Community Impact on Urban Forestry in Tree San Diego

Matthew Gonzalez

ABSTRACT

Conservation nonprofit organizations often interact with communities, but in the case of nonprofits such as Tree San Diego, this relationship is one of mutual reliance. However, the extent and consequences of this reliance is still in question. By utilizing social media analytical data and physical indexing and growth measurements, the interdependence of Tree San Diego and its community have been analyzed. Observations insist that community is integral to the success of the organization, as well as local urban forests. Specifically, community-centric digital outreach and consistent watering and maintenance serve to enable the nonprofit to function, and community trees to thrive. Considering this community-organization relationship is essential to the San Diego conservation effort, as well as for individuals and their neighborhoods.

1. INTRODUCTION

Urban forestry is a field as essential as it is under-represented and researched. Benefits range from environmental, curbing the Urban Heat Island Effect and increasing habitats, to aesthetic, psychological, historical, and even cultural [1,2]. The need for urban trees has a paradoxically inverse relationship with increasing urbanization; while essential to the wellbeing

of cities observing population growth and weather fluctuations, these trees are found increasingly difficult to place in the modern world [3].

San Diego experiences a dynamic balance between urban centers and a biodiverse natural coast, and marks a forerunner in green leadership, both publicly and privately. Consideration of the region's urban forest is necessary and practical. For instance, windbreak tree formations offer inherent protection from natural hazards to coastal homes [4]. Identifying needs, shortcomings, and solutions specific to the region require diligence from organizations based on conservation, and more specifically, urban forestry.

Tree San Diego (TSD) is a 501c3 non-profit organization which develops projects focused on urban forestry, serving the San Diego community and partnering with other prevalent organizations in the field. Project topics include community outreach and education, as well as tree distribution and maintenance. Their motto, "The right tree, the right place, the right care" highlights the components necessary to succeed in their mission, although following this ideal is not met without difficulties. "The right tree" signifies the need to consider what trees are appropriate for conditions like drought tolerance and environmental differences, continued in the phrase "the right place," which emphasizes the decisions concerning suitability and nativity of a species in a region. "The right care" serves as a reminder to communities and the organization to continue to monitor, water, and maintain trees after planting them, so that they may live to adulthood. In combination, these pillars form the foundation of the TSD workflow.

To achieve their goals, TSD must overcome obstacles faced by creating and expanding urban canopy. Survival of trees is a priority, and is negatively impacted by the pavement surface temperature, increased pollution, competition for land use, diminishing ecological foundation, and overall lack of old-growth trees [4]. Additionally, urban soils are overall less suitable for

growth, enduring drought, saline conditions, over-compaction, and restricted root space due to pavement, which each constrict a tree's natural hydrologic process [3,5]. The difficulty of planting trees is minimal in comparison to that of maintaining them in a way that enables them to grow to maturity.

The solution to proper urban tree maintenance is continual and individualized to the trends and patterns of growth, in regards to both trees and cities. The growth of tree species is dependent on and limited by resource scarcity, competition with other species, and the non-linear pattern of growth due to internal and external disturbances [6]. External factors may include any combination of natural land cover replacement with man-made substitutes, increased environment temperatures, diminished air circulation via impermeable pavement, and alterations in soil moisture and nutrients [7,8]. These issues are not novel, given that since 1991, barren environments have undergone more than a doubling in urban regions [7], leaving action up to communities to support organizations such as TSD.

Communities alone create opportunities for TSD to thrive in their conservation efforts, and this organization relies more heavily on this support than others. The condition of a region's urban climate can either contribute to the increase or lapse of tree growth, as well as anthropogenic interventions [8]. The creation of an urban forest is only sustainable through the efforts of those designing it, where planning based on the amount of trees, budget, and function determine general outcomes [2]. Average low lifespans of urban trees will only improve by better placement, care, and involvement by the community [9], and the latter is the focus of this research.

To underline the impact of community on TSD's success, several projects I participated in as an intern will be reviewed, noting the commonality of community elements in each.

Projects I focused on include *Branch Out San Diego* (BOSD), a social outreach campaign with digital and physical presence, and *tree surveying* using TSD's "Tree Plotter" application.

The goal of BOSD is to deliver sapling trees, free of charge, to private properties, which differs from the general condition of the organization to provide for public property, potentially benefiting citizens and incentivizing them to participate directly. To receive a tree, participants exchange a watering agreement, and are encouraged to undergo TSD led tree stewardship training, which details tree care, facts, and tips by a certified arborist. Regions focused on by the organization are Disadvantaged Communities (DAC), being that there is a lower presence of green space in minority communities with social and economic hardships [10].

In regards to tree surveying, the objective is to provide accurate, current information on planted trees, which might reflect on the conditional differences of various San Diego communities. The survey site studied, zone A **(Fig. 1)**, is located in Encinitas, and includes 62 trees. Species present in this zone are 21 Australian Willow (*Geijera parviflora*), 11 Brisbane Box (*Lophostemon confertus*), and 30 Kurrajong (*Brachychiton populneus*) trees. The following sections of this paper will consider Branch Out San Diego and Tree Plotting projects of TSD separately as means of measuring the impact of community on the organization.

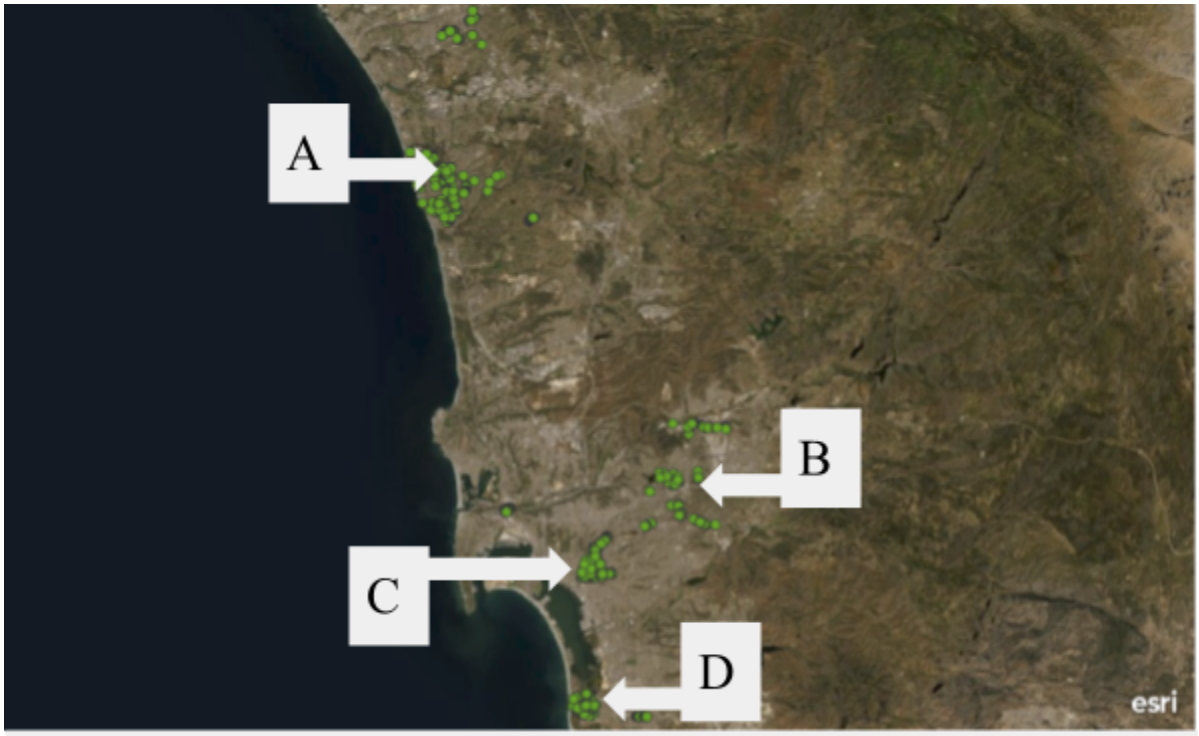


Figure 1. TSD Planting Sites. Green markers indicated placement of a tree. Letters A-D indicate survey zones. Zone regions: **A**. Encinitas, **B**. El Cajon, **C**. National City, **D**. Imperial Beach.

2. BRANCH OUT SAN DIEGO

2.1 Methods

Social media components of BOSD included creating and posting graphic and textual media for Twitter, Instagram, and Facebook. An example of a social media post created for the organization is visible below **(Fig. 2)**.

Figure 2. Sample twitter post for TSD.

To consider the effectiveness of the organization's social media presence, Twitter media data was taken and analyzed. Measured data includes: tweets published, impressions, engagements, engagement rate, retweets, replies, likes, user profile clicks, url clicks, detail expands, media views, and media engagements. Data is organized by date, and is color conditioned to highlight high (white) and low (green) numbers. Engagement is calculated by dividing total engagements (active interactions) by total impressions (passive viewings).

Physical components of the project include canvassing, flyering, and delivering trees to be planted. A sample of a door hanger I created is visible below **(Fig. 3).** The TSD survey zones **(Fig. 1)** highlight areas with planting sites created before the initiation of the BOSD project, but can still display trends of tree placement related to income of each region.

Figure 3. Sample door hanger for TSD.

2.2 Results

To measure the communal impact on BOSD, digital engagement and physical results will be considered. Of social media, the Twitter analytical data **(Fig. 4)** gives some indication of what posts and schedules are most algorithmically effective. From dates 04-03 to 04-05-2021, there are no new tweets published, which results in lower impressions—147 impressions for the 3rd, 28 for the 4th, and 41 for the 5th respectively. In contrast, the highest numbers regarding most data types was on 04-19-2021, with the maximum value of impressions, engagements, retweets, likes, user profile clicks, detail expands, media views, and media engagements.

Date	Tweets published	impressions	engagements	engagement rate
2021-04-01	1	120	0	0
2021-04-02	1	163	2	0.01226993865
2021-04-03	0	147	1	0.006802721088
2021-04-04	0	28	0	0
2021-04-05	0	41	0	0
2021-04-06	1	239	16	0.06694560669
2021-04-07	0	261	12	0.04597701149
2021-04-08	0	120	4	0.03333333333
2021-04-09	1	209	7	0.03349282297
2021-04-10	0	222	0	0
2021-04-11	0	158	0	0
2021-04-12	1	326	21	0.06441717791
2021-04-13	0	170	5	0.02941176471
2021-04-14	0	65	1	0.01538461538
2021-04-15	1	84	3	0.03571428571
2021-04-16	0	39	4	0.1025641026
2021-04-17	0	19	0	0
2021-04-18	0	61	0	0
2021-04-19	1	383	45	0.1174934726
2021-04-20	0	204	8	0.03921568627

2021-04-21	1	115	13	0.1130434783
2021-04-22	0	317	14	0.04416403785
2021-04-23	0	125	0	0
2021-04-24	0	45	4	0.08888888889
2021-04-25	0	14	0	0
2021-04-26	0	0	0	0

Figure 4. Twitter analytics dataset over the month of April, 2021. Temperature conditioned from lowest (green) to highest (white) values.

The 04-19-2021 post is displayed below **(Fig. 5)**, and focuses on a recent planting event of 350 trees alongside the Indigenous Regeneration group. This digital outreach resulted in higher data values than other posts, for instance **(Fig. 2)**, which might indicate the difference made from different posting topics.

Figure 5. A TSD Twitter post which had the highest engagement rate in the month measured.

The engagement rate data is the most direct analysis of this organization's online community involvement, and these data points are presented below **(Fig. 6)**. Impressions appear to have some causal relationship to engagements, where a greater proportion of impressions often leads to a greater proportion of engagements, clearly visible in the trendline of engagement rate. Also, it may be noted that there is no apparent minimum amount of impressions to result in engagements, for instance 04-16-2021, which had some engagements despite having one of the lowest impression counts. There is a possible correlation between impressions above 200-300, whose dates each have some of the highest engagement levels of the dataset.

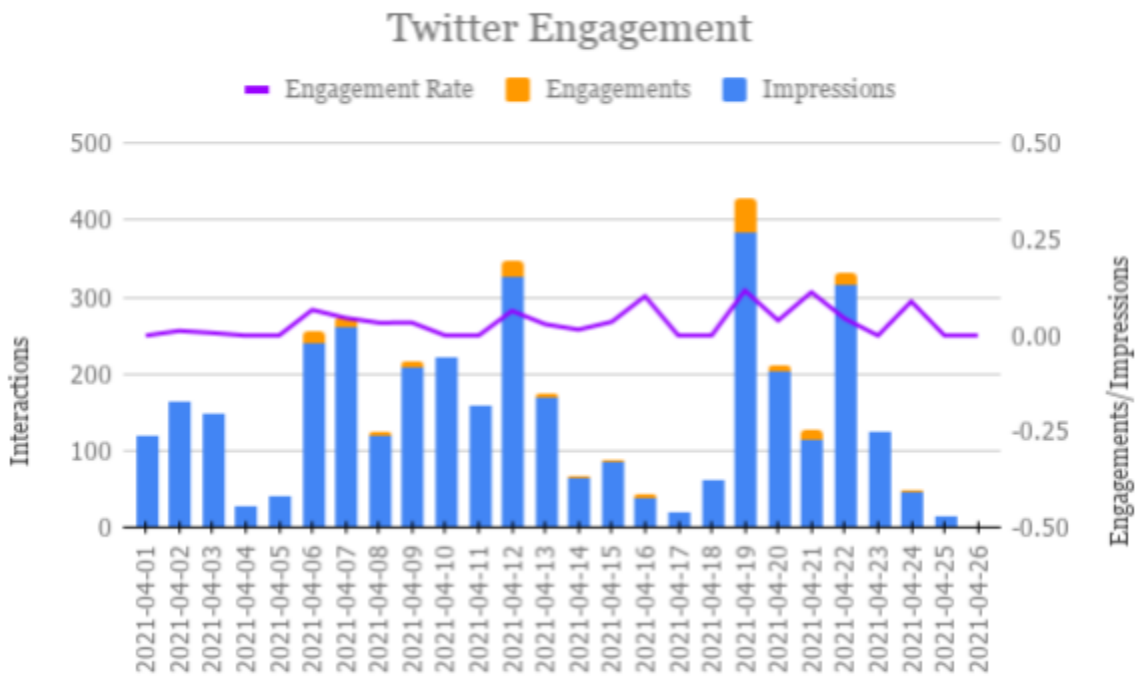


Figure 6. Twitter Analytical Data Stacked Bar and Line Graph. Number of impressions (blue) are compared over time, overlaid with engagements (orange) made from impressions. The engagement rate (purple) is plotted to generalize trends between posts.

For physical results, planting site placement is considered in relation to tree condition and regional income levels to discern community involvement and potential discrepancies. Because planting of BOSD trees is currently restricted, the entirety of TSD planting sites has been analyzed. Using ArcGIS software by ESRI, along with the 2010 Census Tract Data Feature Layer and tree spatial data from the Tree Plotter application, a map correlating TSD planting sites with regional income has been analyzed **(Fig. 7)**.

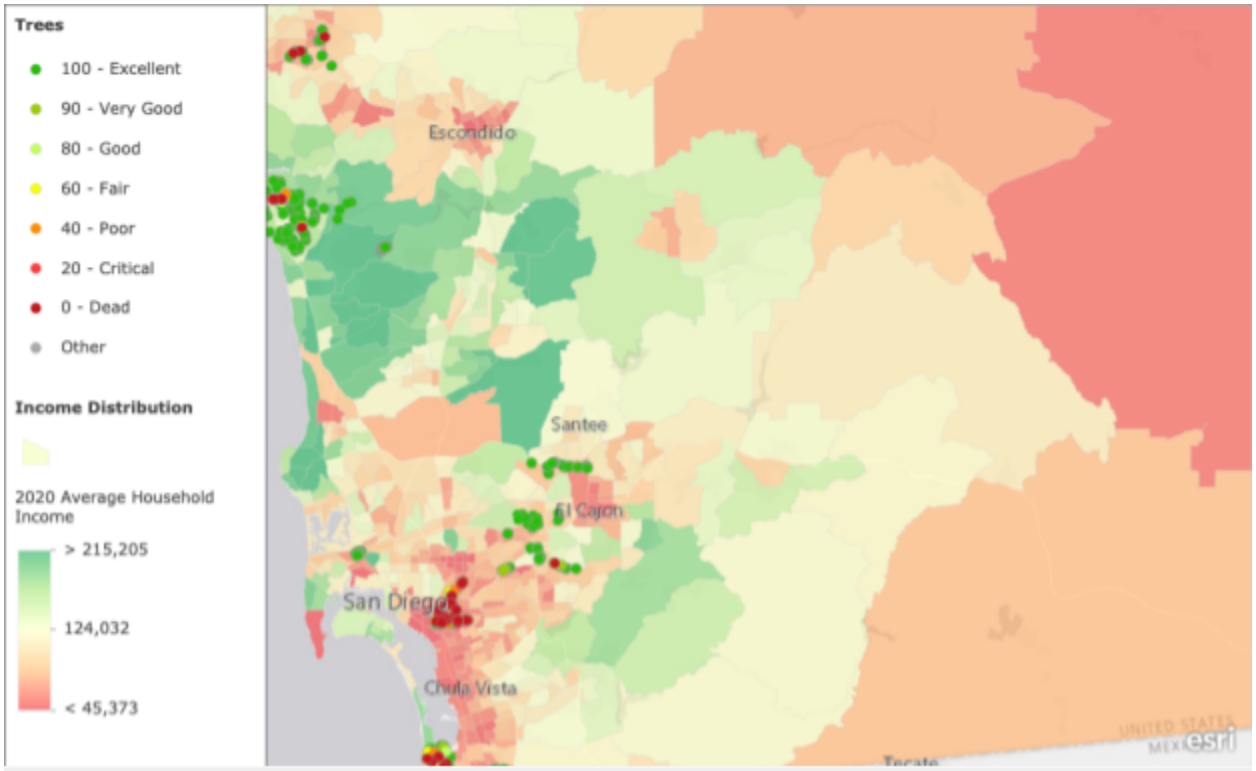


Figure 7. TSD Income Correlation Map. Tree marker colors indicate range of conditions from Excellent (Green) to Dead (Red). Tree markers overlay 2020 Census Average Household Income Distribution by region, ranging from high (green) to low (red).

Zone A, located in Encinitas, contains a majority of the highest income areas where trees have been planted by TSD. It also holds a large number of trees in excellent condition, along

with a small amount in poor or critical condition, or dead. Zone B, located in El Cajon, contains a range of income levels, both slightly above and below the midpoint of the region. The condition of these trees is also generally excellent, with a smaller number of trees total, as well as less in subpar conditions than zone A. Zone C, located in National City, has the lowest average household income, both among planting sites and the San Diego region overall. The condition of trees in this region ranges overall from poor to dead, with few in viable living conditions. Zone D, located at Imperial Beach, contains an income level somewhat below the midpoint, though above that of Zone C. The condition of these trees has a broad range, with many trees above and below fair conditions.

2.3 Discussion

In consideration of the above results, there are several stipulations to evaluate before drawing conclusions on Branch Out San Diego data. Regarding the Twitter data analysis, the only conclusive approach to gauge the entirety of the organization's social media presence would be to consider every platform for which they are present, and look from the first to most recent post in each. Because the only data available was for the most recent month, adequate scope cannot be determined for the impact social media communities have on the organization. This is why the focus is on the tangible results post-to-post, where some approaches quantitatively outperform others.

Secondly, there is a distinction that must be made between correlation and causation with provided income data. While one may convincingly connect different datasets by a number of commonalities, this does not prove unequivocally that there is a cause-effect relationship between the two. Given this caveat, there are reasonable bounds of likelihood which are noted, as

well as comments on any data that contradicts proposed correlation. For instance, the highest and lowest income areas received the highest and lowest condition rankings, respectively, yet the in-between income regions had concentrations of above and below average tree conditions. Efforts were made to minimize any discrepancies, but without strict, repeated laboratory experiments, results are based on qualitative observation.

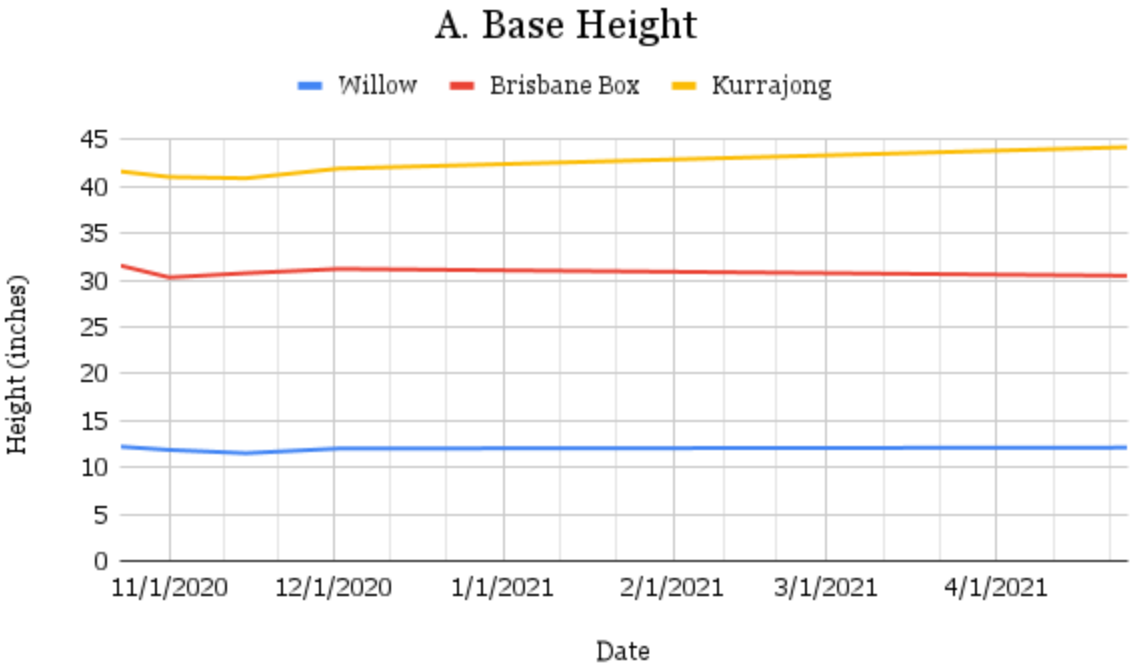
Overall, the Branch Out program was a large opportunity for TSD, founded on a $1 Million grant, which gave the organization a unique opportunity to reach communities which are generally underserved in their urban canopy. Outreach efforts are a primary step that act as a foundation for eventual tree planting and education workshops. The strength of this project is in its involvement with the community through private land, enabling a greater direct impact to those receiving trees.

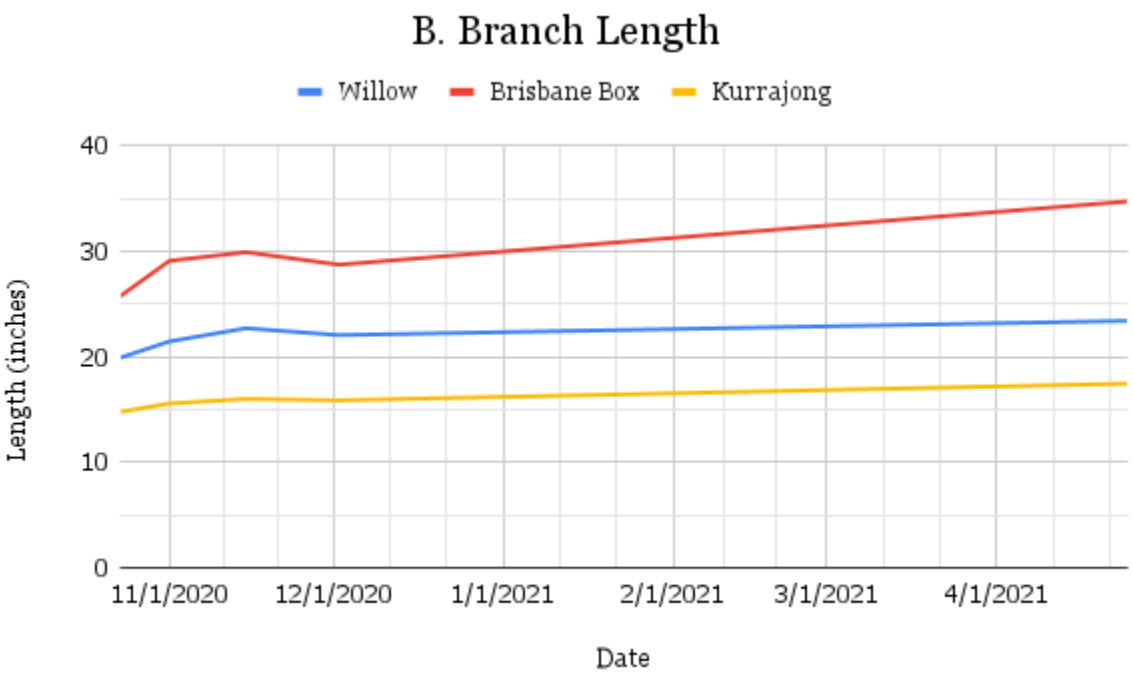
3. TREE PLOTTER

3.1 Methods

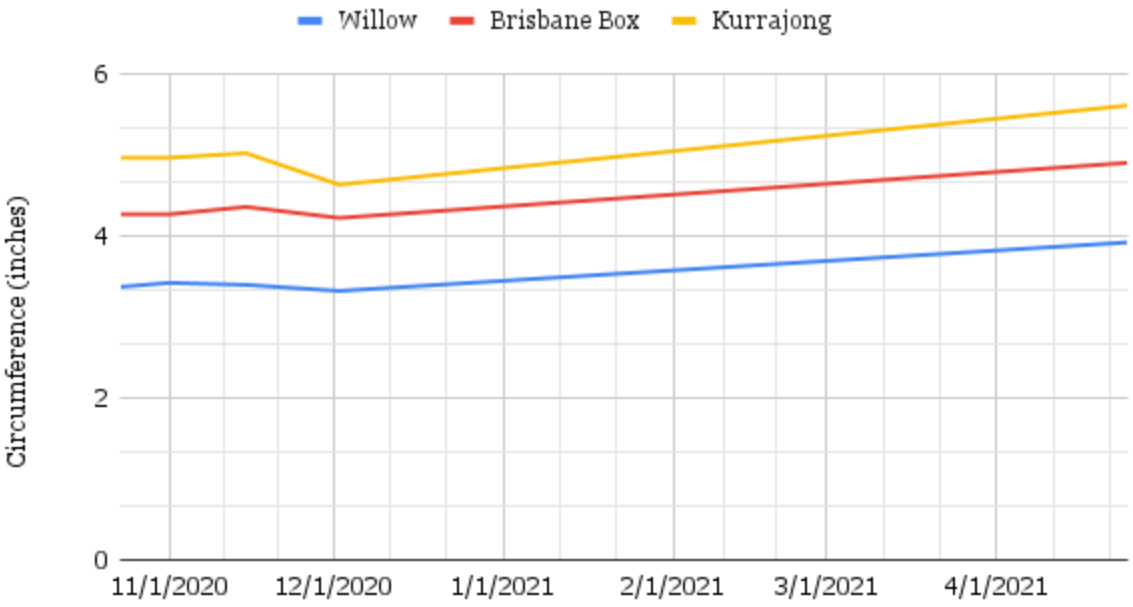
Indexing and gathering data on trees planted by TSD involved physical and digital data entry. A small group of interns would travel to a specific zone to plot trees. Photos, number labels, and comments regarding condition, soil moisture, and similar relevant data were submitted to the organization-run "Tree Plotter" application for later reference. Additional data includes sapling tree growth rates, along with an example of each measurement, using tree 517 from zone A **(Fig. 8)**, namely **A.** trunk base to lowest branch height, measured in inches, **B**. maximum branch length, measured in inches, **C.** trunk circumference, measured in inches and 8

inches above the ground, **D**. soil pH, and **E.** soil moisture. These measurements are used to consider the effectiveness of the organization's maintenance and observance of trees once planted. Tools used to measure include a tape measure, sewing tape, and 3-way soil meter, and are also shown below **(Fig. 9).**

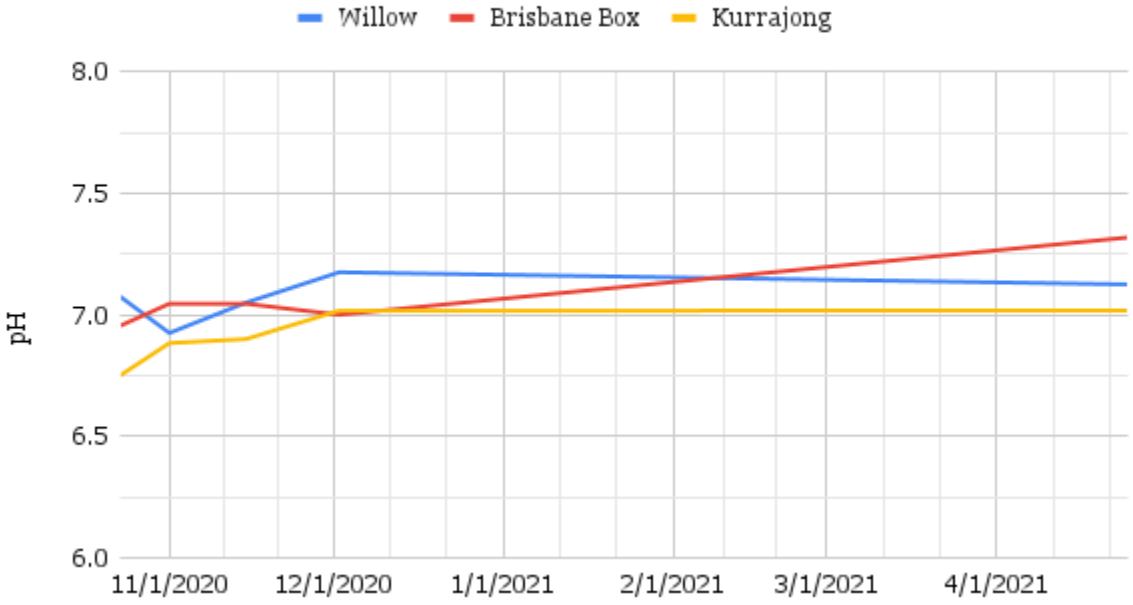

A. Base Height
Willow
Brisbane Box
Kurrajong
Height (inches)
45
40
35
30
25
20
15
10
5
0
11/1/2020
12/1/2020
1/1/2021
2/1/2021
3/1/2021
4/1/2021
Date

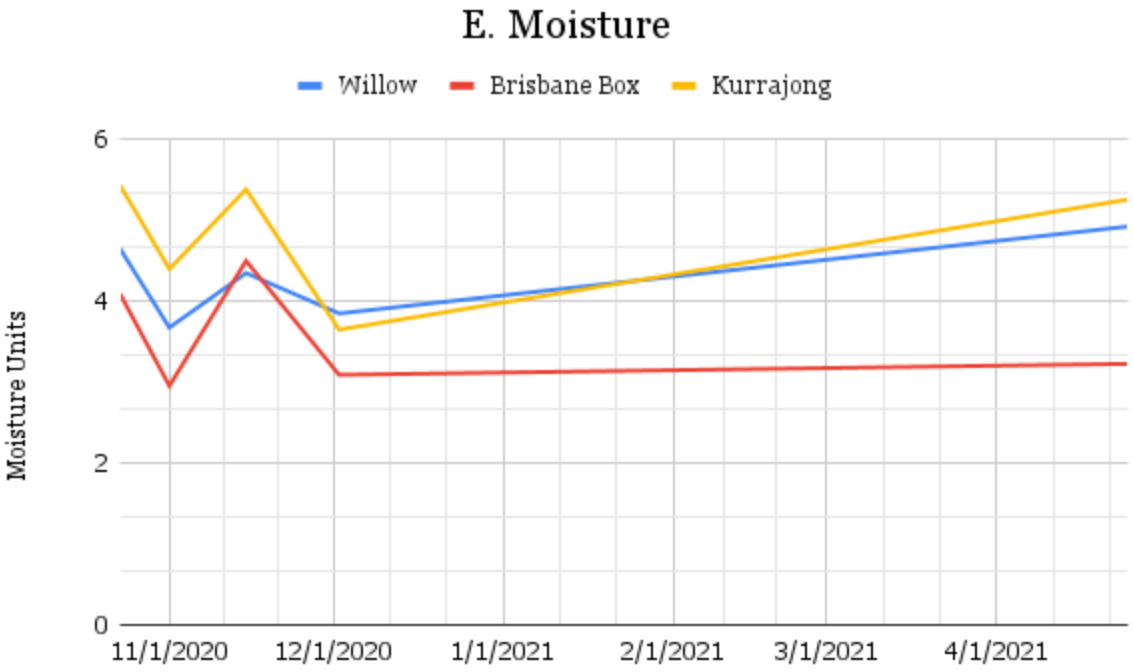

B. Branch Length
Willow
Brisbane Box
Kurrajong
Length (inches)
40
30
20
10
0
11/1/2020
12/1/2020
1/1/2021
2/1/2021
3/1/2021
4/1/2021
Date

C. Circumference



D. pH





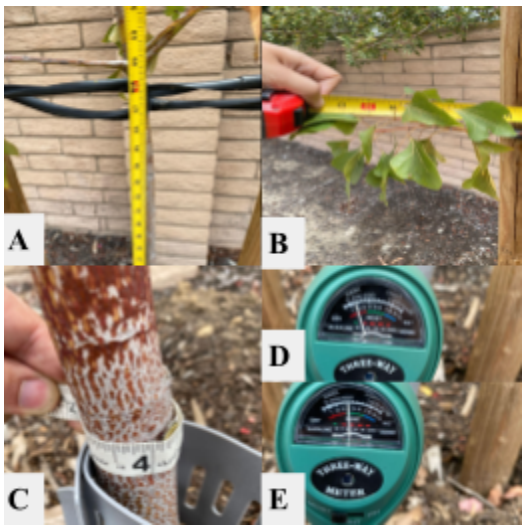


Figure 8. Tree Growth Measurements. Graphs display measurements over time of three measured species: Australian Willow (blue), Brisbane Box (red), and Kurrajong (Yellow). Measurements (y-axis) are as follows:
A. Base height from ground to lowest branch; **B**. Maximum Branch Length; **C**. Circumference at 8in. Height; **D**. Soil pH; **E**. Soil Moisture.

Figure 9. Tools used for data collection. (From left to right) 3-way soil meter, sewing tape, tape measure.

3.2 Results

Tree plotting enables physical analysis of planted trees within the community of zone A for this study, and how significant the actions of the community are on the results. Tree plotter data for this region gives the condition of each tree for zone A **(Fig. 10)**, which is largely excellent, except for a concentrated street length containing less than fair conditions.

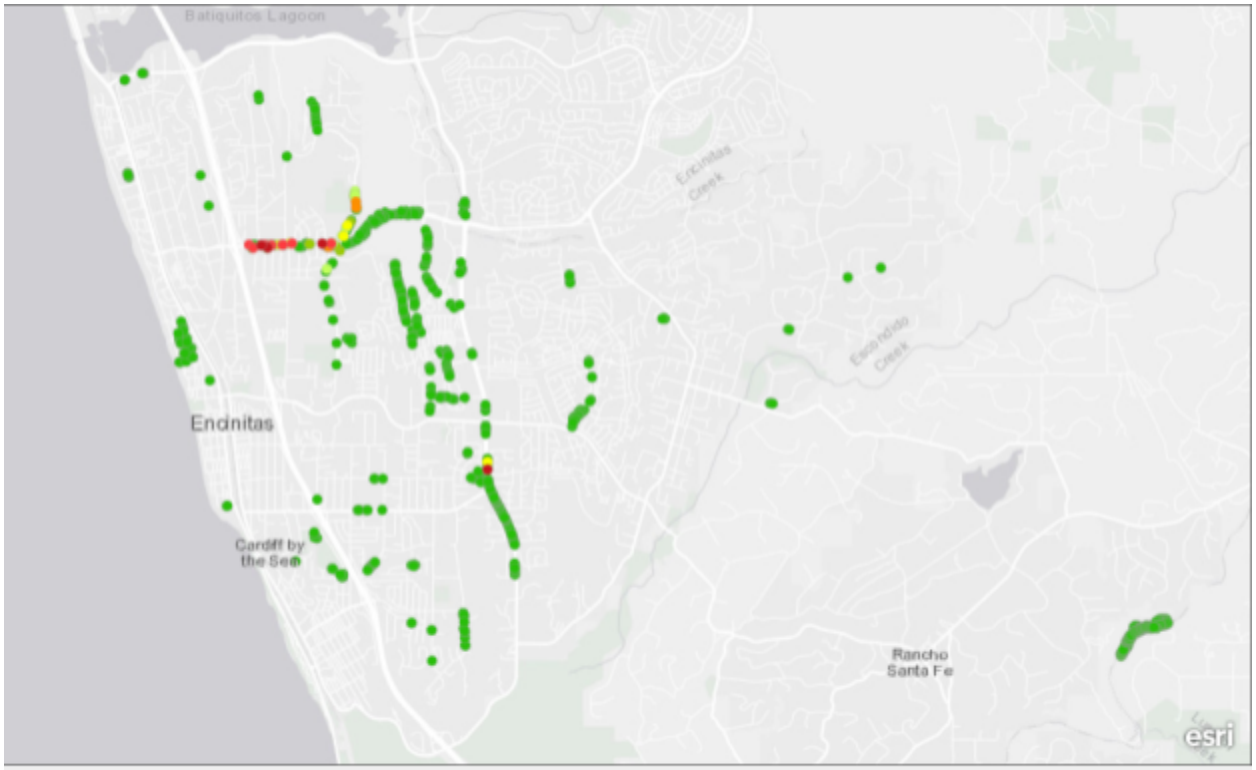


Figure 10. Tree Plotter Zone A (Encinitas) Map of Tree Conditions.

While indexing trees, common detriments to tree condition were visible, as pictured below **(Fig. 11)**. **A.** Disease and insect infestation were common occurrences, especially around other trees with similarly apparent diseases. The condition of trees with such diseases was generally lower than those without. **B.** Invasive weed species are potential dangers to planted trees, but given the small size and high frequency of them throughout the zone without noticeable differences, their effect on tree condition is likely negligible. **C. / D.** Examples of litter were present consistently within proximity of trees in the zone, to unknown impact. During tree indexing, the group of interns cleaned areas of litter, although by each new instance plotting, new litter would usually replace it.

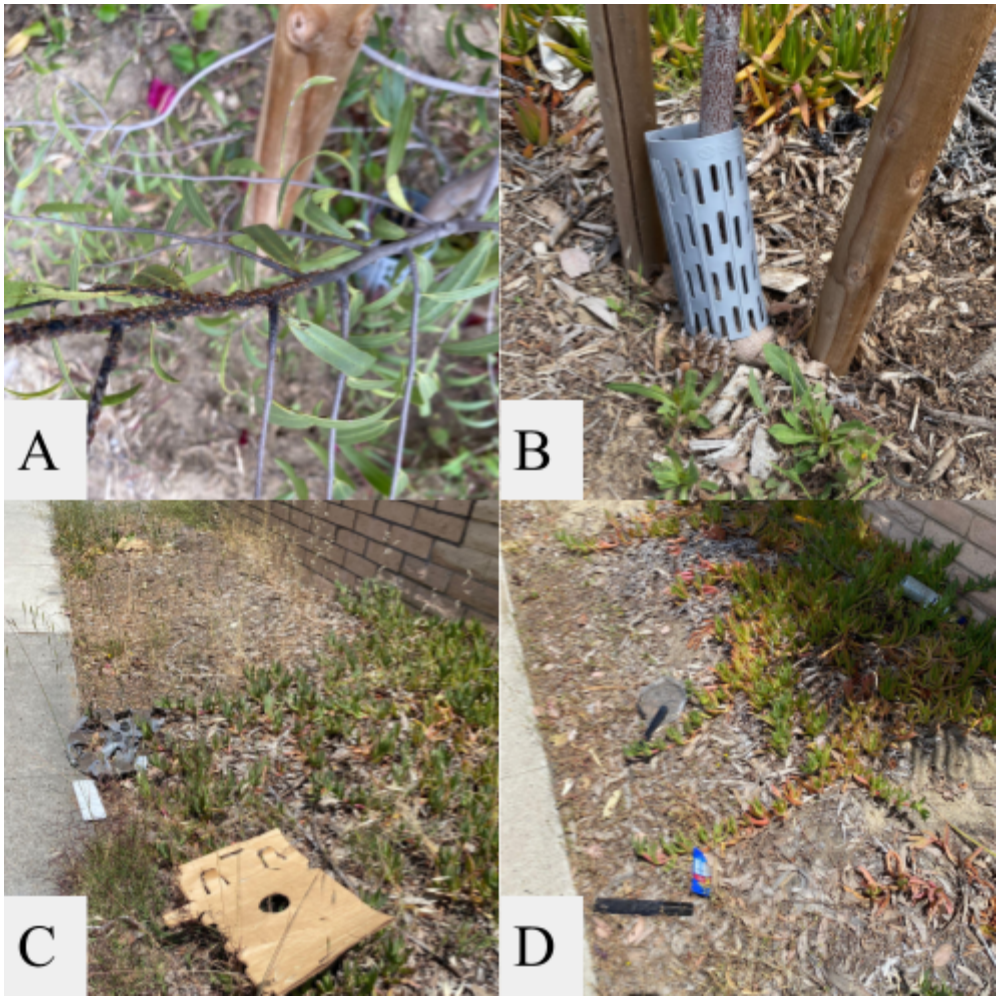


Figure 11. Inhibitors of tree growth. A. Disease and insect infestation. B. Invasive plants at roots. C. Litter. D. Litter.

3.3 Discussion

Tree plotting is a considerable factor in the TSD makeup, since every new planting project extends the range of trees to monitor, and its large impact parallels its need for scrutiny. The index data of trees was collected discontinuously, resulting in a time gap in Figure 4. Because the measurements are of growth, this is not an issue overall, because growth is a variable independent of consistent monitoring. An equation for growth rate based on this data

would be inadequate, however. Another factor of influence is the range of data: trees measured are from one of many sites, only observing three out of a multitude of species planted, and with imperfect methods of measurement. Human error is another consideration, given that different groups survey different regions, and may grade tree conditions differently, or may make input errors on the Tree Plotter app.

The importance of Tree Plotting for TSD is that once trees are planted, they are not without care. Planting is a costly, time-consuming endeavor, and is only worthwhile if the trees survive into adulthood. Visualizing tree growth and conditions ensures that maintenance is successful, which means less dead tree extraction and replanting over time. The Tree Plotter app is the greatest source of quantifiable data for the organization to share with the community, and because it is public it encourages feedback from citizens as well.

4. CONCLUSIONS

4.1 Branch Out San Diego

Outreach for BOSD generally coincides with community involvement. First, with social media, there is an outlying successful Twitter post within **Fig. 4**, which mentions a tangible impact on the community **(Fig. 5)**, suggesting that this content is the most consumed of the organization's. This is reinforced by the Twitter engagement data **(Fig. 6)**, which suggests a correlation between such content and algorithmic favorability. Another likely factor is the frequency of posts, which likely condition a positive feedback, gaining more exposure to further increase engagement.

Regarding the physical component of BOSD, community appears considerably important in the success of tree plantings. Additionally, the visible correlation between income and tree

condition **(Fig. 7)** reinforces the idea that DAC areas require attention, to keep trees alive rather than to just plant them. A specific region of note in Zone A **(Fig. 10)** highlights the need for communal cooperation with tree care, given that the entire zone has excellent tree conditions save for a particular street, which has far below average conditions, despite very high income overall.

4.2 Tree Plotter

Tree Plotting reveals some trends in tree conditions by location, as well as potential forces either caused or affected by community involvement. While plotting in Zone A, measurements of tree conditions were consistent in a given street or neighborhood, though not consistent from one area to another. This suggests a different level of success among various neighborhoods, the least successful of which either have not maintained TSD recommended caring agreements or recieved trees ill-suited to their region.

Considering the growth measurements of trees in zone A **(Fig. 8)**, there are consistencies between the data types measured, including an early drop in soil moisture readings, shortly followed by plateauing of base heights, branch lengths, and circumferences. This implies that soil moisture is a direct driver of tree growth, so much so that lower water might cause regression to conserve. The pH readings varied through each region, but were consistent among each species, suggesting tree type dictates soil pH values to some extent, or that different pH-bearing soils were distributed to different species. Between base height, branch length, and circumference, the latter two seem to be most indicative of growth rate, suggesting that these trees strengthen at a low height before vertically expanding. This data involves community effort, because soil moisture acted as the single-largest factor to successful growth, meaning that

for communities to receive and maintain healthy trees, they need to consistently water their plants.

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