Assessing the Relationship Between California Native Plants and Pollinator Abundance

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1. Abstract

Pollinators are declining globally, with one hypotheses pointing towards the loss of habitat as a leading cause. This study aims to understand how plants native to southern California can increase the diversity or abundance of pollinators in Los Angeles. 12 home gardens using exclusively native plants in Los Angeles were sampled for pollinators using pan traps. Each native garden was matched spatially with a non-native home garden, which was sampled similarly. Pollinator samples were tallied for each garden. Data which is statistically significant shows native gardens will support a larger diversity of bee species when compared to a non-native garden. Pollinator samples also show trends that native gardens support more honey bees and total bees; these trends are statistically insignificant however.

To understand why native plants are not used more in home gardens in Los Angeles, a survey was created. This survey was distributed to three populations, the general public, gardeners, and native gardeners. Data gained from this survey showed a lack of knowledge of native plants. Data obtained also showed there is a perceived additional cost to purchasing a native plant over a non-native plant; data also showed that many respondents believe it is difficult to obtain native plants in Los Angeles.

2. Introduction

Pollinators are crucial components of functioning ecosystems, and affect the livelihood of human beings by pollinating food crops globally. Pollinators are a prime example of ecosystem service providers. Estimates of the economic value of pollinators range from 163 billion to 221 billion dollars globally (Hanley, et al 2015; Gallai, et al 2009). It is critical, therefore, to understand what variables affect pollinator abundance and diversity.

While pollinators are crucial to human well-being, increasing amounts of studies are recognizing global decline of pollinators (Ghazoul 2005; Potts, et al 2010; Vanbergen 2013). The hypotheses behind the cause of global pollinator decline are wide ranged, and a consensus on the driving factors has not been reached in the scientific community. Some of the proposed hypotheses include decline due to habitat fragmentation, loss of native ecosystems, increased pesticide use, climate change, urbanization, and more (Ghazoul 2005; Potts, et al 2010; Vanbergen 2013).

In light of California's 6,500 native plant species (CA Department of Fish and Wildlife), we are choosing to focus on hypotheses that assess the relationship between native plants and pollinators. We aim to test whether native vegetation has an influence on pollinator abundance and diversity, and whether the loss of native vegetation impacts pollinator decline.

Pollinating insects may be influenced by native vegetation, because many pollinating insects have ecological niches with specific native plants. When these plants are removed and replaced with foreign vegetation, pollinators lose their ability to take advantage of pollen resources (Sardiñas & Kremen 2015; Holzshuh, et al 2016). Additionally, removing native

landscape may remove traditional nesting sites, and possibly increase competition among pollinator species (Winfree, et al 2009; Neame, et al 2013).

Supplementarily, we are interested in the motives behind native plant implementation in Los Angeles residences. Over the past decade, Los Angeles residents have been encouraged to turnover traditional lawn landscaping to California native gardens. The City of Los Angeles, nonprofits, and NGOs are providing rebates, grant funding, and educational resources to help locals use native plants in their landscape. We do not know if most Los Angeles residents know about these programs, or if they are interested in them. If, in our study, native plants have a statistically sound effect on pollinator distribution, then understanding people's perspectives of native plants is important.

While there are other hypothesis as to what is causing the decline of pollinator species, we chose to focus specifically on the influence of native plants species in the gardens of Los Angeles. For this we investigated: Can wider use of native plants boost pollinators populations in Southern California? This was tested with pan traps left at different locations across Los Angeles county. In order to understand the choices made when people choose the plants their gardens, we focused on the question: Why aren't native plants used more frequently in home gardens? This was investigated with our surveys that were done at the Theodore Payne Foundation, Home Depot, and local DMVs.

3. Methods

3.1 Pollinator Study

To test whether native plants support higher pollinator populations, 24 gardens around Los Angeles were sampled over two weekends in the month of April (Fig. 1). The 24 gardens were composed of 12 garden pairs that consisted of one native garden and one non-native garden match. The non-native garden match was selected to have a comparable number of floral resources to the native garden, and in close proximity to the native garden to control for variability in climate across Los Angeles. The farthest distance a non-native garden was located from its native pair was 0.53 miles.
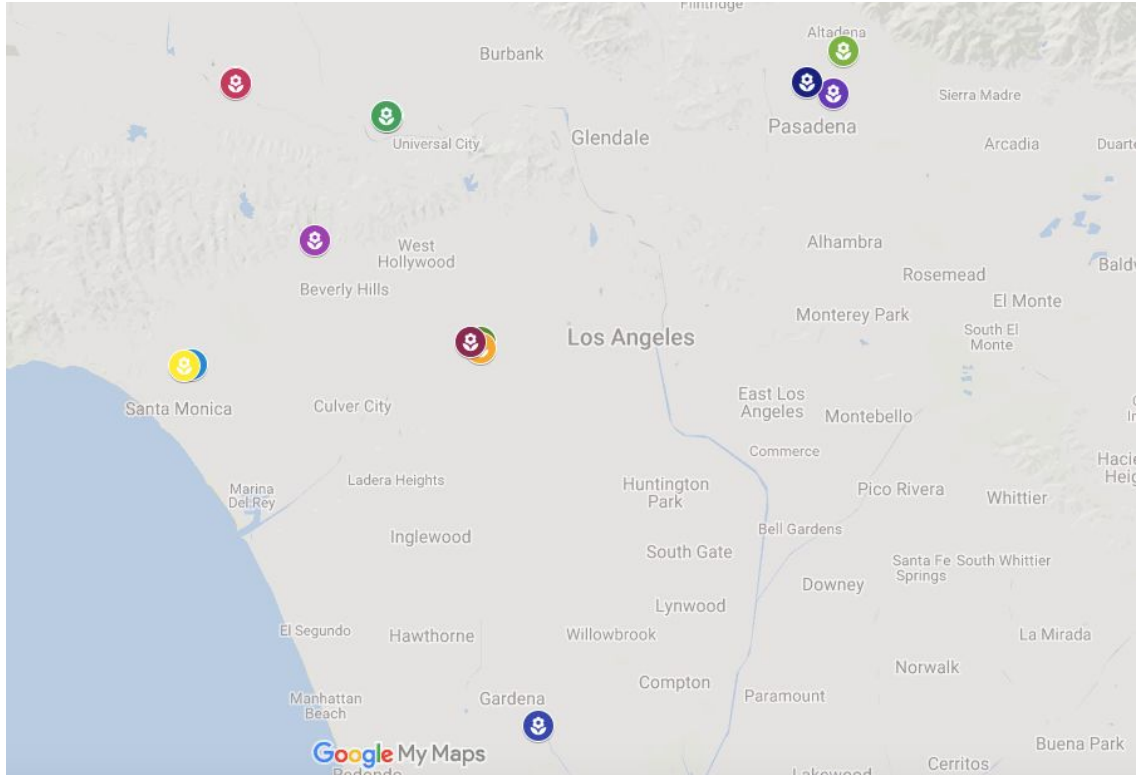
Fig. 1: Map of Los Angeles showing native and non-native garden pairs.

Sampling of the gardens was conducted by placing 10 pan traps in each garden for 24 hours. The pan traps, 12 oz. yellow plastic bowls, were filled with water and clear soap. The color of the bowls served to attract the pollinators, while the soapy water prevented the insects from escaping. The 10 pan traps were placed at ground level around each garden next to variety of to floral resources to maximize the number and diversity of pollinators collected (Fig. 2). Sampling took place over the weekends of April 21st and 22nd, and April 28th and 29th, 2018. During the two trials, the pan traps were set out on Saturday morning, and picked up 24 hours later on Sunday to capture pollinator activity throughout an entire day's cycle. Weather and temperature data were also noted. Sampling took place on warm, sunny days to capture high pollinator activity.

Fig. 2: Placement of pan traps in the field at ground level next to floral resources.

Pollinator samples were analyzed in the lab using a dissecting microscope. The samples were first sorted to only include Hymenoptera species. The samples were then further categorized into honey bee (*Apis mellifera*) and non-honey bee species by identifying morphological differences and referencing the Photographic Atlas of Entomology & Guide to Insect Identification (Castner, 2001). The number of honey bees, non-honey bees, total bees, and number of bee species per garden was recorded. For each of these four categories, a one-way analysis of variance was then conducted to measure the statistical significance of the differences found between native and non-native gardens.

3.2 Human Survey

To address our additional research question of why native plants aren't used more frequently in home gardens, a human survey was designed and distributed to three sample populations. The survey (Appendix Fig. 3) consisted of nine multiple choice questions that could be completed by respondents in two minutes or less. The survey included questions regarding demographics and aimed to understand the respondent's gardening habits, as well as their thoughts regarding native plants and pollinators. The surveys were distributed at three locations, the DMV, representing the general public, Home Depot Nurseries, representing gardeners, and the Theodore Payne Foundation, representing native gardeners. 44 surveys were collected at the DMV during weekdays, and 40 surveys at Home Depot, and 45 surveys at the Theodore Payne Foundation were collected on the weekends. Data collected from the survey was used to compare various categories of gardeners based on population.

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4. Results

4.1 Pollinator Study

Pollinator data collected from the pan traps show a consistent trend towards higher bee density and greater number of bee species in the native gardens compared to the non-native gardens (Fig. 4). Box and whisker plots were used to visualize the distribution of data collected from both native and non-native gardens. Four categories comparing native and non-native gardens were assessed; number of non-honey bees per garden, number of honey bees per garden, total bees (honey bees + non-honey bees) per garden, and number of bee species per garden.
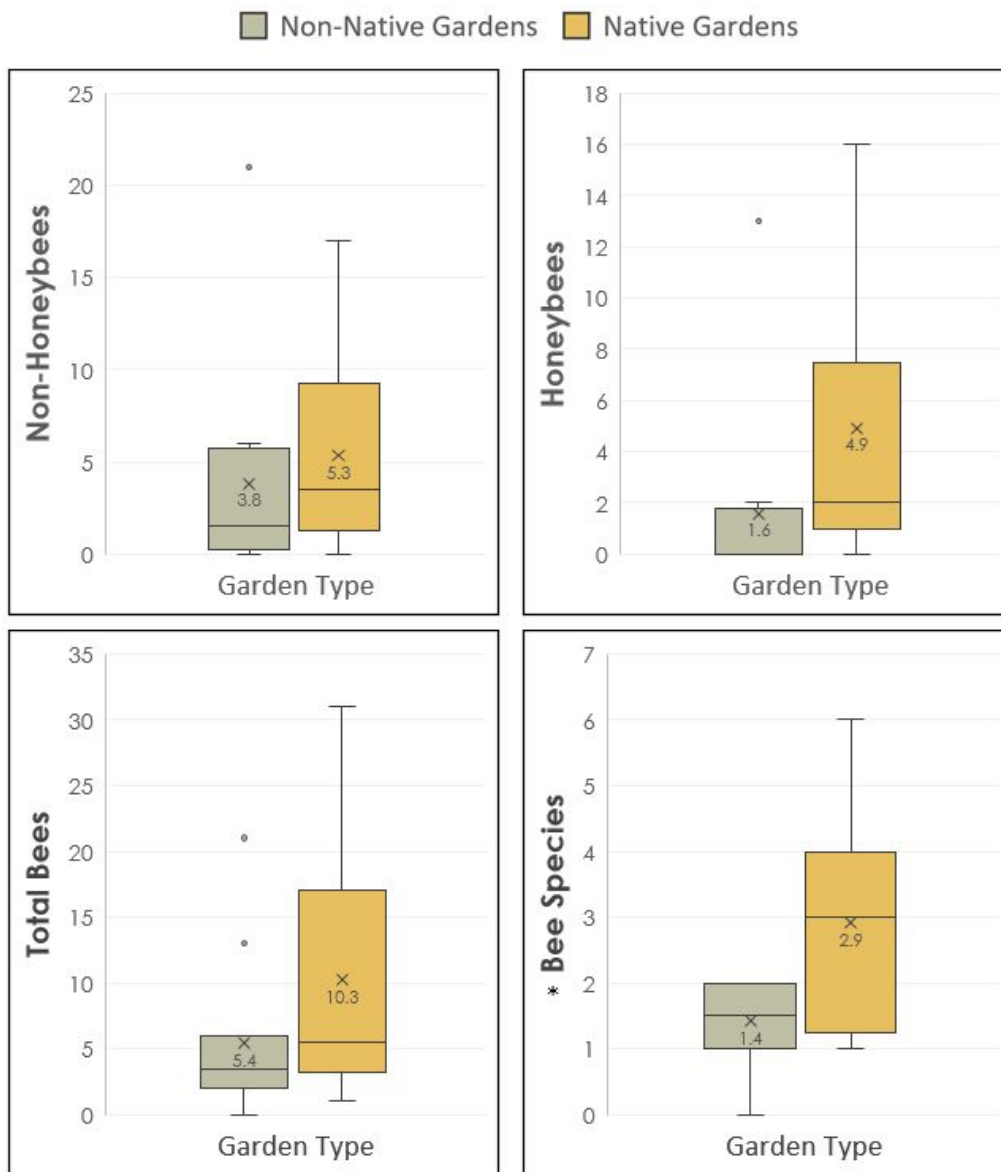

Fig. 4: Number of bees in native vs. non-native gardens. Non-Honey bees (P = 0.541), Honey bees (P = 0.089), Total bees (P = 0.150), Species (P = 0.007)

In each of the four categories, both the mean and median number of bees was higher in the native gardens compared to the non-native gardens. While the data trended towards native gardens supporting more pollinators, the only dataset that proved statistically significant was the number of bee species in native vs. non native gardens, with a p-value of 0.007. The number of non-honey bees per garden in native vs. nonnative gardens showed the least disparity, while the number of honey bees per garden showed most variance between native and non-native gardens. The average number of honey bees in native gardens was more than three times higher than in the non-native gardens. The total number of bees, and the number of bee species in native gardens both had a mean about double that of the non-native gardens. While the data trended towards native gardens hosting more bees, there was high variation between gardens of the same category. A larger sample size would be beneficial to fleshing out a statistically significant trend.

4.2 Human Survey

Our human survey revealed about 40% of the general population and about 47% of typical gardeners do not pay attention to whether a plant is native or not; only 5% of native gardeners responded the same (Fig. 4).
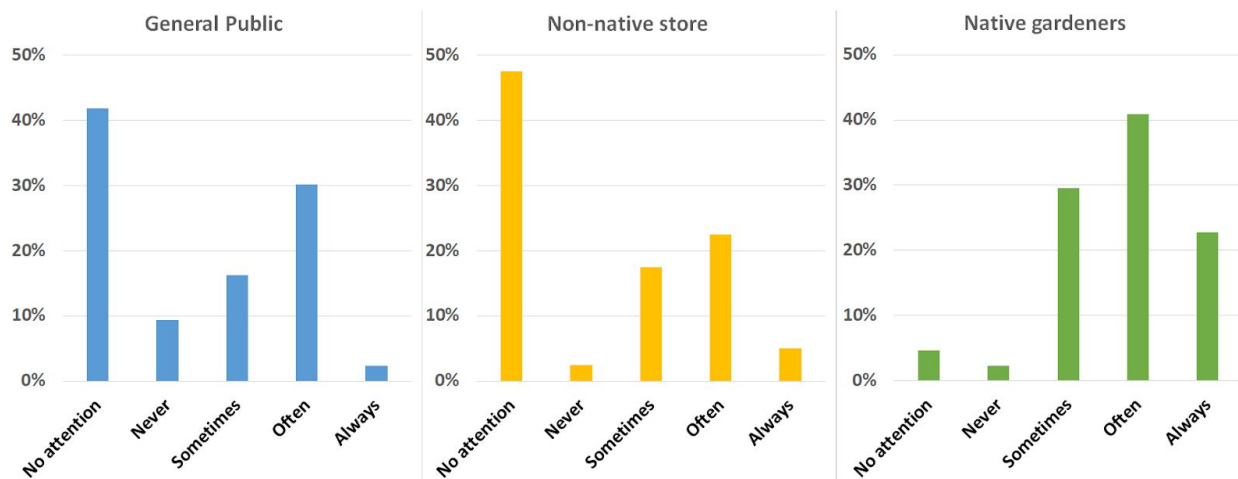

Fig. 5: Chart detailing responses given to how native plants are used by the individual, by population. ($x^2 = 32.368$; $p = 0.00008001$; degrees of freedom = 8)

Data comparing income ranges were compared with respondents who responded that they were willing to pay 10% more money to buy a native plant compared to a non-native plant. Fig. 5 shows a clear trend, correlating higher annual income levels to willingness to pay 10% more for a native plant.
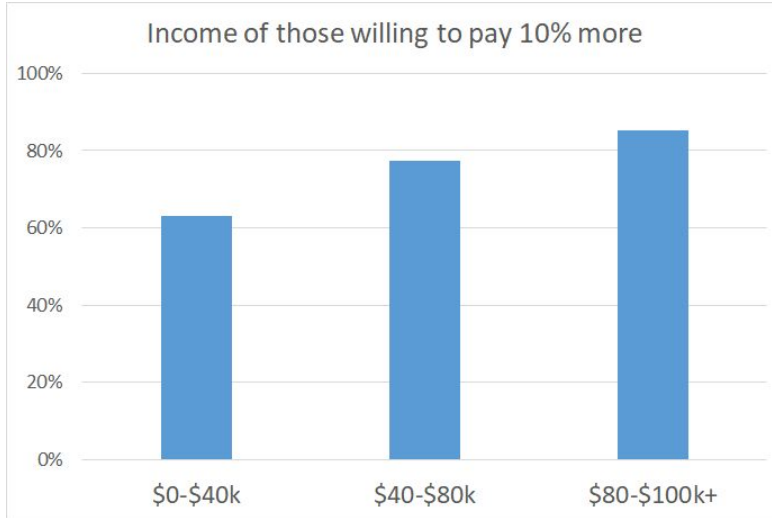
Fig. 6: Chart detailing the percent of respondents willing to pay 10% more for a native plant by income range.

Data for respondents gardening frequency was related to respondents who claimed obtaining a native plant in Los Angeles is difficult. Fig. 6 shows that about 20% of avid gardeners claim obtaining a native plant in Los Angeles is difficult. About 30% of frequent gardeners and about 35% of occasional gardeners responded the same.
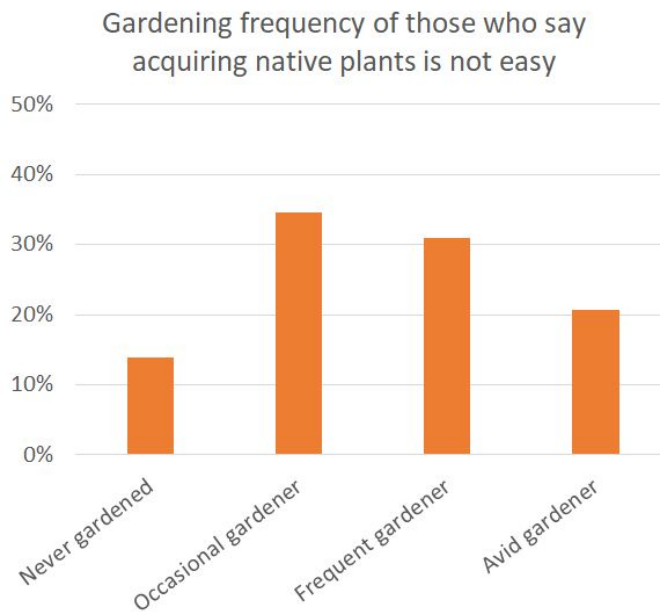

Fig. 7: Graph showing respondents who claimed obtaining a native plant in Los Angeles is difficult, based on gardening frequency.

5. Discussion

In response to our research question of whether wider use of native plants can boost pollinator populations in Southern California, the pan trap data we collected from 24 gardens around Los Angeles showed a clear trend towards native gardens supporting more bees than non-native gardens. Though the data trended towards native gardens boosting pollinator populations, the only statistically significant difference between native and non-native gardens was in respect to the number of bee species. We hypothesize that given a larger sample size, more statistically significant results could be obtained, given that there was high variability between gardens of the same classification of "native" or "non-native".

Improvements that could be made to future studies to reduce variability and strengthen results are a larger sample size, more rigorous matching criteria between native and non-native gardens, a longer sampling season, and placement of the pan traps at flower height. More rigorous pairing between native and non-native gardens could include vegetation transects of the gardens or data on the plant species diversity of the gardens to ensure garden pairs have similar availability of floral resources. Additionally, a longer sampling season would give more insight into any fluctuations in pollinator density and diversity between native and non-native gardens during different times of the year. Placement of pan traps above ground level would also elicit better results as bees reside at flower level.

Our initial results point toward the conclusion that wider use of native plants could potentially help support bee populations in Los Angeles. These preliminary results are important for both homeowners and policy makers in the region. If more homeowners were made aware that their yard could be more than ornamental, but a dynamic habitat that supports declining species, perhaps native gardens could become the norm instead of the exception in Los Angeles. It is through organizations like the Theodore Payne Foundation who work to promote native landscaping and make native plants available to the public, that native plant landscaping could be a mainstream practice in the future. The conclusions of our data point toward native plants supporting bee populations, however the research needs to be both strengthened and effectively communicated to the public in order to tip the scales to favor the use of native plants.

Our human survey data show that the major reason native plants are not used more in Los Angeles is due to two factors: a perceived increase in cost of obtaining a native plant and a perceived difficulty in obtaining a native plant in Los Angeles. Respondents were willing to pay 10% more for a native plant more frequently when their annual household income was high. Interestingly, the respondents gardening frequency did not determine their willingness to pay 10% more for a native plant; people who responded that they never garden were just as likely to be willing to pay more for a native plant than those people who responded they are avid gardeners. This may be because those who never garden are unfamiliar with the true cost of gardening, making their response misinformed. The other factor our survey data has shown is that people think obtaining a native plant in Los Angeles is difficult. This is likely a combination of two issues: that native plants are not sold at many locations and that native plants are not

clearly labeled as native when they are sold. We feel that with better education as to how gardening native can possibly support a pollinator population; as well as reducing the background knowledge required in order to purchase a plant which is known to be native, more home gardeners in Los Angeles will be willing to increase their native plant usage.

Because our survey showed respondents avoided using native plants because of a perceived cost increase, we compared the prices of native plants with non-native plants which serve a similar home garden purpose. When comparing the prices of native and non-native plants, six native plants were matched with six non-native plants. The prices of native plants are obtained from Theodore Payne Foundation Inventory, and the prices of non-native plants are from the Home Depot garden center website. In order to make sure the native and non-native plants are in the same gardening purposes, we used some certain criteria such as type of plants (annual, perennial, shrub), flower colors, the shape of the petals and the shape of flowers. Surprisingly, the average price of the six native plants is found as $13.80, and that of non-native plants is $17.51. The average cost of six native plants is even 27% cheaper than non-native plants. While price is subject to change depending on seasons and place of purchase, native plants do not seem to be consistently more expensive.

Table 1: Price comparison of native plants obtained from Theodore Payne Foundation with similar non-native plants obtained from the Home Depot garden center website. Data obtained 6/16/18.

Type	Native Plants	Price ($)	Non-native plants	Price ($)
Perennial	Yarrow (Achillea millefolium)	10	Isago Clematis Plant Bareroot	11.97
Annual	Matilija Poppy (Romneya coulteri)	40	Superbells Over Easy (Calibrachoa)	34.99
Shrub	Baja Bush Sunflower (Encelia ventorum) 1G	9	Bluebird Rose (Hibiscus syriacus 'Bluebird') 4-in pot	14.98

Perennial	Seaside daisy (Erigeron glaucus) 4"	5	Amazing Daisies Daisy May Shasta Daisy (Leucanthemum) Live Plant, White Flowers, 4.5 in. Qt.	14.99
Shrub	California Buckwheat (Eriogonum fasciculatum var. foliolosum)	9	Miss Pearl Butterfly Bush (Buddleia)	18.17
Perennial	Scarlet Bugler (Penstemon centranthifoliu)	10	Cardinal Flower Plant (Lobelia cardinalis)	9.98

6. Conclusion

      Pollinator populations are declining; our data show that native plants may help in supporting pollinator populations, giving credence to the hypothesis that loss of native vegetation has led to the loss of pollinators. Our survey data give two explanations as to why native plants are not used more in Los Angeles. There is a cost increase to obtaining a native plant and many respondents find it difficult to find a native plant. However, with the trend showing native plants are more useful than non-native plants in supporting pollinator life, more gardeners and home owners will choose to plant native; despite the increased cost and difficulty in doing so. By educating city officials and the general public, we hope more thought will be given to native plants in landscaping and home gardens, providing a habitat which may increase local pollinator populations.

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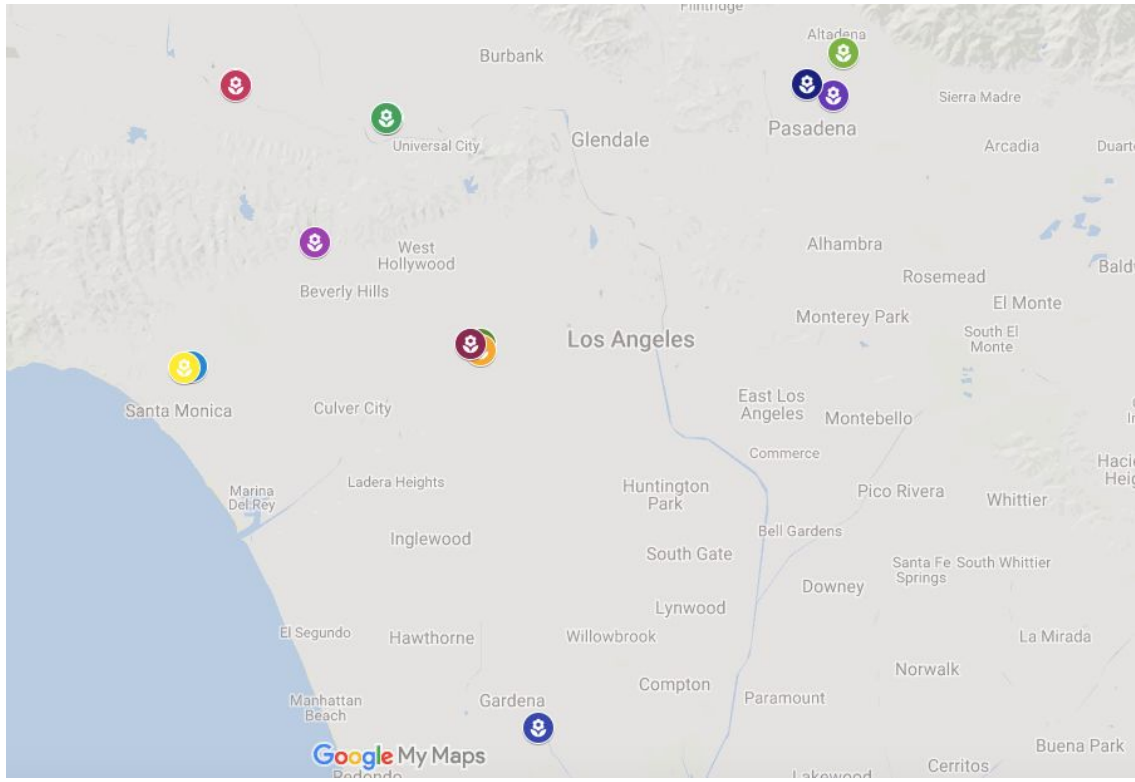251-259

9. Appendix

Figure 1: Map of garden locations.

1. **What is your highest level of education completed?**
   - ❏ High School Diploma/GED
   - ❏ Trade School/Certificate Program
   - ❏ College Degree (AA, BA, BS)
   - ❏ Professional Degree (JD, MD, MPH, MBA, PhD)
   - ❏ Does not apply

2. **What is your total household income?**
   - ❏ $0-$20,000
   - ❏ $20,001-$40,000
   - ❏ $40,001-$60,000
   - ❏ $60,001-$80,000
   - ❏ $80,001-$100,000
   - ❏ $100,001 and above
   - ❏ N/A

3. **What is your primary race/ethnicity?**
   - ❏ White/Caucasian
   - ❏ Black or African American
   - ❏ Asian or Pacific Islander
   - ❏ Latino
   - ❏ Native American
   - ❏ Other _____

4. **Check the statement that best describes you:**
   - ❏ I have never gardened
   - ❏ On a few occasions I have gardened
   - ❏ I have often gardened—when I had the time and opportunity
   - ❏ I am an avid gardener

5. **Check the statement that best describes you:**
   - ❏ I never use native plants when gardening
   - ❏ I sometimes use native plants when gardening
   - ❏ I often use native plants when gardening
   - ❏ I always use native plants when gardening
   - ❏ I do not pay attention to whether something is a native plant or not

6. **Indicate if the following statements are completely true, somewhat true, somewhat untrue, or completely untrue:**

   (a) **"It is easy to acquire native plants for gardening in Los Angeles."**
   - ❏ Completely True
   - ❏ Somewhat True
   - ❏ Somewhat Untrue
   - ❏ Completely Untrue

   (b) **"I'm willing to pay 10% more for a native than non-native plant."**
   - ❏ Completely True
   - ❏ Somewhat True
   - ❏ Somewhat Untrue
   - ❏ Completely Untrue

   (c) **"Pollinators are facing global decline."**
   - ❏ Completely True
   - ❏ Somewhat True
   - ❏ Somewhat Untrue
   - ❏ Completely Untrue

   (d) **"Gardens can be used as habitat for pollinators."**
   - ❏ Completely True
   - ❏ Somewhat True
   - ❏ Somewhat Untrue
   - ❏ Completely Untrue

Figure 2: Human survey

Sample ID	Native (Yes/No)	Honeybees	Non-Honeybees	Total Bees	# Bee Species
1B	N	0	6	6	1
2B	N	13	0	13	1
3B	N	2	1	3	2
4B	N	0	0	0	0
5B	N	1	1	2	2
6B	N	1	3	4	2
7B	N	0	5	5	2
8B	N	0	6	6	2
9B	N	0	21	21	2
10B	N	0	1	1	1
11B	N	0	2	2	1
12B	N	2	0	2	1
1A	Y	1	2	3	2
2A	Y	16	1	17	2
3A	Y	1	0	1	1
4A	Y	1	4	5	3
5A	Y	2	4	6	3
6A	Y	2	2	4	3
7A	Y	6	16	22	6
8A	Y	6	11	17	4
9A	Y	14	17	31	5
10A	Y	0	4	4	1
11A	Y	2	0	2	1
12A	Y	8	3	11	4

Appendix 1: Pollinator raw data