Evaluating Certified Wildlife Habitats & the Minds Behind Them

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Abstract:

National Wildlife Federation (NWF) solicited research on how well their Certified Wildlife Habitat (CWH) program attracts wildlife, promotes sustainable practices, and increases the awareness of the benefits of these practices and presence of wildlife to people in California. To address these questions we used three different methods of assessment on CWH properties: a survey, analysis of tree cover using remotely sensed imagery, and case studies.

The survey evaluated the perceived stress and environmental attitude of each participant in addition to other sustainability and demographic questions. Surveys were sent to a pool of NWF members in California, who had previously answered another survey from the NWF. Using i-Tree, we gathered data from the same pool of NWF members. We chose local case studies and compared these to respective comparison habitats. After we collected our survey responses, i-Tree data, and concluded our case study interviews, we conducted qualitative and quantitative analysis. We compared CWH-owners and non-CWH owners, CWH owners and their respective census tracts, as well as CWH owners and populations from other studies. From these comparisons we found that in general, CWH owners exhibit more sustainable practices than the average homeowner, and that CWHs can provide ecosystem benefits.

Based on the results of the surveys and CWH property assessments, we compiled a set of recommendations for the NWF based on our findings. These recommendations range from marketing strategies, what populations the NWF might focus on for outreach, and what locations could be targeted for the CWH program.

1 Introduction

As the world's population increases exponentially, cities expand to accommodate this growth. We must recognize, however, that other species are striving to survive off of the same land resource. The National Wildlife Federation (NWF) created a Certified Wildlife Habitat (CWH) program to encourage private landowners to make their homes, places of work, learning, and worship more hospitable to local wildlife. CWHs provide food, water, and shelter resources to promote wildlife. By attracting and preserving diverse populations of local plants and animals, humans stand to benefit as well. This study focuses on evaluating the ability of Certified Wildlife Habitats to attract wildlife, promulgate ecosystem services, and improve human physical and psychological health.

We investigated the geographic and demographic contexts of CWHs, by looking at how certified habitat owners differ in comparison with their corresponding communities, as measured by the census tract. The tools that we used in our analyses include ArcGIS, online databases, and US Census tract data, depending on the study area. Additionally, we referenced previous research and widely accepted survey methods to evaluate the environmental attitudes, beliefs, perceived mental stress, and demographics of Certified Wildlife Habitat owners. We also used an online USDA Forest Service tool called i-Tree Canopy to analyze vegetation and tree cover of California CWHs and estimate the economic and air-quality benefits of tree cover on CWH properties.

We designed an online survey to collect information about CWH owners and their certified property including frequency of wildlife sightings, water and chemical usage, and owner's beliefs regarding conservation and the environment. For further examination of CWHs we conducted case studies on three Certified Wildlife Habitats in the Los Angeles area. In-person interviews with Los Angeles CWH owners provided more detailed responses and served to complement the more general data we gathered through the online survey sent to CWH owners in California.

Our findings inform the NWF about the effectiveness and applicability of the CWH program in terms of nature conservation, human interest, and well-being. We also identify the typical demographics and environmental attitudes of CWH owners in California. Knowing their current participants better should allow the NWF to target and encourage similar audiences to join the CWH program. Furthermore, the NWF can focus on educating and reaching out to people not represented in the population of current CWH owners.

2 Research Questions

Research Question 1

What is the value of the CWH & how does it compare to non-certified locations?

To measure "the value" of a property we decided to evaluate the value of tree coverage found on the property and compare it to that of a non-certified location.

There exist three most commonly used top-down approaches for analyzing urban tree canopy cover: high-resolution image analyses, National Land Cover Database (NLCD) analyses, and aerial photo interpretation. Each of the three methods yields estimations of tree and other vegetative cover types, and differ in cost, accuracy, and resolution. Using the 30-m resolution NLCD cover maps that cover the contiguous United States, our team confidently analyzed various backyard habitats with i-Tree Canopy to approximate tree cover.

i-Tree is a software suite developed by the USDA Forest Service that allows its users to conduct forestry analysis and utilize benefit assessment tools. It is vital to the top down analysis of the structure and function of forests. The top down approach uses analysis of canopy cover with aerial imagery. It is highly useful in determining the distribution and amount of tree cover. We used this approach with the i-Tree suite.

Research Question 2

How do CWHs affect critical species?

To see how CWHs affect critical species we chose to ask CWH owners to self-report the frequency and species of wildlife spotted in their CWH. We chose 12 species or species groups representing vital niches within California's ecosystems, and asked California CWH owners to report in our online survey how often they saw them.

Among the 12 species/species groups of wildlife people reported seeing, we focused on three indicators: Monarch butterflies, bumble bees, and hummingbirds. We also focused on Mule Deer as an indicator of habitat connectivity and the presence of corridors. We wanted to see whether CWHs are helping to preserve the aforementioned species groups, because bumble bees and monarch butterflies are both in decline, and hummingbirds are an ubiquitous must see in back yards. By observing bumble bee populations, people can participate in citizen science initiatives and contribute to sustainability by logging sightings *on bumblebeewatch.org.* Monarch butterflies are also important to monitor because changes in their migration patterns serve as indicators of pesticide use and habitat and climate change.

Research Question 3

What motivated CWH owners to certify their properties?

In our online survey we asked CWH owners to choose from the following options and report what motivated them to modify their property to meet the CWH requirements: aesthetics, concern about pollution (noise, heat, and air), preserve/create space for wildlife, enjoy wildlife, health reasons, increase property value, to be a more sustainable resident, for educational purposes, did not modify property to meet CWH standards, and "other" (please specify). The results of this question indicate which features of the CWH program are most attractive to current/potential participants, and help the NWF promote the program more effectively.

Research Question 4
Do CWH owners have different attitudes with respect to conservation / land stewardship from non-owners?

In order to answer this question, we used a modified version of the New Ecological Paradigm (NEP) in our statewide email survey to assess CWH owners' environmental attitudes. We distributed the same NEP questions to non-CWH owners in the neighborhoods surrounding CWH owners. After knocking on about 60 doors, we received a total of 8 surveys back. Because the number of responses was insufficient to compare with our survey population, we turned to existing literature and found NEP scores for two different study populations. We compared our survey population to the two study populations.

Research Question 5
What are the ethnicity & age profiles of CWH owners in California?

To identify which specific ethnicity groups and ages groups participate the Certified Wildlife Habitat we asked CWH owners in the online survey about which ethnicity group they most identify with and to specify their birth year. The ethnicity group options we gave were those standardly used by the U.S. census.

Research Question 6
How do neighborhoods with current CWHs overlay with income & education?

Answering this question would allow us to provide recommendations to the NWF on how to improve the CWH program. Determining which demographic groups the program appealed to could help the NWF improve their outreach to popular demographics the program already appeals to, and the demographic groups the program does not currently appeal to. Increasing awareness of the program can increase urban green spaces across the nation.

Research Question 7
Are CWH owners sustainable homeowners?

Determining the presence or lack of sustainable living can also help the NWF to decided whether it may want to expand their CWH program or create other programs and mechanisms to encourage sustainable lifestyles for their members.

Research Question 8
Do the green spaces offered by CWHs elicit low stress scores in their owners?

Correlating stress levels with the availability of green spaces (in the form of CWHs) is important as it may suggest that not only are green spaces beneficial to wildlife and ecosystem health, but that they can benefit humans. In an urbanized society, green spaces may offer great health benefits if they can be associated with low stress scores.

Research Question 9
What is the longevity of CWH?

The longevity of a CWH is just as essential as the amount of CWHs that exist. A CWH can act as a rest stop for migrating species or serve as a constant source of resources for wildlife. This report attempts to determine factors that halt the functioning of a CWH and how to address those problems.

3 Ecosystem Services from CWHs

3.1 | Introduction

Tree coverage appropriately measures ecosystem benefits because trees provide a wide range of services to both local and global ecosystems.

For example, tree coverage in urban areas significantly reduces pollution levels, because leaves work as filters and reaction sites for air pollutants. Automobiles and urban constructions release a wide range of pollutants into the air creating conditions ripe for health crises. Native trees that encourage airflow have many or large leaves and release relatively few volatile organic compounds (VOCs), can serve as both a property defense against air pollutants, such as ozone and PM_{10}, and as another source of habitat for native animals. The combined effect of a city's tree leaves have the potential to reduce CO_2, SO_2 and NO levels (McPherson et al. 1997) at a "magnitude of… hundreds to thousands of metric tons per year" (Nowak et al. 2006).

Trees benefit urban environments in particular as the "Urban heat island effect" can drive up temperatures. Cities can be up to 3°C warmer than surrounding areas because of the numbers and types of manmade constructions (Del Tredici 2010), and high temperatures increase the likelihood of "heat strokes, exhaustion, syncope… cramps" (Kovatz et al. 2008) and even death for those with cardiovascular and respiratory illnesses (Patz et al. 2005). However, trees in urban spaces enhance ventilation, capture and release water, and provide shade. A well-positioned "isolated tree… with a high stem" can alter airflow to move heat away from an area (Givoni 1991). To reduce heat in the leaf and the air surrounding it a plant also releases or transpires water through leaf stomata, by "consum[ing] energy from solar radiation [and] increase[ing] latent… heat" in its vicinity (Bowler et al 2010; Givoni 1991). In addition, trees and other plants can provide indirect local cooling by enhancing soil moisture. Tree roots facilitate percolation of surface water into the ground, by breaking up soil clumps and increasing soil porosity while also drawing water towards the tree (Givoni 1991). Because of its high heat capacity, higher levels of water in the soil mean more soil heat retention, with minimal surface temperature increase.

Also by preventing soil compaction, trees and plant roots in general help to promote clean surface waters and vibrant soil biology. Plant roots make the soil more like a sponge (Cunningham et al.1995). While soil with vegetation retains up to 85% of precipitation, developed areas retain only up to 40% (Bolund et al 1999). When soil loses its permeability, the number of pollutants in water runoff goes up, contributing to surface water quality degradation (Frumkin 2002). Plant roots also help hold soil in place (Cunningham et al.1995), preventing erosion (which can further degrade water quality) and providing a stable habitat for soil fauna and flora to colonize. These organisms facilitate the creation of a soil humus layer, which is rich in nutrients from organic material, has ample pore space, and is soft.

Lastly, Tree coverage has the potential to reduce urban sound pollution. At certain levels sound can impose physiological and psychological stress (Skanberg 2001), which can include anywhere from feelings of annoyance to the decreased ability to think straight, sleep problems, high blood pressure, to hearing loss (Passchier-Vermeer et al. 2000). Vegetation or green space can minimize home and property exposure to noisy automobile traffic. Leaves can scatter and "absorb acoustic energy" (Pathak et al 2007), making dense foliage a necessity to combating street noise. Positioning such foliage as close to the street as possible is important, as the ability of leaves to scatter and attenuate noise actually decreases with distance from the sound source (Fang 2003; Aylor 1972). Utilizing shrubs and trees together is ideal, as when placed one beneath the other, they effectively form a vegetative sound barrier/disperser (Fang 2003). Finally, also just spending time outdoors, in "green areas [reduces] the prevalence of stress-related psychosocial symptoms" (Gidlof-Gunnarsson et. al 2007), such as "depression… aggression, [and] excessive use of [drugs]" (Passchier-Vermeer et al 2000), caused by annoying noise exposure.

I-Tree is a software suite developed by the USDA Forest Service that allows its users to conduct forestry analysis and utilize benefit assessment tools (i-Tree). It is vital to the top down analysis of the structure and function of forests. The top down approach uses analysis of canopy cover with aerial imagery. It is highly useful in determining the distribution and amount of tree cover. We used this approach with i-Tree Canopy.

3.2 | Methods

Using the USDA Forest Service's peer-reviewed software i-Tree Canopy (i-Tree), we measured the presence of different land cover types (including tree cover, non-tree permeable surfaces, and impervious services) found in both NWF Certified Wildlife Habitat properties and neighboring non-certified properties. The sample size of points classified per property was set for each parcel to achieve an estimate of which types of surface coverage it had. We used i-Tree to quantify the benefits of tree coverage by estimating the physical amount and economic value of air pollution reduction and capture of atmospheric carbon.

We evaluated 126 certified properties and 126 comparison properties. The certified properties were from the same pool as the survey pool provided by NWF. Each comparison property was chosen by selecting the property across the street from the certified property. Using the property across the street gives a comparison in the same neighborhood, with similar demographics, but avoids the spillover effect that occurs with adjacent properties. The size and property boundaries of CWHs and their neighbors were found using www.Zillow.com.

Using i-Tree Canopy, we quantified three categories: tree coverage, non-tree vegetation (e.g. grass, shrubs, and permeable surfaces), and impermeable surfaces (e.g. concrete, asphalt, roof covering, and swimming pools). i-Tree calculated the percentage of each category present in each property. In addition, i-Tree calculated ecological benefits, such as the amount of carbon dioxide removed and carbon sequestered each year.

We used a matched-pairs T-test to evaluate the significance of differences in the means of the matched pairs (pollutant removal amounts and land cover percentages of NWF Certified Wildlife Habitat properties compared to those of non-certified properties).

3.3 | Results

CWH properties were covered with significantly more tree cover, significantly less impermeable surfaces, and significantly less non-tree permeable surfaces (e.g. grass) than non-certified neighbors, (Table 1 and Table 2)

Table 1: Difference in the mean percentages of land cover types

Category	NWF Certified Habitat Property Mean (n=125)[a]	Non-certified Neighbor Mean (n=125)[a]	Mean difference	Standard Error	p-value
Tree Cover (%)	32.9	22.2	10.722	1.80435	0.0001
Non-Tree Permeable Surfaces (%)	23.2	28.8	5.67737	1.59417	0.0005
Impermeable Surfaces (%)	28.8	33.9	5.05208	1.58838	0.0019

[a] only 125 of registered Certified Wildlife Habitat properties in California had identifiable plot boundaries

Table 2: Amount of air pollutants removed by trees in Certified Wildlife Habitats and neighboring non-certified properties. All amounts are annual unless otherwise indicated.

Pollutant Removed	NWF Certified Habitat Property Mean (n=125)[a]	Non-certified Neighbor Mean (n=125)[a]	Mean difference	Standard Error	p-value
Carbon Monoxide (CO) (oz)	8.36808	5.39397	2.9741	0.82687	0.0005
Nitrogen Dioxide (NO_2) (oz)	44.9426	28.8128	16.13	4.60359	0.0006
Ozone (O_3) (oz)	343.075	222.521	120.55	39.8812	0.003
PM 2.5 (oz)	15.709	10.7677	4.9414	1.69066	0.0044
Sulfur Dioxide (SO_2) (oz)	13.4916	9.42312	4.0684	1.26663	0.0018
PM 10 (oz)	226.244	90.4213	135.82	88.7186	0.1304*
CO_2 Sequestered (lbs)	3513.24	2701.61	811.62	366.042	0.0284
CO_2 stored in trees (not annual) (metric tons)	232.241	44.4359	187.8	47.1907	0.0001

[a] only 125 of registered Certified Wildlife Habitat properties in California had identifiable plot boundaries

* does not have statistically significant p-value

Table 3: Economic value of pollutants removed by tree coverage on certified properties and neighboring non-certified properties.

Economic Value of Pollutant Value Removed	NWF Certified Habitat Property Mean (n=125)[a]	Non-certified Neighbor Mean (n=125)[a]	Mean difference	Standard Error	p-value
Carbon Monoxide (CO) (oz)	0.01827	0.00971	0.0086	0.0086	0.0153
Nitrogen Dioxide (NO_2) (oz)	0.08238	0.03632	0.0461	0.0461	0.0545*
Ozone (O_3) (oz)	4.0219	1.97073	2.0512	2.0512	0.0305
PM 2.5 (oz)	4.91168	2.37886	2.5328	2.5328	0.1825*
Sulfur Dioxide (SO_2) (oz)	0.0034	0.0009	0.0025	0.0025	0.0917*
PM 10 (oz)	1.35023	0.892	0.4582	0.5199	0.0027
CO_2 Sequestered (lbs)	834.417	28.3854	806.03	814.59	0.0056
CO_2 stored in trees (not annual) (metric tons)	1198.11	867.711	330.4	332.17	0.0006

[a] only 125 of registered Certified Wildlife Habitat properties in California had identifiable plot boundaries
* does not have statistically significant p-value

3.4 | Limitations

A population size of n=126 produced mostly significant statistical results, with the exception of four comparison properties. Our population size was limited to the California Certified Wildlife Habitat addresses and plot shapes we were able to locate using Zillow.com. Eight addresses were unusable. Further research could expand the population to include more states, ideally all Certified Wildlife Habitats countrywide. A second limitation we encountered is the human error associated with visual air photograph interpretation. Using i-Tree we assigned a land cover type (tree, non-tree vegetation, and impermeable) to each random point sampled within the property boundaries. Because i-Tree uses aerial images, at times it was difficult to discern what was a small tree and what was a shrub from a bird's eye perspective. We accounted for this issue by categorizing such questionable points as "non-tree vegetation." Therefore our tree coverage estimate could potentially be greater, but due to visual interpretation limitations we could not be certain.

3.5 | Analysis and Discussion

NWF Certified Wildlife Habitats have on average 48.5% more tree coverage than their neighbor. More tree coverage is an ecosystem benefit as it either directly or indirectly decreases surface heat, increases soil water retention, prevents erosion, provides stable habitats, and reduces urban sound pollution (refer to Literature Review for more information)

Our results also illustrate the ability of more tree coverage to remove more air pollutants and annually sequester more carbon in trees. Properties containing NWF Certified Wildlife Habitat sequester 811.62 metric tons of CO_2 annually more than their non-certified neighbor. In addition, Table 2 shows more NO_2, O_3, $PM_{2.5}$, PM_{10}, and SO_2 are removed in Certified Wildlife Habitats due to the presence of trees. Most of the pollutant values are statistically significant, such that random chance is not responsible for the outcomes. The removal of these pollutants is a human benefit because many of these air pollutants are inhaled and disrupt regular respiratory processes. For particulate matter, the smaller it is the farther it can penetrate, possibly reaching the circulatory system and disrupting circulatory functions. Likewise, the sequestering of atmospheric carbon is essential for human and ecosystem health. The carbon cycle relies on the balance between the input and output of carbon into the atmosphere. Currently, the rate of carbon input exceeds the amount stored and sequestered in the environment. Trees are a natural carbon sink and can decrease the amount of atmospheric CO2. Less atmospheric CO2 implies a reduced greenhouse gas effect on the planet. There are also possible implications for humans. Reduced greenhouse gas effect suggests lower surface temperatures, which implies less heat waves and deaths or illnesses due to heat waves. Lastly, tree coverage provides shelter for wildlife. Habitat loss is an unfortunate consequence of urbanization. Providing resources aids in the survival of wildlife as the environment around them changes. Not only is tree coverage an ecosystem and wildlife benefit, it also benefits human health and provides free services for humans.

The i-Tree results also portrayed more impermeable surfaces, such as concrete and asphalt, and non-tree permeable surfaces in non-certified habitats compared to certified habitats. Impermeable surfaces increase urban runoff, which can carry pollutants and chemicals. These usually become integrated into marine ecosystems and bioaccumulate or biomagnify in high trophic level organisms. Moreover, impermeable surfaces contribute to the urban heat island effect. Concrete and asphalt have lower heat capacities than water so they increase in temperature faster. On the other hand, soil traps water, which absorbs heat and cools surface temperatures. Non-tree permeable surfaces, including shrubs, soil, and grass, have similar effects as tree coverage but on a smaller scale. Nevertheless, grass may cool surface temperatures, but it also requires maintenance that may not be ideal for California because it needs to be watered often. Trees, non-tree vegetation, and permeable surfaces, like soil, are important for maintaining ecosystem health, which also benefits wildlife and humans.

These results suggest that CWHs provide a quantifiable ecosystem benefit in the form of (1) greater tree coverage and (2) greater removal of air pollutants, including greenhouse gasses, than adjacent properties in the same neighborhoods. Ecosystem benefits also have implications for wildlife and human benefits.

4 Survey of California CWH Owners

4.1 | Literature Review

American cities have been encroaching on natural habitats for centuries. To address the decline of natural spaces in developed areas, the National Wildlife Federation created the Certified Wildlife Habitat (CWH) program to restore habitat in commercial and residential areas. The program encourages people to apply more sustainable, wildlife-friendly practices by requiring certified properties to provide water, food, and cover for wildlife and a place for wildlife to raise their young.

The effectiveness of the CWH program depends on whether or not these criteria deliver benefits to wildlife, humans, and ecosystems. Previous literature indicates that specific property characteristics (such as increased vegetation, the presence of certain wildlife, tree coverage, and ground permeability) do indeed have beneficial effects on humans and ecosystems (Nowak and Greenfield 2012, Nowak and Dwyer, Jacobson and Ten Hoeve 2011). We conducted literature reviews pertaining to environmental attitudes, benefits of permeable surfaces, and physiological benefits of nature to humans to model our survey of CWH owners after.

4.1.1 | Attitudes Towards the Environment

Environmental attitudes refer to a set of values, norms and beliefs employed by people to understand and interpret the relationship between the human society and the natural environment. Historically, western culture has exhibited an anthropocentric view. An anthropocentric belief system emphasizes that the human species is above the rest of nature. Anthropocentrism refers to "the belief that nature exists primarily for human use and has no inherent value of its own" (Dunlap et al. 2000). A belief in economic advancement and material affluence as well as belief in science and technology had dominated western societies till the late 20th century. This set of values came into being alongside the institutional development during the Industrial Revolution, resulting in the public adopting such a perception tend to consider science and technology as solutions to the problems of society (Pirages & Ehrlich 1974).

After the upswing of environmental awareness in the 1970s, scientists started to put more effort into exploring the public's attitude regarding the human-nature relationship (Gooch 1995). In the past decades, Dunlap and Van Liere's (1978) New Environmental Paradigm (NEP) scale has gained much currency and popularity as a tool to measure the public environmental attitudes in various geographical and cultural contexts. An earlier environmental attitudes scale called the DSP or Dominant Social Paradigm took a much more anthropocentric and technology-dominant standpoint, which Dunlap and Van Liere considered anti-ecological and outdated. Therefore, they developed NEP and made an effort to examine the extent to which the public accepts the concepts in NEP.

NEP constitutes a new worldview regarding the public's environmental awareness by emphasizing three key notions: "balance of nature", "limits to growth," and "anti-anthropocentrism." First, "balance of nature" emphasizes the fragility of ecological balance that can be easily disrupted or even destroyed by human intervention. Second, "limits to growth" is conceptualized upon the notion that ecological resources are of limited amounts, which inevitably constraint material development of human society. The third notion, "anti-anthropocentrism" bears upon the rejection of anthropocentrism, which is the central value of DSP. The basic concept of the NEP can be well captured by a metaphor of the earth as a spaceship, where limited energy and resources are available for human consumption (Dunlap et al. 2000). Increasingly, the public has embraced the idea that material and technological advancement should be made with interests of sustainable environmental development in mind.

Since NEP was first developed in 1978, environmental problems affecting social and economic aspects of human society have evolved significantly (Dunlap et al. 2000). Responding to the changes, authors of NEP revised it in their study "Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale." To coincide with the evolution of environmental problems and public concerns, the revised scale added the notions of "exemptionalism" and "ecocrisis" to the original three concepts. "Exemptionalism" refers to the idea that "human society is exempt from the biophysical that control other species because of human ingenuity, technology, creativity and economic systems" (Cairns 1999). The revised NEP measures rejection of exemptionalism. Ecocrisis refers the possibility of dramatic environmental changes that will post catastrophic threats on human society. In sum, the measurements in the revised NEP offer us a useful tool to gauge and interpret the public's general environmental attitudes.

4.1.2 | Permeable Surfaces

Urban stormwater runoff acts as the leading cause of pollutants to California's receiving waters (Smith & Perdek, 2004). Stormwater can carry fecal bacteria, debris, and other waste into bays and streams through which the polluted runoff is eventually discharged into the ocean. Once in the ocean, the pollution can cause negative health effects to humans and wildlife. Illnesses such as skin rashes, ear and eye discharge, and gastrointestinal problems can all result from exposure to urban runoff containing bacteria and parasites (Gaffield, Goo, Richards, & Jackson, 2003). The impacts of stormwater runoff can be reduced through waste reduction and low impact land development. Examples of low impact development include improving soil infiltration, planting shrubs and trees rather than turf, and adding vegetated swales (EPA, 2007). The purpose of low impact development practices is to reduce the amount of impervious surfaces such as concrete and improve water infiltration. Addition of soil and vegetation in urban areas instead of impermeable surfaces allows rainwater to percolate through the ground rather than flow through stormwater drains.

Porous soil can trap more water and decrease surface heat, while softer ground can decrease sound propagation (Bolund et al. 1999). Water retention in the soil is also important to the replenishment of aquifers (Frumkin 2002),"sequestration" of nutrients and contaminants (Cunningham et al. 1995), and prevention of flashfloods. Soil compaction reduces the soil's ability to provide these services. In the city, the "impervious surfaces and high extraction of water cause groundwater levels to decrease" (Bolund et al 1999) and the ground to sink and compact. Furthermore the large extent of such impervious surfaces causes the flow rate, amount of, and subsequent erosive and flooding capabilities of precipitation runoff to increase (Wheater et al. 2009). Erosion removes the softer and fertile upper layers of the soil and gradually exposes the harder bedrock.

4.1.3| Psychological Benefits

The attention restoration theory is one of two widely studied explanations of how nature serves as a restorative environment. While attention restoration theory focuses on the characteristics necessary for an environment to promote renewed attention, Ulrich (1991) proposes a theory that focuses on nature's ability to invoke positive emotions and reduce stress. Ulrich performed a study in which participants watched a stressful movie and were then exposed to videos of either natural or urban settings. Participants exposed to natural settings displayed shifts to more positive emotional states and better physiological activity levels. Ulrich concluded that nature promotes stress recovery by invoking positive emotions, reducing negative thoughts, and eliciting effortless attention.

Cohen and Williamson (1988) bring up how "coping resources" are important to people's perception of their ability to deal with stressful events. When people judge a certain event as "threatening or otherwise demanding and [see] coping resource [as] insufficient" their stress level goes up. Cohen, Kamarck, and Mermelstein in 1983 developed a Perceived Stress Scale (PSS) to show how perceived stress closely relates to increased "risk factors in ... physical and psychological illnesses." Specifically, the PSS "tap[s] [into] how unpredictable, uncontrollable, and overloading respondents find their lives" (Cohen and Janicki-Deverts 2012). We use the PSS in our survey to see whether owning participating in the CWH program may facilitate more time spent outdoors in nature and decrease CWH owners' perceived stress by acting as a coping resource.

4.2 | Methods

Aiming to understand the human benefits and ecological benefits of certified natural habitats, both quantitative and qualitative research methods were used. First, we designed and distributed a web-based survey to all the CWH owners who had agreed to participate in a study. The survey assesses participants' environmental attitudes, psychological stress level, and motivations for adopting CWH requirements. It also evaluates the owners' experience with their CWH and other sustainable practices they adopt.

Before our study, NWF distributed an online survey to all of the CWH owners located in California. In this survey, participants were asked to answer questions on a voluntary basis. Results collected from this survey included addresses of the CWHs, property type, property size, coverage of native plants, the owner's favorite feature of the habitat and wildlife visits. Based on the existing data, we created a new survey that builds on NWF's first survey to avoid asking repeating questions. Moreover, the initial survey also asked participants to indicate whether they will be willing to be contacted again for research purpose. Out of 135 participants who returned their survey, 134 indicated they would be willing to be contacted again via email. Therefore, we reached out to all the 134 potential participants via email when distributing our survey.

In creating the survey, we utilized the popular online survey service provider SurveyMonkey. The National Wildlife Federation distributed the survey as a web link to all the participants. Invitation emails were sent from the NWF official email address. The email contained a brief introduction of our research, our contact information, and a link to the online SurveyMonkey link. The reminder emails were sent two weeks after the initial invitation emails through the same procedure.

4.2.1 | Survey Design

The survey includes three major sections: human assessment, ecosystem assessment and demographic information. For human assessment, we specifically address the topic of environmental attitudes, motivation for certification, and stress relieving effect of the certified habitats. Environmental attitudes are measured by a tested matrix of revised NEP that is developed by Dunlap et al. 2000. Stress level is tested using the Perceived Stress Scale Test (PSST) created by Cohen, Kamarck, and Mermelstein, (1983) and provides a measure of one's own assessment of his or her stress level. PSS tested to be a better stress predictor than life event scores (Cohen, Kamarck, & Mermelstein, 1983). Additionally, we asked the CWH owners to self-report on wildlife quantity and frequency on their certified property. Lastly, a set of questions was devoted to finding about the respondents' demographic information. We asked the respondents to report their ethnicity, age, household income, and level of completed education.

Our survey has 21 questions in total, which takes roughly 25 minutes to complete. The first page of the survey was a consent form. Only by clicking "I agree to participation in this study" can the respondents further access the real survey questions. Before the survey was sent out, the study was processed and certified Exempt by UCLA's Institutional Review Board. The IRB number is 14-000386.

In analyzing the date collected from the online survey, we focused on first comparing our results with those reported by existing literatures to understand how our respondents are comparing with the general public. In doing it, we used US census data. We linked the reported zip code with the census tracts based on which the US Census Bureau collected data. Specifically, we compared the demographic characteristics such education level and household income level of the CWH owners the median level of the census they belong.

We also gathered existing literature on the PSS and NEP application to the general public and matched our results with them.

Secondly, we tried to delineate the variations within the group of respondents and draw correlations between the respondents' environmental attitude, demographic data, psychological stress level with their sustainable practices, contentment with their CWH, types of vegetation cover in their CWH, and percentage of native plants in the CWHs.

We scored PSS according to the method developed by the creators. To evaluate the PSS responses from our survey we added up each response (1 point for a response of 1, 2 points for a response of 2 and so on); 4 out of 10 of questions we scored in a reverse order, allotting 0 points for a response of 4, 1point for 3 and so on. The higher the PSS score, the worse off the participant was doing physically and psychologically, as the high score would in theory "indicate greater psychological stress" (Cohen and Janicki-Deverts 2012) and "poorer health practices, such as sleeping fewer hours, skipping breakfast, and consuming greater quantities of alcohol" (Cohen & Williamson, 1988).

While we did compare the PSS scores of the CWH owners with the amount of time they spent outdoors after certification, we also compared our CWH owner population to Cohen and Janicki-Deverts (2012) 2009 sample of the US population.

4.3 | Results

4.3.1 | Demographics

The email invitations were sent to 143 CWH owners and we received 43 valid responses, yielding a response rate of 30%. Eight more people started the survey but did not continue after consenting to participate in the research. In general, our response rate is about the average regarding an online survey response rate (Nulty, 2008). However, not all of our respondents answered all the questions thoroughly. The response rate on the questions regarding household income level is the lowest among all the questions (about 29%).

Of the 43 participants, 41 of them described their ethnicity as "White, not Hispanic or Latino" (Figure 1). One participant indicated their ethnicity as "Asian" and one participant indicated their ethnicity as "Hispanic or Latino". An overwhelming majority (96%) of the respondents were White.

The average age of our survey respondents was approximately 64 years (Figure 2). The median age of our respondents is 65 years old. The youngest respondent was 27 years old, followed by a 39-year-old participant. The oldest participant was 86 years old. Most of the respondents were middle aged to elderly individuals.

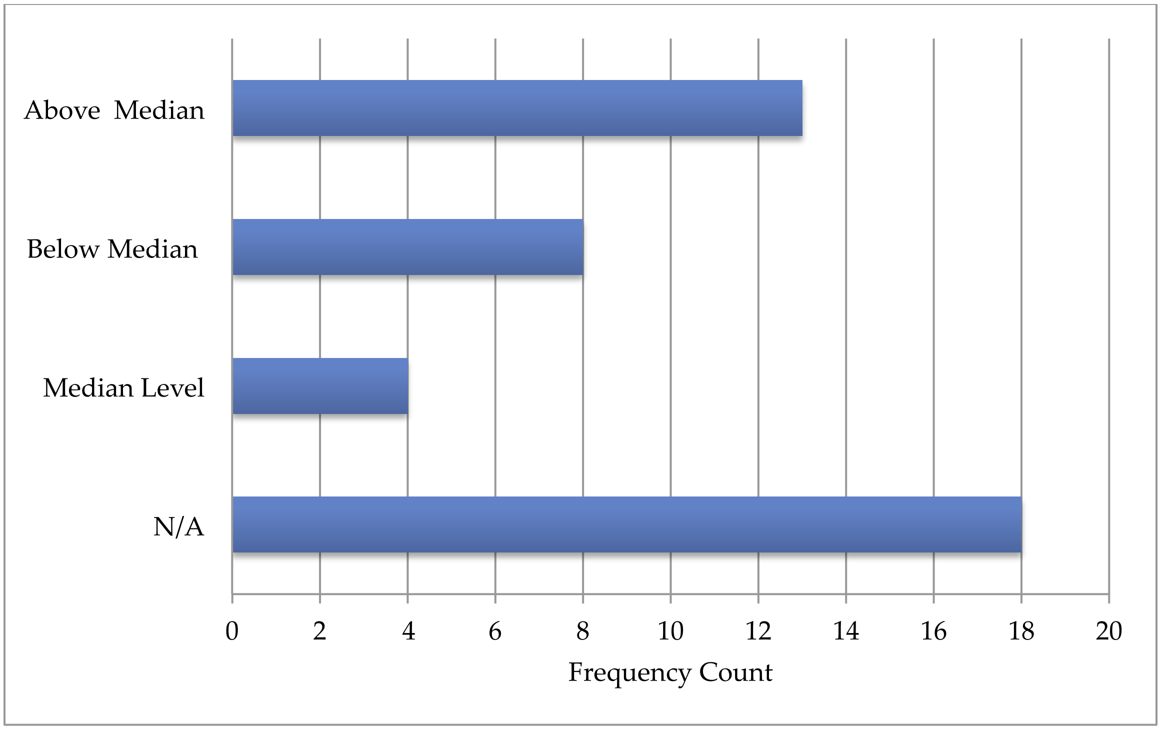

Figure 3. Income level of survey respondents compared to the median income of their census tracts (N=43).

Many respondents (17 participants) chose not to reveal their level of income and one respondent lived in a census tract for which data was unavailable. Out of the 25 participants who did choose to indicate their level of income, the majority of them (13 participants) have income levels above the median income level of their census tracts (Figure 3). This comes out to 52% of respondents whose income is higher than the median income of their census tracts. There were 8 respondents whose income fell below the median income level of their census tracts and 4 respondents whose income fell within the median income level of their census tracts.

Out of 26 respondents who indicated the highest level of income in their household, the most common response fell in the range between $100,000 to $149,000 with 34% of respondents falling into this category (Figure 4). The second most frequently indicated range was $200,000 or more. The third most indicated range was $150,000 to $199,999.

One person chose not to indicate the highest level of education in the household. Out of those who did respond, 27 participants or 64% of participants had a graduate or professional degree. Nine participants had a bachelor's degree and 6 had some college or an associate's degree. CWH owners tend to be highly educated (Figure 5).

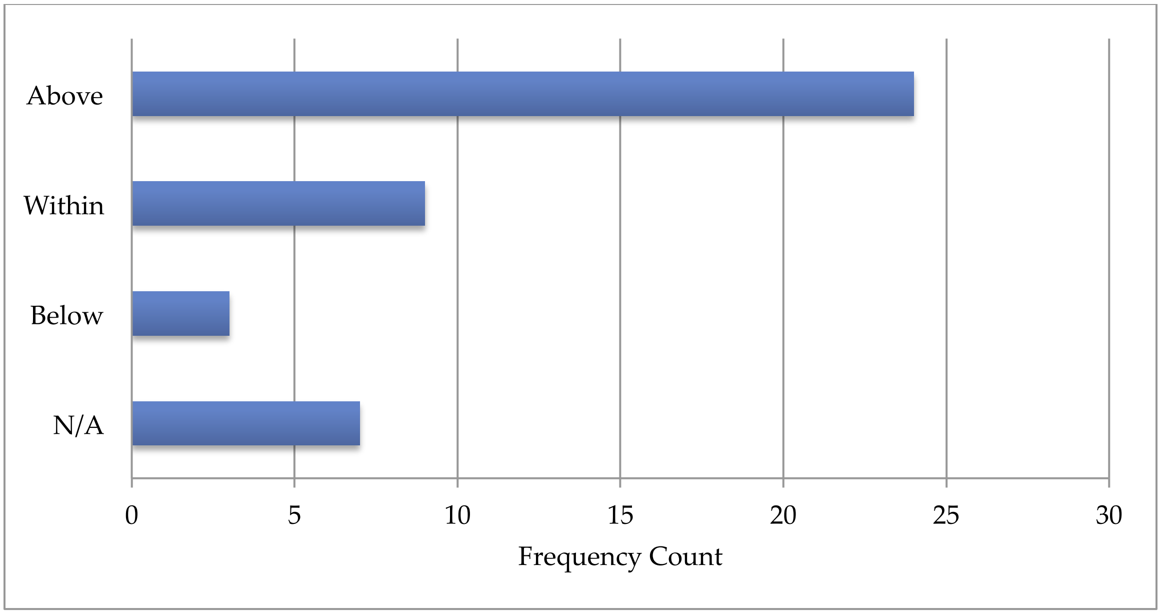

Figure 6. Education level of survey respondents compared to the most common education level of their census tract (N=43).

Out of the 36 respondents whose education we could compare, 66.7% of the respondents had a higher level of education than the most dominant education level of their census tract (Figure 6). 25% of respondents had an education level within the dominant education level of their census tract and 8% of respondents had an education level below the dominant education level of their census tract. Approximately 92% of all respondents were either more educated or received the same level of education as the rest of the people within their census tract. This chart indicates that CWH owners tend to be more highly educated than other people within their census tract.

4.3.2 | New Environmental Paradigm (NEP)

We included selected questions from the New Environmental Paradigm to determine if there were correlations between the NEP scores of CWH owners and their actions.

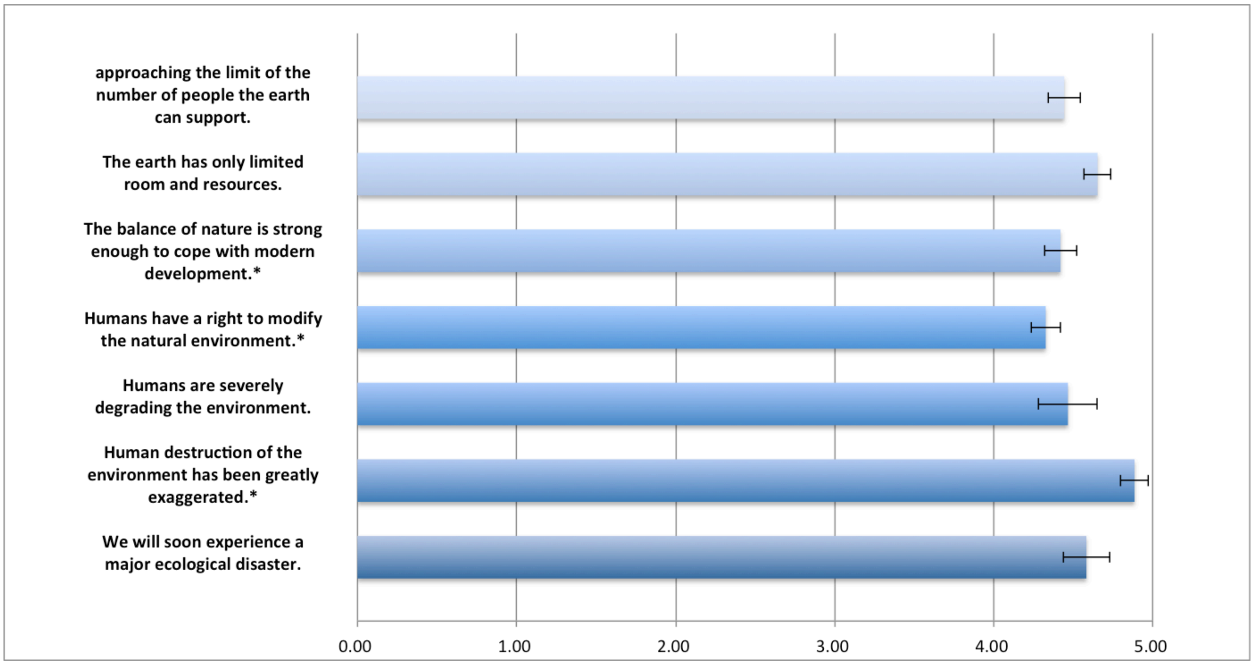

Figure 7. The above graph shows the average score and standard deviation (n=43) for each statement in the NEP question panel from our survey data. One the scale from one to five, one indicates attitude that is least environmentally friendly and five the most environmentally friendly. Some items are reverse coded so that the most environmentally oriented response is always 5.

Our survey results suggest that the respondents have strong environmental awareness (Table 4, Figure 7). The respondents overwhelmingly believe that the earth has limited resources and that human species is approaching such limit and is causing severe burdens to nature. In addition, the respondents also reported a strong belief in the possibility of ecological disaster in the near future and do not believe that the current environmental destruction has been exaggerated, human has rights to modify the environment or that the nature can adapt to anthropogenic interruption to the ecosystem.

4.3.2 | CWH Features

The results from 43 respondents were collected and averaged to yield the average percentage of "Native", "Non-native but Climate Adapted", "Other", and "Not sure" plants in each owner's CWH. On average, CWH owners reported that 40.86% of the plants in their CWH are native, 26.40% of plants are non-native but climate adapted, and 22.16% of plants are neither native nor climate adapted. Approximately 10.58% of CWHs are covered in plants that CWH owners cannot identify and indicated as "not sure." Only four respondents reported not knowing anything regarding the plant types in their CWH.

On average, 58% of CWHs consist of non-grass vegetation such as trees or shrubs (Figure 8). The second most common land cover is impermeable surfaces which make up 15% of an average CWH. The third most common land cover is bare soil consisting of 12% of an average CWH. Participants indicated 8% of their CWHs containing other coverage such as a pool, porch or deck and 7% of their CWH covered in lawn.

Perennial water features are the most commonly occurring feature in CWHs with a total count of 32 out of 43 (Figure 9). Permeable pavement is the second most common feature with a count of 18 followed by rain barrels with a total count of 13. Eleven participants indicated having a seasonal water feature. Three participants indicated that they did not have any of these features and one participant did not know what any of the features were.

Voluntary recycling was the most common sustainable practice among CWH owners with 42 out of 43 participants contributing to voluntary recycling (Figure 10). This amounts to approximately 98% of all survey participants. Owning low flow utilities such as toilets and showerheads is practiced among 37 participants or 86% of all respondents. Composting occurs among 28 participants or 65% of all respondents. Fourteen participants indicated owning solar panels. Fourteen participants also indicated participating in other sustainable practices. Eighteen participants own hybrid cars, which approximates to 19% of all respondents. Eighteen participants also have a greywater system on their property.

Natural fertilizer was the most commonly used product in CWHs with a total of 33 respondents who indicated using it (Figure 11). Herbicide and artificial fertilizer were the two second most commonly used products, each showing twelve responses. Six participants indicated that zero chemical products were used in their CWH. Both insecticides and other chemical product had total counts of four participants who indicated using these products. None of the CWH owners indicated using rodenticide.

Participants were asked to choose their top three motivations for attaining a Certified Wildlife Habitat. A total of 41 participants responded to this question. As a result, the total respondent count totals 123 since each participant submitted three motivations (Figure 12).

The most frequently chosen motivation to modify property to meet CWH standards was to “preserve and create space for wildlife.” Thirty-seven participants listed this option as one of their top three motivations for attaining a CWH. The second most frequently chosen motivation was to “enjoy wildlife” with a total of 35 respondent counts. The third most common motivation was “to be a more sustainable resident” with a total of 28 respondent counts. Other options included “aesthetics” which totaled 11 counts, “concern about pollution” which totaled 8 counts, and “for educational purposes” which totaled 5 counts. Four participants indicated that they did not have to make any modifications for their property to meet CWH standards and four participants indicated other motivations for modifying their properties. Other motivations included peace of mind, add privacy, inspire neighbors and friends to do the same, and provide more beauty in nature. No one attributed their motivations to “health reasons” or to “increase property value.”

In Figure 13, hummingbirds were the most frequently sighted species overall, since 42 out of 43 respondents reported seeing them “very often (weekly)”, compared to only 22 of 43 respondents reporting the same for hawks. Bumblebees were close behind, with 42 out of 43 respondents (97.7%). As for the other species and species groups, of 43 respondents, 37 (86%) reported monarch butterfly sightings, 26 (60.5%) for snakes, 24 (55.8%) for frogs, 22 (51.2%) for salamanders, 25 (58.1%) for gophers, 20 (46.5%) for rabbits, 17 (39.5%) for bats, and 18 (41.9%) for coyotes.

Out of the 42 participants who responded, 29 participants reported that they were content with their CWH (Figure 14). Ten participants expressed an interest in seeing more wildlife in their CWH and three participants expressed a desire to see less of a certain animal in their CWH. No one indicated that his or her CWH takes too much maintenance.

Out of 41 respondents, we found that on average CWH owners spend more time outside in their CWH after certification. CWH owners spend about 82.12 more minutes per week in their CWH after certification (Figure 15).

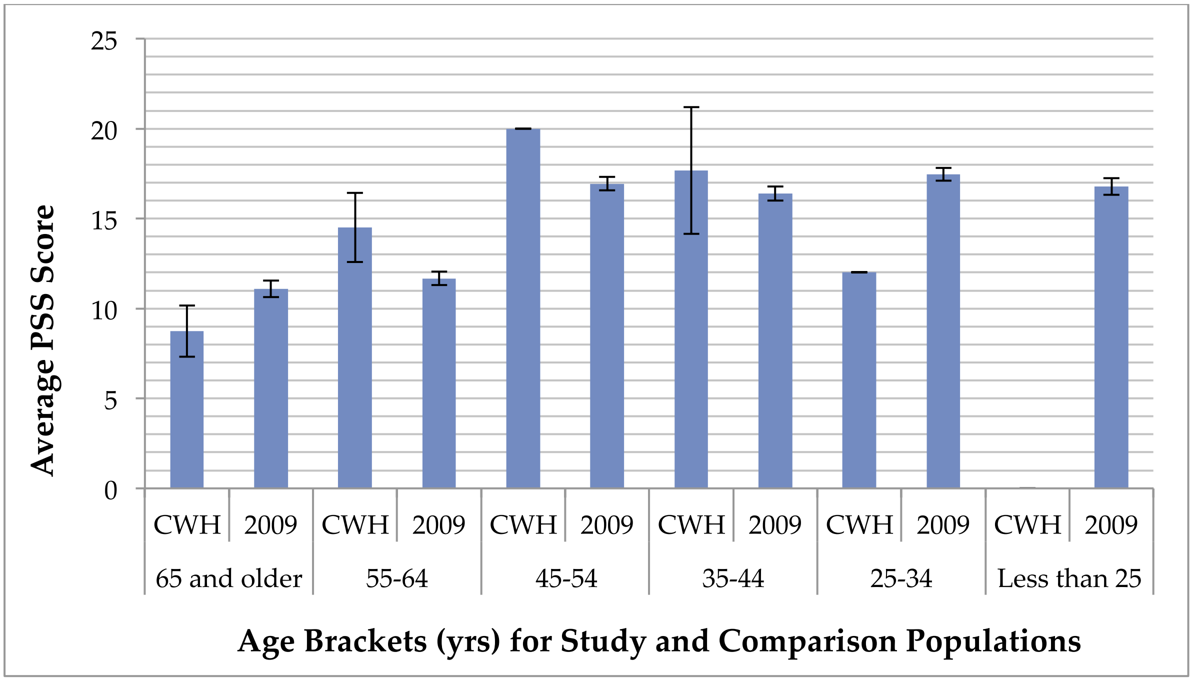

Figure 16. This chart compares the average PSS scores of the CWH owner population of our study with that of Cohen and Janicki- Deverts's 2009 survey group from their 2012 research publication. Each column shows the average score with standard error for that age bracket population. Where n= population size, for age bracket "Less than 25," CWH: n=0, 2009: n=223; for "25-34," CWH: n=1, 2009: n=433; for "35-44," CWH: n=3, 2009: n=331; for "45-54," CWH: n=1, 2009: n= 419; for "55-64," CWH: n=12, 2009: n=372; for "65 and older," CWH n=20, 2009: n=222. Of the CWH owner population that responded to this questionnaire (n=37), 86.49% was concentrated within the age brackets of "55-64" (n=12) and "65 and older" (n=20). The 2009 survey group had a population of 2000 with an even distribution of participants for each age category. For the most part, within age brackets, standard deviations were similar between the two groups, while standard errors were typically much larger for CWHs.

To compare our CWH owner scores with those of the general US population Cohen and Janicki Deverts' (2012) study (refer to methodology for more details), we divided respondent scores into age brackets (Figure 16) and compared and calculated the sample size, mean, standard deviation, and standard error of each. We also calculated the average PSS score for each population in total. The CWH owner population had a mean score of 11.55, while that of the 2009 study had a mean score of 15.27. The standard deviations within each age bracket were similar for the two studies (ranging from 6.40 -7.83), though because n=0 or 1 for age brackets "Less than 25," "25–34," and "45–54" in our study, these groups had a standard deviation of 0. The standard errors for CWH owners in each age bracket were on average much higher than those of the 2009 study. For the "65 and older" bracket in particular, of which we had the most responses, the standard error was three times larger than that of the other. The 2009 study had a wide age variation (SD= 93.10) and population of 2000. Ours featured a population of 37, with 86.49% concentrated in age brackets of "55–64" (n=12) and "65 and older" (n=20), and a relatively small age variation (SD= 8.38).

4.4 | Limitations

Initially, we considered a few potential limitations to our emailed survey to CWH owners. Some of which cannot be fully accounted for in survey design. General limitations include: lack of participation (43 returned surveys, 135 sent surveys,) response bias, selection bias, sample size (n=43 CWHs in California).

Potential respondents may have dismissed the survey as a waste of their time. We cannot control who responds, and generally those who respond will be those most enthusiastic about the CWH Program, skewing our data significantly. Selection bias will be mostly mitigated with randomized blind selection. Perhaps most detrimental to the scientific integrity of our endeavor is the sample size. To counteract some of the potential limitations, we designed our survey to entice our respondents to answer sincerely, completely, and without confusion.

4.5 | Analysis and Discussion

Our survey results demonstrate that the survey answers we collected are from a highly homogeneous group of respondents who are overwhelmingly non-Hispanic White, highly educated with a relatively high level of income. Surprisingly, our respondents are mostly seniors who are in the 60–80 age range. Research has suggested that in general people age 65 and above are least likely of any other age group to respond to survey requests, especially for electronic-based ones (Kailowitz et al. 2004), but we have pre-selected for electronic survey response through the NWF pre-survey.

Given the homogenous nature of the sample, we suspect that our respondents are so highly self-selected that they cannot sufficiently represent the general profile of all the CHW owners. Though we assumed variations among the respondents prior to the study, our results eventually reveals that the CHW owners chose to answer the survey are of highly similar profile in terms of demographic characteristic, environmental attitude, psychological stress level and sustainable practices. Additionally, the small sample size does not provide large statistical power. However, the data we collected communicates important information regarding the CWHs and their owners that are important for future improvement of the program.

To understand how the demographic characteristics of our respondents compare with the common demographics of their census tracts, we used the 2010 U.S. Census Bureau data results. A little more than half of all responding CWH owners have income levels above that of the median income level of their corresponding census tract (Figure 3). Comparing the reported education level with the average education level of their census tracts, we found that two thirds of all CWH respondents have a higher level of education than the average education level of their census tracts (Figure 4). Based on these comparisons, we were able to characterize the majority of survey respondents as non-Hispanic White, highly educated individuals with relatively high level of income.

4.5.1 |Environmental attitude and sustainable behaviors

In quantifying CWH owners' environmental attitudes, we used the New Environment Paradigm. Our respondents mostly believe that the earth has only limited resources and that humans are causing severe damaging to the natural environment and resources. To understand how the environmental attitude of our respondents compares to that of the general public, we found data in existing literature and compared the results.

In a research attempts to gauge college students' environmental attitudes, Rideout (2014) surveyed an east coast small liberal arts college with the NEP questions. He found that students are weakly pro-environmental and the endorsement remained the same during the years of college study. Class status has no effect on the NEP endorsement. Dunlap, Van Liere, Mertig and Jones did another study, applying NEP to measure the public's environmental attitude (Dunlap et al., 2000). The researchers sent out mail survey to a random sample of Washington state residents. Both of these studies reported NEP scores for each individual NEP statement, therefore enabling us to compare our results with what other researchers have found. The comparison is demonstrated in the graph below.

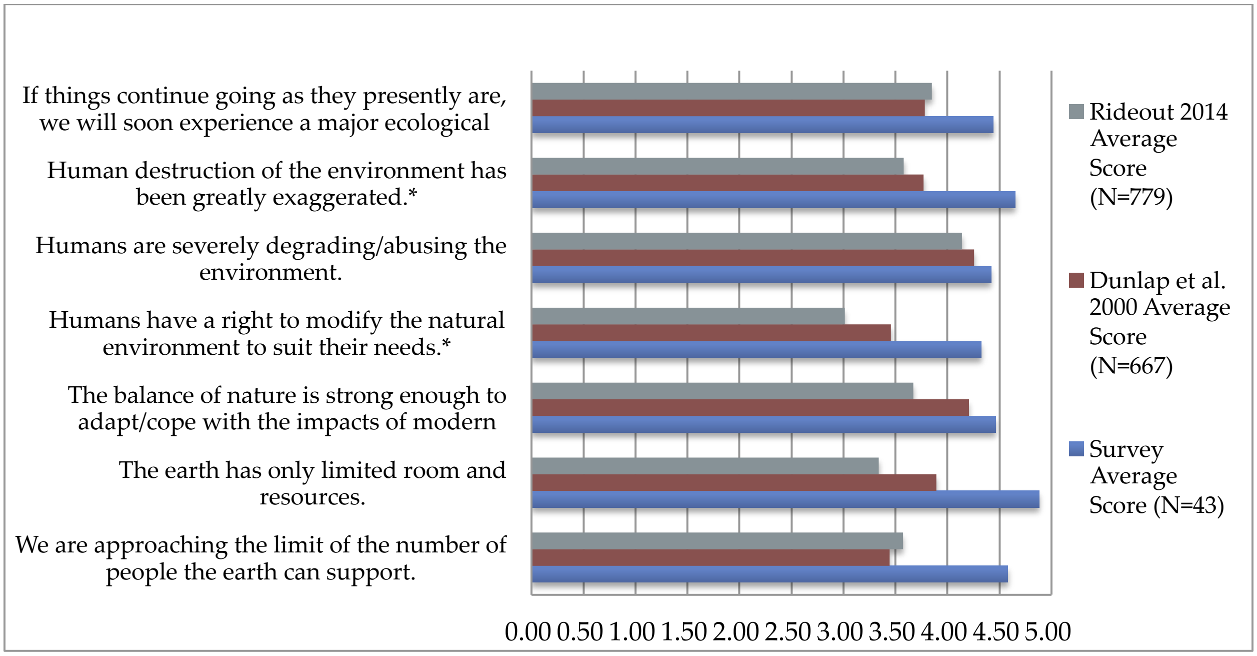

Figure 16 Average NEP scores from three different studies pertaining to specific questions taken from the New Environmental Paradigm. Survey scores are indicated by the blue bar where N=43.

Comparing with the results reported by Rideout and Dunlap et al., we conclude that our respondents are well above average public in terms of pro-environmental attitude, meaning that they are substantially more environmentally friendly than the general public.

Not only that our participants reported higher NEP scores compared with the general public, most of them reported offering more space for wildlife and sustainability as their motivations of becoming certified. This suggests that most of the respondents have had high awareness for environmental protection and sustainable practices before subscribing to CHW program. This result is not surprising given the respondents' education attainment. However, due to the time and resources limitations for this study, we are not able to quantify how might the participants' environmental attitudes have changed by being a CWH owner.

It has been argued that pro-environmental attitudes contribute to higher likelihood of behaving environmentally friendly (Stern, 2011). Our result indeed shows evidence for the connection between environmental attitudes and pro-environmental conducts. As respondents subscribe to CWH out of environmental motivations, they also reported practicing other kind of sustainable behaviors. In quantifying the owners' sustainable practices, we utilize the answers collected from four questions in the survey—plant types in the CWHs, stormwater capture device adoption, sustainable practices and chemical use in CWHs. We define having native plant coverage over 40% as sustainable practice, possessing any kind of water feature and using natural fertilizer as sustainable practices. All of the respondents reported doing at least two types of sustainable behavior.

The use of native plants is considered a sustainable practice because native plants are adapted to the environment in which it is native. The plant is adapted to the existing climate, precipitation pattern, and local soil and animals. Therefore, these plants are low maintenance and do not require the use of excessive amounts of water. Because native plants have evolved alongside the local wildlife in the area, the use of these plants can also support native wildlife species.

In addition to choosing to grow native plants, survey respondents also engage in stormwater runoff prevention. One way in which they do this through the land cover implemented in their CWH. The average CWH land cover consists of 58% non-grass vegetation such as trees and shrubs, 12% bare soil, and 7% lawn (Figure 8). This amounts to 77% of permeable surface through which stormwater can percolate through the ground rather than flow off into the streets and into stormwater drains. Out of the CWH survey respondents, 30% of CWH owners indicated using rain barrels and 42% reported having permeable pavement (Figure 9). We consider the implementation of these stormwater capture devices as sustainable practices because both devices collect stormwater runoff. Because urban stormwater runoff is the leading cause of pollutants to California's receiving waters (Smith & Perdek, 2004), creating space within urban areas for stormwater to percolate through the ground is an important practice to reduce the pollution that ends up in the ocean.

Survey respondents adopt sustainable practices such as, but not limited to, the avoidance of chemical pesticides and installing low flow utilities in an effort to be sustainable residents. An overwhelming proportion (97.6%) of respondents voluntarily recycle, 86% have low flow utilities, and 65% have some sort of composting system (Figure 10). Installing low flow utilities and composting take additional effort and a conscientious effort to use. The use of composting may explain the large number of respondents who indicated using natural fertilizers in their CWHs. Approximately 77% of respondents reported using natural fertilizers while 28% reported using artificial fertilizers. None of the respondents reported using rodenticides, which are used to kill rodents. Rodenticides can also kill non-target mammals when ingested and can also harm birds (Bartos et al., 2012). CWH owners' decisions to avoid the use of rodenticides may a result of their desire to act responsibly toward the environment and not endanger the wildlife. The true explanation behind their actions can be a future topic of interest though because a small percent of CWH owners do use pesticides and herbicides in their CWHs.

By adopting all kinds of sustainable practices mentioned above, our respondents generally keep their CWHs environmentally friendly, which in turn may have promoted their CWH's attractiveness to wildlife. Our survey results suggest that CWHs are attractive to certain species, and that these species are more adaptable and mobile than the others. From our results, the most frequently sighted species reported by 43 respondents were winged organisms: monarch butterflies (86% respondents reported sightings), bumblebees (97%), hawks (100%), and hummingbirds (100%). Species with the ability to fly are able to roam and access different habitats more easily than walking or swimming species. This suggests that CWHs are not necessarily attractive to animals that need large areas and land connectivity in order to thrive. On the other side of the spectrum is the Mule Deer, which was seen by 27.9% of respondents. One circumstance that may account for the lack of sightings is that most CWHs are not located on wildlife "corridors". Deer, like other large herbivores, need plenty of room to move about in order to thrive. As most of the properties we surveyed were in relatively urban or suburban areas, which accounts for less frequent deer sightings. From our i-Tree assessment, we observed that few CWH properties were found in intact open spaces where mule deer would typically roam.

We suspect that the high frequency and variety of wildlife spotting is related with the respondents' contentment with their CWHs and their psychological health. From our survey results we can gauge the health of CWHs as ecosystems. Of the 12 species that we asked our participants about, a few of them are considered indicator species, that is they are species that are moderately affected by disturbances to ecosystems, and can act as an index of ecosystem health. Monarch butterflies, bumblebees, and frogs are common indicator species that we questioned our participants about. It was found that bumblebees and butterflies are very common, but frogs were less frequently reported because they require specific habitats that are not required to become certified. Both monarchs and bumblebees are pollinators, and this is another sign of ecosystem health. Though frogs were not as readily present, there were still ample butterflies and bees, which may indicate that CWHs readily provide habitats for these species.

When comparing the PSS scores of our CWH owners with the number of hours spent in their yards after certifying them, we did not find a significant correlation. When looking in general at the change in time spent in the yard before and after certification, we found that on average CWH owners reported spending 82.12 more minutes outside after certification (Figure 15).

Perceived stress relates to physical and psychological well being. When comparing scores of our population with average amount of time spent by the owner in their CWH after certification, we were hoping to see that scores decreased with increasing time. The lower the score, the less is your perceived stress for this scale. We found no correlation. Most likely our sample size (n=37) was not large enough to show such a correlation. It might be useful though if new CWH owners are given the PSS scores before and after certification, to see whether there is a correlating difference in perceived stress and change in time spent in the CWH area.

Still we would like to note how owners spent on average more time in their CWH area after certification, and as mentioned in the literature review exposure to natural settings helps shifts the mind and body toward more positive emotional states and better physiological activity levels.

Comparing our CWH owner scores to those of the general US population was another measure with which to see whether those owning a certified wildlife habitat perceived less stress. The CWH owners did have a lower score on average than that of Cohen and Janicki Devert's study (M= 11.55 compared to 15.27), but when comparing the two populations, our survey had far fewer respondents, with a majority of the population concentrated within the two highest age brackets (n=32 of a population of 37), a non-representative population sample (the standard error for each age bracket was large; 3 times higher than the 2009 study for "65 and older") and a nonrandom sampling method. Cohen and Janicki-Deverts (2012) 2009 sample on the other hand "was balanced to be representative of the general population based on region, sex, age, and household income data … with counties as primary sampling units" and chosen randomly.

We might actually be able to interpret our population's average score as representative of a subset group of Cohen & Janicki-Deverts' sample population. Their research found that unemployed persons reported high levels of stress, while retired reported low, and that stress increased with decreasing age, education, and income. Our CWH owners with their low stress score, somewhat match up with their finding, as our population was an older group, with an average age of 64; highly educated, with 66.6% reporting education levels higher than the most dominant level in their census tract, and wealthy, with 52% reporting incomes higher than the surrounding population.

5 Case Studies

5.1 | Introduction to Case Studies

We visited and interviewed three local Los Angeles Certified Wildlife Habitat owners in the following neighborhoods: Brentwood, Malibu, and Manhattan Beach. These properties were chosen based on prior willingness participate in research and the proximity of property to UCLA, for transportation logistic reasons.

In-person interviews are optimal, because they allow us to collect honest responses and the true beliefs of our respondents, as well as putting a face to our quantitative survey data. Furthermore, these visits to CWHs allowed us to examine the physical features, vegetation, and wildlife present on the property.

Mimicking our i-Tree evaluation, we attempted to compare the three Los Angeles Case Study residents to their non-certified neighbors. We were curious to see how non-certified neighbors compared CWH owners in environmental attitudes, sustainable practices, and perceived stress levels. To do this we modified the online survey distributed to California CWH owners, removed CWH specific questions and wording, and knocked door-to-door in the three selected neighborhoods.

5.2 | Methods

5.2.1 | CWH Visit Methodology

In groups of 2–3 researchers, we visited CWHs to conduct qualitative in-person filmed interviews and record their responses for reference in later research. All CWH owners were first asked to agree to and sign a "consent to participate in research" form and a media release form. In the interview, we asked the following questions not included in our online survey:

1. How did you find out about the Certified Wildlife Habitat program?
2. Does your Certified Wildlife Habitat require maintenance (weeding/watering/irrigation)?
3. Do you frequent local or national parks and designated nature areas?
4. Did you modify your property to meet CWH requirements, or did it already qualify for certification?
5. Do you think it is important for others to have CWHs?
6. What do you hope to accomplish by having a CWH?
7. What did you learn from you certifying your habitat, if anything?
8. What kind of animal do you see most frequently?
9. How do you think your CWH contributes to conservation?
10. Is there anything you want to mention about your CWH that we haven't asked in the interview?

5.2.2 | Surveying Non-Certified Neighbors Methodology

First, we mailed out a postcard to 20 selected residences in each neighborhood of our three case studies. These were mailed out prior to our site visits and informed selected residences of the general purpose of our research, date and time of our visits, and our contact information. This preliminary postcard gives residents the opportunity to contact us for questions and concerns and to actively volunteer in our research.

Neighboring mail addresses were selected based on their proximity to the CWH properties, comparable property type (residential), and comparable property size, and were identified using Zillow.com, an online real estate database of more than 110 million U.S. homes.

Because we received no response from our postcards, we systematically visited each of the prospective 20 comparison properties and knocked on their door. Once we found a volunteer from this door-to-door approach, we asked them to complete a survey (a modified form of the survey sent to California CWH owners.) We repeated the process in all three neighborhoods.

To incentivize non-CWH owners to participate in our written survey, we raffled off one $25.00 Amazon gift card per case study neighborhood. By completing our survey, the resident was entered into their neighborhood's raffle once.

The written survey allows us to assess the social, psychological, and physical benefits of residences without CWHs in the neighborhoods of our case studies. We asked them to fill out a modified version of the survey emailed to CWH-owners, which did not contain CWH specific questions. We asked residents to leave their completed surveys outside their front door, and waited 30 minutes before retrieving the completed surveys.

We reached out to a fourth CWH owner located in the Brentwood neighborhood of Los Angeles. The certified habitat was identified by a NWF "Certified Wildlife Habitat" sign displayed on the front of the property. The owner was then asked in-person if she wanted to participate in our research. All owners except the Brentwood owner, were contacted first via an introductory email and then a phone call or secondary email to schedule a visit time. We were able to set up a site visit with two of the three initial CWH owners contacted by email.

5.3 | Results

5.3.1 | CWH Visit Results

We spent an average of 1 hour at each site interviewing, filming footage of the CWH and any wildlife it attracted.

5.3.2 | Malibu

Through our case study visits, we were able to learn about CWH owners in personal settings and learned details we would not have been able to discover through an email survey. During our case study visit to Malibu, we met a CWH owner named Georgia. She is a huge proponent of citizen science and participates in many of the wildlife sighting websites online. Georgia is a well educated, wealthy, White, older woman who dreamed of becoming a marine biologist but ultimately pursued a different path. Her garden was full of native plants and she knew the species of approximately 95% of the plants on her property. In addition to having a certified wildlife habitat, she also has an eco-friendly home, which was built with the intention of being energy efficient.

Georgia faced several large limitations to creating her Certified Wildlife Habitat. The location of her house receives very strong winds, which has killed many of the plants she has tried to grow in the past. The wind influences what she can and cannot grow in her yard. The region around their home is also very vulnerable to wildfires. This also dictates what she grows in her yard because she doesn't grow anything that easily catches fire.

5.3.3 | Brentwood

In addition, we visited Laurie's certified wildlife habitat in Brentwood. She first heard about the program on television, in a show called "Backyard Habitat." Here CWH requires regular maintenance, including frequent seeding and bird feeding. She considers it to be a low maintenance habitat. Birds, namely hummingbirds, most frequently visit the habitat. Laurie describes her habitat as "hummingbird alley." In the evening, possums and raccoons pay their respects to fallen seeds.

Laurie strongly believes that it is vital for others to have certified habitats in their backyard. She is an advocate of creating such habitats in schools, hospitals, and businesses. She believes the relaxing effects of CWHs give a bit of direction to those who have no direction in life.

5.3.4 | Manhattan Beach

Our final Case Study was conducted at Manhattan Beach. We visited the habitat of a woman named Pat. She prefers native vegetation to non-native plant species, and uses birdbaths as water sources in her habitat. Each day, she and her husband set out birdseed on their porch to feed the sparrows, jays, and mourning doves that frequent their yard. Pat believes that Certified Wildlife Habitats and similar endeavors are vital to protect vulnerable species and ecosystems negatively impacted by humans.

Pat explained that abrupt temperature changes are mitigated by the proximity of her home to the Pacific Ocean. Because of this, she said, different species of wildlife have better opportunities to make her habitat their home, or temporary sanctuary.

5.4 | Limitations

We received 8 fully or partially completed surveys from non-CWH neighbors in all three case study neighborhoods combined. The common responses were:

1. No one answered the door.
2. The person who answered the door was a housekeeper, butler, or not the owner of the house and was not eligible to take the survey
3. The owner said they were too busy or did not have the time to participate.

5.5 | Analysis and Discussion

5.5.1 | Case Site Discussion

From our case site visits, we learned that CWH owners are inclined to be sustainable residents. These owners have a love for wildlife and opt into the program in order to actively participate in creating safe habitats for wildlife. Out of the three participants we interviewed, all three believe their Certified Wildlife Habitats are vital in protecting species' habitats. The information we gathered during our interviews offers additional support to the data we gathered from the statewide email survey. From the survey we learned that most CWH owners have environmentally friendly attitudes, voluntarily engage in sustainable practices, and have a desire to create spaces for wildlife to enjoy. These three traits were common among the three owners we visited as well.

6 Recommendations

6.1 | Marketing

6.1.1 | Ecosystem Benefits

It is vital to encourage CWH owners to plant trees on their properties. In addition to sequestering known greenhouse gases, trees in urban and suburban settings offset the heat island effect and reduce air pollution.

Because cities can be up to 3°C warmer than surrounding areas, have an abundance of concrete and "dark surfaces… that efficiently absorb [and] reradiate" heat, and often at the same time, have a lot of "cars, air conditioners, heating units, and electrical equipment generat[ing] heat" (Del Tredici 2010), warm months of the year can bring especially debilitating heat waves to the city (Frumkin 2002). Because of the "urban heat island effect," there is an increased likelihood that "heat strokes, exhaustion, syncope, and cramps" (Kovatz et al. 2008) and even death for those with cardiovascular and respiratory illnesses (Patz et al. 2005) will occur. While the elderly, the mentally ill, women, and children, are at especial risk of these health ordeals (McMichael 2006), everyone has a part to play in keeping temperatures cool.

The same characteristics that enable trees to improve air quality also help to mitigate the city and neighborhood heat coming from engines, asphalt, and concrete (Del Tredici 2010). Trees enhance ventilation, capture and release water, and provide shade. While trees with dense canopies can contribute to the stratification of air temperature layers, concentrating heat near the ground, a well-positioned "isolated tree… with a high stem" can alter airflow to move heat away from an area (Givoni 1991). As with air pollution reduction, a large tree leaf surface area matters, for heat reduction, in two respects. First off, the leaves are a location where the plant can contribute water directly to the air (Novak 2006; Breuste et al. 2011). To reduce heat in the leaf and the air surrounding it, a plant releases, or transpires water through leaf stomata, and "consumes energy from solar radiation [to] increase latent rather than sensible heat" in its vicinity (Bowler et al 2010; Givoni 1991). Trees are effective in this evapo-transpirative cooling, as even one tree can "transpire 450 L of water [in a] day [and consume] 1000 MJ of heat energy" (Bolund et al. 1999). Tree leaves are important in a second regard, in that they can provide shade (Ibid). The larger or more leaves a tree has, the more it is able to block infrared radiation from reaching the ground surface. Positioned by the street, a tree with a lot of foliage can prevent the sun's radiation from reaching the "impervious... asphalt and concrete" which have low heat capacities and will increase in temperature and sensible heat quickly (Bowler et al 2010). Some urban planning research indicates that large trees can provide up to 70% shade during the spring and autumn months (Gomez- Munoz et al. 2010). It is important though to consider using a mix of trees species for temperature regulation, to ensure that evapo-transpiration and shade are available when needed, i.e. the warm seasonal months. Lastly, trees and other plants can provide indirect local cooling by enhancing soil moisture. Tree roots facilitate percolation of surface water into the ground, by breaking up soil clumps and increasing soil porosity while also drawing water towards the tree (Givoni 1991). Because of its high heat capacity, higher levels of water in the soil mean more soil heat retention, with minimal surface temperature increase.

For economic and ecological reasons, it is important to encourage planting native species, whilst promoting the battle against air and sound pollution, the urban heat wave, and poor soil quality, with tree planting (Del Angel-Perez et al. 2004). Adapted to the microclimate, native plants are likely to survive well and require the least water expenditures and maintenance. Also planting native provides the opportunity to incorporate local food crops into one's diet and garden, which can (Escobedo et al. 2011) help ameliorate dependence on a fluctuating food market. Ultimately though, native vegetation provide apt niches, habitats, and food sources for native animal species/ wildlife, which the National Wildlife Federation aims to support. A well thought out home garden can create a safety net for both humans and animals.

6.1.2 | Wildlife Benefits

The Certified Wildlife Habitat program is already a great proponent of citizen science. This is something that we feel can be capitalized on when marketing the program to citizens. As we saw from our case studies and survey results, birds and bees were some of the most common inhabitants of CWHs. This program can encourage citizen science such as bird watching, as well as the documentation bee populations.

There was a lack of larger, more terrestrial-bound animals spotted in the CWHs we surveyed and visited. However there were many birds and other flying species. The NWF can market the CWH program as an attractor of birds, and other flying species, and put less stress on attracting species that require corridors and connectivity between habitat patches.

6.1.3 | Human Benefits

In terms of human benefits derived from tree coverage, it is important to note that trees can help reduce air and sound pollution as well as the urban heat wave. The automobiles so connected to our homes release two airborne pollutants that are especially hazardous to our respiratory systems: PM_{10} and ozone. Rises in PM_{10} levels by even 10µg/m^3 are associated with increases in asthmatic attacks by 3% (Dockery 1994) and risks of mortality by 1% (Seaton et al. 1995). Vehicle exhaust, by releasing hydrocarbons and nitrous oxide fumes, also aids in the formation of ground level ozone, which contributes to "higher incidences and severity of respiratory [ailments, leading to not only] worse lung function, [but also increased] emergency room visits and hospitalization" (Frumkin 2002).

Trees that allow airflow, have many or large leaves, and release relatively few volatile organic compounds (VOCs), can serve as a backyard defense against these pollutants. Trees can help moderate clean air flow and dissipation of polluted air (Givoni 1991; Nowak et al. 2006). The combined effect of a city's tree leaves have the potential to reduce CO_2, SO_2 and NO levels (McPherson et al. 1997) at a "magnitude of… hundreds to thousands of metric tons per year" (Nowak et al. 2006).

Also, it would be good to teach how trees, can help reduce the urban heat island effect, as cities tend to be up to 3°C warmer than surrounding areas, have an abundance of concrete and "dark surfaces… that efficiently absorb [and] reradiate" heat, and often at the same time, have a lot of "cars, air conditioners, heating units, and electrical equipment generat[ing] heat" (Del Tredici 2010), while warm months of the year can bring especially debilitating heat waves to the city (Frumkin 2002). Trees meanwhile can enhance air ventilation, capture and release water- cooling the air (Bowler et al 2010; Givoni 1991) and provide shade. Also trees can provide indirect local cooling by enhancing soil moisture. Tree roots facilitate percolation of surface water into the ground (Givoni 1991), and with its high heat capacity, water can help keep the soil and surface temperatures low.

Lastly, trees can directly and indirectly reduce loud noises. At certain levels sound can impose physiological and psychological stress (Skanberg 2001), which can include anywhere from feelings of annoyance to decreased ability to think straight, to sleep problems, high blood pressure, and hearing loss (Passchier-Vermeer et al. 2000). By keeping the ground porous and soft, tree roots can decrease sound propagation (Bolund et al. 1999) also strategically placed trees and dense shrubbery can effectively diminish sound travel (Bolund et al 1999; Aylor 1972; Fang 2003), by masking, scattering and "absorb[ing] [the] acoustic energy" (Aylor 1972; Pathak et al 2007), as well as even forming a vegetative sound barrier (Fang 2003).

Apart from physical benefits, it is important to mention how the presence of trees, and the availability of really any green space can serve as a potential reliever of mental stress. Gidlof-Gunnarsson et al 2007, found in his study how just spending time outdoors, in "green areas [reduces] the prevalence of stress-related psychosocial symptoms" (Gidlof-Gunnarsson et. al 2007), such as "depression… aggression, [and] excessive use of [drugs]" (Passchier-Vermeer et al 2000). While the PSS portion of our questionnaire failed to show a correlation between amount of time spent outside in the CWH and perceived stress, so many other studies have shown that providing people with outlets to nature via green spaces, views of nature, or increased biodiversity can improve human mental health (Barton & Pretty, 2010), increase the human feel good factor (Dallimer et al., 2012), reduce crime rate (Donovan & Prestemon, 2010) and provide benefits such as increased productivity in the workplace (Lohr, Pearson-Mims, & Goodwin, 1996).

6.2 | Target Audience

6.2.1 | Continue targeting current demographic

We recommend that the NWF continue to target communities consistent with the current demographic of the program: white (non-Latino), elderly well educated citizens who act due to their strong beliefs about environmental conservation. That said, additional segmentation of the market is required for expanding the continuing success of the program.

6.2.2 | Younger generation

From our survey results, we found that most CWH owners are older, white, wealthy people. To widen the participation in the program, and capitalize on the educational qualities that the CWH program possesses, the NWF could reach out to a younger population in schools. Contacting teachers, doing presentations in classrooms, and helping facilitate the establishment of CWHs in schools, could reach a much wider and unique audience.

6.2.3 | People who already participate in environmentally activities

We found that most of the participants in the CWH program were already sustainably minded people before they certified their yard, and that was one of their main motivations behind getting certified. To reach a larger audience, the NWF could target people who are already involved in sustainable practices and activities. The NWF could advertise at farmer's markets, environmental clubs, and other sustainability events in order to gain interest from a population that is most likely to be enthusiastic about the idea.

6.2.4 | People who have environmental attitudes (high NEP scores)

We found that most of the participants in the CWH program were already sustainability-minded people before they certified their yard, and that was one of their main motivations behind getting certified. To reach a larger audience, the NWF could target people who are already involved in sustainable practices and activities. The NWF could advertise at farmer's markets, environmental clubs, and other sustainability events in order to gain interest from a population that is most likely to be enthusiastic about the idea.

6.3 | Target Locations

6.3.1 | People in the path of migratory pathways for birds

From our survey results, as well as case study visits, we saw that birds were the most common animal sighted in CWHs, as well as what many homeowners were interested in attracting. We suggest that the NWF target populations within the migratory path of native bird species.

6.3.2 | People with balconies (apartments) suitable for bird/flying species

Through our research, we found that the Certified Wildlife Habitats make suitable habitats for animals that travel by flight. Examples of these organisms are butterflies, bumblebees, hawks and hummingbirds. On the other hand, mule deer, coyotes and rabbits were among the animals that were seen much less frequently.

We found that out of the CWH owner respondents, the majority of these individuals are among the upper class and highly educated. Most of the respondents indicated having a CWH on their residential properties.

Based on our observations, we recommend that the National Wildlife Federation take advantage of growing their program by reaching out to people of middle-class or low-income status who live in apartment buildings with balconies. Because CWHs most frequently attract animals that travel by flight, these animals could easily reach an apartment balcony to stop for food, water or shelter. The growth of more certified balconies would increase the number of places providing resources for birds within cities in areas that don't require people to have large amounts of property with lush yards. This would expand the demographic profile of CWH owners to people of other economic classes.

We recommend that NWF markets and advertises its program to people living in apartment complexes by offering simple examples of how to easily certify a balcony setting. For example, leaving a birdhouse, food, water source and any other resource could serve as a sufficient space for flying species to stop, rest and refuel. Posting suggestions on the NWF website and sending NWF catalogs or flyers to apartment complexes would facilitate the process for apartment dwellers who may not have the time or patience to put in all the work on their own.

6.3.3 | Campus-style corporate offices

The Facebook campus is already a Certified Wildlife Habitat, and we recommend the NWF to recruit campus-style offices, including but not limited to: YouTube (Culver City, CA), Google (Mountain View, CA), Pixar (Emeryville, CA), and Walt Disney Studios (Burbank, CA).

These campus style buildings are created to foster creativity and keep their employees happy and healthy. These offices are good candidates for Certified Wildlife Habitats because their employees could benefit from the stress relieving effects of green spaces (Ulrich 1991).

Furthermore, large corporations are always looking for ways to improve their public image and certifying their campus as a Certified Wildlife Habitat is an opportunity to do so.

6.3.4 | Universities

Potential candidates for certified wildlife habitats are university campuses. Most universities already have their own botanical gardens and meet almost all of the requirements of certified wildlife habitats. They are regularly maintained by university staff and attract several wildlife species, especially insects and birds. On a national level, there are thousands of campuses that have botanical gardens and could easily become certified wildlife habitats. Even converting a small fraction of botanical gardens could make a big difference for their respective local ecosystems.

For example, UCLA's botanical garden is certified, and it attracts numerous birds, insects, and other wildlife. It also drastically decreases surface temperature because it harbors many tree species, and the creek that flows throughout the garden absorbs heat. Many wildlife species call UCLA's botanical garden home. Furthermore, many people can be seen in the garden taking a lunchtime walk, or it acts as a rendezvous point for people to meet up and socialize. Not only are botanical gardens important for ecosystem health and wildlife, but they also integrate humans into the natural environment.

An important step is spreading awareness of this program. Many probably do not know of the Certified Wildlife Habitat program. Therefore, introducing the program to many universities is vital. This could be through emails to the botanical garden staff, outreach programs, or other means of communication. Even students can be used as mechanisms to spread awareness. Reaching out to different campus environmental clubs is a great way to involve students and the local university community to bring about local environmental changes that can accumulate and bring about national change. Impacting university students is an efficient way to reach universities and certify their botanical gardens. Transitioning to become certified wildlife habitats would take minimal effort, so university campuses seem like ideal candidates to provide conservation benefits.

7 Conclusion

Throughout this project, we have realized limitations, in answering in full the questions of client interest, in finding a comprehensive way to compare certified to non certified homes, in choosing questions to ask for the survey, in collecting enough participant responses, and of course in maximizing our time. Yet we feel that we have realized the main objectives of this project: to learn the value of CWH habitats in relation to neighboring homes, to find out how CWHs affect or relate to critical species, to learn the motivations behind those who certify their yards, to characterize and compare their environmental attitudes, stress levels, and demographics to the general population, and to measure their sustainability and the longevity of their certified wildlife habitats. We feel we have provided an intriguing data set in general in regards to the human, wild life, and ecosystem benefits of the certified wildlife program. In terms of application, such data can inform marketing tactics/practices on how, to whom, and what locations to promote/advertise the advantages of participating in the CWH program.

8 Acknowledgements

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are grateful to have had this opportunity and wish the best of luck to the class of 2015 in their IoES senior practicum experience.

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10 Appendix

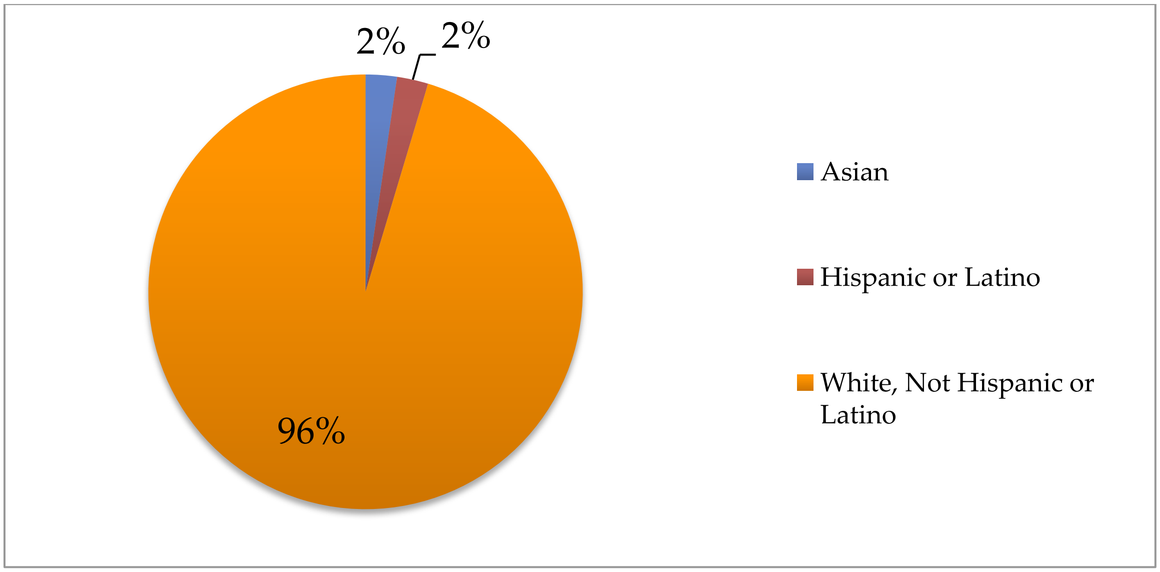


Figure 1. Ethnic representation of survey respondents self indicated on the statewide email survey (N=43).

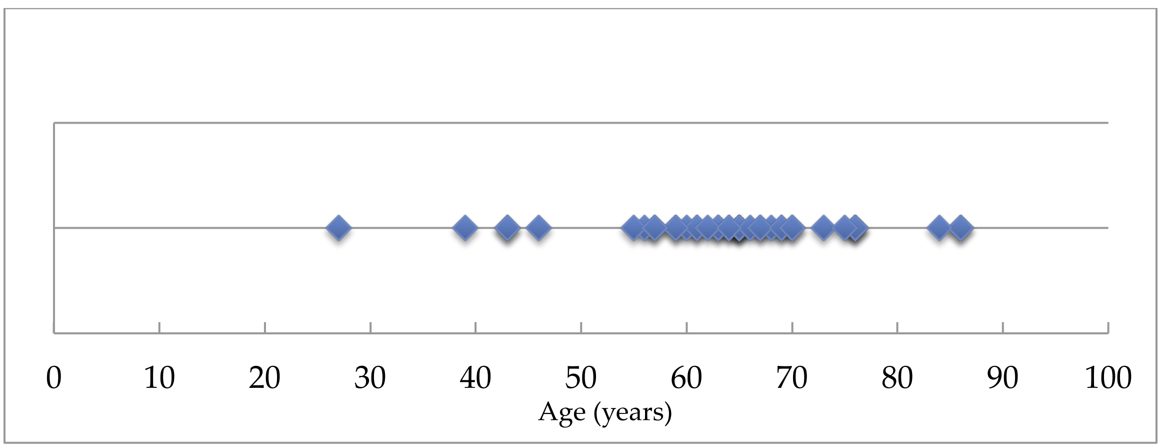


Figure 2. Age distribution of survey respondents with ages spanning from 27 years old to 86 years old. Average age is 64 years old and median age is 65 years old (N=43).

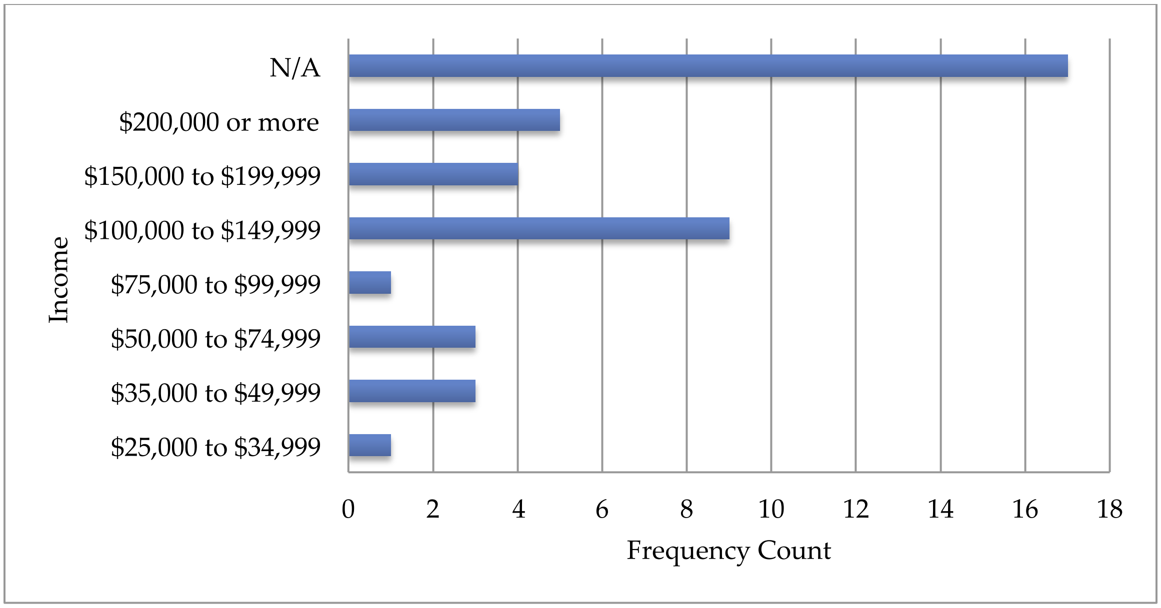


Figure 4. Respondents' Reported Income Levels from Survey (N=43). Due to the sensitivity of this data, 17 of our respondents did not report their household income level.

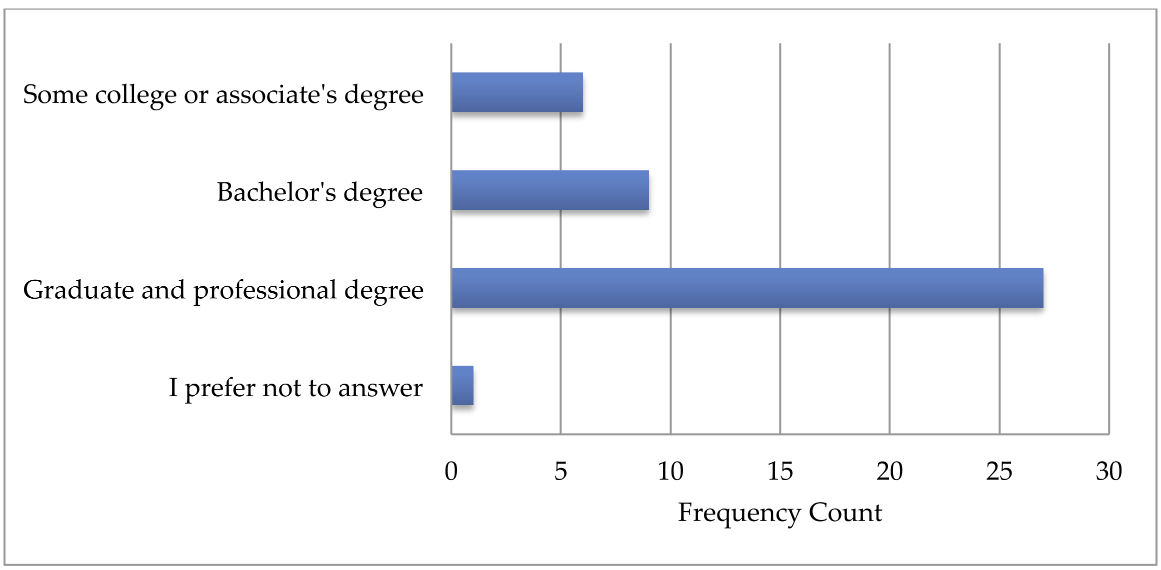


Figure 5. Respondents' highest levels of education in the household (N=43).

Table 4. Results from the survey section devoted to measuring respondents' environmental attitudes. Respondents are asked to indicate their level of agreement with the selected NEP statement. SA=strongly agree, MA=moderately agree, N=neutral, MD=moderately disagree, SD=strongly disagree. Answers for statement 3, statement 4 and statement 6 are reversely coded in calculating the total NEP score.

Selected NEP statements		SA	MA	N	MD	SD
1.	We are approaching the limit of the number of people the earth can support.	65.1%	30.2%	2.3%	2.3%	0.0%
2.	The earth has only limited room and resources.	95.3%	0.0%	2.3%	2.3%	0.0%
3.	The balance of nature is strong enough to adapt/cope with the impacts of modern industrial development.	0.0%	2.3%	2.3%	41.9%	53.5%
4.	Humans have a right to modify the natural environment to suit their needs.	0.0%	0.0%	7.0%	53.5%	39.5%
5.	Humans are severely degrading/abusing the environment.	74.4%	11.6%	2.3%	4.7%	7.0%
6.	Human destruction of the environment has been greatly exaggerated.	0.0%	0.0%	4.7%	25.6%	69.8%
7.	If things continue going as they presently are, we will soon experience a major ecological disaster.	65.1%	23.3%	4.7%	4.7%	2.3%

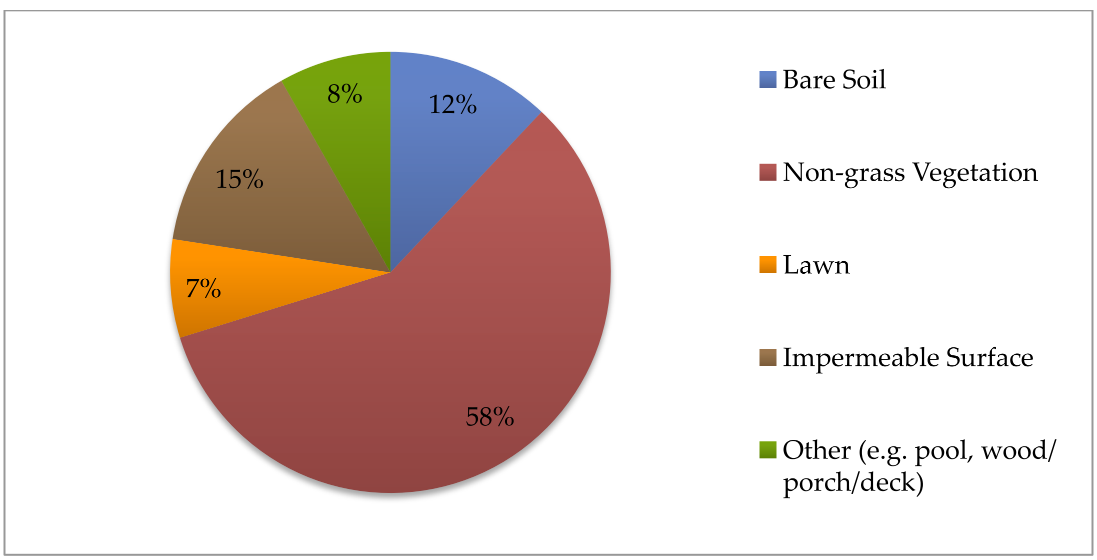


Figure 8. Average type of land cover within Certified Wildlife Habitats (n=42).

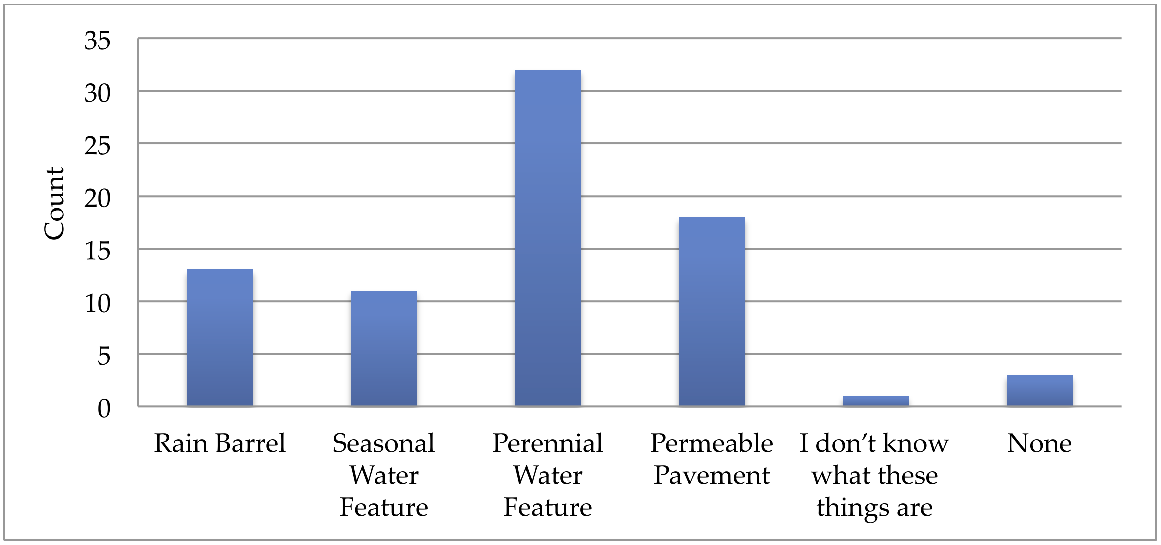


Figure 9. Results from a survey question in which participants were asked to indicate all of the following water features that existed in their CWH (n=43).

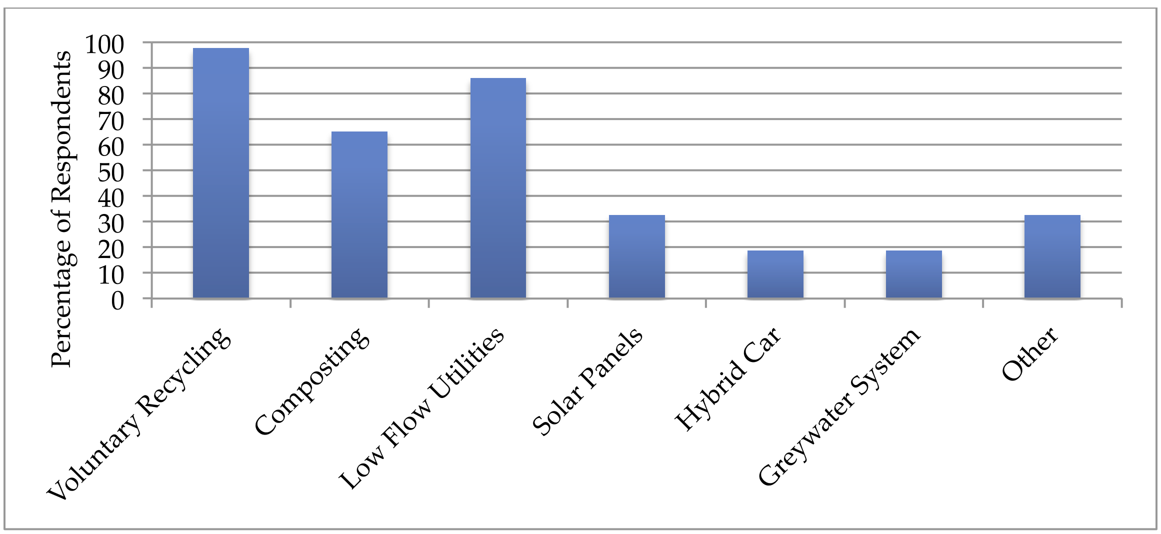
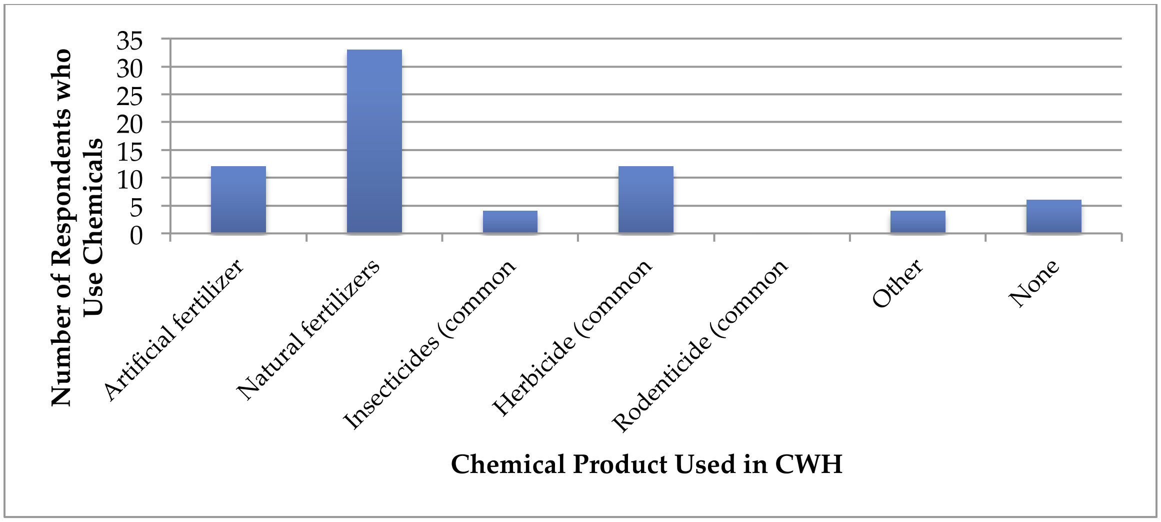


Figure 10. Results from a survey question in which participants where asked if CWH households participate in any of these sustainable practices. Participants were asked to select all options that applied (n=43).

Figure 11. Results from a survey question in which participants were asked to indicate all of the chemical products used in their CWH (n=43).



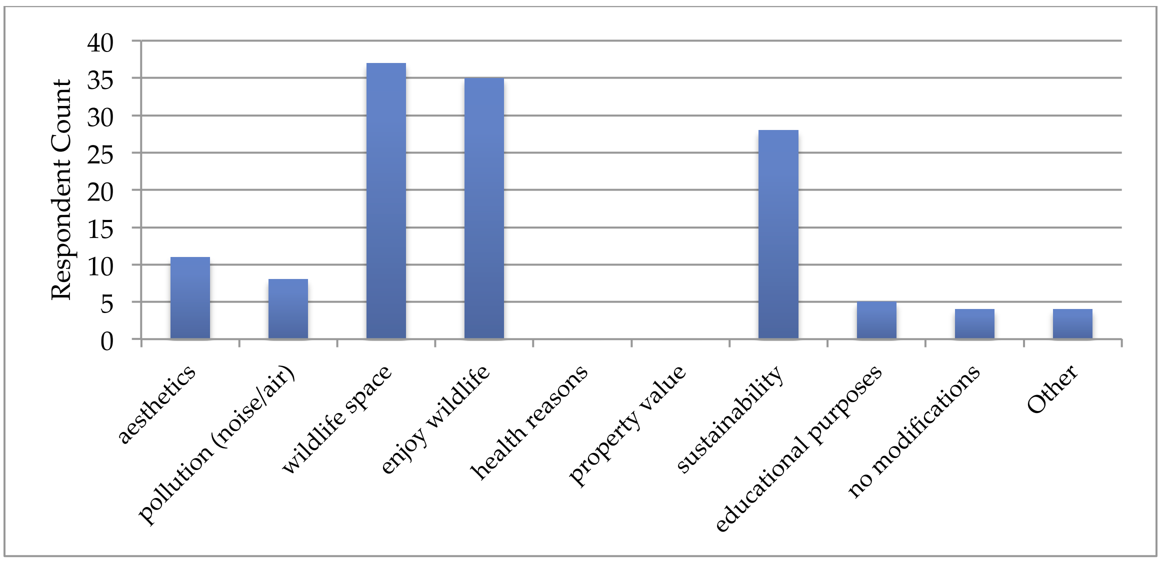


Figure 12. Primary motivations to become certified. Participants were asked to choose their top three motivations for attaining a Certified Wildlife Habitat. Sample size is 41 participants where each participant indicated three motivations. Total respondent count = 123.

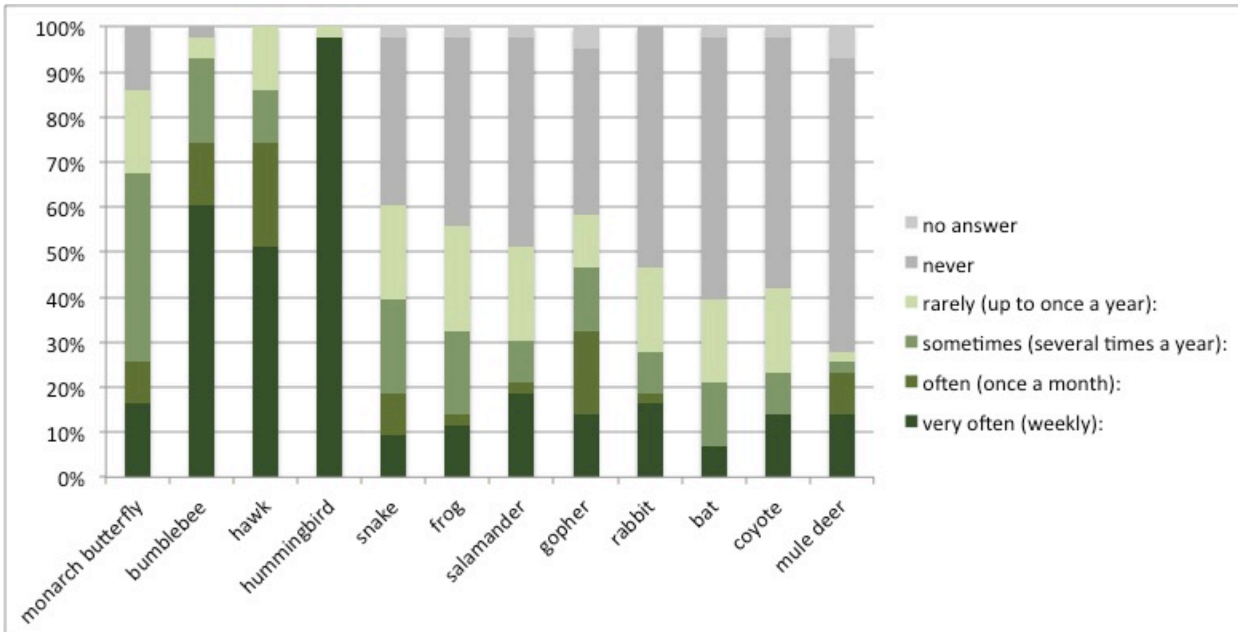


Figure 13. Visualization of certain wildlife species and how frequent they were spotted by certified wildlife habitat owners.

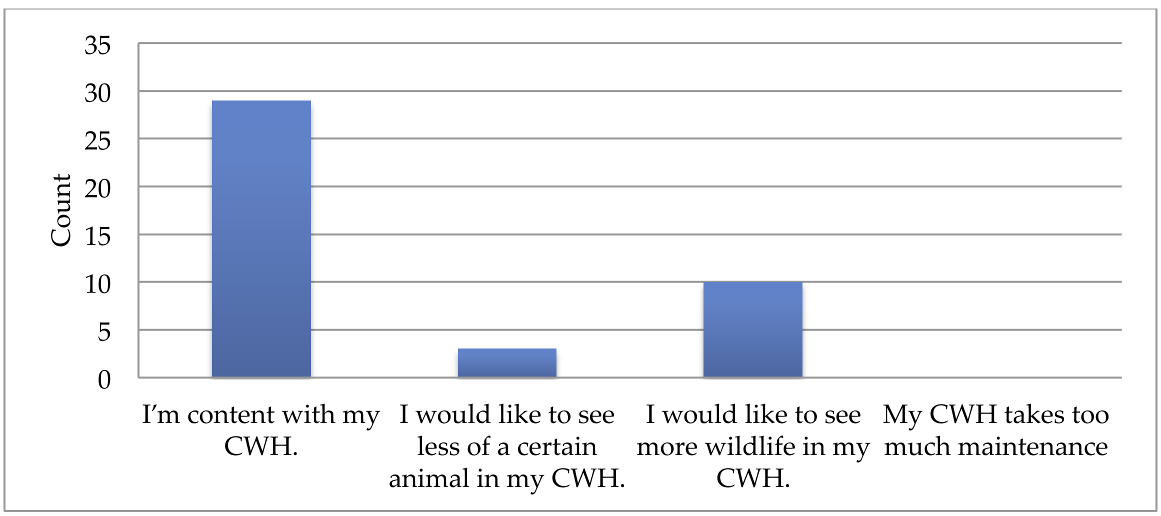


Figure 14. Results to a survey question in which participants were asked to choose which of the following statements best applied to them (n=42).

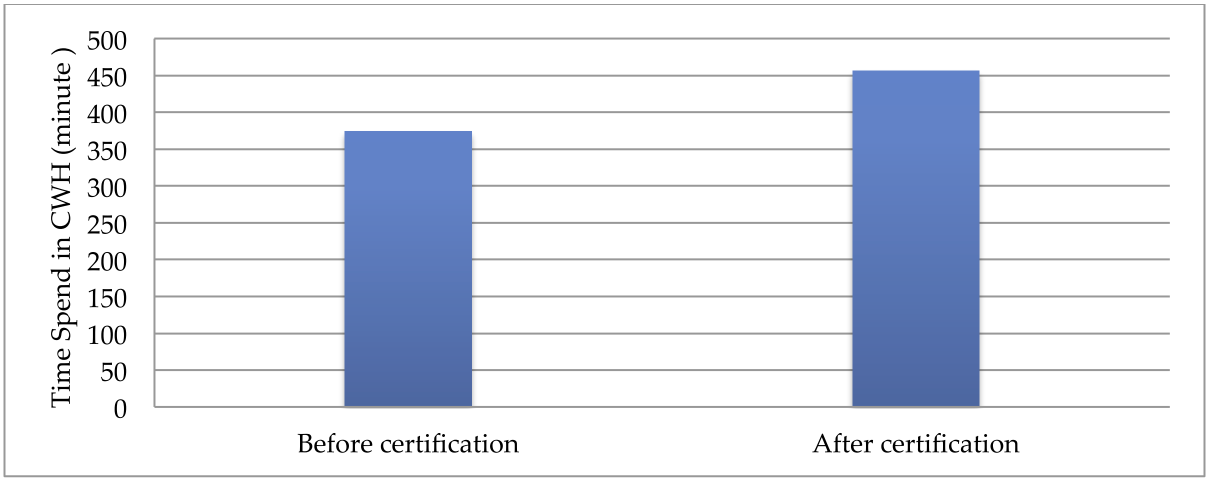


Figure 15. Average time spent in CWH before and after certification per week. On average, CWH owners spend more time outside in their CWH after certification than before certification by 82.12 minutes (n=41).