



University of British Columbia

Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Effects of diversity within urban green spaces on students' mental health and general wellbeing benefits

Prepared by: Jiayi Shi

Course Code: UFOR 449F

University of British Columbia

Date: 2023/1/9

Disclaimer: "UBC SEEDS Sustainability Program provides students with the opportunity to share the findings of their studies, as well as their opinions, conclusions and recommendations with the UBC community. The reader should bear in mind that this is a student research project and is not an official document of UBC. Furthermore, readers should bear in mind that these reports may not reflect the current status of activities at UBC. We urge

Executive summary

Under rapid urbanization, urban green space is an important medium to reconnect humans and nature. It provides a both natural and healthy space for people to do physical and mental recreation. Qualities of greenspace can contribute to mental health benefits. I conducted a literature review to identify 14 greenspace qualities (for example plant richness, water accessibility and serenity) related to mental wellbeing. I used UBC Campus as the experimental site to confirm 8 observation greenspace that varies from good qualities (such as high plant richness, high serenity and high cleanness) to bad qualities and annotated locations in a map using GIS. I recorded site feature descriptions, assessed site quality based on 14 identified criteria and observed human behavior at 8 observation sites two times in consistent weeks, each site for 30 mins. I performed data analysis on site quality and behavioral variability (vigorous and passive activity) using histogram and GIS maps. I concluded that different human behaviors are associated with different greenspace qualities specifically; spaciousness and access to walking paths/trails are more likely to motivate vigorous behavior (mainly walking); color richness, smell, serenity, cleanness and vegetation cover are likely to induce passive behavior (mainly arts and rest); man-made facilities can motivate both vigorous and passive behavior; water can promote the intensity of human behavior but it is not a necessary quality; plant biodiversity, tree canopy, density & height are not actively related to the intensity of human behavior; perceived safety is not a significant quality in this study.

Practitioner summary

1. Introduction

- 1.1 The importance of urban green space
- 1.2 Why to study qualities of green space
- 1.3 Why to choose university students as targeted study group
- 1.4 Why to focus on campuses as observation sites
- 1.5 Why to choose UBC campus
- 1.6 Knowledge gap and research questions

2. Methods

- 2.1 Identification of greenspace qualities
- 2.2 Experimental sites
 - 2.2.1 Location of 8 green spaces
 - 2.2.2 Site quality assessment
- 2.3 Usage of diverse green spaces
 - 2.3.1 Observation record
 - 2.3.2 Classification of human behavior

3. Results

- 3.1 A list of 14 qualities related to stress reduction/what are they/why choose them
- 3.2 Assessment of 8 sites
- 3.3 Current use of UBC green spaces with different qualities
 - 3.3.1 Vigorous behavior and associated greenspace qualities
 - 3.3.2 Passive behavior and associated greenspace qualities

4. Discussion

5. Recommendation

- 5.1 Recommendations for actions and implementations
- 5.2 Recommendations for future research

6. Conclusion

References

1. Introduction

1.1 The importance of urban green space

Urban green spaces can be broadly defined as green landscapes that include plants and water, such as forests, parks, private gardens or higher education campuses, located in urban and peri-urban settings (Jabbar et al., 2021; Taylor & Hochuli, 2017). Under rapid urbanization, urban green space is an important medium to reconnect humans and nature (Li, 2021). It provides a both natural and healthy space for people to do physical and mental recreation (Jabbar et al., 2021; Seitz et al., 2014). Humans have an inherent predisposition to admire and respond positively to natural elements such as vegetation and water (Ulrich et al., 1991). Especially, views of green spaces have been widely linked to health-promoting characteristics, including facilitating perceived stress reduction/recovery, alleviating psychological distress, and improving cognitive performance (Aerts et al., 2021; Beyer et al., 2014; Honold et al., 2016; Shaffee & Shukor, 2018; Ulrich et al., 1991). Conserving or creating urban green space has also great potential to promote biodiversity, such as wetlands for maintaining multi-stage wild vegetation (Bonthoux et al., 2014). Biodiversity patterns, which refers to population structure and distribution varying from various species, communities, regions, habitats to the whole ecosystems, can also be affected by social and biophysical factors of urban landscapes (Alberti & Wang, 2022; Patterns of biodiversity, 2022).

1.2 Why to study qualities of green space

Quantity and quality of green space produce mental health benefits (Feng & Astell-Burt, 2018). Considering the psychological effects, green space quality matters more than quantity (Feng & Astell-Burt, 2018). Green space quality (e.g., accessibility, configuration, features, and usability) is a major factor for how people evaluate the benefits from green space and it plays a crucial role in reducing stress (Akpınar, 2016; Hedblom et al., 2019; Roe et al., 2013; Zhang et al., 2017). Indeed, and increasing number of studies have suggested that experiencing urban green spaces is positively associated with mental health and well-being, for example, how people interact with green space and their preferences of using green space (Aerts et al., 2021; Fuller et al., 2007; Hedblom et al., 2019; Houlden et al., 2018; Jabbar et al., 2021; McFarland et al., 2008; Nguemini Tiako et al., 2021; Pazhouhanfar, 2018; Pope et al., 2018; Sloat, 2019; van den Berg et al., 2007; Weimann et al., 2015; X. Jiang et al., 2020). Nonetheless, there is a missing link in how specific qualities and features of green space impact stress level (Houlden et al., 2018).

The qualities of green space vary from good to bad ones (e.g., clean water vs. dirty water) (Nguyen et al., 2021). To be more specific, objectively good qualities contain vegetation, tree canopy, footpaths and benches, while subjective ones pertain more to the experience in nature, such as an emotional connection to a particular green space (Nguyen et al., 2021). 'Bad' qualities include litter and poorly-kept green infrastructure which may negatively affect visitation and health benefits (Nguyen et al., 2021). Studying qualities can help us better understand the relationship between green spaces and human health. Understanding the role of diverse qualities of green spaces, especially related to stress alleviation, is imperative to promote human well-being and guide urban planners in charge of improving recreation infrastructure in city landscapes (Aerts et al., 2021; Nguyen et al., 2021).

1.3 Why to choose university students as targeted study group

People living in cities are getting more and more stressed under the double pressure of modern competition and Covid-19 pandemic. Stress is the process by which a person responds with fear, anxiety, frustration or sadness and often with corresponding behaviors, to a situation that challenges or threatens human well-being (Ulrich et al., 1991). University students are one of the population groups who are being overwhelmed by heavy school work and intense employment stress. According to the 2013 National College Health Assessment, nearly 65% of students felt stressed out by their campus work, while 32% of

students suffered anxiety (American College Health Association, 2013). The US recently reported that approximately 20-30% of undergraduate students have a mental health problem (Devisscher, 2022). The Covid-19 pandemic restricted university students to virtual education during school closures (Devisscher, 2022). A study conducted in North England during the first COVID-19 wave in 2020, found university students experience higher levels of anxiety and depression (Devisscher, 2022). A large proportion of university students are facing psychological issues due to the burden of various assignments, competition with peers, emotional/relational problems, low financial support and low self-esteem (Hurst et al., 2013; Robotham, 2008). Students who are highly eager to succeed in courses are particularly vulnerable to stress (Hipp et al., 2016; Sohail, 2013).

Other than academic demand, studies present that students' environment-based happiness should also be emphasized in school life (McFarland et al., 2008). Admiring plants or green spaces can render students to be more positive and resilient in stressful situations (i.e., during the test-taking period) (Lindemann-Matthies & Matthies, 2018; Ulrich et al., 1991). There are more and more students in USA college/university experiencing high levels of stress (Holt et al., 2019). Another research conducted in Texas State University-San Marcos, has found that almost 50% of graduate students suffered from frequent mental distress caused by academic achievement (McFarland et al., 2010).

According to the Wellbeing Strategic Framework (2018), nearly one quarter (24%) of students at UBC have been diagnosed for mental health conditions in 2017, such as anxiety and depression; less than half (47%) of staff and faculty report having energy left at the end of most day workdays for their personal life. Here at UBC, the 2018 Undergraduate Experience Survey (UES) also found that 45% of students are physically inactive (not meeting recommended Canadian physical activity guidelines). With a growing concern on mental health of college and university students around the world, there is a great need to make full use of campus sites to improve their health (Foellmer et al., 2021; Hunt and Eisenberg, 2010).

1.4 Why to focus on campuses as observation sites

A university campus, as one of the representative urban green spaces, plays an important role in students' life (Department of Geography, Liverpool Hope University, Liverpool, UK et al., 2013; McFarland et al., 2010). The campus of a university offers an integral space for all teaching staff and students to do daily living, working, studying as well as entertaining, more importantly, developing students' personal and social identity (Abu-Ghazze, 1999). One study conducted in Fujian Agriculture and Forestry University in Fuzhou, China, found that students' self-rated restoration and health is positively associated with universities' perceived naturalness (Liu et al., 2018). Academic green space is one of the important components on campus, which has great potential to support healthy design for students to enjoy and learn (Foellmer et al., 2021). Students usually spend a considerable amount of time on campus to complete classes and activities that need high concentration (Felsten, 2009). Therefore, green spaces on campus have a large potential to promote mind restoration (e.g., outdoor activities) and buffer the pressure from school (Abu-Ghazze, 1999; Holt et al., 2019). Several studies revealed that the more frequent students actively engage in green spaces or the perceived campus greenness/naturalness, the higher quality of life and lower perceived stress they have (Hipp et al., 2016; Holt et al., 2019; Liu et al., 2018). Although a variety of interventions such as free yoga class or student gyms have been used to address student stress, there are relatively few studies dedicated to assess how green space can help students reduce stress (Seitz et al., 2014).

1.5 Why to choose UBC campus

Located at the Point Grey Peninsula surrounded by ocean and forest, the UBC Vancouver campus is the home of 58,400 students, including about 30% Aboriginal students and international students (Planning, 2022; The University of British Columbia, 2020). The UBC Campus is dedicated to multiple and adaptive

disciplines to manage green spaces, including around 8,000 planted trees and over 10,000 native trees (Li, 2021). Forests along the campus's periphery are also significant to wildlife habitat such as raccoons and coyotes. From gray to green, UBC has become a thriving urban area more than just a typical university campus. UBC's unique location and climate give it an inherent advantage in land greening. The campus consists of 402 hectares of academic and neighborhood areas with a rich array of parks and open space, and world-class educational and cultural facilities to serve students and workers on campus (Li, 2021).

According to UBC's Land Use Plan in 2015, more emphasis will be put on public spaces and green areas, including both natural and human-made ones, as well as cultural architecture. For instance, a continuous, multi-use, people-oriented greenway has been developed along Main Mall and University Boulevard that connect different zones (e.g., academic space, adjacent green edges) from east to west and north to south. Simultaneously, tree management is integrated into these greenway systems, and an inventory of all trees on campus is under way. The increasing number of residents and growing area size on UBC campus means more demand and support for a variety of services and amenities to satisfy the needs of different student users and consider the implications for a university's green space development (Department of Geography, Liverpool Hope University, Liverpool, UK et al., 2013). Currently, Campus Vision 2050 is designed to adapt to the constantly evolving campus (About Campus Vision 2050, n.d.). It is aimed to enhance ecological connectivity and biodiversity to maintain campus sustainability, climate resilience, human health and wellbeing, which can be a good experimental site for researchers to study how the campus affects students' stress reduction (About Campus Vision 2050, n.d.). Under the emerging Campus Vision 2050 plan, developing green elements of campus is increasingly crucial for achieving sustainable targets to help UBC effectively respond to climate change, reconciliation and then become a regenerative and zero-carbon emission urban ecosystem in the future (About Campus Vision 2050, n.d.).

1.6 Knowledge gap and research questions

Specifying green spaces is a big project and most studies have taken green spaces as a whole to consider their relationship with human wellbeing, but few studies identify the quality and diversity in green spaces that support students' resilience to stress. This study is aimed to underscore the importance of diverse qualities within green spaces on stress resilience and supports how to design effective landscapes in urban green spaces while improving human wellbeing and quality of life. Also, this study aims to help inform strategies on campus that can enhance mental health, create a supportive campus culture, and ensure that faculty, staff, and students have the access to resources that help them tackle mental problems, improve resiliency and coping skills (Wellbeing Strategic Framework, 2018). The main research questions guiding this study are the following:

1. What kind of green space qualities support mental well-being?
2. How do green spaces on UBC campus manifest these qualities?
3. How are UBC students using green spaces on campus that exhibit different qualities for mental well-being?

2. Methods

2.1 Identification of greenspace qualities

Studies focus on the relationship between urban green space and general wellbeing, particularly on university student's mental health not including a detailed investigation of specific mental diseases. Keywords for two main concepts were generated and used for the literature search (Table 1. Key words related to urban green spaces and mental health and wellbeing Table 1). Relevant studies and literature

reviews from peer-reviewed journals were identified using Web of Science, Google scholar, and PubMed. All papers were pooled and duplicates removed, resulting in a total of 79 papers.

Table 1. Key words related to urban green spaces and mental health and wellbeing

Key words	Urban green spaces	Mental health and wellbeing
Alternative Terms/Synonyms (combined with OR)	"Urban green space*", "green space*", "green*", "green environ*", "green infrastruct*", "natural space"	"Mental wellbeing", "mental well-being", "mental health", "psychological wellbeing", "psychological well-being", "psychological health"
Broader terms (combined with OR)	"Nature therapy", "nature connect*", "near nature*", "green therap*", "natur*"	"Self-esteem", "social wellbeing", "social well-being", "psychological issue*", "mental disease*", "emotional health"
Narrower terms (combined with OR)	"Park*", "forest*", "campus", "universit*", "greenspace qualit*", "biodiversity", "plant*"	"Well-being", "wellbeing", "quality of life", "life satisfaction", "emotion", "depress*", "anxi*", "stress", "stress reduction", "reduce stress", "stress recovery", "resilien*"

2.2 Experimental sites

2.2.1 Location of 8 green spaces

I selected 8 green spaces on campus, including the Bosque, The Irving K. Barber Learning Centre (Ikb), Rose Garden, Arthur Lord Field, Martha Piper Plaza, Ponderosa Commons, Forest Science grassland, and Totem Park (Figure 1). They have different levels of greenspace qualities and represent different greenspace types, which can help me study diverse human behavior in each site and further establish behavior patterns related to specific greenspace quality. Different locations of 8 sites may lead to different populations passing by. For instance, Totem Park that lies in the edge corner of the campus might have low population using it, while Martha Piper Plaza that lies close to the center of the campus might have high population using it. Moreover, I chose the sites in collaboration with SEEDS because they considered these sites strategic for my study based on previous studies conducted on campus.



Figure 1. Location of 8 experimental sites within UBC Vancouver campus (Halliday, 2022).

2.2.2 Site quality assessment

















I assessed site quality based on 14 identified qualities and using scores from 1 to 5. 5 represents for very strong feelings of the greenspace quality, while 1 represents for no feeling of greenspace quality. The higher the score, the better qualities greenspaces have. I did the site quality assessment on July 31st, sunny day, assessed sites one by one starting from 9:00 am and each site was spent around 10 mins. I followed the sequence and walked (based on the map above), “Forest Science Grassland, Totem Park, Ponderosa Commons, Martha Piper Plaza, Arthur Lord Field, the Bosque, Ikb, and Rose Garden”, to do assessments of each site. As for each site, I walked around to observe the level of each greenspace quality and record the score I assigned (based on my own perspective) on a paper.

2.3 Usage of diverse green spaces

2.3.1 Observation record

I conducted an observation of human behavior at 8 sites on UBC Vancouver campus in the summer holiday of 2022 (i.e., during August) (Table 2). I totally observed two times on each site for 30 mins. Simultaneously, I chose to do the two observations on the same day in two consistent weeks and I tried to observe at similar periods (i.e., both in the morning or in the afternoon) under similar weather conditions (i.e., mostly sunny days). Except for Ikb, I found a sit spot in all sites to observe diverse human activities (Table 3) due to less shelters from buildings or vegetations. I walked around the Ikb to observe since it has many steps and medium-height shrubs that blocked my view.

Table 2. Observation time and weather record of 8 sites. I chose to observe mostly in the morning, with 4 times in the afternoon. As for observation weather, it is mostly sunny, except for August 13th that is cloudy.

Observation	1 st observation			2 nd observation		
	Date	Period	Weather	Date	Period	Weather
Greenspace						
The Bosque	02/08; Tuesday	12:30 am- 13:00 am		09/08; Tuesday	10:30 am- 11:00 am	
Ikb	03/08; Wednesday	10:30 am- 11:00 am		10/08; Wednesday	10:30 am- 11:00 am	
Rose Garden	8/08; Monday	10:30 am- 11:00 am		15/08; Monday	10:30 am- 11:00 am	
Arthur Lord Field	15/08; Monday	2:30 pm- 3:00 pm		22/08; Monday	2:30 pm- 3:00 pm	
Martha Piper Plaza	11/08; Thursday	11:30 am- 12:00 am		18/08; Thursday	11:30 am- 12:00 am	
Ponderosa Commons	15/08; Monday	1:50 pm- 2:20 pm		22/08; Monday	1:50 pm- 2:20 pm	
Forest Science grassland	06/08; Saturday	9:50 am- 10:20 am		13/08; Saturday	9:50 am- 10:20 am	
Totem Park	01/08; Monday	10:30 am- 11:00 am		08/08; Monday	10:30 am- 11:00 am	

2.3.2 Classification of human behavior

Table 3. Types of human behavior. Vigorous behavior involves high-intensity movements such as walking, while passive behavior means few, slow, low-intensity movements such as resting.

Vigorous behavior	Sport/fitness	Walking	Dog walking	Running	Biking	Other
Icon						
Passive behavior	Resting	On phone/pc	Gardening	Eating/picnic	Arts/crafting	Other
Icon						

3. Results

3.1 A list of 14 qualities related to stress reduction/what are they/why choose them I identified 14 greenspace qualities related to mental health based on literature review (Table 4).

Table 4. 14 Qualities of greenspace with brief description.

Greenspace quality	Description used for the assessments
Plant biodiversity	The number of different plants represented in a region is large (“Species Richness,” 2022).
Color richness	Diverse colors (e.g., red, white or yellow) can be seen.
Water accessibility & quality	Water is accessible with high water flow, cleanness, good smell and vigorous aquatic creature (Wang et al., 2019).
Vegetation cover	The portion of soil which is highly covered by green vegetation (Pazhouhanfar, 2018).
Tree canopy, density & height	The layer of leaves, branches, and stems of mature trees highly cover the ground when viewed from above, with a large number of trees per hectare and high height (Sloat, 2019).
Bird/bird songs	Birds are visible; bird songs are audible.
Access to walking paths/trails	Walking paths/trails are accessible.
Man-made facilities	Fountains, benches, tables, light, or cultural architectures can be seen.
Serenity	Serenity is a place of peace with only natural sounds (e.g., water sound, bird sound, breeze) without traffic or construction noise (Stoltz et al., 2016).
Spaciousness	Spaciousness is the quality of being large, with plenty of space for people to move around (Weimann et al., 2015).
Cleanness	The amount of litter is low (Arnberger & Eder, 2015).
Smell	Floral scents from plants or flowers are good (Jo et al., 2013; Warner, 2009).
Maintenance	Few dead trees or broken branches; no broken public property, no vandalism can be seen.
Perceived safety	The feeling about reduced visibility of dense vegetation, chance of crime, fear of injury or loss, and feeling unwell (Tan et al., 2019).

Plant biodiversity (high richness of plants): Plant species richness, as one crucial component of biodiversity, is the number of different plants represented in a region (“Species Richness,” 2022). The area with varieties of plants is likely to attract people to stay and has the significant potential to lessen mental stress, produce higher psychological well-being and improve stress recovery (Lindemann-Matthies & Matthies, 2018; Methorst et al., 2021; Wang et al., 2019; Weimann et al., 2015). In a British study, people’s perceived likelihood of recovery from mental fatigue increased with perceived plant species richness (Dallimer et al., 2012). Another study shows that planting trees in a barren (without trees) area can greatly

improve people's stress recovery (Jiang et al., 2014). Improving species richness within urban green spaces can both facilitate human physical and mental health, especially subjective wellbeing (Dallimer et al., 2012; Fuller et al., 2007; Houlden et al., 2018; Methorst et al., 2021).

Diverse color (e.g, flowers) vs. green: As various landscapes are designed for urban green spaces, color richness is the most direct performance for people's visualization (Velarde et al., 2007). Color is direct feedback when we observe the environment through eyes, which can affect our psychological process and emotions, create happiness or even anxiety (Elliot & Maier, 2014; Sodagar & Mafakher, 2017). One study shows that participants reported lower levels of stress and anxiety after viewing diverse colors (i.e., orange, yellow, green, blue and purple) (Jonaskaite et al., 2020). Color can be used as a therapy to heal health issues, like satisfying and comforting patients (Gupta, 2021). Cross-cultural studies show that visual exposure to flowers can help mitigate perceived stress (Alvarsson et al., 2010; Honold et al., 2016; Wang et al., 2019). A study made in workplace presents that viewing purple or blue flowers offers comfort and relaxation to employees (Elsadek & Liu, 2021). Yellow and red flowers can immediately cause strong positive emotions in human (Xie et al., 2021). Also, people prefer to walk on trails surrounded by flowerbeds (Arnberger & Eder, 2015). One study made in the historic city of Padua in north-eastern Italy of 2017, found that respondents prefer a complex scenario with aesthetically appealing features like colorful flowers (Arnberger & Eder, 2015).

Water accessibility (access to water vs. no access to water): Water is regarded as one of the most important landscape elements (Wang et al., 2019). Water can evoke individual positive emotions, maintain a relaxed state and reduce negative feelings, thereby decreasing stress (Lindemann-Matthies & Matthies, 2018; Shaffee & Shukor, 2018). In one study, students mentioned listening to the water sound can help to mitigate their stress and they prefer to sit on the rocks besides the stream (Seitz et al., 2014). Furthermore, patients with stress-related mental disorders enjoy visiting easily-accessible forests with visible water (Stoltz et al., 2016). Water quality, which includes water flow, cleanness, smell and the diversity of aquatic creatures, is another key factor since evidence shows that green space with clear water is likely to attract people and has potential to alleviate people's mental stress (Wang et al., 2019).

Vegetation cover (high vegetation cover vs. low vegetation cover): Vegetation cover is the portion of land which is covered by vegetation (Pazhouhanfar, 2018). As a main element within urban space, vegetation has been widely acknowledged to benefit human health (Pazhouhanfar, 2018). Studies have presented that access to /presence of vegetation can contribute to positive mental-health benefits, including a lower prevalence of stress, enhanced mood and promoted recovery of mental fatigue (Alvarsson et al. 2010; Honold et al., 2016; Lindemann-Matthies & Matthies, 2018; Schebella et al., 2019; Shaffee & Shukor, 2018; X. Jiang et al., 2020). Studies also show that people have an inclination for green spaces with dense and moderate vegetation (Astell-Burt & Feng, 2019; Harris et al., 2018). A study conducted in southern England, United Kingdom of 2014 showed that neighborhoods with higher vegetation cover make residents have reduced severity of depression, anxiety, and stress (Cox et al., 2017). One interesting research found that people dislike understory vegetation since high concentrations of understory vegetation may increase people's stress level and negate mental health (Arnberger & Eder, 2015; Jiang et al., 2020).

Tree canopy, density and height: Tree canopy is the layer of leaves, branches, and stems of mature trees that cover the ground when viewed from above (Sloat, 2019). One study conducted from 46786 participants in Sydney, Wollongong, and Newcastle, Australia, in the baseline of the Sax Institute's 45 from

2006 to 2009, and from 2012 to 2015, found that exposures of 30% or more tree canopy are associated with lower incidence of psychological distress (Astell-Burt, & Feng, 2019). Higher tree canopy has the potential to boost the mental health of vulnerable groups. A study made in Philadelphia, PA, shows that residential tree canopy cover is associated with reduced perceived stress among pregnant women who suffered from anxiety or depression (Nguemeni Tiako et al., 2021). An online survey made in the United States of 2017, found that higher concentrations of tree canopy in neighborhoods are related to an increased capacity to control stress (Jiang et al., 2020). In regard to children with autism spectrum disorder, higher green canopy might bring them stress-reducing benefits (Larson et al., 2018). Moreover, settings that include trees and open green spaces have been verified to aid in stress recovery, and higher tree cover density supports improved stress recovery (B. Jiang et al., 2014; van den Berg et al., 2007).

Bird sounds vs. no bird sounds/Birds vs. no birds: Studies on the relationship between sound and stress recovery are currently limited (Stoltz et al., 2016). Natural sounds are typically perceived as pleasant components of the soundscape and bird songs undoubtedly deserve to be considered (Nilsson & Berglund, 2006; Stoltz et al., 2016). Listening to bird songs is good for perceived attention restoration, multisensory stress reduction and stress recovery (Hedblom et al., 2019; Ratcliffe et al., 2013). Besides, it is good for people's psychological well-being to observe birds in the environment (Cox et al., 2017). A study shows afternoon bird abundance is positively associated with lower stress (Cox et al., 2017). Vocalization of different bird species has a different influence on stress mitigation (Hedblom et al., 2019). Exposure to interesting species (e.g., birds or orchids) may activate positive emotions and improve emotional resilience (Aerts et al., 2021).

Access to walking paths/trail: Residents in the neighborhood with a higher access to usable green spaces are more satisfied with their neighborhood (Zhang et al., 2017). A study related to students shows that they prefer to walk through the park's trail to lessen stress compared to streets (Seitz et al., 2014). More pertinent research is needed to examine if walking paths can impact people's stress degree.

Man-made facilities: Man-made facilities such as fountains and benches have a significant positive effect on human health, for example by preventing individual's mental fatigue (e.g., stress and anxiety), improving mood, self-esteem and creativity (Adevi and Mårtensson, 2013; Fjørtoft and Sageie, 2000; Jo et al., 2013; Kaplan, 1995; Liu et al., 2018; Pretty et al., 2005; Seitz et al., 2014; Tyrväinen et al., 2014). Benches/tables offer students a great opportunity to peacefully observe and engage with surrounding nature like trees or bushes, which has potential for alleviating stress (Seitz et al., 2014). The number of people occupying the benches/tables may affect people's preference on choosing where to relieve stress (Arnberger & Eder, 2015). Empty benches/tables are the optimal choice, while full benches/tables might have negative effects on stress reduction (Arnberger & Eder, 2015). No benches/tables also help to reduce stress but are less effective than empty ones (Arnberger & Eder, 2015). Another human-made facility can be historic/modern architecture (e.g., figure sculptures or ancient enclosures) which stands for cultural elements in green space (Stoltz et al., 2016). Indeed, the cultural history of an area was recently found to be positively related to green quality as well as public health (Campagnaro et al., 2020). However, historic walls have a negative effect on general preferences that are similar to stress relief preferences (Campagnaro et al., 2020). Individuals living in areas with cultural architecture have a higher possibility of psychological well-being (Weimann et al., 2015). Good lighting might have an influence on green space quality but little research is related to this aspect (Grahn & Stigsdotter, 2010).

Quietness, spaciousness, cleanliness and maintenance and feeling of safety are all identified as important qualities of green spaces for people's preference to stay in greenness (Stessens et al., 2020).

Serenity (no man-made noise) vs. *noise* (traffic noise/construction noise): Serenity is a place of peace, and people can only hear natural sounds (e.g., water sounds, bird sounds, breeze) (Stoltz et al., 2016). People who live in more serene areas probably have a higher psychological well-being (Weimann et al., 2015). Natural sounds may be capable of positively affecting the major human stress systems, and have a stress-reducing effect (Arnberger & Eder, 2015; Shaffee & Shukor, 2018; Thoma et al., 2018). Whereas, if improperly used, sound stimulation could be a potent stressor, causing physiological stress reactions, especially at high sound pressure levels (Stoltz et al., 2016). Environmental noise disturbs daily communication, activities and even sleep, resulting in mental stress (Arnberger & Eder, 2015). Noise level affects people's preferences on choosing space to reduce stress (Arnberger & Eder, 2015). Visitors like to stay where there is no noise, even if little noise, the preferences will be undermined (Arnberger & Eder, 2015).

Spaciousness is the quality of being large, with plenty of space for people to move around in synonym roominess. Individuals living in areas with spaciousness have a higher likelihood of psychological well-being (Weimann et al., 2015). One study shows that people prefer to stay in a small area (120ha) for stress relief in comparison to very small (10ha) or medium area (600ha) (Arnberger & Eder, 2015).

Cleanness (litter vs. no litter): One study conducted in Vienna, Austria, focused on the preferences of choosing where to relieve stress among 692 visitors on 8 different greenspaces, and found that people greatly prefer to do stress relief where there is no litter (Arnberger & Eder, 2015). Another study in the south Philadelphia community shows that trash on the street decreases feelings of safety and security, and raises stress (WPVI, 2019). Besides, in a community-based participatory research project, 45 undergraduate students who enrolled in an emotional health course during the fall of 2012 mentioned green spaces covered with cigarette butts are not helpful in soothing stress (Seitz et al., 2014).

Compared to visual and auditory stimuli, the impact of *odors/smell* in urban areas has been scarcely studied (Hedblom et al., 2019). Hedblom et al (2019) found that olfactory inputs may significantly matter in facilitating stress reduction. Studies have presented that inhaling floral scents from plants or flowers can help reduce the stressful feelings and improve mental health (Jo et al., 2013; Warner, 2009). In one study made in a college campus, students complained that the trash cans were smelly with swarms of bees, which discouraged their stress relief (Seitz et al., 2014).

Maintenance: Good condition (broken trees, no broken public property, no vandalism) vs. bad condition (e.g., vandalism): Maintenance is one of the important factors for people to decide if they want to visit a green space (Wu & Song, 2017). People prefer to stay in well-kept green space to exercise (Akpınar, 2016; Pope et al., 2018). Graffiti or some vandalism may abate people's preference of choosing which place for stress reduction (Arnberger & Eder, 2015). Thus, more improvements are needed to enhance these infrastructure (e.g., poorly placed trash cans, areas that need landscaping or removing litter) on campus in terms of alleviating stress (Seitz et al., 2014).

Perceived safety: Perceived safety is how people feel about reduced visibility of dense vegetation, chance of crime, fear of injury or loss, and feeling unwell (Tan et al., 2019). Perceived safety is a prerequisite for people to determine whether they visit a green space, especially for old people (Tan et al., 2019; Wu & Song, 2017). It is undeniable that people prefer to stay in safe green space to relax or exercise (Pope et

al., 2018). One study conducted in the historic city of Padua in north-eastern Italy of 2017, found that if a location is considered as unsafe, it would not reduce people's stress (Campagnaro et al., 2020).

3.2 Assessment of 8 sites

Based on the assessment (Table 5), I found Ikb and Rose Garden generally have high level of site qualities based on the highest average score, while Ponderosa Commons generally has the lowest level of site qualities based on the lowest average score. Ikb and Rose Garden both have high level of plant biodiversity, vegetation cover, access to walking paths/trails, man-made facilities, spaciousness, and perceived safety. Ponderosa Commons has low level of all qualities except for access to walking paths/trails, man-made facilities, spaciousness and perceived safety. Among all sites, Ikb and Totem Park well manifest high plant biodiversity. Only Rose Garden well manifests high color richness. Water is not a necessary site quality and only Ikb, Arthur Lord Field, and Martha Piper Plaza have water elements. Ikb and Rose Garden well manifest high vegetation cover. Ikb and Totem Park well manifest high tree canopy, density & height. Only the Bosque well manifests bird/bird songs. All the greenspaces have many man-made facilities (except for Totem Park) and have good access to walking paths/trails. Only Ikb well manifests high serenity. The Bosque, Ikb, Arthur Lord Field, and Forest Science grassland well manifest high spaciousness. Only Rose Garden well manifests high cleanness. All sites do not have bad smell. Ikb, Rose Garden, Martha Piper Plaza, and Forest Science grassland well manifest good maintenance. Except for Totem Park, all sites have good perceived safety.

Table 5. 8 Site quality assessment based on 14 criteria. The average score of qualities in each site was calculated.

Greenspace Quality	The Bosque	lkb	Rose Garden	Arthur Lord Field	Martha Piper Plaza	Ponderosa Commons	Forest Science grassland	Totem Park
High plant biodiversity	2	4	3	2	1	2	2	4
High color richness	1	2	5	2	1	2	2	1
High water accessibility & quality	0	4	0	3	5	0	0	0
High vegetation cover	3	4	4	2	1	2	3	3
High tree canopy, density & height	3	4	1	1	1	2	1	5
Have bird/Bird songs	4	3	3	3	3	3	2	3
Have access to walking paths/trails	4	3	4	4	4	4	5	3
Many man-made facilities	4	5	5	4	5	4	4	1
High serenity	2	4	3	1	1	2	2	3
High spaciousness	4	4	3	4	3	3	5	2
High cleanness	2	2	4	3	2	1	3	3
No bad smell	3	3	4	3	3	3	3	4
Good maintenance	2	4	4	3	4	1	4	3
High perceived safety	3	4	4	5	5	3	5	2
Average score	2.64	3.57	3.38	2.86	2.79	2.28	2.93	2.64
Ranking scale: (no feeling) 0 1 2 3 4 5 (very strong feeling)								

3.3 Current use of UBC green spaces with different qualities

As shown in Figure 2, Arthur Lord Field, Forest Science grassland, Ikb, the Bosque and Totem Park all have higher populations of vigorous behavior than passive behavior in two observations. Rose Garden both has a higher population of passive behavior than vigorous behavior in two observations. An interesting result I find is that Martha Piper Plaza and Ponderosa Commons have a high population of passive behavior in the first observation, while have a high population of vigorous one in the second observation. In addition, it is clear to see Ikb and Totem Park both have low populations of vigorous and passive behavior in two observations. The population of vigorous and passive behavior in the Bosque is not very high, especially low in passive behavior.

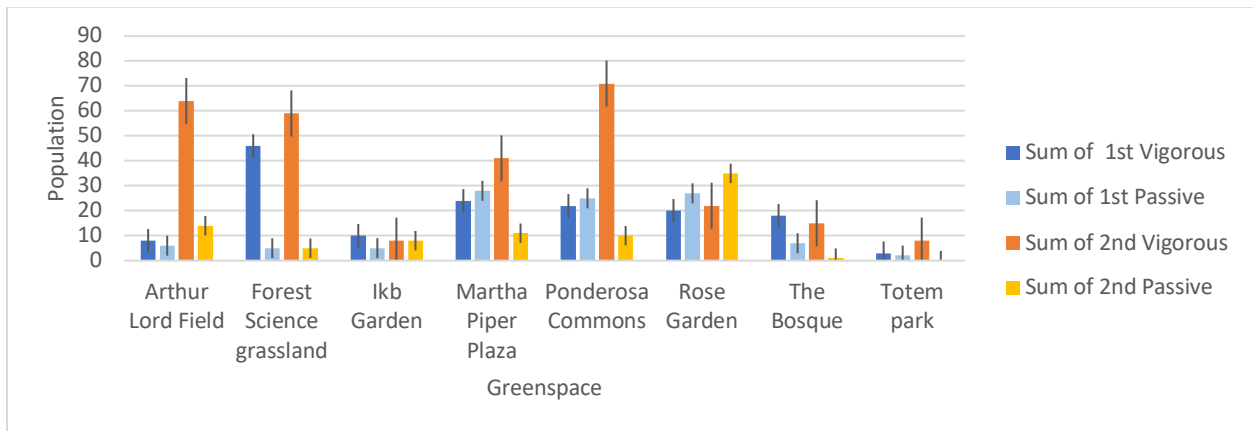


Figure 2. Population of 8 greenspace based on vigorous and passive behavior in first and second observation, respectively.

3.3.1 Vigorous behavior and associated greenspace qualities

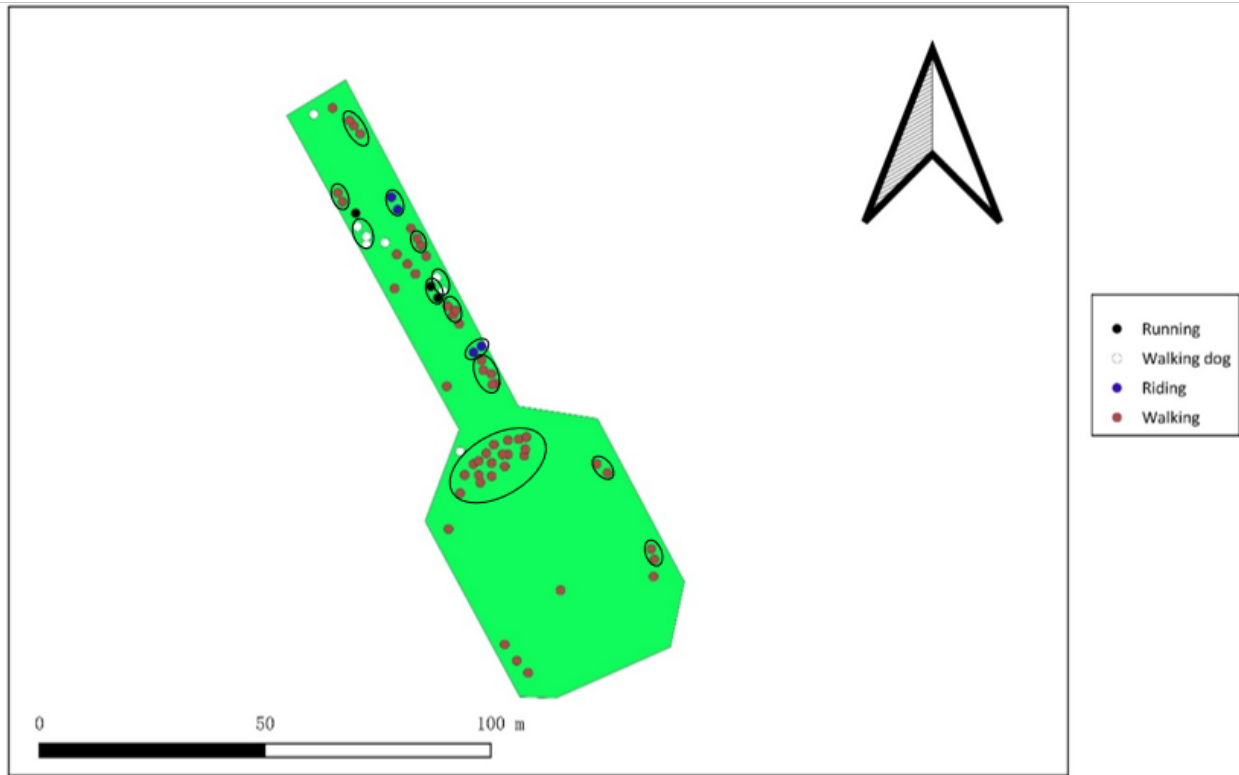


Figure 3. Population of vigorous behavior in Forest Science Grassland of second observation. (One point represents one person alone; the points in black circle represent a group. Same for graphs below)

Forest Science grassland has the highest population of vigorous behavior in two observations (Figure 2). Walking is the most popular vigorous behavior in Forest Science grassland, compared with running, walking dogs and riding (Figure 3). It is clear to see some people stay alone but some people stay as a group (i.e., in black circle) to do vigorous activities. This greenspace has high qualities in spaciousness, access to walking paths/trails (easy for people to walk on), man-made facilities (e.g., Reconciliation Pole, benches), maintenance and perceived safety (Table 5). As an open area, the spaciousness is large enough for many people/dogs to walk around. The large and open grassland is a good place for people to gather, socialize and relax. The perceived safety is very high since it is surrounded by Forest Science Center, Thunderbird Residence and Old Barn Community, where lots of people pass by. It can be regarded as a social, landscape, and cultural space. I did the two observations both on Saturday mornings without rainy days when people (mainly residents nearby) prefer to go outside for morning exercises, such as walking. There are some photos of various behavior below taken in Forest Science grassland (Figure 4).



Figure 4. Diverse human behavior in Forest Science grassland from 9:50 am to 10:20 am on August 13rd (Saturday), cloudy.

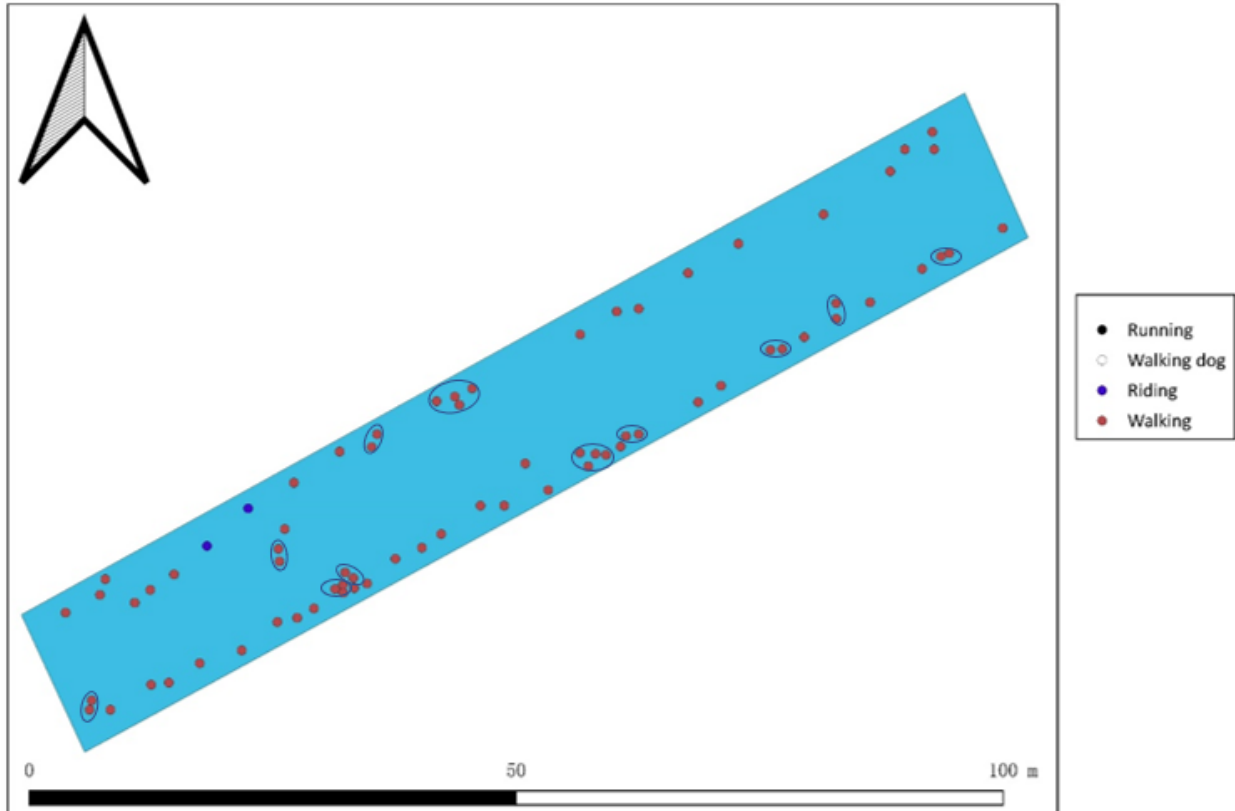


Figure 5. Population of vigorous behavior in Arthur Lord Field of second observation.

Arthur Lord Field has a high population of vigorous behavior in the second observation (Figure 2). Walking is the most popular vigorous behavior in Arthur Lord Field, compared with running, walking dogs and riding (Figure 5). It is clear to see some people stay alone but some people stay as a group (i.e., in black circle) to do vigorous activities. It has high qualities in spaciousness, access to walking paths/trails and man-made facilities and perceived safety (Table 5). Arthur Lord Field, located along the university blvd, close to main mall, Biological Science Building and UBC bookstore, offers people a high perceived safety since many people pass by. The overall spaciousness is large enough for many people to move around. Many walking paths are easy to access. Man-made facilities include the stone steps, streetlights and First Nation sculpture. I did the second observation of this site on the afternoon of August 22nd, sunny days when it is close to the start of school season, therefore many people (mainly students) come to campus for early check-in and walk around the campus. There are some photos of various vigorous behavior below taken in Arthur Lord Field (Figure 6)



Figure 6. Diverse vigorous human behavior in Arthur Lord Field from 2:30 pm to 3:00 pm on August 22nd (Monday), sunny.

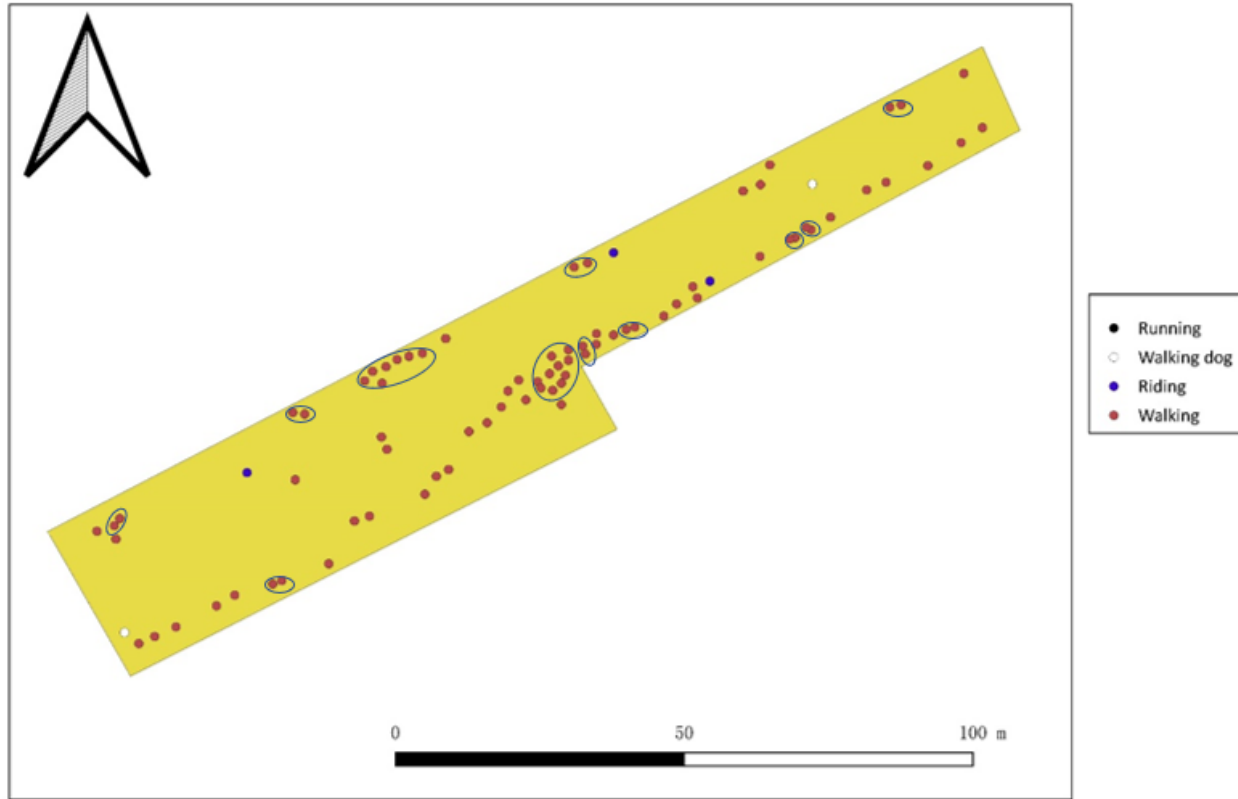


Figure 7. Population of vigorous behavior in Ponderosa Commons of second observation.

Ponderosa Commons has a high population of vigorous behavior in the second observation (Figure 2). Walking is the most popular vigorous behavior in Arthur Lord Field, compared with running, walking dogs and riding (Figure 7). It is clear to see some people stay alone but some people stay as a group (i.e., in black circle) to do vigorous activities. It has high qualities in spaciousness, access to walking paths/trails and man-made facilities (Table 5). Located along the university blvd, it has large spaciousness for people to move around. Many walking paths are easy to access. Man-made facilities include the benches, stone steps, streetlights and modern architecture. It offers people a high perceived safety since many people pass by and it is also close to student accommodation. I did the second observation of two seats both on the afternoon of August 22nd, sunny days when it is close to the start of school season, therefore many people (mainly students) come to campus for early check-in and walk around the campus. There are some photos of various vigorous behavior below taken in Ponderosa Commons (Figure 8).

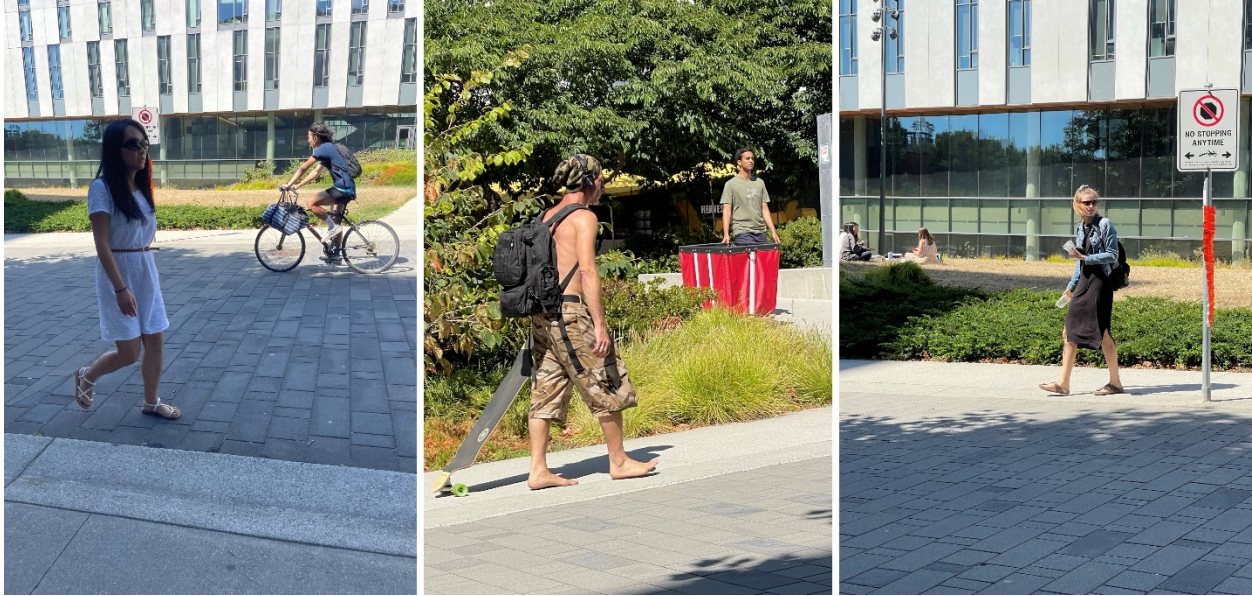


Figure 8. Diverse vigorous human behavior in Ponderosa Commons from 1:50 pm to 2:20 pm on August 22nd (Monday), sunny.

Totem Park and Ikb both have the lowest population of vigorous and passive behavior in two observations and people seldom go there (Figure 2). They both have a high quality of plant biodiversity (varying from understory to trees), tree canopy, density & height, in comparison to other sites (Table 5). So we discussed that plant biodiversity, tree canopy, density & height are not actively related to the intensity of human behavior and other factors might affect, like weather and the time of the day. Especially, Totem Park has low perceived safety, man-made facilities and spaciousness but highest level of tree canopy, density and height and plant biodiversity. The quality of access to walking paths/trails in these two sites is good. People seldom go to Totem Park since it is a closed area with low light and is located at the edge of the campus where people seldom walk by. There are few man-made facilities in the park, which gives people a high sense of refuge, richness in species and wilderness. The overall spaciousness is not large for many people to move around, which is shaded by the big tree canopy. Several walking paths that are filled with mud, gravel, branches, cones and leaves are easy to access but hard to walk on. Ikb has vigorous tall and big trees with a medium canopy and high density. The overall spaciousness without being shaded by trees is large enough for many people to move around. Many walking paths are easy to access, including stone benches and stone steps. Man-made facilities include the Ladner Carillon and Clock Tower, a stonewall (Valedictory Gift of The Classes of 1928 in Memory of Frank Fairchild Westbrook), benches, tables, streetlights, a fountain and staircases. It offers people a high perceived safety since it is close to the library where many people pass by. Whereas, I made two observations during the summer holiday when there are not so many students on campus, and it is sunny from 10:30 am to 11:00 am when the sunlight is strong in this open area without shades. That is why people do not prefer to stay here.

3.3.2 Passive behavior and associated greenspace qualities

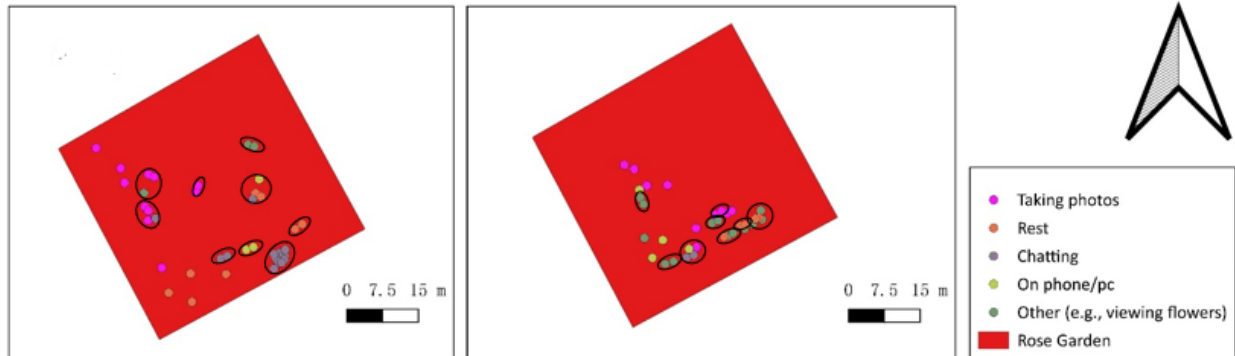


Figure 9. Population of passive behavior in Rose Garden of two observations.

Rose Garden both has the highest population of passive behavior among all sites in two observations (Figure 2). Taking photos and resting are the most popular passive behaviors in the Rose Garden (Figure 9). It is clear to see some people stay alone but some people stay as a group (i.e., in black circle) to do vigorous activities. It has high qualities in plant richness (most plants are bushes), color richness (flowers (e.g., red, yellow, white, pink, orange flowers), man-made facilities and maintenance, cleanness, smell and vegetation cover (Table 5). The garden contains mostly hybrid tea and floribunda roses. The overall spaciousness without being shaded by trees is large enough for many people to move around. Many walking paths are easy to access and interconnect with each other. Little trash can be seen. Man-made facilities include benches, staircases, corridors, ancient columns and viewing platforms. There are benches and places to sit and relax in the aromatic calm of the garden. It offers people a high perceived safety since there are lots of people visiting here and it has beautiful scenery. It is the perfect place to snap a souvenir photo, linger over a picnic lunch, rest, and learn about culture (i.e., history and design of Rose Garden). It also gives people a high sense of prospect. Besides, I did two observations on Monday mornings during the summer holiday, sunny, when people (mainly middle aged and elderly people) prefer to go there for fresh air or admire views. There are some photos of various passive behaviors below taken in the Rose Garden (Figure 10).



Figure 10. Diverse passive behaviors in the Rose Garden from 10:30 am to 11:00 am on August 15th (Monday), sunny.

The Bosque has a low population of passive behavior, which has large spaciousness but low level of serenity, maintenance and cleanliness. The overall spaciousness is large enough for many people to move around. Vegetations only include tall trees (monoculturally planted) and flat grassland. Space and distance can be found between trees. Many birds like crows stay on the grass with songs, but sometimes machine operation sounds from the construction site nearby can be heard. It is clear to see litter (e.g., paper, can, masks) on the grassland or around benches. Dust can be found at the area which is close to the construction site (e.g., excavators and debris). One white sculpture (i.e., Goddess of Democracy) can be seen close to the construction site, where people are unwilling to stay for admiring. There are few benches for people to rest, with Graffiti and vandalism, which are badly maintained. Although it is close to Ikb library where many people pass by, the perceived safety is reduced by the construction site nearby. In addition, the Bosque is blocked by the Ikb library that is taller than it, which makes sunlight hard to enter and mostly in the shadows. Therefore, people do not prefer to stay there for a while to do some passive activities like resting or studying.

As for Martha Piper Plaza and Ponderosa Commons, the population of passive behavior is higher than vigorous behavior in the first observation, while vigorous one is higher than passive one in the second observation. Located at the crossroads of the main mall, there is a big Martha Piper Fountain at the center of this area, encircled by stone steps where people can sit. Flowable and clean fountain sprays attract

people to take photos and view the fountain. Other man-made facilities like benches and a cabin with woody benches provide much space for people to do passive activities like rest. Ponderosa Commons lies along the university blvd, several big trees with a medium-big canopy, which provide shade for people here, stand around the square benches. Much trash can be seen in grasses or around benches, like paper and food trash. Man-made facilities include the benches, stone steps, streetlights and modern architecture. The overall spaciousness in these two sites is large for people to move around. Some birds like crows stay on the grass with songs. Many walking paths are easy to access, some of which are under the tree shade. Two sites offer people a high perceived safety since many people pass by and it is also close to teaching buildings and student accommodation, and also provide a temporary space for people to rest, chill and photograph. I did the first observation of Ponderosa Commons during lunch time during summer holiday, sunny days when people are likely to do passive activities such as eating food or resting while enjoying the sunshine. I did the second observation of Martha Piper Plaza and Ponderosa Commons on August 18th and 22nd, respectively, close to the start of school, which means more students come to school and walk around the campus. Thus, the population of vigorous behavior is higher than before.

4. Discussion

Overall, I think the campus is doing a good job with the greenspaces, especially for Ikb and Rose Garden that have high average scores of site qualities. All the greenspaces, except for Totem Park, have a high level of spaciousness and access to walking paths/trails that induce vigorous behavior, which is good for general health. The spaciousness and man-made facilities (e.g., benches) in Totem Park needs improvement to provide more space and facilities for students to do activities. When it comes to passive behavior, color richness, smell, serenity, cleanness and vegetation cover should be maintained and further improved in all sites since the score of these qualities is not very high. Although insignificant qualities (i.e., water, plant biodiversity, tree canopy, density & height, birds/bird sounds, perceived safety) cannot greatly contribute to human behavior, they need to be maintained and improved for better landscape and environment on campus.

There are some limitations in this study. First, this study is only based on my own perspectives, including 14 qualities' identification and site quality assessment, which might produce subjective bias. A wide range of perspectives are needed to assess the site quality. Second, I did the two observations in the summer holiday (i.e., August) when most students or staff do not stay on campus, therefore there are not so many people on campus for me to observe their behaviors. As we get closer to the early September, there are more and more people like students coming to campus and we will see a variety of behaviors. Third, as for different sites, I did the observation in different time of the day like morning or afternoon for only 30 mins, which might get limited results of behavior types. For instance, lunch time is likely to see many people have food. Third, the site quality assessment (on July 31st) was conducted several days/couples of weeks earlier than behavior observations (during the whole August), which means the site quality might change over the time. For instance, more litter might be found as more and more students come back to school; fewer flowers can be seen as it gets closer to the early September. These changes might affect how I linked UBC students' usage of green spaces on campus to different qualities for mental well-being.

5. Recommendation

5.1 Recommendations for actions and implementations

According to Wellbeing Strategic Framework (2018), the actions to promote wellbeing are based on six priority areas whose leaders are students, staff, faculty, and community. In my study, I focus on Built & Natural Environments, Mental Health & Resilience, Physical Activity, and Social Connection.

Built & Natural Environments: Active transportation is recommended such as increasing trips to and from UBC made by walking, cycling, or transit. (Wellbeing Strategic Framework, 2018). For instance, the campus-wide bike share program in 2018, called “Campus-wide bike share pilots” has started to reduce barriers for cyclists on campus and provide new ideas for other active transportation initiatives. In addition, it is advisable to maintain a smooth surface for walking paths/trails (e.g., mud trails in Totem Park), which is convenient and safe for cyclists and walkers to move around. Based on my study, UBC Rose garden, with stunning ocean, mountain views, and more than a dozen types of roses blooming abundantly between June and September, can be regarded as prospect (i.e., geometrical designs amid a field of grass and flowers) with and biodiversity space, which requires maintenance and cultivation.

Mental Health & Resilience: UBC closely works with local and Indigenous community members to make sure everyone, regardless of identity, has access to cultural opportunities to learn and share knowledge related to enhancing mental health. University leadership are highly responsible for creating a culture and environment that promotes mental health and resilience for all. UBC is aimed to increase community members who feel confident in mental health by 2025. For instance, Mental Health Literacy for Students UBC has started to integrate mental health literacy into students’ study and study, like Jump Start orientation for first-year students. Related projects like Teaching & Learning Enhancement fund grant will be assessed for impact on students’ mental health literacy outcomes. Based on my study, Totem Park can be a good space like refuge, for people to do forest meditation and connect with nature if more light, more spaciousness and maintenance of the walking trails are provided.

What is more, being physically active is good for mental health while helping prevent chronic disease. Collaboration and partnerships across our campuses produce accessible programs, policies, and facilities that support physical activity for all ages and abilities, making it simple and convenient to be active. More diverse and inclusive opportunities like active and sustainable transportation can be provided to promote movement rather than be sedentary. UBC is aimed to reduce by 10% in the prevalence of physical inactivity for community members and increase by 10% in their satisfaction with recreation facilities and programs by 2025. For instance, the Physical Activity Office has been established by diverse partnerships (i.e., Creation of UBC Physical Activity Office UBC Kinesiology, UBC Athletics & Recreation, and UBC Wellbeing) in 2018 on the UBC Point Grey Campus, which aims to change behaviors, improve health, advance and translate research, and positively impact our campus and broader community through physical activity.

Being socially connected can help maintain good mental health, reduce the risk of having higher anxiety, stress, and depression (Soares et al., 2022). People who feel more connected to others tend to have lower levels of anxiety and depression (Seppala, 2014). Therefore, universities are encouraged to establish communities or free talks involving diverse cultures and perspectives to enhance social interaction among students. For instance, two new Collegia locations that started in 2019, offer high opportunities for freshmen to experience this “home away from home.” Based on my study, Forest Science grassland can be designed as an optimal area for people to gather, socialize and participate in vigorous activities like outdoor class or physical games. Rose Garden can also be a good place for family, friends or couples to do passive activities like viewing scenery or taking photos.

Meanwhile, when we focus on establishing wellbeing-oriented greenspace, we should also consider protecting the intactness of nature that is not disturbed by humans, including biodiversity as well as the environment. It is difficult to promote intactness on campus, but we can add nature into the center of the design through ‘biophilic design’ to strengthen connections to the natural world and improve people’s intimate awareness of nature and engagement (14 Patterns of Biophilic Design, 2014). Three design models are included in biophilic design: nature in the space like presence of water; natural analogues like

material connection with nature; nature of the space like a beautiful view over a distance for visiting (i.e., prospect) (14 Patterns of Biophilic Design, 2014).

5.2 Recommendations for future research

Research indicates that diverse greenspace qualities have different impacts on human behavior and general wellbeing. There is a growing need for greenspace quality-driven mental health and wellbeing impacts to be prioritized across community planning, policy, and decision making. A holistic approach to wellbeing must be community-based, intersectional and systemic, with a focus on improving wellbeing through campus greening and urban planning. How diverse greenspace on UBC campus affects students' mental health and general well-being only provides a tip of the iceberg for improving human well-being. Diverse perspectives from other universities or areas are highly welcomed to study nature and wellness. As the frequency and severity of health issues increase, we must build community resilience and wellbeing more strongly into risk reduction and advanced preparedness.

6. Conclusion

We conclude that spaciousness, access to walking paths/trails are more likely to motivate vigorous behavior (i.e., walking). Color richness, smell, serenity, cleanness and vegetation cover are more likely to induce passive behavior (i.e., admiring arts, rest, connection with nature). Man-made facilities can motivate both vigorous and passive behavior. Water can promote the intensity of human behavior but it is not a significant quality. Plant biodiversity, tree canopy, density & height, birds/bird sounds are not actively related to the intensity of human behavior. The perceived safety is not a significant quality in this study since we chose the UBC campus as our experimental site, which means the perceived safety is generally good. In addition, social connection (e.g., conversations, group activities) with more than one person, exists in both vigorous and passive activities, which supports social wellbeing.

References

- About Campus Vision 2050. (n.d.). *UBC Campus Vision 2050*. Retrieved from <https://campusvision2050.ubc.ca/about>
- Abu-Ghazze, T. M. (1999). Communicating behavioral research to campus design: Factors affecting the perception and use of outdoor spaces at the University of Jordan. *Environment and Behavior*, 31(6), 764–804. <https://doi.org/10.1177/00139169921972344>
- Aerts, R., Vanlessen, N., & Honnay, O. (2021). Exposure to green spaces may strengthen resilience and support mental health in the face of the covid-19 pandemic. *BMJ*, 373, n1601. <https://doi.org/10.1136/bmj.n1601>
- Akpınar, A. (2016). How is quality of urban green spaces associated with physical activity and health? *Urban Forestry & Urban Greening*, 16, 76–83. <https://doi.org/10.1016/j.ufug.2016.01.011>
- Alberti, M., & Wang, T. (2022). Detecting patterns of vertebrate biodiversity across the multidimensional urban landscape. *Ecology Letters*, 25(4), 1027–1045. <https://doi.org/10.1111/ele.13969>
- Alvarsson, J. J., Wiens, S., & Nilsson, M. E. (2010). Stress recovery during exposure to nature sound and environmental noise. *International Journal of Environmental Research and Public Health*, 7(3), 1036–1046. <https://doi.org/10.3390/ijerph7031036>
- American College Health Association. (2013). American College Health Association—National College Health Assessment II: Reference group executive summary spring 2013. *Hanover, MD: American College Health Association*.
- Arnberger, A., & Eder, R. (2015). Are urban visitors' general preferences for green-spaces similar to their preferences when seeking stress relief? *Urban Forestry & Urban Greening*, 14(4), 872–882. <https://doi.org/10.1016/j.ufug.2015.07.005>
- Astell-Burt, T., & Feng, X. (2019). Association of urban green space with mental health and general health among adults in Australia. *JAMA Network Open*, 2(7), e198209. <https://doi.org/10.1001/jamanetworkopen.2019.8209>
- Beyer, K. M. M., Kaltenbach, A., Szabo, A., Bogar, S., Nieto, F. J., & Malecki, K. M. (2014). Exposure to neighborhood green space and mental health: Evidence from the survey of the health of Wisconsin. *International Journal of Environmental Research and Public Health*, 11(3), 3453–3472. <https://doi.org/10.3390/ijerph110303453>
- Bonthoux, S., Brun, M., Di Pietro, F., Greulich, S., & Bouché-Pillon, S. (2014). How can wastelands promote biodiversity in cities? A review. *Landscape and Urban Planning*, 132, 79–88. <https://doi.org/10.1016/j.landurbplan.2014.08.010>
- Campagnaro, T., Vecchiato, D., Arnberger, A., Celegato, R., Da Re, R., Rizzetto, R., Semenzato, P., Sitzia, T., Tempesta, T., & Cattaneo, D. (2020). General, stress relief and perceived safety preferences for green spaces in the historic city of Padua (Italy). *Urban Forestry & Urban Greening*, 52, 126695. <https://doi.org/10.1016/j.ufug.2020.126695>
- Cox, D. T. C., Shanahan, D. F., Hudson, H. L., Plummer, K. E., Siriwardena, G. M., Fuller, R. A., Anderson, K., Hancock, S., & Gaston, K. J. (2017). Doses of neighborhood nature: The benefits for mental health of living with nature. *BioScience*, 67(2), 147–155. <https://doi.org/10.1093/biosci/biw173>
- Dallimer, M., Irvine, K. N., Skinner, A. M. J., Davies, Z. G., Rouquette, J. R., Maltby, L. L., Warren, P. H., Armsworth, P. R., & Gaston, K. J. (2012). Biodiversity and the feel-good factor: Understanding associations between self-reported human well-being and species richness. *BioScience*, 62(1), 47–55. <https://doi.org/10.1525/bio.2012.62.1.9>
- Department of Geography, Liverpool Hope University, Liverpool, UK, Speake, J., Edmondson, S., & Nawaz, H. (2013). Everyday encounters with nature: Students' perceptions and use of university campus green spaces. *Human Geographies – Journal of Studies and Research in Human Geography*, 7(1), 21–31. <https://doi.org/10.5719/hgeo.2013.71.21>

- Devisscher, T. (2022). COVID-19 pandemic hit hard, and now what? *Green4C*. Retrieved from <https://www.greenforcare.eu/news/covid-19-mental-health-students/>
- Elliot, A. J., & Maier, M. A. (2014). Color psychology: Effects of perceiving color on psychological functioning in humans. *Annual Review of Psychology, 65*(1), 95–120. <https://doi.org/10.1146/annurev-psych-010213-115035>
- Elsadek, M., & Liu, B. (2021). Effects of viewing flowering plants on employees' wellbeing in an office-like environment. *Indoor and Built Environment, 30*(9), 1429–1440. <https://doi.org/10.1177/1420326X20942572>
- Felsten, G. (2009). Where to take a study break on a college campus: An attention restoration perspective. *Journal of Environmental Psychology, 29*, 160–167. <https://doi.org/10.1016/j.jenvp.2008.11.006>
- Feng, X., & Astell-Burt, T. (2018). Residential green space quantity and quality and symptoms of psychological distress: A 15-year longitudinal study of 3897 women in postpartum. *BMC Psychiatry, 18*(1), 348. <https://doi.org/10.1186/s12888-018-1926-1>
- Foellmer, J., Kistemann, T., & Anthonj, C. (2021). Academic greenspace and well-Being — Can campus landscape be therapeutic? Evidence from a German university. *Wellbeing, Space and Society, 2*, 100003. <https://doi.org/10.1016/j.wss.2020.100003>
- Fuller, R. A., Irvine, K. N., Devine-Wright, P., Warren, P. H., & Gaston, K. J. (2007). Psychological benefits of greenspace increase with biodiversity. *Biology Letters, 3*(4), 390–394. <https://doi.org/10.1098/rsbl.2007.0149>
- Gupta, R. (2021). Color therapy in mental health and wellbeing.
- Halliday, M. (2022). Inside UBC's Indian Residential School History and Dialogue Centre. *Macleans.Ca*. Retrieved from <https://www.macleans.ca/longforms/inside-ubcs-indian-residential-school-history-and-dialogue-centre/>
- Harris, V., Kendal, D., Hahs, A. K., & Threlfall, C. G. (2018). Green space context and vegetation complexity shape people's preferences for urban public parks and residential gardens. *Landscape Research, 43*(1), 150–162. <https://doi.org/10.1080/01426397.2017.1302571>
- Hedblom, M., Gunnarsson, B., Irvani, B., Knez, I., Schaefer, M., Thorsson, P., & Lundstrom, J. N. (2019). Reduction of physiological stress by urban green space in a multisensory virtual experiment. *Scientific Reports, 9*, 10113. <https://doi.org/10.1038/s41598-019-46099-7>
- Hipp, J. A., Gulwadi, G. B., Alves, S., & Sequeira, S. (2016). The relationship between perceived greenness and perceived restorativeness of university campuses and student-reported quality of life. *Environment and Behavior, 48*(10), 1292–1308. <https://doi.org/10.1177/0013916515598200>
- Holt, E. W., Lombard, Q. K., Best, N., Smiley-Smith, S., & Quinn, J. E. (2019). Active and passive use of green space, health, and well-being amongst university students. *International Journal of Environmental Research and Public Health, 16*(3), Article 3. <https://doi.org/10.3390/ijerph16030424>
- Honold, J., Lakes, T., Beyer, R., & van der Meer, E. (2016). Restoration in urban spaces: Nature views from home, greenways, and public parks. *Environment and Behavior, 48*(6), 796–825. <https://doi.org/10.1177/0013916514568556>
- Houlden, V., Weich, S., Albuquerque, J. P. de, Jarvis, S., & Rees, K. (2018). The relationship between greenspace and the mental wellbeing of adults: A systematic review. *Plos One, 13*(9), e0203000. <https://doi.org/10.1371/journal.pone.0203000>
- Hunt, J., & Eisenberg, D. (2010). Mental health problems and help-seeking behavior among college students. *Journal of Adolescent Health, 46*(1), 3–10. <https://doi.org/10.1016/j.jadohealth.2009.08.008>
- Hurst, C. S., Baranik, L. E., & Daniel, F. (2013). College student stressors: A review of the qualitative research. *Stress and Health, 29*(4), 275–285. <https://doi.org/10.1002/smi.2465>

- Jabbar, M., Yusoff, M. M., & Shafie, A. (2021). Assessing the role of urban green spaces for human well-being: A systematic review. *GeoJournal*. <https://doi.org/10.1007/s10708-021-10474-7>
- Jiang, X., Larsen, L., & Sullivan, W. (2020). Connections between daily greenness exposure and health outcomes. *International Journal of Environmental Research and Public Health*, 17(11), 3965. <https://doi.org/10.3390/ijerph17113965>
- Jo, H., Rodiek, S., Fujii, E., Miyazaki, Y., Park, B.-J., & Ann, S.-W. (2013). Physiological and psychological response to floral scent. *HortScience*, 48(1), 82–88. <https://doi.org/10.21273/HORTSCI.48.1.82>
- Jonauskaitė, D., Tremea, I., Bürki, L., Diouf, C. N., & Mohr, C. (2020). To see or not to see: Importance of color perception to color therapy. *Color Research & Application*, 45(3), 450–464. <https://doi.org/10.1002/col.22490>
- Larson, L. R., Barger, B., Ogletree, S., Torquati, J., Rosenberg, S., Gaither, C. J., Bartz, J. M., Gardner, A., Moody, E., & Schutte, A. (2018). Gray space and green space proximity associated with higher anxiety in youth with autism. *Health & Place*, 53, 94–102. <https://doi.org/10.1016/j.healthplace.2018.07.006>
- Li, Y. (Ella). (2021). Urban green space analysis on UBC Vancouver campus: Integrating virtual gaming technology to map cultural use and biodiversity value of urban green space. <https://doi.org/10.14288/1.0400158>
- Lindemann-Matthies, P., & Matthies, D. (2018). The influence of plant species richness on stress recovery of humans. *Web Ecology*, 18(2), 121–128. <https://doi.org/10.5194/we-18-121-2018>
- Liu, Q., Zhang, Y., Lin, Y., You, D., Zhang, W., Huang, Q., van den Bosch, C. C. K., & Lan, S. (2018). The relationship between self-rated naturalness of university green space and students' restoration and health. *Urban Forestry & Urban Greening*, 34, 259–268. <https://doi.org/10.1016/j.ufug.2018.07.008>
- McFarland, A. L., Waliczek, T. M., & Zajicek, J. M. (2008). The relationship between student use of campus green spaces and perceptions of quality of life. *HortTechnology*, 18(2), 232–238. <https://doi.org/10.21273/HORTTECH.18.2.232>
- McFarland, A. L., Waliczek, T. M., & Zajicek, J. M. (2010). Graduate student use of campus green spaces and the impact on their perceptions of quality of life. *HortTechnology*, 20(1), 186–192. <https://doi.org/10.21273/HORTTECH.20.1.186>
- Methorst, J., Rehdanz, K., Mueller, T., Hansjürgens, B., Bonn, A., & Böhning-Gaese, K. (2021). The importance of species diversity for human well-being in Europe. *Ecological Economics*, 181, 106917. <https://doi.org/10.1016/j.ecolecon.2020.106917>
- Nguemini Tiako, M. J., South, E., Shannon, M. M., McCarthy, C., Meisel, Z. F., Elovitz, M. A., & Burris, H. H. (2021). Urban residential tree canopy and perceived stress among pregnant women. *Environmental Research*, 201, 111620. <https://doi.org/10.1016/j.envres.2021.111620>
- Nguyen, P.-Y., Astell-Burt, T., Rahimi-Ardabili, H., & Feng, X. (2021). Green space quality and Health: A systematic review. *International Journal of Environmental Research and Public Health*, 18(21), Article 21. <https://doi.org/10.3390/ijerph182111028>
- Patterns of biodiversity: Types & patterns. (2022). *Embibe Exams*. Retrieved from <https://www.embibe.com/exams/patterns-of-biodiversity/>
- 14 Patterns of Biophilic Design. (2014). *Terrapin Bright Green*. Retrieved from <http://www.terrapinbrightgreen.com/reports/14-patterns-of-biophilic-design/>
- Pazhouhanfar, M. (2018). Role of space qualities of urban parks on mood change. *Psychological Studies*, 63(1), 25–31. <https://doi.org/10.1007/s12646-017-0434-6>
- Planning, C. + C. (2022). UBC Vancouver campus profile. *ArcGIS StoryMaps*. Retrieved from <https://storymaps.arcgis.com/stories/691e1b264846475d987c162d4dcf1bb5>
- Pope, D., Tisdall, R., Middleton, J., Verma, A., van Ameijden, E., Birt, C., Macherianakis, A., & Bruce, N. G. (2018). Quality of and access to green space in relation to psychological distress: Results from a

- population-based cross-sectional study as part of the EURO-URHIS 2 project. *European Journal of Public Health*, 28(1), 35–38. <https://doi.org/10.1093/eurpub/ckv094>
- Ratcliffe, E., Gatersleben, B., & Sowden, P. T. (2013). Bird sounds and their contributions to perceived attention restoration and stress recovery. *Journal of Environmental Psychology*, 36, 221–228. <https://doi.org/10.1016/j.jenvp.2013.08.004>
- Reid, C. E., Rieves, E. S., & Carlson, K. (2022). Perceptions of green space usage, abundance, and quality of green space were associated with better mental health during the COVID-19 pandemic among residents of Denver. *Plos One*, 17(3), e0263779. <https://doi.org/10.1371/journal.pone.0263779>
- Robotham, D. (2008). Stress among higher education students: Towards a research agenda. *Higher Education*, 56(6), 735–746. <https://doi.org/10.1007/s10734-008-9137-1>
- Roe, J. J., Thompson, C. W., Aspinall, P. A., Brewer, M. J., Duff, E. I., Miller, D., Mitchell, R., & Clow, A. (2013). Green space and stress: Evidence from cortisol measures in deprived urban communities. *International Journal of Environmental Research and Public Health*, 10(9), 4086–4103. <https://doi.org/10.3390/ijerph10094086>
- Schebella, M. F., Weber, D., Schultz, L., & Weinstein, P. (2019). The wellbeing benefits associated with perceived and measured biodiversity in Australian urban green spaces. *Sustainability*, 11(3), Article 3. <https://doi.org/10.3390/su11030802>
- Seitz, C. M., Reese, R. F., Strack, R. W., Frantz, S., & West, B. (2014). Identifying and improving green spaces on a college campus: A photovoice study. *Ecopsychology*, 6(2), 98–108. <https://doi.org/10.1089/eco.2013.0103>
- Seppala, E. (2014). Connectedness & Health: The Science of Social Connection. *The Center for Compassion and Altruism Research and Education*. Retrieved from <http://ccare.stanford.edu/uncategorized/connectedness-health-the-science-of-social-connection-infographic/>
- Shaffee, N., & Shukor, S. F. A. (2018). The effect of natural settings on stress reduction. 11, 9.
- Sloat, S. (2019). Mental health: Benefits of nature depend on type of green space. *Inverse*. Retrieved from <https://www.inverse.com/mind-body/58013-green-space-psychology-tree-canopy>
- Soares, A. K. S., Goedert, M. C. F., & Vargas, A. F. (2022). Mental Health and Social Connectedness During the COVID-19 Pandemic: An Analysis of Sports and E-Sports Players. *Frontiers in Psychology*, 13. <https://www.frontiersin.org/articles/10.3389/fpsyg.2022.802653>
- Sodagar, S., & Mafakher, F. (2017). *Analysis of the effects of color in the design of hospital inpatient care*. 10.
- Sohail, N. (2013). Stress and academic performance among medical students. *Journal of the College of Physicians and Surgeons--Pakistan: JCPSP*, 23(1), 67–71. <https://doi.org/01.2013/JCPSP.6771>
- Species richness. (2022). In *Wikipedia*. Retrieved from https://en.wikipedia.org/w/index.php?title=Species_richness&oldid=1080696510
- Stessens, P., Canters, F., Huysmans, M., & Khan, A. Z. (2020). Urban green space qualities: An integrated approach towards GIS-based assessment reflecting user perception. *Land Use Policy*, 91, 104319. <https://doi.org/10.1016/j.landusepol.2019.104319>
- Stoltz, J., Lundell, Y., Skarback, E., van den Bosch, M. A., Grahn, P., Nordstrom, E.-M., & Dolling, A. (2016). Planning for restorative forests: Describing stress-reducing qualities of forest stands using available forest stand data. *European Journal of Forest Research*, 135(5), 803–813. <https://doi.org/10.1007/s10342-016-0974-7>
- Tan, Z., Lau, K. K.-L., Roberts, A. C., Chao, S. T.-Y., & Ng, E. (2019). Designing urban green spaces for older adults in Asian cities. *International Journal of Environmental Research and Public Health*, 16(22), Article 22. <https://doi.org/10.3390/ijerph16224423>
- Taylor, L., & Hochuli, D. F. (2017). Defining greenspace: Multiple uses across multiple disciplines.

- Landscape and Urban Planning*, 158, 25–38. <https://doi.org/10.1016/j.landurbplan.2016.09.024>
- Thoma, M. V., Mewes, R., & Nater, U. M. (2018). Preliminary evidence: The stress-reducing effect of listening to water sounds depends on somatic complaints. *Medicine*, 97(8), e9851. <https://doi.org/10.1097/MD.00000000000009851>
- Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, 11(3), 201–230. [https://doi.org/10.1016/S0272-4944\(05\)80184-7](https://doi.org/10.1016/S0272-4944(05)80184-7)
- Van den Berg, A. E., Hartig, T., & Staats, H. (2007). Preference for nature in urbanized societies: Stress, restoration, and the pursuit of sustainability. *Journal of Social Issues*, 63(1), 79–96. <https://doi.org/10.1111/j.1540-4560.2007.00497.x>
- Velarde, M. D., Fry, G., & Tveit, M. (2007). Health effects of viewing landscapes – Landscape types in environmental psychology. *Urban Forestry & Urban Greening*, 6(4), 199–212. <https://doi.org/10.1016/j.ufug.2007.07.001>
- Wang, R., Zhao, J., Meitner, M. J., Hu, Y., & Xu, X. (2019). Characteristics of urban green spaces in relation to aesthetic preference and stress recovery. *Urban Forestry & Urban Greening*, 41, 6–13. <https://doi.org/10.1016/j.ufug.2019.03.005>
- Warner, J. (2009). Floral scent soothes stress. *WebMD*. <https://www.webmd.com/balance/news/20090724/floral-scent-soothes-stress>
- Weimann, H., Rylander, L., Albin, M., Skärbäck, E., Grahn, P., Östergren, P.-O., & Björk, J. (2015). Effects of changing exposure to neighbourhood greenness on general and mental health: A longitudinal study. *Health & Place*, 33, 48–56. <https://doi.org/10.1016/j.healthplace.2015.02.003>
- Wellbeing Strategic Framework. (2018). *University of British Columbia: Vancouver and Okanagan Campuses*.
- WPVI. (2019). Building it better together: Living litter-free means taking action in your community. *6abc Philadelphia*. Retrieved from <https://6abc.com/philadelphia-news-building-it-better-together-litter-trash-in/5397475/>
- Wu, K.-C., & Song, L.-Y. (2017). A case for inclusive design: Analyzing the needs of those who frequent Taiwan’s urban parks. *Applied Ergonomics*, 58, 254–264. <https://doi.org/10.1016/j.apergo.2016.06.015>
- Xie, J., Liu, B., & Elsadek, M. (2021). How can flowers and their colors promote individuals’ physiological and psychological states during the Covid-19 lockdown? *International Journal of Environmental Research and Public Health*, 18(19), Article 19. <https://doi.org/10.3390/ijerph181910258>
- Zhang, Y., Van den Berg, A. E., Van Dijk, T., & Weitkamp, G. (2017). Quality over quantity: Contribution of urban green space to neighborhood satisfaction. *International Journal of Environmental Research and Public Health*, 14(5), 535. <https://doi.org/10.3390/ijerph14050535>