Feeling Green

The Benefits of Green Space on Urbanites' Mental Health

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by

Kathryn A. Hoagland

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Introduction

Human society is shifting to an increasingly urbanized way of life as the population continues to grow. A reliance on industry and technology and increasingly dense construction at urban centers also pushes this shift towards urbanism and away from a rural way of life. As of 2014, 54% of the world's population lived in an urban area, and by 2050 it is projected that 66% of the global population will reside in an urban area (30). The World Bank's data on urban populations shows this steady upward trend from 1960, when only 33% of the world's population, or 1.019 billion people, lived in an urban area (29). Shown graphically in **Figure 1** below, the rate of urbanization is positive and has increased dramatically since 1950, whereas the the world's rural population growth has tapered off and is projected to decrease slowly as we approach 2050, even with a growing total global population.
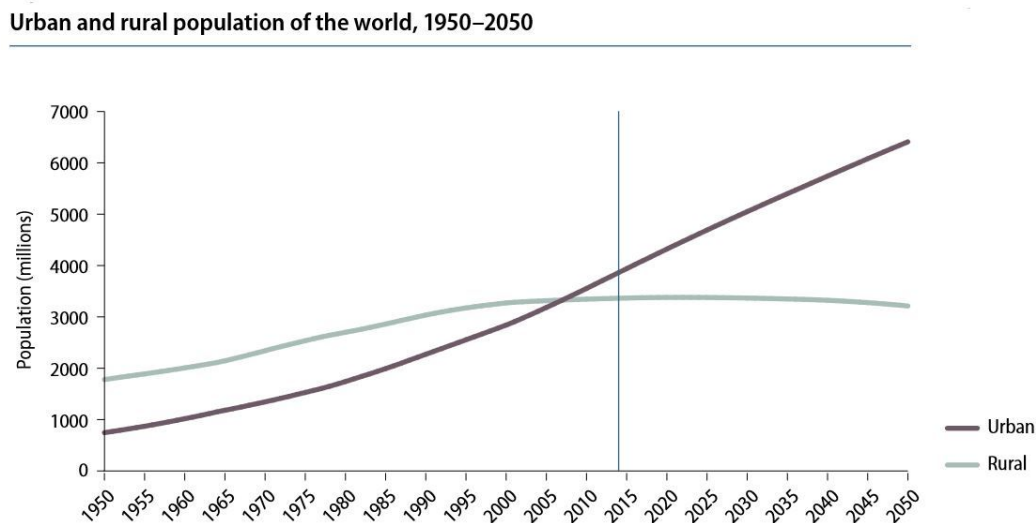

Figure 1. Urban and rural population of the world, 1950-2050, United Nations, (30).

As more people move towards urban loci, city infrastructure and design must shift to accommodate the increasing density of urban populations. Human history has never seen as many people living in urban centers as it sees today, and if the predicted continuous steady upward trend in urban populations globally holds true the world will need to handle the currently unknown repercussions of urbanization at these high future levels. Planners, engineers, and psychologists will play a key role in shaping these swelling urban centers into sustainable, healthy, happy, and productive systems.

Application

Ideas discussed in the following pages may be useful to city and county planners when determining why and how accessible nature should be implemented into community design. The benefits of accessible green space on residents' mental well-being are not always obviously quantifiable, but research does show these spaces may have some mitigating effect on certain mental health disorders. To implement green space as a benefit to mental health most effectively, it is important to consider what qualifies as a useful green space, and what characteristics that green space needs to have. The following pages will give a detailed look into the need for health-conscious design and how nature can play a role in that design most effectively.

Background on Urban-Rural Differences in Mental Health

With an upward trend in global population levels we see a shift towards an increasingly more urban way of life and social structure. This comes with a plethora of new and unforeseen consequences for human health, both physical and mental. Many times, mental health issues go unnoticed until they become extremely tragic, but city planning and design have the potential to help mitigate these issues before they develop into something with tragic consequences. Shown below in **Figure 2**, we can see that suicide rates have increased across the board from 2004 to 2013 (20). While the rate of suicide occurrence has increased more so in rural areas than urban areas there is still a general upward trend over the past decade among the population of the United States, which implies an upward trend in various mood-related mental conditions as well, since instances of suicide are often associated with these conditions.
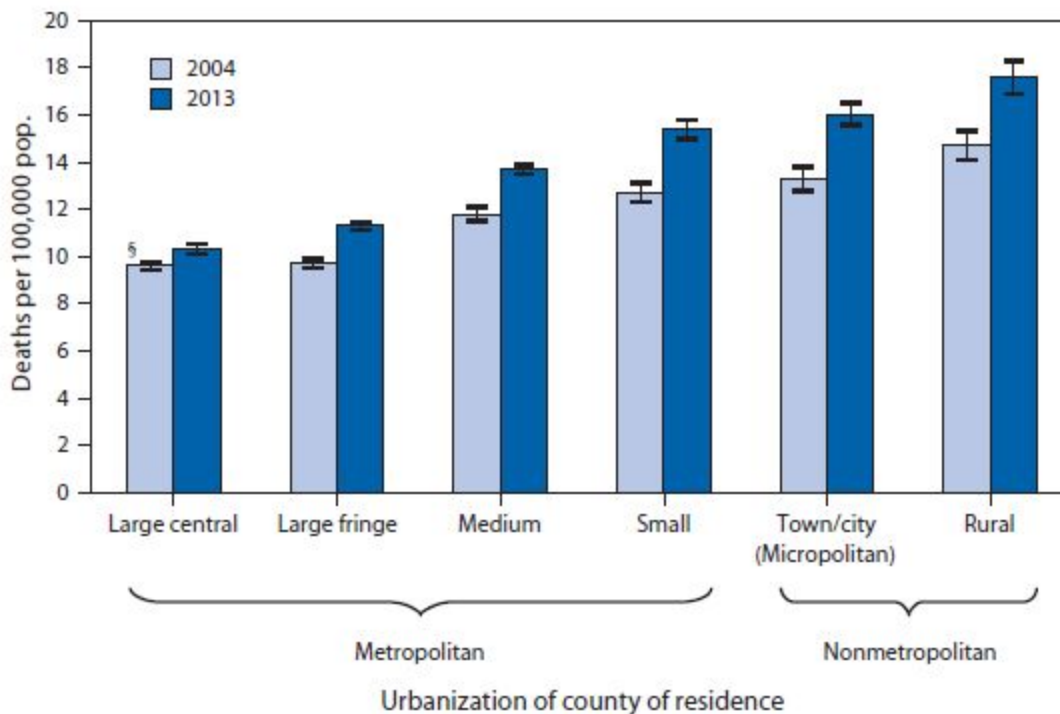

Figure 2. Age-Adjusted Rates for Suicide, by Urbanization of County of Residence, CDC, (20).

Using the most recent data from 2008, the reported population percentage of adults in the United States given a diagnosis of depression in their lifetime is 16.1% (21). Surveys given continuously from 2005 to 2008 report rates of depression experienced in the two weeks prior to an individual taking the survey as 6.8%, though this varies substantially by state likely due to demographic characteristics, socioeconomic conditions, and access to health care (21). By comparison, an estimated 9.4% of the U.S. population was living with diabetes in 2015 (15). That is to say, when comparing the prevalence of depression in 2008 to the prevalence of diabetes in 2015, over 1.5 times the number of people with diabetes likely live with a diagnosis of depression in the United States. Rates of a lifetime anxiety diagnosis were similar to those of depression, though data from the Center for Disease Control was not as complete for that specific issue.

Estimates on depression and anxiety rates in the United States were calculated by the Center for Disease Control using the National Health and Nutrition Examination survey and the BRFSS state-based telephone survey, which specifically implemented Patient Health Questionnaire-8 and Patient Health Questionnaire-9. Both of these questionnaires are widely used and are considered valid instruments for measuring rates of depression in population-based surveys (21). Survey methods are often useful in calculating prevalence of mental health disorders, due to their anonymous, private, self-reported nature. More quantitative calculations such as antidepressant prescription rates can be useful but are often not wholly representative, as many individuals with mental health disorders choose to remain unmedicated or only use healthcare services as needed, often sporadically.

Economic Repercussions. Mental illnesses such as depression and anxiety among adults in the United States are not only a public health issue or social issue, but an economic issue as well. According to an editorial in the American Journal of Psychiatry by Dr. Thomas Insel, based on the extrapolation of results from the National Comorbidity Survey Replication (NCS-R), a conservatively estimated $193.2 billion is lost in earnings per year due to effects of serious mental illness (9). This survey did not account for individuals diagnosed with schizophrenia or autism, and did not account for cost of healthcare for comorbid conditions or loss of productivity due to premature death, institutionalization, incarceration, or homelessness (9). If this estimate is conservative it is likely that a considerably greater amount of wages are actually lost per year due to serious mental illness, considering the magnitude of the aspects not accounted for in this study. Loss of economic productivity in a nation that prides itself on wealth, capitalism, individuality, and success should make mental illness prevention and healthful environmental design an attractive priority issue for politicians and social justice advocates alike.

Urban-Rural Differences in Mental Health. Urban-rural differences in mental health have less substantial amounts of data, as these studies are often complicated by definitions of what is urban and rural, as well as outlying cultural and socioeconomic factors and faults in survey methodology. While there is less of a consensus on the question of whether instances of mental illness are affected specifically by urban-rural differences and why this might be, there are many studies that give us insight into statistics and potential compounding reasons for increased levels of mental illness in urban areas.

The first complication of these studies comes with the researcher's definition of "mental illness." For this paper we will be focusing specifically on research relating to depression and anxiety, as these illnesses are often affected by environmental factors that are more present in urban areas than rural areas. According to a meta-analysis of urban-rural differences in mental health by Peen, Schoevers, Beekman, and Dekker, the pooled urban prevalence rates of both mood disorders and anxiety disorders were significantly higher in urban areas when compared with rural areas, however no difference was found for substance use disorders (18). This study was restricted to population surveys in developed countries presenting urban-rural differences in psychopathology since 1985 (18). Depression rates in urban areas of Canada were shown to be modestly higher than depression rates in rural Canada in a study by Romans, Cohen, and Forte (23).

Romans et al. investigated confounding factors such as age, marital status, education, household income, physical activity, perceived stress, sense of community belonging, and social support. An interesting relationship researchers found was that, "Participants in the urban core and urban fringe had a weaker sense of belonging to their community and reported lower social support" (23). In residents of rural areas of Canada, lower rates of depression were associated with a stronger sense of community belonging (23). When looking at urban community design, these social capital factors may be key in creating the best community design to benefit mental health. Poor physical health was also strongly associated with high rates of depression (23). These correlations were extracted from data gathered by the Canadian Community Health Survey 1.2, a national survey with in 2002 focused on mental health (23). Interviews were

conducted face to face or via the telephone, and the sample size was 31,321 people aged 15-69 years (23).

Variation in results between studies implies no clear consensus on the existence of urban-rural differences in mental health disorders, however many studies do show some skew towards a correlation between urbanization and prevalence of mood and anxiety disorders. A study by Blazer et al. showed doubled rates of major depression in urban areas of the United States in 1985 (1). Conversely, more recent studies by Kessler et al. did not confirm these findings using the National Comorbidity Survey (11, 13).

Peen, Dekker, Schoevers, ten Have, de Graaf, and Beekman completed a study in the Netherlands using a wider range of specific definitions of urban and rural, with five categories from not urbanized to very highly urbanized. The disorders were addressed using DSM-III-R criteria and the sample consisted of 7076 individuals, 17% of whom were residents of rural areas (17). They found that after adjusting for confounders, urbanization was positively correlated with the prevalence of mood disorders such as major depression, the prevalence of anxiety disorders, and the prevalence of one or more comorbid disorders (17). This study's intended application was to determine the significance of these results as they relate to the allocation of mental health services, as many studies of urban-rural differences in mental health aim to do. Data from the Netherlands Mental Health Survey and Incidence Study showed that the proportion of people using mental health services in urban and rural areas was the same, therefore there is more demand for mental health services in highly urbanized areas because prevalence of mood disorders, anxiety disorders, and comorbid conditions is significantly higher in these areas.

Peen et al. in their Netherlands study bring up an important and relevant point when stating, "An indirect way of coping with higher demand for mental health care in strongly urbanized areas is to put extra effort into prevention activities" (17). Determining the best allocation of resources and most effective types of prevention activities depends on the hypothesized factors contributing to the high prevalence of mental disorders in urban areas. The two main theoretical ideas relating to urban-rural differences in psychiatric morbidity are the breeder hypothesis and the drift hypothesis. The drift hypothesis supports the idea of "selective migration" resulting in the concentration of the mentally ill in more urbanized environments (17). While this hypothesis may have seemed applicable in early schizophrenia research, there is little evidence of the drift process actually occurring in cities today as modern studies on the hypothesis are sparse.

A more credible hypothesis regarding urban-rural differences in mental health is the breeder hypothesis. This hypothesis attributes illness in part to various environmental factors, both physical and social (18). Physical factors may include population density and air pollution, and social factors may include things such as stress and social isolation (18). Urbanization goes hand in hand with many chronic stressors; something that access to nature may be able to help mitigate. Increased social capital may also be an effective tool when combatting depression and anxiety in urban areas. Social capital is the descriptor for community level variables such as social networks, relationships, trust and power (23). Social capital's relevance to health is an emerging topic of study, but should be kept in mind when designing for the betterment of urban residents' mental health.

Purpose. From the literature reviewed we can see that, while there is still some level of debate, it is likely that higher levels of urbanization are at least somewhat correlated with poorer mental health, specifically with increased rates of depression, other mood disorders, and anxiety. We can look to literature further to find insight into how specific types of green space and access to nature might affect the mental health of urban residents, as will follow in the section below.

While much of this section focused on mental health data gathered through extensive nationwide survey and interview techniques, it may be of interest to investigate any potential correlation between mood and contentedness of area residents and their proximity to specific green spaces and natural public gathering places in urban areas. This data can be gathered by administering a short, standardized survey to residents of a chosen area of interest. While the samples will be smaller than those in nationwide surveys, we can gather much more specific data relevant to each type of green space by focusing on proximity. A smaller sample size and more localized study will be accompanied by confounding factors which could prevent validity of any further analysis. The design and construction of this survey will depend on the specific information desired, and the manner in which the survey is to be administered. A localized survey designed and administered for this project can be found in **Appendix A**, and the data analysis will be discussed in the section titled "Survey Design Considerations" in the following pages.

Nature and Human Health

The concept of nature as a restorative agent seems to be hardwired into human brains across place, culture, and historical context. Perhaps this is biological, stemming from an ever present evolutionary connection to nature despite man's construction of a designed, unnatural habitat. In the context of today's urbanized and industrialized environments, access to nature is increasingly necessary to people as it provides emotional restoration not readily available in man-made settings.

In his text, *Our National Parks*, preservationist, iconic naturalist, and co-founder of the Sierra Club John Muir describes the inescapable realization of the pull that city-dwellers feel towards the natural world, saying,

> The tendency nowadays to wander in wildernesses is delightful to see. Thousands of tired, nerve-shaken, over-civilized people are beginning to find out that going to the mountains is going home; that wildness is a necessity; and that mountain parks and reservations are useful not only as fountains of timber and irrigating rivers, but as fountains of life. Awakening from the stupefying effects of the vice of over-industry and the deadly apathy of luxury, they are trying as best they can to mix and enrich their own little ongoings with those of nature, and to get rid of rust and disease (14).

Muir depicts "over-civilized people" taking to nature in order to cleanse themselves from "rust and disease," restoring both mind and body by physically removing themselves from the mind-numbing world of industry. The same can be said to describe urbanites of today, who benefit mentally and physically from experiences in nature. While Muir's comments were related to the benefits of the United State's National Park system, the sentiment can be applied to the benefits many people receive from the presence of accessible and quality urban parks and green spaces.

Ebenezer Howard (1850-1928), a city planner from the United Kingdom, coined the concept of the "Garden City," which he believed intertwined the most advantageous aspects of town and country life into one holistic city. Howard's ideas are still relevant for city planners today, as they try to incorporate the advantages of accessible nature into complex urban systems.
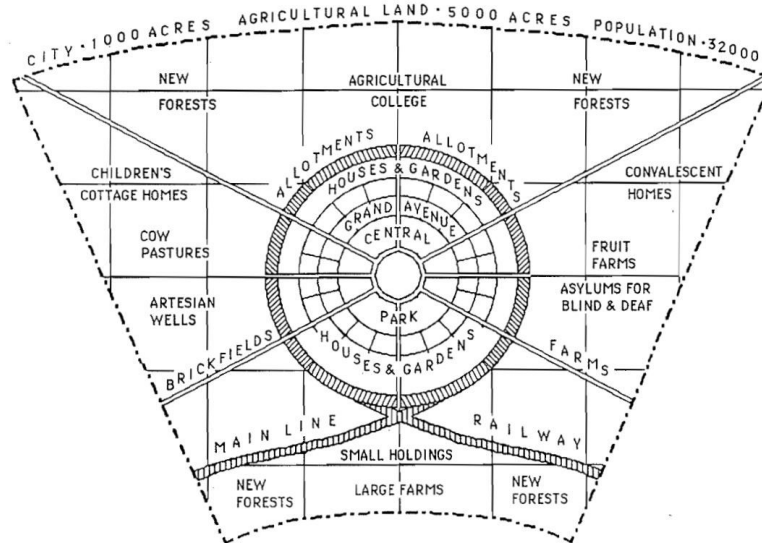

Figure 3. Ebenezer Howard's "Garden City" plan, (3).

Each garden city is surrounded by an agriculture hinterland that offered forests, food, and refuge. The community is centered around a large park and the residential areas are combined with small gardens to ensure access to nature for all residents. The intentionally small communities offer adequate space for residential and commercial uses, but make access to nature a priority. Howard's concept was brought to fruition with the creation of Letchworth and Welwyn in the United Kingdom, and his ideas inspired Greenbelt communities in Maryland, Ohio, and Wisconsin. While most city planners do not or cannot follow this exact model, it is still

especially important to integrate the design of restorative urban pockets of nature into the hyper-productive, over-civilized and tiresome city.

Nature's Effects on Feelings of Stress. Nature's restorative effects are linked to physical processes like air purification as well as restoration theories related to stress and overstimulation. People living in urban environments face more chronic stressors that rural dwellers, such as high population density and crowding, high levels of air pollution, traffic and airplane noise, and higher ambient temperatures. These chronic stressors can lead to physical and psychological health problems, but access to nature may be able to mitigate some of those problems by addressing humans' mental and physical responses to stress.

The link between environmental stressors and physical and mental health is explained in part by stress and stimulation theory. Robert Gifford writes that "behavioral and health effects occur when environmental stimulation exceeds an individual's adaptive resources" (4). To put it more simply, when an individual experiences a level of stimulation they are unable to cope with, they feel stress which is accompanied by psychological and physiological responses. Stress affects the mind and the body when the pituitary and adrenal glands respond to stressors with alarm, resistance, and then exhaustion (4). Chronic stress can cause problems with cardiovascular function, vomiting and digestion problems, and can decrease mental well-being (26). Stress and its effects should be a topic of concern for a world facing increasing urbanization, because urban living comes with inescapable overstimulation and chronic stress for many people. The combination of constant noise, density and feelings of crowding, polluted air, and other daily hassles can lead to feelings of stress at unmanageable levels for many people.

Chronic stress is associated with particular psychiatric disorders such as unipolar depression (12), which is concerning for governments and planners who aim to create and maintain healthy and productive urban populations. Having spent much of human history as rural dwellers, human are adapted to this rural style of life and the stressors that come with it. There is some evidence that exposure to the natural elements found in rural life can provide restoration for people by lowering stress levels, as humans are evolutionarily more accustomed to environments that allow interaction with nature (28) and feel comforted when interacting with these environments. While the stressors found in urban settings are different than those in rural environments, a person's interaction with nature will still have the same restorative effects on feelings of stress, and therefore will decrease the physical and mental health repercussions that accompany life in urban areas. As access to nature may be an easily-implementable mitigating factor, it is necessary to consider how best to incorporate it into our cities.

Green spaces provide an area for seclusion, relaxation, and outdoor recreation. Outdoor recreation such as walking and running is often used by people as an outlet for stress reduction, and preserved open spaces provide an accessible, relaxing area for such activities. Open spaces and natural areas with many trees provide clean air and sunlight, counterbalancing effects from chronic stressors like air pollution and harsh artificial light. Additionally, depending on the level of physical screening that a green space provides, users of the space may experience beneficial psychological distancing from everyday worries and concerns (16).

It is important to note that due to the abstract nature of variables such as stress and restoration, nature's ability to promote stress recovery is less physically quantifiable than something such as the rate of depression in a given urban area. However, effects can be studied

indirectly with data from cardiovascular activity and with statements and ratings of personal emotions or psychological states in a given place, and explained through commonplace experiences and desires.

Effective Green Space Design

This investigation will focus on data looking at the correlation between mental health disorders and two specific types of integrated natural space in urban areas - street trees and small parks. Both of these tactics can help to create an outdoor space within the urban setting that fosters relaxation and restoration through physical activity, clean air, seclusion, and psychological distancing from worries. Small parks and increased presence of street trees can be implemented easily into many city design plans, and may be beneficial to the health of residents. These tactics should be of interest both to city planners and public health officials, as they may provide mitigation of some mental health disorders as well as general benefits to public health in urban areas.

The purpose of this review is to look at the characteristics of certain types of green spaces (small parks and street trees) and examine what correlation there may between access to those types of space and the better mental health of residents. Outliers affecting the following data may include differences in accessibility of local mental health services, climate and location of each specific place, and individual demographics of residents. That being said, we can still gather a

general idea of the potential relationship between these types of green spaces and rates of depression and anxiety in urban settings by examining the existing literature.

Street Trees. A cross-sectional study done by Taylor et al. looks specifically at the potential relationship between urban street tree density and antidepressant prescription rates in London, UK. Antidepressant prescription data was used as an indicator of the prevalence of depression in this London study because the vast majority of patients received their healthcare through the National Health Service, and antidepressants were only available by prescription (27). However, it is also noted in the study that this choice of data is an imperfect indicator, as residents with depression may not seek medical services or may choose other forms of treatment such as cognitive behavioral therapy (27).

Taylor et al. used antidepressant prescription data along with data concerning the density of street trees per linear kilometer of street within the boroughs of London. The scatter plot comparing both sets of data is found in **Figure 4**, below. A linear regression model was used to further compare these two sets of data, and researchers determined that higher density of street trees within London boroughs was associated with lower antidepressant prescription rates. Specifically, "a greater tree density was associated with 1.38 fewer prescriptions for antidepressants per 1000 population" (27).
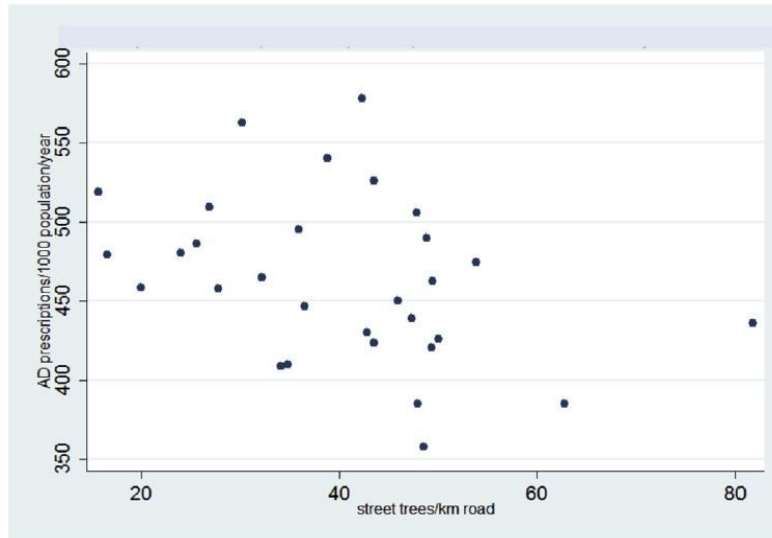
Figure 4. Scatter plot of street tree density and antidepressant prescription rate in London, UK, (27).

Researchers claimed this analysis remained true even after controlling for potential confounders such as socioeconomic status, prevalence of smoking, and mean age of subjects. Researchers did note however that there is a possibility that more affluent and healthy people are attracted to residential areas with a greater density of street trees, and that private antidepressant prescriptions (not prescribed by the National Health Service, and not included in this study's data) may be more prevalent in those more affluent areas (27). Areas of high street tree density, with prescriptions not accounted for in this study's data, may skew the analysis of the relationship between these two factors.

The validity of the study could be increased by combining data from antidepressant prescription rates, both from the National Health Service and private, with self-reported data regarding feelings of depression and individual use of health services such as cognitive behavioral therapy. That being said, gathering this amount and type of data may pose legal and

ethical complications, as private medical data is not easily accessible. For the data gathering constraints faced, and the decision not to rely on self-reported survey data, antidepressant prescription rate data from the National Health Service provides an adequate sample source for estimating the prevalence of depression in the boroughs of London.

Overall, when considering the analysis of this London study, it is reasonable to believe that street trees may play some role in bolstering neighborhood mental health. This is likely due to multiple factors relating to the presence of street trees, which combine to create an overall more positive living environment. The presence of street trees can reduce stress by creating a pleasing and relaxing view from homes, encouraging outdoor activity and active commutes, and fostering stronger social ties within the community. Stress reduction and social cohesion have both been found to relate to better mental and physical health, and the presence of street trees may be an easily implementable tactic to encourage stress reduction and social cohesion within communities.

Parks. To consider the effects of green space in the form of small parks on mental health, we will discuss research from two studies on this topic. One study by Reklaitiene et al. comes from data sampled in Kaunas, Lithuania, and shows a correlation between proximity to local city parks and appropriate use of those parks with decreased prevalence of depressive symptoms and poor perceived general health (22). Among women who used the parks four or more hours per week, a distance from the subject's home to the nearest park greater than or equal to 300 meters correlated with an increase in the prevalence of depressive symptoms and poor and very poor perceived general health, as compared to subjects who lived within 300 meters of a park (22).

Similar trends were seen in men, but were only determined to be statistically significant for women.

Proximity to parks seemed to play a more important role than frequency of usage, as women who lived within 300 meters of a park but only used the park less than four hours per week showed a lower prevalence of depressive symptoms when compared to the 4+ hours/week users living greater than 300 meters away (22). While these findings were only statistically significant among women, they still support other studies showing that a lack of proximity to and accessibility of green spaces such as parks may contribute to greater stress and lesser mental well-being.

This study by Reklaitiene et al. is one of the few large-scale population studies, having sampled 6,944 Kaunas city residents ages 45-72, that employed GIS techniques to objectively measure distances between residences and public green spaces (22). This, along with data from the common, self-reported CES-D10 scale for evaluation of depressive symptoms, gives researcher a fairly concrete base from which to analyze data correlations. Shortcomings of this study include a lack of data regarding privately-owned green spaces or small scale green elements such as street trees and greenery in close proximity to each home.

Another study completed by Pope et al. analyzes a population sample in Sandwell, UK, looking specifically at the relationship between attributes of local green spaces and prevalence of psychological distress. Psychological distress is defined as, "minor mental health symptoms (including stress and anxiety) that have clinical measures" (19). Researchers measured psychological distress using the 12-item General Health Questionnaire, which is similar to the Patient Health Questionnaire-9 used in the original survey research completed for the purpose of

this report (see page 25). Accessibility and quality of local green spaces were also measured through survey research with questions relating to whether the green spaces were accessible, well-kept, within walking distance, and perceived as relaxing and usable for recreation (19).

According to this study's analysis, a reduction in the risk of psychological distress was only seen in individuals who indicated green spaces were accessible, sufficient, and safe for relaxation and recreation (19). This supports the idea that if a small park or green space is to be beneficial to a community's mental health, it must not only be accessible and in close proximity to residents, but also must have some characteristics allowing for and encouraging relaxation and recreation. This falls in line with our theories on stress reduction and better quality of mental health, as properly designed local green spaces can help encourage movement and relaxation allowing for individuals to destress in a natural setting.

Model Implementations of Public Green Space

In looking at current implementations of urban green space we find many examples of community betterment through planned green space at both small and large scales. Reincorporating the natural world into the daily lives of residents of urban centers has the power to revitalize these communities through health, social, environmental, and economic factors. Some examples of cities who have made green space a priority in design can be seen in San Francisco, California, New York City, New York, and Portland, Oregon.

San Francisco's Golden Gate Park is an iconic feature of the city, inviting tourists and locals alike into an interaction with nature in the midst of a bustling urban center. Golden Gate Park is a strip of 1017 acres stretching from the northern central of the city west to the Pacific Ocean. It is called "San Francisco's backyard," and gives 13 million visitors per year a chance to relax, unwind, and reconnect with nature (24). Music festivals, museums, and gardens attract people together into one massive, central, natural space. The park was built along with the city, beginning as a vast stretch of sand dunes turned to a masterfully cultivated, designed, and preserved green space.

Figure 5. Aerial View of Golden Gate Park, San Francisco, California, (5).

While Golden Gate Park is an example of an intentionally planned large open space in the center of a dense metropolitan city, perhaps a more relevant example of community revitalization and renewal through incorporation of designated natural space would be new York City's High Line. Neighborhood residents partnered with the New York City Department of Parks & Recreation to build this 1.45 mile long public park on an elevated freight rail line on the

west side of Manhattan (7). Rather than demolishing the freight line and damaging the properties below it, the community rallied to convert the space above into a large public park for residents and visitors. The park acts as a 1.45-mile-long green roof, capturing stormwater runoff, harboring wildlife, and sequestering carbon in the middle of this urban center.

Figure 6. Stretch of the High Line, New York City, New York, (6).

Green Streets. Unlike large parks, green streets provide an urban green space by taking a primarily vehicle-focused urban area, and transforming it into a more environmentally responsible, community-focused place. The definition of green street can vary from a "complete street" model that allows passage while accounting for people, trees, and various modes of transportation such as automobile, bicycle, pedestrian, and bus, to automobile-free "pedestrian zones" for walking and gathering. What makes these streets intentional "green space" is usually the presence of trees and other greenery.

The Kent State University Cleveland Urban Design Collaborative in Cleveland, Ohio implemented a pop-up complete and green street on Rockwell Avenue as a spatial exploration and design consideration experiment, to help stakeholders envision potential alternative uses for the space (10). The temporary installation was a physical example to bring awareness to and garner support for the Cleveland City Council's "Green and Complete Streets" ordinance, which would provide financial support to road projects that provide amenities to bicyclists, pedestrians, and people with disabilities, as well as sustainability measures such as porous pavement, energy efficiency, and stormwater management (10).

Figure 7. BiFi Bench, Pop up Rockwell, Cleveland, Ohio, (10).

Along with minimizing the lanes of automobile and bus traffic and expanding designated bike lanes, the pop up street featured "BiFi" transit waiting benches. These green-roofed benches were a combination of wifi hotspots and biofiltration systems that captured stormwater runoff

from the street and utilized it in watering the structure's plantings (10). A design like this provides users a comfortable transit waiting area with contact to nature through the plantings, and an environmentally beneficial stormwater capture and reuse system.

Portland, Oregon saw a similar push for green streets as a method of reducing stormwater runoff. The SW 12th Avenue Green Street was one of the first projects that maintained curbside parking and transformed the existing landscaping into a planter that managed stormwater runoff (8).

Figure 8. SW 12th Avenue, Portland, Oregon, (8).

The planter area on SW 12th Avenue was previously underused, so this project redesigned that area to capture, slow, cleanse, and infiltrate approximately 7500 square feet of street runoff (8). Not only do the new planter designs address the problem of runoff, they also provide a visibly green component of the city's infrastructure and bring a bit of the natural world back to the city street experience.

While statistics on the mental health of residents interacting with each of these particular examples are not available, with a standardized survey design we could gather information relevant to each locale. This may be useful in assessing the cost benefits of designing for specific types of green space in other urban areas. Problems in assessment due to confounding or unconsidered factors may arise with small scale surveys particular to residents local to specific parks and green streets, as the sample numbers will be significantly smaller than those of large nationwide surveys.

Survey Design Considerations

To supplement the research addressed in this paper, and to investigate my own community's mental health trends, I created a brief survey using the Patient Health Questionnaire - 9, copied with permission from the Anxiety and Depression Association of America, and two qualifying questions regarding participants' proximity to local parks. This survey was administered to students in the Liberal Arts and Engineering Studies program at California Polytechnic State University, in San Luis Obispo, California, and to local residents of San Luis Obispo County. The survey itself can be seen in **Appendix A**, and research protocol and informed consent forms can be found in **Appendix B**. Data gathered from the survey can be found in **Appendix D**.

Survey Design. The survey, administered via the online platform www.surveymonkey.com, consisted of questions from the PHQ-9, two questions regarding awareness of proximity to local

parks and usage of local parks, one question regarding experience of anxiety, and four demographic questions regarding age, gender, race and ethnicity. The standardized nature of the PHQ-9 provides and easy tool for understanding self-reported levels of depression. Survey questions 3.A. through 3.I. are taken directly from the PHQ-9, and are used to score each subject's self assessment of their own level of depression. The numerical score resulting from answers to the PHQ-9 section indicate minimal depression, mild depression, moderate depression, moderately severe depression, severe depression, or no indication of depression. The exact method of scoring is explained in **Appendix C**. These numerical scores are then analyzed in conjunction with responses to the questions regarding awareness of proximity and use of local parks to determine if any correlation exists within this community.

Data Results and Analysis.

The data was split into two distinct categories - participants who living within walking distance of a park (Prox = yes) and participants who do not live within walking distance of a park (Prox = No). Each participant's responses to the questions taken from the PHQ-9 were scored to determine an overall score for depression rating, on a scale from 0-26. The mean PHQ-9 score for the Prox = Yes group was then compared to the mean PHQ-9 score for the Prox = No group, using a 2-Sample T-Test with 95% confidence intervals. The data from the two groups were plotted on an individual value plot shown in **Figure 9**, and their means were compared.
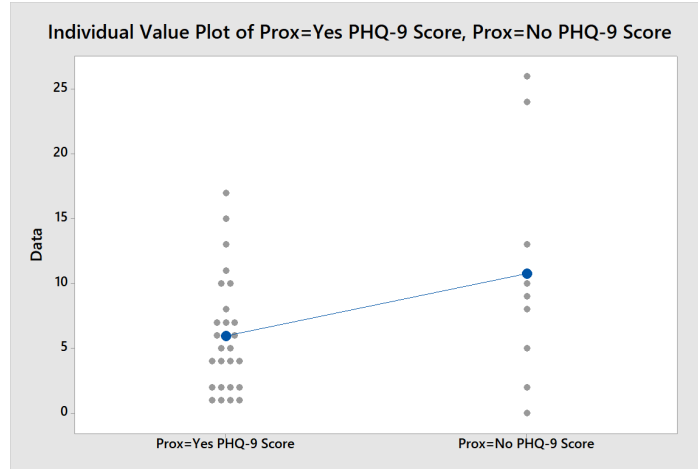
Figure 9. Dot Plot of PHQ-9 Scores for Yes and No Proximity to Local Parks.

Of the 36 responses gathered, 27 indicated they lived within close proximity to a park and 9

indicated they did not live in close proximity to a park. The following highlights the results from

the 2-Sample T-Test comparison of means:

Two-Sample T-Test and CI: Prox=Yes PHQ-9 Score, Prox=No PHQ-9 Score
Method

μ_1: mean of Prox=Yes PHQ-9 Score

μ_2: mean of Prox=No PHQ-9 Score

Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
Prox=Yes PHQ-9 Score	27	5.96	4.37	0.84
Prox=No PHQ-9 Score	9	10.78	9.01	3.0

Estimation for Difference

Difference	95% Upper Bound for Difference
-4.81	0.90

Test

Null hypothesis	$H_0: \mu_1 - \mu_2 = 0$
Alternative hypothesis	$H_1: \mu_1 - \mu_2 < 0$

T-Value	DF	P-Value
-1.54	9	0.079

While the individual value plot and the summary tables for each group (Prox = Yes, Prox = No) seen in **Figure 10** and **Figure 11** seem to indicate a significant difference in mean PHQ-9 depression ratings for those living within walking distance of a park and those not living within walking distance of a park, the 2-Sample T-Test indicates that while there is a difference in the means of each group, the difference is not statistically significant. Because the null hypothesis ($H_0: \mu_1 - \mu_2 = 0$) failed to be rejected (P=0.079, α=0.05), we are unable to draw any conclusions regarding the correlation between proximity to local green space and rates of depression in San Luis Obispo County. The most likely problem with this data set is its small sample size. If a larger sample had been gathered, we may have been able to see more trends in the data.
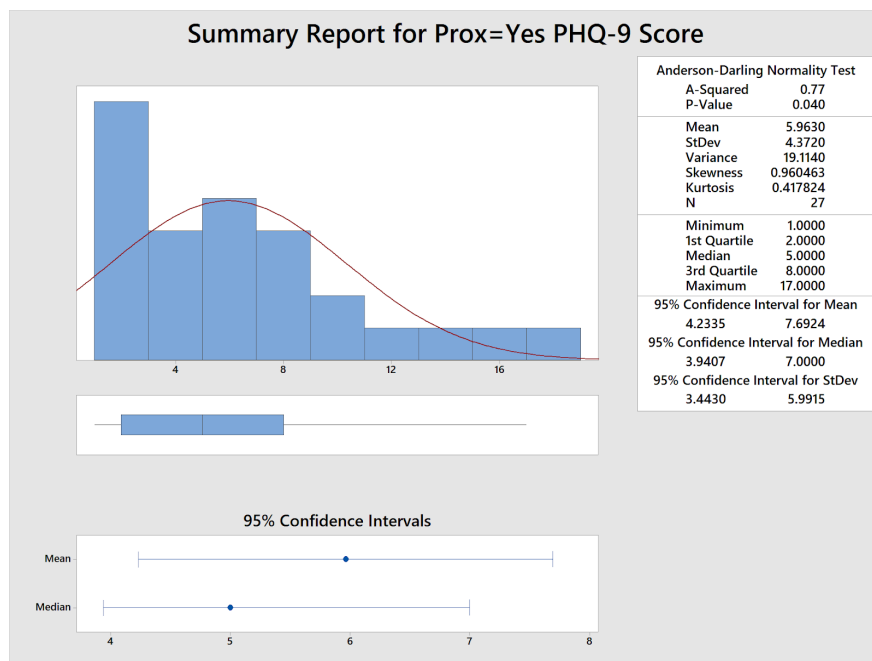

Figure 10. Summary Table for Mean PHQ-9 Score, Respondents Answering "Yes" to Proximity Qualifier.
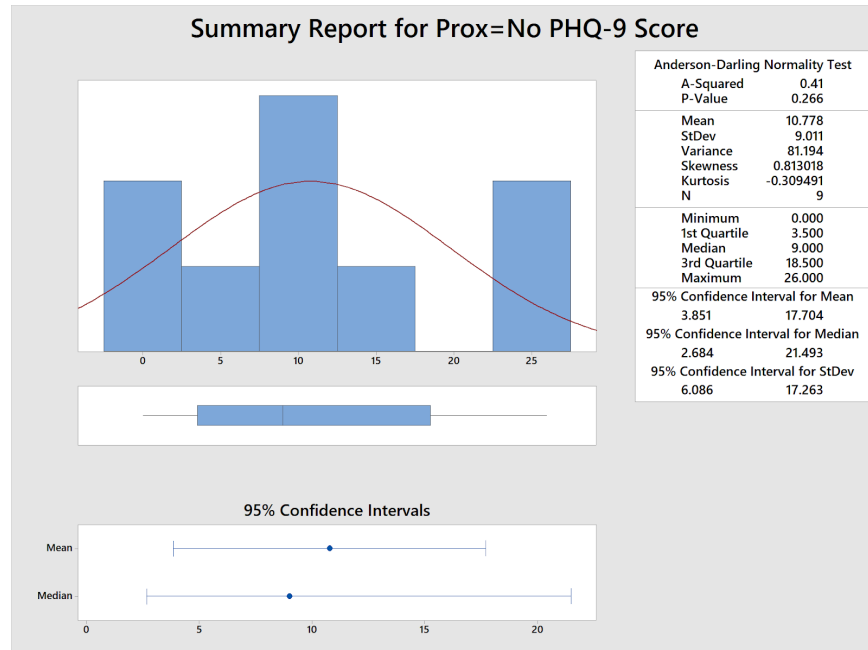
Figure 11. Summary Table for Mean PHQ-9 Score, Respondents Answering "No" to Proximity Qualifier.

Future Work.

I recommend that this survey data be gathered again in San Luis Obispo County or elsewhere, with a sample size of 100 or more participants. I believe the simplicity of the compared variables makes the data useful in researching localized correlations between proximity and access to local parks and rates of depression. The methods used in this small study are similar to those used in the large scale studies reviewed in the "Effective Green Space Design" section on page 15, and are easily applicable to further iterations and analysis of data gathered from this type of survey. This study does not account for confounding factors such as socioeconomic status, gender, marital status, etc., and would be stronger in the future if these potential factors are accounted for. I recommend taking the questions from this survey while better accounting for confounding factors, and repeating the study with a much larger sample size, in order to better see any potential relationship between the two factors in a localized setting.

Interdisciplinary Connections

The value of a Liberal Arts and Engineering Studies education at Cal Poly lies in the program's emphasis on an interdisciplinary approach to real-world problem solving. This senior project has attempted to further investigate an issue that relates to psychology, public health, public policy, city and regional planning, and design in order to better understand how to create healthy, happy cities in an ever-increasingly urbanized world. With a solid knowledge base and understanding of the data supporting public green space as a factor relating to mental health, we can work together to make design decisions that benefit both humans and the natural environment, by creating greener cities and urban areas.

Conclusion

From this exploration it is apparent that, while the specific extent to which it occurs is somewhat controversial, nature has some amount of beneficial effects on humans who are able to interact with it. This is especially important knowledge in the ever-rapidly urbanizing world that we live in, because access to experiences in nature must become more intentionally designed for within our increasingly dense society and built world. It is difficult to determine the exact effects that access to green space and experiences in nature have on residents' mental health, but through localized surveys and analysis of concrete data such as physical proximity and antidepressant prescription rates, we can gather a good understanding of these potential effects. Urban environments provide great opportunity for a connected, healthy, and sustainable society, but

must be planned and designed to do so. Increasing the presence of street trees or allocating small

amounts of land on the ground or on rooftops may benefit community health and mental vitality.

These projects do require upfront costs, however their benefits may reduce health-related

expenses and help sustain a happier, healthier population. Overall, investing in public health

requires investing in ecological health - in the environment and green spaces around us.

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Appendix A. Local Research Survey.

The following survey was used to gather data from local San Luis Obispo County residents, via the online surveymonkey.com platform. Questions 3.A. through 3.I. come directly from Patient Health Questionnaire - 9. Data results and analysis are discussed on Page (INSERT PAGE NUMBER) of this report.

Mental Health and Green Space Proximity

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT: "Feeling Green: The Benefits of Green Space on Urbanites' Mental Health"
a Cal Poly LAES Senior Project

By completing this survey, you consent to participate in a research project on mental health and access to nature in urban areas. This survey should take approximately 5 minutes. There are no risks anticipated with your participation. Those in city planning and community design may benefit from your participation. Please review the following information before completing this survey:

The purpose of this survey is to provide supplementary data and to examine the effects of proximity to parks and/or green spaces on individuals' mental health, specifically on rates of depression and anxiety. Potential benefits associated with the study include improvements to public health through informed city and community design. This brief, 5-minute survey will ask you questions about your daily experiences and your proximity to open green spaces.

Please be aware that participation in this research is voluntary, refusal to participate will not involve any penalty or loss of benefits to which you are otherwise entitled, and you may discontinue your participation at any time. You may omit responses to any questions you choose not to answer. There are no risks anticipated with your participation in this study, as your survey responses will be collected anonymously.

This research is being conducted by Kathryn Hoagland in the Liberal Arts and Engineering Studies Program at Cal Poly, San Luis Obispo, under the supervision of Dr. Michael Haungs. If you have questions regarding this study or would like to be informed of the results when the study is completed, please contact Kathryn at khoaglan@calpoly.edu, or Dr. Haungs, at mhaungs@calpoly.edu.

If you have concerns regarding the manner in which the study is conducted, you may contact Dr. Michael Black, Chair of the Cal Poly Institutional Review Board, at (805) 756-2894, mblack@calpoly.edu, or Ms. Debbie Hart, Compliance Officer, at (805) 756-1508, dahart@calpoly.edu.

If you are concerned about your mental health in any way, or are having suicidal thoughts, please find your local support services by dialing 2-1-1. Cal Poly students can reach out to Cal Poly Counseling Services at (805) 756-2511. The National Suicide Prevention Lifeline can be reached at 1-800-273-8255.

If you agree to participate, you can indicate your participation by answering the survey questions. Thank you for your participation.

OK

1. Choose the statement that best represents your living situation in San Luis Obispo county. (A park is defined as any large green area designated for public use)

○ A. I live within walking distance of a park.

○ B. I do not live within walking distance of a park.

2. If you answered A above. On average, how often do you go to that park?

○ Less than once per month

○ A few times per month

○ About once per week

○ Multiple times per week

3. Over the last 2 weeks, how often have you been bothered by any of the following problems?

	Not at all	A few days	More than half the days	Nearly every day
A. Little interest or pleasure in doing things	○	○	○	○
B. Feeling down, depressed, or hopeless	○	○	○	○
C. Trouble falling asleep or staying asleep, or sleeping too much	○	○	○	○
D. Feeling tired or having little energy	○	○	○	○
E. Poor appetite or overeating	○	○	○	○
F. Feeling bad about yourself - or that you are a failure or have let yoursel or your family down	○	○	○	○
G. Trouble concentrating on things, such as reading or watching television	○	○	○	○

| H. Moving or speaking so slowly that other people could have noticed? Or the opposite—being so fidgety or restless that you have been moving around a lot more than usual | ○ | ○ | ○ | ○ |
| I. Thoughts that you would be better off dead or of hurting yourself in some way | ○ | ○ | ○ | ○ |

4. Over the last several months, have you been continually worried or anxious about a number of events or activities in your daily life?

○ Yes

○ No

5. Select your age range

○ 18-21   ○ 30-39

○ 22-25   ○ 40-59

○ 26-29   ○ 60 or older

6. Are you of Hispanic, Latino, or Spanish origin?

○ Yes

○ No

○ Prefer not to answer

8. Do you identify as

○ Female

○ Male

○ Prefer not to answer

DONE

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Appendix B. Survey Protocol.

Below is a copy of the research protocol for this local survey research, submitted to the Cal Poly Institutional Review Board for approval of research involving human subjects. The research protocol was approved by the Cal Poly IRB on 3 February 2019, and is valid through 3 February 2020.

"Feeling Green: The Benefits of Green Space on Urbanites' Mental Health"
A Cal Poly LAES Senior Project by Kathryn Hoagland
Faculty Advisor Michael Haungs

Research Protocol

Introduction. This senior project for the Liberal Arts and Engineering Studies program at Cal Poly is mainly comprised of research and literature review regarding the differences in mental health between urban and rural areas, and how specific types of public green space affect mental health. To supplement the literature review, there is also a small component of original research that involves gathering data via an online survey. This project will potentially benefit city and community planners as well as public health officials interested in mitigating depression and anxiety in urban settings through the implementation of certain types of public green space. The survey will focus specifically on public parks and symptoms of depression. I expect the results to show some correlation between access to parks and less symptoms of depression, however if the results follow those of previous studies this correlation will likely be minimal. Potential subjects of this study include current Cal Poly students, as well as the general public. There are minimal risks associated with the study, and the survey does provide resources for anyone who may be interested in seeking assistance for issues of mental health. The survey will be administered via a Survey Monkey link, and the data will be gathered on that same platform. Analysis will be contained to my personal computer and will only be gathered and analyzed by me. The data will be received anonymously through the Survey Monkey platform, and results will then be compiled anonymously.

Methods.
(a) The subjects of this study are intended to be a random sample of the public. The faculty of the Liberal Arts and Engineering Studies program have agreed to help circulate the survey, however as I also plan to circulate the survey elsewhere, I do not feel I am targeting these students specifically. I expect the age range to be approximately 18-60, given the characteristics of my connections for circulation of the survey. I do not expect prospective subjects to be members of a vulnerable group, and I hope to receive approximately 100 responses.
(b) I, Kathryn Hoagland, am the sole investigator for this project. As a graduating fourth-year Liberal Arts and Engineering Studies student, I feel I have the relevant qualifications to administer and analyze this brief online survey.
(c) As stated above, the research portion of this project consists of one survey administered via the Survey Monkey platform. This survey consists of nine questions taken directly from the

Patient Health Questionnaire - 9, a commonly used tool for depression screening and diagnostic severity measure. This questionnaire is available to the public from the Anxiety and Depression Association of America. The survey also contains two questions relating to proximity to local parks and time spent in those parks, along with a handful of questions relating to demographics.

The survey and its administrative platform can be seen at this link:
https://www.surveymonkey.com/r/5VTP598

This link is exactly how each participant will receive the survey and participate in the research. The survey link and a brief description will be circulated by faculty in the Liberal Arts and Engineering Studies program, and participants will opt to take part in the survey research voluntarily. The survey may also be circulated by me, to students at other universities and within the general public. One the survey is released, I will allow participants to submit responses for no more than 2 weeks. At this point I will close the survey and begin data analysis. Subjects are responsible for their own health and safety, however I have provided links to resources for those seeking mental health help.
(d) This study takes place online, via Survey Monkey. The survey can be found at the link provided in part (c).

Informed Consent Form. This form is copied at the beginning of the survey. By participating in the survey and submitting a response, each participant is agreeing to this form, and consenting to the use of their data in this research project.

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT:
"Feeling Green: The Benefits of Green Space on Urbanites' Mental Health"
a Cal Poly LAES Senior Project

By completing this survey, you consent to participate in a research project on mental health and access to nature in urban areas. This survey should take approximately 5 minutes. There are no risks anticipated with your participation. Those in city planning and community design may benefit from your participation. Please review the following information before completing this survey:

The purpose of this survey is to provide supplementary data and to examine the effects of proximity to parks and/or green spaces on individuals' mental health, specifically on rates of depression and anxiety. Potential benefits associated with the study include improvements to public health through informed city and community design. This brief, 5-minute survey will ask you questions about your daily experiences and your proximity to open green spaces.
Please be aware that participation in this research is voluntary, refusal to participate will not involve any penalty or loss of benefits to which you are otherwise entitled, and you may discontinue your participation at any time. You may omit responses to any questions you choose not to answer. There are no risks anticipated with your participation in this study, as your survey responses will be collected anonymously.

This research is being conducted by Kathryn Hoagland in the Liberal Arts and Engineering Studies Program at Cal Poly, San Luis Obispo, under the supervision of Dr. Michael Haungs. If you have questions regarding this study or would like to be informed of the results when the study is completed, please contact Kathryn at khoaglan@calpoly.edu, or Dr. Haungs, at mhaungs@calpoly.edu.

If you have concerns regarding the manner in which the study is conducted, you may contact Dr. Michael Black, Chair of the Cal Poly Institutional Review Board, at (805) 756-2894, mblack@calpoly.edu, or Ms. Debbie Hart, Compliance Officer, at (805) 756-1508, dahart@calpoly.edu.

If you are concerned about your mental health in any way, or are having suicidal thoughts, please find your local support services by dialing 2-1-1. Cal Poly students can reach out to Cal Poly Counseling Services at (805) 756-2511. The National Suicide Prevention Lifeline can be reached at 1-800-273-8255.

If you agree to participate, you can indicate your participation by answering the survey questions. Thank you for your participation.

Debriefing Statement. This project does not involve deception or incomplete disclosure, therefore a debrief is not necessary.

Appendix C. Patient Health Questionnaire - 9 and Scoring Protocol.

Used with permission from the Anxiety and Depression Association of America and the U.S. Preventive Services Task Force.

PATIENT HEALTH QUESTIONNAIRE (PHQ-9)

NAME:_____ DATE:_____

Over the last *2 weeks*, how often have you been bothered by any of the following problems? (use "✓" to indicate your answer)	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself—or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed. Or the opposite —being so figety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead, or of hurting yourself	0	1	2	3
add columns		_____ + _____ + _____		
(Healthcare professional: For interpretation of TOTAL, please refer to accompanying scoring card).	TOTAL:			

10. If you checked off *any problems,* how *difficult* have these problems made it for you to do your work, take care of things at home, or get along with other people?	Not difficult at all _____
	Somewhat difficult _____
	Very difficult _____
	Extremely difficult _____

PHQ-9 Patient Depression Questionnaire

For initial diagnosis:

1. Patient completes PHQ-9 Quick Depression Assessment.
2. If there are at least 4 ✓s in the shaded section (including Questions #1 and #2), consider a depressive disorder. Add score to determine severity.

Consider Major Depressive Disorder

- if there are at least 5 ✓s in the shaded section (one of which corresponds to Question #1 or #2)

Consider Other Depressive Disorder

- if there are 2-4 ✓s in the shaded section (one of which corresponds to Question #1 or #2)

Note: Since the questionnaire relies on patient self-report, all responses should be verified by the clinician, and a definitive diagnosis is made on clinical grounds taking into account how well the patient understood the questionnaire, as well as other relevant information from the patient.
Diagnoses of Major Depressive Disorder or Other Depressive Disorder also require impairment of social, occupational, or other important areas of functioning (Question #10) and ruling out normal bereavement, a history of a Manic Episode (Bipolar Disorder), and a physical disorder, medication, or other drug as the biological cause of the depressive symptoms.

To monitor severity over time for newly diagnosed patients or patients in current treatment for depression:

1. Patients may complete questionnaires at baseline and at regular intervals (eg, every 2 weeks) at home and bring them in at their next appointment for scoring or they may complete the questionnaire during each scheduled appointment.
2. Add up ✓s by column. For every ✓: Several days = 1 More than half the days = 2 Nearly every day = 3
3. Add together column scores to get a TOTAL score.
4. Refer to the accompanying **PHQ-9 Scoring Box** to interpret the TOTAL score.
5. Results may be included in patient files to assist you in setting up a treatment goal, determining degree of response, as well as guiding treatment intervention.

Scoring: add up all checked boxes on PHQ-9

For every ✓ Not at all = 0; Several days = 1;
More than half the days = 2; Nearly every day = 3

Interpretation of Total Score

Total Score	Depression Severity
1-4	Minimal depression
5-9	Mild depression
10-14	Moderate depression
15-19	Moderately severe depression
20-27	Severe depression

Appendix D. Survey Data.

Survey data gathered via surveymonkey.com, from 2/11/2019 through 2/25/2019.

	PHQ-9 Numerical Score	Proximity Qualifier (Y/N)	Monthly Usage	Anxious over last month (Y/N)	PHQ-9 Depression Severity Categ
1	9	No	*	Yes	Mild
2	13	No	*	Yes	Moderate
3	7	Yes	2	No	Mild
4	8	No	*	Yes	Mild
5	2	No	*	Yes	Minimal
6	10	Yes	0	Yes	Moderate
7	2	Yes	4	No	Minimal
8	10	Yes	0	Yes	Moderate
9	2	Yes	0	Yes	Minimal
10	5	Yes	2	Yes	Mild
11	0	No	*	No	None
12	10	No	*	Yes	Moderate
13	15	Yes	2	Yes	Moderately severe
14	6	Yes	0	Yes	Mild
15	2	Yes	0	Yes	Minimal
16	1	Yes	0	No	Minimal
17	6	Yes	0	Yes	Mild
18	8	Yes	0	No	Mild
19	5	No	*	No	Mild
20	4	Yes	0	Yes	Minimal
21	13	Yes	0	Yes	Moderate
22	17	Yes	0	Yes	Moderately severe
23	24	No	*	Yes	Severe
24	11	Yes	12	No	Moderate
25	5	Yes	0	Yes	Mild
26	4	Yes	12	No	Minimal
27	1	Yes	12	Yes	Minimal
28	2	Yes	0	Yes	Minimal
29	26	No	*	Yes	Severe
30	1	Yes	2	No	Minimal
31	7	Yes	2	Yes	Mild
32	1	Yes	2	Yes	Minimal
33	4	Yes	0	Yes	Minimal
34	7	Yes	0	Yes	Mild
35	4	Yes	0	No	Minimal
36	6	Yes	12	Yes	Mild