Shade Tree Impact Report

inspiring sustainable urban living in the desert southwest

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Message from Valley Permaculture Alliance

To our friends, family, and supporters, both new and returning,

Greetings from Valley Permaculture Alliance (VPA). VPA started out as a volunteer driven grassroots organization, hosting a myriad of educational classes across the valley since 2006. Since the days of backyard classes, we have grown into an official 501(3)c, touching thousands of lives here in the valley of the sun.

VPA could not exist without the support of our community, which has allowed us to continue inspiring sustainable urban living in the desert southwest. Our passionate volunteers have helped give away almost 30,000 desert adapted shade trees, educated 1,250 adult students through our sustainability-focused classes, and engaged thousands of community members through a plethora of outreach efforts. We are eternally grateful for their hard work and are truly inspired by their enthusiasm.

It is because of our community's commitment that has made 2015 a year of firsts. VPA has developed partnership with city recreation departments to expand access to sustainability-focused education as well as kick-started a brand-new community tree planting program where we aim to plant desert adapted trees in public spaces in concert with statewide partners.

At VPA, we are always looking forward. The progress we have made in harmony with many like-minded people has reaffirmed our mission and we could not be more excited. Thank you for joining us as agents of change.

Sincerely,

K. Jung

Kendon Jung
Strategic Initiatives Coordinator
Proud Member of VPA since 2014

Executive Summary

Trees are vital to the health and wellbeing of every community, especially in the desert southwest. Desert adapted trees, including Mesquites, Willows, and Palo Verdes, truly embody sustainable living, thriving in this harsh environment. Since 2012, Valley Permaculture Alliance (VPA) has partnered with local utility companies to give free desert adapted shade trees to our community members. This initiative was designed to educate and empower valley residents on the *"power of trees."* Through this outreach, VPA has been able to teach thousands of people about the benefits of trees and how they can use those benefits to help reduce their utility bill.

VPA is launching an impact initiative to quantify and narrate how we are leaving a positive imprint on our community. Over the past couple of months, VPA has partnered with Arizona State University's School of Sustainability to engage their students in meaningful and impactful projects. With the help of these passionate students, we have been working hard to develop and publish a Shade Tree Impact Report.

This report will narrate the true value of trees and their impact in our community. The Shade Tree Impact Report is broken up into sections that focus on a particular benefit of a tree. These include carbon sequestration, oxygen production, increased property value, and other assets.

Trees offer not only beautiful aesthetics in landscaping, but a reservoir of benefits designed to thrive in our harsh environment. That is why at VPA, we believe Trees Matter™ (which coincidentally is the perfect name for our new community tree-planting program). We hope the use-inspired research in this report will expand your idea of why trees are valuable in your neighborhood. It is time to see trees for what they are; vital partners who are deeply rooted at the core of a healthy, sustainable community.

Introduction

The VPA shade tree program distributes free shade trees to valley residents through our local utility companies Arizona Public Service (APS) and Salt River Project (SRP). Afterward attending a brief class on tree planting and continuing care, these proud new tree owners then take between two to three trees (depending on which utility they use and how old their house is) home to plant. Our trees are distributed at classes/workshops throughout the greater Phoenix area, as far north as New River on I-17, as far east as the intersection of U.S. 60 and AZ 79, south to I-8 and AZ 85, and west out to Aguila. The intent behind giving away desert-adapted trees is to provide energy savings in the home through the shading, cooling, and many other benefits that come with planting shade trees on a residential property.

Though several of the perks of having shade trees are clearly seen, some are more difficult to shown. For example, CO_2 sequestration, oxygen production, and land-value increase are extremely valuable benefits, but are often overlooked. Other benefits, such as canopy coverage and community health are more difficult to conceptualize. For example, play areas with increased numbers of trees are shown to reduce the negative symptoms of Attention Deficit Disorder (ADD) in children with the disorder (Faber Taylor, 2001), but it is almost impossible to measure how many children are affected by a specific tree and exactly to what degree.

Depending on where trees are planted, they can have a different impact on their environment. Because our program participants come from a wide variety of neighborhoods across Maricopa County and plant their trees in different places, this slightly changes the impact of each tree. Despite these measurement challenges, several impact aspects of shade trees can be measured and used to assess the value provided to the broader community. With a continuing awareness of the multifaceted and occasionally elusive nature of the benefits that trees provide, a selection of key metrics that represent the overall impact of the shade trees is presented. We hope to show the positive impact of these trees through rich comparative graphics and an engaging narrative.

Methodology/Metrics

The goal of this report is to define Valley Permaculture Alliance's (VPA) environmental impact here in the valley. One of the many ways we do this is through the distribution of free shade trees subsidized through local utility companies. Since 2012, VPA has given away **29,572** trees. But why is this important?

Trees, especially desert-adapted trees, have a wide variety of benefits to you and your community. Trees can absorb harmful air pollutants, provide shade and cool your environment, increase property values, and much more. In this report, we will talk about what things like what carbon dioxide (CO_2) sequestration means, how we calculated the average land value increase, and whose research helped us figure out how much square footage of shade our trees have created.

These benefits, or "metrics" were defined with research-backed studies to estimate these positive benefits. For example, the iTree (US Department of Agriculture, 2015) suite of tree analysis tools was used to determine values that were not already available in studies. Values for each metric were determined for each tree species and for the total number of trees planted. The maps and value metrics may be used together to understand the reach of the Shade Tree Program as well as its overall value. From all of this information, we can see the positive economical, environmental, and social effects of VPA's work on our urban ecosystem.

- Metrics -

Tree Distribution Mapping

Tree Species

CO_2 Sequestration

O_2 Production

Urban Heat Island Effect

Shade Canopy Coverage

Land Value Increase

Water Consumption

Cost of Water Consumption

Household Energy Use Changes

Mapping

Thirty-thousand trees is an incredibly big accomplishment for the staff size at VPA. But more importantly, it is hard to visualize what 30,000 actually looks like. In order to help, we collected all the data from tree distribution workshops since 2012. This information was compiled, cleaned and plotted by year, utility, and species. The resulting maps are shown below and in Appendix A.

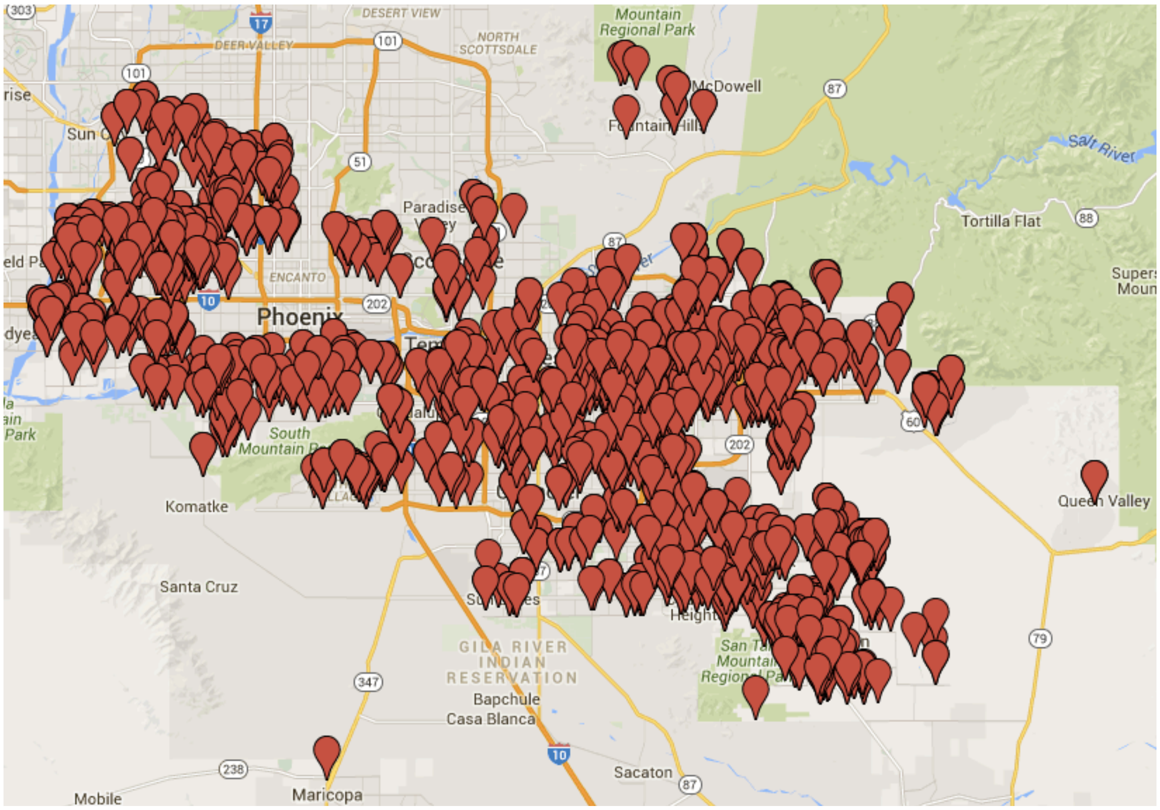


Figure 1. Trees planted in 2015

The number of data points VPA could plot on one map was limited to 2,000. In 2015, VPA planted 2,424 trees. The map above only shows a single year of planted trees, maxing out the 2,000-plot limit and excluding 424 un-plotted trees. Additional data points may also be excluded from other year's maps.

The preface of this report is to provide context to our Shade Tree program. The reason why these maps are important is because they help us paint a picture of our work and give meaning to the numbers. All 2,424 trees planted in 2015 directly impacted at least one person, their owner. But those trees also impacted the owner's family and indirectly impacted everyone in the vicinity.

Tree Species

VPA distributes six species of trees: Velvet mesquite or native mesquite (NM), Parkinsonia desert museum or thornless palo verde (TPV), desert willow (DW), Chilean mesquite or thornless mesquite (TM), willow acacia (WA), and Parkinsonia Florida or blue palo verde (BPV). These trees were specifically chosen because they grow quickly, provide large amounts of shade and use very little water.


Thornless palo verde (TPV)


Thornless mesquite (TM)


Blue palo verde (BPV)


Willow acacia (WA)


Native mesquite (NM)


Desert willow (DW)

Figure 1. Species of trees planted by VPA

Why is this important? Have you ever tried to keep a garden in the summer in Phoenix? The summer sun is extremely harsh and quickly kills un-established plants. The trees mentioned above are able to quickly and efficiently establish themselves and enjoy the desert soil. Each of these species is desert-adapted or native, meaning they are designed to thrive in our arid environment and need much less water to get established.

These trees also vary by size, allowing homeowners to plant trees best suited to their needs and home environment. CO_2 sequestration, oxygen (O_2) production, and other metrics identified in the following pages are specific to each species where such information was available. Generalized metrics on non-specific desert-adapted trees may be applied to all species.

CO_2 Sequestration

Carbon dioxide, or CO_2 is a greenhouse gas that has a huge negative impact on our environment, specifically through air pollution, which contributes to global climate change. Plants are a fantastic method of reducing CO_2 emissions because of their ability to photosynthesize, combining CO_2 with water and sunlight to grow. Removing carbon from the air is called *carbon sequestration*. But carbon sequestration does not stop at photosynthesis. Studies show that a tree's total carbon sequestration may even be up to three times larger because of the energy savings benefits of trees. This means that the shading and cooling a tree can decrease the need for air conditioning and avoid CO_2 emissions to begin with (Akbari H. , 2002).

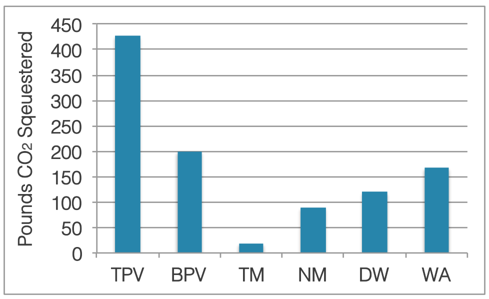


Figure 3. Species rate of sequestration per year

(Casey Trees & Davey Tree Expert Co.), (Davey Resource Group, 2014)

In 2012, city operations across Phoenix generated 629,504 metric tons of CO_2 (Walton Sustainability Solutions Services, 2013). From 2012 to 2015, VPA planted trees have sequestered 6,023 metric tons of CO_2, or nearly 1% of Phoenix yearly municipal emissions. Now that may not look like a lot, but keep in mind that Phoenix is the 6^{th} largest city in the country and VPA only has 2.5 full time equivalent staff members designated to the Shade Tree program.

But what does a metric ton even look like? A metric ton is approximately 2,204.6 pounds. Six-thousand twenty-three metric tons (or 13,278,132 pounds) is almost impossible to visualize and the average resident does not typically measure in tons. So let us shift this number into something most of us use, cars. The average car emits 9,737 pounds of CO_2 per year (EPA, 2008). Since 2012, VPA trees have sequestered 13,278,132 pounds of CO_2, enough to offset the annual emissions of 1,364 cars, valiantly fighting the valley's "brown cloud."

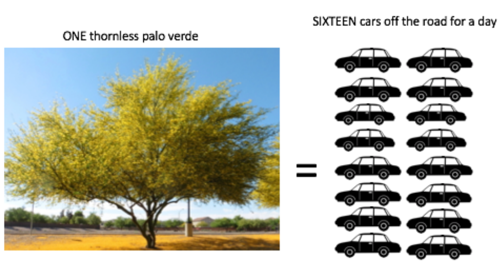
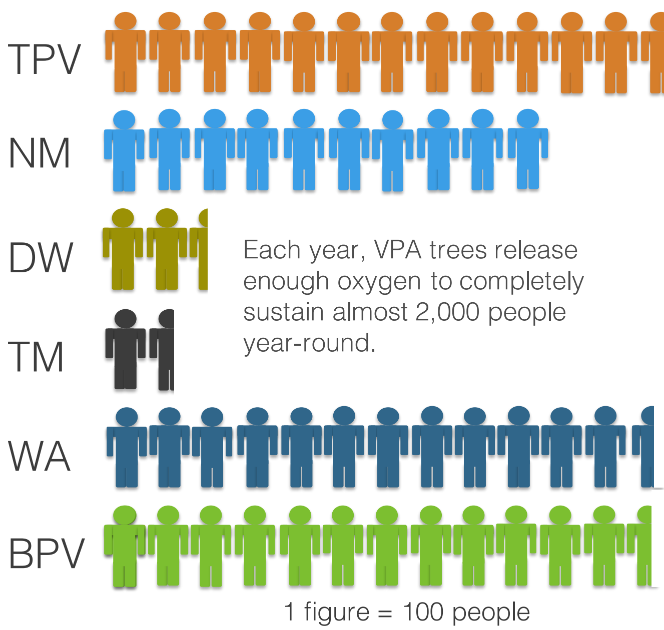


Figure 4. Thornless Palo Verde to Car CO2 Sequestration Equivalent

Planting a thornless palo verde takes as much carbon out of the atmosphere as taking sixteen cars off the road for a day.

O_2 Production

Oxygen (O_2) is a vital life-giving element, and trees produce it for free every day. By absorbing harmful CO_2 in the atmosphere and converting pollution into oxygen, trees improve local air quality. Reducing the negative effects of air pollution leads to a variety of community health improvements, especially reducing the severity of respiratory illnesses. For example, neighborhoods with tree-lined streets report lower rates of asthma among children than others (Lovasi, 2008).



An acre of tree canopy generates enough oxygen for 18 people (Evans, 2002). VPA trees cover almost 108 acres, providing oxygen for 1,944 people for one year.

Each tree produces about 260 pounds of oxygen per year, or 73 times the oxygen in a standard medical tank (McPherson, 2007).

Figure 5. Yearly oxygen production by species

Urban Heat Island Effect

Cities, especially high-density urban areas like Phoenix, are covered in concrete. Concrete and other building materials (i.e. steel, brick, etc.) retain heat from the sun and gradually release that heat during the day and into the night. When there is a high concentration of these materials, they cause temperatures to raise higher than in areas with greater amounts of exposed land and organic materials that absorb less heat. This is known as urban heat island (UHI) effect. In some climates, especially the colder ones, this can be a benefit during the winter. But here in the desert, a high UHI can be dangerous during the summer. In a hot environment where average summer days are 114°F, a high UHI effect actually increase the daily average temperature, further straining air conditioning (AC) costs and increasing energy consumption. Higher temperatures increase health risks as well, which can be as mild as heat rash or as extreme as heatstroke.

Trees have an opposite response to heat. Like any other organic plant material, trees are an excellent way to combat the UHI effect because they absorb heat, cooling their surrounding area. By shading building, streets, and sidewalks, tree absorb much of the heat those materials would have retained. By preventing paved surfaces from trapping heat, trees can reduce energy consumption indoors (AC) and decrease outside temperatures.

For example, look at the pictures to the right. The first picture is a satellite image of a segment of the ASU Tempe campus (Sun Devil Fitness Field [center], Hassayumpa Residence Hall [lower right]).

The second image is the same area, but taken with a thermal camera. The thermal spectrum indicates red to be hot, and blue to be cold. You will notice that the buildings and surrounding areas are colored in reds and yellow, indicating a increased temperature. But as you progress right, and the tree-lined field in the center appears in blue, indicating a cooler temperature by several degrees.

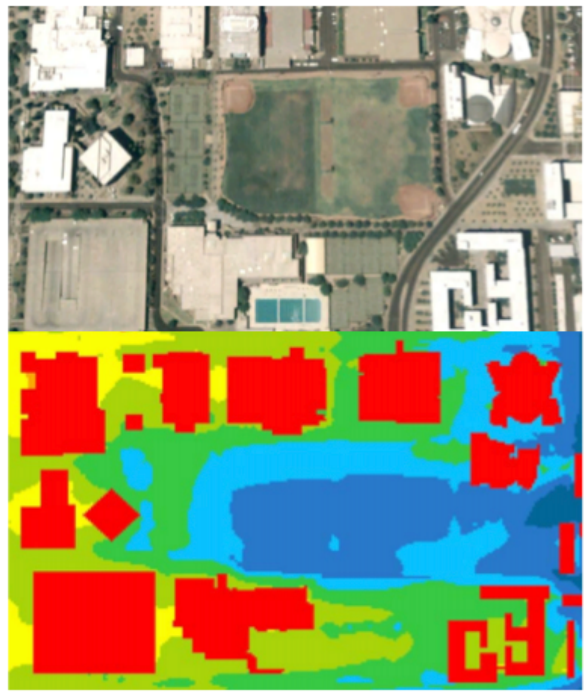


Figure 6. Satellite vs. thermal map of the ASU Tempe Campus

Trees placed around a building may lower temperatures on the lot by up to 5 °F, and increases in tree canopy on a larger scale (i.e. over several square miles) may reduce temperatures by more than 9 °F (McPherson, 2007). And as temperatures rise in urban heat island areas, energy use and smog can increase exponentially (Akbari H. P., 2001). Trees combat this problem by helping to decrease heat, reduce energy use, absorb pollutants, and releasing oxygen.

Shade Canopy Coverage

One of the most obvious benefits of trees is their shade (also known as canopy coverage). As a tree grows, the canopy grows as well, increasing the tree's other benefits (i.e. cooling, air purification, walkability). In this report, leaf surface area (LSA) is used to represent canopy coverage. Since the area of the leaf is close to the same as the area of the shadow it will cast, this measurement accurately conveys the amount of canopy coverage. Since 2012, VPA is proud to announce that our Shade Tree Program have given out 30,000 trees, equating to 347 acres of canopy coverage. That's about 263 football fields of shade!

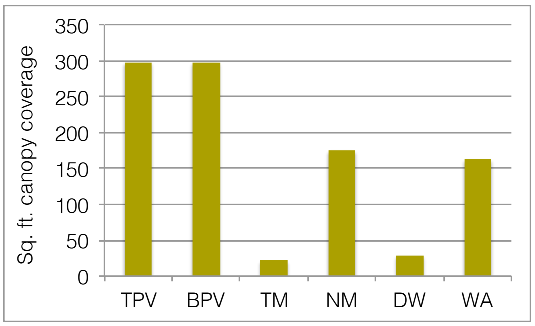


Figure 7. Canopy coverage added per year by species

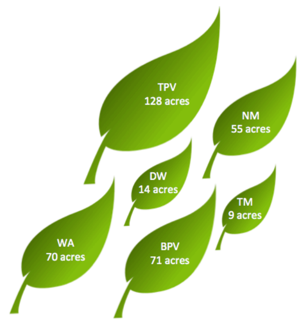


Figure 8. Acres of canopy coverage, separated by species

Land Value Increase

Planting trees is an excellent way to increase property value. The value of single-family residential areas, commercial properties, and public spaces can increase when more trees are planted on site or nearby. Trees have been recognized as a major factor in determining property value for over a century (Figure Value of Trees, 1914), and a recent study shows that a 10% increase in tree cover within 100 meters of a home increases the value of the home by $1,371 (Sander, 2010). VPA trees alone have influenced $1,992,535 in property value increases since 2012. As trees grow each year, so too does the value of the property. The data below represent yearly addition to property value for a relatively young tree; these numbers will grow as the trees mature.

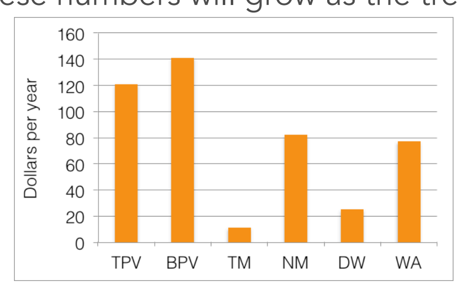


Figure 9. Yearly property value increases by species

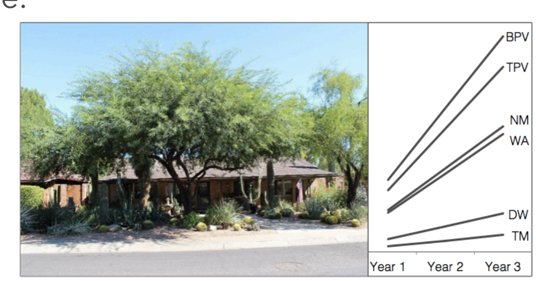


Figure 10. Three-year property value change by species

Water Consumption

Every shade tree distributed in the VPA program is categorized as a very low water (AMWUA, 2015) tree, or desert-adapted. These trees need no more than approximately 7 inches of water per square foot of canopy cover (Wadsworth, 2014). When trees are first planted, they need the more water to establish themselves. But the great part about desert-adapted trees is that they establish much faster than other trees. Once they are established, these trees require little to no additional water from the homeowner. With that being said, many owners needlessly over-water their trees.

The values below represent the total water consumption by each species over one year including when it rains.

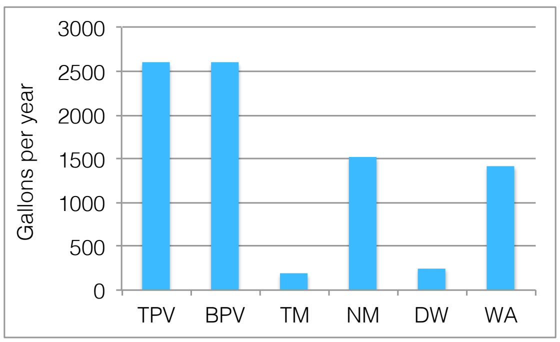


Figure 11. Water consumption per year by species

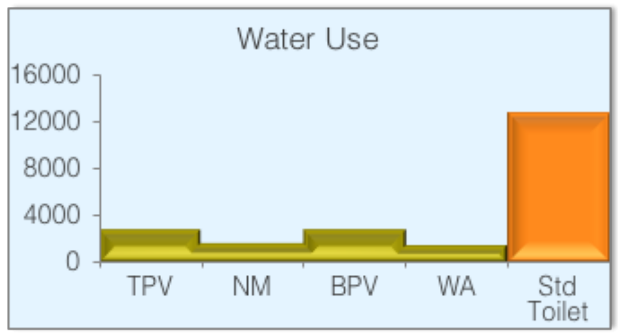


Figure 12. Shade tree vs. standard toilet water use comparison

Did you know a standard toilet uses vastly much more water than an established desert-adapted tree? Using an older, low-efficiency toilet (indicated with the color orange in Fig. 10 above), a person is likely to use 12,775 gallons per year on flushes alone (Regional Water Providers Consortium, 2015). By switching to a high efficiency toilet, you can save about 10,438 gallons per year. That is equivalent to half a standard swimming pool, which can completely sustain 1,416 established VPA trees for an entire year.

Cost of Water Consumption

The good thing about desert-adapted tree is, they won't cost homeowners a much in water use once they are established. But what about when the tree is getting established? Water bills can be expensive--leaky faucets and broken pipes can cause monthly costs to skyrocket, and filling a pool will show up on the bill for sure. However, desert-adapted trees hardly cost anything at all. Although new trees need to be watered, they don't need much, and it is shockingly cheap. Desert-adapted trees are a much lower-cost and lowmaintenance landscaping solution, but are often over-watered well past becoming established.

The City of Phoenix has some of the lowest water prices in the country, charging $0.0034 per gallon. That is almost one quarter of a cent per gallon. Although this doesn't mean we should use lots of water simply because we can afford it, it does mean that very low water plants are a very inexpensive way during their establishment to cool and beautify your home. Once established, desert-adapted trees will get most of their water from rain and groundwater sources. But let's bring some perspective to what it would cost if a tree only received water from the homeowner.

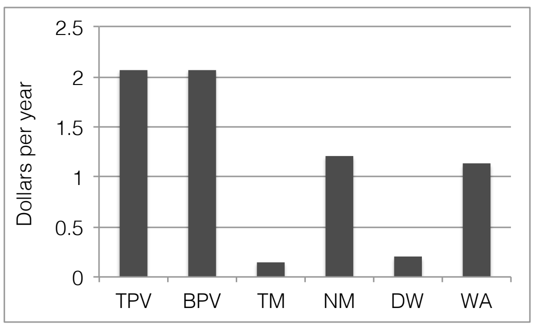


Figure 13. Cost of water use per year by species

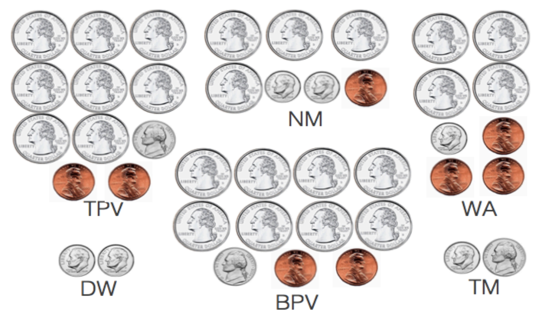


Figure 14. Water cost by species illustration

If homeowners were a tree's only source of water, VPA's most water-intensive tree [thornless palo verde (TPV) or blue palo verde (BPV)] would cost less a pack of gum to water a tree for an entire year. And VPA's most water efficient trees would cost about as much as a single stick of gum. You can buy all the water your desert-adapted tree could need with pocket change. Because of this, desert-adapted trees are one of the quickest payoffs and easiest to install investments you could possibly make for your home.

Household Energy Use Reduction/Stabilization

Especially in hot, sunny places like Phoenix, trees can provide much needed shade as well as lower energy costs. Strategically placing trees near the west side of buildings and around lots to block evening sun can reduce costs tremendously (FirstEnergy, 2011). In fact, the cooling benefits of trees could reduce the amount of energy used for air conditioning by up to 20% nationwide, saving more than $10 billion in energy costs and air quality (Akbari H. P., 2001; Akbari H. P., 2001). A staggering 5-10% of electricity use in urban areas is for cooling purposes, and shade trees are able to defray those costs as well as reduce the environmental impacts of energy production and delivery (Akbari H. P., 2001).

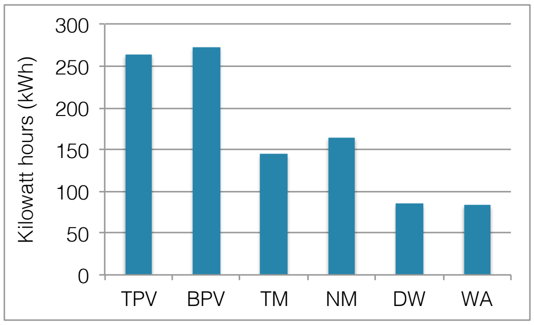


Figure 15. Yearly energy savings by species

Figure 16. Energy savings illustration

Desert adapted trees save enough energy to run household appliances for days at a time. Each year, VPA trees are projected to have helped saved a total of 4,590,679 kWh. That is a staggering $518,287.66 per year!

Impact

The VPA Shade Tree Program has made tremendous impact. From the millions of kilowatt-hours of energy saved to the nearly $2 million in property value increases, VPA with the help of utility partners have made a positive change in thousands of homeowners across the valley. But it does not stop there. Trees are not only property assets, but community assets. Neighbors of proud new tree owners feel the presence from these tree's, enjoying the health benefits associated with air quality improvements and cooler temperatures that trees create. A new shade tree impacts every member of a household, their neighbors, and the community surrounding that one tree.

It is incredible what a little pocket change can do. VPA trees this year have helped save over half a million dollars in energy bills, taken almost 1,400 cars off the roads, and provided clean O_2 to 2,000 people. To date, 263 football fields worth of shade has been added across the valley, creating more walk-able, healthy communities.

We are proud to that so many valley residents have joined us on our mission. VPA is transforming greater Phoenix into a cooler, more beautiful city with cleaner air and lower energy costs. We have found significant success through our Shade Tree Program and plan to continue adding value and providing environmental benefits to Phoenix communities into the future.

This is why trees are important. This is why trees are vital members of our community.

This is why trees matter.

Acknowledgements

Kendon Jung — Principle Investigator
Strategic Initiatives Coordinator
Valley Permaculture Alliance

Michaela Jones — Contributing Editor
Impact Intern
Valley Permaculture Alliance

Aimee Williamson — Authority Reference
Tree Program Director
Valley Permaculture Alliance

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- TM image: http://borregospringsliving.blogspot.com/2013/07/growing-shade-chilean-thornless.html

Appendix: Maps

Tree Map by Year

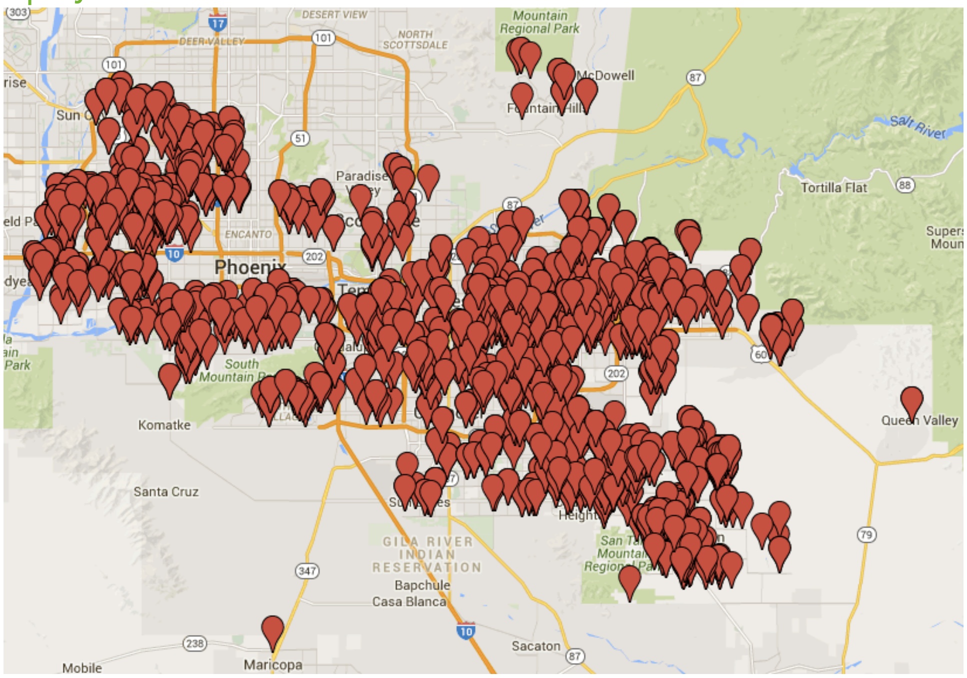

Figure A-1: Trees planted in 2015.

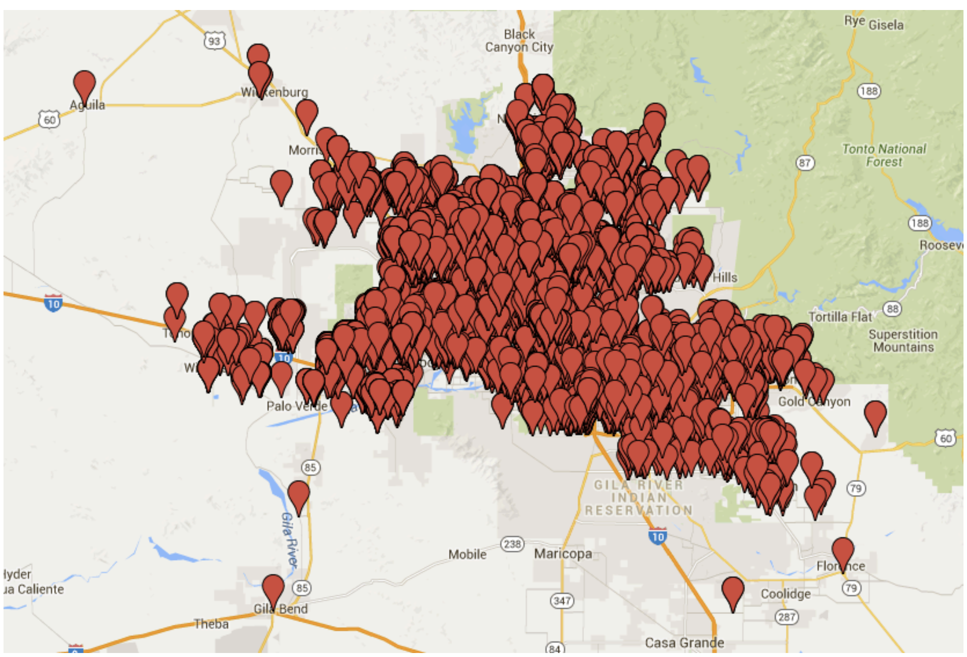

Figure A-2: Trees planted in 2014.

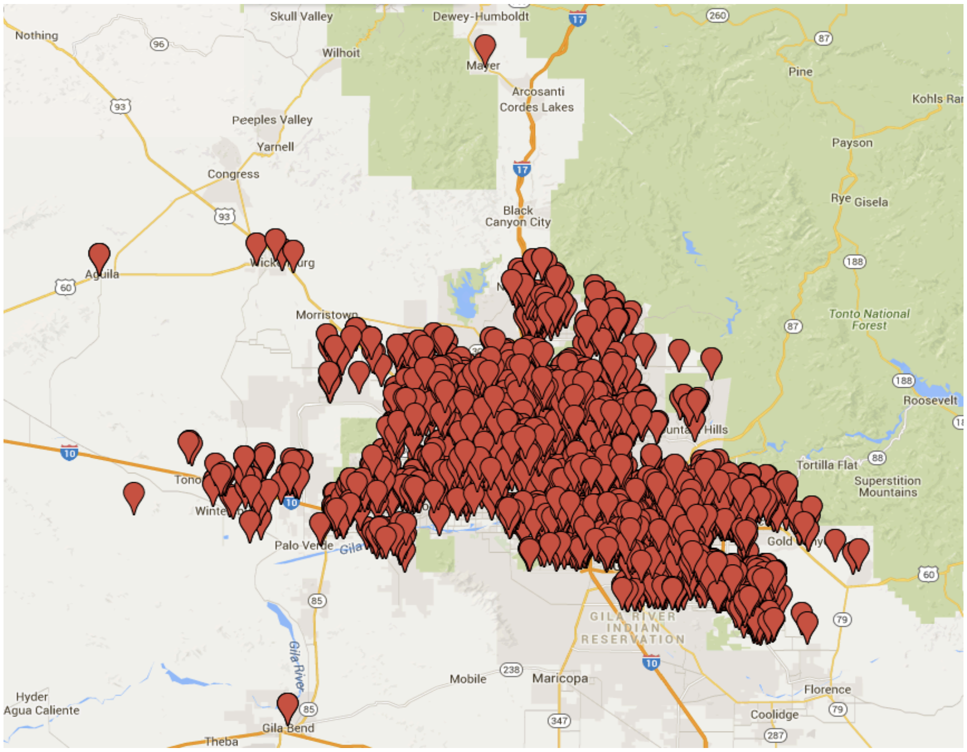

Figure A-3: Trees planted in 2013.

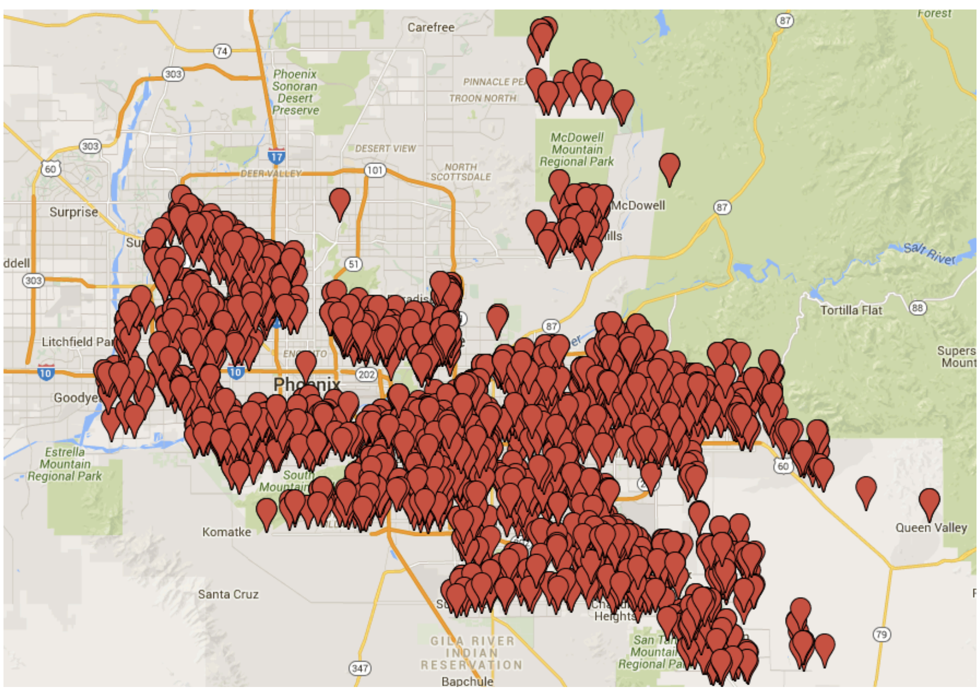

Figure A-4: Trees planted in 2012.

By Utility

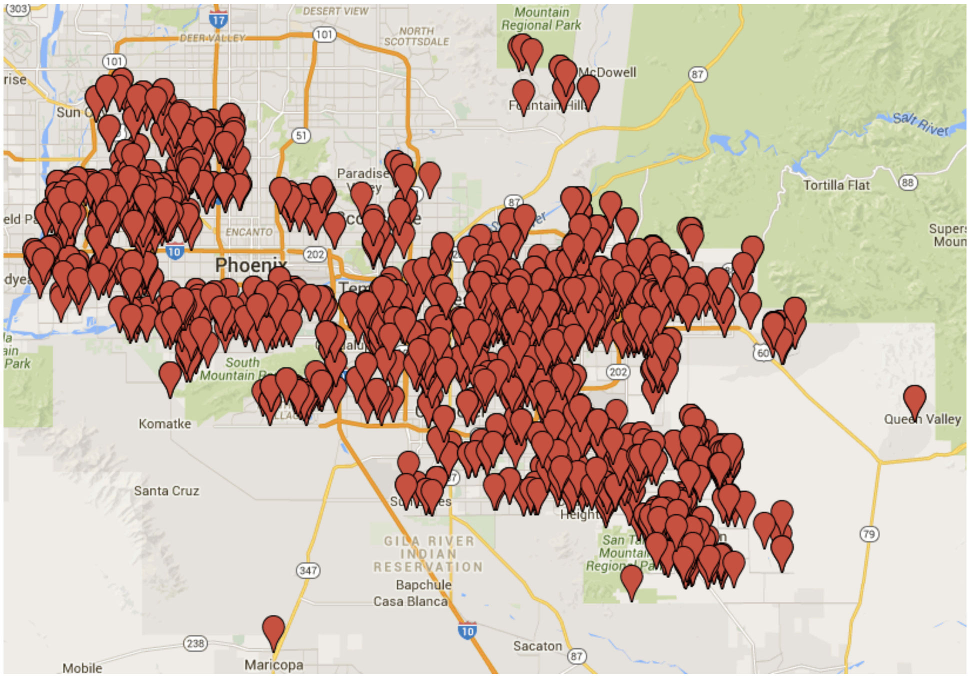

Figure A-5: Trees planted in 2015 (only SRP)

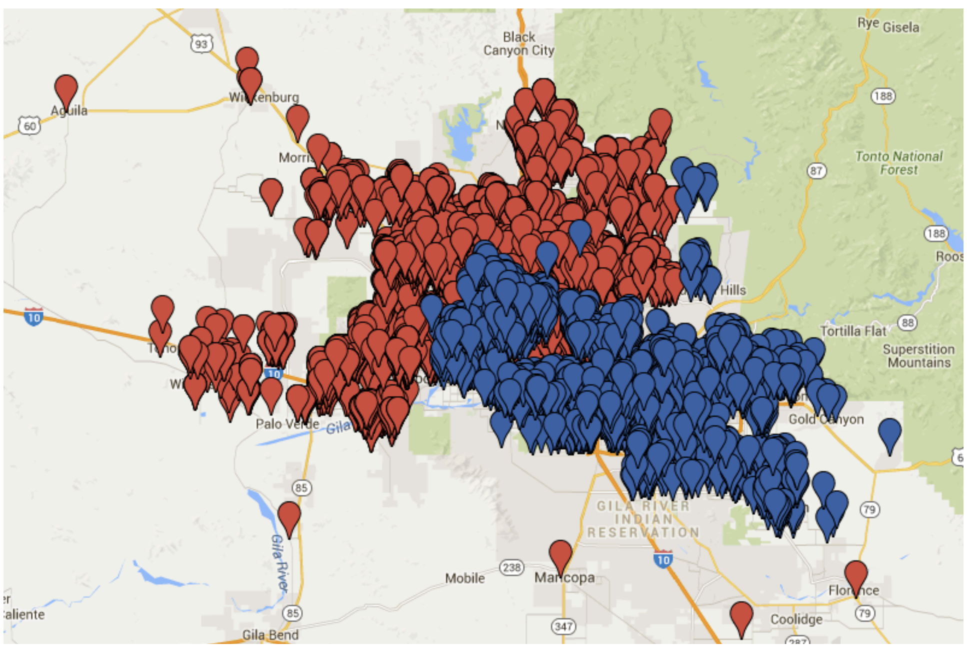

Figure A-6: Trees planted in 2014 (APS in red, SRP in blue)

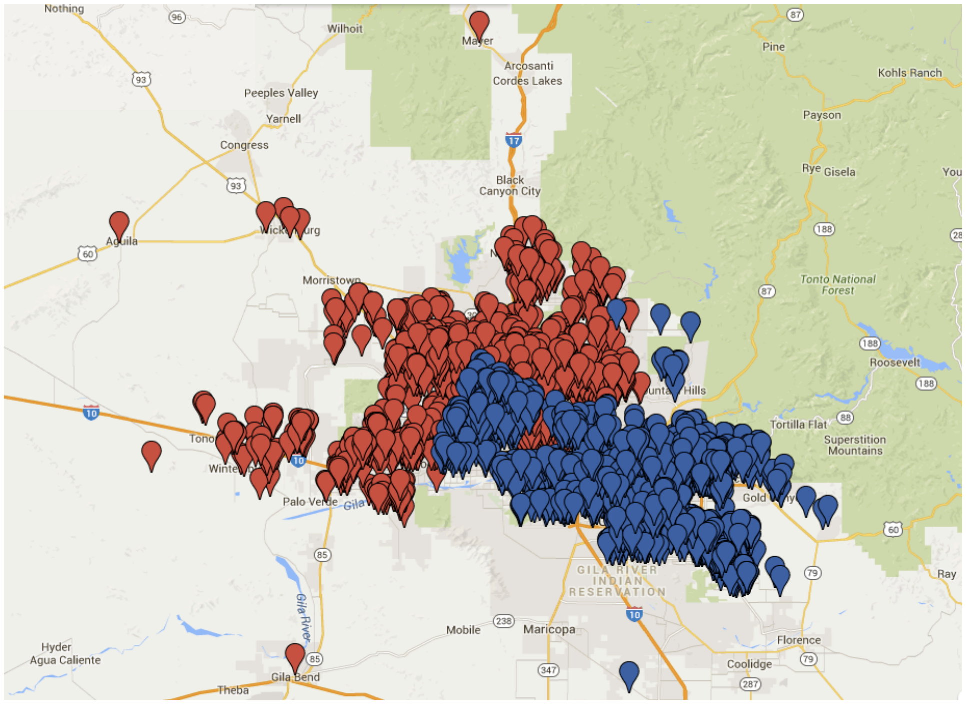

Figure A-7: Trees planted in 2013 (APS in red, SRP in blue)

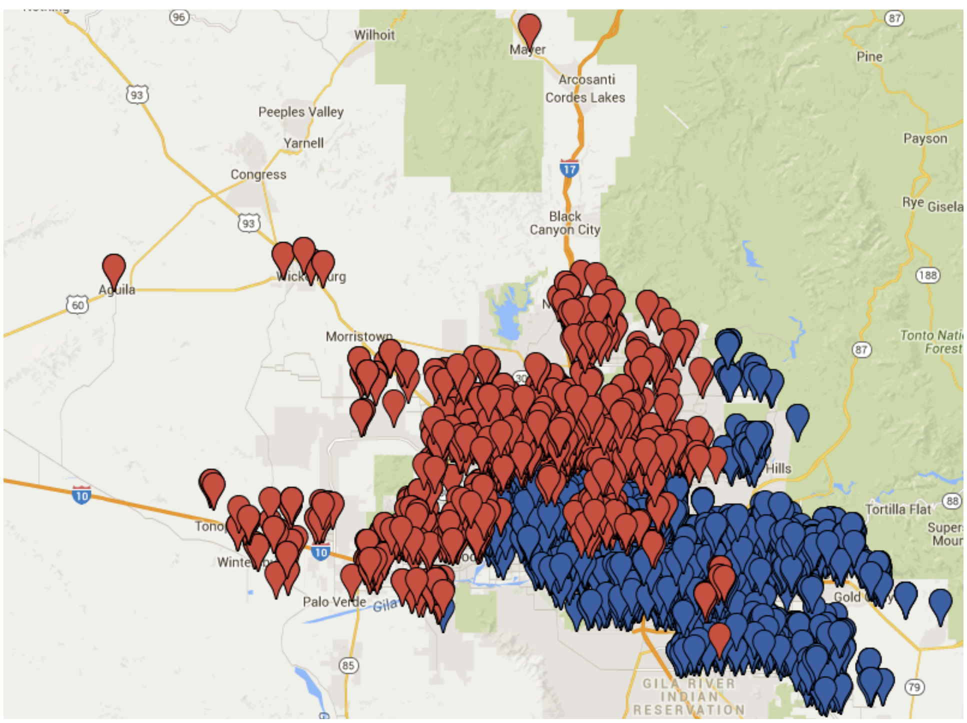

Figure A-8: Trees planted in 2012 (APS in red, SRP in blue)

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