ASSESSING THE ASSOCIATIONS AMONG GREEN SPACE TYPE, STRUCTURE, GENERAL MENTAL HEALTH AND GENERAL HEALTH EMPLOYING THE BRFSS AND THE US NATIONAL LAND COVER DATA

By

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Abstract

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Today, mental health has become a common problem. One of the remedies for this problem includes green space. Researchers have been paying attention to effects of green space on mental and general health for over three decades. Studies have shown that green space plays an important role in mental and general health. However, most of the studies considered different types of green space as “simply green” and little was known about what types and structures of green space impact mental health and general health positively or negatively. This research was conducted to determine what types and structures of green space have relationships with general mental health and general health in positive or negative ways. This study consists of three levels. At Level 1, the relationship between amount of unified green space and general mental health and general health was tested. At Level 2, the relationships between different types of green space and general mental health and general health were analyzed. At Level 3, the relationships between structures of significant green space and general mental health and general health were assessed. A multivariate regression model was also used to test whether significant types and structures of green space are predictors of general mental health and general health by controlling socio-demographic characteristics. Level 1 results did not show significant relationships, which means green space types should be considered separately. Level 2 results
revealed urban green space was affirmatively correlated with general mental health and general health, forest was affirmatively related to mental health, rangeland was adversely correlated with general mental health and general health, agricultural land was adversely related to general health, and wetlands did not show a significant result. Level 3 results showed that fragmentation and distance were adversely related to general mental health and general health, connectivity is affirmatively related to general mental health and general health, and size and shape did not show significant results. The regression model revealed that significant green space and distance were predictors of general mental health and general health with age, sex, income, and education. Fragmentation and connectivity did not show significant results.

Keywords: Types and Structure of Green Space, Stress, Depression, Anxiety, General Mental Health, General Health, BRFSS, NLCD, GIS, FRAGSTATS.
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To Fatma... my lovely wife.
INTRODUCTION

“There is an increasing evidence suggesting that mental health and emotional stability of populations may be profoundly influenced by frustrating aspects of an urban, biological artificial environment. It seems likely that we are genetically programmed to a natural habitat of clean air and a varied green landscape, like any other mammal. The specific physiological reactions to natural beauty and diversity, to the shapes and colors of nature, especially to green, to the motions and sounds of other animals, we do not comprehend and are reluctant to include in studies of environmental quality. Yet it is evident that in our daily lives nature must be thought of not as a luxury to be made available if possible, but as part of our inherent indispensable biological need”

Frederick Law Olmstead, in Biography by (Todd, 1982)

Throughout history, different forms of green space have been considered a fundamental human need and attractive, green, and well-watered landscape an essential constituent of the ideal, healthy environment. Researchers emphasized that the significance of access to landscape appears to be as relevant as ever in the context of modern urban lifestyles (Thompson, 2011). Research revealed that green space is important and has positive effects on human physical and mental health. Hence, green space has been found to be more than “simply green” (Jorgensen & Gobster, 2010). On the other hand, researchers emphasized that it should not be presumed that all green space measures are relevant across the whole spectrum of human benefits (Jorgensen & Gobster, 2010).

Researchers highlighted that view, access, and exposure to nature and green space and physical activity should be a central part of policies and strategies of a large number of organizations (Pretty, et al., 2007; Maas, et al., 2006; Ulrich, 1979). Today, health professionals and policy makers are once again open to an ecological approach to public health (Morris, Beck, Hanlon, & Robertson, 2006). However, researchers recommend that more research is needed to understand the effect of green space on human mental and general health before different types and characteristics of green space are used by practitioners as tools to promote health through
design and urban planning (Grahn & Stigsdotter, 2010). It is important to know what type and structure of green space are more useful to general mental health and general health to recommend to policy makers, planners, and designers regarding where and how to design, create, preserve, or restore green space. Appropriate green space can help people reduce their mental health problems and assist in restoring feelings and improving general health. This research, therefore, aims to provide those recommendations to the policy makers, planners, and designers focusing on the types and structures of green space.

**RESEARCH PROBLEM**

Today, many people suffer from mental health problems. Prevalent among them are depression and anxiety. The lifetime prevalence of depression and anxiety in the US is 16.1% and 12.3%, respectively (Reeves, et al., 2011). Depression is defined as “a manifestation of felt hopelessness regarding the attainment of goals when responsibility for the hopelessness is attributed to one`s personal defects” (Lichtenberg, 1957, p. 519). Anxiety is defined as “an unpleasant emotional state or condition which is characterized by subjective feelings of tension, apprehension, and worry, and by activation or arousal of the autonomic nervous system” (Schwarzer, 1984, p. 5). The World Health Organization (WHO) reports that mental health disorders are expected to be one of the major contributors to illnesses in all parts of the world by 2020 (WHO, 2008).

Another important phenomenon that decreases mental well-being is stress. Stress is a negative emotional experience that is accompanied by predictable biochemical, physiological, and behavioral changes that occur when a person appraises an event or situation as threatening (Lazarus & Folkman, 1984). Although the individual needs to respond to the event or situation, an appropriate response is not accessible, which results an adaptation either by manipulating the
situation to alter the stressor or by accommodating its effects (Baum, 1990; Lazarus & Folkman, 1984). Stress is also defined as “any vigorous, extreme, or unusual stimulation which being a threat, causes some significant change in behavior” (Lazarus & Folkman, 1984, p. 15). Today, stress is estimated to affect 75-90% of people (AIS, 2013). Stress is a reaction to a situation when someone feels threatened or anxious (CDC, 2011). Stressor effects occur when a situation is appraised as threatening or otherwise demanding and insufficient resources are available to cope with the situation (Lazarus & Folkman, 1984). People find their lives unpredictable, uncontrollable, and overloaded so they perceive stress and feel stressed (Cohen, Kamarck, & Mermelstein, 1983).

Stress, depression, and anxiety are specific conditions to assess when addressing mental well-being, and there exist specific instruments to examine each in detail. However, this study examined responses from more general questions that may indicate stress, depression, and/or anxiety and adopts the term “general mental health” to describe the conditions elicited in the BRFSS and employed here as indicators of possible stress, anxiety, and/or depression.

In addition, researchers have found that mental health and general health are related to each other (Jensen, 1949; Mechanic & Hansell, 1987; WHO, 2004). Mechanic & Hansell, (1987) found that adolescents who were initially less depressed assessed their physical health more positively. New York City Community Health Survey released a report stating that poor general health is three times more common among people who report significant emotional distress (NY City Department of Health and Mental Hygiene, 2003). As will be discussed in the next chapter, stress-anxiety-depression may cause serious health problems. Therefore, general health is another issue to examine.
A survey of existing research reveals that green space has positive effects on human
general and mental health. It further demonstrates that green space may mitigate general mental
health problems and improve general health, but has not demonstrated which types of green
space are more effective than others to mitigate general mental health problems and improve
general health. Today, there are concerns for environmental factors and the challenge for
researchers is, therefore, to identify appropriate green environments with positive effects on
general mental health and general health. Therefore, this research aimed to define and determine
which types and structures of green space have effects on general mental health and general
health in positive or negative ways in order to create recommendations for policy makers,
planners, and designers.

RESEARCH PURPOSES AND OBJECTIVES

The purpose of this research was to review, analyze, and synthesize the different pieces
from the literature in the related fields to understand the relationship between green space and
general mental health and general health. Specific aims include addressing the question of
whether a general specification of green space is positively associated with general mental health
and general health. This was done by adopting a three-tiered, hierarchical approach: first
examining the relationship between unitary green space (all green space types) and people`s
general mental health and general health; secondly, assessing the relationship between specific
types of green space, general mental health and general health; and thirdly, the relationship
between structures of significant green space and general mental health and general health. The
objectives of this research were to fill the gap in existing knowledge in the literature and create
recommendations for policy makers, planners, and designers regarding where and how to design,
create, preserve, or restore green space that people can use to reduce mental health problems and improve general health.

**RESEARCH QUESTIONS**

This research has three primary and four sub-questions. These questions were formalized based on the literature review and discussion presented in the Chapter Two. The first question explores the relationship between the amount of green space, regardless of type, and general mental health and general health. The second question and its sub-questions explore the relationships between different types and structures of green space and general mental health and general health. The third question and its sub-questions investigate whether the data used for the research is applicable to answer the questions posed above. Below are the research questions and specifics hypotheses for each variable and relationship. Hypotheses are presented in Chapter Two in section 2.12. The research questions are as follows:

1. What are the relationships between the amount of green space and general mental health and general health regardless of green space type?
2. Does the type and structure of green space matter in terms of general mental health and general health?
   a. What are the relationships between different types of green space and general mental health and general health?
   b. What are the relationships between structures of green space and general mental health and general health?
3. Can existing large national datasets (the BRFSS and the NLCD) provide answers to these questions?
   a. Can I feasibly use these national datasets for my study?
b. Will these national collected datasets support useful results?

RESEARCH SIGNIFICANCE, CONTRIBUTIONS, AND LIMITATIONS

Green space is important for human mental and general health. Therefore, green space could be used as a strategy for preventive medicine against mental health and disorder problems (Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki, 2010). Interacting with nature could be useful clinically as a supplement to existing treatments for depressive disorder problems (Berman, et al., 2012). In addition, quality, as well as quantity, of green space could be significant in determining health benefits (Maas J., Verheij, Groenewegen, de Vries, & Spreeuwenberg, Green space, urbanity, and health: how strong is the relation?, 2006). Hence, this study provides some significant results that could be used to address mental health and disorder problems and be useful in support of other treatments.

Additional significance of this research is that it approaches green space differently than most previous studies. It defines different types of green space and highlights their types. Knowing their different characteristics, this research focuses on different types of green space. Therefore, as previous studies suggested, this study claims that different types of green space should not be considered as “simply green.” Hence, the study focused on each type of green space and their relationship with general mental health and general health. This research tested whether different types have the same relationships with general mental health and general health.

Another significant aspect of this research is that it also focuses on the structure of green space. It is known in landscape ecology that structure of green space is important for wildlife and habitat. However, this research also questions that in addition to the types and amount of green space, their structure may be important to human mental and general health. That is why this
research also studied the spatial structure of green space. Furthermore, this research also contributes methodology that may be employed for other studies of green space.

One of the contributions of this study is to fill the gaps in existing knowledge. Since previous studies considered all different types of green space as simply green, this research did not presume that all green space’s effects are relevant across the whole spectrum of human benefits. Hence, this research highlighted that it is important and crucial to know the effects of different types and structures of green space on general mental health and general health.

Another contribution of this research is that its recommendations may be used to guide policy makers, planners, and designers regarding where and how to design, create, preserve or restore green space that people can mitigate and positively affect general mental health problems and assist themselves in restoring feelings and improving general health.

Limitations

As with any work, this research is subject to limitations. One of the limitations was that this study used secondary data which did not provide respondents’ exact locations within the zip-codes. Therefore, it was only possible to focus at the zip-code level. It was also not possible to know whether respondents engage with green spaces or not. Another limitation of this study is that the NLCD data is 30 m cells so that some details might be skewed. This is a particularly important limitation to measure the effect of different types of green space on health. In order to measure better details, higher resolution land cover data is needed.

The other limitation of this study about the latest available data was in 2006 for the NLCD. It is also available for 2001 but no later. On the other hand, the BRFSS data was available in 2010. However, availability of the NLCD data limited its use to two time periods.
The NLCD and the BRFSS were two primary sources and their data must be matched at the same year. That is because 2010 BRFSS data could not be used.

**STRUCTURE OF THE DISSERTATION**

Chapter One focuses upon definitions of stress, anxiety, and depression as well as their relationship with each other and effects on human health. The chapter also focuses on green space, the Behavioral Risk Factor Surveillance System (BRFSS) and the National Land Cover Dataset (NLCD) and gives information and discussion about them. Chapter Two provides a review of research relevant to green space and general mental health and general health. This chapter concludes with summaries, critiques, and responses to researches findings.

Chapter Three describes the methodology employed in this dissertation. Chapter Four discusses results, employing descriptive statistics about general mental health and general health, as well as demographics and green space data. Then, this chapter provides research results for each analytic level. Chapter Four concludes with a summary of findings and discussion. Chapter Five provides the summary and conclusions as well as recommendations for policy makers, planners and designers, and for future research.
CHAPTER ONE: DEFINITION OF STRESS, ANXIETY, DEPRESSION, GREEN SPACE, BRFSS, AND NLCD

1.0. INTRODUCTION TO CHAPTER ONE

The purpose of this chapter is to give detailed information about the main components (stress, depression, anxiety, green spaces, the BRFSS, and the NLCD) of the research. A synoptic look at the past provides background about (a) the relationship between stress and anxiety-depression and their effects on humans and (b) the types and structures of green spaces and their benefits and functions. Critical review of the Behavioral Risk Factor Surveillance System (BRFSS) and the National Land Cover Dataset (NLCD) also provides clear understanding so that it is easier to comprehend what each dataset provides and how it functions.

First, the definition of stress, depression, and anxiety is introduced. Then, a diathesis-stress model is given and the effects of stress and anxiety-depression on human health are provided. The ways of assessment and mitigation of general mental health are also introduced. Second, the definition of green space and its differences and similarities with open space are presented. Then, the types and structures of green space are defined based on the literature and land cover classification systems, as well as their benefits and roles. Next, the BRFSS is introduced and discussed. Finally, the definition, function, and critical awareness of the NLCD are described.

1.1 DIATHESIS-STRESS MODEL

According to the diathesis-stress model, psychological disorders, such as depression or anxiety, are triggered and/or worsened because of the interaction of environmental stressors (stress) with a genetic predisposition to the psychological problem (Monroe & Simons, 1991).
Diathesis-stress is defined as "the one in which genuine meaning attaches to the commonly repeated statement that heredity and environment interact” by (Rosenthal, 1963, p. 509). In the diathesis-stress model, the basic premise is that stress activates a ‘diathesis,’ which is defined as “a nervous system so sensitively constituted and illy adjusted to its surroundings that when brought in contact with unusually exciting influences, there may occur deranged instead of natural mental action, and it becomes more or less continuous instead of evanescent” (Monroe & Simons, 1991, p. 406), transforming the potential of predisposition into the presence of psychopathology.

1.1.1 The Relationship Between Stress and Anxiety and Depression

All higher living organisms respond to stress as “fight or flight.” In the wild, persistent fear of attacks by predators generates an existence fraught with ever-present anxiety. Human beings’ reaction to stress was similar, “fight or flee”, and this helped our early ancestors survive (Wheatley, 1997). Life-endangering stress is not often encountered by human beings; however, this type of stress has been substituted by other, more subtle, stresses that have far-reaching effects on the mental processes (Wheatley, 1997). The “fight or flight” response is unsuitable for the contemporary lives of mankind and can cause adverse mental and psychological effects such as anxiety, panic disorder, phobias, and depression. When stress occurs over a period of time, depression due to diathesis might develop insidiously under the cloak of continuing anxiety symptoms (Wheatley, 1997).

Diathesis gives rise to processes that increases the likelihood of the requisite forms of stress occurring, and this leads to psychological disorders being triggered and/or worsened. Although stress is not a disorder such as depression and anxiety, stress is an important phenomenon that reduces mental well-being and triggers and/or worsens depression and anxiety.
In this study, stress, anxiety, and depression are used in a general way as “general mental health.”

1.1.2 The Effects of Stress, Anxiety, and Depression on Human Health

Unresolved and long-standing stress not only leads to disorders but also damages the body and causes health problems such as fatigue, diabetes, cardiovascular disease, and high blood pressure (Sapolsky, 2004). In children, stress causes pediatric endocrine disorder (stress dwarfism) and in adults, affects the repair and remodeling of bone and other tissues disruption (Sapolsky, 2004). In females, stress may cause menstrual cycle irregularity or ceasing entirely and in males, sperm count and declining testosterone levels (Sapolsky, 2004). Stress affects immune function through central nervous system control of the hypothalamic-pituitary-adrenal (HPA) axis and sympathetic-adrenal medullary (SAM) axis (Thornton & Andersen, 2006). The HPA axis starts when stress-related sensory signals are processed in the paraventricular nucleus of the hypothalamus, which triggers release of corticotropin-releasing hormone (CRH) (Thornton & Andersen, 2006). The SAM axis (this axis produces the classic “fight or flight” response) activates with the processing of stress-related sensory signals in the locus coeruleus of the pons (Thornton & Andersen, 2006). Hormones released from the HPA and SAM axes, such as glucocorticoids, catecholamines, CRH, and opioids, can affect immune function and can lead to diseases (Thornton & Andersen, 2006).

The Centers for Disease Control and Prevention (CDC) reports that depression and anxiety as disorders cause or are associated with many health problems. The effects of anxiety-depression on humans are sleep disorders (too much or too little), shifts in appetite and weight (too much or too little), chronic physical symptoms including pain, gastrointestinal disturbances, and headaches, loss of energy and fatigue, feelings of persistent sadness, guilt, hopelessness, or
loss of self-worth, thinking difficulties such as memory loss, challenges concentrating or making decisions, and thoughts of death or suicide (Lawson & Georgiou, 2011). Depression and anxiety are also associated with an increased occurrence of chronic diseases, such as cardiovascular disease, diabetes, obesity, asthma, epilepsy, and cancer (CDC, 2011a).

1.2 THE WAYS OF ASSESSING AND MITIGATING GENERAL MENTAL HEALTH

1.2.1 How is General Mental Health Measured?

There are different approaches to assessments of general mental health. *Self-report measures* provide information about the relevant affects, appraisals, and similar elements of general mental health. Subjects are asked about their feelings, beliefs, and opinions. *Behavioral measures* are used to reflect either coping or aftereffect assessments. *Psychophysiological measurements* assess the peripheral nervous system response by one or more organ systems (e.g., cardiovascular, pulse rate, blood pressure, respiratory etc.). *Biochemical measures* also are used for useful estimates of psychoendocrine response to stressful conditions (Baum, Fleming, & Singer, 1985).

According to Cohen & Williamson (1988), life-stress scores based on self-ratings of event stressfulness are better predictors than others that either come from a simple counting of events or event scores based on weights assigned by external judges. Although different approaches can be used for assessment, it is accepted that self-report measurement is a better way to assess general mental health. The BRFSS uses *self-report measures* to assess general mental health. Thus, we can accept that this is a sound approach and appropriate measure.

1.2.2 The Types of Treatment to Mitigate General Mental Health

There are different treatments to mitigate and cure general mental health. Psychotherapy (Cognitive Behavioral Therapy [CBT], Interpersonal Therapy, and Psychodynamic Therapy),
medications (selective serotonin reuptake inhibitors [SSRIs], antidepressants), and exercises are the methods used to mitigate and cure general mental health (Antony & Swinson, 2001; Farr, Dietz, Williams, Gibbs, & Tregear, 2011; Lawson & Georgiou, 2012). In addition to these methods, there is evidence that green spaces can also lessen and positively affect general mental health. Different forms of nature (green spaces) are considered fundamental human needs and important elements to mitigate and treat mental health problems. Researchers emphasize that the significance of access to the landscape appears to be as relevant as ever in the context of modern urban lifestyles (Thompson, 2011). As mentioned in the following pages, research shows that green space have positive effects on general and mental health and are an effective way to mitigate and positively affect general mental health.

1.3. GREEN SPACE

1.3.1 Definition of Green Space

Green spaces are unbuilt areas without continuous, closely spaced buildings in an urban region (Forman, 2008). Green space are also defined as land that consists predominantly of unsealed, pervious, soft surfaces such as soil, grass, shrubs, and trees (Dunnett, Swanwick, & Woolley, 2002). Green spaces may be covered by a single natural system or by many: for example, evergreen forest, deciduous woodland, shrubby hilltop, rock outcrop, meadow, hedgerow, aquifer, pond, stream, wetland, vernal pool, and soil (Forman, 2008). Green spaces usually have no buildings, but may contain a small number of relatively scattered structures (Forman, 2008). Green areas whether or not they are publicly accessible or publicly managed, are also regarded as green space (Dunnett, Swanwick, & Woolley, 2002).
1.3.1.1 Open Space: How is Green Space Different or Similar as “Open Space”?

Green space is sometimes called open space. It is important to know the differences between green space and open space. Open space are defined by Tankel (1963) as land and water in urban areas not covered by cars or buildings. Gold (1980) adds on Tankel’s definition that open space are lands that “light above the lands.” Zisman and Ward (1968) define open space is “open to the sky.” Cranz (1982) suggests another definition, adding that open space are wide areas that can be fluid to the extent that the city can flow into the park and the park can flow into the city. Dunnett, Swanwick, and Woolley (2002) define open space as “a mixture of public (or civic) and green space, where public space are mainly ‘hard’ space such as squares, street frontages and paved areas” (p. 23).

The difference between green space and open space is that green space is unbuilt, pervious areas; however, open space also may consist of impervious areas or hard space. In this respect, it is sufficient to say that green space is part of open space, and that green space can be regarded as open space. However, not all open space can be considered green space. Therefore, open space is used to refer to the whole of the external environment outside buildings in urban areas and green space is used to refer all areas of parks, play areas, and other green space specifically intended for recreational, agricultural, and wildlife use, as well as green space with other origins (Dunnett, Swanwick, & Woolley, 2002).

1.3.2 Types of Green Space

In the literature, researchers define types of green space differently from one another. Forman (2008) defines the types of green space as playing fields, wetland, nature reserves, tree corridors, and market-gardening areas. Dunnett, Swanwick, & Woolley (2002) define the types of green space differently than Forman. The authors define three main types of green space and
each main type has subtypes. The main types and subtypes (they also break down the subtypes of green space as well) are as follows:

1. Amenity Green Space: (a) Recreation Green Space: Parks and gardens, informal recreation areas, outdoor sports areas, and play areas; (b) Incidental Green Space: Housing green space and other incidental space; (c) Private Green Space: Domestic gardens;

2. Functional Green Space: (a) Productive Green Space: Remnant farmland, city farms, and allotments; (b) Burial Grounds: Cemeteries and churchyards; (c) Institutional Grounds: School grounds (including school farms and growing areas) and other institutional grounds; and

3. Semi-natural habitats: (a) Wetland: Open/running water and marsh, fen; (b) Woodland: Deciduous woodland, coniferous woodland and mixed woodland; (c) Other Habitats: Moor/Heath, Grassland, and Disturbed Ground (p. 29).

In the Netherlands, Maas and her colleagues (2008) defined types of green space for their study of physical activity as urban green space, forest, nature conservation areas, and agricultural green space. In the same country, Van den Berg, et al. (2010) defined types of green spaces for their study. Van den Berg and her colleagues investigated whether the existence of green space can lessen the negative health impacts of stressful life events. In their study, they defined the types of green spaces as urban green, forests, nature conservation areas, and agricultural green.

In Denmark, Schipperijna, et al. (2010) conducted a study to examine potential health benefits associated with green spaces, in particular the use of green space for health benefits. Schipperijna and his colleagues defined types of green spaces as parks, beaches, seas, and/or
lakes, forests, open nature areas, and agricultural fields. Table 1.0 shows the defined types of green spaces by different researchers.

Table 1.0 Types of Green Space defined by different authors (Source: The Author, 2013).

<table>
<thead>
<tr>
<th>Authors</th>
<th>Types of Green Space</th>
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<tr>
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<td>Wetland</td>
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<td>Tree corridors</td>
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<td>Nature reserves</td>
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<td>Market-gardening areas</td>
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<td>Semi-natural habitats</td>
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<td>Functional Green Space</td>
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<tr>
<td></td>
<td>Forest</td>
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<td>Nature conservation</td>
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<td>Agricultural green space</td>
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<td>Maas, et al. (2008)</td>
<td>Urban green space</td>
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<td>Forest</td>
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<td>Nature conservation areas</td>
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<td>Nature conservation areas</td>
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<td></td>
<td>Agricultural green space</td>
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<tr>
<td>Barton and Pretty (2010)</td>
<td>Urban Green</td>
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<td>Waterside</td>
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<td></td>
<td>Forest/woodland</td>
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<td></td>
<td>Wilderness-type habitats</td>
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<td></td>
<td>Countryside/ farmland</td>
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<td>Schipperijna, et al. (2010)</td>
<td>Parks</td>
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<td></td>
<td>Beach, sea, lake</td>
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<td>Forest</td>
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<td>Open nature areas</td>
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<td>Agricultural fields</td>
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Researchers used land cover classification for their studies to define the types of green space. In the Netherlands, Maas, et al., (2008) and Van den Berg, et al., (2010) used Land Cover Classification (LGN4) for their studies. LGN4 includes agricultural areas, forests, water, urban areas, infrastructure, and nature. LGN4 defines green space as follows: forest, trees, cluster of trees and bushes, hedges and shrubs, plant patches, lawns, rough grass and herbage, sports and playing fields, banks and water nature areas (VROM, 2010, p. 2).
The United States Geological Service (USGS) defines green space in the National Land Cover Database (NLCD) as following:

1. *Urban or Built-up Land*: Open Space and Low Intensity;
2. *Forest Land*: Deciduous Forest Land, Evergreen Forest Land, and Mixed Forest Land;
4. *Agricultural Land*: Cropland and Pasture, Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas, Confined Feeding Operations, and Other Agricultural Land; and

After reviewing various studies, five different types of green space are defined and used for the studies, although the researchers used different names for them. These green spaces are urban green space, agricultural land, forest, wetland as land cover, and nature reserves as land use (more information about land cover and land use will be provided in the next sections). In addition, in the literature and land cover classification systems, rangeland or/and grassland is defined as a type of green space as well. In the LGN4, grassland (rangeland) is defined as a type of green space (VROM, 2010). Similarly, in the NLCD rangeland is defined as well (NLCD, 2011). In the study of Dunnett, Swanwick, & Woolley (2002), rangeland is defined as type of green space under semi-natural habitat section.

In this respect, since the rangeland, or/and grassland, is one of the main land cover components and is defined as green space, then it should be regarded as one of the types of green space. Thus, based on the literature and the land cover classification system, I have defined six main types of green space. However, in my study I used only land cover data and excluded land
use because the NLCD only provides land cover data. Hence, nature reserve was excluded from the research because this type is not a land cover. As a result, five types of green space were defined and used in this research. The types were:

1. **Urban green spaces** include Open Spaces (Impervious surfaces account for less than 20% of total cover) and Low Intensity Area (Impervious surfaces account for 20% to 49% percent of total cover.)

2. **Forests** include Deciduous, Evergreen, and Mixed.

3. **Agricultural lands** include Cropland and Pasture: Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas and Confined Feeding Operations.

4. **Rangelands** include Herbaceous Range, Shrub and Brush Rangeland, and Mixed Rangeland.

5. **Wetlands** include Forested Wetland and Non-forested Wetland.

### 1.3.2.1 Benefits of Green Space in Terms of Biotic, Abiotic and Cultural Milieus

As Forman (2008) states: green space, as unbuilt areas, contain and might sustain natural systems where ecological patterns, processes, and changes are in the most-natural or least-degraded condition. Yet, green space is exceedingly diverse and significant to society and wildlife (Forman, 2008). Therefore, green space serves functions in terms of biotic, abiotic, and cultural milieus. Green space contributes to the ecological and environmental functions of ecosystems. Therefore, it plays an important part in wildlife and habitat conservation (Dunnett, Swanwick, & Woolley, 2002). Forman (2008) indicates the important functions of green space to biotic milieus as following: (a) serve as major source of species dispersing to other green space, (b) reduce flood hazard, (c) cool surrounding downwind built areas for a considerable distance,
(d) attract birds migrating across the metro area, (e) support rich biodiversity, and (f) sustain wildlife (p. 109).

One of the studies showed positive correlations between green space with more diverse and mature forest vegetation and the number of specimens and species observed in different urban zones (Sanesi, Gallis, & Kasperidus, 2011). Therefore, green space conserves the rich biodiversity and ensures that critical habitats and the connections between them are protected zones (Sanesi, Gallis, & Kasperidus, 2011). In addition, green space help to sustain forest, farms, and other working lands and allow natural systems to function as intended (Benedict & McMahon, 2006). Furthermore, green space reduce noise and provide movement enhancement for terrestrial animals and serve as a visual barrier for people (e.g. between house lots) (Forman, 2008).

One of the important functions of green space is hydrology. Forman (2008) emphasizes that natural vegetation on the floodplain absorbs some floodwater and supports rich biodiversity (p. 109). Green space captures and evaporates precipitation water; and reduces impacts of storm water runoff, especially in the urban regions where impervious surfaces exists. Tyrvainen, Pauleit, Seeland, & de Vries, (2005) indicate that green space affects hydrology through: (a) interception of precipitation that can be stored and evaporated by tree foliage, (b) reduction in the peak rates of run-off into drains and water systems, and (c) reduced impact from raindrops, reduced soil erosion and pollutant wash-off.

Another function of green space is to regulate climate, especially the urban heat island effect. Studies show that rural area temperatures that are surrounded by green space are lower than urban area temperature zones (Sanesi, Gallis, & Kasperidus, 2011). Therefore, trees, shrubs, and grass evaporate water and cool leaf surfaces, providing shading so that trees, shrubs,
and grass reduce urban heat island effect (Sanesi, Gallis, & Kasperidus, 2011). Green space also improve air quality, largely through their greenery, which decreases particulates by a process of interception of gases such as ozone (O), carbon dioxide (CO₂), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂) and through surface effects and absorption into the leaves (Sanesi, Gallis, & Kasperidus, 2011).

Other important function of green space includes social benefits. Green space create important opportunities for people to connect with nature, to exercise through involvement in both passive and active recreation, and to be involved in many kinds of social, cultural and community activities (Dunnett, Swanwick, & Woolley, 2002). Especially in last three decades, several studies indicate that green spaces are very important and helpful for human health, well-being, and physiological, and psychological health (Thompson, 2011; Herzog & Strevey, 2008; Pretty et al., 2007; Kaplan & Kaplan, 1995; Morita, et al., 2007; Ulrich, 1979). The United Kingdom Royal commission indicates in their report that access to good quality green space offers an effective, population-wide strategy for the promotion of good health, well-being, and quality of life (Royal Commission on Environmental Pollution, 2007). Therefore, green space improves social capital and most importantly improves human mental and physical health.

Another important function of green space is that it provides a wide range of both formal and informal educational opportunities to all age groups (Dunnett, Swanwick, & Woolley, 2002). In addition to educational functions, green spaces have economic benefits as well. Green spaces create opportunities to attract hidden investment, to maintain businesses, to support tourism, and to increase the value and marketability of nearby property (Dunnett, Swanwick, & Woolley, 2002).
1.3.3 Structures of Green Space

1.3.3.1 Role of Landscape Ecology

Landscape is defined as “a mosaic where a cluster of local ecosystems is repeated in similar form over a kilometers-wide area” (Forman, 1995, p. 39). Landscape is defined as “a mosaic over which particular local ecosystems and land-uses recur” (Dramstad, Olson, & Forman, 1996, p. 12). Urban, O'Neill, & Shugart Jr. (1987) also defined landscape as “mosaic of patches” (p. 119). Landscapes are heterogeneous and fluctuate structurally in the distribution of species, energy, and materials between the patches, corridors, and matrix present. Thus, landscapes vary functionally in the flows of species, energy, and materials among these structural landscape elements (Forman & Godron, 1986).

Ecology is generally defined as “the study of the interactions among organisms and their environment” (Dramstad, Olson, & Forman, 1996, p. 12). Troll (1968) defined landscape ecology as the study of the whole complex cause-effect network between the living communities and their environmental conditions which overcomes in an exact section of landscape and becomes apparent in a specific landscape pattern or in a natural classification of different orders of size. Risser, Karr, & Forman, (1984) emphasized that landscape ecology reflects the development and dynamics of spatial heterogeneous landscapes, impacts of spatial heterogeneity on biotic and abiotic processes, and management of spatial heterogeneity.

Landscape ecology exemplifies a way of thinking that researchers see as very useful for organizing land management approaches. Therefore, the growing field of landscape ecology provides a strong conceptual and theoretical basis for understanding landscape structure, function, and change (McGarigal & Marks, 1995). Forman & Godron (1986) state that landscape ecology focuses on three characteristics of the landscape:
1. **Structure**: the spatial relationships among the distinctive ecosystems or “elements” present—more specifically, the distribution of energy, materials, and species in relation to the sizes, shapes, numbers, kinds and configurations of the ecosystems.

2. **Function**: the interactions among the spatial elements, that is, the flows of energy, materials, and species among the component ecosystems.

3. **Change**: the alteration in the structure and function of the ecological mosaic over time (p. 11).

Thus, landscape ecology contains the study of landscape patterns, the interactions between patches within a landscape mosaic, and how these patterns and interactions alter over time. Furthermore, landscape ecology includes applying these principles to frame and explain real-world problems (McGarigal & Marks, 1995). Landscape ecology studies the evolution and dynamics of spatial heterogeneity and its influences on ecological progressions and the management of spatial heterogeneity (McGarigal & Marks, 1995).

Landscape is represented in landscape ecology by four principle features: patches, edges, corridors, and mosaics (Dramstad, Olson, & Forman, 1996). Among them, patches are the most important because landscape or green space is composed of patches and patches make up the structures of green space. Since this study is interested in the structure of green space, patches are the most significant element. Patches are “nonlinear surface areas differing in appearance from its surroundings” (Forman & Godron, 1986, p. 83). Patches are noticeable and ubiquitous structural features of landscapes and they differ in size, shape, number, type, location, and configuration (Forman & Godron, 1986). Therefore, patches could be as large a national forest, or a small as a single tree. Patches might be numerous in landscape. The location of patches
could be useful or harmful to the optimal functioning of a landscape. Patches distribution could be scattered or clustered or connected (Dramstad, Olson, & Forman, 1996).

An edge is “the outer portion of a patch where the environment differs significantly from the interior of the patch” (Dramstad, Olson, & Forman, 1996, p. 27). The ratio of edge and the edge effect is related and important for biodiversity, wildlife, and land fragmentation. Corridors are defined as “narrow strips of land which differ from the matrix on either side” (Forman & Godron, 1986, p. 123). Corridors could vary in origin, width, degree of connectivity, amount of curvilinearity, whether a stream is present, and whether they are interconnected to form a network. Corridors are important for habitat loss and isolation (Forman & Godron, 1986).

Mosaics are a form of aggregated patches, corridors and matrices and mosaics, which describe the pattern of patches, corridors and matrices that form a landscape in its entirety (Forman, 1995).

Landscape ecology provides information about the characteristics of landscapes, which are landscape structure, landscape function, and landscape change. Among them, the most important and relevant to this research is landscape structure. Landscape structure is characterized by composition and configuration. Composition is mostly related to the presence and amount of each patch type within the landscape but without being spatially explicit. Landscape composition is important to many ecological processes and organisms (McGarigal & Marks, 1995). On the other hand, landscape configuration as one of the characteristics of landscape refers to physical distribution or spatial character of patches within the landscape (McGarigal & Marks, 1995). Thus, because of the nature of my study, I am interested in physical distribution of landscape so that landscape configuration, as a part of landscape structure, is my main focus.
Landscapes are “mosaics of patches”. Landscape ecology provides that patches vary in in size, shape, number, type, location, and configuration. Therefore, landscape structure also differs by size, shape, number, type, location, and configuration. For the parameters of this study, configuration (distribution/fragmentation), size, shape, locations (distance/proximity), and connectivity are the main metrics because this study focuses on the physical distribution of landscape.

1.3.3.2 Metrics for the Structure of Green Space

In order to quantify landscape structure, a spatial pattern analysis program, FRAGSTATS, was developed. The landscape subject to analysis is user defined and can represent any spatial phenomenon. FRAGSTATS quantifies the areal extent and spatial distribution of patches (polygons or areas on map coverage) within a landscape (McGarigal & Marks, 1995). FRAGSTATS provides a comprehensive choice of landscape metrics and was designed to be as versatile as possible (McGarigal & Marks, 1995). Although this program is almost completely automated, the user still needs to establish a sound basis for defining and scaling the landscape and the scheme by which patches within the landscape are classified and delineated (McGarigal & Marks, 1995). The scale (extent or grain) of the landscape subject to analysis is not limited in FRAGSTATS. However, FRAGSTATS reports the distance-based and area-based metrics computed in meters and hectares, respectively. FRAGSTATS is compatible with ArcGIS polygon coverage (vector), and one version also accepts raster data in various formats (McGarigal & Marks, 1995).

FRAGSTATS generates area metrics, patch density, patch size and variability metrics, edge metrics, shape metrics, core area metrics, nearest neighbor metrics, diversity metrics, and contagion and interspersion metrics. FRAGSTATS computes several simple statistics
representing area at the patch, class, and landscape levels (McGarigal & Marks, 1995). At the patch level, FRAGSTATS defines and computes the structure of individual patches. At the class level, FRAGSTATS defines and computes classes or collections of patches of the same type. At the landscape levels, FRAGSTATS defines and computes the entire landscape mosaic (McGarigal & Marks, 1995).

Although there are different metrics, some of the metrics are associated with fragmentation, size, shape, distance, and connectivity. Because I focus on the structure of green space vegetation at the zip-code level, class level metrics were appropriate. All measures will be based on class level metrics. Among the class metrics, the following metrics were selected as in the study of Lee, Ellis, Kweon, & Hong, (2008).

1- For fragmentation:
   a. Large Patch Index (LPI): quantifies the percentage of total landscape area comprised by the largest patch.
   b. Patch Density (PD): is a function of number of patches and fundamental aspect of landscape structure

2- For size:
   a. Standard Deviation of Patch Area (AREA_SD): of each patch comprising a landscape mosaic.

3- For shape:
   a. Shape Mean (SHAPE_MN): measures the average patch shape, or the average perimeter-to-area ratio, for a particular patch type (class).
   b. Shape Standard Deviation (SHAPE_SD): measures the complexity of patch shape compared to a standard shape.
4- For distance:
   a. Euclidean Nearest Neighbor Distance Mean (ENN_MN): shortest straight-line distance (m) between a focal patch and its nearest neighbor of the same class.
   b. Euclidean Nearest Neighbor Distance Standard Deviation (ENN_SD): is a measure of patch dispersion.

5- For connectivity: Cohesion Index (COHESION): an area-weighted mean perimeter-area ratio (McGarigal & Marks, 1995).

1.4 THE BEHAVIORAL RISK FACTOR SURVEILLANCE SYSTEM (BRFSS)

1.4.1 What is the BRFSS and Its Purpose?

The BRFSS is a state-based system of health surveys that create information about health risk behaviors, clinical preventive practices, and health care access and use primarily related to chronic diseases and injury (CDC, 2012). The purpose of the BRFSS is to annually collect information on health risk behaviors, preventive health practices, and health care access related to chronic disease and injury that are associated with the leading causes of morbidity and mortality in the USA (Mokdad, 2009).

1.4.2 How the Survey Conducted and Data Collected in the BRFSS?

The BRFSS is a cross-sectional telephone survey that is conducted by state health departments with technical and methodological assistance provided by the Centers for Disease Control and Prevention (CDC). Each year, states conduct monthly telephone surveillance and use a standardized questionnaire to assess the distribution of risk behaviors and health practices among non-institutionalized adults. The states give the responses to the CDC, where the monthly data are combined for each state. The data are returned to the states, and then published on the BRFSS web site (CDC, 2012)
Each state collects data from a representative sample every year, and the sampling is used to provide national estimates when all state data are combined (Mokdad, 2009). The BRFSS questionnaire is comprised of ‘core questions’ and ‘optional modules.’ All states must ask ‘core questions’ and if states want to cover additional health topics and/or more detailed questions on a health topic, they can add ‘optional modules’ and collect that data. In Washington State, 22 core-questions and 18 state-added questions were asked in 2006. Among them, three psychological constructs which are stress, depression, and anxiety and general health, were assessed via self-report in 2006. These psychological constructs and general health data were collected based on random digit-dialed, self-reports measurements from different zip-codes in the counties in 2006 (Washington State Department of Health, 2007).

1.4.3 Discussion of BRFSS: How is It Used? Quality of the Data, Limitation of BRFSS

As mentioned, every state collects data. However, collecting data differs among them. Some states collect data based on county-level and some states collect data based on zip-code level. Washington State collects data based on the zip-code level (Washington State Department of Health, 2007). The data for 2006 was weighted to remove the bias in the sample and reflect the county population estimates from the Washington State Office of Financial Management (OFM) for 2006 (Washington State Department of Health, 2007). After states collect and analyze the data, CDC and each state announce the results to the public. The BRFSS information is used by some states and local health departments and national health organizations such as the American Cancer Society and the American Heart Association to plan and target their health initiatives (CDC, 2012). The BRFSS data are used to increase the understanding of the relationship between health behavior and health status (CDC, 2006). The data are used to affect health program decisions and to support health policy positions (CDC, 2006).
In 2003, a data submission system via a secured web link was introduced. Rapid data transmission, editing, and report generation were allowed by this system; therefore, the system has a built-in method to check incoming data in terms of faithfulness to collection protocols and deviation from expected prevalence of key demographics (Mokdad, 2009). For instance, the data submitted for Washington State on a monthly basis is compared by age, sex, education, and race with census data that indicate deviation from “true values” and prompt examination of procedures and operation. This is a routine process that monitors the data on a monthly basis with feedback reports to data collectors to fix problems (Mokdad, 2009). The BRFSS data improved enormously (Fahimi, Link, Mokdad, Schwartz, & Levy, 2008). In the past, the BRFSS data have always been regarded as valid and reliable when compared with other national household surveys (Nelson, Holtzman, Bolen, Stanwyck, & Mack, 2001; Nelson, Powell-Griner, Town, & Kovar, 2003). An added benefit of this innovative system is the ability of the BRFSS to add questions and provide reports in real time (Mokdad, 2009).

Like any other work, the BRFSS is also subject to limitations. One of the limitations of the BRFSS is the length limitation. As mentioned earlier, the BRFSS consists of 40 sections and each section has a different amount of questions. That means long surveys may result in premature call termination. Research on telephone interview surveillance indicates that there is a time limit beyond which refusal rates increase (CDC, 2006). Although there might be 15 times the number of call attempts, the respondents may not complete the data. As it is mentioned in the analysis chapter, around 50% of respondents did not complete the telephone survey.

Another limitation of the BRFSS is that the BRFSS does not provide any further information regarding where respondents live and/or where the respondents took the survey. This lack of information limits research to verify whether respondents were able to view, visit, or
engage with green space in their living environment. The other limitation in the BRFSS is that states do not sample all counties and this limits data representations for the whole state. See Chapter 3 for specific BRFSS questions and discussion of how BRFSS weighting is dealt with.

1.5 THE NATIONAL LAND COVER DATASET (NLCD)

1.5.1 What are the NLCD, Land Cover, and Land Use?

The National Land Cover Database 2006 (NLCD2006) is a 16-class land cover classification scheme that has been applied consistently across the conterminous United States at a spatial resolution of 30 meters (Fry, et al., 2011). The NLCD2006 is based primarily upon the unsupervised classification of Landsat Enhanced Thematic Mapper+ (ETM+) circa 2006 satellite data (Fry, et al., 2011). Products of the NLCD provide a valuable tool in order to recognize and evaluate types of changes, their distribution and patterns, and potential consequences of changes in land cover, land use, and land condition throughout the United States (Fry, et al., 2011).

Land cover refers to the vegetative or non-vegetative characteristics of a portion of the Earth’s surface (Siderelis & Nagy, 1994). Land cover is related to the type of feature present on the surface of the earth (Lillesand & Kiefer, 1987, p. 137). Urban buildings, rivers, trees, and glacial ice are some examples of land cover types. Land use is another term that describes the human activity associated with a specific piece of land (Lillesand & Kiefer, 1987, p. 137). For instance, a zone of land on the fringe of an urban area could be used for multi-family housing. The same zone of land would have a land cover consisting of pavements, grass, and trees. Details differ based on the level of mapping and its land use might be defined as urban use, residential use, or multi-family residential use. Land cover is the skin of the earth. We can detect what is on the skin and what is detected may have different reasons and uses. Those different uses are the land use.
1.5.2 NLCD Classification and Types of Green Space in NLCD

The NLCD uses metadata to document the land cover classes. As it mentioned, NLCD 2006, which is one the main sources of this study, is a 16-class land cover classification scheme. The main classes/values and their subclasses are:

1. Water: Open water and perennial ice/snow;
2. Developed: Open space, low intensity, medium intensity, and high intensity;
3. Barren: Barren land (rock/sand/clay);
4. Forest: Deciduous forest, evergreen forest, and mixed forest;
5. Shrubland: Dwarf scrub and shrub/scrub;
6. Herbaceous: grassland/herbaceous, sedge/herbaceous, lichens, and moss;
7. Planted/ cultivated: Pasture/Hay and Cultivated Crops;

The NCLD defines the green spaces based on their class/value and determines the features of the green space—basically the NLCD creates the criteria for green space—that must be met by an area to be accepted as a green space. Normally, the NLCD does not label a class/value as a “green space”, rather gives their definition. Based on the definition of NLCD, literature, and previous studies, green space are determined. The NLCD classes were matched with the types of green space determined. From the literature those are:

1- **Urban Green Space**: (a) **Developed-open space**: “areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover”. (b) **Developed-low intensity**: “areas
with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover.”

2- **Forest: Deciduous Forest:** “areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change”. **Evergreen Forest:** “areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage”. **Mixed Forest:** “areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover”.

3- **Rangeland: Shrub/Scrub:** “areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions”. **Grassland/Herbaceous:** “areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing”.

4- **Agricultural Land: Pasture/Hay:** “areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation”. **Cultivated Crops:** “areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled”.
5. **Wetland: Woody Wetland:** “areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water”. **Emergent Herbaceous Wetland:** “areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water” (NLCD, 2011).

### 1.5.3 Critical Awareness of NLCD: Error, Cell Size, Timing of Data

There exists four different levels to classify land cover and land use. These are: Level I: LANDSAT types of data, Level II: high-altitude data (less than 1:80,000), Level III: medium-altitude data (between 1:20,000 and 1:80,000 scale), and Level IV low-altitude data (more than 1:20,000 scale) (Anderson, Hardy, Roach, & Witmer, 1976). The NLCD generates land cover and land use product by using spectral characteristics of LANDSAT imagery. The NLCD certainly is not 100 percent accurate, so there might be some errors. Sometimes a digital image may contain bad scan lines that are black or contain pixel values of 0. This condition is called line dropout. Line dropout can happen because of (a) detector errors, or (b) errors in transmitting the image data to a ground receiving station, or (c) errors in processing the image data and writing it to a computer tape (Verbyla, 1995, pp. 70-71). This can be corrected by computing the mean of the pixel above and below each bad pixel (Verbyla, 1995).

A systematic banding and striping error can sometimes happen on images produced by scanning mirrors (Verbyla, 1995). This striped form is generally most obvious in dark homogeneous areas of an image, such as water bodies or dense forest areas. Determining an appropriate value to shift the histogram to match the average histogram from the normal detectors can accomplish the correction of digital values from the unusual detector response (Verbyla, 1995). Mislabling of reference control points, which affects the calculation of land
cover based vertical accuracy thresholds for the difference grids, can cause another error. Mislabling locations on the difference grid during thresholding, which results in the wrong threshold being applied and features being either included or excluded incorrectly from the change mask can be the reason of the error as well (USGS, 2008)

In digital remote sensing, spatial resolution corresponds to ground pixel size. For instance, Landsat Enhanced Thematic Mapper has a 30-meter resolution, which means that the immediate field of view the sensor sees corresponds to the ground pixel size is a square with 30-meters (Verbyla, 1995). As a result, all data were geo-registered to the Albers Equal Area projection grid and resampled to 30x30 m² grid cell resolutions (Fry, et al., 2011).

Landsat Thematic Mapper imagery, placed on nominal collection years 2001 and 2006, delivered the foundation for land cover classification and imperviousness modeling for NLCD 2006 products (Fry, et al., 2011). Landsat scene pairs were selected to analysis and classification for each path/row in the conterminous United States (Fry, et al., 2011). The objective of the Landsat data selection was a leaf-on scene pair for each path/row with gaining dates within two weeks of each other (i.e., near anniversary dates) for the target years 2001 and 2006 (Fry, et al., 2011). In order to sustain phenological consistency, a greater emphasis was employed on the near anniversary requirement (Fry, et al., 2011). This requirement gave rise to a range of imagery acquisition dates from April 30, 1999 to August 19, 2003 for early date scenes, and from February 11, 2005 to October 03, 2007 for late date scenes (Fry, et al., 2011). At the end of the work, all data were geo-registered to the Albers Equal Area projection grid with 30 meter cell resolution (Fry, et al., 2011).
1.6 CONCLUSION TO CHAPTER ONE

This chapter provided the definition of diathesis-stress model, the relationship between stress and anxiety-depression was provided. The effects of stress and anxiety-depression on human health were also provided. This chapter also gave information regarding how general mental health was assessed and treated. As an important component of the research, green space was important in this chapter. Besides the definition and benefits of green space, types and structure of green space were determined and defined. Another main component of this research, the BRFSS, was defined and discussed. Likewise, the NLCD was defined and information was provided regarding how types of green spaces were defined in the NLCD.

A number of findings emerged from this presentation, including: (1) diathesis-stress model showed how stress and anxiety-depression related one another, (2) urban green space, forest, and agricultural land were the major types of green space in researchers’ studies, (3) although wetland and rangeland are defined as types of green space in the literature, the researchers did not consider them in their studies for different reasons, and (4) the BRFSS and the NLCD provides significant and appropriate information for this research, including the full variety of green space.

In this chapter, broad parameters within types of green space and general mental health were set out. As we proceed to evaluate the particular types of green space provided in the NLCD, it is important to understand the relationship between different types of green space and general mental health and general health. A lesson of immediate application is that green space needs to be examined in their multi-benefits, multi-effects roles. As these benefits and effects are considered, it is important that relevant research is consulted to help discover and understand the parameters of these. By doing so, the current study will benefit not only the ideas or insights
brought forth by this research, but also from the methodologies employed. Chapter Two will, therefore, be an examination of literature devoted to discovering or evaluating the relationship between different types of green space and general mental health and general health.
CHAPTER TWO:

REVIEW OF LITERATURE RELEVANT TO GREEN SPACE, GENERAL MENTAL HEALTH, AND GENERAL HEALTH

2.0 INTRODUCTION TO CHAPTER TWO

Chapter Two provides a review and synthesis of research related to green space. It explores the relationship between green space and general mental health and general health. The primary purpose was to explore the literature related to green space and general mental health to determine what kinds of studies have been done about green space and general mental health. This chapter addresses these questions: (1) What are the relationships between green space and general mental health and general health? (2) Does the type or structure of green space matter in terms of general mental health and general health? (3) What are the relationships between types of structures of green space and general mental health and general health?

To explore this literature, a simultaneous search was conducted using the cross-database query through the WSU library catalogues and Google Scholar. The search covered four primary databases: Health Science, Social Science Index, Humanities, and Architecture. For this literature, these keywords were used: “green space,” “types/structure of green space,” “urban/public open space,” “stress,” “anxiety-depression,” “mental health,” “general health,” and “well-being.” The query searched for keywords in articles published between 2000 and 2012. Several articles outside the time frame were included for their important contribution to the topic. The selected articles were published either in peer-reviewed journals based mostly in the United States and Europe, or in international peer-reviewed journals. The bibliography contains eighty articles published between 1979 and 2012. Sixty-six articles were published between 2000 and 2012. Thirty-five journals are represented in this literature review.
The literature is presented in ten major sections. The first section includes the importance of green space. The second section describes green space effects on general mental health. The third section presents green space effects on health and well-being. The fourth section comprises psychological effects of green space. The fifth section consists of restorative effects of green space. The sixth section includes effects of visiting green space. The seventh section describes effects of amount of green space on physical, mental, social health and safety, and satisfaction. The eighth section presents effects of viewing green space. The ninth section consists of effects of access and exposure to green space. And the tenth section comprises effects of green space on children and the elderly.

Chapter Two concludes with an overview of the literature, then critiques and responses, followed by a presentation of specific discussion. The hypotheses are stated based on the literature.

2.1 IMPORTANCE OF GREEN SPACE

Thompson (2011) conducted a study to trace the evidence of the impact of the landscape on people’s health, from Greek and Roman times to the present day, to determine how access to nature and attractive green space are associated with healthy lifestyles and are a perennial theme in descriptions of beneficial environments. The author found in her investigation the significance of access to the landscape appears to be as relevant as ever in the context of modern urban lifestyles. Jorgensen and Gobster (2010) reviewed and analyzed the latest research on urban green space and human health and well-being to determine urban green space roles. Based on the literature review, they emphasized that urban green space is more than “simply green”. The authors also pointed out that urban green space is important for human health and well-being because of its restorative effects. However, Jorgensen and Gobster found that researchers did not
make broad distinctions between different types of green space. Hence, the authors emphasized that it should not be presumed that all green space measures are relevant across the whole spectrum of human benefits. In this respect, they indicated that future research should seek to establish what types of green space promote particular well-being outcomes.

Brook (2010) also conducted a study to assess the importance of nature, green space, and gardens to human well-being. The author reviewed four examples of interactive engagement with nature in his study and found that nature brings about health, well-being, and social benefits to people. Tzoulas, et al., (2007) reviewed articles aiming to formulate a conceptual framework of associations between urban green space, and ecosystem and human health. At the end of their review, the authors indicated that ecosystem services provided by a green infrastructure could provide healthy environments, as well as physical and psychological health benefits to the people residing within them. Ulrich & Addoms (1981) conducted a study to examine psychological as well as active recreational benefits of a residential park through a questionnaire, open-ended interviews, a photograph rating procedure, and observation of activity. The results showed parks are important in terms of nature contact and visual amenity. The results also revealed that users and even non-users of the park appeared to derive substantial psychological benefits.

2.2 GREEN SPACE EFFECTS ON GENERAL MENTAL HEALTH

Berman, et al., (2012) conducted a study to explore whether walking in nature could be beneficial for individuals who have major depressive disorder (MDD) problem. Twenty individuals diagnosed with MDD participated in this study in which mood and short term memory span were assessed. Participants were asked to think about an unresolved negative autobiographical event, and then walk in urban or natural environment. The results revealed that there are cognitive and affective benefits of interacting with nature to individuals with MDD.
The authors suggested that interacting with nature could be useful clinically as a supplement to existing treatments for MDD.

Barton & Pretty (2010) conducted a study to assess the impact of green exercise on self-esteem and mood (indicators of mental health) with a multi-study analysis of available data using standardized meta-analysis methods. The study included 1252 participants. Participants’ self-esteem and mood were measured before and after green exercise in the study. Outcomes were identified through a priori subgroup analyses, which were exposure duration, exercise intensity, types of green space, and gender. As types of green space, urban green, countryside/farmland, forest/woodland, waterside, and wilderness-type habitats were used. The results revealed that for exposure duration there was an instant effect obtained from the beginning of green exercise; for exercise intensity there was revealed a health benefit from any short engagement in green exercise. All types of green space improved both self-esteem and mood. In addition, the presence of water generated greater improvements. Therefore, the authors indicated their study confirmed that the environment provides an important health service.

Barton, Hine, & Pretty, (2009) also conducted a study to evaluate changes in self-esteem and mood after walking in four different National Trust sites of natural and heritage value in the East of England. The standardized measures of both self-esteem and mood were measured before and after the activity. The results showed that self-esteem scores were significantly higher for those leaving the sites than those arriving. Overall mood also significantly improved. Feelings of anger, depression, tension, and confusion were all significantly reduced for those leaving; in addition, vigor was also increased.

Maas, et al., (2009) conducted a study to explore possible relations between green space and specific diseases (cardiovascular diseases, musculoskeletal diseases, mental diseases,
respiratory diseases, neurological diseases, digestive diseases, and miscellaneous). The data came from routine primary care electronic medical records—approximately 400,000 people—in the framework of the second Dutch National Survey in General Practice. Results show that the relation was stronger for anxiety disorder and depression. The prevalence of anxiety disorders and depression rate was lower in environments with more green space in a 3 km radius. The study indicates a strong relation between green space and mental health, so that green space can help fight some major public health threats.

MacKay (2008) conducted a study to explore the effects of green exercise on stress and anxiety and the role played by intensity, duration, and degree of greenness. With 101 participants, a quasi-experimental design was applied. The results revealed a significant reduction in participants’ stress and anxiety levels after green exercise. The degree of perceived greenness of the exercise also was associated with greater reductions in anxiety levels. McCaffrey (2007) conducted a study to evaluate the effect of garden walks alone, garden walks with guided imagery, and art therapy on mild to moderate depression in older adults. Sixty people participated in this study for 6 weeks in three groups. In the study, participants were asked to tell stories of the joy and sadness in their lives in the past and present and of their hopes for the future. They also completed the Geriatric Depression Scale. The results suggested that all three interventions the participants experienced helped in relieving depression and improving mood and overall attitude concerning life.

Parsons, et al., (1998) conducted a study to explicitly examine whether stress recovery and/or immunization differs as a function of the roadside environment. 160 college-age participants watched one of four different video-taped simulated drives through outdoor environments immediately following and preceding mildly stressful events. The results revealed,
as expected, that participants who watched artifact-dominated drives, relative to participants who viewed nature-dominated drives, showed greater autonomic activity indicative of stress, as well as altered somatic activity, which is indicative of greater negative effect. Also the results showed that participants who watched nature-dominated drives experienced quicker recovery from stress and greater immunization to subsequent stress than participants who viewed artifact-dominated drives.

Ulrich (1979) conducted a study to find the effects of visual perception of nature on feelings of anxiety and compare the effects of views of urban elements that lack natural elements. In his study, he showed 50 slides of outdoor environments to two groups of mildly stressed subjects. One group was shown nature scenes and the other group was shown scenes lacking nature elements. Results showed stressed participants felt significantly better when they were exposed to nature scenes rather than to urban scenes lacking nature elements. The results revealed that nature scenes reduce anger and aggression. Overall, the results strongly suggest that exposure to the nature scenes have influences on the subjects` anxiety state and reduce anxiety.

2.3 GREEN SPACE EFFECTS ON HEALTH AND WELL-BEING

Van Dillen, de Vries, Groenewegen, & Spreeuwenberg (2011) conducted a study to investigate the link between the objectively assessed quantity and quality of green areas and streetscape greenery and three self-reported health indicators. Eighty Dutch urban neighborhoods were chosen, differing in the amount of nearby green area per dwelling. One hundred forty one participants were asked to complete a questionnaire about their own health. The results indicated that both indicators for the quantity of green space were positively related to all three health indicators. Therefore, the quantity and the quality of greenspace appear relevant to health. In addition, streetscape greenery is also strongly related to self-reported health. Wilson, et al. (2010)
conducted a study to investigate the effects of the Branching Out program, which aims to improve psychological functioning through the use of greenspace. Seventy-seven volunteers completed the course and they were interviewed to measure the effects of the program. The results showed that the use of greenspace improved mental well-being and physical health.

Richardson & Mitchell (2010) conducted a study of the relationship between urban green space and health to investigate gender differences in this relationship. The authors measured all vegetated areas larger than 5m² in area, with the exception of domestic gardens, regardless of their accessibility (public or private). Among 28.6 million adults, they selected participants whose health outcomes were plausibly related to green space (cardiovascular disease mortality, respiratory disease mortality, and self-reported limiting long-term illness) and another that was expected to be unrelated (lung cancer mortality). The results showed that male cardiovascular disease and respiratory disease mortality rates lessened with increasing green space, but no significant associations were found for women. The authors explained the differences between genders are due to perceptions and usage of urban green space.

Herzog & Strevey (2008) conducted research intending to measure contact with nature and psychological well-being using 259 participants in a questionnaire based survey. They found that contact with nature was the better forecaster of effective functioning on psychological well-being. Another study was conducted on 363 students by McFarland, Waliczek, & Zajicek (2008) to investigate the relationship between student use of campus green space and their perceptions of quality of life at a university in Texas. Results showed that more than half the students were frequent users of green space on campus and most students regarded their overall quality of life positively. This study, therefore, revealed that green space and perceptions of quality of life are related one another.
Another study was conducted by Pretty, et al., (2007) in the United Kingdom to find whether 'green exercise' would improve health and psychological well-being by measuring effects of 10 green exercises (walking, cycling, horse-riding, fishing, canal-boating, and conservation activities) on 263 participants. They found that green exercise has significant positive effects on health and mood disturbance (anger-hostility, confusion-bewilderment, depression--dejection, and tension-anxiety all improving post-activity). Pretty, et al. concluded that green exercise has important implications for public and environmental health.

Mitchell & Popham (2007) conducted a study to determine the relationship between the percentage of green space in an area and the standardized rate of self-reported "not good" health, and to explore whether this association holds for areas exhibiting different combinations of urbanity and income deprivation. The authors used the 2001 Generalised Land Use Database, which differentiates green space from other types of land cover such as domestic buildings, gardens, non-domestic buildings, road, rail, path, water and other (largely hardstanding). For the health data, Mitchell and Popham used 2001 United Kingdom census data. The results revealed that a higher amount of green space in an area was generally associated with better population health. However, this relationship varied according to the combination of area income deprivation and urbanity. The authors concluded that the relationship depends on the degree of urbanity and level of income deprivation in an area. Therefore, quality as well as quantity of green space could be significant in determining health benefits.

Diette, Lechtzin, Haponik, Devrotes, & Rubin (2003) conducted a study to determine whether distraction therapy with nature sights and sounds during flexible bronchoscopy reduces pain and anxiety. Eighty consecutive adult patients participated in this study. Nature scene murals were placed at the bedside and patients listened to nature sounds before, during, and after
the procedure. The results revealed that distraction therapy with nature sights and sounds significantly reduces pain. Lee & Maheswaran (2010) reviewed academic literature produced for studies and reviews of the health effects of green space. One of the findings pointed out was that green space influence physical health through its effect on physical activity levels. The results also showed associations between green space and a variety of psychological, emotional, and mental health benefits.

2.4 PSYCHOLOGICAL EFFECTS OF GREEN SPACE

Park, et al., (2008) conducted a study to examine the physiological effects of Shinrin-yoku (taking in the atmosphere of the forest). Twelve male university students participated in this study. Six participants were asked to go to the forest and perform Shinrin-yoku while others went to an urban area. On the second day, the participants went to opposite areas to cross-check. Before and after watching the landscapes in the field areas, participants` heart-rate variability (HRV), salivary cortisol, and pulse rate were measured as physiological indices in the morning and in the evening at the place of accommodation. Participants` HRV was significantly higher, pulse rate was significantly lower, and salivary cortisol was also significantly lower in the forest area than in urban area. The results revealed that Shinrin-yoku was an effective form of relaxation and has positive physiological effects.

Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki (2010) conducted another field experiment in 24 forest across Japan to clarify the physiological effects of Shinrin-yoku in previous study of Park, et al., (2008). In total, 280 people participated in these experiments. In each experiment, participants walked in and viewed either a forest or a city area. Salivary cortisol, blood pressure, pulse rate, and heart rate variability were used as indices. The results revealed that forest environments endorse lower concentrations of cortisol, lower pulse rate,
lower blood pressure, greater parasympathetic nerve activity, and lower sympathetic nerve activity than do city environments. The authors indicated that results will contribute to the development of a research field dedicated to forest medicine, which could be used as a strategy for preventive medicine.

In Japan, Morita, et al. (2007) also surveyed 498 participants to evaluate the psychological effects of Shinrin-yoku and to identify the factors related to these effects. They found that Shinrin-yoku decreased depression and hostility, and had a greater effect on stress. Therefore, this study shows that Shinrin-yoku can help to reduce the risk of psychosocial and psychological stress-related diseases such as depression disorders, and coronary heart diseases.

Thompson (2002) conducted a study to determine what should be demanded from urban open space in the 21st century, examining people’s attitudes to nature and sustainability, their social and spatial implications of new life styles and values, patterns of urban open space and the models for future city life. The author pointed out that access to nature in the city provides important psychological benefits. Thompson emphasized that failure to provide such natural relief within the urban environment will have substantial health costs in the long run.

2.5 RESTORATIVE EFFECTS OF GREEN SPACE

Van den Berg & Custers (2011) conducted a study to investigate whether gardening can promote restoration from stress. Thirty volunteers participated and were recruited among the members of the allotment complex. They were asked to complete and rate their feelings prior to the stressor, after the stressor, and after the experimental activity. The authors found that gardening significantly decreased acute stress and positive mood was fully restored after gardening. Roe & Aspinall (2011) conducted a study to investigate the restorative benefits of walking in urban and rural settings in adults with good and poor mental health (stress or
depression). A total of 123 adults participated in the study by completing a questionnaire. The authors found that the rural walk was beneficial for affective and cognitive restoration in both health groups when compared to an urban walk.

Lee et al. (2009) conducted a study to examine the restorative effects of viewing real forest landscapes through field experiments by comparing the effects of urban landscapes with 12 participants in Japan. Findings of this study showed that forest landscapes increase positive emotion, reduced stress, and helped nervous system relaxation. Laumann, Garling, & Stormark (2003) conducted a study to test whether exposure to nature stimuli restores exhausted voluntary attention capacity and affects selective attention. Twenty-eight subjects first completed a proofreading task to induce mental load and then performed Posner’s attention-orienting task, before viewing a video of either a natural or an urban environment. After viewing the video, they performed the attention-orienting task a second time. The authors found at the end of the study that participants who watched natural environments had lower heart rates than others who viewed urban environments. Therefore, the study revealed that nature had restorative effect on people.

Laumann, Garling, & Stormark (2001) also conducted two studies aiming to develop a set of rating scales to measure the restorative components of environments. In the first study, 238 Norwegian students acted as subjects imagined themselves to be either in a nature environment or a city environment and rated how they experienced the environments. In the second study, 157 subjects recruited from the sample population of Norwegian undergraduates students watched videos of a forest, park, sea area, city, and a snowy mountain. They were also asked to rate how they experience environments. The results revealed that environments with nature elements were generally scored higher on rating scale measures of restoration than city environments.
Therefore, these results support the nature restoration theory proposed by Kaplan & Kaplan (1989).

Kaplan and Kaplan (1995) conducted studies with different groups to find restorative effects of the environment. They found that the immediate outcomes of contacts with nearby nature include enjoyment, relaxation, and lowered stress levels. Their studies also revealed that the experience of a wilderness environment was deeply restorative and the effects of the wilderness environment were powerful. Two studies were also conducted by Hartig, Mang, & Evans (1991) to determine the restorative effects of natural environment experiences on people. In both studies, the self-report and performance results revealed that while participants experienced nature, the restorative effects of nature rose. The results showed that experiences in natural settings have restorative outcomes.

2.6 EFFECTS OF VISITING GREEN SPACE

Lafortezza, et al., (2009) conducted a study in Italy and the United Kingdom with 800 participants. Questionnaires asked about the physical and psychological benefits of green space and the general well-being associated with the use of green space on people when they are stressed. Results showed that longer and more frequent visits to green space make significant improvements in perceived health benefits and well-being, and that green space can reduce the perception of thermal discomfort during heat stress. In Finland, a study was conducted by Korpela, Ylen, Tyrvainen, & Silvennoinen (2008) to identify the determinants of restorative outcomes in everyday life by surveying 3,000 people. The authors found an increase in the strength of the restorative experience was associated with the increased time in the nature/green space.
Grahn & Stigsdotter (2003) conducted a study using 953 respondents to a questionnaire in Sweden to determine the relationship between people’s health and their use of different urban open green space in and near to the city. The authors found significant relationships between the use of urban open green space and self-reported experiences of stress. These results indicate that people who visit urban open green spaces more often reported less frequent stress-related illnesses (burnout syndrome, insomnia and fatigue, depression, and feelings of panic). Korpela & Ylen (2007) conducted a study to determine whether physical health complaints are associated with the selection and frequent use of favorite places in residential areas, and whether natural favorite places actually serve emotion-regulation by transforming negative feelings into positive ones. The results showed that visiting nearby natural favorite places lessened negative feelings associated with recent health symptoms. In addition, the results revealed that people visited neighbouring natural environments in order to normalize negative feelings associated with recent health symptoms.

2.7 EFFECTS OF AMOUNT OF GREEN SPACE ON PHYSICAL, MENTAL, AND SOCIAL HEALTH, SATISFACTION, AND SAFETY

Thompson, et al. (2012) conducted a study regarding whether the existence of different amounts of green space in the environment around people’s homes is associated with stress and general well-being. Twenty-five participants were asked to complete a short questionnaire. The result showed the percentage of green space in the living environment affected stress and well-being. Therefore, the authors indicated that green space close to home can improve health and well-being and reduce stress. Van den Berg, Maas, Verheij, & Groenewegen (2010) conducted a study to investigate whether the existence of green space can lessen negative health impacts of stressful life events using 4,529 participants in the Dutch National Survey of General Practice in
the Netherlands. The authors considered “urban green,” “forest,” “nature conservation areas,” and “agricultural green” as “green space.” Van den Berg and her colleagues found that experiencing a stressful life event affected respondents who lived near high amounts of green space in a 3km radius less than the respondents who lived in a low amount of green space in the same radius. Van den Berg, et al. also found the same result for perceived mental health.

Maas, van Dillen, Verheij, & Groenewegen (2009) conducted a study to investigate whether social contacts are a likely factor mediating the relation between green space and health. The authors measured social contacts and health in 10,089 residents of the Netherlands using self-reported health survey and calculated the percentage of green within 1 and 3-km radius around the postal code coordinates for each individual’s address. Maas and her colleagues also examined the relationship between the amount of green space and respondents’ health. Maas and her colleagues considered urban green, agricultural green, forest and nature conservation areas as green space. The results showed that people with more green space in 1km radius around their homes had better self-perceived health, had experienced less health complaints in the last 14 days, and had a lower self-rated propensity for psychiatric morbidity. The results also revealed that less green space in people’s living environment coincides with feelings of loneliness and with a perceived shortage of social support. The authors concluded that loneliness and perceived shortage of social support partly mediated the relation between green space and health.

Abkar, et al. (2010) conducted a study to find the role of urban green space using 148 respondents who answered a questionnaire. The authors found that the presence of green space is important for users and promotes health. Akbar and his colleagues also found that participants used urban green space to relax and to escape from the stressful environments of the cities and restore their mental health. Sugiyama, Leslie, Giles-Corti, & Owen (2008) examined associations
of perceived neighborhood “greenness” with perceived physical and mental health, surveying 1,895 participants in Australia. The authors found that the participants who perceived their neighborhood as highly green reported better physical and mental health than the participants who perceived their neighborhood as lowest in greenness.

Lee, Ellis, Kweon, & Hong (2008) conducted a study to understand the association between landscape structure and neighborhood satisfaction, which is a perceptual construct of residents. Neighborhood satisfaction was measured using a mail-out survey to single-family households, and 311 households completed survey among 769 households. At a micro-neighborhood scale, landscape structures for respondents were also measured. The authors examined selected landscape structure indices, which were fragmentation, distance, permeability (shape), size, and connectivity. The results showed that neighborhood satisfaction was high where the neighborhood environments were less fragmented, less isolated, and well connected. The authors also found variety in the size and shape of tree patches also showed a positive relationship with neighborhood satisfaction. The results also showed that relationships became stronger when the neighborhood scale was increased.

Maas, et al. (2006) conducted a study to explore the strength of the relation between people’s perceived general health and the amount of green space in their living environment studying 250,782 respondents to the Dutch National Survey of General Practice in the Netherlands. Maas and her colleagues found that the percentage of green space in people’s living environment (in a 1 and 3-km radius) had a significant and positive relation to people’s perceived general health. Maas et al., also found that agricultural green and natural green (forest) positively related to general health, while urban green space is negatively related people’s health because of the lack of green in urban areas. Lohr & Pearson-Mims (2006) conducted a study to
compare people’s preferences and emotional and physiological responses to different tree forms, including the savanna form, and urban elements. Two hundred six participants viewed scenes with different tree forms and urban elements and slide images of spreading, rounded, or columnar trees, or inanimate objects in two urban scenes were created. The results revealed that scenes with trees were rated as more attractive than scenes with inanimate objects, and they rated spreading trees more attractive than rounded or columnar trees. Participants also reported more positive emotions when they viewed trees.

De Vries, Verheij, Groenewegen, & Preeuwenberg (2003) conducted a study to test whether people who live in greener areas are healthier than people living in less green areas. The study was conducted by combining Dutch data on the self-reported health of over 10,000 people with land-use data on the amount of greenspace in their living environment. The result showed that people who live in greener areas report fewer symptoms and have better perceived general health. Also people's mental health appears to be better. In the United States, Kuo and Sullivan (2001) examined whether contact with and presence of nature can reduce aggression and violence in a setting and in a population with relatively high rates of aggression. They used 145 urban public housing residents with varying levels of nearby nature (trees and grass). Kuo and Sullivan found that residents who lived in relatively barren buildings displayed more aggression and violence than their counterparts in greener buildings. The authors also found that levels of mental fatigue were less in greener buildings.

Kuo (2001) also conducted a study to investigate whether the phenomenon that says that exposure to green environments can enhance human effectiveness and make life’s demands manageable extends to poor inner cities where green space is minimal and life’s demands could be overwhelming. One hundred forty-five urban public housing residents were randomly
assigned to buildings with and without nearby nature. The results supported the attention restoration hypothesis that green space enhances residents’ usefulness by reducing mental fatigue. Kuo, Sullivan, Coley, & Brunson (1998) conducted a study to investigate the relationship between the amount of green vegetation in neighborhood common space and neighborhood social ties (NST), sense of safety, and adjustment. The 145 urban public housing residents were randomly assigned to 18 architecturally identical buildings. The results revealed that amount of green vegetation significantly related NST, sense of safety, and adjustment.

2.8 EFFECTS OF VIEWING GREEN SPACE

Ozdemir (2010) conducted a study to examine the effects of window views on people by using a case study with 18 single-room occupants in Turkey. The result showed that occupants in offices that have more open and natural views had higher room satisfaction than others who had less natural views. Another study was conducted by Kearney (2006) to explore the effects of residential density and nature areas on residents’ satisfaction with their neighborhood by using 361 respondents to a survey. The author found that visual proximity to natural areas had a strong effect on neighborhood satisfaction. Van den Berg, Koole, and Van der Wulp (2003) conducted a study to test the mediating role of restoration in environmental preferences. One hundred fourteen participants viewed a frightening movie and then were shown a video of either a natural or a built environment. Before and after they viewed the frightening movie, participants’ mood ratings were assessed, also after viewing the environmental video. The results showed that participants perceived the natural environments as more beautiful than the built environments. Viewing natural environments also prompted greater improvement in mood and marginally better concentration than viewing built environments.
Kaplan (2001) also conducted a study to find out whether having natural elements or settings in the view from the window could contribute to neighborhood satisfaction of residents and their sense of well-being by using 564 participants of mailed questionnaire of six low-rise apartment communities. The result of the study showed that nature content in the view from home contributes significantly to satisfaction and well-being of people. Leather, Pyrgas, Beale, & Lawrance (1998) conducted a study to investigate the direct and indirect effects of windows in the workplace on job satisfaction and general well-being and whether environmental features could moderate the negative consequences of job stress. 100 employees participated in this study in the Mediterranean region of Southern Europe. The results revealed a view of natural elements provided a buffer to negative impact of job stress and provided positive effects on general well-being and satisfaction.

Kaplan (1993) also conducted several studies to investigate the role of nature in the workplace. In the first study, 168 employees participated. The majority of the participants were desk workers, with 55 having no view to the outside or views which included no natural elements and 60 who might see natural elements from their workplace. There were 48 participants whose jobs were mostly outdoors in natural settings, such as parks and recreation maintenance. In the second study, the 615 participants who had relatively sedentary jobs participated. They were asked whether plants and nature could be helpful to get rid of the hassles of daily life. The results revealed that availability of nature in the view strongly affected satisfaction and restorative ratings: less frustration and more patience, higher enthusiasm and life satisfaction as well as overall health. No view or no access gave lower values of satisfaction and restorative ratings.
Tennessen & Cimprich (1995) conducted a study to explore whether university dormitory residents with more natural views from their windows could score better than those with less natural views on tests of directed attention. Seventy-two undergraduate students were categorized into four groups, ranging from all natural to all built. The results showed that natural views gave higher scores on directed attention than built views. Verderber (1986) conducted a study to investigate person-window transactions in the physical medicine and rehabilitation environment by using 250 participants in a two-part interview and questionnaire in six hospitals. The results revealed that the quality of the view out the windows was a significant factor in the recovery of patients in physical medicine and rehabilitation; therefore, views of urban life and nature beyond the hospital were desired by patients.

A similar study conducted by Ulrich (1984) determined whether assignment to a room with a window view of a natural setting might have restorative influences by using 23 surgical patients who were able to view a natural scene. The results revealed that nature content contributed to faster recovery for surgical patients. Ulrich (1981) also conducted a study to test whether visual exposure to nature environments was more beneficial in a psychophysiological sense than exposure to environments lacking nature. Different types of environments were shown to participants and measurements of heart rate and alpha amplitude were taken before, during, and after the slide exposures. The results revealed several significant differences of nature views and urban slides. Therefore, nature views had more positive influences on psychophysiological states than urban views.

**2.9 EFFECTS OF ACCESS AND EXPOSURE TO GREEN SPACE**

Francis, Wood, Knuiman, & Giles-Corti (2012) conducted a study investigating the relationship between Public Open Space (POS) attributes (i.e., quantity and quality) and better
mental health (i.e., low risk of psychological distress) in residents of new housing developments in the Perth metropolitan area of Western Australia. Data were obtained from a cross-sectional survey (n= 911) and Geographical Information Systems. The result indicated that residents of neighborhoods with high quality POS that facilitate contact with nature and the development of supportive relationships had lower psychosocial distress than residents of neighborhoods with low quality POS. Mitchell and Popham (2008) conducted a study to investigate whether the magnitude of income-related health inequality varies by exposure to green space. The authors categorized the population of England at younger than retirement age into groups on the basis of income deficiency and exposure to green space and acquired individual mortality records. Mitchell and Popham found that people who are exposed to the greenest environments had the lowest levels of health inequality. The authors also indicated that physical environments that promote good health might be important to reduce socioeconomic health inequalities.

Berman, Jonides, & Kaplan (2008) conducted two studies to compare the restorative effects on cognitive functioning of interactions with natural versus urban environments. In the first experiment, 38 students participated. The participants were asked to walk in natural and urban environments to explore how interactions with nature and urban areas would affect cognitive performance. The participants’ mood was assessed before and after the walk. The result showed that interactions with nature improved directed-attention abilities. In the second experiments, 8 students participated. The participants were asked to view either pictures of nature or urban areas to test Attention Restoration Theory. The second experiment also confirmed the first experiment in that improvements achieved through interacting with nature were selective to directing attention. A study conducted by Nielsen & Hansen (2007) used 2,000 participants to address the effect of access and use of green areas and their impact on people who
experience stress in Denmark. The authors found that people who have access to green areas are associated with less stress, and people who visit green areas more are less stressed than the people who visit green areas less frequently.

Hartig & Staats (2006) conducted a study to investigate the need for psychological restoration on the relative preferences for natural and urban environments. The experimental design was applied to 103 college students before a less fatigued condition and after a more fatigued condition occurred. The result showed that in both fatigue conditions, participants reported more positive evaluation of attentional recovery and restoration when they walked in a forest than in a city center. Pretty, Peacock, Sellens, & Griffin (2005) investigated whether there is a synergistic benefit to adopting physical activities while being directly exposed to nature. The authors used five groups of 20 subjects and 30 scenes projected on a wall. Blood pressure, self-esteem, and mood were measured before and after the intervention. Pretty, et al. (2005) found nature has important public and environmental health consequences, and green exercise reduced blood pressure, increased self-esteem, and had a positive effect on mood measures.

Stigsdotter (2004) conducted a study to investigate the use of green outdoor environments at people’s workplaces and its effect on stress of those people. The study randomly selected 656 people in Swedish cities and they answered a questionnaire addressing their experiences of stress and their use of green outdoor environments at their workplaces. Results showed that access to a garden at work may have a positive impact both on stress and on “trivsel” (a Swedish word meaning comfort, pleasure, and well-being). The results also revealed that a view of a garden could also lessen employees’ level of stress and affect “trivsel” in a positive way. Hartig, et al. (2003) conducted a study to track restorative effects in different (natural and urban) field settings by collecting data from 112 randomly assigned young adults. They compared
psychophysiological stress recovery and directed attention restoration in natural and urban field settings. Hartig and his colleagues found that sitting in a room with tree views fostered more rapid decline in diastolic blood pressure, which indicated less stress as compared to sitting in a viewless room. They also found that walking in a nature reserve reduced stress more than walking in urban surroundings.

Staats, Kieviet, & Hartig (2003) conducted an experiment to test whether walking in natural and urban environments can provide a likelihood of psychological restoration. 101 participants evaluated recovery, reflection, and social stimulation outcomes, imagining themselves as attentionally fatigued or fully refreshed. They viewed slides simulating a walk through a forest or an urban center, then rated the likelihood of recovery, reflection, and social stimulation outcomes following such a walk. The results revealed that the greater likelihood of restoration in the natural environment was a more positive evaluation of recovery when fatigue appears. Staats, Gatersleben, & Hertig (1997) conducted a study to investigate the effects of two ecologically significant forest design characteristics (accessibility and vegetation density) on mood. There were 98 participants in this study using sets of sequential photographic slides with verbal descriptions regarding aspects of accessibility (i.e. presence versus absence of a path, passableness, possibilities for orientation). The results indicated that accessibility provides high pleasure and positive effects on mood, and vegetation density was somewhat less influential.

Ulrich, et al. (1991) conducted a study to determine what exposure to different everyday outdoor environments may foster or hinder recovery from stress. To do this, 120 participants first watched a stressful movie, and then they were exposed to color/sound videotapes of one of six different natural and urban settings. The authors found that physiological and verbal measures indicated that recovery was faster and more complete when participants were exposed to natural
environments rather than urban environments. Ulrich and Simons (1986) also conducted a study to investigate the effects of exposure to everyday settings on stress. The participants watched a stressful movie and then 120 subjects were exposed to color/sound videotapes of different outdoor environments. The authors assessed recovery during the environmental presentation by recording muscle tension, skin conductance, and pulse transit time. Ulrich and Simons found that individuals recovered significantly faster and more completely from stress when they were exposed to natural settings as opposed to urban environments. In addition, beneficial change occurred to a greater extent of participants in the poor health group.

2.10 EFFECTS OF GREEN SPACE ON CHILDREN AND THE ELDERLY

In Scotland, Day (2008) conducted a study to explore the ways in which the local outdoor physical environment could support or challenge older people’s health by using three case study areas. One of the results indicated that outdoor environments contributed to the quality of older people’s lives and their mental health. Another result showed that the aesthetics of the environment could help elder people to combat depression. Orsega-Smith, Mowen, Payne, and Godbey (2004) also conducted a study to examine the relationship between stress, park-based leisure, and physiological/psychological health among older adults by using 100 mailed questionnaires. The result revealed that there are significant relationships between stress and length of park stay, and stress and desired health benefits; therefore, park-based leisure activities provide opportunities to reduce stress and improve mental and physical health.

Ottosson & Grahn (2005) conducted a study to test whether being outdoors in a green recreational environment causes people to be more focused compared to being in a room indoors, and whether people who are placed in an environment with many green elements experience stress reduction. Fifteen elderly people participated in this study and their powers of
concentration, blood pressure, and heart rate were measured before and after an hour of rest in a garden or in an indoor setting. The results showed that powers of concentration increase for very elderly people after a visit to a garden. The results did not show any effects on blood pressure or heart rate. Overall, it is suggested that being outdoors in a garden setting plays a role in elderly people’s powers of concentration, and might thereby impact their performance of activities of daily living.

Takano, Nakamura, & Watanabe (2002) studied the relationship between greenery-filled public areas that are close to a residence and easy to walk in and the longevity of senior citizens in a densely populated, developed megacity. The authors selected a representative sample of residents born in 1903, 1908, 1913, or 1918 from resident registration records in two cities in the Tokyo metropolitan area. Five thousand nine hundred twenty four people among 7362 consented for mail questionnaire survey, and 3114 people completed the survey. Residents were asked about environmental conditions, and about their functional status, lifestyles, living arrangements, and socioeconomic status. The results revealed that the factor of walkable green streets and space near the residence showed significant predictive value for the survival of the urban senior citizens over the following five years. The authors concluded that living in areas with walkable green space positively affected the longevity of urban senior citizens.

Wells and Evans (2003) conducted a study focusing on nature as a buffer for life stress among rural children to determine whether vegetation near residential environments may defuse or moderate the effect of stressful life events on children’s psychological well-being by collecting data on 337 rural children. They found levels of nearby nature moderate the effects of stressful life events on the psychological well-being of children in a rural setting. The result also
revealed that the effect of life stress was lower among children who live near high levels of nature than among those who live nearby little nature.

Taylor, Kuo, & Sullivan (2002) conducted a study to examine the association between near-home nature and three forms of self-discipline. The study used 169 inner city girls and boys randomly assigned to 12 architecturally identical high-rise buildings with varying levels of close nature. In order to predict children’s performance on tests of concentration, impulse inhibition, and delay of gratification, parent ratings of the naturalness of the view from home were used. The results revealed that for girls, green space immediately outside the home could help them lead more effective, self-disciplined lives. Taylor and his colleagues did not find significant results for boys. The authors indicated that for boys, perhaps more distant green space are equally important.

Wells (2000) also conducted a study to explore the linkage between the naturalness or restorativeness of the home environment and the cognitive functioning of low-income urban children. Seventeen children participated in this study and both before and after relocation, objective measures of “naturalness” which consisted of 10 items regarding the amount of nature in the window view from different rooms, were employed along with a standardized instrument measuring the children’s cognitive functioning. The results revealed that children whose homes improved the most in terms of naturalness following relocation tended to have the highest levels of cognitive functioning following the move.

2.11 SUMMARIES, CRITIQUES, AND RESPONSES

This section summarizes and interrelates the various findings outlined in the above and notes criticisms. In addition, I discuss recommendations of researchers. For consistency, each category of literature is treated in the order used previously.
Research indicated that green space is important for human health and well-being because of its restorative effect so that green space bring about health, well-being, and social benefits to people. Researchers found that the significance of access to the landscape appears to be as relevant as ever in the context of modern urban lifestyles. Thus, green space provides healthy environments as well as physical and psychological health benefits to people residing within them. It is also emphasized that green space is more than “simply green.” It should not be presumed that all green space measures are relevant across the whole spectrum of human benefits.

Researchers found that green space reduce feelings of anger, depression, anxiety, stress, tension, and confusion and help fight some major public health threats. It is emphasized that green environments provide an important health service; there are cognitive and affective benefits of interacting with nature to individuals with major depressive disorders. Thus, green space could be useful clinically as a supplement to existing treatments for major depressive disorders. In addition, green space improves both self-esteem and mood. Overall, research has revealed that green space reduces of anxiety disorders and depression rate, provides quicker recovery from stress, and improves mood and overall attitude concerning life.

Research showed that green space is helpful for human health and that green space improves mental well-being and physical health. Green exercise has important implications for public and environmental health, so green exercise has significant positive effects on health and mood disturbance such as anger, depression, anxiety, tension, and confusion. It is indicated that higher amounts of green space in an area is associated with better population health, and cardiovascular disease and respiratory disease mortality rates lessen with increased green space.
It is reported that contact with nature has a positive effect on psychological well-being and distraction therapy with nature sights and sounds significantly reduces pain.

Research stated that green space is an effective form of relaxation and has positive physiological effects. Green environments endorse lower concentrations of cortisol, lower pulse rate, lower blood pressure, greater parasympathetic nerve activity, and lower sympathetic nerve activity and reduce the risk of psychosocial and psychological stress-related diseases such as depression disorders, and coronary heart diseases. Therefore, it could be used as a strategy for preventive medicine. It is also indicated that nature in the city provides important psychological benefits so that failure to provide such natural relief within the urban environment will have substantial health costs in the long run.

Research showed that green space has restorative effects on people. Gardening significantly decreases acute stress and positive mood is fully restored after gardening. Walking in green spaces is beneficial to affective and cognitive restoration in both poor and good mental health groups. Forest landscapes increase positive emotion, reduce stress, and help nervous system relaxation.

Researchers found that visiting green space makes significant improvements in health benefits and well-being, and green space can reduce the effects of stress. More visits to green space increases their restorative effects and people who visit green space more often reported less frequent stress-related illnesses, such as burnout syndrome, insomnia and fatigue, depression, and feelings of panic. Visiting nearby favorite natural places lessens negative feelings associated with recent health symptoms.

Research showed that high amounts of green space is better for human health and can improve health and well-being, and reduce stress. People who live in high amounts of green
space are less stressful, have better health, and experienced less health complaints than people who live in low amounts of green space. People who perceive their neighborhood as highly green also report better physical and mental health than people who perceive their neighborhood as lowest green. People who live in relatively barren buildings display more aggression and violence than their counterparts in buildings with more green space and people’s levels of mental fatigue are less.

Researchers revealed that viewing green space provided better health and life satisfaction and reduced stress effects. People who view green space reported better satisfaction and well-being. Viewing green environments prompted greater improvement in mood and provided a buffer for negative impact of job stress and provided positive effects on general well-being and satisfaction. It is also reported that availability of green nature in the view strongly affected satisfaction and restorative ratings: less frustration and more patience, higher enthusiasm and life satisfaction as well as overall health. No natural view gives lower values of satisfaction and restorative ratings. Viewing green space from windows was a significant factor in the recovery of patients in physical medicine and rehabilitation and it contributed to faster recovery for surgical patients.

Research showed that exposure to green space provided many health benefits. People who are exposed to the greenest environments have lowest levels of health inequality and people who have access to green areas are associated with less stress and people who visit green areas more are less stressed than the people who visit green areas less frequently. Interactions with nature improved directed-attention abilities and people reported positive evaluation of attentional recovery and restoration when they walked in a forest than in a city center. It is also indicated
that recovery is faster and more complete when people are exposed to natural green environments.

Researchers found that green space is also important and helpful for the elderly and children. Green space could help the elderly to combat depression and park-based leisure activities provide opportunities to reduce stress and improve mental and physical health for elderly. Also living in areas with walkable green space positively affects the longevity of urban senior citizens. It is also found the effect of life stress is lower among children who live high levels of nearby nature than among those who live little nearby nature.

**Discussion**

Although numerous studies have been conducted about the effects of green space on health, stress, depression, anxiety and well-being, not enough studies have been conducted about determining the types and the structures of green space that affect stress-anxiety-depression and general health. Through the literature review, I have seen that researchers studied the relationships between green space and health, mental health, well-being, and physiological/psychological health by comparing and contrasting natural green versus urban green (Hartig, et al., 2003; Hartig & Staats, 2006; Lee, et al., 2009; Brook, 2010), or landscape view versus no view (Ulrich, 1979; Ulrich, 1984; Verderber, 1986; Kaplan, 2001; Ozdemir, 2010), or percentage/amount of green space—more versus less or barren (Kuo & Sullivan, 2001; Maas, et al., 2006; Sugiyama, et al., 2008; Abkar, et al., 2010; Van den Berg, et al., 2010) or access/exposure versus no access (Ulrich, et al., 1991; Hartig, et al., 2003; Pretty, et al., 2005; Nielsen & Hansen, 2007). Most of the studies regarded all green areas such as urban green, agricultural green, forest, and nature conservation areas as simply “green space” (Maas, et al., 2008; van den Berg, et al., 2010; Schipperijna, et al., 2010) and only a few studies (Barton & Pretty, 2010;
Maas, et al., 2006; Lee, Ellis, Kweon, & Hong, 2008;) considered different types and structures of green space.

Along with appreciation and acknowledgment, there is an important gap in existing knowledge. What is known about green space, general mental health, and general health and their relationships, based on the literature, is that green space are important for human general health, general mental health and well-being; therefore, green space can mitigate general mental health, improve well-being, and enhance physiological/psychological health. Lack of access to green space removes an opportunity for people to readily recover from general mental health and improve their well-being, more importantly failure to provide such natural relief within the urban environment can cause substantial health costs in the long run (Thompson, 2002) and stress can make people sick (Sapolsky, 2004).

However, as Kaplan and Kaplan (1995) noted, it is not known yet if some types of green space are better than others in terms of stress-anxiety-depression mitigation and general health. And an important question still remains: “what are the effects of different types and structures of green space on general mental health and general health?” Thompson (2011) emphasized a similar point that it is important to know what characteristics of landscape—its quantity, proximity, and configuration in terms of planning, quality, accessibility, and visibility—are critical to health benefits. Jorgensen & Gobster (2010) highlighted similar important questions that ask what important characteristics of green space generate desired health and well-being outcomes are and whether different characteristics of green play different roles to human health.

Velarde, Fry, & Tveit (2007) a conducted a study to identify the landscape and scene types used in environmental psychology studies and their effect on human health and well-being. They reviewed the articles that were related to health effects of viewing landscapes. At the end
of their study, the authors found that a few articles provided information about the specific landscape elements that can make a difference in terms of health effects. They noted that further research is needed to identify key elements of healthy landscapes so that such understanding would contribute to the search for functional landscape designs beneficial to human health and sustainability.

Van den Berg, Hartig and Staats (2007) emphasized that little is known about the strength of the relationships, possible group differences, and the spatial conditions (size, type, layout of green space) that promote beneficial effects of nearby nature. Purcell, Peron, and Berto (2001) conducted a study to examine why people`s preferences differ among different scene types. At the end of this study, the result supports the idea regarding the use of the restorative value of a scene as an implicit frame of reference for preference judgments. The authors then concluded asking what physical attributes of the different scene types make more restorative than others.

As a result, these studies all show that there is a need for research on determining what types and structures of green space affects general mental health and general health in order to understand the effects of different types and structures of green space on general mental health and general health. This research may help fill the gap in existing knowledge, and help policy makers, planners, and designers regarding where and how to design, create, preserve or restore green space where people can restore their feelings, reduce mental health problems, and improve general health.

2.12 RESEARCH HYPOTHESES BASED UPON THE LITERATURE

This chapter contains a number of research findings and recommendations relating to green space. In combination with the discussion of green space, uses, and functions presented in the chapters, it is now possible to present a specific set of research hypotheses that inform and
guide the present study’s evaluation of green space in Washington State. There were some key studies that help to create the hypotheses. This research consists of three levels and the questions one, two and its sub-questions posited three hypotheses for three levels based upon findings of key studies, discussion presented in the literature, and the questions asked respondents in the BRFSS survey.

In the Netherlands, van den Berg, et al. (2010) conducted a study to determine if the existence of green space can lessen negative health impacts of stressful life events. They used the Dutch National Survey for health variables and considered “urban green”, “forest”, “nature conservation area”, and “agricultural green” as “green space”. The results showed that respondents who lived in high amounts of green space experienced less stressful life events than the respondents who lived in a low amount of green space. This study uses similar methodology for the first level, so the first hypothesis is that there is a negative statistical relationship between the amount of undifferentiated green space and increased level of poorer, BRFSS-reported general mental health and general health variables where increased green space related to less general mental health problems and better general health. Normally, there should be a positive relationship between the amount of green space and general health. However, the BRFSS variables are structured such that higher values indicate potentially ‘poorer’ mental health (more ‘bad days’). Similarly, a higher ordinal value indicates worse general health, with 1 and ‘excellent and 5 as ‘poor.’ That is why the hypothesis expects a negative relationship between amount of green space and general health.

Maas, et al. (2006) conducted a study to explore the strength of the relation between people’s perceived general health and the amount of green space in their living environment. In that study the authors also looked at the relationship between different types of green space and
general health. Maas and her colleagues found that agricultural green and natural green (forest) are positively related to general health, while urban green is negatively related to people’s health because of the lack of urban green. In addition to this study, Barton & Pretty (2010) conducted a study to assess the impact of green exercise on self-esteem and mood (indicators of mental health). In this study, the authors found that green space with water showed higher relation to self-esteem and mood. Based on these studies, the second hypothesis is that there are negative statistical relationships between urban green space, forest, rangeland, agricultural land, and wetland and general mental health and general health variables where increased types of different green space correlated with less general mental health problems and better general health. As explained above, the negative expectation is because of the BRFSS questions.

Although there was not a similar study regarding relationship between structure of green space and general mental health and general health, a study was conducted by Lee, Ellis, Kweon, & Hong (2008) about the landscape structure and neighborhood satisfaction. The authors found that less fragmented, less isolated and well-connected green space showed significant relation to neighborhood satisfaction. Size and shape of tree patches also showed positive correlation to neighborhood satisfaction. Therefore, based on this key study, the third hypothesis is that there are positive statistical relationships between landscape fragmentation and distance metrics and general mental health and general health variables, and negative relationships between size, shape and connectivity metrics and general mental health and general health variables.

In addition to these three levels, there is a supportive analysis in the study. In the regression model, significant green space and significant structure of green space are used with socio-economic characteristics to test whether they are the predictors of the health variables. Both types and structures of green space are significantly related to general mental health and
general health. Therefore, it was expected to have stronger results. The hypothesis for the regression analysis is that together, there are stronger relationships between significant green space and significant landscape structural metrics and general mental health and general health.

As a result, the research questions posited three hypotheses based upon findings and discussion in the literature and research questions in the BRFSS. In addition, the regression model also posited a hypothesis as well. The alternative and the null hypotheses are listed below:

1. There is a negative statistical relationship between the amount of undifferentiated green space and increased level of poorer, BRFSS-reported general mental health and general health variables where increased green space related to fewer general mental health problems and better general health.

   The following specific null hypotheses are tested:
   - $H_{0a}$: There is no negative relationship between the amount of undifferentiated green space and increased level of poorer, BRFSS-reported general mental health variables.
   - $H_{0b}$: There is no negative relationship between the amount of undifferentiated green space and increased level of poorer, BRFSS-reported general health variable.

2. There are negative statistical relationships between urban green space, forest, rangeland, agricultural land, and wetland and general mental health and general health variables where increased types of green space is correlated with fewer general mental health problems and better general health.

   The following specific null hypotheses are tested:
   - $H_{0c}$: There is no negative relationship between urban green space and general mental health variables.
- $H_{0d}$: There is no negative relationship between urban green space and general health variable.

- $H_{0e}$: There is no negative relationship between forest and general mental health variables.

- $H_{0f}$: There is no negative relationship between forest and general health variable.

- $H_{0g}$: There is no negative relationship between rangeland and general mental health variables.

- $H_{0h}$: There is no negative relationship between rangeland and general health variable.

- $H_{0i}$: There is no negative relationship between Agricultural Land and general mental health variables.

- $H_{0j}$: There is no negative relationship between Agricultural Land and general health variable.

- $H_{0k}$: There is no negative relationship between wetland and general mental health variables.

- $H_{0l}$: There is no negative relationship between wetland and general health variable.

3. There are positive statistical relationships between landscape fragmentation and distance metrics and general mental health and general health variables, and negative relationships between size, shape and connectivity metrics and general mental health and general health variables.

The following specific null hypotheses are tested:

- $H_{0m}$: There is no positive relationship between green space fragmentation and general mental health variables.
- Ho: There is no positive relationship between green space fragmentation and general health variable.

- Ho: There is no negative relationship between green space size and general mental health variables.

- Ho: There is no negative relationship between green space size and general health variable.

- Ho: There is no negative relationship between green space shape and general mental health variables.

- Ho: There is no negative relationship between green space shape and general health variable.

- Ho: There is no positive relationship between green space distance and general mental health variables.

- Ho: There is no positive relationship between green space distance and general health variable.

- Ho: There is no negative relationship between green space connectivity and general mental health variables.

- Ho: There is no negative relationship between green space connectivity general health variable.

4. Together, there are stronger relationships between significant green space and significant landscape structural metrics and general mental health and general health variables.

- Ho: Together, there is no stronger relationship between significant green space and significant landscape structural metrics and general mental health and general health variables.
2.13 CONCLUSION TO CHAPTER TWO

This chapter provides an overview of research describing the effects of green space on human mental, general, and social health as well as well-being. The green space as “simply green” has different effects on human being; however, it is not clear that if the research continues to consider all types of green space as simply green. As the literature showed, the different types and structures of green space have different relations with general mental health and general health. Along with this notion, an annotated bibliography was presented, followed by the summaries, and critiques. As a final, the hypotheses were stated based upon the literature and discussion. The application, as well as a detailed description of the methodology of this research employed and the research instruments developed is presented in the following Chapter Three.
CHAPTER THREE:
RESEARCH METHODOLOGY

3.0 INTRODUCTION TO CHAPTER THREE

This chapter outlines the methods employed in the conduction of this study. It begins with an overview of the methodology used to conduct this research. Chapter Three continues on the BRFSS data and shows how the received data was chosen from the BRFSS data. The chapter also provides each survey questions related to variables. The info was given regarding how the received data was organized. The site evolution in the state of Washington is also presented and it was presented how types of green space were organized and calculated.

3.1 METHODOLOGICAL OVERVIEW

As mentioned before, there are three important variables in this study: General Mental Health, General Health, and Green Space (Figure 3.0). In order to conduct this research, two important instruments were employed: the BRFSS and the NLCD. The BRFSS provides the data needed for the study as secondary data. In the BRFSS, three psychological constructs: stress, depression and anxiety, general health, and demographics: age, sex, education, income and race, were assessed. These variables were collected based on random digit-dialed, self-reported surveys from different zip-codes and counties in Washington State in 2006. The data was collected from different zip-codes with different amounts of participants without knowing where the participants lived in the zip-codes. The NLCD provides the land cover data, which was needed for the green space in Washington State. In the NLCD data, urban green space, forest, rangeland, Agricultural Land, and wetland were provided (NLCD, 2011).
The methodology of this research was constructed on three levels (Figure 3.1). At Level 1, the answer of the first question, which was “What are the relationships between amount of green space and general mental health and general health regardless of green space type?” was sought and the first hypothesis, which was “There is a negative statistical relationship between the amount of undifferentiated green space and increased level of poorer, BRFSS-reported general mental health and general health variables where more green space related to less general mental health problems and better general health” was established. At Level 2, the answer of the first of the two sub-questions, which was “What are the relationships between different types of green space and general mental health and general health?” was sought and the second hypothesis, which was “There are negative statistical relationships between urban green space, forest, rangeland, agricultural land, and wetland and general mental health and general health variables where increased types of different green space correlated with less general mental health problems and better general health” was established.
Figure 3.1 Research Methodology

**SURVEY**  
(BRFSS data)

* General Mental Health (GMH)  
* General Health  
* Demographics: Age, Sex, Race, Education and SES

**LAND COVER**  
(NLCD data)

The Types of Green Space  
* Urban green space  
* Forest  
* Agricultural Land  
* Rangeland  
* Wetlands

**LEVEL 1**: The relationships between the unified green space and GMH and General Health

Unified Green Space  
Correlation  
GMH - General Health

**LEVEL 2**: The relationships between the types of green space and GMH and General Health

- Urban Green Space  
- Forest  
- Rangeland  
- Agricultural Land  
- Wetlands

Significant Green Space  
Correlation  
GMH-General Health

**LEVEL 3**: The relationships between the structures of green space and GMH and General Health

- Fragmentation  
- Size  
- Shape  
- Distance  
- Connectivity

Significant Types and Structures of GS and Demographic Characteristics  
Regression  
GMH-General Health

**RESULTS**

**RECOMMENDATIONS**  
For policy makers, planners, and designers
health problems and better general health” was posited.

At Level 3, the answer of the second of two sub-questions, which was “What are the relationships between structures of green space and general mental health and general health?” was sought and the last hypothesis, “There are positive statistical relationships between landscape fragmentation and distance metrics and general mental health and general health variables, and negative relationships between size, shape and connectivity metrics and general mental health and general health variables” was established. As a last hypothesis, which was “Together, there are stronger relationships between significant green space and significant landscape structural metrics and general mental health and general health variables” was posited for the regression model as a supportive analysis.

In order to measure the amount and percentage of the green space in each zip-code for Level 1 and Level 2, a Geographical Information System (GIS) was used. At Level 3, FRAGSTATS was used in order to calculate the structures of green space. To analyze the BRFSS data, as well as the NLCD, SPSS, which is a powerful, complex computer program for statistical analysis, was used. For the hypothesis testing, Pearson correlation coefficient (Pearson $r$) was used for all levels. To support the results, Linear Regression was used for significant types and structures of green space with demographics.

### 3.2 BRFSS SURVEY

#### 3.2.1 Choosing Variables from the BRFSS Data

As mentioned before, secondary data, the BRFSS survey data, was used in this research. All the variables were collected by Washington State Department of Health on behalf of Centers for Disease Control and Prevention (CDC) in 2006. The BRFSS data consists of 40 sections, 22 sections are CDC Core Questions and 18 sections are State-Added Questions. Among those
sections, only related questions were selected. In the BRFSS survey, responses supplied by the
residents of Washington State, who provided 1) General health status; 2) Mental health status; 3)
Anxiety-Depression status; and 4) Demographics: 4.1) Age of respondents; 4.2) Race of
respondents; 4.3) Education; 4.4) Household income; 4.5) Zip-code where respondents live; and
4.6) Sex. The specific variables are presented in the following paragraphs. Please note that each
rating has different scales, which are shown after the questions. Each question, phrased as it
actually appeared in the questionnaire, and the response categories associated with it, is
presented.

**Section 1: Health Status**

Q1.1- Would you say that in general your health is:

1 = Excellent  
2 = Very good  
3 = Good  
4 = Fair  
5 = Poor  
7 = Don’t know/Not Sure  
9 = Refused

**Section 2: Mental Health**

Q2.1- Now thinking about your mental health, which includes stress, depression, and
problems with emotions, for how many days during the past 30 days was your mental
health not good?

__Number of days (1-30)  
__None (88)  
__Don’t know / Not sure (77)  
__Refused (99)

**Section 11: Demographics**

Q11.1- What is your age?

__ = Code age in years  
07 = Don’t know/Not sure  
09 = Refused
Q11.3- Which one or more of the following would you say is your race?

1 = White
2 = Black or African American
3 = Asian
4 = Native Hawaiian or Other Pacific Islander
5 = American Indian, Alaska Native
6 = Other Specify__________
8 = No additional choices
7 = Don’t know /Not sure
9 = Refused.

Q11.7- What is the highest grade or year of school you completed?

1 = Never attended school or only attended kindergarten
2 = Grades 1 through 8 (Elementary)
3 = Grades 9 through 11 (Some high school)
4 = Grade 12 or GED (High school graduate)
5 = College 1 year to 3 years (Some college or technical school)
6 = College 4 years or more (College graduate)
9 = Refused

Q11.9- Is your annual household income from all sources:

01 = Less than $10,000
02 = $10,000 to less than $15,000
03 = $15,000 to less than $20,000
04 = $20,000 to less than $25,000
05 = $25,000 to less than $35,000
06 = $35,000 to less than $50,000
07 = $50,000 to less than $75,000
08 = $75,000 or more
77 = Don’t know / Not sure
99 = Refused

Q11.13- What is your ZIP code where you live?

__ __ __ __ __ = ZIP code
7 7 7 7 7 = Don’t Know/ Not sure
9 9 9 9 9 = Refused

Q11.16- Indicate sex of respondent

1 = Male
2 = Female
**Section 24: Anxiety-Depression**

Same categories applied from Q24.1 to Q24.8.

Q24.1 - Over the last 2 weeks, how many days have you had little interest or pleasure in doing things?

- 01–14 days
- None (88)
- Don’t know / Not sure (77)
- Refused (99)

Q24.2 - Over the last 2 weeks, how many days have you felt down, depressed or hopeless?

Q24.3 - Over the last 2 weeks, how many days have you had trouble falling asleep or staying asleep or sleeping too much?

Q24.4 - Over the last 2 weeks, how many days have you felt tired or had little energy?

Q24.5 - Over the last 2 weeks, how many days have you had a poor appetite or eaten too much?

Q24.6 - Over the last 2 weeks, how many days have you felt bad about yourself or that you were a failure or had let yourself or your family down?

Q24.7 - Over the last 2 weeks, how many days have you had trouble concentrating on things, such as reading the newspaper or watching the TV?

Q24.8 - Over the last 2 weeks, how many days have you moved or spoken so slowly that other people could have noticed? Or the opposite – being so fidgety or restless that you were moving around a lot more than usual?

Same categories applied for Q24.9 and Q24.10

Q24.9 - Has a doctor or other healthcare provider EVER told you that you had an anxiety disorder (including acute stress disorder, anxiety, generalized anxiety disorder, obsessive-compulsive disorder, panic disorder, phobia, posttraumatic stress disorder, or social anxiety disorder)?

- Yes (1)
- No (2)
- Don’t know / Not sure (7)
- Refused (9)

Q24.10 - Has a doctor or other healthcare provider EVER told you that you have a depressive disorder (including depression, major depression, dysthymia, or minor depression)?
3.2.2 Organizing the Received Data

As mentioned, the secondary data was used in this study. The Washington State Department of Health collected the BRFSS data. The BRFSS data was acquired from Washington State Department of Health as a STATA data. This STATA data was exported into SPSS program. In order to avoid confusion, some changes have been made.

3.2.2.1 Zip-Code Data

As indicated before, the BRFSS only provides zip-code level data. First, the zip-codes in 2006 were checked by looking at the United States Postal Service. In the BRFSS data, 668 zip-codes were listed in Washington State in 2006. Among these zip-codes, some of them represented P.O. Boxes and private companies. In the GIS zip-code, 532 zip-codes were listed in Washington State. In order to be consistent, the BRFSS and the zip-codes in the GIS were matched. The zip-codes that were not matched in both the BRFSS and the GIS were excluded from the zip-code list. After the match of the BRFSS and the NLCD data, 509 zip-codes remained. In this match, P.O. Boxes and private companies’ zip-codes were excluded, because it was unknown where the participants actually live. Also, the responses of “77777” as don’t “know/not sure” and “99999” as “refused” for the zip-code section in the BRFSS were excluded. Because of the uncompleted data in the BRFSS, missing responses were excluded as well. In this deletion, listwise deletion was used.

In addition, the code of “88,” which represents “none” in mental health and anxiety-depression sections, was recoded as “0”. Also, the answers coded “7” and “77” as “don’t know,” “not sure” and “9” and “99” as “refused” were excluded from the data as well. Furthermore, the 9th and 10th questions of Anxiety-Depression section were excluded because the rest of the questions were perception of self-report questions; however, the 9th and 10th questions were
reports of medical diagnosis of doctor/health providers report. In order to be consistent, only self-report questions were chosen. As a result, completed data in 481 zip-codes were left. In order to maintain the statistical validity of the study, the criterion was set up for each zip-code. Thus, the participation of at least 10 respondents was required for every zip-code in order to be considered in the study. Therefore, completed data of 10,416 participants in 298 zip-codes were conducted in this study.

3.2.2.2 Organizing Variables

As mentioned before, this study was constructed at the zip-code level. For general mental health, mean response scores were calculated for each zip-code. To do that, all responses’ scores were summed up (BRFSS Section 2 and Section 24) and divided by total responses for every zip-code. That is how the means of general mental health were acquired for zip-codes. For the general health, the mean of responses on general health scores (BRFSS Section 1) were calculated as the same way as general mental health means were calculated.

In this study, 6 health variables were used. Three of the variables, Mental Health (Section 2), Anxiety-Depression (Section 24), and General Health (Section 1), already existed in the BRFSS data and in order to strengthen the study, three more variables were created. When the new health variables created, I followed the same calculation methods as for the existing health variables. The response scores were summed up and divided by the total number of participants for each zip-code. The created variables were No Report of General Mental Health, which was created from the Mental Health and Anxiety-Depression variables (Section 2 and Section 24) for the participants who said “0 not good day” in their responses for Mental Health and Anxiety-Depression (for this variable, the percentage of respondents who said “0 not good day” for Mental Health and Anxiety-Depression was calculated for each zip-code).
Table 3.0 The Health Variables from the BRFSS data (Source: The Author, 2013).

<table>
<thead>
<tr>
<th>Questions</th>
<th>Labeled in the BRFSS</th>
<th>Author’s Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?</td>
<td>Mental Health</td>
<td>Mental Health</td>
</tr>
<tr>
<td>(1) Over the last 2 weeks, how many days have you had little interest or pleasure in doing things?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Over the last 2 weeks, how many days have you felt down, depressed or hopeless?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Over the last 2 weeks, how many days have you had trouble falling asleep or staying asleep or sleeping too much?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Over the last 2 weeks, how many days have you felt tired or had little energy?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) Over the last 2 weeks, how many days have you had a poor appetite or eaten too much?</td>
<td>Anxiety-Depression</td>
<td>Anxiety-Depression</td>
</tr>
<tr>
<td>(6) Over the last 2 weeks, how many days have you felt bad about yourself or that you were a failure or had let yourself or your family down?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7) Over the last 2 weeks, how many days have you had trouble concentrating on things, such as reading the newspaper or watching the TV?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) Over the last 2 weeks, how many days have you moved or spoken so slowly that other people could have noticed? Or the opposite – being so fidgety or restless that you were moving around a lot more than usual?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Created from variable (1) in Mental Health and variables (1) to (8) in Anxiety-Depression section for participants who said “0”</td>
<td>Mental Health and Anxiety-Depression</td>
<td>No Report of General Mental Health</td>
</tr>
<tr>
<td>Created from variable (1) in Mental Health section for participants who said at least 1 day or more.</td>
<td>Mental Health</td>
<td>Report of Mental Health</td>
</tr>
<tr>
<td>Created from variables (1) to (8) in Anxiety-Depression section for participants who said at least 1 day or more.</td>
<td>Anxiety-Depression</td>
<td>Report of Anxiety-Depression</td>
</tr>
<tr>
<td>(1) Would you say that in general your health is...</td>
<td>Health Status</td>
<td>General Health</td>
</tr>
</tbody>
</table>
Report of Mental Health was created from Mental Health section for participants who said “1 through 30 days not good” in the responses for Mental Health, and Report of Anxiety-Depression from Anxiety-Depression variable for participants who said “1 through 14 days issues” in their responses for Anxiety-Depression (Table 3.0).

For the demographics variables, the mean of the respondents’ age was calculated for each zip-code. It was calculated the same way as the mean of general mental health. For the rest of the demographic components, their percentages were calculated for each zip-code. As a result, the mean of mental health, general health, participants who reported one or more days mental health not good, participants who reported one or more days of anxiety-depression issues, and respondents’ age were calculated. Percentage of participants who reported no days of general mental health issues and percentage of the respondents’ race, percentage of the education levels, percentage of the income levels, and percentage of the sex were calculated for every zip-code.

3.3 GREEN SPACE EVALUATION

The NLCD2006 Land Cover data provides data for the whole United States. After acquiring the NLCD2006 Land Cover data from the U.S. Geological survey website, the data for Washington State was extracted using ArcGIS (ESRI 2012). In the NLCD data, different land cover classifications are provided. Those classifications and their codes were as follows: 11-Open Space; 12-Prennial Ice/Snow; 21- Developed-Open Space; 22- Developed-Low Intensity; 23- Developed-Medium Intensity; 24- Developed-High Intensity; 31-Barren Land (Rock/Sand/Clay); 41-Deciduous Forest; 42-Evergreen Forest; 43-Mixed Forest; 51-Dwarf Scrub; 52-Shrub/Scrub; 71-Grassland/Herbaceous; 72-Sedge/Herbaceous; 73-Lichens; 74-Moss; 81-Pasture/Hay; 82-Cultivated Crops; 90-Woody Wetland; and 95-Emergent Herbaceous Wetland. The Rest of the unclassified numbers are presented as “background”.
Based on the definition of green space presented in Chapter 1, land cover classes were chosen from the NLCD2006 Land Cover data. The chosen land cover classifications were as following: 21 and 22 as “Urban Green Space;” 41, 42, and 43 as “Forest;” 52 and 71 as “Rangeland;” 81 and 82 as “Agricultural Land;” and 90 and 95 as “Wetland.” After Land Cover was determined, the NLCD2006 Land Cover data was re-projected as “Albers Conical Equal Area.” Then, the land cover data was reclassified and only green space were kept. After reclassifying the land cover, “21” was coded as urban green space, “41” was coded as forest, “52” was coded as rangeland, “81” was coded as Agricultural Land, and “90” was coded as wetland (Table 3.1).

Table 3.1 The Green Space Variables from the NLCD data (Source: The Author, 2013).

<table>
<thead>
<tr>
<th>The NLCD Code</th>
<th>Author’s Code</th>
<th>Author’s Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>21: Developed Open Space</td>
<td>21</td>
<td>Urban Green Space</td>
</tr>
<tr>
<td>22: Developed Low Intensity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41: Deciduous Forest</td>
<td>41</td>
<td>Forest</td>
</tr>
<tr>
<td>42: Evergreen Forest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43: Mixed Forest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52: Shrub/Scrub</td>
<td>52</td>
<td>Rangeland</td>
</tr>
<tr>
<td>71: Grasslands/Herbaceous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>81: Pasture/Hay</td>
<td>81</td>
<td>Agricultural Land</td>
</tr>
<tr>
<td>82: Cultivated Crops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90: Woody Wetland</td>
<td>90</td>
<td>Wetland</td>
</tr>
<tr>
<td>95: Emergent Herbaceous Wetland</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As mentioned, there were 532 zip-codes in the GIS zip-code data. However, 509 zip-codes remained after matching the zip-codes in both the NLCD and the BRFSS. After at least 10 respondents requirements applied, 298 zip-codes were left. In order to calculate the amount and the percentage of the green space in every zip-code area, each type of green space was measured separately. To do that, each type was reclassified and all of them were calculated one by one.
with Zonal Statistic tool in the ArcGIS. After measuring the percentage of each type of green space, all types were exported into Excel file. From the Excel file, the results were entered into SPSS program to analyze.

### 3.3.1 Significant Green Space

Another important variable of the study is the significant green space. In order to calculate the structure of significant green space at Level 3, I needed to create the significant green space variable. Significant green space was created based on the Level 2 result. At Level 2, results showed that urban green space and forest are significantly related to general mental health and general health variables. Therefore, it was clear by looking at the distributions of the types of green space across the state that people might have either/or in their zip codes, they might have a lot of urban green space or forest. Both urban green space and forest share similar characteristics. Therefore, I combined the percentage of urban green space and forest in every zip-code and analyzed the structure of significant green space at Level 3.

### 3.4 FRAGSTATS ANALYSIS

FRAGSTATS is a spatial pattern analysis program to quantify landscape (green space) structures. FRAGSTATS quantifies the areal extent and spatial distribution of patches (that is, polygons or areas on map coverage) within a landscape (McGarigal & Marks, 1995). FRAGSTATS reports the distance and area-based metrics computed in meters and hectares, respectively (McGarigal & Marks, 1995).

After creating the significant green space, I calculated the percentage of green space for each zip-code using the ArcGIS. Since I had 298 zip-codes to calculate in Washington State, the size of 298 zip-codes was too big for the FRAGSTATS to calculate. Therefore, I clipped every zip-code that contained significant green space separately. After that, every zip-code was
exported as GRID to be used in FRAGSTATS. After the zip-codes were exported, I put them into FRAGSTATS. As mentioned before, in FRAGSTATS I chose to use class metrics to calculate structures. Among the class metrics:

For *Fragmentation*: Large Patch Index (LPI), Patch Density (PD) and Standard Deviation of Patch Area (AREA_SD);

For *Size*: Standard Deviation of Patch Area (AREA_SD);

For *Shape*: Shape Mean (SHAPE_MN) and Shape Standard Deviation (SHAPE_SD);

For *Distance*: Euclidean Nearest Neighbor Distance Mean (ENN_MN) and Euclidean Nearest Neighbor Distance Standard Deviation (ENN_SD); and

For *Connectivity*: Cohesion Index (COHESION) was selected. When selected metrics were calculated, the results were exported into an Excel file. From the Excel file, the results were entered into SPSS program to analyze.

### 3.5 CONCLUSION TO CHAPTER THREE

This chapter described the developments and organization of the secondary BRFSS data in this study. In addition, the variables themselves were presented with each question. This collected BRFSS data is employed in the following chapter for analysis of the research questions. Chapter Four gives descriptive statistics and analyzes the survey data. The questions one, two, and its sub-questions were answered in that chapter. In addition, the hypotheses were tested in Chapter Four as well.
Chapter Three Notes

1 GIS is a computer system which is capable of capturing, storing, analyzing, and displaying geographically referenced information; that is, data identified according to location. GIS is also defined by practitioners including the procedures, operating personnel, and spatial data that go into the system. More info can be found at http://egsc.usgs.gov/isb/pubs/gis_poster/

2 In order to quantify landscape structure, a spatial pattern analysis program FRAGSTATS was developed. FRAGSTATS computes the areal extent and spatial distribution of patches (that is, polygons on map coverage) within a landscape. FRAGSTATS offers a comprehensive choice of landscape metrics and was intended to be as useful as possible (McGarigal & Marks, 1995). More info can be found at http://www.uMaas.edu/landeco/research/fragstats/fragstats.html

3 SPSS is a widely used program, which is strong, complex computer program for statistical analysis. SPSS allows users to predict with confidence and make choices for their analysis. More info can be found at http://www-01.ibm.com/software/analytics/spss/

4 Alaska Only
CHAPTER FOUR:
DATA ANALYSIS AND RESEARCH RESULTS

4.0 INTRODUCTION TO CHAPTER FOUR

This chapter presents and analyzes data describing the characteristics of all independent and dependent variables. In the first part, descriptive statistics of mental health, anxiety-depression, general health, zip-codes level, demographic, green space, and structure of green space are presented. In the second part, I analyze the relationship between green space and general mental health and general health. In the third part, the relationship between different types of green space and general mental health and general health is presented. The most significant green space types are also identified and presented. The fourth part presents analysis of the relationship between structures of significant green space and general mental health and general health variables. Following the fourth section, the interpretations of the results are presented. The concluding section of the chapter presents summaries of findings and as well as an integrative discussion of the research questions.

As noted previously, the first research question focused on the relationship between green space, regardless of its type in respondents' zip-codes and their reported general mental health and general health. The first sub-question of the second question focused on the relationship between different types of green space and general mental health and general health. The second sub-question of the second question addressed the relationship between structure of significant green space and general mental health and general health. In addition, a regression model including important independent variables from both Level 2 and Level 3 was developed.

Question one and sub-questions of question two posited three hypotheses, or expectations, and the regression model posited another hypothesis based on findings from the
literature. These hypotheses posited expectations regarding the effect or influence of green space upon mental and physical health as reported in the BRFSS. These hypotheses posited that:

a) There is a negative statistical relationship between the amount of undifferentiated green space and increased level of poorer, BRFSS-reported general mental health and general health variables where more green space related to less general mental health problems and better general health. The following specific null hypotheses are tested at Level 1: 

\[ H_{0a} - H_{0b}: \] 
There is no negative relationship between amount of green space and general mental health and general health variables;

b) There are negative statistical relationships between urban green space, forest, rangeland, Agricultural Land, and wetland and general mental health and general health variables where more types of different green space correlated with less general mental health problems and better general health. The following specific hypotheses were tested at Level 2: 

\[ H_{0c} - H_{0d}: \] 
There is no negative relationship between urban green space and general mental health and general health variables. 
\[ H_{0e} - H_{0f}: \] There is no negative relationship between forest and general mental health and general health variables. 
\[ H_{0g} - H_{0h}: \] There is no negative relationship between rangeland and general mental health and general health variables. 
\[ H_{0i} - H_{0j}: \] There is no negative relationship between Agricultural Land and general mental health and general health variables. 
\[ H_{0k} - H_{0l}: \] There is no negative relationship between wetland and general mental health and general health variables.

c) There are positive statistical relationships between fragmentation and distance and general mental health and general health variables and negative relationships between size, shape and connectivity and general mental health and general health variables. The following specific hypotheses were tested at Level 3: 

\[ H_{0m} - H_{0n}: \] There is no positive relationship between green
space fragmentation and general mental health and general health variables. $H_{0q} - H_{0p}$: There is no positive relationship between green space distance and general mental health and general health variables. $H_{0r} - H_{0q}$: There is no negative relationship between green space size and general mental health and general health variables. $H_{0s} - H_{0r}$: There is no negative relationship between green space shape and general mental health and general health variables. $H_{0t} - H_{0s}$: There is no negative relationship between green space connectivity and general mental health and general health variables.

d) Together, there are stronger relationships between significant green space and significant landscape structural metrics and general mental health and general health variables. The following hypothesis was tested $H_{0w}$: Together, there is no stronger relationship between significant green space and significant landscape structural metrics and general mental health and general health variables.

This chapter presents descriptive statistics and thematic maps (figures) describing the variables from BRFSS (demographics, mental health, anxiety-depression, and general health) and the green space data from the NLCD. Thus, means, standard errors, minimum, maximum, and standard deviation are presented (a) at Level 1 for unified green space and general mental health and general health; (b) at Level 2 for types of green space (i.e. urban green space, forest, rangeland, Agricultural Land, and wetland) and general mental health and general health; and (c) at Level 3 for structure of significant types of green space (i.e. fragmentation, size, shape, distance, and connectivity) and general mental health and general health. In addition, frequencies and percentages are also presented at all levels for every variable.
This site data is useful for purposes beyond answering the research hypotheses. Hence, sections 4.1 through 4.5 present findings regarding every variable collected. Readers interested only in the results of the research questions may wish to turn to the summaries in section 4.6.

### 4.1 DESCRIPTIVE STATISTICS

#### 4.1.1 Descriptive Statistics of Mental Health Variable

All respondents were asked to rate their mental health level. The question (BRFSS Section 2, Question 2.1) was “Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?” The categories were: Number of days (1-30), none, don’t know/not sure, and refused. The minimum response was “0” days, whilst the maximum day was “30.”

There were 23,760 total responses to this question. Of these, 318 participants, which was 1.3% of total participants, answered “don’t know/not sure” and 65 participants, which was 0.3% of total participants, “refused” to answer. As a result, there were 23,377 (98.4%) usable responses to this question (See Table 4.0).

Table 4.0 Descriptive Statistics for Days Mental Health Not Good Variable (Source: The Author, 2013).

<table>
<thead>
<tr>
<th>Valid</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 30</td>
<td>23337</td>
<td>98.4</td>
<td>98.4</td>
<td>98.4</td>
</tr>
<tr>
<td>77</td>
<td>318</td>
<td>1.3</td>
<td>1.3</td>
<td>99.7</td>
</tr>
<tr>
<td>99</td>
<td>65</td>
<td>.3</td>
<td>.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>23760</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

As shown in Table 4.1, the mean response was 3.25 “not good” days of possible 30 (St. error of $\bar{X} = .048$, $SD = 7.373$) (Table 4.1). The distribution of days of not good mental health was normal. Though the mean was 3.25, note that the number of days ranged from 0 days to 30 days, indicating that some respondents reported zero days of “not good” mental health, while some
reported that every day was a “bad” day. Based on the notion that 0 bad days might be
significant, a ‘0 days’ variable derived and is described below.

Table 4.1 Descriptive Statistics for Days Mental Health Not Good Responses (Source: The Author, 2013).

<table>
<thead>
<tr>
<th>Valid (0-30)</th>
<th>Missing (77 / 99)</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Error of Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>23337</td>
<td>383</td>
<td>0</td>
<td>30</td>
<td>3.25</td>
<td>.048</td>
<td>7.373</td>
</tr>
</tbody>
</table>

4.1.2 Descriptive Statistics of Anxiety-Depression Variable

All participants were asked to rate their anxiety-depression level. The questions (BRFSS
Section 24, Questions 24.1 to 24.8) were “(1) Over the last 2 weeks, how many days have you
had little interest or pleasure in doing things? (2) Over the last 2 weeks, how many days have
you felt down, depressed or hopeless? (3) Over the last 2 weeks, how many days have you had
trouble falling asleep or staying asleep or sleeping too much? (4) Over the last 2 weeks, how
many days have you felt tired or had little energy? (5) Over the last 2 weeks, how many days
have you had a poor appetite or eaten too much? (6) Over the last 2 weeks, how many days have
you felt bad about yourself or that you were a failure or had let yourself or your family down?
(7) Over the last 2 weeks, how many days have you had trouble concentrating on things, such as
reading the newspaper or watching the TV? and (8) Over the last 2 weeks, how many days have
you moved or spoken so slowly that other people could have noticed? Or the opposite – being so
fidgety or restless that you were moving around a lot more than usual? The categories were:
number of days (1-14), none, don’t know/not sure, and refused.

There were 23,760 total responses to these questions. 12,400 responses were incomplete
and 11,360 responses were complete. Of these complete responses, 173 participants, which was
0.7% of the total, said “don’t know/not sure” and 16 participants, which was 0.1% of the total,
“refused” answering. As a result, there were 11,171 (47%) useable responses to these questions (See Table 4.2).

Table 4.2 Descriptive Statistics for Anxiety-Depression Variable (Source: The Author, 2013).

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>0 - 14</td>
<td>11171</td>
<td>47</td>
<td>98.3</td>
</tr>
<tr>
<td></td>
<td>77</td>
<td>173</td>
<td>.7</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>99</td>
<td>16</td>
<td>.1</td>
<td>.1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>11360</td>
<td>47.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Missing</td>
<td>System</td>
<td>12400</td>
<td>52.2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>23760</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

To help clarify the relationship between anxiety-depression and green space, eight questions were reduced to one factor (i.e. anxiety-depression index) using maximum likelihood exploratory factor analysis. The factor analysis was used because these questions together were intended to measure the level of anxiety-depression. Each question asked a different symptom of anxiety-depression so that they should be considered together. When I looked at the total value in the factor analysis, only one factor was higher than 1, which means I had only one factor. It was also clear by looking at the screen plot that there was a big drop left elbow so that all items are related each other in one way. In this respect, items were summed to create a total score. In the anxiety-depression index, the minimum response was “0” days whilst the maximum days were “14.” The mean response was 1.6 (St. error of $\bar{X}= .021$, $SD= 2.266$) (Table 4.3). The result of anxiety-depression was normally distributed. As such, the mean was 1.6. Note that the number of days ranged from 0 days to 14 days, showing that some respondents reported 0 days of anxiety-depression problems, whilst some reported that every day had anxiety-depression problems. Based on the impression that 0 days might be significant, a (0) days variable was derived and is described below.
Table 4.3 Descriptive Statistics for Anxiety-Depression Responses (Source: The Author, 2013).

<table>
<thead>
<tr>
<th>Valid (0-14)</th>
<th>Missing (77 / 99)</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Error of Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11360</td>
<td>189</td>
<td>0</td>
<td>14</td>
<td>1.6</td>
<td>.021</td>
<td>2.266</td>
</tr>
</tbody>
</table>

4.1.3. Descriptive Statistics of General Health Variable

All respondents were asked to rate their general health level. The question (BRFSS Section 1, Question 1.1) was “Would you say that in general your health is...” The categories were: 1 = Excellent, 2 = Very Good, 3 = Good, 4 = Fair, 5 = Poor, 7 = Don’t know/Not Sure, and 9 = Refused. The minimum response was “1” as “excellent,” whilst the maximum response was “5” as “poor.” There were 23,760 responses to this question. Among them 23,684 responses were completed. Of these, 61 participants, which was 0.3% of the total, said “don’t know/not sure” and 15 participants, which was 0.1% of the total, “refused” answering. As a result, there were 23,684 (99.6%) useable responses to this question (See Table 4.4).

Table 4.4 Descriptive Statistics for General Health Variable (Source: The Author, 2013).

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>1 - 5</td>
<td>23684</td>
<td>99.6</td>
<td>99.6</td>
</tr>
<tr>
<td>77</td>
<td>61</td>
<td>.3</td>
<td>.3</td>
<td>99.9</td>
</tr>
<tr>
<td>99</td>
<td>15</td>
<td>.1</td>
<td>.1</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>23760</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

As shown in Table 4.5, the mean response was 2.52 (St. error of $\bar{X}=.007$, SD= 1.116) (Table 4.5). The general health result was normally distributed. Looking at the mean, which was 2.52, the number of days general health was excellent or poor was equally distributed among the responses.

Table 4.5 Descriptive Statistics for General Health Responses (Source: The Author, 2013).

<table>
<thead>
<tr>
<th></th>
<th>Missing (77 / 99)</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Error of Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>2.52</td>
<td>.007</td>
<td>1.116</td>
</tr>
</tbody>
</table>
Besides the section on Mental Health, Anxiety-Depression, and General Health variables, three more variables were created from the complete data of 10,416 respondents in order to strengthen the study. Those variables were “Participants who reported no days of general mental health issues,” including data for those who reported 0 days mental health not good (BRFSS Section 2, Question 2.1) and anxiety-depression issues (BRFSS Section 24, Questions 24.1 to 24.8), “Participants who reported one or more days mental health not good”, (BRFSS Section 2, Question 2.1), and “Participants who reported one or more days of anxiety-depression issues,” based on those who reported more than 0 days (BRFSS Section 24, Questions 24.1 to 24.8) (See Table 4.6). Distributions of all variables were normal.


<table>
<thead>
<tr>
<th></th>
<th>Valid</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Report of General Mental Health</td>
<td>0</td>
<td>6989</td>
<td>67.1</td>
<td>67.1</td>
<td>67.1</td>
</tr>
<tr>
<td>Report of Mental Health</td>
<td>1-30</td>
<td>3570</td>
<td>32.9</td>
<td>32.9</td>
<td>100</td>
</tr>
<tr>
<td>Report of Anxiety-Depression</td>
<td>1-14</td>
<td>3166</td>
<td>30.4</td>
<td>30.4</td>
<td>99.5</td>
</tr>
</tbody>
</table>

4.1.4 Descriptive Statistics of BRFSS Data Aggregated by Zip-Code

There were 298 zip-code areas remaining from the full 668 zip-codes that contained complete data for 10,416 respondents and a minimum of 10 responses (Figure 4.0). It was clear by looking at the map and checking the county boundaries that the zip-codes are located in both rural and urban areas. The smallest size of the zip-code area was 1.19 km$^2$, while the biggest size of the zip-code area was 3685.36 km$^2$. The mean of the zip-codes’ area was ‘328.89’ km$^2$ (SD= 564.24 km$^2$) (See Table 4.7).

Table 4.7 Descriptive Statistics for Zip-Code Size (Source: The Author, 2013).

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zip-Codes</td>
<td>298</td>
<td>1.19</td>
<td>3685.36</td>
<td>328.89</td>
<td>564.24</td>
</tr>
</tbody>
</table>
In 298 zip-codes, there were different numbers of responses for each zip-code. As mentioned, there was at least 10 response criterion for each zip-code, which is why the minimum number of responses was 10, the maximum number of responses was 212, and the mean was 34.92 (St. error of $\bar{X} = 1.722$, $SD = 29.721$) (Figure 4.0). There are two reasons for response differences in the zip-codes. The first one is the data that was weighted to remove the bias in the sample and reflect the county population estimates from the Washington State Office of Financial Management (OFM) for 2006. Therefore, certain numbers were selected for each zip-code based on their population. The other reason is because of the incomplete data, which was excluded from the study. Thus, there are some different numbers of participants for zip-codes.

The mean responses for each variable in every zip-code were calculated (Table 4.8). The minimum was .08, the maximum was 11.93, the mean was 3.22 ($SD = 1.659$) for mental health variable (Figure 4.1). For the anxiety-depression variable, the minimum was .55, the maximum was 3.46, and the mean was 1.57 ($SD = .493$) (Figure 4.2). The minimum was 1.00, the maximum was 30, and the mean was 9.71 ($SD = 4.375$) for participants who reported 1 or more days of ‘not good’ mental health (Figure 4.4). For participants who showed signs of anxiety-depression problems, the minimum was 1.64, the maximum was 9.08, and the mean was 4.87 ($SD = 1.308$) (Figure 4.4). For the general health variable, the minimum was 2, the maximum was 4, and the mean was 2.47 ($SD = .295$) (Figure 4.5). Percentage of the participants’ numbers among all participants was calculated for the participants who reported no days of general mental health issues. Thus, the minimum was 48.72, the maximum was 85.47, and the mean was 68.09 ($SD = 6.197$) (Figure 4.6).
Figure 4.0 The distribution of the number of responses by zip-code in Washington (Source: The Author, 2013).
Table 4.8 Descriptive Statistics for Aggregated Dependent Variables (Percentage by Zip-Codes) (Source: The Author, 2013).

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental Health</td>
<td>298</td>
<td>.08</td>
<td>11.93</td>
<td>3.22</td>
<td>1.659</td>
</tr>
<tr>
<td>Anxiety-Depression</td>
<td>298</td>
<td>.55</td>
<td>3.46</td>
<td>1.57</td>
<td>.493</td>
</tr>
<tr>
<td>No Report of General Mental Health</td>
<td>298</td>
<td>48.72</td>
<td>85.47</td>
<td>68.09</td>
<td>6.197</td>
</tr>
<tr>
<td>Report of Mental Health</td>
<td>298</td>
<td>1.00</td>
<td>30.00</td>
<td>9.71</td>
<td>4.375</td>
</tr>
<tr>
<td>Report of Anxiety-Depression</td>
<td>298</td>
<td>1.64</td>
<td>9.08</td>
<td>4.87</td>
<td>1.307</td>
</tr>
<tr>
<td>General Health</td>
<td>298</td>
<td>2</td>
<td>4</td>
<td>2.47</td>
<td>.295</td>
</tr>
</tbody>
</table>

It is important to note that all variables seen in Table 4.8 are the aggregated data and this aggregated data is used for all subsequent analyses that are shown below. Regarding variable distribution, as seen in the Figures 4.2, 4.4, 4.5, and 4.7, there is not any particular concentration of reported Mental Health, Report of Mental Health, Report of Anxiety-Depression, and No Report of General Mental Health in one area or another. The cause of a lack of concentration on a specific place might be due to other factors that affected general mental health, or there was a possibility that green space might play a role in this concentration.

On the other hand, Figure 4.6 shows that there is a particular concentration of General Health in the Seattle area. The respondents’ reported general health was higher in that area. The reason might be because of amount of urban green space and forest, which is supported by the results as explained in later sections. In addition, in the southeast of Washington, there is another concentration that shows worse general health. These areas are mostly covered by Agricultural Land, which are also supported by the results. Figure 4.3 also shows a concentration of anxiety-depression on the west side of the mountains of west Washington. The reason respondents showed a higher anxiety-depression level than other areas might be due to factors other than forest. The distribution shows why the whole state should be considered and examined.
Figure 4.1 The distribution of days mental health not good by zip-code in Washington. (Source: The Author, 2013).
Figure 4.2 The distribution of reported days of anxiety-depression issues by zip-code in Washington (Source: The Author, 2013).
Mean of One or More Days Mental Health Not Good by ZipCodes in WA

Figure 4.3 The distribution of one or more days mental health not good by zip-code in Washington (Source: The Author, 2013).
Mean of One or More Days of Anxiety-Depression Issues by ZipCodes in WA

Figure 4.4 The distribution of one or more days of anxiety-depression issues by zip-code in Washington (Source: The Author, 2013).
Figure 4.5 The distribution of general health level by zip-code in Washington (Source: The Author, 2013).
Figure 4.6 The distribution of responses who reported 0 day general mental health issues by zip-code in Washington (Source: The Author, 2013)
4.1.5 Descriptive Statistics of Demographics

In this study, 23,760 respondents participated in the survey. Among the 23,760 participants, 47% (11,171) had complete data. As explained previously, in order to ensure that there were enough people in each zip-code area to capture a valid statistical representation of that area, it was required that at least 10 participants in each zip-code area respond in order to be included in the analyses. Therefore, 10,416 participants remained. Among the 10,416 participants, 38.3% were men and 61.7% were women. According to US Census 2010 data, the percentage of men and women in Washington are 49.8% and 50.2%, respectively (US Census Bureau, 2010).

The average age of the participants was 53.10 years old; the youngest participant’s age was 18 years old while the oldest participant’s age was 99 years old. 4.3% of the participants were between 18 to 24 years old; 11.4% of the participants were between 25 to 34 years old; 16.3% of the participants were 35 to 44 years old; 20.5% of the participants were between 45 to 54 years old; 20.6% of the participants were between 55 to 64 years old; 14.7% of the participants were between 65 to 74 years old; and 12% of the participants were 75 years old or older. The American Community Survey reports that 20 to 24 ages compose of 7.1%, 25 to 34 ages make up 14%, 35 to 44 ages comprise 13.4%, 45 to 54 ages compose of 14.3%, 55 to 64 ages comprise of 12.8%, 65 to 74 ages make up of 7.1%, and 75 to older ages compose of 5.5% of total population in Washington (American Community Survey, 2011).

According to the distribution of the highest degree of education achieved by the respondents, the lowest was never attended school or only attended kindergarten (0.3%), elementary school (2.4%), some high school (4.7%), high school graduate (26.8%), some college or technical school (32.6%), college graduate or more (32.9%), and 0.2% refused to answer.
According to the 2011 American Community Survey, 13.15% has less than high school degree, 26.65% has high school degree, 39.75% has some college or associate’s degree, and 20.4% has bachelor’s degree or higher (American Community Survey, 2011).

Table 4.9 Demographic Statistics (Source: The Author, 2013).

<table>
<thead>
<tr>
<th>Items</th>
<th>Study Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>38.3%</td>
</tr>
<tr>
<td>Female</td>
<td>61.7%</td>
</tr>
<tr>
<td>18 to 24</td>
<td>4.3%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>25 to 34</td>
<td>11.4%</td>
</tr>
<tr>
<td>35 to 44</td>
<td>16.3%</td>
</tr>
<tr>
<td>45 to 54</td>
<td>20.5%</td>
</tr>
<tr>
<td>55 to 64</td>
<td>20.6%</td>
</tr>
<tr>
<td>65 to 74</td>
<td>14.7%</td>
</tr>
<tr>
<td>75 or older</td>
<td>12%</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>Never attended school or only attended kindergarten</td>
<td>0.3%</td>
</tr>
<tr>
<td>Grades 1 through 8 (Elementary)</td>
<td>2.4%</td>
</tr>
<tr>
<td>Grades 9 through 11 (Some high school)</td>
<td>4.7%</td>
</tr>
<tr>
<td>Grade 12 or GED (High school graduate)</td>
<td>26.8%</td>
</tr>
<tr>
<td>College 1 year to 3 years (Some college or technical school)</td>
<td>32.6%</td>
</tr>
<tr>
<td>College 4 years or more (College graduate)</td>
<td>32.9%</td>
</tr>
<tr>
<td>Refused</td>
<td>0.2%</td>
</tr>
<tr>
<td>Income</td>
<td></td>
</tr>
<tr>
<td>Less than $10,000</td>
<td>3%</td>
</tr>
<tr>
<td>$10,000 to less than $15,000</td>
<td>3.8%</td>
</tr>
<tr>
<td>$15,000 to less than $20,000</td>
<td>4.8%</td>
</tr>
<tr>
<td>$20,000 to less than $25,000</td>
<td>9.9%</td>
</tr>
<tr>
<td>$25,000 to less than $35,000</td>
<td>12.6%</td>
</tr>
<tr>
<td>$35,000 to less than $50,000</td>
<td>15.9%</td>
</tr>
<tr>
<td>$50,000 to less than $75,000</td>
<td>16.5%</td>
</tr>
<tr>
<td>$75,000 or more</td>
<td>21.9%</td>
</tr>
<tr>
<td>Don’t know / Not sure / Refused</td>
<td>11.6%</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>89.2%</td>
</tr>
<tr>
<td>(Hispanic)</td>
<td>5.4%</td>
</tr>
<tr>
<td>African American</td>
<td>1.1%</td>
</tr>
<tr>
<td>Asian</td>
<td>1.9%</td>
</tr>
<tr>
<td>Native Hawaiian or Other Pacific Islander</td>
<td>0.3%</td>
</tr>
<tr>
<td>American Indian, Alaska Native</td>
<td>1.2%</td>
</tr>
<tr>
<td>Multiracial</td>
<td>2.5%</td>
</tr>
<tr>
<td>Others</td>
<td>2.8%</td>
</tr>
<tr>
<td>Don’t know / Not sure / Refused</td>
<td>0.8%</td>
</tr>
</tbody>
</table>
In terms of the total annual household income, 3.0% earned less than $10,000, 3.8% earned between $10,000 to $15,000, 4.8% earned between $15,000 to $20,000, 9.9% earned between $20,000 to $25,000, 12.6% earned between $25,000 to $35,000, 15.9% earned between $35,000 to $50,000, 16.5% earned between $50,000 to $75,000, 21.9% earned between $75,000 or more, and 11.6% was either not sure, did not know, or refused to answer. American Community Survey reports that 1.9% earned less than $10,000, 3.0% earned between $10,000 to $15,000, 4.8% earned between $15,000 to $20,000, 11.8% earned between $20,000 to $25,000, 14.9% earned between $25,000 to $35,000, 20.4% earned between $50,000 to $75,000, and 24.1% earned $75,000 or more in Washington (American Community Survey, 2011).

Regarding race, 89.2% were Caucasian (5.4% Hispanic), 1.1% were African American, 1.9% were Asian, 0.3% were Native Hawaiian or Other Pacific Islander, 1.2% were American Indian or Alaska Native, 2.5% were Multiracial, 2.8% were Others, and 0.8% were either not sure, did not know, or refused to answer (See Table 4.9). According to United States Census 2010 data, 81.4% were Caucasian (including Hispanic), 4.8% were African American, 9.0% were Asian, 1.0% were Native Hawaiian or Other Pacific Islander, 3.0% were American Indian or Alaska Native, and 6.0% were some other race (US Census Bureau, 2010).

When the BRFSS data and the United States Census data and the American Community Survey data are compared, generally the BRFSS data captures the demographic characteristics of Washington State. For the gender, the BRFSS captured women, but did not fully represent men. For age, some age ranges were fully represented while some were not. The same can be applied for the education level. Race and income were the demographics that the BFSS represented best. Of course it is not possible to fully represent all demographics, but it can be said the BRFSS data generally covers the demographics characteristics and represents Washington State.
4.1.6 Descriptive Statistics of Green Space

In the study, there were five different types of green space (Level II) which are “Urban Green Space,” “Forest,” “Rangeland,” “Agricultural Land,” and “Wetland” (Figure 4.7). All types were considered together as “simply green” (in Level I) types. In addition, based on the results, two significant types, which were urban green space and forest, were considered as “significant green space.” All types of green space were considered according to the percentage they occupy in every zip-code (See Table 4.10).

Table 4.10 Descriptive statistics of percentage of all types of green space (Source: The Author, 2013).

<table>
<thead>
<tr>
<th></th>
<th>Unified Green Space</th>
<th>Urban Green Space</th>
<th>Forest</th>
<th>Rangeland</th>
<th>Agricultural Land</th>
<th>Wetland</th>
<th>Significant Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>298</td>
<td>298</td>
<td>298</td>
<td>298</td>
<td>298</td>
<td>298</td>
<td>298</td>
</tr>
<tr>
<td>Mean</td>
<td>83.40</td>
<td>25.70</td>
<td>29.21</td>
<td>15.12</td>
<td>3.44</td>
<td>54.91</td>
<td></td>
</tr>
<tr>
<td>Std. Error of Mean</td>
<td>1.150</td>
<td>1.209</td>
<td>1.473</td>
<td>1.067</td>
<td>.996</td>
<td>.298</td>
<td>1.367</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>19.848</td>
<td>20.862</td>
<td>25.421</td>
<td>18.419</td>
<td>17.191</td>
<td>5.137</td>
<td>23.598</td>
</tr>
<tr>
<td>Minimum</td>
<td>1.69</td>
<td>.39</td>
<td>.00</td>
<td>.00</td>
<td>.00</td>
<td>.00</td>
<td>.77</td>
</tr>
<tr>
<td>Maximum</td>
<td>99.94</td>
<td>79.62</td>
<td>89.30</td>
<td>79.43</td>
<td>87.83</td>
<td>39.61</td>
<td>91.25</td>
</tr>
</tbody>
</table>

As Figures 4.8 through 4.12 show, urban green spaces are particularly concentrated in the urban areas such as Seattle, Tacoma, Vancouver, and Spokane. Forests are mostly concentrated on the west and northeast of state, rangelands are mostly concentrated in the middle and southeast of state, agricultural lands are particularly concentrated on the southeast of Washington, wetlands are not particularly concentrated, except along the pacific ocean, and significant green spaces (urban green spaces and forest) are mostly concentrated on the northeast and northwest of Washington.
Regarding the statistics of unified green space, in the 298 studied zip-codes, the minimum was 1.69%, the maximum was 99.94%, and the mean was 83.40% (St. error of $\bar{X} = 1.150$, SD= 11.948). For individual green space types, the following results were obtained: for urban green space (Figure 4.8), the mean was 25.70% (St. error of $\bar{X} = 1.209$, SD= 20.862), the minimum was .39%, and the maximum was 79.62%. For the forest, the mean was 29.21% (St. error of $\bar{X} = 1.473$, SD= 25.421), the minimum was .00%, and the maximum was 89.30% (Figure 4.9). For rangeland, the mean was 15.12% (St. error of $\bar{X} = 1.067$, SD= 18.419), the minimum and the maximum were .00% and 79.43%, respectively (Figure 4.10). For Agricultural Land (Figure 4.11) the mean was 9.94% (St. error of $\bar{X} = 0.996$, SD= 17.191), the minimum and the maximum were .00% and 87.83%, respectively. For wetland, the mean was 3.44% (St. error of $\bar{X} = .298$, SD= 5.317), the minimum was .00%, and the maximum was 39.61% (Figure 4.12). Though discussed later, I report here also the descriptive statistics for significant green space: the mean was 54.91% (St. error of $\bar{X} = 1.367$, SD= 23.598), the minimum and the maximum were .77% and 91.25%, respectively (Figure 4.13).

4.1.7 Descriptive Statistics of the Structure of Green Space

For Level III, I analyzed five main structural components of the Significant Green Space: Fragmentation, Size, Shape, Distance, and Connectivity. For Fragmentation, the Large Patch Index (LPI) and the Patch Density (PD) were used. For Size, the Standard Deviation of Patch Area (AREA_SD) was calculated. The Shape Mean (SHAPE_MN) and the Shape Standard Deviation (SHAPE_SD) were used to assess Shape. For Distance, the Euclidean Nearest Neighbor Distance Mean (ENN_MN) and the Euclidean Nearest Neighbor Distance Standard Deviation (ENN_SD) statistics were calculated. For Connectivity, the Cohesion Index (COHESION) was used.
Figure 4.7 The distribution of the Land Cover Classification in Washington (Source: The Author, 2013).
Figure 4.8 The percentage of Urban Green Space by zip-code in Washington (Source: The Author, 2013).
Figure 4.9 The percentage of Forest by zip-code in Washington (Source: The Author, 2013).
Figure 4.10 The percentage of Rangeland by zip-code in Washington (Source: The Author, 2013).
Figure 4.11 The percentage of Agricultural Land by zip-code in Washington (Source: The Author, 2013).
Figure 4.12 The percentage of Wetland by zip-code in Washington (Source: The Author, 2013).
Figure 4.13 The percentage of Significant Green Space by zip-code in Washington (Source: The Author, 2013).
The mean was 22.42 (St. error of $\bar{x}$ = 13.54, SD= .784), the minimum was .15, and the maximum was 56.07 for the LPI. For the PD, the mean was .80 (St. error of $\bar{x}$ = .059, SD= 1.01), the minimum was .02, and the maximum was 7.68. For the AREA_SD, the mean was 827.32 (St. error of $\bar{x}$ = 71.152, SD= 1228.27), the minimum was .00, and the maximum was 8633.01. For the SHAPE_MN, the mean was 1.91 (St. error of $\bar{x}$ = 0.14, SD= .24), the minimum was 1.30, and the maximum was 3.20. For the SHAPE_SD, the mean was 2.24 (St. error of $\bar{x}$ = .045, SD= .77), the minimum was .77, and the maximum was .10. For the ENN_MN, the mean was 93.53 (St. error of $\bar{x}$ = 1.718, SD= 29.65), the minimum was 60.00, and the maximum was 261.14. The mean was 82.30 (St. error of $\bar{x}$ = 6.41, SD= 110.65) whilst the minimum was .00 and the maximum was 872.44 for the ENN_SD. For the COHESION, the mean was 98.96 (St. error of $\bar{x}$ = .173, SD= 2.98), the minimum was 56.25, and the maximum was 99.98 (Table 4.11).

Table 4.11 Descriptive statistics of the structure components of significant green space (Source: The Author, 2013).

<table>
<thead>
<tr>
<th></th>
<th>LPI</th>
<th>PD</th>
<th>AREA_SD</th>
<th>SHAPE_MN</th>
<th>SHAPE_SD</th>
<th>ENN_MN</th>
<th>ENN_SD</th>
<th>COHESION</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>298</td>
<td>298</td>
<td>298</td>
<td>298</td>
<td>298</td>
<td>298</td>
<td>298</td>
<td>298</td>
</tr>
<tr>
<td>Mean</td>
<td>22.42</td>
<td>.80</td>
<td>827.32</td>
<td>1.91</td>
<td>2.24</td>
<td>93.53</td>
<td>82.30</td>
<td>98.96</td>
</tr>
<tr>
<td>Std. Error of Mean</td>
<td>.784</td>
<td>.059</td>
<td>71.152</td>
<td>.014</td>
<td>.045</td>
<td>1.718</td>
<td>6.410</td>
<td>.173</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>13.54</td>
<td>1.01</td>
<td>1228.27</td>
<td>.24</td>
<td>.77</td>
<td>29.65</td>
<td>110.65</td>
<td>2.98</td>
</tr>
<tr>
<td>Minimum</td>
<td>.15</td>
<td>.02</td>
<td>.00</td>
<td>1.30</td>
<td>.10</td>
<td>60.00</td>
<td>.00</td>
<td>56.25</td>
</tr>
<tr>
<td>Maximum</td>
<td>56.07</td>
<td>7.68</td>
<td>8633.01</td>
<td>3.20</td>
<td>5.50</td>
<td>261.14</td>
<td>872.44</td>
<td>99.98</td>
</tr>
</tbody>
</table>

Based on the values shown in Table 4.11, LPI and PD values indicate that the landscape (significant green space) is not fragmented. The values of AREA_SD show that the size of landscape patches vary. Some of them are large, while some are small. The SHAPE_MN and SHAPE_SD values indicate that standard patch shape and complexity of patch shape are not so different. The values of ENN_MN and ENN_SD show that the distance between landscapes
(green space) patches vary. While some of green space is close to each other, some are far away from one another. The COHESION values indicate that the connectivity between landscape patches is strong, which also means they are not fragmented.

Before going into the research results, it is important to highlight how the results will be presented and discussed. First, there will be an introduction section for each main level. The table provided will show the results. Then, the significant results will be presented and the discussion will follow what the results imply.

### 4.2. THE RELATIONSHIP BETWEEN GENERAL HEALTH AND GENERAL MENTAL HEALTH

Researchers found that general health and mental health are related to each other. Since general health and mental health are used in this study, the relationship between general health and general mental health was tested first. Please note that the relationship between general health and general mental health is based on variables’ mean level per zip-code.

Table 4.12 The Correlations between General Health variable and General Mental Health variables

(Source: The Author, 2013).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mental Health</th>
<th>Anxiety-Depression</th>
<th>No Report of Gen. Mental Health</th>
<th>Report of Mental Health</th>
<th>Report of Anxiety-Depression</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Health</td>
<td>Pearson $r$</td>
<td>.364**</td>
<td>.467**</td>
<td>-.290**</td>
<td>.359**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
</tbody>
</table>

**. p< .01, *. p< .05

Based on the Pearson correlation coefficient (Pearson $r$), Table 4.12 above shows the following results. First, note that all relationships were statistically significant at a minimum .05. The relationship between general health and mental health was direct and moderate (Pearson $r = .36, p< .001$). The relationship between general health and anxiety-depression was direct and
moderate (Pearson $r = .47, p < .001$). The relationship between general health and people who reported no general mental health issues was inverse and moderate (Pearson $r = .29, p < .001$). The relationship between general health and people who reported one or more day mental health not good was direct and moderate (Pearson $r = .36, p < .001$). The relationship between general health and people who reported one or more days of anxiety-depression issues was direct and moderate (Pearson $r = .38, p < .001$).

The results showed that when the general health level is better, general mental health problems are lower, which means there is a significant adverse correlation between general health and general mental health. This result confirms previous studies that general health and general mental health are correlated with each other.

4.3 LEVEL 1: THE RELATIONSHIPS BETWEEN UNIFIED GREEN SPACE AND GENERAL MENTAL HEALTH AND GENERAL HEALTH

As discussed above, the Level 1 relationship between unified green space and general mental health and general health was analyzed. The purpose of this level was to determine if, statistically, there is a negative relationship between the amount of green space, regardless of type, and general mental health and general health variables. Thus, the Level 1 analysis presents the relationship between all types of green space represented as ‘simply green’ and general mental health and general health. In this level, “$H_{0a}$: There is no negative relationship between the amount of green space and general mental health variables” and “$H_{0b}$: There is no negative relationship between the amount of green space and general heath variable” were tested. Results are presented in Table 4.13 and in Figure 4.14.
Based on the Pearson correlation coefficient (Pearson $r$), Table 4.13 shows the following results. Please note the significant relationship was statistically significant at a minimum .05. The relationship between the percentage of unified green space and people who reported no days of general mental health issues was direct and weak (Pearson $r = .13$, $p < .05$). There were not any other significant results. The scatter plots summarize these results in Figure 4.14.

Figure 4.14 Scatter plot summarizes the relationship between percentage of unified green space and each variable (Source: The Author, 2013).
The results revealed there was only a significant weak relationship between unified green space and people who reported no days of general mental health issues. The results also disclosed that the direction of the relationships between green space and both mental health and anxiety-depression variables indicate green space have some degree of relationship with general mental health. Overall, Level 1 revealed different results contrary to previous studies, so it does not mean general mental health problems are lower and general health level is better where green space are more abundant, regardless of green space type. This result supports the idea that not all types of green space have the same effect on human general and mental health. Hence, the types of green space indicated at Level 2 should not be considered as “simply green,” but Level 2 types of green space should be considered separately. As a result, the null hypotheses $H_{0a}$ and $H_{0b}$ were accepted that there is no negative relationship between percentage of unified green space and general mental health and general health variables.

4.4 LEVEL 2: THE RELATIONSHIPS BETWEEN DIFFERENT TYPES OF GREEN SPACE AND GENERAL MENTAL HEALTH AND GENERAL HEALTH

At Level 2, the relationship between each type of green space and general mental health and general health variables was analyzed. Level 2 presents the relationship between urban green space and general mental health and general health, the relationship between forest and general mental health and general health, the relationship between rangeland and general mental health and general health, the relationship between agricultural land and general mental health and general health, and the relationship between wetland and general mental health and general health. The percentage of each type was calculated in zip-codes. The purpose of this level was to determine if there are significant relationships between the types of green space and general
mental health and general health, and if these relationships matter in terms of general mental health reduction and better general health.

In this level, “H₀c: There is no negative relationship between urban green space and general mental health variables,” “H₀d: There is no negative relationship between urban green space and general health variable,” “H₀e: There is no negative relationship between forest and general mental health variables,” “H₀f: There is no negative relationship between forest and general health variable,” “H₀g: There is no positive relationship between rangeland and general mental health variables,” “H₀h: There is no positive relationship between rangeland and general health variable,” “H₀i: There is no negative relationship between Agricultural Land and general mental health variables,” “H₀j: There is no negative relationship between Agricultural Land and general health variable,” “H₀k: There is no negative relationship between wetland and general mental health variables,” and “H₀l: There is no negative relationship between wetland and general health variable” were tested. The results are discussed in order below.

### 4.4.1 The Relationships Between Urban Green Space and General Mental Health and General Health

Based on the Pearson correlation coefficient (Pearson r), Table 4.14 shows the following. First, note that the significant relationships were statistically significant at a minimum .05. The relationship between the amount of urban green space and people who reported one or more days of mental health not good was inverse and weak (Pearson r = -.13, p< .05). The relationship between urban green space and people who reported one or more days of anxiety-depression issues was inverse and weak (Pearson r = -.14, p< .05). The relationship between urban green space and general health was inverse and moderate (Pearson r = -.27, p< .01). The other variables did not show significant results. The scatter plots summarize the results in Figure 4.15.
Table 4.14

The Correlations between Different Types of Green Space and General Mental Health and General Health variables (Source: The Author, 2013).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mental Health</th>
<th>Anxiety-Depression</th>
<th>No Report of General Mental Health</th>
<th>Report of Mental Health</th>
<th>Report of Anxiety-Depression</th>
<th>General Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Green Space</td>
<td>Pearson r</td>
<td>-.041</td>
<td>-.092</td>
<td>-.045</td>
<td>-.125*</td>
<td>-.139*</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.477</td>
<td>.111</td>
<td>.435</td>
<td>.031</td>
<td>.016</td>
</tr>
<tr>
<td>Forest</td>
<td>Pearson r</td>
<td>-.125*</td>
<td>.000</td>
<td>-.092</td>
<td>-.010</td>
<td>-.013</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.031</td>
<td>.998</td>
<td>.290</td>
<td>.113</td>
<td>.870</td>
</tr>
<tr>
<td>Rangeland</td>
<td>Pearson r</td>
<td>.136*</td>
<td>.084</td>
<td>.053</td>
<td>.207**</td>
<td>.196**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.019</td>
<td>.146</td>
<td>.358</td>
<td>.000</td>
<td>.001</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>Pearson r</td>
<td>.004</td>
<td>-.030</td>
<td>.059</td>
<td>.089</td>
<td>.041</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.948</td>
<td>.601</td>
<td>.308</td>
<td>.127</td>
<td>.484</td>
</tr>
<tr>
<td>Wetland</td>
<td>Pearson r</td>
<td>.015</td>
<td>.051</td>
<td>-.024</td>
<td>-.040</td>
<td>.036</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.793</td>
<td>.379</td>
<td>.674</td>
<td>.487</td>
<td>.541</td>
</tr>
</tbody>
</table>

**. p< .01, *. p< .05
a- \( r = .04, \text{n.s.} \)

b- \( r = .09, \text{n.s.} \)

c- \( r = .05, \text{n.s.} \)

d- \( r = -.13, p < .05 \)

e- \( r = -.14, p < .05 \)

f- \( r = -.27, p < .01 \)

Figure 4.15 Scatter plot summarizes the relationship between Urban Green Space and each variable (Source: The Author, 2013).

Overall, the results indicated statistically negative significant relationships between urban green space and the general mental health and general health variables. Self-reports of general mental health levels are lower, and general health is reported as better where urban green space is more abundant. Thus, the data showed that urban green space has an affirmative relationship with general mental health and general health. Therefore, the null hypotheses \( H_{0c} \) and \( H_{0d} \) were rejected: there is a negative relationship between urban green space and general mental health and general health.
4.4.2 The Relationships Between Forest and General Mental Health and General Health

Based on the Pearson correlation coefficient (Pearson $r$), Table 4.14 shows the following. Please note that the significant relationship was statistically significant at a minimum .05. The relationship between forest and mental health level was inverse and weak (Pearson $r = -0.13, p < .05$). There was no other significant relationship. The scatter plots summarize these results in Figure 4.16.

- $a - r = -0.13, p < .05$
- $b - r = 0.00, n.s.$
- $c - r = 0.06, n.s.$
- $d - r = 0.09, n.s.$
- $e - r = -0.01, n.s.$
- $f - r = -0.01, n.s.$

Figure 4.16 Scatter plot summarizes the relationship between Forest and each variable (Source: The Author, 2013).

The results revealed a negative significant relationship between forest and the mental health variable. Self-reported mental health level was lower where forest was more abundant. Although the correlation between forest and anxiety-depression level was not significant, direction of the correlation indicates participants reported less anxiety-depression issues where
the amount of forest was higher. Overall, the null hypothesis $H_{0e}$ was rejected; there is a negative statistical relationship between forest and the mental health variable. On the other hand, I fail to reject $H_{0f}$ so that the null hypothesis was accepted that there is no significant negative relationship between forest and general health variable.

4.4.3 The Relationships Between Rangeland and General Mental Health and General Health

Based on the Pearson correlation coefficient (Pearson $r$), Table 4.14 shows the following. The relationship between rangeland and mental health level was direct and weak (Pearson $r = .14$, $p < .05$). The relationship between rangeland and people who reported one or more day mental health not good was direct and weak (Pearson $r = .21$, $p < .01$). The relationship between rangeland and people who reported one or more days of anxiety-depression issues was direct and weak (Pearson $r = .20$, $p < .01$). The relationship between rangeland and general health level was direct and moderate (Pearson $r = .27$, $p < .01$). There were no other significant results. The scatter plots summarize these results in Figure 4.17.
d- $r = .21, p < .01$

e- $r = .20, p < .01$

f- $r = .27, p < .01$

Figure 4.17 Scatter plot summarizes the relationship between Rangeland and each variable (Source: The Author, 2013).

Overall, the results revealed that there was a positive and significant relationship between rangeland and general mental health and general health variables. The level of general mental health was reported higher, and self-reported general health level was worse where the percentage of rangeland was higher. This indicates that rangeland have an adverse relationship with human general mental health and general health. Based on the results, the null hypotheses $H_{0g}$ and $H_{0h}$ were rejected that there is a positive relationship between rangeland and general mental health and general health variables.

4.4.4 The Relationships Between Agricultural Land and General Mental Health and General Health

Based on the Pearson correlation coefficient (Pearson $r$), Table 4.14 shows the following. Please note the significant relationship was statistically significant at a minimum .05. The relationship between agricultural land and general health level was direct and weak (Pearson $r = .13, p < .05$). The others did not show any significant results. The scatter plots summarize these results in Figure 4.18.
The results indicated that there was not a significant relationship between agricultural land and general mental health variables, although direction of the correlations shows a negative relationship. On the other hand, there was a positive significant relationship between agricultural land and general health variable. Reported general health level is better where agricultural land is less abundant. Therefore, I fail to reject $H_{0i}$ so that the null hypothesis was accepted that there is no negative relationship between agricultural land and general mental health variable. On the other hand, the null hypothesis $H_{0j}$ was rejected that there is a positive relationship between agricultural land and general health variable.

Figure 4.18 Scatter plot summarizes the relationship between Agricultural Land and each variable (Source: The Author, 2013).
4.4.5 The Relationships Between Wetland and General Mental Health and General Health

Based on the Pearson correlation coefficient (Pearson $r$), Table 4.14 shows no significant relationship between wetland and the general mental health and general health variables. The scatter plots summarize these results in Figure 4.19.

- $a- r = .02$, n.s.
- $b- r = .05$, n.s.
- $c- r = -.02$, n.s.
- $d- r = -.04$, n.s.
- $e- r = .04$, n.s.
- $f- r = .07$, n.s.

Figure 4.19 Scatter plot summarizes the relationship between Wetland and each variable (Source: The Author, 2013).

The results revealed that, contrary to expectation, there was not a significant relationship between wetland and general mental health and general health variables. Therefore, I fail to reject $H_{0k}$ and $H_{0l}$: the null hypotheses were accepted that there is no negative relationship between wetland and general mental health and general health variables.
4.4.6 The Relationships Between Significant Green Space and General Mental Health and General Health

This section was created based on the Level 2 results. In the results, it was clear by looking at the distributions of the types of green space across the state that people might have either/or in their zip codes; they might have a lot of urban green space land cover or forest land cover. Both urban green space and forest share a similar statistical correlation and significant characteristics as demonstrated in the results presented above. Therefore, I combined and analyzed these two and found stronger results than urban green space and forest alone (Table 4.15). The combined category is what I call “significant green space”.

Table 4.15 The Correlations between percentage of Significant Green Space and General Mental Health and General Health variables (Source: The Author, 2013).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mental Health</th>
<th>Anxiety-Depression</th>
<th>No Report of GMH</th>
<th>Report of Mental Health</th>
<th>Report of Anxiety-Depression</th>
<th>General Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant</td>
<td>Pearson r</td>
<td>-.171**</td>
<td>-.082</td>
<td>.026</td>
<td>-.210**</td>
<td>-.133*</td>
</tr>
<tr>
<td>Green Space</td>
<td>Sig. (2-tailed)</td>
<td>.003</td>
<td>.158</td>
<td>.654</td>
<td>.000</td>
<td>.021</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.000</td>
</tr>
</tbody>
</table>

**. p < .01, *. p < .05; GMH: General Mental Health

Based on the Pearson correlation coefficient (Pearson r), Table 4.15 shows the following results. First note the significant relationships were statistically significant at a minimum .05.

The relationship between significant green space and mental health level was inverse and weak (Pearson r = -.17, p < .01). The relationship between significant green space and people who reported one or more days mental health not good was inverse and weak (Pearson r = -.21, p < .01). The relationship between significant types of green space and people who showed signs of anxiety-depression levels was inverse and weak (Pearson r = -.13, p < .05). The relationship
between significant types of green space and general health level was inverse and moderate (Pearson $r = -.25$, $p < .01$). The others did not show significant results. The scatter plots summarize these results in Figure 4.20.

![Scatter plots](image)

Figure 4.20 Scatter plot summarizes the relationship between Significant Green Space and each variable (Source: The Author, 2013).

Overall, the results revealed negative significant relationships between significant green space and the general mental health and general health variables. The strength of relationships was stronger than urban green space or forest alone. The results indicated that self-reported general mental health level is lower and general health level is reported as better where significant green space are higher and more abundant. This means urban green space and forest combined are affirmatively related to general mental health and general health. Urban green space and forest could help people to mitigate and positively affect their general mental health problems and improve general health.
4.5 LEVEL 3: THE RELATIONSHIPS BETWEEN STRUCTURES OF SIGNIFICANT GREEN SPACE AND GENERAL MENTAL HEALTH AND GENERAL HEALTH

At Level 3, the relationship between structures of significant green space and general mental health and general health was analyzed. Level 3 presents the relationship between fragmentation of green space and general mental health and general health variables, the relationship between size of green space and general mental health and general health variables, the relationship between shape of green space and general mental health and general health variables, the relationship between distance of green space and general mental health and general health variables, and the relationship between connection of green space and general mental health and general health variables. The purpose of this level was to determine whether there are relationships between the structures of significant green space and general mental health and general health variables, and if these relationships matter in terms of general mental health reduction and better general health.

In this level, ‘$H_{0m}$: There is no positive relationship between green space fragmentation and general mental health variables,’ ‘$H_{0n}$: There is no positive relationship between green space fragmentation and general health variable,’ ‘$H_{0o}$: There is no negative relationship between green space size and general mental health variables,’ ‘$H_{0p}$: There is no negative relationship between green space size and general health variable,’ ‘$H_{0q}$: There is no negative relationship between green space shape and general mental health variables,’ ‘$H_{0r}$: There is no negative relationship between green space shape and general health variable,’ ‘$H_{0t}$: There is no positive relationship between green space distance and general mental health variables,’ ‘$H_{0u}$: There is no positive relationship between green space distance and general health variable,’ ‘$H_{0v}$: There is no negative relationship between green space connectivity and general mental health variables,’ and
‘H0: There is no negative relationship between green space connectivity general health variable’ were tested.

4.5.1 The Relationships Between Fragmentation of Green Space and General Mental Health and General Health

Based on the Pearson correlation coefficient (Pearson r), Table 4.16 shows the following. Please note that the significant relationships were statistically significant at a minimum .05. The relationship between the largest patch index and mental health level was inverse and weak (Pearson r = -.12, p < .05). The relationship between patch density and people who reported no days of general mental health issues level was inverse and weak (Pearson r = -.12, p < .05). The relationship between the largest patch index and people who reported one or more day mental health not good level was inverse and weak (Pearson r = -.18, p < .01). The relationship between the largest patch index and people who reported one or more days of anxiety-depression issues level was inverse and weak (Pearson r = -.21, p < .01). The relationship between largest patch index and general health level was inverse and weak (Pearson r = -.14, p < .05). The scatter plots summarize the large patch index results in Figure 4.21.

![Scatter plots](image-url)
Table 4.16


<table>
<thead>
<tr>
<th>Variables</th>
<th>Mental Health</th>
<th>Anxiety-Depression</th>
<th>No Report of GMH</th>
<th>Report of Mental Health</th>
<th>Report of Anxiety-Depression</th>
<th>General Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest patch index (Fragmentation)</td>
<td>Pearson $r$</td>
<td>-.124*</td>
<td>-.077</td>
<td>.016</td>
<td>-178**</td>
<td>-.210**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.032</td>
<td>.183</td>
<td>.781</td>
<td>.002</td>
<td>.000</td>
</tr>
<tr>
<td>Patch density (Fragmentation)</td>
<td>Pearson $r$</td>
<td>.021</td>
<td>.077</td>
<td>.117*</td>
<td>-.036</td>
<td>-.021</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.724</td>
<td>.866</td>
<td>.043</td>
<td>.538</td>
<td>.717</td>
</tr>
<tr>
<td>Standard deviation of patch area (Size)</td>
<td>Pearson $r$</td>
<td>-.011</td>
<td>.094</td>
<td>.001</td>
<td>-.018</td>
<td>.049</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.856</td>
<td>.104</td>
<td>.897</td>
<td>.752</td>
<td>.401</td>
</tr>
<tr>
<td>Shape Mean (Shape)</td>
<td>Pearson $r$</td>
<td>.084</td>
<td>-.011</td>
<td>-.002</td>
<td>.091</td>
<td>-.029</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.149</td>
<td>.853</td>
<td>.979</td>
<td>.118</td>
<td>.617</td>
</tr>
<tr>
<td>Shape standard deviation (Shape)</td>
<td>Pearson $r$</td>
<td>-.005</td>
<td>-.050</td>
<td>.077</td>
<td>.052</td>
<td>.112</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.926</td>
<td>.388</td>
<td>.182</td>
<td>.372</td>
<td>.053</td>
</tr>
<tr>
<td>Euclidian nearest neighbor distance mean (Distance)</td>
<td>Pearson $r$</td>
<td>.179**</td>
<td>.130*</td>
<td>.020</td>
<td>.230**</td>
<td>.184**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.002</td>
<td>.025</td>
<td>.725</td>
<td>.000</td>
<td>.001</td>
</tr>
<tr>
<td>Euclidian nearest neighbor distance standard deviation (Distance)</td>
<td>Pearson $r$</td>
<td>.096</td>
<td>.073</td>
<td>.059</td>
<td>.154**</td>
<td>.150**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.097</td>
<td>.207</td>
<td>.313</td>
<td>.008</td>
<td>.010</td>
</tr>
<tr>
<td>Cohesion index (Connectivity)</td>
<td>Pearson $r$</td>
<td>-.091</td>
<td>-.128*</td>
<td>.095</td>
<td>-.100</td>
<td>-.030</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.116</td>
<td>.027</td>
<td>.103</td>
<td>.085</td>
<td>.602</td>
</tr>
</tbody>
</table>

**. p< .01, *. p< .05

GMH: General Mental Health
The results indicated there was a negative significant relationship between large patch index and general mental health and general health variables. In addition, there was a positive significant relationship between patch density and the general mental health variable. This means fragmentation of green space is adversely related to general mental health and general health levels and defragmented green space are affirmatively related to general mental health and general health levels. Therefore, the null hypotheses $H_{0m}$ and $H_{0n}$ were rejected that there is a negative relationship between green space fragmentation and general mental health and general health variables.

### 4.5.2 The Relationships between Size of Green Space and General Mental Health and General Health

Based on the Pearson correlation coefficient (Pearson $r$), Table 4.16 shows no significant results between green space size and the general mental health and general health. The scatter plots summarize these results in Figure 4.22.
The results revealed that there was not a significant relationship between the size of green space and the general mental health and general health variables, which means size of green space is not related to general mental health and general health levels. Therefore, the null hypotheses $H_{00}$ and $H_{0p}$ were accepted that there is no negative relationship between size of green space and general mental health and general health variables.

4.5.3 The Relationships between Shape of Green Space and General Mental Health and General Health

Based on the Pearson correlation coefficient (Pearson $r$), Table 4.16 shows no significant relationships between green space size and the general mental health and general health. The scatter plots summarize these results in Figure 4.23.
The results showed there was not a significant relationship between the shape of green space and general mental health and general health variables, which indicates that the shape of green space is not related to general mental health and general health levels. Thus, the null hypotheses $H_{0q}$ and $H_{0r}$ were accepted that there is no negative relationship between shape of green space and general mental health and general health variables.

**4.5.4 The Relationships between Distance to Green Space and General Mental Health and General Health**

Based on the Pearson correlation coefficient (Pearson $r$), Table 4.16 shows the following results. Please note that the significant relationships were statistically significant at a minimum
The relationship between Euclidian nearest neighbor distance mean and mental health level was direct and weak (Pearson $r = .18, p < .01$). The relationship between Euclidian nearest neighbor distance mean and anxiety-depression level was direct and weak (Pearson $r = .13, p < .05$). The relationship between Euclidian nearest neighbor distance mean and people who reported one or more days mental health not good level was direct and weak (Pearson $r = .23, p < .01$). The relationship between Euclidian nearest neighbor distance standard deviation and people who reported one or more days mental health not good level was direct and weak (Pearson $r = .15, p < .01$). The relationship between Euclidian nearest neighbor distance mean and anxiety-depression issues level was direct and weak (Pearson $r = .18, p < .01$). The relationship between Euclidian nearest neighbor distance standard deviation and people who reported one or more days of anxiety-depression issues level was direct and weak (Pearson $r = .15, p < .05$). The relationship between Euclidian nearest neighbor distance mean and general health level was direct and weak (Pearson $r = .22, p < .05$). The relationship between Euclidian nearest neighbor distance standard deviation and general health level was direct and weak (Pearson $r = .15, p < .05$). The scatter plots summarize Euclidian Nearest Neighbor Distance Mean results in Figure 4.24.
The results revealed that there was a positive significant relationship between distance to green space and general mental health and general health variables, meaning when the distance of green space increases, general mental health problems increase and general health level decreases. The results indicate that distance of green spaces is related to general mental health and general health levels. Thus, the null hypotheses $H_0$ and $H_{0r}$ were rejected that there is a positive relationship between green space distance and general mental health and general health.

4.5.5 The Relationships between Connectivity of Green Space and General Mental Health and General Health

Based on the Pearson correlation coefficient (Pearson $r$), Table 4.16 shows the following results. Please note that the significant relationship was statistically significant at a minimum .05. The relationship between cohesion index and anxiety-depression level was inverse and weak (Pearson $r = -.13, p < .05$). The scatter plots summarize these results in Figure 4.25.

The results indicated that there was a significant relationship between connectivity of green space and the anxiety-depression variable. The relationship between connectivity of green space and mental health and general health variables was not significant; however, the direction
of the correlation showed some degree of associations. Overall, the null hypothesis $H_0$ was rejected that there is a negative relationship between connectivity of green space and anxiety-depression variable. On the other hand, I fail to reject $H_0$: the null hypothesis was accepted that there is no negative relationship between connectivity of green space and general health variable.

4.6. REGRESSION MODEL OF SIGNIFICANT TYPES AND STRUCTURES OF GREEN SPACE

This section was created based on the results of Level 2 and Level 3. In the results, it was clear urban green space and forest, fragmentation, distance, and connectivity were significant by looking at the distributions of the types and structures of green space across the state. Significant results of Level 2 were combined, as it was explained in section 4.4.6, as significant types of
green space and significant structures which were fragmentation, distance, and connectivity of green space’ results at Level 3 were used in the regression model to see whether these independent variables predict the dependent variables. In this regression model, respondents’ age, sex, SES, and education level were controlled (See Table 4.17).

In the regression model, first, curvilinear relationships were checked and no curvilinear relationships were found between variables. Second, multicollinearity was checked by running collinearity statistics and greater than .50 of tolerance was accepted as indicating no multicollinearity. Then, spatial autocorrelation was measured because the way the model is structured might be imposed by spatial units rather than the true relationships between independent and dependent variables in the model (Mitchell A. , 2005). The spatial autocorrelation was run for independent variables, dependent variables, and residuals. The results showed that independent variables are clustered and a less than 1% likelihood that the clustered pattern could be the result of random chance for independent variables. As it was expected, after having significant clustered results for the independent variables, the dependent variables should also be significantly clustered. Therefore, the dependent variables were also clustered, with less than a 5% likelihood the clustered pattern could happen by chance.

The residuals are important to understand if there is an unmeasured process that affects the outcome I am interested in (Spatial Regression, 2010). The residuals of dependent variables were first created in the SPSS. The residuals were then exported into GIS and Moran’s I spatial autocorrelation was run. The result did not show any statistically significant spatial autocorrelation for the residuals, which is an indicator that there is not a missing spatial variable in the model (Mitchell A. , 2005).
Table 4.17 The Regression Analysis between independent variables and dependent variables (Source: The Author, 2013).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mental Health</th>
<th>Anxiety-Depression</th>
<th>No Report of GMH</th>
<th>Report of Mental Health</th>
<th>Report of Anxiety-Depression</th>
<th>General Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-.053 (.019)*</td>
<td>-.015 (.006)*</td>
<td>.327 (.072)**</td>
<td>.001 (.051)</td>
<td>.006 (.015)</td>
<td>.011 (.003)*</td>
</tr>
<tr>
<td>Sex (Male)</td>
<td>-.003 (.009)</td>
<td>-.007 (.003)*</td>
<td>.066 (.033)*</td>
<td>.016 (.024)</td>
<td>-.003 (.007)</td>
<td>-.002 (.001)</td>
</tr>
<tr>
<td>SES</td>
<td>-.071 (.020)**</td>
<td>-.031 (.006)**</td>
<td>.212 (.075)*</td>
<td>-.126 (.054)*</td>
<td>-.077 (.016)**</td>
<td>-.023 (.003)**</td>
</tr>
<tr>
<td>Education Level</td>
<td>.000 (.009)</td>
<td>-.001 (.002)</td>
<td>.023 (.032)</td>
<td>-.018 (.023)</td>
<td>.005 (.007)</td>
<td>-.003 (.001)*</td>
</tr>
<tr>
<td>Significant Green Space</td>
<td>-.002 (.005)</td>
<td>.003 (.002)</td>
<td>-.020 (.020)</td>
<td>-.020 (.014)</td>
<td>.004 (.004)</td>
<td>.002 (.019)*</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>.041 (.013)</td>
<td>.023 (.034)</td>
<td>-.651 (.444)</td>
<td>-.275 (.319)</td>
<td>.008 (.093)</td>
<td>.001 (.001)</td>
</tr>
<tr>
<td>Distance</td>
<td>.009 (.004)*</td>
<td>.003 (.001)*</td>
<td>-.012 (.016)</td>
<td>.021 (.011)</td>
<td>.010 (.003)*</td>
<td>.001 (.001)</td>
</tr>
<tr>
<td>Connectivity</td>
<td>.003 (.034)</td>
<td>-.009 (.011)</td>
<td>.060 (.136)</td>
<td>-.052 (.098)</td>
<td>-.010 (.028)</td>
<td>.011 (.006)</td>
</tr>
</tbody>
</table>

**, p< .01; *, p< .05

GMH: General Mental Health

Units: B and (Std. Error)
**Mental Health**

A linear regression analysis was conducted with respondents’ age, sex, SES, and education level, with significant green space, fragmentation, distance, and connectivity as the independent variables and Mental Health as the dependent variable to identify which factors significantly predict mental health level. No multicollinearity was observed among the independent variables. The results of regression revealed that the model significantly predicts mental health level ($R^2 = .103, R^2_{adj} = .078$, $F (8,297)= 4.139, p < .001$), where three of the independent variables, age ($b = -.053, p = .007$), SES ($b = -.071, p < .001$), and distance ($b = .009, p = .03$), significantly contributed to the model, accounting for 10.3% of the variance in mental health, and sex ($b = -.003, p = .75$), education ($b = .000, p = .96$), significant green space ($b = -.002, p = .70$); fragmentation ($b = .041, p = .73$), and connectivity ($b = .003, p = .94$) did not significantly contribute to the model.

**Anxiety-Depression**

A linear regression analysis was conducted with respondents’ age, sex, SES, and education level, significant green space, fragmentation, distance, and connectivity as independent variables, and Anxiety-Depression as the dependent variable to identify which factors significantly predict anxiety-depression level. No multicollinearity was observed among the independent variables. The results of regression revealed that the model significantly predicts anxiety-depression level ($R^2 = .164, R^2_{adj} = .140$, $F (8,297)= 7.067, p < .001$), where four of the independent variables, age ($b = -.015, p = .007$), sex ($b = -.007, p = .006$), SES ($b = -.031, p < .001$), and distance ($b = .003, p = .008$) significantly contributed to the model, accounting for 16.4% of the variance in anxiety-depression level; and education ($b = -.001, p = .79$), significant green
space ($b = .003, p = .07$); fragmentation ($b = .023, p = .50$), and connectivity ($b = -.009, p = .38$) did not significantly contribute to the model.

**No Report of General Mental Health**

A linear regression analysis was conducted with respondents’ age, sex, SES, and education level, significant green space, fragmentation, distance, and connectivity as independent variables and No Report of General Mental Health as the dependent variable to identify which factors significantly predict no report of general mental health level. No multicollinearity was observed among the independent variables. The results of regression revealed that the model significantly predicts no report of general mental health level ($R^2 = .119, R^2_{adj} = .095, F (8,297) = 4.882, p < .001$), where three of the independent variables, age ($b = .327, p < .001$), sex ($b = .066, p = .05$), and SES ($b = .212, p = .005$), significantly contributed to the model, accounting for 11.9% of the variance in no report of general mental health: education ($b = .023, p = .47$), significant green space ($b = -.020, p = .31$), fragmentation ($b = -.651, p = .14$), distance ($b = -.012, p = .46$), and connectivity ($b = .060, p = .66$) did not significantly contribute to the model.

**Report of Mental Health**

A linear regression analysis was conducted with respondents’ age, sex, SES, and education level, using significant green space, fragmentation, distance, and connectivity as independent variables and Report of Mental Health as the dependent variable to identify which factors significantly predict report of mental health level. No multicollinearity was observed among the independent variables. The results of regression revealed that the model significantly predicts report of mental health level ($R^2 = .086, R^2_{adj} = .061, F (8,297) = 3.393, p = .001$), where only one of the independent variables, SES ($b = -.126, p = .02$), significantly contributed to the model, accounting for 8.6% of the variance in report of mental health, and age ($b = .327, p <
.001), sex (b=.066, p=.05), education (b=-.018, p=.44), significant green space (b=-.020, p=.17); fragmentation (b=-.275, p=.39), distance (b=.021, p=.06), and connectivity (b=-.052, p=.60) did not significantly contribute to the model.

**Report of Anxiety-Depression**

A linear regression analysis was conducted with respondents` age, sex, SES, and education level, significant green space, fragmentation, distance, and connectivity as independent variables and Report of Anxiety-Depression as the dependent variable to identify which factors significantly predicted report of anxiety-depression level. No multicollinearity was observed among the independent variables. The results of regression revealed that the model significantly predicted report of anxiety-depression level ($R^2 = .135, R^2_{adj} = .111, F(8,297)= 5.615, p< .001$), where two of the independent variables, SES (b=-.077, p< .001) and distance (b=.010, p=.003), significantly contributed to the model accounting for 13.5% of the variance in report of anxiety-depression; and age (b=.006, p=.68), sex (b=-.003, p=.62), education (b=.005, p=.49), significant green space (b=.004, p=.39), fragmentation (b=.008, p=.94), and connectivity (b=-.010, p=.71) did not significantly contribute to the model.

**General Health**

A linear regression analysis was conducted with respondents` age, sex, SES, and education level, using significant green space, fragmentation, distance, and connectivity as independent variables and General Health as the dependent variable to identify which factors significantly predict general health level. No multicollinearity was observed among the independent variables. The results of regression revealed that the model significantly predicts general health level ($R^2 = .258, R^2_{adj} = .237, F(8,297) = 12.540, p< .001$), where four of the independent variables, age (b=.011, p=.01), SES (b=-.023, p<.001), education (b=-.003, p=
.28), and significant green space (b= -.002, p= .35), significantly contributed to the model accounting for 25.8% of the variance in general health; sex (b= -.002, p= .86), fragmentation (b= .002, p= .94), distance (b= .001, p= .21), and connectivity (b= .011, p= .06) did not significantly contribute to the model.

Discussion

Overall, the regression results revealed that age, sex, socio-economic status (SES), education, significant green space, and distance are together statistically valid predictors of general mental health and general health variables. The results showed that when people get older, general mental health problems reduce and general health get worse. On the other hand, the results also revealed that younger people get more benefits from urban green space and forest than elderly in terms of general health. One of the important results is that SES plays an important role in general mental health and general health levels. In every result, SES showed significant results that when SES is higher, general mental health level is lower and general health level is better with green space. Education also seems important in terms of general health. As expected, significant green space and distance showed significant results with age, sex, SES, and education on general mental health and general health. Interestingly, fragmentation and connectivity somehow did not show any significant results differently than correlation coefficient results.

Another important finding of the regression model was that neither significant green space nor significant structures of green space showed significant relationship with no report of general mental health, which means green space is important in only those that have some mental health issues, not for the healthy people. As a result, the regression model showed stronger association that age, sex, SES, education, significant green space, and distance are the
significantly valid predictors of general mental health and general health variables. Therefore, the null hypothesis rejected that there are stronger relationships between significant green space and significant landscape structural metrics and general mental health and general health variables. In contrast, fragmentation and connectivity of green space are not significant predictors of general mental health and general health variables.

4.7 SUMMARY OF FINDINGS AND DISCUSSION OF RESEARCH QUESTIONS

This section addresses the research questions, which are one, two, three and their sub-questions, hypotheses based upon literature, results of the study and discussion based upon the previous key studies, and findings of this study. This section focuses upon these questions because those questions address the relationship between green space, types of green space, and structures of green space and general mental health and general health and asks validity, reliability, and accuracy of the national datasets (the BRFSS and the NLCD).

The first research question focused upon the relationship between green space, regardless of type, in respondents’ zip-codes and their general mental health and general health. The second question and its sub-questions focused on the relationship between different types of green space and general mental health and general health; the relationship between structure of the significant green space and general mental health and general health. The third question and its sub-questions focused upon large existing datasets and whether they were appropriate to get answers to the first and second questions.

The questions one, two, and its sub-questions posited three hypotheses, or expectations, based upon findings and discussion presented in the literature. In addition, there was another hypothesis for the regression model. These hypotheses posited expectations regarding green space types and structures. These notions posited that a) there is a negative statistical relationship
between the amount of undifferentiated green space and increased level of poorer, BRFSS-reported general mental health and general health variables where more green space related to less general mental health problems and better general health; b) there are negative statistical relationships between urban green space, forest, rangeland, Agricultural Land, and wetland and general mental health and general health variables where more types of different green space correlated with less general mental health problems and better general health; c) there are positive statistical relationships between fragmentation and distance and general mental health and general health variables and negative relationships between size, shape and connectivity and general mental health and general health variables; and d) together, there are stronger relationships between significant green space and significant landscape structural metrics and general mental health and general health.

The summary findings are discussed in the same order in which they were presented above. Hence, this presentation will consist of five subsections: Level 1: Green space as “simply green”, Level 2: Green space as “different types of green”, Level 3: Structures of significant green space; Combining the significant types and structures of green space with controlled socio-demographic characteristics in the regression model; and Availability of the BRFSS and the NLCD to Get at Answers to Question One and Two.

4.7.1 Level 1: Green Space as “Simply Green”

Regarding the relationship between the amount of green space, regardless of type, and general mental health and general health variables, the question was asked if there is any relationship between the amount of green space and general mental health and general health levels. This question posited that statistically there should be a negative relationship between the amount of green space and general mental health and general health variables, regardless of
green space types. Hence, general mental health level would be lower and general health would be better where green space are more abundant, regardless of green space types. It was found that there was not a significant relationship between amount of green space and general mental health and general health levels. Thus, the null hypotheses $H_{0a}$ and $H_{0b}$ were accepted that there is no negative relationship between amount of green space and general mental health and general health levels regardless of green space types.

Contrary to expectation, the significant relationship between amount of green space and general mental health and general health variables was not found. Why were the findings different although the literature said general mental health level is lower and general health level is better where green spaces are more abundant? It is important to look at the key studies in the literature. One of the key studies in the literature was conducted by Van den Berg, Maas, Verheij, & Groenewegen, (2010) in the Netherlands. The authors investigated to what extent the presence of green space can buffer adverse health impacts of stressful life events. In their study, “urban green,” “forest,” “nature conservation areas,” and “agricultural green” were regarded as “green space.” This is the one of the main reasons for the difference between my study and Van den Berg, Maas, Verheij, & Groenewegen`s study.

At first level of my study, I have defined and used “urban green space,” “forest,” “rangeland,” “agricultural land,” and “wetland” as “green space”. As it was found in the second level of this study, there was not a significant relationship between agricultural land and general mental health variables and wetland and general mental health and general health variables. On the other hand, the positive relationship between rangeland and general mental health and general health levels was found. In this respect, it is highly possible that van den Berg, Maas, Verheij, & Groenewegen found that people who live high amounts of green space experience
less stressful life events and mental health problems and have better general health than those people who live less amounts of green space because they did not consider rangeland and wetland in their study. In addition, the results of the second level also support the notion that although there were significant relationships for urban green space and forest, I did not get the significant results for the first level because of the mix of different types of green space used in my study.

Another reason of different results might be the distance factor. Interaction with green space is important so that people who have access and exposure to green space have better mental and general health when compared to those who do not access and have exposure to green space. Therefore, in the study of Van den Berg, Maas, Verheij, & Groenewegen, the authors looked at the relationship between the amount of green space and stressful life events and general health within a 1-3 km radius around the participants’ homes. On the other hand, in my study I looked at the zip-code level so that the possibility of interaction with green space in my study might be less than van den Berg, Maas, Verheij, & Groenewegen`s study. Therefore, different results were found in this study.

Similar results were found in other key study of Maas, et al., (2006). Maas, et al. similarly looked at the relationship between the amount of green space and perceived general health within a 1-3 km radius around the participants` homes. The authors cosidered “urban green space,” “agricultural space,” and “natural green space” as green space. Therefore, Maas and her colleagues found the same results as the other key study. In addition, the key studies were conducted in the people`s living environment, which may not have covered the rural environment such as rangeland or wetland. That might be another reason for the difference in results.
As a result, this study revealed that not every green space is similarly related to general mental health and general health. Hence, it does not mean that people who live in high amounts of green space will have less general mental health problems and have better general health, regardless of green space type. This study indicated that each type of green space should be considered differently in order to have more accurate and better results.

4.7.2 Level 2: Green Space as “Different Types of Green”

About the relationship between different types of green space and general mental health and general health, the questions were asked what the relationship between types of green space and general mental health and general health are. The literature posited the expectation that there are negative statistical relationships between urban green space, forest, rangeland, Agricultural Land, and wetland and general mental health and general health variables where more types of different green space correlated with less general mental health problems and better general health.

It was found that: (a) significant negative relationships between urban green space and general mental health and general health variables, (b) a significant negative relationship between forest and mental health variable, (c) significant positive relationships between rangeland and general mental health and general health variables, (d) a positive relationship between agricultural land and general health variable, and (e) not significant relationships between wetland and general mental health and general health variables. Thus, the null hypotheses (a) were rejected that there are significant relationships between urban green space, forest, and rangeland and general mental health variables, (b) were rejected that there are significant relationships between urban green space, rangeland, and agricultural land and general health variable, but I fail to reject that (c) there is no significant relationship between agricultural
land and general mental health variable, and (d) were accepted that there is no significant
relationship between wetland and general mental health and general health variable.

Although there were not enough studies about the relationship between the types of green
space and general mental health and general health, there are a few key studies. One of the key
studies was conducted by Maas, et al., (2006) in the Netherlands. Even though the purpose of
this study was to explore the strength of the relationship between people`s perceived general
health and the amount of green space in their living environment, the authors also analyzed the
relation between different types of green space and general health. Maas and her colleagues
considered agricultural green, natural green (forest, peat grass-land, etc.), and urban green as
types of green space. In that study, they found a positive relation between general health and
both natural green and agricultural green. Maas, et al. also found negative relationship between
urban green and general health.

There are similar results, as well as some different results, between my findings and their
findings. In both studies, affirmative relation between forest and general health was found. On
the other hand, Maas, et al. found affirmative relation between agricultural green and general
health while an adverse relationship was found in my study. They also found an adverse
relationship between urban green and general health, while an affirmative relationship was found
in my study. One of the reasons for the different results might be the fact that the Netherlands is
a very densely populated country and the United States is less densely populated. Thus, this
might affect the generalization of their results (Maas, et al., 2006, p. 591). The other reason also
the authors found different results for the urban green is because of the lower total amount of
green space, which can only be found in urban areas (Maas, et al., 2006, p. 590). Another reason
also might be the different type of agricultural fields in the Netherlands and in the US.
It was not possible to compare the results of rangeland and wetland of my study with a key study, because of the fact that there was not previous study to use rangeland and wetland as green space. Contrary to the expectation, wetland did not show a significant result with general mental health and general health variables. The reason might be because of the lack of the wetland in the zip-code areas. In Figure 4.12, the amount of wetland in the state is limited, therefore, this might have affected the results.

Why did previous studies not include wetland and rangeland in their studies? The reason these two types have not been used yet may be the perception of green space and types of land cover. In the literature, urban green, forest, natural green, and agricultural green were considered as green space. When their characteristics are examined, they mostly consist of trees, shrubs, grasses, and crops (i.e. vegetation). Many studies reported that ‘naturalness’ is a powerful predictor of human preferences for certain environments (Kaplan, Kaplan, & Wendt, 1972; Herzog, Kaplan, & Kaplan, 1982; Kaplan S., 1987; Kaplan R., 2001; Lamb & Purcell, 1990; Ulrich, 1977). That might be one of the reasons for previous studies not considering rangeland and wetland. However, this study suggests that rangeland and wetland should be considered as types of green space based on the definition of green space (Forman, 2008; Dunnett, Swanwick, & Woolley, 2002; NLCD, 2006). The other reason might be because of the characteristics of geography of the country. The United States has different land cover characteristics than the Netherlands. Thus, researchers have to consider the characteristics of their countries’ land covers. In this respect, the researchers may not have used them because the land cover types may be different in the Netherlands than in the United States.

As it was discussed in Chapter 2, one of the important issues was whether the effects of different types of green space have the same relations on both general mental health and general
health. Based on the literature and questions raised by researchers, characteristics of each type of green space is different; hence, their relations with both general mental health and general health should be different. As it was expected, the findings revealed some facts that some types of green space showed positive relation and some types showed negative relation with both general mental health and general health variables. In this respect, urban green space and forest have potential to mitigate and ease stress as well as anxiety and depression. Likewise, those types help people to improve their general health. In contrast, rangeland has adverse association with the general mental health as well as with general health. Similarly, agricultural land seems to have adverse associations with general health. Overall, the findings indicate that certain types of green space in rural areas seem to have negative influence on general mental health and general health. In contrast, types of green space in urban areas have positive effects on general mental health and general health.

4.7.3 Level 3: Structure of Significant Green Space

Regarding the relationship between the structures of significant green space and general mental health and general health, the question was asked if there is any relationship between structures of significant green space and general mental health and general health. The literature hypothesized the expectation that there are positive statistical relationships between fragmentation and distance and general mental health and general health variables, and negative relationships between size, shape and connectivity and general mental health and general health variables. The findings revealed that there was (a) positive significant relationships between fragmentation and distance and general mental health and general health variables, (b) negative significant relationships between connectivity and general mental health and general health variables, and (c) no significant relationship exists between size and shape and both general
mental health and general health variables. Thus, the null hypotheses (a) were rejected that there are significant relationships between fragmentation, distance, and connectivity and both general mental health and general health variables, and (b) were accepted that there is no significant relationship between size and shape and general mental health and general health variables.

Although there was not a similar study on general mental health and general health, a study was conducted by Lee, Ellis, Kweon, & Hong, (2008). The authors attempted to understand the relationship between landscape structure and neighborhood satisfaction. Lee and colleagues found that neighborhood satisfaction was higher where landscapes were less fragmented, less isolated, and well-connected. Similar results were found in this study that general mental health problems were lower and general health was better where green space were less fragmented, less isolated, and more-connected. Thus, my study also suggested that fragmentation, distance, and connectivity are important on both general mental health and general health. On the other hand, size and shape showed no relation with general mental health and general health.

This study highlighted an important fact that the structures of green space are not only important for wildlife and habitat, but also important for human mental and general health. Gaining the knowledge about the structure of green space will help policy makers, planners, and designers to create better places for people to interact with green space. As Lee, Ellis, Kweon, & Hong (2008) mentioned, it is essential to understand the true nature of interactive relationships between human systems and ecosystems in order to integrate green space structures into landscape planning and management. Hence, when policy makers decide new settlements, suburbs, and city expansions they should take into consideration to design, preserve, or restore structures of green space in terms of their relationships with general mental health and general
health. Similarly, designers and planners also consider the structure of green space regarding where and how to design or create green space so that people can reduce their stress, depression, and anxiety and help themselves in restoring feelings and improving general health.

4.7.4 Combining the Significant Types and Structures of Green Space with Controlled Socio-Demographic Characteristics in the Regression Model

A supportive analysis for the study, a multilevel linear regression analysis was used. In this model, age, sex, income level (SES), and education level were controlled and significant green space (mixed of urban green space and forest) from Level 2, and significant structures of green space (fragmentation, distance, and connectivity) from Level 3 were put in the regression model. The results revealed that when people get older, general mental health problems decrease and general health get worse. On the other hand, the results showed that younger people get more benefits from urban green space and forest than elderly in terms of general health.

The results also indicated that SES plays an important role on general mental health and general health. In every result, SES showed significant results that when SES was higher, general mental health level was lower and general health was better with green space. Education also seems important in terms of general health. As expected, significant green space and distance showed significant results with age, sex, SES, and education on general mental health and general health. Fragmentation and connectivity somehow did not show any significant result differently than correlation coefficient results.

Another important finding of the regression model was that neither significant green space nor significant structures of green space showed significant relationship with no report of general mental health, which means green space is important in only those that have some mental health issues, not for the healthy people. As a result, the null hypothesis was rejected that
together there are stronger relationships between significant green space and significant landscape structural metrics and general mental health and general health variables.

Although there is not a study that uses different types and structures of green space with controlled socio-demographics characteristics, there is a similar key study conducted by Maas, et al., (2006). In that study, the authors investigated the strength of the relation between the amount of green space in people’s living environment and their perceived general health. The socio-demographics characteristics were also analyzed in that study. In that study, multilevel regression analysis was used. The authors found positive relation between perceived general health and both agricultural green and natural green (forest) in 1km living environments. Urban green space in a 3 km radius around the home seems to be negatively related to people’s health. In that study, it was found that people with a secondary education level and the elderly benefit most from green space.

As it can be seen, there are different results in my study and the key study. Normally, it would be more appropriate to discuss the differences between my study and the key study. However, my study and the Maas and her colleagues’s study used different variables. As I mentioned before, this study brought a new concept and methodology to the literature. That is why there may be some differences in this study. The reasons for the different results I found might be the variables. In my research, I defined five different types and structures of green space. However, when we look at the previous study a few studies considered different types of green space and none of the studies used wetland and rangeland as different types of green space. The level of the study: In my study, although I had individual level responses, I did not have the respondents’ addresses, while the key study had the participants’ addresses. In this respect, the key study was able to conduct a neighborhood level research (1 km and 3 km radius around the
The key studies I used were from the Netherlands, which has higher population density. On the other hand, the United States has low population density, which may affect the results of the study. As a result, despite the differences, both studies found that age, education, and forest have positive relationships with general health.

The differences indicate that more study is needed in terms of having better results and appropriate suggestions for policy makers, planners, and designers. Using the different types of green space that had not been used before and considering the relationship between structure of green space and general mental health and general health shed new light on the relationship between green space and general mental health and general health. Therefore, considering age, sex, income, and education level, urban green space and forest and their connectivity could be used to mitigate and positively affect general mental health and improve general health or may be useful clinically as a supplement to existing treatments for general mental health problems. In addition, quality as well as quantity of green space could be significant in determining health benefits. Furthermore, it might be useful to develop a global land cover database so that researchers can look at the relationship between health and green space across the globe.

4.7.5 Availability of the BRFSS and the NLCD to Get at Answers to Questions One and Two

One of the questions of this research was seeking the answer of this question: “Can existing large national datasets (the BRFSS and the NLCD) provide answers to these questions (Question one and two)” More specifically, two sub-questions of question three sought the answers which were (a) Can I feasibly use these national datasets for my study? and (b) Will these national collected datasets support useful results?
In order to answer the questions, it is important to understand reliability and validity of the BRFSS and accuracy of the NLCD2006. As indicated earlier, the Behavioral Risk Factor Surveillance System (BRFSS) is a cross-sectional telephone survey that collects data based on random digit-dialed, self-reports measurements for every state. Nelson, Holtzman, Bolen, Stanwyck, & Mack (2001) conducted a study to assess reliability and validity of measures on the BRFSS. The authors found that the BRFSS data are considered to be moderately reliable and highly valid (p. S12). Another important study about the BRFSS was conducted by Mokdad (2009). The author examined the past, present, and the future of the BRFSS. He indicated that the BRFSS data has improved tremendously since 1984 (p. 48). Therefore, the BRFSS data have always been considered valid and reliable when it is compared with other national house-hold surveys (Mokdad, 2009; Nelson, Powell-Griner, Town, & Kovar, 2003; Nelson, Holtzman, Bolen, Stanwyck, & Mack, 2001).

This question may be asked that why do we need to worry about mental or general health in the BRFSS since people are healthy? Level 1, Level 2, Level 3, and the regression model showed that even the healthy people showed relationship with green space. That is because it is important to examine and use the BRFSS data.

As stated before, the National Land Cover Database (NLCD) is used as the definitive Landsat-based, 30-meter resolution, land cover database for the Nation. U.S. Geological Survey has released a report about the NLCD (USGS, 2012). About the land cover accuracy, the report says large complex national databases such as NLCD are most accurate when they are used to support regional and national analysis (USGS, 2012). The report indicates that the land cover accuracy assessment is in progress. For the previous version of the NLCD, which was the NLCD2001, the land cover product accuracy got better than the NLCD1992. For instance,
Anderson Level I class accuracy was 80.4% and Anderson Level II class accuracy was 55.7%. On the other hand, for the NLCD2001 the Anderson Level I class accuracy was 85.3 and Anderson Level II class accuracy of 78.7% (USGS, 2012). As a result, the accuracy of the NLCD gets better every year and the accuracy of the NLCD data is expected to better than the accuracy of the NLCD2001.

As mentioned earlier, there was a key study that was conducted by Van den Berg, Maas, Verheij, & Groenewegen (2010) in the Netherlands who used similar methods to conduct their study. In that study, the authors used individual-level data on health and socio-demographic characteristics were drawn from Dutch National Survey of General Practice and the data about the green space direved from the 2001 National Land Cover Classification database. Similarly, in my study, I needed to have (a) individual-level data on mental and general health, and socio-demographic characteristics, and (b) land cover data for the types of green space.

One of the sub-questions asked if I could use these national datasets (the BRFSS and the NLCD) for my study. The BRFSS data provided individual-level data on the mental and general health and socio-demographic characteristics but only one exception that the participants’ addresses were anonymous while Van den Berg and her colleagues knew the respondents’ addresses in their study. The NLCD2006 data also provided land cover data for the types of green space with 30x30 resolution. On the other hand, Van den Berg, Maas, Verheij, & Groenewegen (2010) used 25x25 resolution land cover data. Since the BRFSS data is reliable and valid and the NLCD2006 data is accurate and all data I needed was provided by the BRFSS and the NLCD, then the answer of the question is “yes, I can use these national datasets for my study.”
The second sub-question asked if these national collected datasets will support useful results. This question is related to results of this study. As already mentioned, this study consists of three levels. At Level 1, results revealed that not each green space is similarly related to general mental health and general health variables. Hence, it does not imply that people who live in high amount of green space will have less general mental health problems and have better general health regardless of green space type. This level indicated that each type of green space should be considered differently in terms of their relation to general mental health and general health. At Level 2, the results showed that urban green space has negative relationships with general mental health and general health variables; forest has a negative relationship with mental health variable. On the other hand, rangeland has positive associations with general mental health and general health variables. In addition, agricultural land has a positive relationship with general health variable. The wetland does not have significant relationships with general mental health and general health variables.

At Level 3, the results indicated that fragmentation and distance have positive relationships with general mental health and general health variables. On the other hand, connectivity has negative relationships with general mental health and general health variables. This level indicated that green space should be less fragmented, less isolated, and more-connected to have affirmative relation with general mental health and general health. To support the study, a multilevel linear regression analysis was also used. The regression model revealed that age, sex, socio-economic status (SES), education, significant types of green space and distance are together statistically valid predictors of general mental health and general health.

All levels and regression models revealed significant results that can be used to create suggestions for policy makers, planners, designers and researchers for the future studies. In this
respect, based on the results it is appropriate to say that using the BRFSS and the NLCD making useful inferences is possible. Therefore, the answer for the second sub-question is “yes, these national collected datasets will support useful results.” Suggestions for policy makers, planners, designers, and researchers for the future studies will be given in the Chapter 5. Readers who wish to see the recommendations may turn to Chapter 5 in the section of 5.5 and 5.6.

4.7. CONCLUSION TO CHAPTER FOUR

This chapter presented the results of Level 1, Level 2 and Level 3. It presented these findings in detailed and summary form, and discussed them in relation to two of the three major questions posed for this study. It is also discussed in relation to previous studies whether the results similar or different and/or support them. The regression model results also discussed in the chapter and compared to previous key studies, although the studies are not same. In addition, the third question about the BRFSS and the NLCD discussed in the Chapter 4. The following chapter will provide the recommendations for policy makers, designers, and researchers for the future studies.
CHAPTER FIVE:
CONCLUSIONS AND RECOMMENDATIONS

5.0 INTRODUCTION TO CHAPTER FIVE

This chapter presents three topics. First, the most important of the points and findings discussed in previous chapters are summarized. Second, a number of recommendations for policy makers, planners, and designers regarding where and how to design, create, preserve or restore green space that people could use to mitigate and cure general mental health and improve general health. Third, recommendations for future research are presented. Each of these topics will be discussed in turn.

5.1 SUMMARY OF RESEARCH

The previous chapters of this study have presented the results of the research tasks set out in the introduction, and contained in Chapters One through Five. The results will be briefly summarized by chapter.

Chapter One

Chapter One outlined stress, anxiety, and depression functions and their relationships to each other. Stress was defined as an important phenomenon that can trigger and/or worsen anxiety-depression in the diathesis-stress model. Therefore, the relationship between stress and anxiety-depression was found crucial. This chapter also highlighted the effect of stress-anxiety-depression on human body and human health. The ways of treatment to general mental health were also examined in this chapter. Another important aspect of this chapter was green space. Green space was defined and its types and structures were listed based on the literature and previous studies. In addition, the functions and benefits of green space were outlined.
Furthermore, this chapter defined the national datasets (the BRFSS and the NLCD), their roles in the study, as well as functions.

A number of findings emerged from this presentation, including 1) diathesis gives rise to processes that increase the likelihood of the requisite forms of stress occurring and this leads psychological disorders being triggered and/or worsened. Although stress is not a disorder, it is an important phenomenon that affects and reduces mental well-being and triggers and/or worsens anxiety-depression; 2) unresolved and long-standing stress not only leads to disorders but also damages the body and promotes health problems; 3) anxiety-depression as disorders cause or are associated to many health problems; 4) there are different treatments to mitigate and cure general mental health and green space is one of them to mitigate and positively affect general mental health problems; and 5) there are five different main types of green space: urban green space, forest, agricultural land, rangeland, and wetland.

**Chapter Two**

Chapter Two categorized, presented, and summarized literature that contains findings related to green space and general mental health and general health. In this literature review, the studies that were related each other were organized into ten different sections. As noted in the introduction, today the challenge of researchers is discerning actionable details of stress-anxiety-depression through defining appropriate green environments. Therefore, it was necessary to construct hypotheses to determine the types and the structures of green space that affect general mental health and general health.

Based upon the literature presented in this chapter, two research questions and two sub-questions were developed for application to the green space under study. Briefly, these questions asked 1) what are the relationships between amount of green space and general mental health and
general health regardless of green space type?, 2) what are the relationships between different types of green space and general mental health and general health?, and 3) what are the relationships between structures of green space and general mental health and general health?

The literature review produced important methodological guidance regarding the conduct of the needed different types and structures of green space and the determining types and structures of green space which are positively or negatively related to human mental and general health. Interpretation and criticism of this literature led to a number of recommendations that were incorporated into the current study.

Chapter Three

Chapter Three developed a methodology useful for the conduct of future green space studies. While many of the studies considered all different types of green space as “simply green,” this study developed a methodology to consider different types of green space as not simply green, but based on their types since their characteristics are different. In addition, the methodology of this research brought the structures of green space on the table that may not only be important for ecology and wildlife but also for human mental and general health.

Chapter Three, overall, outlined BRFSS variables that explain how to choose variables from the BRFSS data; explained organizing the received data as zip-code level and variables; showed green space evaluation; and FRAGSTATS analysis.

Chapter Four

Chapter Four represented the data analysis and the research results. While detailing questions one, two, and its sub-questions, it presented an analysis of data and sites in terms of questions one and two. The results are briefly summarized here.
The findings regarding the first research questions presented a different result than expected in the first hypothesis. That is, the relationship between the amount of unified green space, regardless of green space type, and general mental health and general health variables is not significant, which indicated that it should not be presumed that different types of green space have the same effects on general mental health and general health. Hence, different types of green space should be regarded separately in studies to have better and more accurate results.

The second question and its sub-questions sought the relationships between different types of green space as well as structures of green space and general mental health and general health variables based on the second and third hypotheses. The findings revealed that urban green space has affirmative relationships with general mental health and general health variables. Forest has a affirmative relationship with mental health variable. On the other hand, rangeland has adverse relationships with general mental health and general health variables. Agricultural land also has an adverse relationship with general health variable. Wetland did not show significant results. These results indicated that different types of green space have different associations with general mental health and general health. Thus, they should be considered separately.

One of the second sub-questions also sought the answer regarding the structures of green space. The findings revealed that fragmentation and distance have positive relationships with general mental health and general health variables. On the other hand, connectivity has negative relationships with general mental health and general health variables. The results indicated that green space should be less fragmented, less isolated, and more-connected to have affirmative relationship with general mental health and general health. Besides these findings, the regression model was performed to determine whether the significant types and structures of green space
are the predictors of general mental health and general health with the socio-demographic characteristics. The results indicated that significant green space (mix of urban green space and forest) and connectivity predicted general mental health and general health levels with age, sex, income, and education level.

In Chapter Four, the validity, reability and accuracy of the largest datasets (the BRFSS and the NLCD) were discussed to answer the third question and its sub-questions. The discussion showed that the BRFSS is a valid and reliable source and the NLCD is an accurate national dataset. Therefore, these large national datasets can be used in this study and the studies similar to this study.

**Conclusion**

Findings from the previous studies showed that green space is significantly important in terms of human mental, physical, physiological/psychological health and well-being. However, there was an important gap in existing knowledge about whether different types/characteristics of green space play different roles to general mental health and general health and what important types of green space could generate desired health and well-being outcomes for human beings. Therefore, the present study was conducted in an attempt to answer the research questions regarding the relationships between different types and structures of green space and general mental health and general health.

As a result, this study revealed important results that can be useful for policy makers, planners, and designers regarding where and how to design, create, preserve or restore green space where people can mitigate and/or positively affect their general mental health, help to restore feelings, and improve general health. This study is also important for researchers in future
studies, as suggestions are made to have better and accurate results in their research. Now, let us proceed to a discussion of the recommendations.

5.2 RECOMMENDATIONS FOR POLICY MAKERS, PLANNERS, AND DESIGNERS

Landscape has been recognized since the earliest times that it not only provides for human nutritional needs, but it also supports human beings at every level in their well-being (Thompson, 2011). A hundred years ago, Frederick Law Olmstead emphasized the importance of the green space to human health (Todd, 1982). Today, once again health professionals and policy makers are open to an ecological approach to public health (Morris, Beck, Hanlon, & Robertson, 2006). Based on the results of this study, several recommendations were created for policy makers, planners, and designers regarding where/how to design, create, preserve or restore green space where people can positively affect their general mental health, help themselves to restore their feelings, and improve general health. The recommendations are as follows:

- This study showed that green space is more than just a “luxury” or “simply green”. Thus, green space should not be seen as “luxury” or “simply green” in the planning, designing, and decision making process. In this respect, the development of green space, which includes designing, creating, preserving or restoring, should be allocated a more central position in planning, design and decision making policy.

- This research found that some certain types of green space, such as urban green space or forest, are affirmatively related to general mental health and/or general health. Therefore, healthy planning should include a place for green space and policy makers, designers, and planners should take the amount of certain green space in the living environment into account when endeavoring to improve human health.
• This research revealed that respondents’ general mental health level is lower and general health level is better where urban green space and forest are more abundant and rangeland and agricultural land are less abundant. In this respect, policy makers, designers, and planners should consider using urban green space and forest as a strategy for preventive medicine against general mental health problems.

• This study showed that urban green space is affirmatively associated with general mental health and general health, and forest is affirmatively correlated with general mental health. Therefore, when deciding, designing, and planning new residential developments or renovating existing urban infrastructure or consulting on land use priorities, the amount of urban green space and forest should be as much as possible, and the distance between them should be as close as possible. In addition, in cities and existing settlements, the amount of green space should be increased and access to the forest should be improved as well.

• This research revealed that rangeland is adversely correlated with general mental health and general health, and agricultural land is adversely associated with general health. In this respect, new settlements or residential developments should be away as much as possible from these types of green space.

• This research revealed that knowledge of the relationship between structures of green space and general mental health and general health is important. The structure of green space is not only important for wildlife but it is also important for general mental health and general health. In this respect, policy makers, designers, and planners should fully accommodate the positive responses of urban and rural residents to structures of green space into planning and management practices.
This research showed that fragmentation and distance are adversely correlated with general mental health and general health, and connectivity is affirmatively related with general mental health and general health. Therefore, green space should be less fragmented, less isolated, and more-connected when they are planned or designed.

5.3 RECOMMENDATIONS FOR FUTURE RESEARCH

The following are the recommendations for future studies. These recommendations would serve to strengthen the findings of this study, as well as to better specify a number of its recommendations.

- Future research should definitely consider the different types of green space in the studies. In order to have better and accurate results, different types of green space should not be regarded as “simply green” since this result showed that it should not presumed that every green space has the same/similar relation with general mental health and general health. Therefore, every type of green space should be considered separately in terms of their relationship with human health.

- This study showed that rangeland and wetland are types of green space, so they should be considered in the studies regarding green space. In this regard, future research should use rangeland and wetland as types of green space.

- This research indicated that structures of green space are also important for human mental and general health. Therefore, structures of green space should be studied in the future research.

- In future studies, researchers need to move beyond secondary data analysis and collect primary data, and when collecting primary data responses’ view, visits, and
exposure to the types of green space should also be considered to measure the relationships between types of green space and human mental and general health.

- Further research is needed to give more insight into the mechanisms behind the relation between green space and health by not only looking at the types of green space, but also looking at the characteristics of types of green space. By doing this, it will be more clear which components or characteristics of specific types of green space constitute the most important drivers of human health.

- In future studies, it should be studied to determine how big a green space should be in terms of better effects on human mental and general health.

- For future research, interdisciplinary collaboration between the social, health, and natural sciences is recommended.

5.4 CONCLUSION TO CHAPTER FIVE

The work presented in this study demonstrates the importance and the need for defining and determining the types and the structures of green space for human mental and general health. This research showed that different types and structures of green space have different association to general mental health and general health. Therefore, they should be considered separately in order to have better and accurate results.

This research shed light the relationship between green space and human mental and general health by using different types and structures of green space in three levels. This study is one of the steps to deliver the highest standards of evidence achievable in our complex world of human/environment interactions. If enacted, the recommendations presented here could do much to deliver answers to the challenge of health professionals and policy makers regarding how to
create environments that would encourage healthy lifestyles and provide health benefits to human beings.
BIBLIOGRAPHY


