	831-724-6361	sales@montereybaynursery.com	montereybaynursery.com	
	Mountain States Wholesale Nursery	Wendy		760-539-7099	Wendy@mswn.com	mswn.com	
	Native Sons Nursery		379 W. Campo Rd. Arroyo Grande, CA 93420	805-4815996	orders@nativeson.com	nativeson.com	
	Norman's Nursery	Gregg	various locations	626-237-0622	gream@nngrower.com	nngrower.com	Trees and much more
	Ricardo's Nursery	Ricardo	6850 Atlantic Ave. Long Beach, CA 90805	562-261-5782			
	San Marcos Growers	Peggy	125 South San Marcos Road Santa Barbara, CA	805-683-1561	pkoegler@smgrowers.com	smgrowers.com	
	Soquel Nursery Growers	Curtis	3645 North Main Street Soquel, CA 95073	831-475-3533	info@soquelnursery.com	soquelnursery.com	
	Suncrest Nurseries Inc.		400 Casserly Rd. Watsonville, CA 95076	831-728-2595	postmaster@suncrestnurseries.com	suncrestnurseries.com	
	Tiedemann Nursery		4707 Cherryvale Soquel, CA 95073	831-475-5163		tiedemannllc.com	
	Waterwise Botanicals		32183 Old Hwy 395 Escondido, CA 92026	760-728-2641		www.waterwisebotanicals.com	
	West Covina Wholesale Nursery	Tino	5297 Shoreline Dr. Santa Barbara, CA 93111	805-964-8270	tino@wcnurseries.com	wcnurseries.com	

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Gen. Retail							
	Australian Native Plants Nursery	Jo O'Connell	9040 North Ventura Ave Ventura, CA 93001	805-649-3362	jo@australianplants.com	www.australianplants.com	By appointment only
	Dream Garden	John	6751 Sunset Blvd. Los Angeles, CA 90028	323-465-0161			Nice retail specimens
	Greenwood Daylilies	John	8000 Balcom Canyon Rd. Somis, CA 93066	562-494-8944	info@greenwoodgarden.com	www.greenwoodgarden.com	Daylilies, Irises, Geranium & more
	Hashimoto Nursery		1935 Sawtelle Blvd. West LA, CA 90025	310-473-6232			
	House of Bonsai	Victoria	5214 Palo Verde Ave. Lakewood, CA 90713	562-804-6888		houseofbonsai.com	Bonsai
	Kimura Bonsai Nursery		17230 Roscoe Blvd. Northridge, CA	818-343-4090		kimurabonsainursery.com	Bonsai
	Maples for All Seasons Nursery	Barry		925-461-4389	barry@maplesforallseasons.com		Japanese Maples etc..
	Rolling Greens		9528 Jefferson Blvd. Culver City, CA 90232	310-559-8656			
	Seaside Gardens		3700 Via Real Carpinteria, CA 93013	805-684-6001		www.seaside-gardens.com	Great demonstration gardens
	Sunset Nursery		4368 Sunset Blvd. Los Angeles, CA 90029	323-661-1642		sunsetblvdnursery.com	
	The Jungle Nursery		1900 Sawtelle Blvd. Los Angeles, CA 90025	310-235-2875	infoQ@dryjungle.com	dryjungle.com	
	The Tropics	Ryan	7056 Santa Monica Blvd. Weho, CA 90038	323-469-1682	thetropicshollywood@gmail.com	www.thetropicsinc.com	
	Vintage Nursery	Paul	78755 Darby Road Bermuda Dunes, CA 92203	760-772-6494	joee@thevintageco.com	vintagenursery.com	Palm Springs Nursery
	Worldwide Exotics	Shelley	11157 Orcas Ave. Lake View Terrace, CA 91342	818-890-1915	shelly.jennings5824@hotmail.com	www.worldwideexoticsnursery.com	
	Xotx Tropico		900 N. Fairfax Ave. West Hollywood, CA 90046	323-654-9999			
	Yamaguchi Bonsai Nursery		1905 Sawtelle Blvd. West LA, CA 90025	310-473-5444			Bonsai

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Bamboo							
	Bamboo Headquarters		2498 Majella Rd. Vista, CA 92084	760-758-6181		www.bamboohq.com	
	San Marcos Growers	Peggy	125 South San Marcos Road Santa Barbara, CA	805-683-1561	pkoegler@smgrowers.com	smgrowers.com	
	The Jungle Nursery		1900 Sawtelle Blvd. Los Angeles, CA 90025	310-235-2875	infoQ@dryjungle.com	dryjungle.com	

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Cactus/Succulent							
	California Cactus Center	Molly	216 S. Rosemead Blvd. Pasadena, CA 91107	626-795-2788	california.cactuscenter@gmail.com	cactuscenter.com	

Appendix B-3: Nursery Directory (by Kat Superfisky)

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
	California Desert Nursery	Joey	78-600 Darby Road Bermuda Dunes, CA 92255	760-345-5859	sales@cdnursery.com	www.cdnursery.com	Palm Springs Area
	California Nursery Specialties		19420 Saticoy St. Reseda, CA 91335	818-894-5694		www.california-cactus-succulents.com	
	Desert Theater	Brandon	9655 Kiwi Meadown Lane Escondido	760-594-2330	sixstring1 <sixstring1@sbcglobal.net>	deserttheater.com	Quality specimen plants
	Norman's Nursery	Gregg	various locations	626-237-0622	gream@nngrower.com	nngrower.com	Trees and much more
	Randy Meyers Nursery	Randy`	Desert Hot Springs	760-329-8757	RGMNURSERY@MSN.COM		Trees, Agaves, cactus & more
	Rolling Greens		9528 Jefferson Blvd. Culver City, CA 90232	310-559-8656	don@serragardens.com	serragardens.com	
	San Marcos Growers	Peggy	125 South San Marcos Road Santa Barbara, CA	805-683-1561	pkoegler@smgrowers.com	smgrowers.com	
	Serra Gardens	Donald	897 Quail Hill Road Fallbrook, CA	760-990-4762		serragardens.com	
	The Good Earth		1855 South Alturas Fallbrook, CA 92028	760-728-8066		palms4u.com	Succulent, Palm and other specimens
	The Jungle Nursery		1900 Sawtelle Blvd. Los Angeles, CA 90025	310-235-2875	infoQ@dryjungle.com	dryjungle.com	
	The Tropics	Ryan	7056 Santa Monica Blvd. Weho, CA 90038	323-469-1682	thetropicshollywood@gmail.com	www.thetropicsinc.com	

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
California Native							
	El Nativo		200 S. Peckham Rd. Azusa, CA 91702	626-969-8449	sales@elnativogrowers.com	elnativogrowers.com	Drought Tolerant Plants
	Grow Native Nursery		100 Davis Ave. Los Angeles, CA 90049	424-234-0481	gnnwestla@rsabg.org	www.rsabg.org/grow-native-nursery	Retail prices and quality
	Recon Native Plants	Patrick	1755 Saturn Blvd. San Diego, CA 92154	619-423-2884	patrick@reconnativeplants.com	reconnativeplants.com	Wholesale - good quality
	Las Pilitas Nursery		3232 Las Pilitas Rd. Santa Margarita, CA 93453	805-438-5992		laspilitas.com	
	Las Pilitas Nursery		8331 Nelson Way Escondido, CA 92026	760-749-5930			
	Native Sons Nursery		379 W. Campo Rd. Arroyo Grande, CA 93420	805-481-5996	orders@nativeson.com	nativeson.com	
	Suncrest Nurseries Inc.		400 Casserly Rd. Watsonville, CA 95076	831-728-2595	postmaster@suncrestnurseries.com	suncrestnurseries.com	
	Theodore Payne Foundation		10459 Tuxford St. Sun Valley, CA 91352	818-768-1802		theodorepayne.org	Retail prices and quality
	Tree of Life Nursery		33201 Ortega Hwy. San Juan Capistrano, CA 92375	949-728-0685		www.californianativeplants.com	Quality is not so great - quality check!!
	Yerba Buena Nursery		19500 Skyline Blvd. Woodside, CA 94062	650-851-1668		yerbabuenanursery.com	

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Fruit/Veggie							
	California Tropical Fruit Trees	Perry	Elevado Road Vista, CA	760-434-5085		www.tropicalfruittrees.com	Not great stock - Hand pick only!!
	Durling Nursery		40401 De Luz Rd. Fallbrook, CA 92028	760-728-9572	durlingnursery@aol.com		
	Exotica Rare Fruit Tree Nursery		2508 E. Vista Way #B Vista, CA 92084	760-724-9093			check for quality - Hand pick ??
	Mimosa Nursery		6270 Allston Street Los Angeles, CA				Big and small exotic fruit and bonsai/topiary
	Ong Nursery		2528 Crandall Drive San Diego, CA 92111	858-277-8167		www.ongnursery.com	Small nursery - some nice stock
	Temple Garden Nursery		11314 Lower Azusa Road El Monte, CA				Mostly small some bigger exotic fruit
	Two Dog Nursery	Jo Anne		323-422-3835	twodognursery@gmail.com	twodognursery.com	Organic Retail - by appointment only

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Grass/like/Turf							
	Delta Bluegrass Company		111 Zukerman Rd. Stockton, CA 95206	209-469-7979		www.deltabluegrass.com	Local rep is S&S Seeds for ordering
	S&S Seeds Inc.		6155 Carpenteria Ave. Carpenteria, CA 93013	805-684-0436	info@ssseeds.com	www.ssseeds.com	Hydroseed/Seed mixes
	San Marcos Growers	Peggy	125 South San Marcos Road Santa Barbara, CA	805-683-1561	pkoegler@smgrowers.com	smgrowers.com	
	Southland Sod Farm	Rosa	2599 E. Hueneme Rd. Oxnard, CA 93033	805-488-3585		www.sod.com	

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Orchids/Bromeliads							
	Andy's Orchids		734 Ocean View Avenue Encinitas, CA 92024	760-436-4239	info@andysorchids.com	www.andysorchids.com	Specializes in species - by appointment only
	Cal Orchid Inc.		1251 Orchid Dr. Santa Barbara, CA 93111	805-967-1312		calorchid.com	
	Orchid Fever		10242 Culver Blvd. Culver City, CA 90232	310-559-6599			
	Rain Forest Flora Inc.	Paul/Jerry	19121 Hawthorne Blvd. Torrance, CA 90503	310-370-8044	pti@rainforestflora.com	rainforestflora.com	Tillandsias and bromeliads
	The Tropics	Ryan	7056 Santa Monica Blvd. Weho, CA 90038	323-469-1682	thetropicshollywood@gmail.com	www.thetropicsinc.com	
	Santa Barbara Orchid Estate		1250 Orchid Drive Santa Barbara, CA 93111	805-967-1284		www.sborchid.com	

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Palm/Cycad							
	Hanson Palms	Isaac	31931 Palos Verdes Drive Escondido, CA 92026	760-884-6706	isaac@hansonpalms.com	www.hansonpalms.com	
	Instant Jungle	Greg	2560 S. Birch St. Santa Ana, CA 92707	714-850-9227	greg@instantjungle.com	www.instantjungle.com	
	Jungle Music	Phil	450 Ocean Way Ave. Encinitas, CA 92024	619-291-4605	Phil@junglemusic.net	www.junglemusic.net	

Appendix B-3: Nursery Directory (by Kat Superfisky)

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
	Rancho Soledad Nursery	Eric	18539 Aliso Canyon Rd. Rancho Santa Fe, CA 92091	858-756-3717	sales@ranchosoledad.com	www.ranchosoledad.com	
	Rolling Greens		9528 Jefferson Blvd. Culver City, CA 90232	310-559-8656			
	Sea Crest Nursery	Christi	5299 Shoreline Drive Santa Barbara, CA 93111	310-480-0538	seacrestpalm@aol.com	seacrestnursery.com	
	The Good Earth		1855 South Alturas Fallbrook, CA 92028	760-728-8066		palms4u.com	Succulent, Palm and other specimens
	The Jungle Nursery		1900 Sawtelle Blvd. Los Angeles, CA 90025	310-235-2875	infoQ@dryjungle.com	dryjungle.com	
	The Tropics	Ryan	7056 Santa Monica Blvd. Weho, CA 90038	323-469-1682	thetropicshollywood@gmail.com	www.thetropicsinc.com	

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Topiary/Sculptural							
	Ben K Nursery		2301 Kelburn Avenue Rosemead, CA				large bonsai-like junipers and olives
	Mimosa Nursery		6270 Allston Street Los Angeles, CA				Big and small exotic fruit and bonsai/topiary
	Monrovia Nursery		817 E. Monrovia Pl. Azusa, CA 91702	626-334-9321		monrovia.com	
	Perla Nursery		4827 Peck Road El Monte, CA 91732	626-442-4488			Big and small specimen bonsai/topiary and more

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Trees							
	Ancient Olive Trees	Aaron		707-953-8562	aaron@ancientolivetrees.com	ancientolivetrees.com	Specialize in Olive Trees
	Arid Zone Trees		9750 East Germann Road Mesa, AZ	480-987-9094	kevin@aridzonetrees.com	aridzonetrees.com	Randy Myers Nusery is So Cal Wholesale Distributor
	Baron Brothers	Richard	7568 Santa Rosa Rd. Camarillo, CA 93012	805-484-0085	rich101@me.com	www.baronbrothers.com	
	Berylwood Treefarm	Charles	1048 E. La Loma Ave. Somis, CA 93066	805-485-7601	Charles@berylwoodtreefarm.com	www.berylwoodtreefarm.com	Specimen Trees 48" box and up
	Big Olive Trees		1940 Garnet Ave. San Diego, CA	858-366-2982	info@bigolivetree.com	bigolivetree.com	Specialize in Olive Trees
	Big Trees Nursery	Charlie	12450 Highland Valley Rd. Escondido, CA 92025	858-487-5553	charlie@bigtreesnursery.com	bigtreesnursery.com	
	Boething Treeland	Douglas	multiple locations	818-316-2057	DHenderson@boethingtreeland.com	www.boethingtreeland.com	
	Heritage Olive Trees	Troy		707-732-6596	info@heritageolivetrees.com	heritageolivetrees.com	Specialize in Olive Trees
	Jimenez Nursery	Allyson	3800 Via Real Carpenteria, CA 93013	805-684-7955	Allyson@jimeneznursery.com	www.jimeneznursery.com	
	Morales Olive Trees		28201 Rancho Pkwy. Lake Forest, CA 92630	949-240-0445	info@moralestree.com	moralestrees.com	Specialize in Olive Trees
	Moon Valley Nursery	Steve	1700 Growest Ave. Riverside, CA 92504	951-768-9897	sandresen@mvncorp.com	moonvalleynurseryca.com	
	Norman's Nursery	Jorge Mercado	various locations	626-237-0625	jmercado@nngrower.com	nngrower.com	Trees and much more
	Oshan Trees	Ori Gat	233 Mobile Ave. Suite 106 Camarillo, CA 93012	805-479-0355	oshantrees@gmail.com	oshantrees.com	Specimen/field dug trees
	Pacific Coast Nursery	Steve	1924 Monroe St. Riverside, CA 92504	951-689-1777		pacificcoastnursery.com	
	Pardee Tree Nursery	Ray	30970 Via Puerta Del Sol Oceanside, CA 92057	760-630-5400 x119	RDAVIS@PARDEETREE.COM	pardeetree.com	
	Randy Meyers Nursery	Randy	Desert Hot Springs	760-329-8757	RGMNURSERY@MSN.COM		Trees, Agaves, cactus & more
	San Marcos Growers	Peggy	125 South San Marcos Road Santa Barbara, CA	805-683-1561	pkoegler@smgrowers.com	smgrowers.com	
	Sea Crest Nursery	Christi	5299 Shoreline Drive Santa Barbara, CA 93111	310-480-0538	seacrestpalm@aol.com	seacrestnursery.com	
	Senna Tree Company	John		818-957-5755	john@sennatree.com	sennatree.com	Specimen and field dug trees
	Valley Crest	Bill	3200 W. Telegraph Rd. Fillmore, CA 93015	805-524-3939	BLong@vctree.com	valleycrest.com	
	Ventura Co. Nursery	Tony	4595 Balcom Canyon Rd. Somis, CA 93066		tony@vcnursery.com		

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Tropical							
	Instant Jungle	Greg	2560 S. Birch St. Santa Ana, CA 92707	714-850-9227	greg@instantjungle.com	www.instantjungle.com	
	Jungle Music	Phil	450 Ocean Way Ave. Encinitas, CA 92024	619-291-4605	Phil@junglemusic.net	www.junglemusic.net	
	Rancho Soledad Nursery	Eric	18539 Aliso Canyon Rd. Rancho Santa Fe, CA 92091	858-756-3717	sales@ranchosoledad.com	www.ranchosoledad.com	
	Rolling Greens		9528 Jefferson Blvd. Culver City, CA 90232	310-559-8656			
	Sea Crest Nursery	Christi	5299 Shoreline Drive Santa Barbara, CA 93111	310-480-0538	seacrestpalm@aol.com	seacrestnursery.com	
	The Jungle Nursery		1900 Sawtelle Blvd. Los Angeles, CA 90025	310-235-2875	infoQ@dryjungle.com	dryjungle.com	
	The Tropics	Ryan	7056 Santa Monica Blvd. Weho, CA 90038	323-469-1682	thetropicshollywood@gmail.com	www.thetropicsinc.com	
	Dry Jungle			310-235-2875		http://dryjungle.com	

Plant Search	Name	Contact	Address	Phone	Email	Website	Notes
Water Garden							
	McDonald's Aquatic Garden	Randy	18157 W. Arminta St. Reseda, CA 91335	818-345-7525			
	Sunland Water Gardens		9948 Sunland Blvd. Sunland, CA 91040	818-353-5131			
	Van Ness Water Gardens		2460 N. Euclid Ave. Upland, CA 91784	909-982-2425		vnwg.com	

Appendix C-1: Transportation Distances, Costs, and Emissions

Nursery	Destination	Miles	Cost (one-way trip)	Cost (round trip	kg CO2
Tree People Nursery	Los Angeles River	17	$2.50	5.00	11.50
Matilija Nursery	Los Angeles River	19	$2.38	4.76	13.06
Tree of Life Nursery	Los Angeles River	72	$10.56	21.12	48.72
S&S Seeds	Los Angeles River	81	$11.88	23.76	54.82
Theodore Payne Foundation Nurser	Los Angeles River	30	$4.40	8.80	20.30
Las Pilitas Nursery	Los Angeles River	208	$30.50	61.00	169.65
El Nativo Nursery	Los Angeles River	40	$5.93	11.86	27.12
Rancho Santa Ana Nursery	Los Angeles River	54	$7.85	15.70	36.00
RECON Native Plants	Los Angeles River	137	$20.09	40.18	91.98
Native Sons Nursery	Los Angeles River	170	$24.93	49.86	114.14
Suncrest Nurseries	Los Angeles River	329	$48.25	96.50	220.90
Yerba Buena Nursery	Los Angeles River	376	$55.15	110.30	252.45
Average cost				$37.40	

Assumptions:

Diesel cost/gallon = $2.20/gal

Carbon emissions: 22.38 lbs/gal diesel (EIA data)

Assumption (based on EPA data) - fuel economy = 15 mpg

IMPORTANT NOTE: The above distances were all to the same point of the LA River. This may not accurately represent the distance to the closest possible spot on the river for each nursery.

Calculations:

Tree People to LA River: 17 miles × 1 gal/15mi × $2.20/gal = $2.50

17 miles × 1gal/15mi × 22.38 lbs CO2/gal diesel = 25.36 lbs CO2 = 11.50 kg CO2

Matilija to LA River: 19.3 mi × 1gal/15mi × $2.20/gal = $2.83

19.3 mi × 1gal/15mi × 22.38 lbs/gal = 28.80 lbs CO2 = 13.06 kg CO2

Tree of Life to LA River: 72 mi × 1gal/15mi × $2.20/gal = $10.56

72 mi × 1gal/15mi × 22.38 lbs CO2/gal = 107.42 lbs CO2 = 48.72 kg CO2

S&S to LAR: 81 mi × 1gal/15mi × $2.20/gal = $11.88

81 mi × 1gal/15mi × 22.38 lbs CO2/gal = 120.85 lbs CO2 = 54.82 kg CO2

TPayne to LAR: 30 mi × 1gal/15 mi × $2.20/gal = $4.40

30 mi × 1gal/15mi × 22.38 lbs CO2/gal = 44.76 lbs CO2 = 20.30 kg CO2

Yerba Buena Nursery: 376 miles -> $55.15

561 lbs CO2 = 252.45 kg CO2

Rancho Santa Ana: 53.5 miles × 1gal/15mi × $2.20/gal = $7.85

53.5 mi × 1gal/15mi × 22.38 lbs CO2/gal = 80 lbs CO2 = 36 kg CO2

Las Pilitas: 208 miles × 1gal/15mi × $2.20/gal = $30.50

310.34 lbs CO2 = 139.65 kg CO2

El Nativo: 40.4 miles -> $5.93

60.28 lbs CO2 = 27.12 kg CO2

RECON Native Plants: 137 miles -> $20.09

204.40 lbs CO2 = 91.98 kg CO2

Native Sons: 170 miles -> $24.93

253.64 lbs CO2 = 114.14 kg CO2

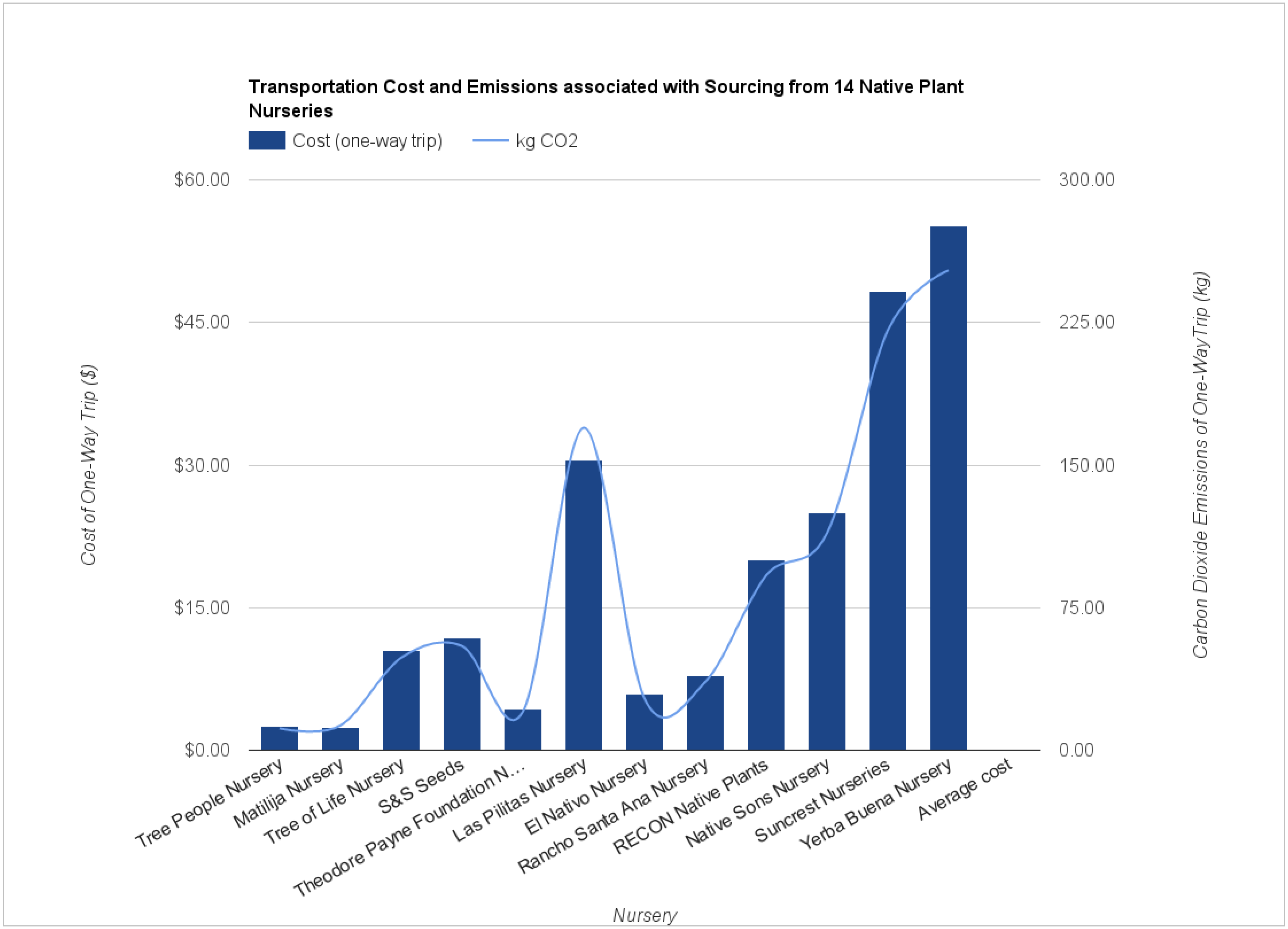
Suncrest Nurseries: 329 miles -> $48.25

490.87 lbs CO2 = 220.90 kg CO2

Accounting for multiple trips, and plant-packing effieciency (4-inch pots)

Dimensions for 4-inch pots (inches) Source: http://www.greenhousemegastore.com/product/black-form-pots/containers-for-schools			Dimensions for Tray holding 15 - 4inch Pots (inches) Source: http://www.greenhousemegastore.com/product/black-form-pots/containers-for-schools			17 ft Box Truck Dimensions (inches) Source: https://www.uhaul.com/Trucks/17ft-Moving-Truck-Rental/EL/		
Length	Width	Height	Length	Width	Height	Length	Width	Height
3.75	3.75	3.25	19.625	11.5	2	171	87	77

Amount of trays that can be placed in a truck can be calculated by:
Width of truck / Width of tray = 87in./11.5in = 7 trays
Length of truck / Length of tray = 171 in./3.75in. = 8 trays
Height of truck/ Height of tray plus a 2 inch clearane top and bottom = 77in./(3.25+2+4)in. = 8 trays
Total amount of trays that can fit in the truck = 7 x 8 x 8 = 448 trays
Plants per tray = 15 plants. Total plants per truckload = 15 plants x 448 trays = 6720 plants per truckload
At 2000 plants per day per year needed, 2000 plants x 365 days = 730,000 plants
730,000 plants / 6720 plants per truckload = 109 trips
Average cost of a round trip from nurseries to Los Angeles is $37.40
Yearly cost for total trips = $37.40 per trip x 109 trips = $ 4,076.60



Transportation Cost and Emissions associated with Sourcing from 14 Native Plant Nurseries
Cost (one-way trip)
kg CO2
$60.00
$45.00
$30.00
$15.00
$0.00
Cost of One-Way Trip ($)
300.00
225.00
150.00
75.00
0.00
Carbon Dioxide Emissions of One-WayTrip (kg)
Tree People Nursery
Matilija Nursery
Tree of Life Nursery
S&S Seeds
Theodore Payne Foundation N…
Las Pilitas Nursery
El Nativo Nursery
Rancho Santa Ana Nursery
RECON Native Plants
Native Sons Nursery
Suncrest Nurseries
Yerba Buena Nursery
Average cost
Nursery

Appendix C-2: Green Job Creation

"Advanced" Nursery Positions	Salary	Source
Nursery Manager	$43,825.00	Job Search Engine
Horticulturist	$38,480.00	Job Search Engine
Sales Associate	$24,000.00	Theodore Payne Foundation Website
Nursery Technician	$26,000.00	Job Search Engine
Environmental Educator	$58,060.00	Job Search Engine
Total	$190,365.00	

"Bare Bones" Nursery Positions	Salary	Source
Nursery Manager	$43,825.00	Job Search Engine
Volunteers	$0	
Total	$43,825.00	

Sources: Retrieved 2016

Salary.com (May 31, 2016) *Nursery/Greenhouse Manager Salaries.* Retrieved from http://www1.salary.com/Nursery-Greenhouse-Manager-Salaries.html

Glassdoor.com (May 31, 2016) Horticulturist Salaries in Los Angeles, CA. Retrieved from https://www.glassdoor.com/Salaries/los-angeles-horticulturist-salary-SRCH_IL.0,11_IM508_KO12,26.htm

Theodore Payne Foundation (February 18, 2016) *Nursery Sales Associate* http://theodorepayne.org/wp-content/uploads/2014/05/JobDescription-NurserySalesAssociate.pdf

Simply Hired (February 18, 2016) *Nursery Technician Salaries.* Retrieved from http://www.simplyhired.com/salaries-k-nursery-technician-jobs.html

EnvironmentalScience.org (February 18, 2016) *What is an Environmental Educator?* Retrieived from http://www.environmentalscience.org/career/environmental-educator

Appendix C-3: Start-Up Nursery Costs

Structural Costs (2015): Los Nogales Start-Up Nursery

Supplier	Item	Expense	Applies to:
Glendale Fence Co.	Fence	$1,275.00	LAUSD and Public Parcel
G.N.A. Transport	Pea Gravel (25 yd)	$1,350.00	LAUSD and Public Parcel
G.N.A. Transport	Pea Gravel (5 yd)	$480.00	LAUSD and Public Parcel
Home Depot	Materials for Table	$291.80	LAUSD and Public Parcel
Home depot	Lumber, Hardware	$387.46	Public Parcel Only
Home Depot	Lumber, Hardware	$73.59	Public Parcel Only
Home Depot	Lumber, Hardware	$219.66	Public Parcel Only
Home Depot	Lumber	$27.38	Public Parcel Only
Home Depot	Lumber, hardware	$166.28	Public Parcel Only
Home Depot	Hose Rack x2	$21.73	Public Parcel Only
Southwest Mobile Storage	Lock	$15.95	LAUSD and Public Parcel
Southwest Mobile Storage	10’ Storage Box	$2,775.85	LAUSD and Public Parcel
LA City	Public Parcel Lease	$1.00	Public Parcel Only
	Total LAUSD Cost:	$6,188.60	
	Total Public Parcel Cost:	$7,085.70	

(Assuming existing infrastructure at LAUSD sites)

Other Material Costs (2015): Los Nogales Start-Up Nursery

Item	Expense
Soil (75 yd3)	$480.00
7,000 1-Gal Pots	$1,750.00
Hose Nozzle	$25.00
Germination Media (10 bags)	$280.00
6,000 Conetainers	$1,000.00
Total	$3,535.00

Source:

J. Yee, Personal Communication

Appendix C-3.1: Start-Up Nursery Costs and Opportunity Comparisons

Option 1: A small, educational nursery utilizing LAUSD existing infrastructure. One paid staff, and heavy reliance on (student) volunteer labor.

Option 1: LAUSD Existing Infrastructure Model

	Year	Infrastructure	Staff	Year	Plants Produced/150 square yards	Volunteer Hours
**	0	$6,188.60	$0.00	0	0	0
**	1	$3,535.00	$45,077.00	1	7,682	990
**	2	$3,535.00	$45,077.00	2	7,682	990
**	3	$3,535.00	$45,077.00	3	7,682	990
	Initial Investment	$7,084.70	$0.00	Total	23,046	2,970
	3 Years	$10,605.00	$135,231.00	Unit Value	$4.00	$10.00
	Subtotals: Cost	-$16,793.60	-$135,231.00	Subtotal: Benefit	$92,184.00	$29,700.00
	Total Cost	-$152,024.60		Total Benefit	$121,884.00	

** Yee, J. (2016). Personal Communication

Assumptions: **Initial Cost: $6,188.60** **Yearly Cost: $3536** **Output: 7682 plants per year (150 sq yards)**

Alternative A to Option 1: Investing in 1-gallon plants †	
Total Cost:	-$156,512.75
Number of Plants:	39,128

† Landregan, S. (2016). Personal Communication.

Average $4 per 1-gallon plant (wholesale cost estimate)

Alternative B to Option 1: Investing in 4-inch pots ††	
Total Cost:	-$156,512.75
Number of Plants:	104,342

†† Landregan, S. (2016). Personal Communicatoin

Average $1.50 per 4-inch pot

Alternative A = 39,128/ 3,000,000 --> **1.30%**

of total restoration need for next five years

Appendix C-3.2: Start-Up Nursery Costs and Opportunity Comparisons

Option 2: Again using figures provided by Jusin Yee for nursery output and yearly operational cost. This scenario is similar to Option 1, with one paid staff, and heavy reliance on (student) volunteer labor. The difference in the need to establish infrastructure on site (initial investment gleaned from Kat Superfisky). However, the cost of land is minimal

	Option 2: "BARE BONES" Public Parcel Nursery					
	Year	Infrastructure	Staff	Year	Plants Produced/150 squa	Volunteer Hours
	0	$7,085.70	$0.00	0	0	0
**	1	$3,535.00	$45,077.00	1	7,682	990
**	2	$3,535.00	$45,077.00	2	7,682	990
**	3	$3,535.00	$45,077.00	3	7,682	990
	Initial Investment	$7,084.70	$0.00	Total	23,046	2,970
	3 Years	$10,605.00	$135,231.00	Unit Value	$4.00	$10.00
	Subtotals: Cost	-$17,690.70	-$135,231.00	Subtotal: Benefit	$92,184.00	$29,700.00
	Total Cost	-$152,921.70		Total Benefit	$121,884.00	

** Yee, J. (2016). Personal Communication

Assumptions: **Initial Cost: $7,085.70** **Yearly Cost: $3536** **Output: 7682 plants per year (150 sq yards)**

Alternative to Option 2: Investing in 1-gallon plants †	
Total Cost:	-$217,252.25
Number of Plants:	54,313

† Landregan, S. (2016). Personal Communication.

Average $4 per 1-gallon plant (wholesale cost estimate)

Alternative 2 to Option 2: Investing in 4-inch pots ††	
Total Cost:	-$217,252.25
Number of Plants:	144,835

†† Landregan, S. (2016). Personal Communicatoin

Average $1.50 per 4-inch pot

Alternative A = 54,313 / 3,000,000 --> **1.81%**

of total restoration need for next five years

Appendix C-3.3: Start-Up Nursery Costs and Opportunity Comparisons

Option 3: A nursery complete with extensive resources, education programming, demonstration gardens, and staff dedicated to Horticulture, Nursery Management, Environmental Education, and Nursery Maintenance.

	Option 3: "Reach" Start-Up Nursery (Theoretical)						
	Year	Infrastructure	Staff	Year	Plants Produc	Volunteer Hours	
*	0	$500,000.00	$0.00	0	0	0	
†††	1	$166,365.00	$190,365.00	1	10,000	1200	***
†††	2	$166,365.00	$190,365.00	2	10,000	1500	***
†††	3	$166,365.00	$190,365.00	3	10,000	2000	***
	Initial Investment	-$500,000.00	$0.00	Total	30,000	4,700	
	3 Years	-$470,581.93	-$571,095.00	Unit Value	$4.00	$10.00	
	Subtotal Cost	-$970,581.93	-$571,095.00	Subtotal: Benefit	$120,000.00	$47,000.00	
	Total Cost:	-$1,541,676.93		Total Benefit:	$167,000.00		

Alternative to Option 3: Investing in 1-gallon plants †	
Total Cost:	-$1,541,676.93
Number of Plants:	385,419

† Landregan, S. (2016). Personal Communication.

Average $4 per 1-gallon plant (wholesale cost estimate)

Alternative 2 to Option 3: Investing in 4-inch pots	
Total Cost:	-$1,541,676.93
Number of Plants:	1,027,785

* Jao, C. (2015). Imagining a Network of Native Plant Nurseries for the L.A. River.

$500,000 for more advanced (environmental education, demonstration, etc.) "reach" nursery

††† Appendix C-2: Compilation of Nursery Job Salaries

*** Inferred figures assuming (a) more efficient plant production and (b) growth in volunteer base

†† Landregan, S. (2016). Personal Communicatoin

Average $1.50 per 4-inch pot

Alternative A = 54,313 / 3,000,000 -- **12.85%** of total restoration need for next five years

Appendix C-4: SAMPLE PLANT PALLET - Comparative Nursery Prices

	Plant Prices				
Preliminary Plant List	Matilija Nursery	RSV Nursery	Theodore Payne Foundation	Tree of Life Nursery	Las Pilitas Nursery
Artemisia californica (1-gal)	$4.50	$3.00	$8.00	$4.75	$7.99
Baccharis pilularis var. consanguinea (1-gal)	$4.50	$3.00	$9.00	$4.50	$7.99
Baccharis salicifolia (1-gal)	$4.25	$3.00	$9.00	$4.50	N/A
Eriogonum fasciculatum var. foliolosum (1-gal	$4.50	$3.00	$9.00	$4.75	$8.99
Juglans californica (15-gal)	$60.00	$3.00	$10.00	$70.00	$9.99
Leymus condensatus (1-gal)	$4.25	$3.00	$8.00	$4.75	N/A
Lotus scoparius (1-gal)	$4.35	$3.00	$8.00	$4.50	$7.99
Mimulus (Diplacus) aurantiacus (1-gal)	$4.50	$3.00	$9.00	$4.75	$7.99
Muhlenbergia rigens (1-gal)	$4.50	$3.00	$8.00	$4.75	$7.99
Platanus racemosa (15-gal)	$45.00	$3.00	$9.00	$65.00	$7.99
Rhamnus ilicifolia (1-gal)	$5.50	$3.00	$9.00	$5.25	$11.99
Rhus intergrifolia (1-gal)	$4.50	$3.00	$9.00	$5.25	$26.99
Salix lasiolepis (15-gal)	$45.00	$3.00	$8.00	$45.00	N/A
Salvia apiana (1-gal)	$4.50	$3.00	$8.00	$4.75	$9.99
Salvia leucophylla (1-gal)	$4.50	$3.00	$8.00	$4.75	$8.99
Sambucus mexicana (1-gal)	$4.50	$3.00	$8.00	$5.25	$9.99
Totals	$208.85	$48.00	$137.00	$242.50	$134.87
Average Plant Cost:	$13.00	$3.00	$8.56	$15.16	$9.61

Sources:

Distributed Survey: Appendix C-4.1 and C-4.2

Matilija: B. Sussman, personal communication, May 4, 2016

RSV: J. Algiers, personal communication, May 7, 2016

Theodore Payne: T. Beckers, personal communication, May 12, 2016

Tree of Life: M. Evans, personal communication, June 1, 2016

Las Pilitas: Online Store - Printable Plant Product Listing. (2014). Retrieved from http://www.laspilitas.com/stores/online/plant-products/listing

UCLA Native Plants Practicum

Given the scenario to contract grow 10 acres of restoration for the LA River of locally grown Southern California species incrementally along one year... (preliminary plant list compiled by looking at various plant palettes attached, as suggested in LA River restoration guides: goo.gl/DhdQ79)

* Required

Name of nursery *

Your answer

Are these plants in your inventory?

- ○ Yes
- ○ No, need to custom grow

Is your facility sufficient to supply the needs?

- ○ Yes
- ○ Yes, but will need to hire temporary employee and rent extra land
- ○ No
- ○ Other : ____________

What is a reasonable attrition rate for stock we should account for?

Some plants have a higher attrition rate than others. What is a general average you would advise? e.g., 30% rate

Your answer

33% complete NEXT

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UCLA Native Plants Practicum

Plant costs

Here, we are looking at the estimate cost for EACH 1-gal potted plants (trees will be in 15-gal pots), using these numbers as a base cost for our calculations

Artemisia californica (1-gal)

Your answer

Baccharis pilularis var. consanguinea (1-gal)

Your answer

Baccharis salicifolia (1-gal)

Your answer

Eriogonum fasciculatum var. foliolosum (1-gal)

Your answer

Juglans californica (15-gal)

Your answer

Leymus condensatus (1-gal)

Your answer

Lotus scoparius (1-gal)

Your answer

Mimulus (Diplacus) aurantiacus (1-gal)

Your answer

Muhlenbergia rigens (1-gal)

Your answer

Platanus racemosa (15-gal)

Your answer

Rhamnus ilicifolia (1-gal)

Your answer

Rhus intergrifolia (1-gal)

Your answer

Salix lasiolepis (15-gal)

Your answer

Salvia apiana (1-gal)

Your answer

Salvia leucophylla (1-gal)

Your answer

Sambucus mexicana (1-gal)

Your answer

66% complete

BACK NEXT

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UCLA Native Plants Practicum

Custom grow

If some plant listed are not in your inventory, we understand custom growing is necessary.

What is the minimum number of plants needed to custom grow?
If they vary with each plant, what is an average number of plants (per species) we need to order?

Your answer

What is the time frame needed for a notification to start the order? (local seed collection required)

Your answer

How much time is needed for these custom-grow plants to reach 1-gal plant and 15-gal trees?

Your answer

What is the maintenance cost of holding plants per month for over-contract period?

Your answer

100%: You made it.

BACK SUBMIT

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Appendix C-4.2: Survey Response - Comparative Nursery Prices

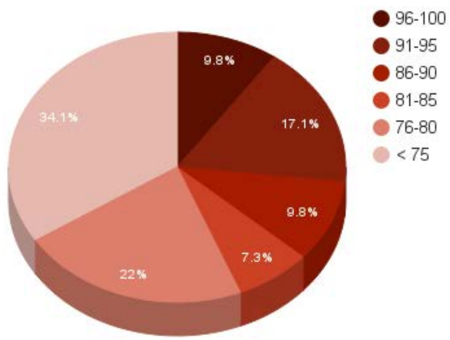
Name of nursery	Matilija Nursery	RSV Nursery	Theodore Payne Foundation	Tree of Life Nursery	Las Pilitas (online reference)
Timestamp	5/4/2016	5/7/2016	5/12/2016	6/1/2016	Accessed on 5/10/2016
Are these plants in your inventory?	No, need to custom grow	Yes	Yes	Yes	N/A
Is your facility sufficient to supply the needs?	Yes, but will need to hire temporary employee and rent extra land	Yes	Maybe, need quantities and size	Yes	N/A
What is a reasonable attrition rate for stock we should account for?	totally depends on planting, time of year planted out, and care once planted out, from 10% to 50%.	15%	25%	20%	N/A
Artemisia californica (1-gal)	$4.50	$3.00	$8.00	$4.75	$7.99
Baccharis pilularis var. consanguinea (1-gal)	$4.50	$3.00	$9.00	$4.50	$7.99
Baccharis salicifolia (1-gal)	$4.25	$3.00	$9.00	$4.50	N/A
Eriogonum fasciculatum var. foliolosum (1-gal)	$4.50	$3.00	$9.00	$4.75	$8.99
Juglans californica (15-gal)	$60.00	$3.00	$10.00	$70.00	$9.99
Leymus condensatus (1-gal)	$4.25	$3.00	$8.00	$4.75	N/A
Lotus scoparius (1-gal)	$4.35	$3.00	$8.00	$4.50	$7.99
Mimulus (Diplacus) aurantiacus (1-gal)	$4.50	$3.00	$9.00	$4.75	$7.99
Muhlenbergia rigens (1-gal)	$4.50	$3.00	$8.00	$4.75	$7.99
Platanus racemosa (15-gal)	$45.00	$3.00	$9.00	$65.00	$7.99
Rhamnus ilicifolia (1-gal)	$5.50	$3.00	$9.00	$5.25	$11.99
Rhus intergrifolia (1-gal)	$4.50	$3.00	$9.00	$5.25	$26.99
Salix lasiolepis (15-gal)	$45.00	$3.00	$8.00	$45.00	N/A
Salvia apiana (1-gal)	$4.50	$3.00	$8.00	$4.75	$9.99
Salvia leucophylla (1-gal)	$4.50	$3.00	$8.00	$4.75	$8.99
Sambucus mexicana (1-gal)	$4.50	$3.00	$8.00	$5.25	$9.99
What is the minimum number of plants needed to custom grow?	N/A	25	300	1500	N/A
What is the time frame needed for a notification to start the order? (local seed collection required)	1 year	6 months	12 months	6 months	N/A
How much time is needed for these custom-grow plants to reach 1-gal plant and 15-gal trees?	Between 1 and 2 years	6 months	1G - 4-10 months, 15G - 2 years	2 years and 5 years	N/A
What is the maintenance cost of holding plants per month for over-contract period?	Between 5% and 6% of the invoice/finished cost.	$1.00 per month per plant	10% of plant cost per month	5% price	N/A

Appendix D-1: LAUSD Table

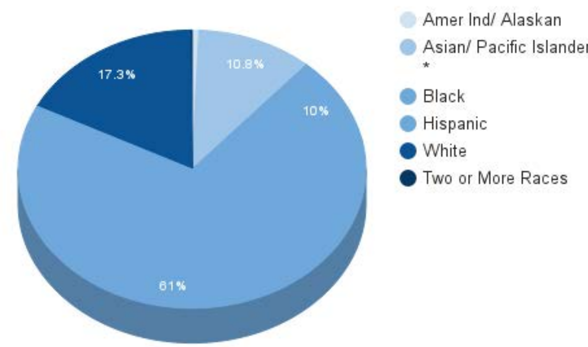
School Information		EPA Information	National Center for Education Statistics Data								
Site Name	Address	Disadvantaged Community (DAC) Designation Percentile	Amer Ind/ Alaskan	Asian/ Pacific Islander *	Black	Hispanic	White	Two or More Races	Free lunch Eligible	Reduced Lunch Elegible	Total Students
BROOKLYN AVE EL	4620 East Cesar E Chavez Avenue, Los Angeles, CA 90022	96-100	1	0	1	611	2	0	514	37	615
CANOGA PARK SH	6850 Topanga Canyon Blvd, Canoga Park, CA 91303	96-100	8	91	83	1,379	100	0	1182	129	1661
MONLUX EL	6051 Bellaire Ave, North Hollywood, CA 91606	96-100	3	43	24	260	378	0	452	90	708
SYLMAR SH	13050 Borden Ave, Sylmar, CA 91342	96-100	3	30	72	2,157	44	0	1665	243	2306
186TH ST EL	1581 W 186TH ST GARDENA, CA 90248	91-95	2	83	143	585	30	0	607	73	843
96TH ST EL	1471 E 96TH ST LOS ANGELES, CA 90002	91-95	1	1	205	691	0	0	798	30	898
AUDUBON MS	4120 11th Avenue, Los Angeles, CA 90008	91-95	4	5	442	257	5	0	507	29	713
BELVEDERE MS	312 N Record Ave, Los Angeles, CA 90063	91-95	1	3	4	1,343	5	0	1145	63	1356
SAN FERNANDO MS	130 N Brand Blvd, San Fernando, CA 91340	91-95	1	4	8	815	14	0	727	50	842
STONEHURST EL	9851 Stonehurst Ave, Sun Valley, CA 91352	91-95	0	15	10	262	52	0	209	47	339
SUN VALLEY SH	9171 Telfair Ave, Sun Valley, CA 91352	91-95	1	12	12	590	14	0	355	14	629
CARSON SH	22328 S Main St, Carson, CA 90745	86-90	50	52	13	884	1,133	60	727	175	2192
PORTER MS	15960 Kingsbury St, Granada Hills, CA 91344	86-90	6	235	50	1,235	134	5	859	254	1665
SEPULVEDA MS	15330 Plummer St, North Hills, CA 91343	86-90	7	147	40	1,379	52	0	1262	102	1625
POLYTECHNIC SH	12431 Roscoe Blvd, Sun Valley, CA 91352	86-90	7	152	32	2,690	54	2	2285	269	2937
DODSON MS	28014 Montereina Dr, Rancho Palos Verdes, CA 90275	81-85	10	205	195	1,170	296	7	916	188	1883
N HOLLYWOOD SH	5231 Colfax Ave, North Hollywood, CA 91601	81-85	14	276	135	1,980	437	0	1877	337	2842
WILLENBERG SP ED CTR	308 S Weymouth Ave, San Pedro, CA 90732	81-85	3	25	39	110	28	0	136	29	205
MARINA DEL REY MS	2500 Braddock Dr, Los Angeles, CA 90066	76-80	8	19	267	386	36	0	504	75	716
LOS ANGELES SH	4650 W Olympic Blvd, Los Angeles, CA 90019	76-80	10	117	181	1,223	13	0	1175	100	1544
JEFFERSON SH	1319 E 41st St, Los Angeles, CA 90011	76-80	2	0	1045	96	1	1	910	24	1145
HENRY MS	17340 San Jose St, Granada Hills, CA 91344	76-80	7	120	72	600	154	1	513	166	954
HALE MS	23830 Califa St, Woodland Hills, CA 91367	76-80	25	240	157	469	1,045	1	417	92	1935
GRANT SH	13000 Oxnard St, Valley Glen, CA 91401	76-80	11	86	103	1,339	654	0	1510	178	2193
WHITE MS	22102 S Figueroa St, Carson, CA 90745	76-80	9	383	155	1,086	57	0	1038	201	1690
GRANADA HILLS SH	10535 Zelzah Ave, Granada Hills, CA 91344	76-80	45	1210	179	1702	1209	0	1322	879	4478
WEBSTER MS	11330 Graham Pl, Los Angeles, CA 90064	76-80	9	13	110	346	42	0	426	40	520
BANNEKER SPECIAL EDUCATION CENTER	14024 S San Pedro St, Los Angeles, CA 90061	< 75	0	0	65	140	1	0	118	5	206
CARNEGIE MS	21820 Bonita St, Carson, CA 90745	< 75	7	213	223	420	15	1	598	127	879
CHATSWORTH SH	10027 Lurline Ave, Chatsworth, CA 91311	< 75	12	338	169	1,350	490	1	1206	283	2360
EAGLE ROCK SH	1750 Yosemite Dr, Los Angeles, CA 90041	< 75	24	698	48	1387	239	10	793	218	2391
MARKHAM MS	1650 E 104th St, Los Angeles, CA 90002	< 75	0	5	267	887	1	0	963	29	1160
MULHOLLAND MS	17120 Vanowen St, Van Nuys, CA 91406	< 75	5	48	56	1,129	64	1	1035	111	1303
NOBEL MS	9950 Tampa Ave, Northridge, CA 91324	< 75	16	596	142	997	795	7	757	267	2553
PEARY MS	1415 W Gardena Blvd, Gardena, CA 90247	< 75	3	106	382	923	23	2	1064	104	1439
PORTOLA MS	18720 Linnet St, Tarzana, CA 91356	< 75	7	237	137	640	801	3	751	180	1825
REED MS	4525 Irvine Ave, North Hollwood, CA 91602	< 75	18	241	148	777	513	0	786	147	1697
REVERE MS	1450 Allenford Ave, Los Angeles, CA 90049	< 75	19	229	306	475	1,053	0	449	96	2082
SOTOMAYOR LEARNING ACADEMIES	2050 N San Fernando Rd, Los Angeles, CA 90065	< 75	0	17	4	273	1	0	246	19	295
VENICE SH	13000 Venice Blvd, Los Angeles, CA 90066	< 75	10	174	235	1,422	296	2	1202	162	2139
WOODLAND HILLS ACADEMY	20800 Burbank Blvd, Woodland Hills, CA 91367	< 75	15	100	131	625	264	0	590	110	1135
	Demographic/Socioeconomic TOTALS:		384	6569	6090	37090	10545	104	34596	5772	60898
	RATIOS:		0.63%	10.79%	10.00%	60.91%	17.32%	0.17%	56.81%	9.48%	100.00%

Appendix D-2: LAUSD Figures

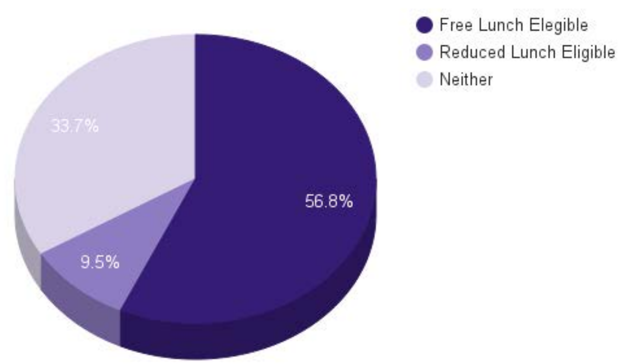
A. Percentage of Schools per Disadvantaged Community (DAC) Designation Percentile



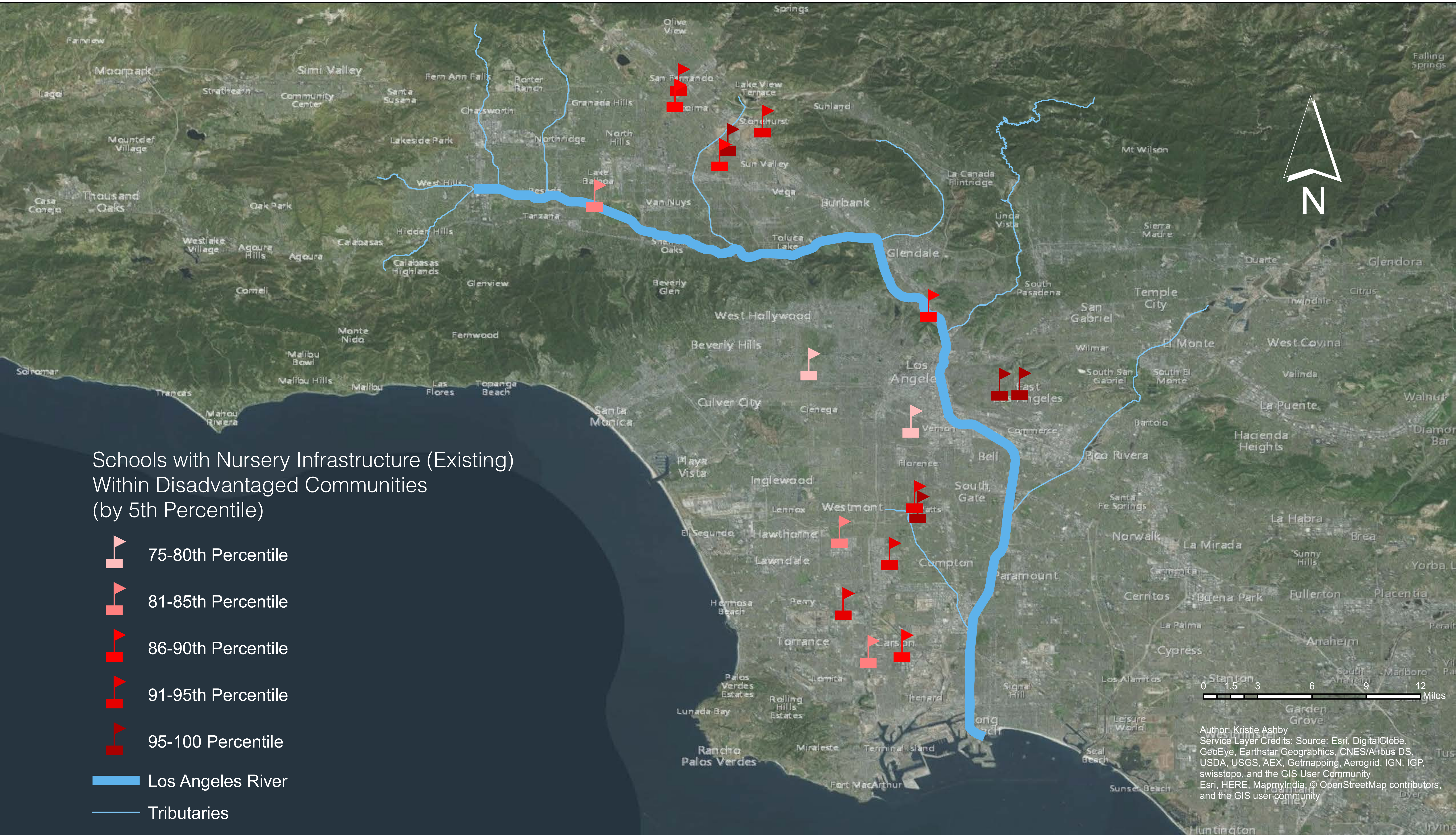
B. Ethnic Diversity at LAUSD Schools with Existing Infrastructure for Nursery Establishment (LAUSD-Wide)



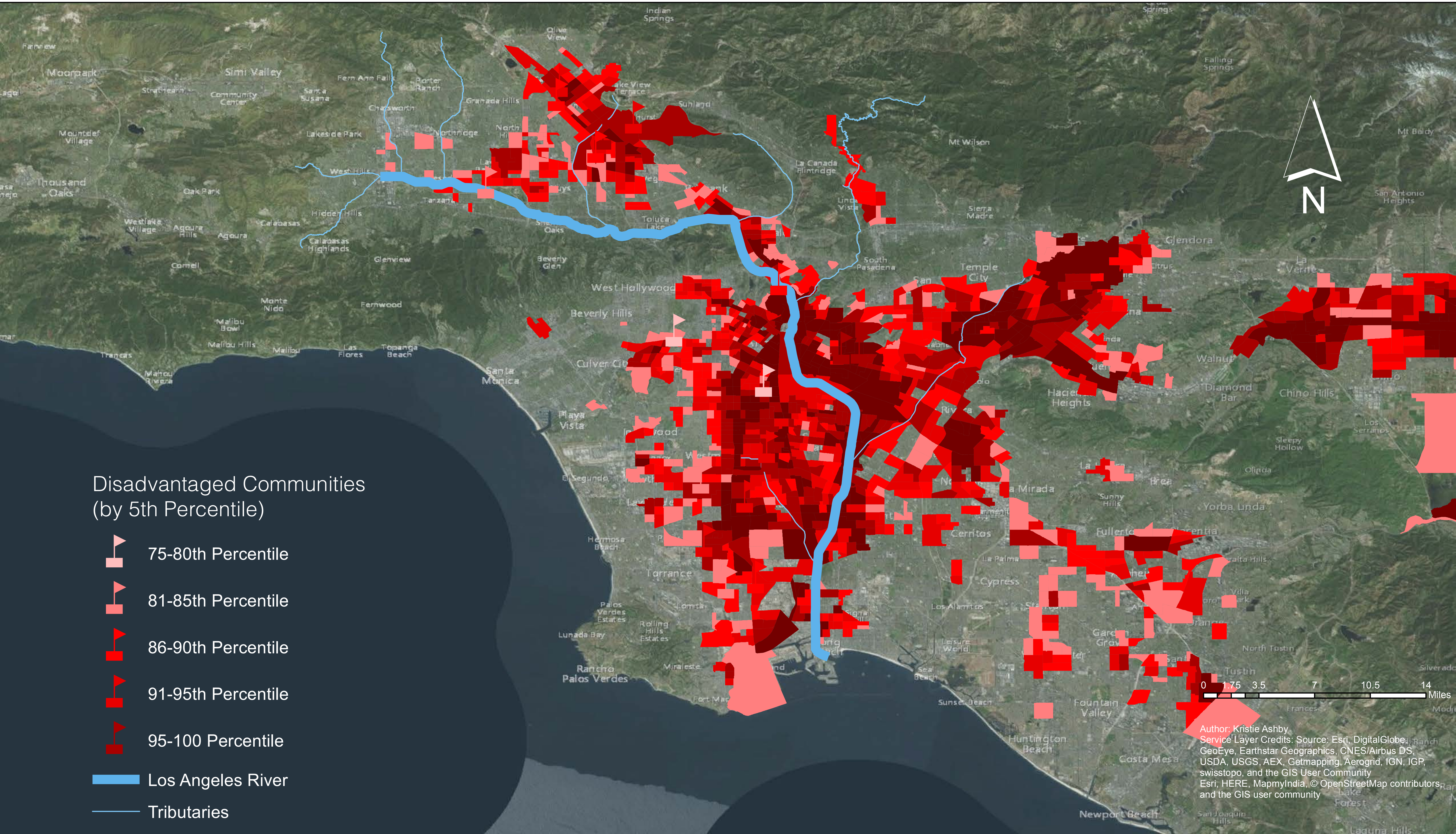
C. Free and Reduced Lunch Eligibility of LAUSD Schools (With Nursery Infrastructure Available)



Appendix D-3: LAUSD Schools with Existing Nursery Infrastructure (And EPA Disadvantaged Designation)

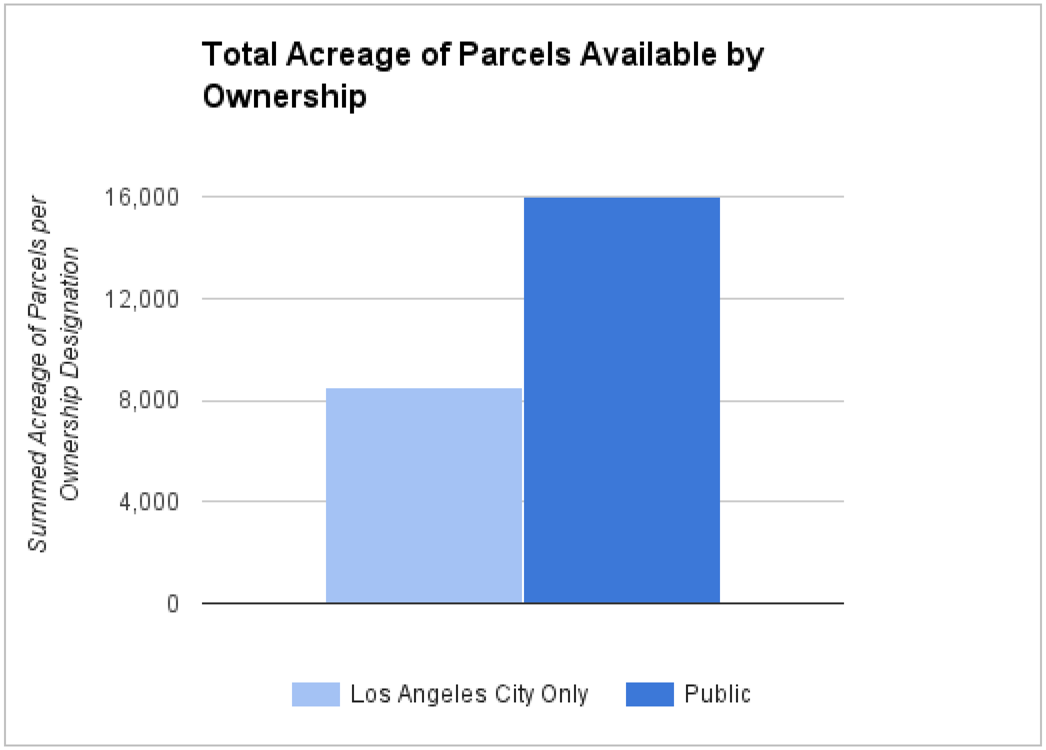


Appendix D-3.2: EPA Disadvantaged Communities in Los Angeles



Appendix D-5: Public Parcel Table

Public Parcels On Los Angeles River (1 Acre or Larger)			
Parcel Ownership Type	Number of Parcels	Mean Acreage of Parcels	Total Parcel Acreage
Los Angeles City Only	711	12.02	8,544
Public	1783	8.99	16,045



Guerrero, M. (Personal Communication): Public Parcel (shapefile data)

Landregan, S. (Personal Communication): Typical leasing arrangements for Non-Profit Organizations are $1 per year, over the course of a 10-year lease

Appendix D-4: Public Parcels on the LA River (1 acre or larger)

Appendix D-6: Nursery Models

The following case studies serve as models for environmental education that may stimulate an environmentally literate population if promoted widely across Los Angeles. They are in the City of LA's and NPS's best interest to support in order to ensure the success of the LA River and its Revitalization. The models provided are supported by either nonprofit or government agencies. They include the following:

- ❖ Co-op nurseries
- ❖ School nurseries
- ❖ Schoolyard habitats
- ❖ Educational trucks
- ❖ Public parcel satellite nurseries

Co-op nursery

- Model: Hahamongna Cooperative Nursery (HCN) managed by Arroyo Seco Foundation in Pasadena, C
- Co-op nurseries are unique in that they rely on their community for success. The experience of HCN is that with a single, motivated, and knowledgeable nursery manager, volunteers will be inspired and frequently return. HCN provides additional educational opportunities to the public, at a cost. One example of this is a class aimed to educate individuals about the medicinal purposes of native plants that was offered in April, 2016 for twenty dollars per person. (T. Brick, personal communication, April 12, 2016).

School nursery

- Model: Oceana High School Nursery managed by the Parks Conservancy in Pacifica, CA
- A nursery established at a high school supplies hands-on learning and green job training to dedicated students through internship and volunteer opportunities. Oceana High School serves as a contract grower to the National Park Service, which also funds the nursery. Students are encouraged to collect local seeds and transplant natives directly to the national park that is adjacent to their campus. A supervisor is necessary to manage the site and ensure a high quality of work. As displayed in Appendix D-3, there are several LAUSD schools within proximity to the LA River that may follow Oceana High School's steps towards establishing a native plant nursery. (B. Teng, personal communication, April 22, 2016).

Schoolyard habitat

- Model: Rio Vista Middle School, School Garden managed by U.S. Fish & Wildlife Service in Oxnard, CA

- Native plant school gardens present paperwork-free alternatives to field trips while providing green space on campuses. Additionally, they serve as learning environments for teachers that wish to incorporate environmental education into their curriculum, which is often limited by standards set by the California Department of Education. Rio Vista Middle School teacher Allison Brown states, "Unfortunately, all the standards we are expected to cover as part of our curriculum during the school year don't leave much room, if any, for additional programs...However, I can try to incorporate some aspects of Environmental Ed. here and there within my lessons. The School Yard Habitat is a good reference and one the students are familiar with." (A. Brown, personal communication, April 28, 2016). The program Sustainable Environment Enhancement Development for Schools (SEEDS) provides a total of five million dollars to LAUSD campuses to create green spaces that students may interact with. SEEDS and programs similar to it promote the feasibility of projects such as schoolyard habitats.[1]

Educational truck

- Models: LA Ranger Troca by the National Park Service, the River Rover by Friends of the Los Angeles River
- Educational trucks provide equal environmental education opportunities to individuals that attend schools or events that the trucks visit. However, the extent of this education is limited to the short amount of time that individuals are able to experience the truck, and how actively the curriculum allows them to participate. The National Park Service's LA Ranger Troca and Friends of the Los Angeles River's River Rover are two examples of educational trucks in Los Angeles. These services should be expanded so that environmental education can be provided to everyone in Los Angeles. (S. Mejia, personal communication, March 12, 2016).

Public parcel satellite nursery

- Models: Though a model for utilizing public parcels does not currently exist (to the group's knowledge), the Los Nogales Nursery at Deb's Park is a similar fit in that it is an interagency collaboration, utilizing space (provided by Audobon) and expertise and labor (provided by the National Park Service) in an efficient and strategic partnership.[2]
- A public parcel satellite nursery model capitalizes on existing, vacant public land. By forming partnerships between existing nurseries, local non-profit organizations (Grown in LA possibly, for example), and government agencies, resources and knowledge can be pooled in a manner that benefits all parties. For example, nurseries seeking additional

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[1] LAUSD. Sustainable Environment Enhancement Developments for Schools. *Facilities Services Division.* http://www.laschools.org/new-site/seeds/

[2] Rees, B. (2016.) Debs Park native plant nursery gets growing without El Niño rains. *The Eastsider*.

space for plant storage and mainteneance will be able to lease parcels for as little as $1.00 per year. Non-profits seeking to provide environmental education, vocational training, and a stronger linkage between communities and their River, will receive the materials and infrastructure provided by existing nurseries, along with these nurseries' knowledge of native plants and their maintenance. Additionally, the city will theoretically save money and ensure greater restoration success, as native plants benefit from more gradual acclimatization; providing space for these plants to "harden off" *in* their new environments, as opposed to shocking them with immediate weather and climate changes will help the city's bottom line.[3]

The following chart outlines the advantages and disadvantages of each nursery network alternative:

	Advantages	Disadvantage s	Cost	People reached
Co-op Nurseries[4]	- Presents educational opportunities to the general public, not limited to youth - Hands-on learning - Green jobs training - Grow plants for restoration projects - Preserve habitat, local genetics - Powerful motivator for the public to participate and then see their difference	- Reliant on volunteers - Requires a scheduled school trip	Hahamongna Cooperative Nursery: N/A	Hahamongn a Nursery: N/A
School nurseries[5]	- Provides volunteer programs for both students and the public - Hands-on learning - Green job training - Students tend to return often and become skilled workers - Grow plants for restoration projects - Preserve habitat, local	- Reliant on volunteers - Must be able to coordinate with student schedules	Oceana High School Nursery: N/A	Oceana High School Nursery: 131 through volunteer work, field trips, and a spring break backpackin

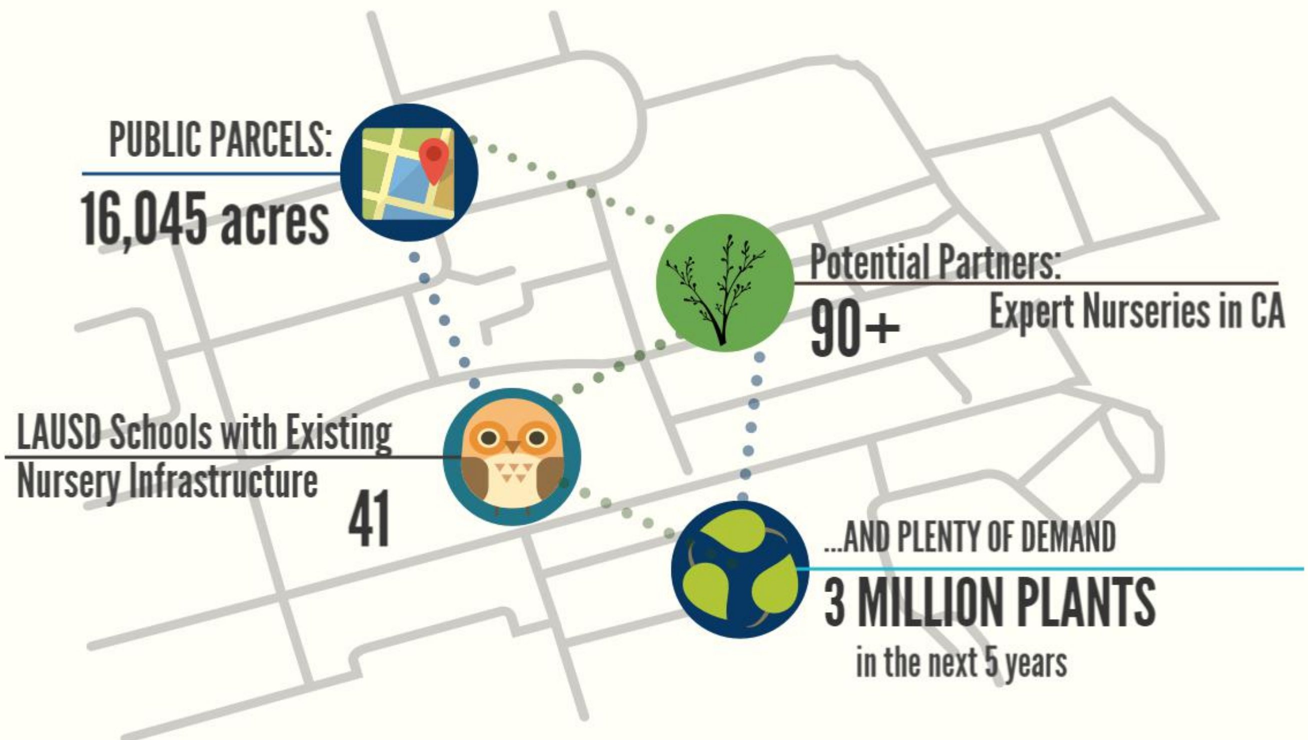
[3] *Hardening Off*. (n.d.). North Dakota State University Extension Service.
[4] T. Brick, personal communication, April 12, 2016.
[5] B. Teng, personal communication, April 22, 2016.

	genetics - On school site, no field trips required			g trip
Schoolyard habitat[6]	- Provides volunteer opportunities for students and the public - Allows ecosystem to be a part of education - Hands-on learning - Guaranteed access for disadvantaged children - Contributions to restoration (limited) - Create habitat, preserve local genetics - On school site, no field trips required	- Reliant on volunteers	SEEDS project (LAUSD) to receive a max of $35,000/school Rio Vista Middle School: $6,000	Rio Vista Middle School: Estimated amount is 750
Educational Truck[7]	- Can teach the same curriculum to many students - Equal education for all - Presentation is not reliant on plant success - Reliant on paid workers - On school site	- Liabilities - Education limited to one trip - Does not offer green job training - Does not contribute to restoration efforts - Emits CO2	River Rover: N/A LA Ranger Troca: N/A	River Rover: N/A LA Ranger Troca: N/A
Public Parcel Satellite Nursery	-Low cost of land -Space is freed for existing nurseries -Locations for acclimatization -Community-based: allows for potential environmental education and vocational training opportunities	-Coordinating efforts takes time and commitment -Still reliant on volunteer labor -Security and pests	$1 annual lease [8]	

[6] Brown, A. personal communication, April 28, 2016.
[7] Mejia, S. personal communication, March 12, 2016.
[8] Landregan, S. personal communication, 2016

Appendix E: Envisioning a Native Plant Nursery Network!

A NATIVE PLANT NETWORK IN LOS ANGELES



Shared Investment: Native Plants and Communities

Utilizing Existing Resources to Ensure a Revitalized Los Angeles

COMMUNITY

PROJECT-BASED LEARNING OPPORTUNITIES

LAUSD's project-based Linked Learning Model has been shown to increase graduation rates by 10% in seniors, and increase postsecondary enrollment by 9%

GREEN JOBS

The Environmental sector is a growing field, also lacking in diversity. It's time to create pathways for River communities

ENVIRONMENTAL EDUCATION

Targets young Angelos and promotes environmental stewardship and leadership

ENGAGING IN REVITALIZATION

Engagement in the process is key to a successful LA River Revitalization

VOCATIONAL TRAINING

Provides skills training in communities characterized by low employment and income; potential pathways for veterans and homeless

OPPORTUNITY

Up to 3 MILLION Plants Needed — 5 YEAR PRIORITY PROJECTS

Up to 4.3 MILLION Plants Needed — 20 YEAR ARBOR PROJECTS

GROWING DEMAND for NATIVE PLANTS

LOCAL COMMUNITY ADVANTAGES

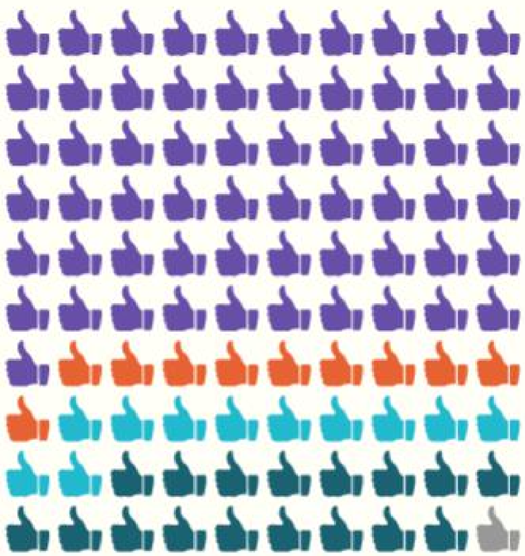
Engaged in future of their River and city
Opportunities for project-based learning and environmental education
Green jobs and vocational training
Vacant, underutilized assets put to use

PLANT SURVIVORSHIP ADVANTAGES

Plants can "harden" to local climate
Arrive at early stage (4-inch pots) and acclimatize before up-size -- ideal time
Future opportunities for local seed banking = Insurance Policy against natural disaster, disease, etc. affecting ONLY current seed sources

CULTURE DIVERSITY

LAUSD Schools with Nursery Infrastructure



HISPANIC
61%

AFRICAN AMERICAN
10%

ASIAN/PACIFIC ISLANDER
11%

WHITE
17%

OTHERS
1%

CHALLENGES

- SEED COLLECTION LIMITATIONS
- SECURITY AND PEST MANAGEMENT
- VIABILITY OF PRODUCT
- RELIABILITY OF VOLUNTEERS
- FUNDING

RECOMMENDATIONS

A PROJECT BY:

Kristie Ashby, Karan Shetty, Irene Farr, Juan-Carlos Ruiz, Mindy Pham, Thalia Laguna

Appendix F: Literature Reviews

1. Research the control of genetic material used in ecological restoration (look at Kew Gardens and Center for Plant Conservation web pages for ideas/sample bibliographies)
2. Inadvertent selection – misnamed/misidentified plant concerns and consequences of inadvertent selection on restoration projects (e.g., not starting with collection and verification at the seed level) – Look at Ladybird Johnson center – and Arizona DOT for ideas.
3. What are the standards for plant propagation for restoration/reclamation? There are many standards out there that could be reviewed an analyzed including stuff from USDA, NPS, BLM, and botanical gardens.
4. Please research the available cost benefit analyses of native plants and of native plant nurseries (look at NGO nurseries, plant societies) Are there lifecycle analyses available for native plants?
5. Please conduct research on the ecosystem services provided by native plants/ plant assemblages
6. Policy question - please conduct research into the availability of incentives/funding/etc. for use of native plants or for development of nurseries

Control of Genetic Material

in

Ecological Restoration

Literature Review

by

Juan Carlos Ruiz

Los Angeles Native Plants

Abstract

The control of genetics in ecological restoration is one of the most important aspects when considering any ecological restoration project. This literature review will provides an overview of the risks that are associated with various techniques that are employed when dealing with the selection of source material as well as providing a synthesis of the major works in the scientific literature on the topic. This review also argues that there is a lot more research necessary in many aspects of ecological restoration and more work can be done with genetics in order to effectively achieve a successful restoration site.

One of the many factors that are involved in ecological restoration is the control of genetic material. Genetics can play a critical role in habitat restoration efforts. There are many ways in which genetics can be used to improve the outcomes of ecological restoration efforts. Applying a suite of genetic approaches can provide the best outcomes in a restoration effort. Knowing how to apply our knowledge of restoration genetics is critical for providing the best outcome in a restoration effort. In this literature review, many aspects of genetics are reflected upon, as well the as the controversies and the knowledge gap which currently exists in the field. Control of genetic material is heavily underused. Using the many tools that genetics provides can help address all the issues that have continued to come up. (Mijangos *et al*. 2014).

As defined by SER I, ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (SER I, 2004). Ecological restoration has emerged as a powerful tool in order to combat the destruction of biodiversity and ecological services (Mijangos *et al*. 2014.) It is a relatively new field in the sciences, and the exact criteria on how to generate a population that is both self-sustaining and that can retain adaptive genetic variation is few and needed (Hufford *et al*. 2003.) How to do this exactly has been subject to debate within the scientific community. Approaches using genetic disciplines have lead to theoretical and applied frameworks on which ecological restoration is based (Mijangos et al. 2014). Examining the literature on genetic restoration and techniques has lead to certain conclusions which will be reviewed here.

The source of genetic material and understanding the genetics behind the source material for restoration projects can prove to be crucial. Many of the risks involved related to ecological restoration described by the literature include founder effects, genetic swamping, bottleneck effect, outbreeding depression, hybrid breakdown, and cryptic invasion (Aitken *et al*. 2013; Hufford *et al*. 2003; McKay *et al*. 2005; Godefroid *et al*. 2011; Jones, 2013; Stachowicz *et al.* 2013; Ritchie *et al*. 2012; Mijangos *et al*.

2014). Founder effect occurs when a new population is formed by initially a small amount of individuals. This can potentially lead to a population with low genetic diversity. In restoration ecology, this phenomena occurs often when the source seeds for a restoration project are not genetically diverse (Knapp & Rice, 1994). Outbreeding depression occurs when the breeding of a non-native population with a native population of the same species results in a reduction of fitness (Aitken et al, 2013; Hufford et al, 2003). These risks affect the overall genetic variability of the population. Genetic diversity is needed in order for vegetation to adapt to the local environment. Populations with a high genetic diversity have the capacity to withstand and respond to selective pressures therefore having a higher chance of survival. (Knapp & Rice, 1994). Knapp & Rice emphasize on collecting seeds in order to maximize genetic diversity. However, McKay *et al.* argue that not all evolution is adaptive, therefore maximizing variation alone should not be the goal of restoration (McKay *et al*. 2005). Many of these phenomena result from poor genetic research prior to the restoration and “little is known about the extent to which practitioners should be concerned with genetic composition of the plants used in restoration” (McKay *et al*. 2005).

A major controversy in the literature is deciding on the source material for a restoration project, specifically on whether it should be strictly native or not (Jones & Thomas, 2009). Jones & Thomas, 2009 discuss 2 “paradigms” of ecological restoration, an evolutionary paradigm and a resource paradigm. The evolutionary paradigm “seeks to restore putative natural patterns of genetic variation, in order to generate an evolutionary trajectory as similar as possible to that which prevailed before the advent of any anthropogenic disturbance, such as weed invasion or soil degradation” while the resource paradigm “depends on the delivery of economic products and ecosystem services, with minimal regard for species or genotype.” In the context of our objective, the resource paradigm would not be an attractive option. However, the evolutionary paradigm has proven to not be the solution either. Desjardins in his paper, “Historicity and ecological restoration” (2014) argues in favor of “historical fidelity” which is defined as “the practice of attempting to restore an ecological system to some sort of idealized past condition.” Although Desjarnins admits that an complete reversal to a “pristine” ecosystem is “idealized”, the author does suggest that historical fidelity should be a guiding principle in ecological restoration. Due to the fact that a degraded environment has already been altered, a native population may not be the ideal source for restoration of that particular region. Evolutionary biologist thus suggest to provide plant material with the greatest genetic variability, even though the plant material may not be necessarily local (Jones, 2013). A greater variability of genetic material allows flexibility for the plant to locally adapt to specific environmental conditions (Jones & Thomas, 2009).

Local adaptation has emerged as the current leading topic in ecological restoration and genetics (Mijangos *et al*. 2014). Local adaptation occurs when different populations of the same species adapt to their respective environments. There is very little research done on the extent of local adaptation which has greatly undermined the efforts of many restoration projects. (McKay *et al*. 2005).The literature suggest that the degree of local adaptation can be critical. Certain populations can have such a degree of adaptation that a geographic scale is needed in order to determine the best source material.

Some restoration efforts have attempted to use individuals or seeds of different populations, but the same species which has resulted in restoration failures. The concern for local adaptation has lead to the creation of seed transfer zones, which are geographical areas is which plant material can be used with little disruption to genetic patterns or loss of local adaptation (Mijardos *et al.* 2013). Seed transfer zones were sought after the negative effects of introducing novel genetics (translocation) in a population were observed (Hufford & Mazer, 2003). Some of these effects, also called genetic pollution, include founder effects and genetic swamping (McKay *et al*. 2005). Within species, there are ecotypic and epitypic variation. Ecotypes are distinct genotypes resulting from adaptation to the local environmental conditions and is capable of interbreeding with other epitypes or ecotypes (Hufford & Mazer, 2003). In order to predict the risks of population genetic consequences of translocation, ecotypic and epitypic differentiation estimates are needed, as well as the likelihood of hybridization.

The literature touches on the difficulty of analyzing genetic material and attributing it to either quantitative (phenotypic) traits or other genetic markers. Although genetic methods like microsatellite markers may help identifying genetic variation at the genome level, there seems to be a consensus that quantitative traits are better indicated to provide a better estimation of local adaptation (Knapp & Rice, 1998; Mijardis et al.2013). A study on eelgrass genetics using the genetic marker isozyme and quantitative traits showed that the two types of traits did not lead to the same conclusions. This study also suggested that the exclusive use of isozyme analysis would be an incorrect approach. The isozyme analysis technique works under the assumption that the genes that are being analyzed are also under selection, which is often not the case (Knapp & Rice, 1998). In ecological restoration, traits that are necessary for survival are usually those that are under selection therefore an analysis on quantitative traits would be of better use. Unfortunately, it also wide accepted that obtaining phenotypic data is costly and time consuming (Hufford & Mazer, 2003). In the eelgrass experiment previous cited, quantitative data was collected from a 2 year period (Knapp & Rice, 1998).

Linear regression was used on a number of the literature reviewed (Stachowicz et al. 2013; Alcala et al. 2014). There is a potential problem when using linear regression to examine the magnitude of selection on a trait. (Rausher, 1992). Due to a trait being affected by genetic and environmental factors, linear regression does not explain for the environmental factors, therefore providing an inaccurate amount of "selection" due to genetic factors. Again, this shows how easily local adaptation can be overlooked and although genetic markers show that a certain population should be adequate for restoration, it fails due to the lack of information on local adaptation and environmental stressors. Although the study suggests an alternative methodology for the statistical analysis, it does foresee its downfall, which is the collection of data which is termed "nearly impossible." However, the study does make a good point in that there are ways to test for different co-variances without unbiased results. This study also suggests that any regression test should be considered a "preliminary result" (Rausher, 1992). This type of approach complements the type of approach that is needed for restoration ecology. The need for a critical analysis at all levels of a restoration project is critical for its success.

The major issue often cited in the literature was the lack of research. Given that the field of ecological restoration is relatively young, the lack of significant amount of data is not surprising. A significant topic was the effects of translocation (Hufford and Mazer, 2003; McKay *et al*. 2005; Knapp & Rice, 1994; Aitken & Whitlock, 2013; Godefroid *et al*. 2011; Jones & Thomas, 2009)Another area that requires research is in the measurement of genetic variability using different types of traits. The classical method of measuring variability includes the garden method which can only measure a certain type of traits. Using genetic markers can completely miss the effect of the environmental stress that a plant experiences, therefore underestimating local adaptation. Methods that can help evaluate variances in both genotypes and phenotypes can provide substantial plant material that can be utilized for successful restoration projects. Outbreeding effects, among others related with translocation must be documented in order to provide data on which to make sound decisions on vegetation and/or seed sources for a restoration project.

Current literature emphasizes the need for genetic methods in ecological restoration. The application of genetic methodologies is currently being underutilized (Mijangos, 2014.) Even though there is a widely acknowledge importance of genetic management for restoration ecology, genetic assessments are rarely utilized (Ritchie & Krauss, 2012.) Although more research is needed on the role played by genetics in restoration ecology, it is predicted that with improvements on genetic technology as well as the decrease in costs will propel genetics as a major contributor to ecological restoration.

There is a direct a direct relationship between population dynamics and genetic diversity (Mijangos et al., 2014.) In order for a population to be able to evolve, genetic diversity is then required (McKay et al, 2005.) However, not all evolution is adaptive (McKay et al, 2005.) Restoration interventions can produce negative effects in a population including loss of genetic diversity, inbreeding and outbreeding depression, which is "the reduction in mean population fitness resulting from hybridization between genetically distinct individuals or populations of the same species (Mijangos et al., 2014.)Therefore, are native species the best source of genetic material given the different ecotypes and epitypes and that the environment is constantly changing? As land managers, genetics should be considered in order to achieve a sustainable and resilient population in order for a long term success. Plants (assisted adaptation) that are better suited for harsher climates can sometimes provide a better solution for restoration.

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Inadvertent Plant Selection:
Concerns and Consequences on Restoration Projects

Industrialization and rapid land development throughout history has shifted the natural flow of ecosystems. The ecological balance between soil, plants, wildlife, and insects has been disturbed through changing landscapes and human development projects. Today there are efforts to restore parts of urbanized landscapes that have led to the degradation of ecosystems. Ecological restoration aims to create environments that are resilient and self-sustaining (Gann & Lamb, 2006) and one component of restoration is choosing the right vegetation that will survive and allow an ecosystem to flourish. The types of vegetation that are likely to be chosen are native due to their suitability and resilience to the region being ecologically restored. Choosing the right type of vegetation entails reintroduction of native plant species into the current ecosystem which includes making sure the plant species being introduced is the correct one. Inadvertent selection of plant species during restoration projects can have detrimental effects towards the restoration outcome. Misidentifying plants and establishing them into a restoration site would affect the whole ecosystem and restoration may not be effective in the long run. Introduction of a misidentified plant species could potentially endanger wildlife, native plants, soil, and ultimately cause adverse restoration effects.

Ecosystems are a complex system of interlinked living organisms and non-living components in the environment. However, with the advent of human development projects, ecosystems that once flourished were degraded and their natural flows disturbed. Urban restoration is the initiative to restore environments that have been degraded through development. Restoring an urban environment is not an easy task as urbanization has negatively influenced, "… nonhuman species diversity and fundamental ecosystem functions… Urban ecosystems present altered soil conditions and processes … creating numerous barriers to fostering native plants, animals, or even predicting what types might survive in such an environment,"(Ecological Restoration, 2008). Figuring out how to best restore an urban area comes with a great deal of work on deciding what type of vegetation to use. Most restorations look towards using native plant species as native plants were there originally and are accustomed to the regions climate and, "Using local sources is an effort to identify populations that have experienced similar evolutionary selective forces (abiotic and biotic interactions), which should result in higher fitness of plants introduced at restoration sites," (Herman, 2014). Also, as stated previously, ecosystems are a complex interlinked system of living organisms and non-living components so, in the sense of restoration, the most beneficial plant to use to restore the ecosystem would be native vegetation. Native vegetation would allow animal, insect, and soil composition to reestablish and restore the ecosystem to a similar way it was before as it will not reestablish itself exactly to as it was before.

Another important component to ecological restoration is thorough planning, especially in the plant identification and sourcing stage. In order to meet restoration goals the correct type of vegetation needs to be found. In identifying plant species for the restoration site it is important to take into consideration the native vegetation already present and also consider," …that species are typically found together in certain groupings, referred to as plant associations or plant communities…. Planting species together based on their typical associations is a good idea because they will all be adapted to the same site conditions. They may also have symbiotic relationships, a relationship where each helps the other in some way," (Dorner, 2002) which is an important factor because positive plant species interactions will help the ecosystem flourish. In an urban restoration context, "… it does not matter as much where the native plant species comes from as long as they are native plants to that region or area," (Dorner, 2002) but being so the right type of native vegetation still needs to be accounted for when looking for plant suppliers. Dorner (2002) also suggest finding out where the plants being sold have grown because if they have grown in a different region under different conditions they may not be well-suited for the restoration site. She also warns to, "Make sure plant material has never been dug from the wild and removed from its natural habitat… [because] this practice does occur and has negative far-reaching effects on natural systems and native plant populations," (Dorner, 2002). It is important to identify where the native plant originates because where it originates from plays a significant role in how it will interact with other species, how well adapted it is locally to the restoration site, and ultimately determine how it will affect the ecosystem flow. Inadvertent selection of plants can cause unintended consequences and hinder restoration efforts.

Identifying plants is not an easy task and most restoration managers lack knowledge with identification of plants and may be confused by competing and sometimes conflicting claims when collecting plant materials (Johnson and Robinson, 2006). Misidentification of plants is also a result of simply not knowing how to properly identify a plant. *How Plants Are Identified*, list common ways plants are identified. They state that, "The easiest method, and the one probably used the most often for learning the names of the plants of a particular location or region, or just the name of a particular plant, is to ask someone who already knows," and other methods include, "comparing the unknown plant with a photograph or sketch of a similar one in a book," although specific plant species cannot be identified in this manner, and another method is using a key which refers to, "… a device in which successive choices between contrasting statements are followed until the correct name is found by the process of elimination," (How Plants Are Identified, n.d.). All these methods do not necessarily guarantee that a plant will be properly identified and during a restoration projects it is very important to know what the needed plant material is and its origin. As a result of not really knowing how to properly identify plants, most restoration managers trust that the nursery or their source for buying native plants is knowledgeable and selling them the correct native species for the restoration project. However, even though some plants are said to be native by sellers, "… it is easy for plants of inappropriate or unknown origin to be sold and planted in local restoration projects," (Johnson & Robinson, 2006) simply because plants were misidentified by the plant provider and restoration managers had no prior plant identification knowledge. This is a huge concern because of the effects the plants will have on the restoration project. Another aspect to take into consideration is the limited amount of funds restoration projects have. The funds are typically stretched to buy whatever native plants are inexpensive or readily available which leads to the introduction of inappropriate and poorly adapted plant materials (Johnson & Robinson, 2006).

Having misidentified plants in restoration projects can lead to unintended consequences. There was a study conducted on how plant genetic variation and evolutionary dynamics influence ecosystem processes such as flux of energy, and nutrients through soil, which then feedback to affect seedling performance in subsequent generations (Anurag et. al., 2015). These types of processes are important to consider during restoration projects because the reintroduction of native plants or any plant, in general, will affect the entire ecosystem. Through the use of the native biennial plant, *Oenothera biennis*, the study found that, "heritable variation among plant genotypes can be an important factor affecting local ecosystem processes," (Anurag et. al., 2015). The ecosystem processes they studied were leaf decay, soil respiration, seedling performance, nitrogen cycling, among other things which were all affected by the introduction of the native plant into the ecosystem. The study is important because during ecological restoration native plants are reintroduced into an existing ecosystem where they will establish themselves and influence the ecosystem structure. If the plant that is reintroduced into the restoration site is misidentified then the whole ecosystem is going to be affected. The whole ecosystem that consists of: energy fluxes, soil nutrient availability, carbon cycling, among other processes are required to keep an ecosystem going will be affected and possibly in an adverse manner.

The risk of inadvertently introducing a misidentified native plant species into a restoration site could potentially wreak havoc on the restoration process as the introduced species could change community dynamics. A study conducted by Jacobs et. al. studies the affect of how an introduced species alters community composition. They specifically looked at how introduced species cause native species to change which then alters community composition. They examined how the dominant native plant, goldenrod, in Arizona and the surrounding ecosystem dynamics were affected by the introduction of Rocky Mountain elk from Yellowstone National Park. They mainly looked at how the plant-associated arthropod community was altered. They found that plants originating from sites with introduced elk flowered nearly 3 weeks before sites that did not have elk. They also saw a 35% reduction of arthropod community and a different species composition in the study region (Jacobs et. el., 2015). Their results show that the introduction of a plant species into a new environment can impact the ecological structure and as a consequence the community change can be long-term and difficult to remediate. This study shows the impact a plant species can have on the ecological system of a community. The community structure can change and the old community that was once there will be difficult to reestablish.

In the *Inadvertent selection in the propagation of native plants,* Delvin and Dunwiddie, warn about how taking shortcuts during restoration projects lead to using misidentified plant species. They looked at restoration efforts in the Puget Sound lowlands of western Washington where grazing livestock and invasive species lead to the decline of the native Roemer's fescue. They focused their efforts on the restoration and reestablishment of the native fescue matrix. Reestablishing the native fescue matrix has been an ongoing project and as the restoration efforts intensified, so did the demand of native fescue from commercial nurseries (Delvin & Dunwiddle, 2006). In the previous years, the restorationists on the prairie project relied on growing their own Roemer fescue from their own seed collection that they used for the restoration of Roemer fescue. However, obtaining "native" seeds plants from the commercial nursery and growing their very own source of seeds are two completely different source methods. They assumed the commercial nurseries were supplying them with the correct native Roemer fescue, but it turned out that native Roemer fescue was very difficult to identify as, “Two very similar species of perennial fescue occur in these prairies… Both Roemer’s and red fescue are quite variable in appearance and can be extremely difficult to differentiate in the field even when flowering,” (Delvin & Dunwiddle, 2006). There was some concern over using the commercial bought plant seeds because as they began to grow in their nursery there were subtle differences between their original native grown plant and the commercial grown seed plant. However, they disregarded the differences as, “nursery-grown plugs of both species often tend to be greener in color and more robust than the parental stock,” and literature for correct identification for distinguishing between Roemer from red fescue is confusing and unreliable for restoration field work (Delvin & Dunwiddle, 2006). They suggest future restoration projects, “… be alert for the sorts of problems [they] encountered, particularly where native taxa have similar invasive counterparts that grow in the same area,” because it can lead to undesired restoration results (Delvin & Dunwiddle, 2006).

Arizona is a state that has existing plant laws that their roadside development projects follow when choosing which native vegetation to use. Arizona’s Department of Transportation (ADOT) mission statement for roadside development is to, “provide landscape architectural and environmental technical design direction and expertise for Arizona Department of Transportation projects statewide [that include] … environmental mitigation and landscape ecological restoration, seeding, revegetation, and native plant salvage and replanting,” **(**ADOT presentation**)**. They have created specific criteria for what it means to employ the goals mentioned in the quotation. For example, landscape restoration plans typically involve the blending of highway with the surrounding natural landscape in which they have to take into consideration the earth form designs of slopes, rounding, and transitions between cuts and fills from the highway **(**ADOT presentation). This means the designed landscape has to have the right types of vegetation to have a long lasting, successful outcome. They need to consider the different types of revegetation options to best fit their designed landscape goals which include choosing the right type of topsoil salvage, native plant salvage, container-grown stock, or how to deal with noxious and invasive vegetation. Choosing the right type of vegetation in itself is a difficult task and ADOT created Native Plant Salvage & Replanting Evaluation Guidelines for roadside development projects. These guidelines require that the vegetation chosen be self-sustaining after it has been initially planted and after its establishment. They also state that, “Replanting of salvaged or planting of nursery plant material maintain or restore wildlife habitat value… be self-sustaining with available natural moisture… [and] are in good condition with high level of assurance for survival and reestablishment,” (Native Plant Salvage, n.d.). So misidentifying plants would not be following the guidelines raised by Arizona. Arizona native plant laws need to be taken into consideration when pursuing a roadside development project as Arizona is conserving its native plants. They do not want to endanger their native plant population and have created very stringent regulations towards native plants to make sure they are protected and not on the verge of being displaced. All the criteria established for restoration projects in Arizona are stringent because implementing an inadvertently misidentified native plant can cause major damage to ecosystem functions and potentially outsource the native vegetation. Once the surrounding community is damaged it is difficult to reestablish.

Los Angeles is currently looking to restore an 11 mile stretch of the LA River. The project entails restoring the ecosystem to a similar way it was before. Since the river is located in a highly urbanized setting there will be several constraints on how to restore the river and as mentioned before one of their goals is to restore the ecosystems, "… as closely as possible, [to] conditions that would occur in the area in the absence of human changes to the landscape and hydrology," (Los Angeles River Ecosystem Restoration Feasibility Study, 2015). The way they plan to measure the success of the restoration is through the presence of native plants and wildlife as well as indicator species. They will also measure success through the restored areas ability to be self-sustaining and require minimal human interventions for sustenance. This means that the right types of vegetation need to be implemented into the area that will create a balanced ecosystem with interactions between living organisms and non-living components in the environment. One misidentified plant species has the potential of ruining the LA River restoration goals. As mentioned previously in the paper, ecosystems are complex and interconnected. This means that having a misidentified plant has the potential to mess up ecological dynamics and community interactions. The wildlife, nutrients present in soil, water quality, insects will all be affected.

Plant misidentifications are serious in restoration projects as they can adversely affect, and possibly outsource, local native vegetation. All plants vary from where their home range is and the ecological impacts they have on their surrounding environment. In *Mistaken Identity,* the consequences of misidentifying plant species and the consequences that come along with it are acknowledged,

"While an occasional case of mistaken identity may result in the removal of only a small proportion of the population of a given native plant, widespread misidentification and "control" of certain native species that are already rare or declining has the potential to result in significant local and population-level impacts. The declines of some native plant species appear to be caused by the spread of closely related invasives," (Kuehn et. al., 2008).

There is a significant difference between two plants and the way they affect the ecological community around them. Take for example the Staghorn Sumac and Smooth Sumac that are native to the mid-Atlantic US regions and are often confused with the invasive Tree-of-Heaven plant which is native to China. The native Sumacs are a winter food source for grouse, turkey, and other game birds as well as rabbits, deer, and insects (Kuehn, 2008). They play an important role in their community structure and help support the surrounding animal populations. However, Sumacs are often confused with the invasive Tree-of-Heaven. Tree-of-Heaven affects their surrounding ecosystem differently than Sumacs as they release chemicals into the soil that inhibit the growth of other plants and have been shown to change nutrient recycling in the ecosystem (Kuehn, 2008). Sumacs and Tree-of-Heaven are an example of how common misidentified plants have different ecological functions. Although, the misidentified plant may not adversely affect the surrounding ecosystem, it is still a possibility and one that could cause detrimental effects to the environment. For this reason, it is important to rightfully identify plants used for restoration projects as unintended consequences may ensue.

Ecological restoration projects all aim towards restoring an ecosystem to the way it was once was or at least close to how it was. Now a day, urban restoration efforts are taking place to restore the damaged ecological environment. An important component to any restoration effort, in general, is choosing the correct native plant species. Native plant species are chosen for restoration projects as they show resilience and suitability for the site. However, misidentifying the type of vegetation used for restoration can occur and lead to unintended consequences. Ecosystem dynamics and communities will all be affected as they are all intertwined with one another. Introducing a misidentified plant into a restoration area has the potential to adversely affect the restoration area and displace native plant populations already settle on the site. Displacement of native plants on site would lead to a decrease of native plant populations and trying to reestablishing native plant populations is a difficult task. No two plants have the same effects on their environment and misidentifying a native plant for restoration efforts can hinder restoration goals.

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A review of plant propagation for restoration

Abstract

The conservation of native plants and their habitats and communities is essential to maintaining biological diversity[18]. Mediterranean-climate riparian areas are extremely vulnerable to the cumulative side effects of anthropogenic disturbances such as pressures from land use, stream flow regulation and diversion, and climate change[7,13,18]. Little is known about how native plants communities compare functionally across these regions. This review will highlight several notable research assessments of California plants as well as examine the standards for plant propagation from public agencies. By examining plant restoration practices and standards, we can reach our ultimate goal to support the establishment of local native plant nurseries to restore native landscapes and wildlife in the Los Angeles region.

Introduction

Two common methods of plant propagation are seed propagation and vegetative propagation. Majority of forest and conservation species are propagated from seed[12]. Seed propagation tends to be a popular method for both biological and economic reasons. Seed propagation is the least expensive propagation method. Seeds are cheap, easy to ship and have little restrictions concerning materials to propagate. Seed propagation is also advantageous because most seed species can be stored for several years[12].

Seed propagation can produce native plants through container nurseries or bareroot nurseries. Most native plants are grown in containers because they are flexible with scheduling and can be grown in a shorter period. Size and shape of seeds limit a plant's ability to grow. Most native plants have seeds that come in irregular shapes and sizes, making mechanized sowing difficult[17]. This review explores the standards of seed propagation and different methods of propagation of California native plants published.

Methodology

Seed collection

Seed quality is a key to development of container nurseries. Consistency in seed quality allows uniform seed germination and seedling growth[12]. Collecting and processing seeds require technical knowledge and special equipment. Many plant species are not persistent with seed production. Seed quality can vary between years, not to mention some species do not produce seeds every year. Many nursery managers purchase seeds from commercial dealers or by customers. The USDA Forest Service's National Tree Seed Laboratory published "Commercial suppliers of free and shrub seed in the United States" as a reference for proper sources for seed purchasing[26].

Another alternative to seed purchasing is personally harvesting seeds. Some seeds come away from plants freely, while some plants hold on their seeds longer than others. In a plant guide for California sage, seed are to be collected from October to February from mature, brown inflorescences. Achenes should be pulled from seed head at time collection when seed is mature and is a light to dark brown color[27]. If seed drops from the plant, California Native Plant Society suggests to place a vase on a clean paper sheet or any area where seed can be easily collected. For plants that fling their seeds outward, enclosing developing seed heads in a box or a bag and be prepared to for seeds to explode out from seedheads[21]. Shrubby lupines pods fling seeds in all direction as they dry. Suncrest nurseries collected pods of shrubby lupines before they dried and let them open in large closed paper bags[19].

Seed storage

Sometimes, more seeds are collected that can be put to immediate use or it is more economical to buy larger quantities of seed lot and store it for future use[12]. There various factors that influence seed storage. Storage temperature, container and method are important. Handling seeds before storing them will also affect storage potential. Exposing seeds to direct sunlight or high temperatures can affect a seed's moisture content and damage the seed. Moisture content is by far the most critical factor to consider when storing seeds. Seed moisture can affect seed dormancy that develops during storage. In addition to moisture temperature should generally be kept low to slow the seed deterioration rate. If economically justified as a reliable power source, refrigerated storage is recommended for seeds[12]. Under natural conditions, most conifer and hardwood seeds can last up to three years. When seeds conditions are controlled in refrigerated storage, seeds can be maintained at high levels for much longer. If seeds are going to be stored, it must be completely dry to prevent it from rotting. Seeds need to be dried and placed in a dry and dark area[21].

Seed Testing

Seeds need to be tested for quality variables such as purity, moisture content, weight, and viability to establish a dollar value of seed and its suitability for different types of regeneration. The most accurate and reliable way to test the seed is to have a sample drawn from the seed lot by an independent third party who submits it for testing to a testing laboratory skilled in testing the kind of seed in question. The least reliable is to take the word of the vendor who cut a few seeds with a pocket knife to estimate the quality[26].

Seed cleansing

Nurseries may have to be cleaned before they can be sown. Seeds are normally contaminated with fungi and bacteria so nursery managers usually treat all seeds with fungicides before sowing. Pesticide use is not recommended due to concerns of phytotoxicity to germinating seeds as well as environmental pollutions[12]. Although fungicides were routinely applied to seeds to control diseases, the use of fungicides to treat seeds should be justified by identifying specific pathogen and operational nursery trials to show that these treatments are truly effective. The use of protective repellent coatings to limit bird depredation is not necessary. Nurseries should confirm that bird-repellent coatings are safe for full-scale use.

Floatation by sinking heavier filled seeds with water is another quick and simple way to remove empty seeds from some species. This will allow lighter and empty or damaged seeds to float. A cut test should follow floatation test since some filled seeds will float if water bubbles are trapped on the seed coat and empty seeds may sink if they are dirty[12].

Elderberries are collected when ripe to extract and clean seeds. Pulp and void seeds float on the water while feasible seeds sink in water and are collected and dried. The viable seeds sink in water and are collected and dried[10]. Air-screen cleaner is a basic seed-cleaning machine that uses a combination of screening and air flow to remove debris as seen in the protocol for curvepod yellowcress and common madia[2,3].

Presowing treatment

Many seeds have evolved to be cleaned by gravel and acid of bird's digestive tract. Comparison of Washingtonia filifera seeds collected from the surface of the ground and coyote scat show that the pericarp was missing from 94% of coyote-consumed seeds. The removal of pericarp increased the probability of germination[14].

Unlike seeds from horticultural crops, which have been bred to germinate after sowing, many conservation species become dormant after they mature. Despite being dormant or not, conservation seeds still need treatment before they can be sown[12]. For seeds from a fleshy fruit, the fruit can decay, which can can act as a germination inhibitor[12]. Imbibition is practiced by soaking seeds in water for 24 to 48 hours for seeds to absorb the water necessary to start metabolic reactions that lead to germination. The Container Tree Nursery Manual recommends rinsing the seeds under running water to keep dissolved oxygen content of water high and avoid stagnated conditions. Treatment also softens the seed coat and removes possible chemical inhibitors or pathogens.

Hot water soak is typically used for many legume seeds or those with waxy seed coats. Seeds can be removed and dried when they become gelatinous. Is best to experiment with each species of seed because treatment time for hot water soak varies with seed coat thickness. Once treated seeds should be sown within a few days to prevent bacterial or fungal infections[12].

Shrubby legumes, such as western redbud, with hard dense seeds with a waxy coat is soften by soaking it under hot water and allowing them to cool and soak overnight (Smith, 2009). California redbud seeds go through the same overnight heat soaking process and then process is repeated in the morning[11].

Acid soak is another treatment method in which seeds are soaked in a strong acid solution, such as sulfuric acid, yet should be considered for worker safety. When properly done, acid scarification can effectively remove hard seed coats and stimulate quick germination. Although seeds treated with acid can be stored for a few days, it is best if they are sown immediately[12]. Giant poppy seeds are dissolved with white gas then are soaked in Super Smoke Plus, which contains smoke extracts and gibberellic acid[19]. A study on pretreatment of Encilia farinosa Torrey & A. Gray shrubs suggested pretreatment with gibberellic acid increased germination by a little more than 2-fold, but there was no clear pattern of increased germination rate with increased soaking rates[15]. The addition of cytokininsor vitamins when seeds were soaked in hypochlorite improved germination of G. oblongifo[1]. Results suggest further studies on manipulating soaking solutions to improve germination.

Several treatments can be used to soften a seed's coat but the best choice is dependent on the cost of the treatment and the availabilities of materials and labor. The degree of dormancy varies from species to species and between ecotypes. Trying out different treatment and keeping accurate and detailed records is important for future seed scarification treatment. Running water rinses are preferred over standing soaks because the bubbling water keeps levels of dissolved oxygen high and cleans the seed coat of pathogenic organisms. The main purpose of presowing treatment is to increase the permeability of the seed coat to water and gases. Scarification treatments will also depend on what is required of a species and a grower's experience in seed treatment.

In addition to scarification treatment, stratifying seed under cold and moist condition is a common treatment to overcome seed dormancy and stimulate germination. Moist prechilling or naked stratification involves placing imbibed seeds in plastic bags under refrigeration where the temperature is held slightly above freezing[12]. Seeds kept in each bag should be relatively small to ensure good aeration throughout the bag. A small tube or straw can be place in the top of the bag to increase aeration. Placing the bags on wire mesh racks ensures air exchange under the bag, and some nurseries hang the stratification bags from hooks. Propagation protocol for western needlegrass found that seeds needed extensive prechilling after finding out seeds were only 28% germinated after 2 days. Western needle grass was kept to for cold-moist stratification for 20 days and resulted in 91% of seeds tested to be rated "successful"[23]. Although Red alder seeds do not require pretreatment, cold stratification by mixing the seeds with three parts moistened peat moss or vermiculite into an airtight container can improve germination for several months[8]. California brome seeds also did not require pretreatment, however references made from protocol for propagation of California brome suggested pretreatment with antifungal seed pretreatment such as Vitavax for smut control[9]. Although peat moss and vermiculite mix was effectively used in the study, airtight containers might make it hard to ensure aeration at the bottom of the container. Propagation protocol for Bolander's Rush stratified seeds by placing them in plastic germination boxes on moistened germination paper to be stored in a growth chamber at 8º C days and 4º C nights with eight hours of light[5].

Seeds are stratified under cold and moist conditions and dried to a lower moisture content then returned to cold storage to prevent premature germination. Germination rates are also improved to a point that total germination can be higher than with traditional presowing treatments[12]. In order for stratification to be effective, seeds need to be fully imbibed and not allowed to dry out for the entire treatment period. However, some seed species may be damaged if soaked for too long[12]. Temperature for cold-moist stratification is dependent on the species and ecotype but most trees and shrubs from colder climates need temperatures slightly above freezing. In propagation protocol for king's sceptor genetian recommend storing the seed in a walk-in cooler for 90 days[4]. Stratification at 41˚F for 15 days is reported to produce more rapid and uniform germination in other species of *Artemisia* and stratification for three months at 41˚F (5˚C) was used to improve germination of California sagebrush in commercial nurseries[27]. Elderberry seeds are soaked in hot water for 24 hours then drained and stratified in perlite at 40-44º F[10].

Seed Sowing

Like other processes, sowing seeds into containers also varies with seed type and quality. as determined by a seed test. Seed size and shape also determines the way seeds are sown. Large or irregularly shaped seeds must be sown by hand. Small seeds can be mechanically sown. Three different sowing techniques are mentioned: direct seeding, planting germinant, and transplanting emergent[12].

Direct seeding involves placing seeds directly into a growth container when they are ready to germinate and grow. Dormant seeds need to be treated before sowing date. Success of direct seeding depends on the accuracy of a seed's test information, the sowing technique, and conditions in the environment where a seed is propagated. Not all seeds require treatment. Fresh Washingtonia filifera seeds can be sown without further treatment into any well-drained growing medium and covered to a depth of 6 to 13 mm[14].

Germinant sowing by placing pregerminated seed into the growth container or trays have been found to be suitable for large seeds. Planting germinant is most commonly used for seeds requiring cold-moist stratification but can also be used for seeds requiring warm-moist stratification. Germinant sowing is particularly useful for seed lots of variable quality or no quality data available[12]. Seeds are soaked in an aerated water tank for 24 to 48 hours to reach full imbibition and cleanse their seed coats. Seeds are then placed in cold-moist or warm-moist stratification until they begin to germinate. Seed placement is a crucial step. Germinated seeds must be placed on their sides or else resultant crop development will be uneven with seeds of different sizes and ages[12].

Germinated California buckwheats seeds are sown right into containers[6]. For restoration projects of California sagebush, especially on steeper slopes, either direct seeding or germinant sowing method can be followed by blowing a thin layer of straw at a rate of approximately 1,500 lbs/acre, with a hydromulch slurry of water, wood fiber at 300 lbs/acre, and tackifier (soil stabilizer) at 120 lbs/acre sprayed over the straw[27]. When germinating saguaro cactus seeds, if greenhouse temperature falls below 75º F, the planting tray is placed on a heating pad. Reducing temperature of the planting tray reduces germination rate from about 50% to less than 5%[16].

After germination, the emerging seedlings go through a process known as "pricking out" or "spotting off" in which emergents are transplanted into growth containers[12]. The best time or size for transplanting varies. Propagation protocols for elderberry, bitterbrush and bitter cherry recommend transplanting as soon as there is a set of leaves grown[10]. When large enough to handle, the seedlings can be placed into individual pots. When large enough to handle, the seedlings can be placed into individual pots. If growth is sufficient, they may be planted into their permanent positions in the summer, if not they can be planted the following spring[8]. Young recommends surface sowing seed in flats, then transplanting seedlings to individual tubes 21 days after germination. Seedlings should stay in shaded areas for at least five weeks to develop further before being planted out[27]. When germination is observed in elderberry seeds, the seeds are sown in a mix of perlite and peat moss and covered with a layer of gravel[10].

Palms are very intolerant of being planted too deeply and can be difficult to transplant at the early stages of seedling development. Transplanting seedlings too deeply can result in high seedling mortality. Furthermore, root-pruning at the transplant stage is not recommended[14]. Thus, species with a difficult time transplanting should be directly sown into wide and deep containers.

Discussion

Although this review only looks at seed propagation, another but less popular technique is vegetation technique. Deciding whether to propagate by seeds vegetatively depends on the objecting of desired project. If the objective is retaining the physical characteristics of a specific ecotype or clone, vegetation propagation is preferred. Techniques to propagating vegetatively varies, but all methods are a form of asexual reproduction so the main objective is to make clones of an individual plant or a selected group of plants with similar genetic composition[12]. Species that root easily can be propagated with rooted cuttings.

As mentioned before, plant propagation varies tremendously depending on species thus it is hard to consider just one specific propagation method as a standard to propagating many species of plants. Aside from biological factors, propagation materials, time constraints, and economics must also be considered. Sometimes it may be impossible to obtain enough seeds if plants do not produce quality seed crops each year. This makes emergency projects, such as fire restoration, hard to complete if crops must be grown in a very short amount of time. Despite seed propagation is responsible for producing over 95% of species and less expensive than vegetative propagation, it does require more hand labor, time, and often requires equipment and structures.

Conclusion

Common methods of plant propagation are seed and vegetative propagation. Seed propagation is preferred for biological and economic reasons. Seed propagation is seen as a cradle to grave approach where seeds are collected, cleaned, treated to germinate, sown, and lastly transported. Seed collection is also relatively cheap because it can be done from harvesting seeds from a native location or bought in large numbers. On the other hand, vegetative propagation is used to genetically replicate a species. Since seeds come in different shapes and sizes, and made up of different components, propagation methods for seeds and vegetation vary tremendously. Best choices for propagation is dependent on costs and availabilities of materials and labor for seed collecting, testing, cleaning, treating, and sowings.

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The Cost Benefit Analysis of Native Plants

The true benefits of native plant restoration can only be examined when the resulting ecosystem services are taken into consideration. Native plants have evolved with local climates, animals and insects, and landscapes. They provide many advantages for individuals that choose to grow them in their gardens and for communities that choose to implement them into their green spaces. However, the lifecycles of native plants heavily influence their contributions to local ecosystems. For this reason, their application must be carefully designed; users must execute seed collection, propagation, and usage at the appropriate times to maximize gains. Costs and benefits of native plants can be examined in relation to the environment, public education and health, and the economy. Despite the costs that are necessary to supplement their growth, native vegetation can hold invaluable benefits when implemented correctly.

To ensure health and success, one necessity that is critical to all environmental communities is balance. A stable ecosystem is capable of resistance and resilience in times of stress and degradation, which gives it the ability to preserve itself during extreme events such as forest fires or human interruption. Ecological stability is heavily reliant on biodiversity (Loureau & de Manzacourt, 2013). When a community is characterized by a multitude of species that carry individual responsibilities, complex interactions that are vital to community functions can be accomplished (The stability of ecosystems, n.d.). This includes forms of interspecies relationships like seed dispersal and pollination. These dynamic community networks are established by vegetation, which provides shelter and food for both animals and insects alike. In fact, a community cannot survive in its natural environment if it is stripped of the plant diversity that it has coevolved with. Species that are native to the same community regularly become dependent upon one another because they face similar evolutionary circumstances such as climate, landscape, and resources.

In one case, a study on bamboo growth and the resulting implications for giant pandas shows that invasive varieties can debilitate the species' success (Reid et. al, 1991). The presence of an indigenous plant species can define the ability for other species to exist. As a result, conservation projects often begin with the restoration of native plants. In areas that face urbanization, an abundance of native vegetation can facilitate species survival by acting as a channel for wildlife to connect from one ecological island to another. Organizations like Mountains Restoration Trust in Los Angeles, which focuses on the Santa Monica Mountain Range, restore habitats to attract indigenous wildlife. For Mountains Restoration Trust, these efforts have been successful; now that their Oak Program has been completed, populations of deer and birds have been revitalized (Restoration, 2005).

Native plants aide ecosystems that belong to inhospitable environments. Native plants are adapted to combat environmental stressors common to their regions. For example, plants native to California tend to be drought tolerant and slow burning, characteristics that are adaptations to their dry and fire-prone environment (Schettler, 2010). Cattails and species native to wetlands also display adaptability because they obtain nutrients in settings that are fairly anaerobic (Wetlands FAQs, n.d.). Environments that are limited in available oxygen typically limit growth in plants; the ability of native species to flourish under hostile conditions displays how effective establishing a community for them can be.

Although the ecosystem services native plants provide are often unclear to human populations, there are many services that benefit locals directly. These include cultural benefits in terms of education and recreation. Environmental education is important in communities because it facilitates a relationship between a region's inhabitants and the outdoors. The environmental services native plants provide can greatly expand one's understanding of how dynamic ecosystems can be, and the role of human beings in them. With this connection comes an individual's greater appreciation for the environment, a realization of their dependency on resources provided by their surroundings, and an understanding of the problems faced by their community (Stapp, 2014). Those living in low-income communities could largely benefit from environmental education because they are often subjected to various forms of environmental injustice that can potentially result in chronic illnesses like cancer, asthma, and obesity. These communities face extreme inequalities such as a lack of access to green spaces and lesser air and water quality.

Studies have shown that access to green spaces can promote childhood activity both physically and psychologically. One study conducted in Spain shows that access to green spaces correlates to a reduction in obesity (Davdand et. al, 2014). Another applied to urban spaces in Illinois demonstrates that green spaces promote creative activity and play (Faber Taylor et.al, 1998). Although these investigations are not specific to native plants and simply analyze the effects of green spaces in general, they provide insight to the potential benefits of implementing green spaces that restore native plants within barren or environmentally degraded areas. Given the opportunity for education that native plants provide, further investigations would likely reveal that native plant implementation amplifies results. However, it is also necessary to consider public access and use when planning restoration projects, as this can greatly contribute to a community's ability to gain from them.

Native plants can also be used to address public health issues such as pollution. Due to the fact that native plants have spent generations acclimating to their regions, they require a lower amount of maintenance to be successful than their non-native counterparts. Equipment such as lawnmowers and leaf blowers are thus often unnecessary; as a result, the amount of fossil fuels burnt in areas dominated by native plants is lower (What's so great about native plants?, n.d.).

It has also been proven that soil and water qualities are improved when native vegetation is present. Since they do not require fertilizers and pesticides, native plants do not produce runoff that has the potential to contaminate other systems (Hagen, n.d.). Plants can even absorb heavy metals and other pollutants from the soil, improving the quality of nearby surface water or underlying groundwater. One survey that analyzed the effects of riparian vegetated buffer strips on water quality reported that nitrate concentrations were reduced up to 90 percent by the vegetation, and that phosphate concentrations were also reduced (Osborne & Kovacic, 1993). Although this form of vegetation releases dissolved nitrate and phosphate later in the year, researchers acknowledge that the discharged amounts are smaller than the levels measured without the implementation of native riparian vegetation. They suggest that collecting plant biomass periodically could reduce the amount discharged. Native plants are capable of remediating the results of environmental degradation, but must be appropriately implemented and managed to maximize their benefits.

Despite the high costs that are associated with native plant management, such as the periodic removal of invasive species, native plants are unique in that they provide several cost-effective advantages that result from their evolutionary background. Their ability to improve soil and water quality lessens costs related to landscaping and water treatment down the line. Furthermore, the amount of human resources required to maintain native plants is minimal. Fertilizer usage, pesticide usage, and landscaping costs related to native plants are much less than those of their non-native counterparts. One economic analysis of native plants shows that non-native grasses can cost up to $17,000 more per acre to maintain over the course of twenty years than native wetlands or prairies (What's so great about native plants?, n.d.). The United States spends an estimated $143 billion per year to maintain non-native plants that are used in landscaping and also to combat the damage that results from their wide-spread implementation (Cusack et. al, 2009).

Individuals hoping to make their yards more sustainable have been offered incentives from both government and private agencies to make their landscaping more environmentally responsible. Turf removal programs offer an exciting opportunity for homeowners to remove their grassy lawns in exchange for rebates, inspiring many to grow native plants instead. Rebates are also offered for other water conservation practices such as using rain barrels and advanced irrigation systems (Residential Rebates, n.d.). However, the conversion to native plants is the most progressive option. A study at UC Davis showed that if the entire city of Davis, California, converted from turf to native plants, there would be a 60 percent reduction in water use in the city (Seapy, 2015). The potential native plants hold to conserve water is great, especially when they can be integrated into urban areas.

When planning a restoration project, it is socially and economically critical to consider the implications of its scale and location. Plans for large projects in cities may have the public confused and concerned. Citizens of Los Angeles currently face fears of unaffordable living as a result of the L.A. River project (Sahagun, 2014). The effort is expected to attract investors and cause gentrification in neighborhoods surrounding the site. However, the project could provide Los Angeles with a great deal of capital--the city only expects to spend $1.3 billion dollars to complete the project, which should spark many billion dollars more in investment (Jamison, 2015). The project is slated to draw $5 billion from investors and create 18,000 jobs (Sahagun, 2014). In cases like Los Angeles, where more people are directly impacted, it is important to examine all the advantages and disadvantages of any given restoration project for the local community.

Planning restoration projects also requires determining the source of native plants. Vendors can include the Native Plant Society, arboretums, and botanical gardens. However, native plant nurseries are the ideal source of native plants (Where to Buy Native Plants, n.d.). In comparison to nurseries that encompass a wide variety of plantlife, nurseries focused on native plant growth are less reliant on pricey services like pesticides and fertilizers that are necessities for alien species. TreePeople, a non-profit environmental organization, does not use any of these materials in its nursery and has contributed greatly to the reintroduction of native plants in Los Angeles. Native plant nurseries also use less water because their products have evolved with the local climates. These nurseries allow for basic irrigation systems because they are catering to plants that all have similar needs. Lastly, investment in native plant nurseries also contributes to the public's environmental education, as these site typically provide tours, require volunteers, and offer internship opportunities.

Although some people consider creating their own nursery for restoration projects, those planning projects with limited time or money should consider purchasing plants from nurseries instead. Purchasing plants provides the user with more flexibility and less commitment, and allows them to focus more of their efforts on other planning necessities. Conversely, managing a nursery requires a staff, investment, and much expertise (Dumroese et. al, 2009). The disadvantages of the suggested approach are that being a buyer results in less control during the growing process, and it is sometimes hard to predict plant quality and availability (Dumroese et. al, 2009).

To maximize the benefits native plants can hold, an understanding of the stages that precede their application to a project is, of course, required. Seeds are first gathered from wildlands, and are then cleaned and tested. Procedures for these steps differ among species. Once these are completed, they may finally be planted.

The Forest Service recommends seed propagation methods that vary according to seed attributes. Direct seeding entails directly growing plants in containers. This process is fast and curtails the necessary labor and handling but requires seeds to be active and of high quality. If seeds are not active, they must be treated. Direct seeding is applicable to 20 percent of native species; it is best for seeds of high quality. An alternative procedure is planting germinants, or sprouts. Sowing sprouts is an efficient use of seeds and space, and seeds do not need to be of high quality. However, it is a longer process that requires more interaction. The length of the procedure varies upon the seed and can take weeks to months before planting is an option. Fifteen percent of species require germination before planting. The last method described by the Forest Service is transplanting. Transplanting emergents offers the same advantages as sowing seeds, but it also allows for consistent development. Disadvantages of this system are that plants may become more susceptible to disease, and that human error during transplants can hinder the growth of the plants' root systems. This process has fewer restrictions and can be applied to the remaining 65 percent of native plant seeds (Dumroese et. al, 2009). Following these suggested courses will lead to the most productive seed-to-growth ratio, according to the Forest Service.

Native plant nurseries, which partake in all methods, develop seeds in greenhouses or containers before they are implemented in the field (Seed and Nursery Stock Production, n.d.). Containers are typically tubes that hold low volumes of soil, as these are not only space-efficient but also sponsor healthy root systems in seedlings (Young, 2012). Plants are later transferred from tubes to one-gallon pots so they may expand. Growers often plant a variety of species, which include native grasses and forbs, to grow distinct communities that are resistant to weeds (Seed and Nursery Stock Production, n.d.).

It is recommended that plants have an established root system before they are used for restoration projects (Seed and Nursery Stock Production, n.d.). Once this has been accomplished, and the plants' future location has been cleared of invasive plants, users may transfer plants from their growing sites to their restoration sites. Costs that must be considered after plant production include the human labor required to remove non-native plants; the fuel and capital required for transportation; and the variables required to ensure success after implementation, such as barriers to prevent human intervention, ways to mitigate pests, and water management.

Removing non-native plants requires special consideration. Studies have shown that different methods used to remove the invasive plants will provoke a variety of responses from native plants (Flory & Clay, 2009). Hand weeding is proven to be the most effective. Although it is the most labor intensive method of invasive plant removal, it ensures a more successful native plant community. If workers take the time to familiarize themselves with the clothing and equipment that has been successfully utilized at other sites, the problem of invasive plants can be reduced even further. Therefore, an investment in time and energy toward detail planning can vastly reduce future investments to remediate native plant failures.

In regards to transportation, while traditional nurseries may import plants from around the world, native plant producers should obtain seeds local to the restoration site to ensure the most natural introduction into the site's ecosystem. This not only contributes to restoration success but again limits fossil fuel expenditures and fuel costs related to trucks used for native plant transportation.

Once plants have been transferred to the restoration site, several measures are required to guarantee outstanding results. When the restoration site is first opened to the public, visitors may be unaware of the vulnerability that the recently transplanted native plants may have. Using netting or mesh to protect young plants can prevent them from being trampled or pulled on. Simple methods such as using stake flags to identify natives are cheaper yet less effective. Another variable that must be considered is pest management. Although native plants are less susceptible to external factors such as insects, hindrances may still be possible from non-native insect species. To determine if this is a potential issue in a given environment, studies should be conducted to identify what pests may be present at the restoration site and their effects on native plants. To decrease pest populations overall, restoration should be maximized. This will attract native bird populations--those that are insectivores will contribute to pest management (Managing Pests, n.d.). When appropriate measures are taken, the potential native plants hold can be reached.

Native plants are capable of attracting biodiversity and are therefore important drivers for evolution and ecosystem stability. To the human population, they provide services such as environmental education and pollution control. Education allows communities to combat prominent social dilemmas like obesity and other forms of environmental injustice. Maintaining pollutants through the use of native plants is a step towards sustainably alleviating the effects of industrial progression. Additionally, projects involving native plants create opportunities for investment. If the privileges of investors are taken into higher consideration than that of communities harboring the sites, however, the social dynamics of the region may collapse. Other implications that must be regarded include plant sources, systems used during plant production, and external factors that affect the vegetation once they have been planted at their restoration site. There are many things to consider when native plants are used for projects; however, their benefits certainly outweigh their consequences. If native plants are applied widely, it is possible for a greener and healthier society to connect with the rest of the natural community.

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Literature Review - Ecosystem Services Provided By Native Plants

A large reason why habitat conservation and environmental protection are important is because of the ecosystem services provided to people by intact habitats. Ecosystem services are benefits that a healthy ecosystem brings to human populations. These benefits range from economic, to social, to environmental (climate regulation, flood protection, etc). An increasing problem that comes with human population growth is the loss of native species of plants and animals to non-native and invasive species. With the loss of native plants comes also the loss of ecosystem services provided by those species. Native plants in California, for example, tend to be drought-tolerant and require much less water to maintain than non-native or invasive species of plants. In the wake of the California drought, such a benefit would prove invaluable in water conservation. However, saving water is not the only ecosystem service provided by native California plants. The primary goal of this paper will be to break down and analyze the several ecosystem services provided to human populations by various plant species native to Southern California, as well as techniques for measuring ecosystem services and the socioeconomic aspect of these services.

The study conducted by Palmer and Filoso defines an ecosystem service as the benefits humans derive from an ecosystem. In order to obtain the maximum amount of benefits from an ecosystem, it must be rehabilitated to its natural, undisturbed state, through the process of ecosystem restoration. While the benefits vary greatly, Palmer and Filoso's study focuses on the economic aspect of ecosystem services and the impacts they have on environmental markets. In particular, they discuss how the combination of ecosystem restoration and ecosystem services can help environmental markets, with the purpose of creating restoration credits which can be purchased and sold[1].

However, the focus cannot solely be placed on the economic side of the picture. Instead, the real goal should involve understanding the science at work that provides these benefits - why restoration efforts usually fail, how efforts can be improved, and understanding that only a direct measurement of the biophysical processes involved in ecosystem services is the only way to ensure success of these environmental markets. In fact, without a proper understanding of these natural ecosystem phenomena, it is possible for ecosystem restoration efforts to end up causing more harm than good. They warn that without properly understanding the shortfalls of ecological restoration, the quality of service provided by the restoration may fail to offset losses, which could end up increasing environmental degradation rather than decreasing it. (Palmer, Filoso, 2009).

Naidoo et. al focused on methods of identifying regions where conservation would both improve biodiversity and increase ecosystem services (which are also defined in this study as economic benefits to people provided by intact ecosystems). While the authors take a global perspective on identifying different areas to practice conservation, their methods could potentially be used for the LA region in Southern California. The researchers found from their initial results that regions selected specifically for maximum biodiversity did not provide more

[1] Palmer, M. A., and S. Filoso. "Restoration of Ecosystem Services for Environmental Markets."*Science* (2009)

ecosystem services than a random region, implying that biodiversity is not the sole environmental factor that provides ecosystem services[2]. As with the study conducted by Palmer et. al, Naidoo et. al states that an interdisciplinary effort will be necessary to fully understand biodiversity conservation and ecosystem benefits.

The global mapping done by Naidoo et. al was conducted by utilizing available global data to map out ecosystem services. The researchers could only render the geographical distribution of four ecosystem services - carbon sequestration, carbon storage, grassland production of livestock, and water provision. The authors emphasize that these four are but a small fraction of all ecosystem services provided globally, but information for other services could not be obtained. A main problem with this study (that the researchers themselves brought up) was the fact that its sheer scope was its primary limitation - since the area of the map is so large, the amount of detail that could be presented is reduced. This problem may not be encountered if a similar method was carried out for this particular project, as the focus is much narrower (Southern California/the Los Angeles region) rather than the entire world.

A similar study conducted by Shaw et. al examined the effects of climate change on ecosystem services such as carbon sequestration in California, a more specific area of study than the above global study. Since climate change is not a focus of this paper, it will not be discussed in depth. However, the researchers' methodology is interesting to note. They were able to determine values for two ecosystem services in Southern California - carbon sequestration and forage production - by using the MC1 Dynamic Global Vegetation Model (which estimates the distribution of vegetation and related carbon, nutrient, and water fluxes), and a biogeochemistry module that emulates plant productivity, organic matter decomposition, and water and nutrient cycling, as well as modules for carbon dioxide, fire, and biomass[3]. These tools may prove to be useful in the upcoming research on the restoration of the Los Angeles River, and should be taken note of.

Since this research will be focused on the restoration of the Los Angeles River, it makes sense, then, to analyze the ecosystem services provided by riparian systems. A riparian system is defined as "transitional zones between terrestrial and aquatic systems exhibiting characteristics of both systems" (NRCS, 2007). These transitional zones include areas progressing from land to river habitats, as with the LA River. The plant life in these transitional zones tend to consist of trees, grasses, shrubs, and forbs tolerant of periodic flooding (NRCS 2007). Although riparian ecosystems vary significantly across the country, each with their own unique benefits and functions, there are several ecosystem services and traits that are universal across all riparian systems. These ecosystem services are water storage, flood control, nutrient cycling, and water quality protection[4]. Native plants influence water flows by dissipating the flows' energy, reducing erosion, and increasing water infiltration time, which allows for better water storage, a great benefit considering the current drought. The quality of the water is also improved, because

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[2] Naidoo, R., A., et.al. "Global Mapping of Ecosystem Services and Conservation Priorities." *Proceedings of the National Academy of Sciences* (2008)

[3] Shaw, M. Rebecca, et. al. "The Impact of Climate Change on California's Ecosystem Services."(2011)

[4] Machtinger, Erika T. 2007. Riparian Systems. Fish and Wildlife Habitat Management Leaflet, no. 45. Washington, DC: Natural Resources Conservation Service

as the plants reduce the flow of the water, sediments are able to settle down, which reduces the probability that they get carried further downstream. In addition to acting as sediment traps, deep wooded vegetation like trees reduce bank erosion, and are effective in stabilizing streambanks. Riparian plants also trap pollutants like pesticides and heavy metals, which are then usually broken down by natural processes, purifying the river (NRCS 2007). Considering the current state of the LA river, the natural purification system brought by native riparian trees, shrubs, and grasses would be an invaluable asset to have.

Examples of native riparian plants of three categories (grasses, trees, and shrubs) are deergrass (*Muhlenbergia rigens*), the California sycamore (*Platanus racemosa*), and the California black walnut (*Juglans californica*), a large shrub. Deergrass is a perennial bunchgrass that can occupy a wide range of environments, spanning grasslands to chaparral to forests, and of course, riparian systems. The ecosystem services it provides include being used to stabilize streambanks and erosion control, due to its extensive root network, as well as displacing invasive species, remediating overtilled agricultural land, and filtering pesticide, herbicide, and particulate matter using its dense and extensive root system[5].

The California sycamore is a large-sized tree that grows in riparian areas. It is characterized by its pale bark and five-lobed leaves. Like most riparian trees, the main ecosystem services the California sycamore provides are the reduction of erosion and the stabilization of streambanks. It is additionally an aesthetically pleasing tree, and is frequently used in natural landscape design[6], making it an ideal candidate for restoring the LA river using native plants.

An example of a native riparian shrub is the California walnut, a species endemic to California. The shrub still holds ground in the Santa Monica Mountains, urban Los Angeles, and the Hollywood Hills. The walnuts grown on the tree can be eaten by humans. The shrub also provides food and habitat for a variety of birds and rodents. Additionally, like the California sycamore, the shrub's root system can stabilize streambanks and mitigate erosion[7].

Soman et. al had more to add about the ecosystem benefits of riparian systems. In their literature review on the ecosystem services of riparian systems in Illinois, they list a variety of rural and urban benefits provided by riparian ecosystems. One of these services is the prevention or reduction of agricultural runoff from entering streams or rivers. Streams located near agricultural areas are frequently polluted by runoff (carrying fertilizer, herbicides, and pesticides), however, the filter strips or riparian buffers consisting of native trees, shrubs, and grasses help to significantly reduce the amount of pollutants entering the water. Riparian zones can additionally benefit urban areas, according to Soman et. al, in many ways similar to how they benefit rural areas. They can improve the quality of water, provide shade, shelter, and food for aquatic organisms, provide habitat for wildlife, provide economic benefits to the community, improving the landscape aesthetically and increasing its diversity, provide recreational opportunities for the community, and protecting the area from flood damage[8].

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[5] Metzger, Sandy. "Muhlenbergia Rigens." *UC Master Gardener Program of Sonoma County*

[6] "Platanus Racemosa, CALIFORNIA PLANE, SYCAMORE. California." *Platanus Racemosa, CALIFORNIA PLANE, SYCAMORE. California*. Stanford University.

[7] Esser, Lora. "Juglans Californica." *Juglans Californica*. USDA Forest Service

[8] Soman, et. al, 2007. Ecosystem Services from Riparian Areas: A Brief Summary of the Literature.

Native riparian plants can provide yet more benefits to both the environment and human communities. Soman et. al cite additional benefits, including reduced soil erosion, increased nutrient storage and cycling, removal of nutrients like nitrogen, phosphorous, and sediment (touched upon above with regards to agricultural runoff), and providing scientific and educational opportunities. Vegetation buffers in riparian systems also help reduce flooding, decrease water temperatures, and improve the biodiversity of the area (Soman, et. al, 2007).

Additional noteworthy native plants (that are not necessarily riparian) are the Pacific bluegrass (*Poe secunda*), the Fremont Cottonwood (*Populus fremontii*), and the blue elderberry (*Sambucus cerulea*). Pacific bluegrass is a species of grass that is widespread in North and South America. This grass is highly drought-resistant, which makes it an ideal choice for Southern California. In addition, it is useful in preventing soil erosion and increasing soil stability, and can also be used as a revegetator after a wildfire (or to begin vegetating sparse areas)[9].

Fremont cottonwood is a riparian cottonwood tree native to the southwestern United States. The ecosystem services it provides are shelter and food for wildlife, windbreaks, erosion control, and recreation (USDA NRCS, 2002). Like the California sycamore, it is used in natural landscaping projects, making it a good candidate for restoration efforts in the LA River.

Finally, the blue elderberry shrub is a plant commonly used in ecological restoration and natural landscaping. Furthermore, its flowers and berries attract various species, ranging from butterflies, various birds, and chipmunks, which can help improve the biodiversity of an area (USDA NRCS). It must be noted that while there are dozens of different native species of trees, shrubs, and grasses, the ecosystem services many of them provide are similar or the same (soil stability, water purification, etc.).

In 1992, 167 countries around the world convened to sign the Convention on Biological Diversity (CBD) to promote and ensure conservation and sustainable use of biodiversity, as well as fair sharing these resources. The standards to significantly reduce biodiversity loss by 2010 were failed. Perrings, et. al, an interdisciplinary group of scientists from DIVERSITAS, an international biodiversity science group, focuses on the feasibility of an ecosystem services-based approach for the 2020 CBD goals. The researchers emphasize that when focused on conserving or restoring biodiversity, it is important to take into account that different ecosystem services are often interdependent with each other. For example, an ecosystem managed for either one ecosystem service or a few (food, fuel, etc.) tend to lose those services as they are harvested, which then affect the services that are not marketable (flood protection, erosion control, water purification, etc.). In fact, the researchers state that a major improvement of the 2020 CBD standards over the 2010 standards is the acknowledgement that the failure to address that the interdependencies between ecosystem services have socioeconomic origins. By this, they mean that market incentives for saleable services, like food, encourage the production of these services over those that have little or no economic or market value, like erosion control[10] Although this research was done on a general, more global scale, it is useful information to note even for region-specific projects like the LA River restoration efforts.

Christopher Lant, et. al describes this phenomenon as “the tragedy of ecosystem services,” where overconsumption of common resources results in the decline of non-marketable

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[9] "Plants Profile for Poa Secunda (Sandberg Bluegrass)," USDA NRCS.

[10] Perrings, et. al. "Ecosystem Services, Targets, and Indicators for the Conservation and Sustainable Use of Biodiversity."

ecosystem services. Economic incentives for marketable services inevitably end up harming the services which are not as easily marketed. These ecosystem services, then, according to Lant et. al, end up underprovided, even though they benefit the general public. A solution to this, according to Lant, is to improve property rights to include non-marketable ecosystem services, to reform economic incentives, and to develop ecosystem service districts (Lant, et. al, 2008).

Native plants face numerous threats, with the primary obstacle being invasive species crowding them out. Moroney et. al[11] studied the impact invasive European annual plants had on an endemic sunflower, *Pentachaeta lyonii*, in Southern California. The researchers found that the presence of invasive annual grasses and forbs had a negative impact on the growth and reproductive potential of *P. lyonii*, and that the invasive plants tended to render the environment ill-suited to the otherwise native *P. lyonii* (Moroney et. al, 2011).

Not only can invasive plants disrupt the lifecycles of native plants, they can also drastically reduce the biodiversity of an area. Kirk Davies describes that in Oregon, species richness and plant diversity had an inverse correlation with a type of invasive grass. This exotic grass accounted for over sixty percent of the variation in plant diversity, and all native plants in the region had a negative relationship with the invasive grass. This implies that the presence of invasive plants such as these grasses confers a negative effect on the region's native plant communities and biodiversity (Davies, 2011).

Besides directly providing ecosystem services to humans in the form of protection, water quality, food, etc, native plants provide more support to native species of insects, birds, and other fauna, which in turn provide their own set of ecosystem services. Isaacs et. al[12] examined the benefits arthropods, such as bees, provide to ecosystems and humans from having access to native plants. The study focused on agriculture and the impacts farmlands have on native plants, however, the core concepts remain the same. Insects can provide invaluable arthropod-mediated ecosystem services, of which the primary two are pollination and pest control (Isaacs et. al, 2009).

An effective way to commence any environmental restoration project, on any scale, is to eliminate invasive and non-native plants from the area and begin reintroducing native species of plants. Native plants can provide a whole host of ecosystem services both for the environment and for humans. There are numerous ways to measure or map out these services, as well as their relationship to economics, biodiversity, and environmental quality. This paper focused primarily on the benefits of native riparian plants, due to their relevance to the upcoming Los Angeles River restoration project. These benefits include erosion prevention, streambank stabilization, water purification, and flood protection, as well as providing recreational opportunities and improving the aesthetic of nearby communities. Non-riparian native plants have similar benefits, with a major one being drought-tolerance, invaluable considering the current California drought. Native plants in general also tend to benefit indigenous populations of insects, birds, and animals, providing a complete ecosystem that can provide even more services to human populations.

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[11] Moroney, et. al, "Invasive European Annual Plants Impact a Rare Endemic Sunflower."

[12] Isaacs, Rufus. "Maximizing Arthropod-mediated Ecosystem Services in Agricultural Landscapes: The Role of Native Plants."

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Literature Review
Native Plant Nurseries - Grant Availabilty

HISTORY

The Los Angeles River, channelized by the Army Corps of Engineers in 1938, was once a natural, fluctuating river.[1] Characterized by unpredictable flow and frequent flooding, the river posed a serious threat to the ever-growinging city of Los Angeles, as it began its development into the urbanized and populous city that we know today. That is why channelization of the river was considered to be an engineering feat; it allowed the citizens of Los Angeles to overcome many setbacks imposed by nature. Deaths caused by flooding decreased, and the now completely "controlled" river caused much less damage, which in turn saved the city millions of dollars. But many argue that the river, with its continuous concrete trapezoidal design, is an eyesore.[2] Not only is the channelized river lacking in aesthetic appeal, but it is also lacking vegetation altogether, and is consequently no longer able to support the migratory and native species that have historically depended on its natural riparian habitat.[3] Starting in 1991, the Los Angeles County Board of Supervisors began directing a review of potential "compatible uses" of the Los Angeles River. Since then, stakeholders have engaged with planners, and the city has continued to make steady progress in the realization of a complete revitalization project. Now, with a Master Plan and a twenty-five year blueprint, the city is emarking on the project; but such a large scale project as the Los Angeles River Revitalization Project requires time, effort, and of course, funding—this is the issue that I will be discussing in this review.

PROJECT

Our particular practicum project explores the feasibility, associated benefits, and possible disadvantages and limitations associated with establishing a network of native plant nurseries in and around Los Angeles. Though we do not currently have a definitive figure for the number of plants needed to realize the native riparian habitat restoration, we have been informed that the number of local native plant nurseries is currently insufficient, and will not be able to meet the large demands of the riparian restoration project[4]. Looking ahead, the city of Los Angeles has two options to combat this problem. The option that we are studying, which includes laying the foundation for a local network of nurseries, is predicted to aid in minimizing the transportation costs and greenhouse gas emissions associated with long-distance plant transport. Additional benefits might include local job creation, educational opportunities, local environmental benefits such as urban cooling effects and increased biodiversity, and citizen engagement in the project. Alternatively, without a local network of nurseries, the city will have to rely on external nurseries, transporting the requisite native plants from facilities outside of Los Angeles. Now, I will explore potential funding opportunities that are available for the former suggestion.

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[1] LADPW: Appendix A: A History of the Los Angeles River
[2] Curbed LA: 25 Photos of the LA River
[3] LADPW: Planting Guidelines (page 3)
[4] Dr. Felicia Federico: LOCAL NATIVE PLANT NURSERIES TO SUPPORT LA RIVER RESTORATION

FUNDING OVERVIEW

Given the scope of the Los Angeles River Revitalization project, we predict that there will be many different projects, all of different scales and scopes, which will be initiated by many different types of organizations. With regards to nursery implementation specifically, there may be nonprofit organizations like TreePeople, for example, seeking to head up native vegetation plantings; there may be schools, churches, and city and county entities that seek to establish native nurseries on their grounds in order to supply plants for the revitalization. Further, local city governments may manage urban clean-up projects, and major construction projects. All of these projects require money, but they all happen to fall under different funding categories; in other words, they qualify for different types of grants from different sources and at different dollar amounts due to the fact that their goals and organization types are different.[5] So, when looking at initiating local native nursery development, we must start with targeting particular locations or stakeholders. From here, drafting definitive project plans will allow us to determine the specific funding categories for which our project qualifies.

There are several categories of aid, including private foundations, corporate sponsorships, volunteer service, and individual contributions to name a few.[6] Public grants are also viable, especially for a project of this nature, which is aimed to impact entire communities; however, public grants vary by jurisdiction and often involve long and complex application processes, making them more complicated to acquire.[7]

In order to solidify any sort of grant or financial aid for the expansion of a local native nursery network, there must be a solid plan and a working model that can serve to demonstrate the value and the vision of the project.[8] Kat Superfisky, a project designer involved with the Los Angeles River revitilazation project, outlines some of the many benefits that a local nursery network might have on its local community, and many of the "boxes" it could fill, including creating job opportunities for veterans and the homeless, recreational opportunities and aesthetic appeal, and the expansion of green infrastructure. But she emphasizes the fact that each nursery operation costs at least $50,000, a figure that grows quickly with added educational spaces and demonstration gardens, for example[9].

As Superfisky mentioned in the article, "Imagining a Network of Native Plant Nurseries for the L.A. River," establishing nurseries is costly. "Bare-bones" operations, as she puts it, can cost as little as $50,000, but when organizations like Grow LA, for example, are committed to truly engaging the local community and stimulating the economy while supplying the plants needed for this project, they require more resources. In order to successfully engage citizens, and provide for meaningful learning opportunities, nursery operations may end up costing upwards of $500,000--perhaps even millions per site.[10] The extra costs of demonstration gardens, education programs, and of hiring the staff associated with research and public education, add up quickly. All of this means that a large initial investment is required in order

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[5] LADWP: Appendix E: Funding Sources
[6] LADWP: Appendix E: Funding Sources
[7] LADWP: Appendix E: Funding Sources
[8] Jao, "Imagining a Network of Native Plant Nurseries for the L.A. River."
[9] Jao, "Imagining a Network of Native Plant Nurseries for the L.A. River."
[10] Jao, "Imagining a Network of Native Plant Nurseries for the L.A. River."

to get an effective nursery running, so engaging stakeholders is sure to be a crucial first step. Superfisky alludes to the fact that once an exemplary model garden has been established, it will be easier to prove the worth of native plant gardens, and future nursery projects will have a better chance at acquiring grants.[11]

DISCUSSION

The United States has made marvelous engineering feats throughout its history. The country's early development boom of the twentieth century created jobs, connected states, and harnessed power. Projects of massive scale, such as the Hoover Dam and the Golden Gate Bridge, are icons today for their universal design appeal and massive scale. But what about the approximate fifty miles of channelized, concrete river that runs through our city of Los Angeles? By all means, it was an effective project; it accomplishing what it was meant to accomplish. It transformed a once unpredictable, meandering river responsible for major floods, destruction, an death, was now completely controlled. Man had harnessed nature, widened it, flattened it, and made it skateable during the low flow season.

But now, the approach to urban development has changed. Restoration, recycling and conversion seem to be emphasized more often than expansion, growth, and new development. And now, the best projects include the marriage of aesthetic appeal, energy efficiency, and fairness and affordability. There is finally a movement that seems to be combining the three, all-important and co-dependent E's: environment, economy, and equity. On the horizon for Los Angeles is a massive project that is set to do the same. The major river restoration project will transform sections of the current brutalist, concrete river to a thriving riparian ecosystem, providing habitat for a diverse range of species, and recreational space for citizens. It only makes sense, then, that the sourcing of material used for this project is native.

So how can this issue--the issue of local sourcing--expand its reach? Aside from *native* plants, planted in the *local* community, how else can nurseries extend this idea of "local?" One option includes engaging young people, particularly those in river communities, in the native plant cultivation process. If schools started native plant nurseries, they would be able weave ecological and environmental topics into their curricula, with a nursery "lab" available for exploration and demonstration right on campus. Schools, with their sufficient land available and plentiful helpful hands and shaping minds, are great places to house native plant nurseries.

Other local groups that might benefit from local nursery implementation are at-risk, homeless, and veteran citizens. Nurseries need people to tend to them, and after some basic training, these people will be given a productive outlet and the opportunity to work in an engaging setting. All of this work will be done for the purpose of building a more biodiverse, healthy, and beautiful community, and that is something that people will want to get behind.

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[11] Jao, "Imagining a Network of Native Plant Nurseries for the L.A. River."

APPENDIX: SPECIFIC GRANTS AVAILABLE - CATEGORIZED

***Information provided by Appendix E of the Los Angeles River Restoration Master Plan*

Public Sector - The following grants are provided by county, state, and federal sources. In order for a project to qualify for receiving a public grant, it must fall under a specific category--one that aligns with the mission and motivation of the particular grant source. I will now categorize some relevant public sector grants by their category and source. This outline will serve as a guide for native nursery projects that are considering grant acquisition.

Source: COUNTY

<u>Proposition A:</u> This funding sorce is provided by the county of Los Angeles, with a maximum award of $500,000. It is open to projects that are aimed toward environmental restoration, watershed management, trail and greenway creation, land acquisition, or park and open space establishment. According to the Los Angeles County Regional Park and Open Space District, over one billion dollars in grant funding has been awarded to date, and new opportunities arise frequently.[12] One foreseeable example of a qualifying project is, for example, a non-profit environmental organization puchasing land so that they can construct a native plant nursery, which also provides recreational and educational space for local community members. All of the intentions of, for example, a non-profic organization like Grow LA align with those of this particular funding source, and a well-established organization with test sites is likely to be considered a qualified recipient.[13]

Source: STATE

The following grants are provided by the state of California, and will be categorized with respect to the purpose that they serve. Categories for grants include land acquisition, parks, recreation and open spaces, trails and greenways, and environmental restoration and clean up. So, different nursery development projects that relate to one or more of these categories may qualify to receive one of more of these grants.

Land Acquisition

The Land and Water Conservation Fund, which the National Park Service operates, has funded park and greenway projects, and has aided in land acquisition all across the state and country.[14] The key in securing this grant, and many other conservation-focused grants, is to frame the nursery network in a conservation context. After all, the establishment of local plant

[12] LA County Department of Parks and Recreation: "Los Angeles County Department of Parks and Recreation - Grants."
[13] UCCE - “”
[14] National Park Service: “State LWCF”

nurseries has the potential to increase biodiversity, not only in the areas to which its plants are relocated, but also in the nurseries themselves. Research into the effects that native plant nurseries have on local biodiversity should be executed in test sites in order to bolster the claim that networks of native plant nurseries are in fact responsible for preserving and enhancing biodiversity.

Additional state-sponsored land acquisition grants come from the California Department of Water Resources[15] and Proposition 117 (which is a gasoline tax). Some grants have particular guidelines and qualifying factors that projects must adhere to. So, qualifying for grants often requires framing the particular project in a context that is actually relevant to the grant program. For example, if applying for a grant from the California Department of Water Resources, one would rightfully assume that the project entails some degree of either water quality enhancement, flood control, or water efficiency, for example.

Source: FEDERAL

The following are some of the highlights that I found within the federal grant category. Los Angeles, being such a prominent city of the United States, has the potential to serve as a model for cities all accross the country. All projects, especially those of larger scale should consult the long list of federal grants available; these are listed in the funding matrix of the "Funding Sources" section of the LA River Revilization Master Plan.[16]

Parks, recreation, and open space

The US Department for Housing and Building Development offers a Community Development Block Grant, which seems suited for a nursery project. It is described as a "flexible" grant.[17] If project planners aim to encompass community outreach and education opportunities into their nursery establishments, then they should be able to market the addition of a nursery as a necessary and fruitful addition to any at-risk neighborhood.

Environmental Education

The Environmental Protection Agency offers grants for the purpose of environmenta education. This grant is targeted at promoting environmental "awareness and stewardship," as well as the skills necessary to ensure the protection of the environment in years to come. [18] Some foreseeable skills that might be gleaned in a nursery, especially one that is located on a school's campus, include general gardening techniques such as pruning and watering, as well as a more involved and complete understanding of plant care. For instance, understanding plants' growing seasons, distinguishing native from invasive plant species, and realizing the benefits of protecting a diverse, tolerant landscape. Many educational opportunities exist in nurseries, also because they are rather controlled; experiments may be done, and students may even engage in

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[15] CA Department of Water Resources: "Financial Assistance"

[16] LADWP: Appendix E: Funding Sources

[17] HUD.Gov - "Community Development Block Grant"

[18] EPA: Environmental Education Grants

small research projects. An environmental education grant would be applicable to many different nursery development projects.

Source: PRIVATE SECTOR

The following grants are sponsored by either large corporations who share an interest in environmental stewardship and education, or by private foundations. Groups apply to these private grants much like college students apply to scholarships; they are awarded on a competitive basis. For this reason, it is important for applicants to craft a compelling narrative around their project, and emphasize the many benefits associated with their plan.

Within the category of environmental education grants, there are grants provided for school nurseries specifically. Home Depot, the National Gardening Association, the California Fertilizer Foundation, Fiskars, and Disney are a few organizations offering school garden grants. [19] The California Native Garden Foundation has a particular grant that seems to fit perfectly with the native nursery network plan. It provides funding for native garden design projects at colleges, schools, museums, and other public places.[20] By housing these native nursery projects in places like museums, colleges, and schools, they are able to reach a larger audience. For example, gardening exhibits at the Museum of Natural History have a wide sphere of influence, as many people visit the museum. Exposing more people over time is an important step in familiarizing people with the gardening practices that best benefit the local ecology, and that are most tolerant to drought.

School gardening grants are rising in popularity and availability. Looking at Education Outside's website, a project planner can choose from dozens of different garden grants. Ranging from the Muhammed Ali Center Peace Garden Grant to the Jamba Juice Grant, it seems that many corporations and private foundations have become involved in the gardening cause. [21] Especially in urban areas with little access for 'nature,' an on-campus nursery or garden is a powerful place for learning, exploring, and connecting with the environment, however man-made or manipulated it is. Plants are plants, no matter where they are, and school gardens will help in dispelling the notion that 'nature' exists outside of the urban environment. With a reasonable expenditure of energy, time, and care, a garden will thrive -- a principle that all people, especially young children ought to learn.

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[21] Education Outside: School Garden Grants

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