ATTACHMENT 2

Photo by Karl Gohl, courtesy of Midpeninsula Regional Open Space District

An examination of the costs and benefits of visitation and recreational use of public open space

PART I: BENEFITS OF EXPERIENCES IN NATURE

PREPARED BY
San Francisco Estuary Institute
with support from Point Blue Conservation Science

PREPARED FOR
Midpeninsula Regional Open Space District

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Executive Summary

The Midpeninsula Regional Open Space District (hereafter "Midpen") manages 65,000 acres of land in Santa Clara and San Mateo Counties. Slightly less than half of this land, 31,000 acres across 26 open space preserves, is open for public recreation. Midpen's mission for the management and protection of these lands is: "To acquire and preserve a regional greenbelt of open space land in perpetuity, protect and restore the natural environment, and provide opportunities for ecologically sensitive public enjoyment and education." This joint mission creates a tension between public use and natural resource protection that is not unique to Midpen; many in the fields of conservation and land management struggle with this same tension. To make science-based management decisions that accomplish both goals, managers and planners must weigh the myriad public health benefits conferred by public access and recreation against a suite of potential detrimental impacts.

Public use has many known negative impacts on protected areas, including trampling of vegetation, alterations to the behavior of wildlife, impacts of domestic animals on wildlife, unsanctioned trail creation, removal of rare plants, and litter. Also, there are many health benefits to be gained from being outside and recreating in nature. Living in urban environments has a number of negative consequences for human health, often leading to disconnection from nature, sedentary lifestyles, and greater exposure to air pollution and other pollutants (McDonald et al., 2018). Midpen lands represent some of the largest and most biodiverse natural areas immediately adjacent to Santa Clara and San Mateo counties, with a population of more than 2.6 million people, and thus represent a critical resource to reduce some of the negative impacts of urban living. A comprehensive understanding of the benefits and tradeoffs of nature access can help to ensure that future visitor management decisions fulfill Midpen's dual mission of protecting natural resources and allowing for public enjoyment of preserves.

To comprehensively evaluate both benefits and impacts, this project will span two years, and will produce two reports. Here, in the first report, we provide a synthesis of the peer-reviewed scientific literature on the associations between nature and health. The consensus is that nature, whether in a smaller urban park or in a larger open space, provides benefits to health behavior, physical health, mental health, and social health. Natural areas tend to impart benefits for a number of reasons: (1) natural areas are a refuge from air and noise pollution in cities, (2) their large size encourages more physical activity and promotes feelings of escape and solitude, (3) they tend to be biodiverse, which supports mental health, and (4) they provide views of special natural resources that promote

a sense of awe and general well-being. Accessibility and moderating factors (e.g., income level, race, gender) influence the magnitude of benefit an individual may receive. Studies have also highlighted significant links between experiences in nature and continued public support for conservation.

A small subset of the nature-health literature is specifically focused on recreation in large open spaces, referred to as wildland recreation. These studies have found that each type of recreational activity is associated with its own set health outcomes. Some activities, in particular hiking, are more commonly studied than others, perhaps due to relative popularity among recreationists. As new research continues to emerge, there may be more to learn about the potential health benefits of specific recreational activities.

In the second report, we will provide a summary of the literature on the negative ecological impacts of visitation and recreation in public open space. We will evaluate existing decision-support tools, such as the visitor use management framework used by federal agencies like the National Park Service, and other resources that evaluate the tradeoffs and benefits associated with public use. We will also consider what additional information may be needed to determine under which conditions the negative impacts outweigh the benefits. For example, a land manager may find public access acceptable as long as the benefits to people are greater than the negative ecological impacts (Figure 1). However, benefits may begin to erode as visitor experience declines with increased crowding (Grau and Freimund, 2016), and ecological impacts may be large relative to benefits when visitor density is high (Figure 1). Together the two reports will provide critical information for assessing tradeoffs between health benefits and negative ecological impacts of open space visitation.

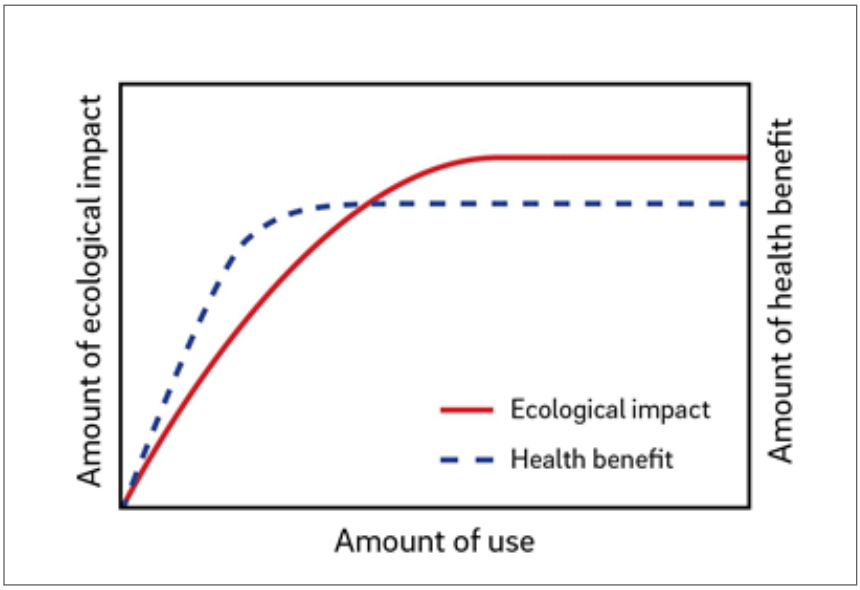
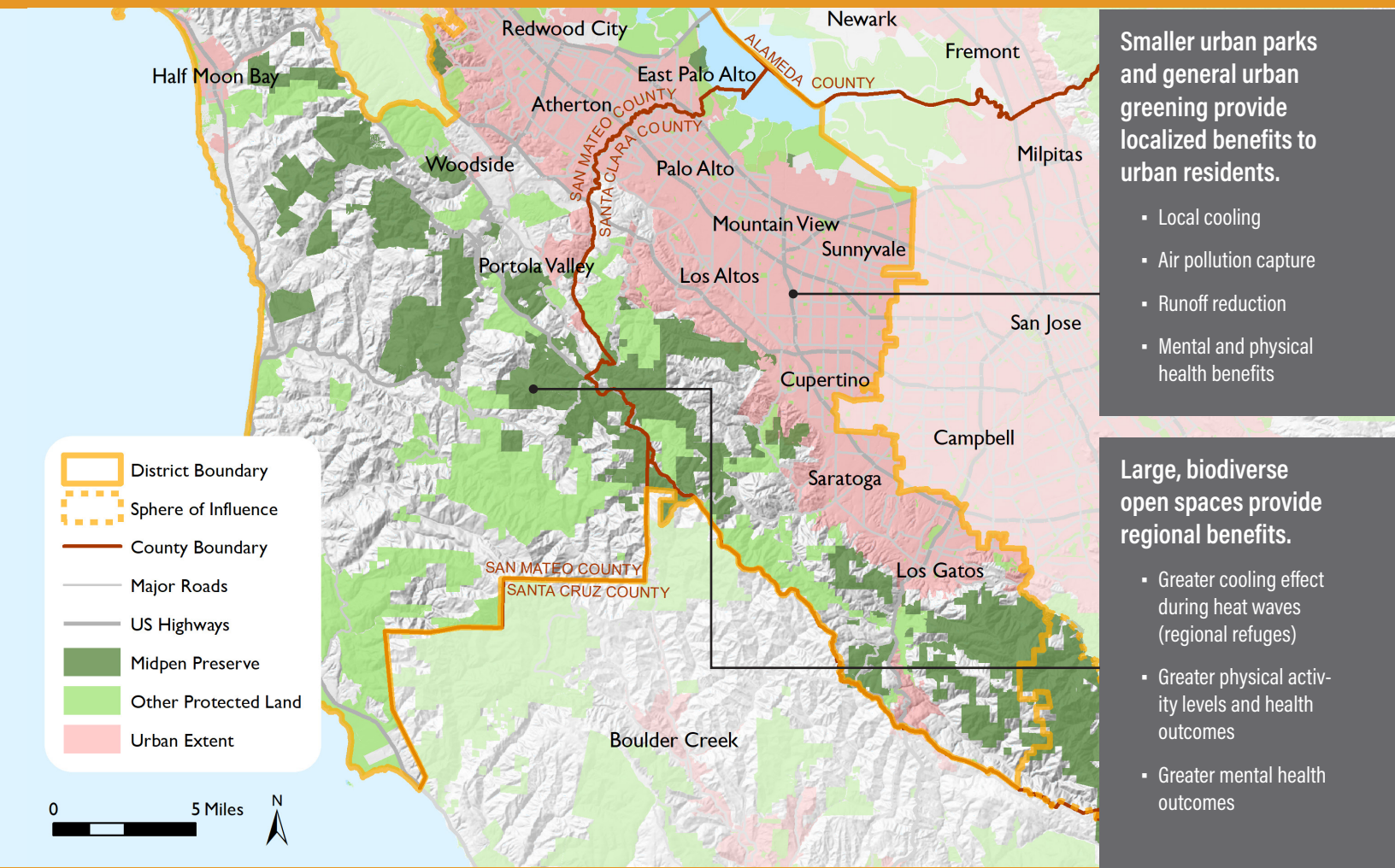


Figure 1. Conceptual framework for considering tradeoffs of impact and community benefits of public access to Midpen preserves. Ecological impact curve adapted from (Cole, 2004).

THE UNIQUE ROLE OF MIDPEN'S PRESERVES

Midpen's preserves offer a large urban population access to expansive, biodiverse, and relatively undeveloped areas for a variety of recreational activities. Due to these characteristics, the preserves play a role that is complementary to local, smaller urban parks (Figure 2). The preserves provide access to unique natural features and expansive views, regional relief from urban heat islands, and likely support higher levels of physical activity and mental restoration. Therefore, the preserves are serving a crucial function for local people by providing these substantial regional benefits. Additionally, providing public access likely contributes to cultivating public support for conservation efforts. In the second phase of this project, we will explore the potential negative impacts of recreation activities to biodiversity, ecology, and visitor experience. Together the two reports will provide critical scientific information for weighing tradeoffs between negative ecological impacts and health benefits.

Accessibility of Midpen's preserves has an impact on what proportion of the population can use the preserves. The health benefits a person can gain from nature depends on their ability to get there in the first place. A lack of public transportation options is a known limitation to access. Accessibility also includes informational resources at the preserve to help guide visitors (e.g., brochures in languages spoken by the community, directional signage, natural and historical resources information). While recent surveys conducted by Midpen gathered important information about visitor experiences, future surveys can help Midpen to better understand who in the service area is not visiting the preserves, and therefore who is not receiving the health benefits of nature experiences. There is a growing body of scientific literature on equity in nature access, which is an area of research Midpen may wish to pursue to better understand which communities are underserved and how better to engage as part of Midpen's diversity, equity, and inclusion efforts.



Smaller urban parks and general urban greening provide localized benefits to urban residents.

- Local cooling
- Air pollution capture
- Runoff reduction
- Mental and physical health benefits

Large, biodiverse open spaces provide regional benefits.

- Greater cooling effect during heat waves (regional refuges)
- Greater physical activity levels and health outcomes
- Greater mental health outcomes

Human health outcomes from nature experience

Over the past two decades, there has been a growing interest in the fields of public health, epidemiology, medicine, and psychology in the various ways experiences with nature improve human health and well-being. This science has grown rapidly, and there are now thousands of scientific papers on the topic (Bratman et al., 2019; Hartig et al., 2014; Kondo et al., 2018; Kuo, 2015). To some extent, nature appears to deliver health benefits no matter in what form people experience it, though we will discuss the nuances to this. While the majority of nature-health research focused on benefits gained by urban residents, studies focused on rural areas show that the results are similar for rural populations (Dennis and James, 2017; Mitchell and Popham, 2007), and therefore many of the findings from urban landscapes can reliably be assumed to be transferable to non-urban contexts. There is also a small subset of studies on expansive natural areas similar in form and context to Midpen's preserves. Given the great volume of literature, we conducted a review of some of the available studies and review articles across the broader nature-health field, then focused on the subset of studies and review articles specific to recreation in large natural areas as the most similar comparison available to Midpen's preserves.

As evidence of nature's benefits to human health has accumulated, researchers have pursued an understanding of how and why benefits are conferred. In a comprehensive review, Shanahan et al. (2016) identified four broad categories of human health outcomes from nature according to the current literature: mental health, physical health, health behavior, and social health (described in detail below). These four categories are not mutually exclusive. They can overlap and influence each other through feedback processes, i.e., enhancement in one category can elicit positive change in another category.

MENTAL HEALTH BENEFITS OF NATURE EXPERIENCE

A growing body of empirical evidence reveals the value of nature experience for mental health (Bratman et al., 2019). The scientific evidence has reached a consensus that: (1) nature experience is associated with psychological well-being; (2) nature experience is associated with reduced risk and lower burdens of some types of mental illness; and (3) opportunities for some types of nature experience are decreasing in quality and quantity for many people around the globe (Bratman et al., 2019). The "extinction of experience" due to urbanization, whereby urban residents grow removed from personal contact with nature, is a growing concern as the consequences include loss of health and well-being benefits of nature and a decline in pro-environmental attitudes and behavior (Cox et al., 2017a; Soga and Gaston, 2016). One of the most well studied pathways from nature experience to human health outcomes is attention restoration, or the recovery from stress and attention fatigue (Mayer et al., 2008). Mental health benefits of nature experience are numerous, for example:

- Walking in nature is restorative and improves mood and cognitive function (Gidlow et al., 2016)
- Walking in nature reduces symptoms related to depression (Bratman et al., 2015)
- More nearby nature leads to reductions in depression, anxiety and stress (Cox et al., 2017b)

HEALTH BEHAVIOR AND PHYSICAL HEALTH BENEFITS OF NATURE EXPERIENCE

Studies indicate that natural areas encourage health behavior, i.e., natural areas provide a venue and a motivation to engage in physical activity (Shanahan et al., 2016b). In part as a result of engaging in health

behavior, people improve their physical health, and may also see benefits in the mental and social health categories. The natural environment also appears to enhance the benefits of physical activity, compared to the benefits if the same activity were conducted in an urban environment (Shanahan et al., 2016b). The following are examples of positive health behavior and physical health outcomes:

- Children with more nearby greenspace spend more time being physically active (de Vries et al., 2007).
- Parks and natural resource areas are associated with more time spent being physically active (Cohen et al., 2006).
- Park users have better cardiovascular health (Grazuleviciene et al., 2015; Paquet et al., 2013)
- Higher neighborhood greenness is associated with higher survival rates after a stroke (Wilker et al., 2014)

SOCIAL HEALTH BENEFITS OF NATURE EXPERIENCE

Studies show that greenspaces facilitate social interactions, thereby fostering community attachment (i.e., the emotional connection between residents and to their place of residence) and neighborhood satisfaction (Larson et al., 2016; Lee and Maheswaran, 2011). Studies specific to recreational experiences in nature have found a range of social health benefits, including an increased sense of community, group cohesion, teamwork, empathy, and cooperation (Holland et al., 2018). The following are examples of positive social health outcomes:

- Greenspaces can strengthen sense of community among residents (Maas et al., 2009)
- Park quantity contributes to physical and social health, as well as overall well-being (Larson et al., 2016)
- Perceived greenspace quality and quantity can foster community attachment (Arnberger and Eder, 2012)

MODERATING FACTORS

While there is consensus in the literature that nature benefits mental, physical, and social well-being, the impact is not equal for all individuals. A suite of potential moderating factors influence the ways in which people interact with nature and whether people benefit from nature (Hartig et al., 2014; Shanahan et al., 2015). These factors include socioeconomic status, gender, ethnicity, age, and physical ability.

Moderating factors also include the physical accessibility of the public open space. As an individual must be able to get there in order to experience and benefit from nature, distant locations, lack of public transportation, and lack of parking are prominent physical access barriers to use of parks (Gibson et al., 2019). Other barriers to access include the perceived safety of a park, which has variable impact on park use across genders and ethnicities (Carlson et al., 2010; Lapham et al., 2015); and how appealing or welcoming a park seems to the community (Gibson et al., 2019). During a visit, conventional trail design can be a physical access barrier, e.g. to persons with mobility differences, and new design strategies for “all persons trails” or “universally designed interpretive trails” can help to reduce this barrier (Gertz et al., 2016).

What benefits are specific to natural areas?

Natural spaces found in parks and preserves adjacent to urban areas can provide unique resources to urban residents. For many urban residents living on the peninsula and in Silicon Valley, Midpen lands provide the closest opportunity to visit a natural space that is biodiverse, large, and relatively undeveloped. While much of the research connecting nature to human health has been conducted in urban areas, a subset of research specific to wildland areas highlights the unique health benefits that larger, more natural open spaces can provide. In this section, we identify the health benefits specific to natural areas, including escape from unhealthy environments found in cities, access to biodiversity, expansive views, and other natural features, and opportunities for recreation which can provide their own set of health benefits.

NATURAL AREAS PRESENT A HEALTHIER ENVIRONMENT

Natural spaces present a healthier environment in which to recreate, exercise and generally spend time (Markevych et al., 2017; Shanahan et al., 2016b). The scientific literature describes multiple pathways, one of which is that natural spaces are a refuge from various stressors found in urban environments. Air temperatures tend to be higher within cities, a phenomenon known as the urban heat island (Voogt and Oke, 2003), and natural environments provide a respite from excessive heat, due to the higher albedo (the reflection of sunlight) of vegetation and the cooling effect of evapotranspiration. Air pollutant concentrations tend to be lower in and around greenspaces, in part due to the absence of most emissions sources within greenspace, i.e., vehicular traffic (Markevych et al., 2017). Open spaces are also quieter than more developed areas, due to buffering effects of vegetation (Markevych et al., 2017).

Simply being in nature, even without participating in activities such as hiking, horseback riding, or mountain biking, has a therapeutic effect. Compared to an experience in an urban setting, an experience

Horseback riding. (photo by Randy Weber, courtesy of Midpeninsula Regional Open Space District and CC BY 2.0)

in forest environments leads to significantly improved attention capacity, as well as lowered heart rate, lower blood pressure, and better mood (Sonntag-Öström et al., 2014). Some studies also show that passively experiencing natural elements near to an individual's home affects human health. More greenness around one's home is associated with higher birth weights (Dzhambov et al., 2014), lower risk of myocardial infarction (Yitshak-Sade et al., 2017), and reduced levels of depression and anxiety (Beyer et al., 2014). A classic study by Ulrich (1984) found that views of nature from hospital windows may influence post-surgery recovery times. Furthermore, environmental biodiversity has been associated with immune function via support of beneficial microorganisms living on skin and in the gut (Kuo, 2015). For instance, a study in Finland found species richness of uncommon native flowering plants to be associated with reduced allergy response, by means of supporting higher diversity of bacterial floral on a person's skin (Hanski et al., 2012). Nearby habitat diversity has been associated with good general health (Wheeler et al., 2015), and a lower risk of asthma in children (Donovan et al., 2018).

NATURAL AREAS ARE LARGE

While the nature-health literature has grown to a vast body of work, there is only a small subset of these papers focused specifically on the experience of wildland recreation and its health outcomes (as opposed to more general urban greening and city park recreation). Hammitt et al. (2015) described the key characteristics of wildlands as:

- dispersed over large areas, and often having low use density compared to designed recreation areas;
- those in which the environment for activities is of greater importance than in developed recreation situations;
- largely natural, where management strives to maintain a natural appearance; and
- limited in facility development extent and function.

Compared to studies on health and urban nature, the subset of studies on health and wildland experiences may be of elevated interest, given the size and expansiveness of Midpen's network of preserves. In a recent review of 113 wildland recreation studies, 33% of studies focused on physical health impacts and 84% focused on mental health impacts (Thomsen et al., 2018). A complementary review of 235 studies explored trends of psychological, social and educational outcomes associated with wildland recreation (Holland et al., 2018). The vast majority of wildland recreation and health studies were published in the last 20 years (Thomsen et al., 2018). Our understanding of the potential unique benefits of experiences in wildlands compared to urban nature will continue to deepen as more research continues to emerge.

The large size of natural areas likely plays a role in enhancing health outcomes. The lack of interruptions (e.g., road intersections) to walking in larger parks allows visitors to sustain both a higher level of physical activity and a longer duration of physical activity (Sellers et al., 2012), supporting better cardiometabolic health (Paquet et al., 2013). While these findings were derived from examination of size variation among urban parks, we expect this trend to translate and be true of wildland settings as well. Furthermore, wildlands can provide unique opportunities for solitude and nature immersion (Holland et al., 2018), possibly due to their large size. Wildland settings make it possible for visitors to perceive escape and solitude, which appears to have an important influence on a variety of health outcomes (Holland et al., 2018; Thomsen et al., 2018).

NATURAL AREAS TEND TO BE BIODIVERSE

Visiting more highly biodiverse parks can confer greater mental health benefits. Studies have found that greater species richness (among birds, bees, butterflies, and plants) is positively correlated with better attention restoration among visitors to parks (Wood et al., 2018; Fuller et al., 2007). Meanwhile Dallimer et al. (2012) found that, regardless of a park's actual species richness, people achieve better attention restoration in parks they perceive as biodiverse.

Parks with high native biodiversity may also encourage physical health by drawing more visitors, although ecological knowledge mediates this effect. Shanahan et al. (2015) found that people with stronger connections to nature are more likely to travel to visit parks with high canopy cover and large areas of remnant native vegetation. Meanwhile, parks with visible ecological deterioration, such as forests invaded by pine beetles in Colorado and Minnesota, may be less appealing as sites for recreation (Arnberger et al., 2018). However, where ecological deterioration occurs without visible damage, such as when a non-native ecosystem displaces a native one, visitor perceptions of the area can vary depending on their knowledge of local ecology (Barendse et al., 2016; Bravo-Vargas et al., 2019).

NATURAL AREAS OFFER VIEWS AND AND EXPERIENCES WITH UNIQUE NATURAL FEATURES

Natural areas provide visitors with views and experiences with unique natural features, such as bodies of water and geological formations. Unique natural features can foster a sense of place, which in turn provides diverse benefits to health and well-being, including recovery from stress and lower risk of mental illness (Hausmann et al., 2016).

In a systematic review, Gascon et al. (2017) found consistent evidence that exposure to blue space (including lakes, coastlines, rivers, and other bodies of water) is associated with improved mental health and increased physical activity. Some studies also suggested correlations between blue space exposure and cardiovascular health, general health, and obesity rates, but these results were not consistently demonstrated across publications (Gascon et al., 2017). While most studies within this review largely used remote sensing to correlate health outcomes with the amount of blue space near one's home (Gascon et al., 2017), several demonstrated health benefits from spending time recreating near blue spaces (e.g., Amoly et al., 2014; Elliott et al., 2015; MacKerron and Mourato, 2013).

California newt. (photo by Ron Wolf, courtesy of Midpeninsula Regional Open Space District and CC BY 2.0) District)

Recreation opportunities in natural areas are linked to their own set of benefits

Each type of recreational activity is associated with its own suite of health outcomes. Our understanding of these health outcomes is limited by the popularity of each recreation type as a focus of study, and the most commonly studied activity is hiking (Thomsen et al., 2018).

BENEFITS OF HIKING AND RECREATIONAL WALKING

In the wildland recreation and health literature, the most commonly studied activity is hiking, possibly due to its popularity (Thomsen et al., 2018). Many studies have also found significant mental health benefits of hiking or walking in nature. Hiking is associated with benefits such as improved self-esteem, reduced diabetes risk, connectedness to nature, and physical fitness (Barton et al., 2016; Freidt et al., 2010). Relative to walking in an urban environment, walking in nature is linked with reduced symptoms of depression (Bratman et al., 2015), lower heart rate and anxiety levels (Song et al., 2014), and better cardiac function among coronary artery disease patients (Grazuleviciene et al., 2015). These studies indicate that for the same activity, a natural venue enhances the health outcome.

Dog-walking is a popular activity on Midpen lands. Dog ownership has an important influence on whether a person gets regular exercise, and access to public open space is positively associated with dog walking (Westgarth et al., 2014). Dog walking can help people increase physical activity levels, and the proximity of parks influences an owner's dog walking behavior (Christian et al., 2016). Through interviews with dog owners who have long-term health conditions (e.g., multiple sclerosis, diabetes, asthma, stroke), one study in New Zealand found that dog walking can alleviate feelings of social isolation and enhance well-being by relieving stress and requiring adequate exercise (Smith et al., 2017).

BENEFITS OF OBSERVING WILDLIFE

Relatively few studies have quantified the health benefits of observing wildlife in natural settings, but the existing literature highlights the potential psychological benefits of human-wildlife encounters. Cobar et al. (2017) assessed the mental health impacts of bird-watching among high school students and found that, compared to those students who took walks without observing birds, students who engaged in bird-watching experienced significantly more reductions in tension, fatigue, and confusion. Curtin (2009) documented feelings of awe, wonder, and well-being among tourists on wildlife tours in Spain and California. Follow-up surveys revealed that such feelings are not necessarily limited to experiences with charismatic megafauna in exotic locations, but can also occur when visitors encounter local wildlife near their homes (Curtin, 2009). The value that people derive from encounters with wildlife depends on a variety of personal factors, particularly their perceptions of and past experiences with the species they encounter. People with greater familiarity with animal diversity may be poised to garner greater benefits from wildlife encounters (Bell et al., 2018). When people perceive animals as a threat to their health or safety, they are unlikely to derive mental health benefits from viewing them (Barua et al., 2013; Soulsbury and White, 2016).

BENEFITS OF MOUNTAIN BIKING

There is a lack of data on the health impacts of mountain biking; in the wildland recreation and health literature, only six papers studied mountain biking (Thomsen et al., 2018). However, Dillard (2017) contends that mountain biking is as healthful an activity as road cycling, for which there is vastly more evidence available. The health benefits of road cycling include cardiorespiratory fitness, lower risk of heart disease, lower risk of stroke, improved muscular fitness, and reduced depression (Oja et al., 2011).

Some studies explored the perceived benefits of mountain biking using survey methods. Mountain bikers engage in the activity for a variety of reasons, including the perception that mountain biking makes them feel more connected to nature (Roberts et al., 2018). The feeling of connection with nature is thought to be of great benefit to human well-being (Mayer and Frantz, 2004; Shanahan et al., 2016a). Other motivations for mountain bikers included the beliefs that the activity helps them to de-stress, improves their self-esteem and helps them deal with negative thoughts or feelings (Roberts et al., 2018). Another study found that some benefits varied by gender; women perceived mental health benefits of mountain biking (e.g., self-reliance, self-esteem, life satisfaction) more strongly than men (Hill and Gómez, 2020).

In recent years, electric pedal-assist bikes (e-bikes) have emerged, and may make it more feasible for some to engage in biking activities (Hall et al., 2019). Following suit, new research is emerging to understand the health benefit from e-bike use, but current studies are very few in number. In the case of electric pedal-assist mountain bikes (eMTB) specifically, the literature is extremely limited. One study found that eMTB use helps individuals meet physical activity guidelines and supports cardiovascular fitness nearly as much as conventional mountain bike use (Hall et al., 2019).

Mountain biking in the forest. (photo by TJ N, courtesy of Midpeninsula Regional Open Space District and CC BY 2.0)

BENEFITS OF ORGANIZED ACTIVITIES

Midpen hosts a wide variety of docent-led activities year-round, including guided hikes, educational programs, and equestrian activities. Midpen also partners with schools and various community groups such as Latino Outdoors to provide guided nature experiences for diverse youth, and conservation groups such as the Sierra Club hold outings for their members in Midpen preserves. As most wildland recreationists travel in social groups, the social aspect of wildland recreation is a key driver of positive health outcomes (Thomsen et al., 2018; Holland et al., 2018). Studies have found that organized activities in the outdoors is important for both children and adults. Among children, access to recreational programs can significantly promote physical activity and lower the risk of being overweight (Wolch et al., 2011). Beyond mental and physical health, the social aspects of wildland recreation also contribute to pro-social behaviors, sense of place, environmental stewardship, and even academic performance (Holland et al., 2018).

Some researchers are beginning to evaluate the potential role of new nature-based therapeutic programs in managing and supporting recovery from mental illness. In the U.K., a nature-based program consisting of weekly countryside and urban park walks resulted in significantly greater self-esteem and mood improvements than other existing programs (Barton et al., 2012). Also in the U.K., a novel 6-week treatment based on visits to a wetland reserve was found to be an effective therapy option for anxiety and/or depression (Maund et al., 2019). The visits included guided walks, watching wildlife and canoeing. Such novel treatment programs are nascent, yet there is growing evidence for the benefits of including nature-based treatment in the management of and recovery from mental illness.

BENEFITS OF OTHER ACTIVITIES

In the wildland recreation and health literature, there are very few studies related to other activities available on Midpen lands. On Midpen lands, one campsite is provided at Monte Bello Open Space Preserve, and in the limited number of studies relating to backpacking and camping, there is evidence of these activities' positive contributions to self-esteem (e.g., Autry, 2001; Kiernan et al., 2004). 21 of Midpen's preserves are open to horseback riding, providing approximately 215 miles of trail. There are very few studies available that examine horseback riding and health outcomes, and most of these studies focus on therapeutic horseback riding as opposed to recreational. A study conducted in Austria found that recreational horseback riding is associated with a greater sense of nature relatedness, greater overall well-being, and better mood (Schwarzmüller-Erber et al., 2020). As research continues to emerge, there may be more to learn about the potential health benefits of these activities.

Broader implications for public support for conservation

While experiences in nature can significantly support human health, they can also play a critical role in sustaining public support for biodiversity conservation. Feelings of connection with nature can lead to pro-environmental behavior (Mackay and Schmitt, 2019). A primary way that both children and adults develop feelings of connection to nature is having direct experiences with nature (Cleary et al., 2020). For children, having an adult role model whom the child perceives to be knowledgeable about the environment and active in trying to maintain environmental quality is another way to foster nature connection (Chawla, 2015; Sivek, 2002).

In adulthood, direct recreational experiences with nature can have a significant impact on public support for conservation. Some characteristics of wildland recreation that influence the outcome of environmental stewardship include examining the natural environment, wilderness as a source of adversity, social interactions, trip leader's interpretation amount and quality, and duration of experience (Holland et al., 2018). Overall, outdoor recreationists — especially those participating in wildlife watching and nature photography — have been found to have higher levels of environmental concern than non-recreationists (Teisl and O'Brien, 2003), and 4-5 times more likely to engage in conservation behaviors like participating in local environmental groups and enhancing wildlife habitat on public lands (Cooper et al., 2015).

Nature experiences also significantly impact willingness to financially support conservation. Bird-watchers are more likely than non-recreationists to donate to local conservation efforts (Cooper et al., 2015). A study in the U.S. found that each hiker or backpacker may contribute $200–$300 annually in the future to conservation NGOs (Zaradic et al., 2009). On a related note, San Mateo County Parks conducted a study to determine willingness to pay through taxes or fees for parks, trails and other amenities at the parks (San Mateo County Parks Department, 2016), an approach which Midpen could also adapt and implement to better understand the connection between nature experiences in Midpen's preserves and willingness to pay for continued conservation efforts. Efforts to educate the public can also be influential, as Buttke et al. (2014) suggested that having an increased understanding of biodiversity's value and benefits to human health and well-being may lead to greater support for conservation. Overall, these studies indicate that encouraging participation in hiking, backpacking, bird-watching, and nature photography should be considered in strategies to secure long-term support for conservation.

Great egrets. (photo by Axel Sudhausen, courtesy of Midpeninsula Regional Open Space District and CC BY 2.0)

Conclusion

A large body of literature on the connections between nature and health illuminates the great diversity of physical, mental, and social benefits derived from nature exposure, including improved cardiovascular health, lower risk of depression, recovery from stress, social cohesion, and much more. These studies have also explored and shed light on moderating factors, which influence the extent of benefit received by an individual, such as accessibility and other characteristics of open space.

In the literature specifically on wildland recreation, each type of recreational activity is associated with its own suite of benefits, and certain characteristics and qualities (e.g., duration of experience, level of challenge) are factors that influence the benefit of the activity. The activities offered in Midpen's preserves are linked with numerous benefits to physical, mental, and social health. Activities within preserves are not without their tradeoffs, which will be explored in the next phase of this project.

In addition to studies specific to wildland recreation and health, land managers can draw from the broader and vastly more plentiful nature-health literature. These studies enable land managers, planners and policymakers to make informed, science-driven decisions about what types of activities to allow and experiences to curate on public lands, not only for health and well-being, but also for fostering and sustaining public support for conservation. Some comparative studies provide evidence to suggest stronger results from certain activities, such as hiking, backpacking, bird watching, and experiences with high quality trip leaders. As research specific to wildland recreation and health continues, findings may emerge that are directly relevant to management and planning future uses on Midpen lands. An adaptive and science-based management approach is recommended as more research becomes available.

PRELIMINARY RECOMMENDATIONS:

- There is a limited amount of available research on certain types of recreational activities. Midpen staff can monitor research as it emerges to deepen their understanding of the health outcomes of horseback riding e-mountain bike use in particular.
- Offer organized group activities that foster a sense of community and support physical and mental health.
- Spending time in nature is linked with public support for conservation. Emphasize bird-watching and nature photography, as these activities in particular are linked with elevated pro-environmental behaviors like participation in environmental stewardship and donating to local conservation efforts.
- Midpen is a major regional resource offering substantial health benefits, but the accessibility of some of its preserves may leave some people out. Midpen may pursue a better understanding of the scientific literature on equity in nature access and develop best practices for engaging certain underserved communities as part of Midpen's diversity, equity, and inclusion efforts.

References

Amoly, E., Dadvand, P., Forns, J., López-Vicente, M., Basagaña, X., Julvez, J., Alvarez-Pedrerol, M., Nieuwenhuijsen, M.J., Sunyer, J., 2014. Green and blue spaces and behavioral development in Barcelona schoolchildren: the BREATHE project. Environ. Health Perspect. 122, 1351–1358.

Arnberger, A., Ebenberger, M., Schneider, I.E., Cottrell, S., Schlueter, A.C., von Ruschkowski, E., Venette, R.C., Snyder, S.A., Gobster, P.H., 2018. Visitor Preferences for Visual Changes in Bark Beetle-Impacted Forest Recreation Settings in the United States and Germany. Environ. Manage. 61, 209–223. https://doi.org/10.1007/s00267-017-0975-4

Arnberger, A., Eder, R., 2012. The influence of green space on community attachment of urban and suburban residents. Urban For. Urban Green. 11, 41–49. https://doi.org/10.1016/j.ufug.2011.11.003

Autry, C.E., 2001. Adventure therapy with girls at-risk: Responses to outdoor experiential activities. Ther. Recreation J. 35, 289.

Barendse, J., Roux, D., Erfmann, W., Baard, J., Kraaij, T., Nieuwoudt, C., 2016. Viewshed and sense of place as conservation features: A case study and research agenda for South Africa's national parks. Koedoe - Afr. Prot. Area Conserv. Sci. 58. https://doi.org/10.4102/koedoe.v58i1.1357

Barton, J., Bragg, R., Pretty, J., Roberts, J., Wood, C., 2016. The Wilderness Expedition: An Effective Life Course Intervention to Improve Young People's Well-Being and Connectedness to Nature. J. Exp. Educ. 39, 59–72. https://doi.org/10.1177/1053825915626933

Barton, J., Griffin, M., Pretty, J., 2012. Exercise-, nature- and socially interactive-based initiatives improve mood and self-esteem in the clinical population. Perspect. Public Health 132, 89–96. https://doi.org/10.1177/1757913910393862

Barua, M., Bhagwat, S.A., Jadhav, S., 2013. The hidden dimensions of human–wildlife conflict: Health impacts, opportunity and transaction costs. Biol. Conserv. 157, 309–316. https://doi.org/10.1016/j.biocon.2012.07.014

Bell, S.L., Westley, M., Lovell, R., Wheeler, B.W., 2018. Everyday green space and experienced well-being: the significance of wildlife encounters. Landsc. Res. 43, 8–19. https://doi.org/10.1080/01426397.2016.1267721

Beyer, K.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. Int. J. Environ. Res. Public. Health 11, 3453–3472.

Bratman, G.N., Anderson, C.B., Berman, M.G., Cochran, B., de Vries, S., Flanders, J., Folke, C., Frumkin, H., Gross, J.J., Hartig, T., Kahn, P.H., Kuo, M., Lawler, J.J., Levin, P.S., Lindahl, T., Meyer-Lindenberg, A., Mitchell, R., Ouyang, Z., Roe, J., Scarlett, L., Smith, J.R., van den Bosch, M., Wheeler, B.W., White, M.P., Zheng, H., Daily, G.C., 2019. Nature and mental health: An ecosystem service perspective. Sci. Adv. 5, eaax0903. https://doi.org/10.1126/sciadv.aax0903

Bratman, G.N., Hamilton, J.P., Hahn, K.S., Daily, G.C., Gross, J.J., 2015. Nature experience reduces rumination and subgenual prefrontal cortex activation. Proc. Natl. Acad. Sci. 112, 8567–8572. https://doi.org/10.1073/pnas.1510459112

Bravo-Vargas, V., García, R.A., Pizarro, J.C., Pauchard, A., 2019. Do people care about pine invasions? Visitor perceptions and willingness to pay for pine control in a protected area. J. Environ. Manage. 229, 57–66. https://doi.org/10.1016/j.jenvman.2018.07.018

Buttke, D., Allen, D., Higgins, C., 2014. Benefits of Biodiversity to Human Health and Well-being. Park Sci. 31.

Carlson, S.A., Brooks, J.D., Brown, D.R., Buchner, D.M., 2010. Racial/Ethnic Differences in Perceived Access, Environmental Barriers to Use, and Use of Community Parks. Prev. Chronic. Dis. 7.

Chawla, L., 2015. Benefits of Nature Contact for Children. J. Plan. Lit. 30, 433–452. https://doi.org/10.1177/0885412215595441

Christian, H., Bauman, A., Epping, J.N., Levine, G.N., McCormack, G., Rhodes, R.E., Richards, E., Rock, M., Westgarth, C., 2016. Encouraging Dog Walking for Health Promotion and Disease Prevention. Am. J. Lifestyle Med. 12, 233–243. https://doi.org/10.1177/1559827616643686

Cleary, A., Fielding, K.S., Murray, Z., Roiko, A., 2020. Predictors of Nature Connection Among Urban Residents: Assessing the Role of Childhood and Adult Nature Experiences. Environ. Behav. 52, 579–610. https://doi.org/10.1177/0013916518811431

Cobar, A.G.C., Borromeo, M.C.B., Agcaoili, J.K.M., Rodil, A.M.T., 2017. Acute effect of birdwatching on mood states of senior high school students in the physical education setting. Ovidius Univ. Ann. Ser. Phys. Educ. SportScience Mov. Health 17.

Cohen, D.A., Ashwood, J.S., Scott, M.M., Overton, A., Evenson, K.R., Staten, L.K., Porter, D., McKenzie, T.L., Catellier, D., 2006. Public Parks and Physical Activity Among Adolescent Girls. Pediatrics 118, e1381–e1389. https://doi.org/10.1542/peds.2006-1226

Cole, D.N., 2004. Impacts of hiking and camping on soils and vegetation: a review. Environ. Impacts Ecotourism 41, 60.

Cooper, C., Larson, L., Dayer, A., Stedman, R., Decker, D., 2015. Are wildlife recreationists conservationists? Linking hunting, birdwatching, and pro-environmental behavior. J. Wildl. Manag. 79, 446–457.

Cox, Daniel T.C., Hudson, H.L., Shanahan, D.F., Fuller, R.A., Gaston, K.J., 2017a. The rarity of direct experiences of nature in an urban population. Landsc. Urban Plan. 160, 79–84. https://doi.org/10.1016/j.landurbplan.2016.12.006

Cox, Daniel T. C., Shanahan, D.F., Hudson, H.L., Plummer, K.E., Siriwardena, G.M., Fuller, R.A., Anderson, K., Hancock, S., Gaston, K.J., 2017b. Doses of Neighborhood Nature: The Benefits for Mental Health of Living with Nature. BioScience biw173. https://doi.org/10.1093/biosci/biw173

Curtin, S., 2009. Wildlife tourism: the intangible, psychological benefits of human–wildlife encounters. Curr. Issues Tour. 12, 451–474. https://doi.org/10.1080/13683500903042857

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, 47–55. https://doi.org/10.1525/bio.2012.62.1.9

de Vries, S.I., Bakker, I., van Mechelen, W., Hopman-Rock, M., 2007. Determinants of Activity-Friendly Neighborhoods for Children: Results from the Space Study. Am. J. Health Promot. 21, 312–316. https://doi.org/10.4278/0890-1171-21.4s.312

Dennis, M., James, P., 2017. Evaluating the relative influence on population health of domestic gardens and green space along a rural-urban gradient. Landsc. Urban Plan. 157, 343–351.

Dillard, S.C., 2017. Mountain Biking as a Means to Encourage Public Health and Wellbeing. Wright State University, Dayton, Ohio.

Donovan, G.H., Gatziolis, D., Longley, I., Douwes, J., 2018. Vegetation diversity protects against childhood asthma: results from a large New Zealand birth cohort. Nat. Plants 4, 358–364.

Dzhambov, A.M., Dimitrova, D.D., Dimitrakova, E.D., 2014. Association between residential greenness and birth weight: Systematic review and meta-analysis. Urban For. Urban Green. 13, 621–629.

Elliott, L.R., White, M.P., Taylor, A.H., Herbert, S., 2015. Energy expenditure on recreational visits to different natural environments. Soc. Sci. Med. 139, 53–60. https://doi.org/10.1016/j.socscimed.2015.06.038

Freidt, B., Hill, E., Gomez, E., Goldenberg, M., 2010. A benefits-based study of Appalachian Trail users: Validation and application of the benefits of hiking scale. Phys. Health Educ. Nexus 2.

Fuller, R.A., Irvine, K.N., Devine-Wright, P., Warren, P.H., Gaston, K.J., 2007. Psychological benefits of greenspace increase with biodiversity. Biol. Lett. 3, 390–394. https://doi.org/10.1098/rsbl.2007.0149

Gascon, M., Zijlema, W., Vert, C., White, M.P., Nieuwenhuijsen, M.J., 2017. Outdoor blue spaces, human health and well-being: A systematic review of quantitative studies. Int. J. Hyg. Environ. Health 220, 1207–1221. https://doi.org/10.1016/j.ijheh.2017.08.004

Gertz, L., Weinreb, S., Scopinich, K., Clayton, G., Berrier, J., Charlson, K., Marchello, M., Ranno, G., 2016. A Manual of Guidelines and Best Practices For Developing and Operating Universally Designed Interpreted Trail Experiences.

Gibson, S., Loukaitou-Sideris, A., Mukhija, V., 2019. Ensuring park equity: a California case study. J. Urban Des. 24, 385–405.

Gidlow, C.J., Jones, M.V., Hurst, G., Masterson, D., Clark-Carter, D., Tarvainen, M.P., Smith, G., Nieuwenhuijsen, M., 2016. Where to put your best foot forward: Psycho-physiological responses to walking in natural and urban environments. J. Environ. Psychol. 45, 22–29. https://doi.org/10.1016/j.jenvp.2015.11.003

Grazuleviciene, R., Vencloviene, J., Kubilius, R., Grizas, V., Dedele, A., Grazulevicius, T., Ceponiene, I., Tamuleviciute-Prasciene, E., Nieuwenhuijsen, M.J., Jones, M., Gidlow, C., 2015. The Effect of Park and Urban Environments on Coronary Artery Disease Patients: A Randomized Trial. BioMed Res. Int. 2015, 1–9. https://doi.org/10.1155/2015/403012

Hall, C., Hoj, T.H., Julian, C., Wright, G., Chaney, R.A., Crookston, B., West, J., 2019. Pedal-Assist Mountain Bikes: A Pilot Study Comparison of the Exercise Response, Perceptions, and Beliefs of Experienced Mountain Bikers. JMIR Form. Res. 3, e13643. https://doi.org/10.2196/13643

Hammitt, W.E., Cole, D.N., Monz, C.A., 2015. Wildland recreation: ecology and management. John Wiley & Sons.

Hanski, I., von Hertzen, L., Fyhrquist, N., Koskinen, K., Torppa, K., Laatikainen, T., Karisola, P., Auvinen, P., Paulin, L., Mäkelä, M.J., 2012. Environmental biodiversity, human microbiota, and allergy are interrelated. Proc. Natl. Acad. Sci. 109, 8334–8339.

Hartig, T., Mitchell, R., de Vries, S., Frumkin, H., 2014. Nature and Health. Annu. Rev. Public Health 35, 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443

Hausmann, A., Slotow, R., Burns, J.K., Di Minin, E., 2016. The ecosystem service of sense of place: benefits for human well-being and biodiversity conservation. Environ. Conserv. 43, 117–127. https://doi.org/10.1017/S0376892915000314

Hill, E., Gómez, E., 2020. Perceived Health Outcomes of Mountain Bikers: A National Demographic Inquiry. J. Park Recreat. Adm. https://doi.org/10.18666/JPRA-2019-9492

Holland, W.H., Powell, R.B., Thomsen, J.M., Monz, C.A., 2018. A Systematic Review of the Psychological, Social, and Educational Outcomes Associated With Participation in Wildland Recreational Activities. J. Outdoor Recreat. Educ. Leadersh. 10, 197–225. https://doi.org/10.18666/JOREL-2018-V10-I3-8382

Kiernan, G., Gormley, M., MacLachlan, M., 2004. Outcomes associated with participation in a therapeutic recreation camping programme for children from 15 European countries: Data from the 'Barretstown Studies.' Soc. Sci. Med. 59, 903–913.

Kondo, M., Fluehr, J., McKeon, T., Branas, C., 2018. Urban Green Space and Its Impact on Human Health. Int. J. Environ. Res. Public. Health 15, 445. https://doi.org/10.3390/ijerph15030445

Kuo, M., 2015. How might contact with nature promote human health? Promising mechanisms and a possible central pathway. Front. Psychol. 6. https://doi.org/10.3389/fpsyg.2015.01093

Lapham, S., Cohen, D., Han, B., Williamson, S., Evenson, K., Mckenzie, T., Hillier, A., Ward, P., 2015. How important is perception of safety to park use? A four-city survey. Urban Stud. 53. https://doi.org/10.1177/0042098015592822

Larson, L.R., Jennings, V., Cloutier, S.A., 2016. Public Parks and Wellbeing in Urban Areas of the United States. PLOS ONE 11, e0153211. https://doi.org/10.1371/journal.pone.0153211

Lee, A.C.K., Maheswaran, R., 2011. The health benefits of urban green spaces: a review of the evidence. J. Public Health 33, 212–222. https://doi.org/10.1093/pubmed/fdq068

Maas, J., Van Dillen, S.M., Verheij, R.A., Groenewegen, P.P., 2009. Social contacts as a possible mechanism behind the relation between green space and health. Health Place 15, 586–595.

Mackay, C.M.L., Schmitt, M.T., 2019. Do people who feel connected to nature do more to protect it? A meta-analysis. J. Environ. Psychol. 65, 101323. https://doi.org/10.1016/j.jenvp.2019.101323

MacKerron, G., Mourato, S., 2013. Happiness is greater in natural environments. Glob. Environ. Change 23, 992–1000. https://doi.org/10.1016/j.gloenvcha.2013.03.010

Markevych, I., Schoierer, J., Hartig, T., Chudnovsky, A., Hystad, P., Dzhambov, A.M., de Vries, S., Triguero-Mas, M., Brauer, M., Nieuwenhuijsen, M.J., Lupp, G., Richardson, E.A., Astell-Burt, T., Dimitrova, D., Feng, X., Sadeh, M., Standl, M., Heinrich, J., Fuertes, E., 2017. Exploring pathways linking greenspace to health: Theoretical and methodological guidance. Environ. Res. 158, 301–317. https://doi.org/10.1016/j.envres.2017.06.028

Maund, P.R., Irvine, K.N., Reeves, J., Strong, E., Cromie, R., Dallimer, M., Davies, Z.G., 2019. Wetlands for wellbeing: piloting a nature-based health intervention for the management of anxiety and depression. Int. J. Environ. Res. Public. Health 16, 4413.

Mayer, F.S., Frantz, C.M., 2004. The connectedness to nature scale: A measure of individuals' feeling in community with nature. J. Environ. Psychol. 24, 503–515.

Mayer, F.S., Frantz, C.M., Bruehlman-Senecal, E., Dolliver, K., 2008. Why Is Nature Beneficial?: The Role of Connectedness to Nature. Environ. Behav. https://doi.org/10.1177/0013916508319745

McDonald, R.I., Beatley, T., Elmqvist, T., 2018. The green soul of the concrete jungle: the urban century, the urban psychological penalty, and the role of nature. Sustain. Earth 1, 3. https://doi.org/10.1186/s42055-018-0002-5

Mitchell, R., Popham, F., 2007. Greenspace, urbanity and health: relationships in England. J. Epidemiol. Amp Community Health 61, 681–683. https://doi.org/10.1136/jech.2006.053553

Oja, P., Titze, S., Bauman, A., De Geus, B., Krenn, P., Reger-Nash, B., Kohlberger, T., 2011. Health benefits of cycling: a systematic review. Scand. J. Med. Sci. Sports 21, 496–509.

Paquet, C., Orschulok, T.P., Coffee, N.T., Howard, N.J., Hugo, G., Taylor, A.W., Adams, R.J., Daniel, M., 2013. Are accessibility and characteristics of public open spaces associated with a better cardiometabolic health? Landsc. Urban Plan. 118, 70–78. https://doi.org/10.1016/j.landurbplan.2012.11.011

Roberts, L., Jones, G., Brooks, R., 2018. Why Do You Ride?: A Characterization of Mountain Bikers, Their Engagement Methods, and Perceived Links to Mental Health and Well-Being. Front. Psychol. 9. https://doi.org/10.3389/fpsyg.2018.01642

San Mateo County Parks Department, 2016. Visitor Use/Non-Use Parks Study. San Mateo County Parks.

Schwarzmüller-Erber, G., Stummer, H., Maier, M., Kundi, M., 2020. Nature Relatedness of Recreational Horseback Riders and Its Association with Mood and Wellbeing. Int. J. Environ. Res. Public. Health 17, 4136.

Sellers, C.E., Grant, P.M., Ryan, C.G., O'Kane, C., Raw, K., Conn, D., 2012. Take a walk in the park? A cross-over pilot trial comparing brisk walking in two different environments: Park and urban. Prev. Med. 55, 438–443. https://doi.org/10.1016/j.ypmed.2012.09.005

Shanahan, D.F., Bush, R., Gaston, K.J., Lin, B.B., Dean, J., Barber, E., Fuller, R.A., 2016a. Health Benefits from Nature Experiences Depend on Dose. Sci. Rep. 6, 28551. https://doi.org/10.1038/srep28551

Shanahan, D.F., Franco, L., Lin, B.B., Gaston, K.J., Fuller, R.A., 2016b. The Benefits of Natural Environments for Physical Activity. Sports Med. 46, 989–995. https://doi.org/10.1007/s40279-016-0502-4

Shanahan, D.F., Lin, B.B., Bush, R., Gaston, K.J., Dean, J.H., Barber, E., Fuller, R.A., 2015. Toward Improved Public Health Outcomes From Urban Nature. Am. J. Public Health 105, 470–477. https://doi.org/10.2105/AJPH.2014.302324

Sivek, D.J., 2002. Environmental sensitivity among Wisconsin high school students. Environ. Educ. Res. 8, 155–170.

Smith, C.M., Treharne, G.J., Tumilty, S., 2017. "All Those Ingredients of the Walk": The Therapeutic Spaces of Dog-walking for People with Long-term Health Conditions. Anthrozoös 30, 327–340. https://doi.org/10.1080/08927936.2017.1311063

Soga, M., Gaston, K.J., 2016. Extinction of experience: the loss of human-nature interactions. Front. Ecol. Environ. 14, 94–101. https://doi.org/10.1002/fee.1225

Song, C., Ikei, H., Igarashi, M., Miwa, M., Takagaki, M., Miyazaki, Y., 2014. Physiological and psychological responses of young males during spring-time walks in urban parks. J. Physiol. Anthropol. 33, 8. https://doi.org/10.1186/1880-6805-33-8

Sonntag-Öström, E., Nordin, M., Lundell, Y., Dolling, A., Wiklund, U., Karlsson, M., Carlberg, B., Slunga Järvholm, L., 2014. Restorative effects of visits to urban and forest environments in patients with exhaustion disorder. Urban For. Urban Green. 13, 344–354. https://doi.org/10.1016/j.ufug.2013.12.007

Soulsbury, C.D., White, P.C.L., 2016. Human–wildlife interactions in urban areas: a review of conflicts, benefits and opportunities. Wildl. Res. 42, 541–553. https://doi.org/10.1071/WR14229

Teisl, M.F., O'Brien, K., 2003. Who cares and who acts? Outdoor recreationists exhibit different levels of environmental concern and behavior. Environ. Behav. 35, 506–522.

Thomsen, J.M., Powell, R.B., Monz, C., 2018. A Systematic Review of the Physical and Mental Health Benefits of Wildland Recreation. J. Park Recreat. Adm. 36, 123–148. https://doi.org/10.18666/JPRA-2018-V36-I1-8095

Ulrich, R.S., 1984. View through a window may influence recovery from surgery. Science 224, 420–421. https://doi.org/10.1126/science.6143402

Voogt, J.A., Oke, T.R., 2003. Thermal remote sensing of urban climates. Remote Sens. Environ. 86, 370–384.

Westgarth, C., Christley, R.M., Christian, H.E., 2014. How might we increase physical activity through dog walking?: A comprehensive review of dog walking correlates. Int. J. Behav. Nutr. Phys. Act. 11, 83. https://doi.org/10.1186/1479-5868-11-83

Wheeler, B.W., Lovell, R., Higgins, S.L., White, M.P., Alcock, I., Osborne, N.J., Husk, K., Sabel, C.E., Depledge, M.H., 2015. Beyond greenspace: an ecological study of population general health and indicators of natural environment type and quality. Int. J. Health Geogr. 14, 17.

Wilker, E.H., Wu, C.-D., McNeely, E., Mostofsky, E., Spengler, J., Wellenius, G.A., Mittleman, M.A., 2014. Green space and mortality following ischemic stroke. Environ. Res. 133, 42–48. https://doi.org/10.1016/j.envres.2014.05.005

Wolch, J., Jerrett, M., Reynolds, K., McConnell, R., Chang, R., Dahmann, N., Brady, K., Gilliland, F., Su, J.G., Berhane, K., 2011. Childhood obesity and proximity to urban parks and recreational resources: A longitudinal cohort study. Health Place 17, 207–214. https://doi.org/10.1016/j.healthplace.2010.10.001

Wood, E., Harsant, A., Dallimer, M., Cronin de Chavez, A., McEachan, R.R.C., Hassall, C., 2018. Not All Green Space Is Created Equal: Biodiversity Predicts Psychological Restorative Benefits From Urban Green Space. Front. Psychol. 9, 2320. https://doi.org/10.3389/fpsyg.2018.02320

Yitshak-Sade, M., Kloog, I., Novack, V., 2017. Do air pollution and neighborhood greenness exposures improve the predicted cardiovascular risk? Environ. Int. 107, 147–153.

Zaradic, P.A., Pergams, O.R., Kareiva, P., 2009. The impact of nature experience on willingness to support conservation. PLoS One 4.