The Nature Conservancy

Outside *our* Doors

the benefits of cities where people and nature thrive

{ A Puget Sound Conservation Publication }

{ *Preface* }

We are pleased and honored to introduce this milestone report from The Nature Conservancy. The authors have worked carefully to present a comprehensive analysis of current evidence on how our human communities need nature in and around them to thrive. This report presents a panoramic view of how our cities and towns benefit from nature—on the streets, next to schools and hospitals, outside our windows; everywhere people are, we can benefit from nature.

In 1865, landscape architect Frederick Law Olmsted was convinced that beautiful green spaces should exist in cities for all to enjoy. He wrote, "It is a scientific fact that the occasional contemplation of natural scenes of an impressive character... is favorable to the health and vigor of men and especially to the health and vigor of their intellect."

While Olmsted's claim of "science" was based on intuition, he was on to something. Today, nearly 40 years of research reveal that nearby nature supports a wide range of positive health outcomes for people.

As natives of the Puget Sound region, we each have witnessed a place that has changed dramatically in recent decades—in culture, economy, and nature. Today it is a place of contrasts. It is a combination of bold, dramatic landscapes contrasted by rapidly growing cities that are testing sustainability innovations in ways that have captured the attention of other nations. It is a region that leads the country for economic growth, but is still challenged to raise the economic standard for many underserved communities. It is a place that promotes the latest technology practices for commerce, medicine, and learning, and also sustains ancient cultures of numerous tribes that have called the Salish Sea home for millennia.

This report addresses these conditions and challenges. Many people recognize the restorative and therapeutic effects of nature, but many assume these benefits are found beyond the city—that one must travel out of the urban mix for positive experiences and benefits. In fact, there is a wealth of evidence that nature is critical within and around the city itself.

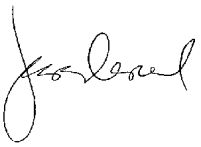
The evidence supporting how natural infrastructure helps people thrive is published across many journals representing numerous academic and scientific disciplines. It can be difficult to identify and access. By bringing together the information into a single document, our hope is this report will make it easier for communities to conserve and create high quality green spaces that support human health and well-being.

The Puget Sound is wonderfully different than the place either of us experienced as children. It is more complex, more diverse, and facing greater challenges. Like the generations that have come before us, we must apply the big thinking, imagination, and passionate energy the world has come to expect from the peoples of the Puget Sound.

We hope this report inspires efforts to integrate nature into our cities in ways that strengthen ecological services and make our neighborhoods greener, safer, more livable, more equitable, and more resilient.

As our region continues to grow, there is no better time to come together across sectors, embrace this approach as a norm, and step up our commitment to ensuring the Puget Sound region thrives long into the future.

Onward,



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Human communities need nature in and around them to thrive.

{ *Urban Nature* }

GREEN INFRASTRUCTURE, also referred to as **natural infrastructure** or **nature based solutions,** describes the structural building blocks of our communities. Ranging in scale from regional landscapes to a single site, designed or conserved nature is integrated with built systems to mimic ecological and natural functions. Roadside raingardens, engineered wetlands for flood storage, or green roofs are a few examples. Nature based solutions are often intended to achieve specific functions like cleaning water, addressing climate change, or reducing traffic noise—but they also offer the opportunity for a wide range of co-benefits, such as human health and wellness.

IMAGE BY NBBJ

NEARBY NATURE refers to any expression of nature located within proximity to the daily activities of city dwellers, including the places where people live, work, play, and learn. The experience of nature in everyday settings is profoundly important for human health and wellness, as we now know from nearly 40 years of research. Certain experiential elements within accessible green spaces, such as complexity, fascination, coherence, and mystery, contribute to more beneficial encounters. Everyday nature settings in communities can include a large park drawing people from across the region, an urban forest next to a school playground, a community garden, or a patch of trees in one's front yard.

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IMAGE BY KEVIN ANOLD

Investments made in bringing nature back into our cities will benefit both the people living here, and the future resilience of the region.

The world is undergoing a tremendous surge of urban population growth, with more than half of all people now living in towns and cities.[1] While nature may seem far from the urban environment, research increasingly shows that it plays a critical role in the lives of city dwellers. It can help us tackle urban environmental challenges such as **stormwater management, pollution reduction**, and **climate resiliency**. Nature also supports the **health and well-being of the people** that live in cities, offering benefits like stress reduction and opportunities for social connection.

The Puget Sound region encompasses the coastal area of Puget Sound and the surrounding lowlands. It is one of the most rapidly urbanizing areas in the nation, anticipating the arrival of approximately 1.7 million more people by 2040.[2] As the region continues to grow, investments in natural infrastructure will benefit the people living here as well as the future resilience of the region. Nature that is integrated within urban areas can **stimulate local economic growth** by making commercial spaces more appealing, and enhance the competitive edge of cities by providing amenities that attract a highly skilled, creative, and productive workforce.

In the Puget Sound region, we are fortunate to have pristine habitat, iconic species such as Orca and salmon, and working landscapes such as farms and forests near the urban edge. Rivers and streams knit together the peaks of the Cascades and Olympics with the more developed lowlands along the shoreline. Within cities and towns are forests, wetlands, and other native ecosystems; parks and gardens provide opportunities for respite, play, and food production.

Engineered solutions, such as streetscapes, raingardens and bioswales, green walls and roofs, and urban farms can be designed and implemented to serve specific, intentional functions and services. Contemporary tribal lands blend cultural resources, ancient ecosystems, and the innovations of urbanization. Together, all of these elements comprise natural

PROMOTES WELL-BEING
People are happier, experience significantly higher well-being, and show significantly lower mental distress when they live in areas with greater amounts of green space.

BOOSTS ECONOMY
Shoppers claim they are willing to spend 9-12% more for goods and services in central business districts having high-quality tree canopies.

MITIGATES POLLUTION
Green walls and roofs are an eye-catching way to combat pollution, improve air quality, and provide a thermal buffer from extreme temperatures.

REDUCES FLOODING BY MANAGING STORMWATER AND DECREASES POLLUTION
Using engineered solutions like bioswales and raingardens solves problems while contributing to more green space.

HELPS CHILDREN LEARN
Children with ADHD concentrate better following a 20-minute walk in an urban park than they do after equivalent walks in other urban settings.

INSPIRES PHYSICAL ACTIVITY
Residents living in areas with more green space are more than three times as likely to be physically active.

IMPROVES NEIGHBORHOOD SAFETY
Residents with higher amounts of nearby nature report fewer violent and minor crimes, and fewer incivilities.

IMAGE BY NBBJ

Nearby nature doesn't need to be expansive to have a positive impact on people in urban areas.

infrastructure in the Puget Sound region and can be managed to optimize ecosystem services and provide opportunities to help the people in our communities thrive.

Even small parks, street-side landscaping, and front yard raingardens provide benefits. Nature can serve certain designed urban functions like managing storm-water, buffering traffic, and beautifying entryways, while simultaneously providing many other benefits to people as described in this report.

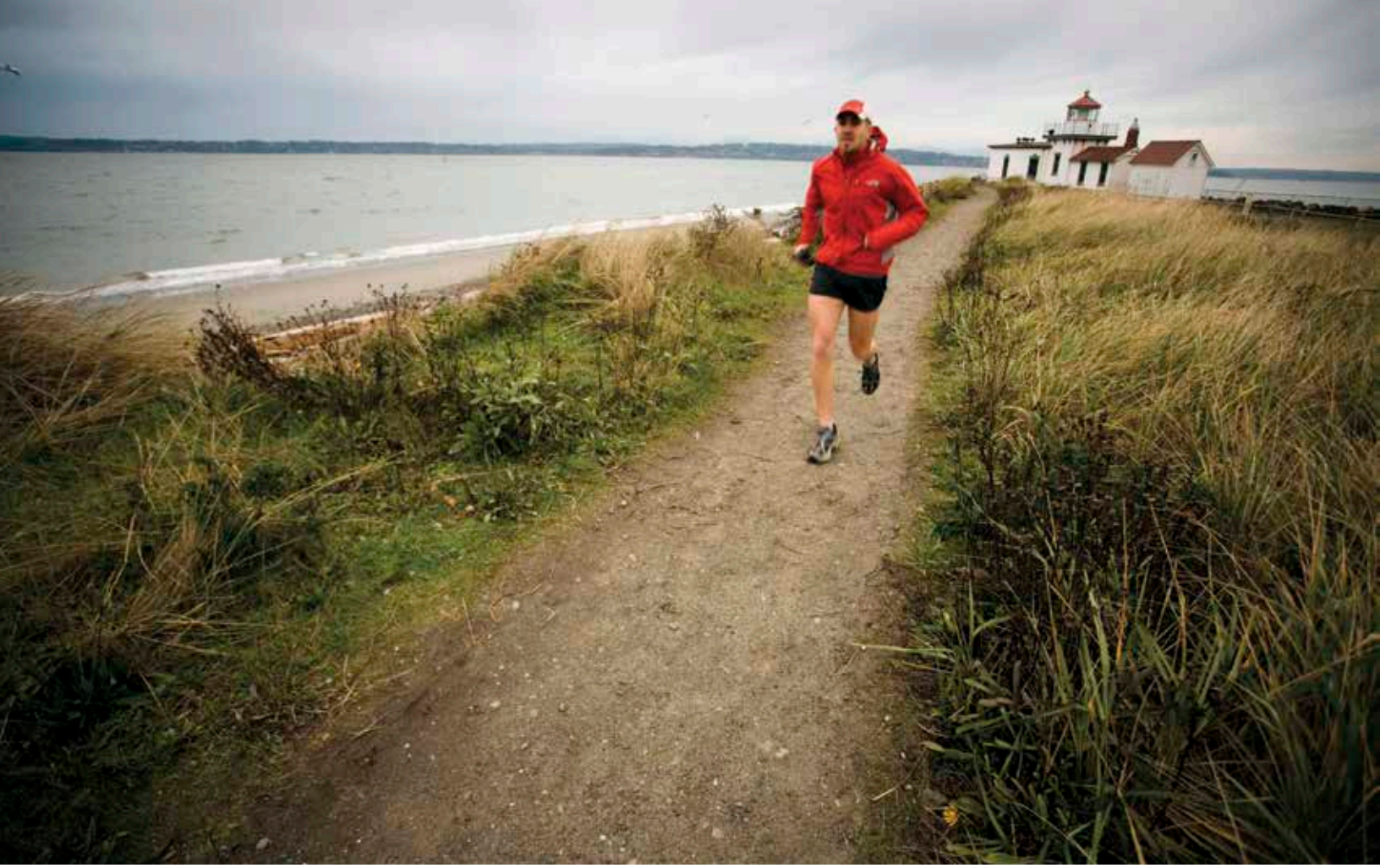
The peer-reviewed research summarized in this report includes studies from the fields of epidemiology, environmental psychology, healthcare studies, urban planning, and other social sciences.

PUGET SOUND CONTEXT

Puget Sound is not only the stunning backdrop for our work and play, it's also integral to our economy—outdoor recreation in the 14 counties that span the Puget Sound watershed basin contributed over $10.5 billion and supported over 123,000 jobs in 2014 alone.[4] Yet even as the Sound's beauty attracts new businesses and residents to the area, unprecedented growth puts the health of this historical resource at risk, and the impact of development has already taken a toll. Being good stewards of Puget Sound is essential to protect the diverse species that make up this unique ecosystem, and vital to the health and viability of local industries, such as fishing and recreation, which are directly impacted by land use decisions across the region.

Puget Sound is the cultural and natural keystone of our region; it's the focal point of where we work, relax, raise families, and spend our free time. A survey conducted by the Puget Sound Partnership (2015) found that 84% of Puget Sound residents say they frequently feel inspiration, awe, or reduced stress as a result of being in the Puget Sound natural environment.[5]

The Nature Conservancy's mission is to conserve the lands and waters on which all life depends. Central to this mission is the recognition that humans are an integral part of the ecosystem and much of our economic success and personal enjoyment depends on local ecosystems. In cities we have the capacity to nurture the relationship between people and nature in ways that benefit both urban communities and the surrounding environment. Over the next 25 years, the Puget Sound population is expected to increase by as many as two million citizens.[3] At this critical moment in the region's growth, we have the opportunity to meet the challenge to find nature-based solutions that welcome new residents to Puget Sound while preserving and enhancing the natural characteristics that make this region a great place to live.



{ *Human Health and Well-Being* }

A growing body of scientific evidence suggests contact with nature provides a multitude of health benefits and may be an important factor in **disease prevention** and **health promotion** for people who live in urban areas. Harvard biologist E.O. Wilson explains the link between personal well-being and nature as a factor of "biophilia," the genetically ingrained connection between humans and the natural world that allows us to thrive when we have contact with nature.[6]

It turns out that interactions with nature have some very tangible health benefits. Nearby nature provides a positive emotional experience that has been shown to **speed up recovery time** for hospitalized patients, **motivate healthy behaviors** such as exercise, and **provide therapeutic benefits** to people living with mental disorders.[7,8,9] Searching for a connection that bridges these findings, researchers found nearby nature may fundamentally **enhance immune function**; emotions of awe and wonder (triggered by nature, art, and religion) can have anti-inflammatory effects, reducing levels of the immune-triggering cytokines linked to chronic diseases such as diabetes, cardiovascular disease, and depression.[10,11] Nature-based health solutions are cost-effective and virtually risk-free interventions that simultaneously provide a range of co-benefits—which is why some physicians are beginning to prescribe time in nature for conditions including obesity, depression, anxiety, and diabetes.[12]

Nature in cities helps people be physically active, which reduces the risk of many chronic diseases.

INSPIRING ACTIVE LIFESTYLES

Regular physical activity is an important component of overall health and reduces the risk of many chronic diseases, yet many adults do not meet the baseline physical activity levels necessary for disease prevention. Fifty percent (50%) of U.S. adults do not engage in the minimum recommendations for aerobic activity—equivalent to 30 minutes of brisk walking five days a week—and 26% do not engage in any physical activity during their leisure time.[13] There is strong evidence that natural infrastructure in cities is an essential public health resource, as nature both motivates and provides opportunities for people to be physically active.[14]

The percentage of green space within a two mile radius of a person's home has been associated with the percentage of residents reporting good health, particularly among homemakers, the elderly, and those with lower socioeconomic status—groups that are typically less likely to get sufficient physical activity.[14,15] **One study found that residents living in areas with more green space were more than three times as likely to be physically active**, and approximately 40% less likely to be overweight or obese, as those living in areas with low levels of green space.[8]

The quality of physical activity is higher when in nature rather than in indoors and built environments, and comes with an enhanced range of benefits. An analysis of national survey data from Finland found a strong connection between physical activity in nature and long-term emotional well-being, while no significant connection was found when the same physical activity was performed indoors.[16] Evidence shows that the link between activity in urban green space and emotional wellness, including stress reduction, is an important mediating factor in the relationship between physical activity and overall health—in other words, **the emotional benefits of activity in nature are central to the better overall health of people** with access to nature in their daily life.[17]

People are likely to visit nature more frequently and with greater duration when they live close to green amenities.[18] A study of the relationship between access to public natural infrastructure—including parks, recreational grounds, sports fields, commons, esplanades, and buffer strips—and physical activity in metropolitan Perth, Australia found that people with easy access to large, attractive public open space are twice as likely to achieve levels of walking that exceed baseline recommendations for physical activity than those with reduced access to these places.[19]

Smaller natural urban elements also play an important role in physical activity and providing restorative experiences for city dwellers. *"[T]o make the environment more pleasant and/or restorative, even a single tree may help." (Sonja van Dillen et al., 2012, p. 2)*[20] **Green streetscapes encourage active modes of transport**, such as walking or cycling, by making routes more attractive and inviting. Researchers from the University of Washington examining the influence of vegetation on walkable destinations in Seattle not only found a positive association between the perception of greenness and the frequency of walking trips, but also that people tend to overestimate the distance of walking trips in areas with less vegetation.[21] Another study of neighborhoods in four large Dutch cities found the quality of streetscape greenery is positively associated with the overall health of residents.[20] **The relationship between green streetscapes and positive health outcomes is notable, as urban residents are exposed to streetscapes more often than green open space, such as parks.**

Even brief contact with nature provides opportunities for restorative experiences.

NURTURING MENTAL AND COGNITIVE HEALTH

With urban living comes increased exposure to noise, pollution, and crowds, which can negatively affect the mood, mental resilience, and cognitive capacity of even healthy individuals. Opportunities to experience urban nature, including window views or being outside in contact with nature, are key to the mental well-being of urban dwellers.[22] Even brief contact with nearby nature provides opportunities for restorative experiences, functioning as a buffer against the stressors of urban living, fortifying mental resiliency, and supporting productive cognitive functioning in everyday life.

A recent longitudinal study by researchers at the University of Exeter's European Center for Environment and Human Health found a strong link between nearby nature and measures of mental health among people living in cities. **People are happier, experience significantly greater well-being, and show significantly lower mental distress when they live in areas with greater amounts of green space**. The effect of green space on life satisfaction is strikingly high relative to other life circumstances, equaling nearly one-third (28%) the effect of being married, and one-fifth (21%) the effect of being employed rather than unemployed.[23]

Walking in nature can decrease neural activity in the part of the brain associated with sadness, withdrawal, and depression.

Reducing Stress in the City

The World Health Organization classifies stress and lack of physical activity as two of the foremost contributors to premature death in developed nations.[24,25] The American Psychological Association reports that unhealthy stress management behaviors are widespread among Americans, and a national survey found stress levels are increasing, with 44% of adults experiencing increased stress over the past five years.[26] Work and financial challenges, family and relationship complexities, and various other everyday challenges characterize modern life and can lead to chronic stress, anxiety, burnout, depression, and decreased overall productivity for many people.[27,28]

The sounds, movements, and visual stimuli of cities can overwhelm our senses, strain our coping mechanisms, and profoundly affect the ways we respond to stressors.[29] Many studies show that **natural infrastructure can relieve stress and improve general wellness** among city residents.[30] Research conducted in nine Swedish cities found that regardless of an individual's sex, age, or socioeconomic status, the more an individual frequents urban nature, the less stress they experience.[28]

Even passive experiences, like viewing nature from an office window or walking by trees, parks, and gardens, can help people recover from daily and chronic stressors.[31,32] A study by Dr. Roger Ulrich found that patients recovered faster, had shorter postoperative hospital stays, and required lower strength pain medication following gallbladder surgery when their postoperative room had a scenic window view of nature instead of a brick wall. **The link between views of nature and faster recovery time is likely facilitated by reduced stress levels, which promotes healing**.[7]

Better Learning, Improved Mental Performance

The concrete jungle can be detrimental to cognitive functioning.[33] The overstimulation of urban environments can impair the ability to acquire and process knowledge, affecting memory, problem solving, and attention. Research shows **encounters with nature lead to enhanced positive affect, decreased stress levels, boosted attention capacity, and improved performance on cognitive memory assessments**.[22]

Researchers at Stanford University recently studied affective and cognitive function before and after a 50-minute walk in either a natural environment or an urban environment without nature. They found participants from the nature walk showed greater decreases in anxiety, rumination, and negative affect, while walks in nature-free environments led to decreased positive affect. Participants also performed better in cognitive tests measuring verbal working memory following a walk in a natural setting, whereas nature-free walks resulted in diminished positive affect.[22]

Nature provides a positive stimulus that helps decrease the patterns of prolonged negative thought and preoccupation with negative experiences that characterize depression and other mental illnesses, and it has been found that walking in a natural setting can decrease the neural activity in the part of the brain associated with sadness, withdrawal, and depression.[34] A study from researchers at the University of Michigan and Stanford University found these benefits extend to individuals diagnosed with major depressive disorder (MDD). Participants with MDD were instructed to think about a painful negative experience prior to a 50-minute walk in a park or in a nature-free urban downtown setting. Not only were there greater improvements in working-memory capacity and positive affect after the walk in nature, but the effect size for people with MDD was nearly five times as large as the effect size for healthy individuals.[9]

IMAGE BY DEVAN KING

Children do not necessarily need "wild nature" to reap the benefits of contact with the natural world.

CONNECTING CHILDREN WITH THE NATURAL WORLD

Growing evidence shows **nearby nature provides tremendous benefits to children in cities, and is an essential element of child development**. Children today are less connected to nature than any other generation in history, with an increasingly digital and urban world pulling children away from opportunities for unstructured outdoor play and interaction with the natural world. While today's 'indoor children' are globally connected through technology, they lack vital connections to their immediate outdoor surroundings.[35] Some results of this 'nature-deficit' include rising rates of childhood obesity, attention disorders, and depression.[36]

While research into the role of nature in child development is grounded in the historical connection between humans and their natural environment—which has shaped our physiological, cognitive, and psychological make-up—children do not necessarily need "wild nature" to reap the benefits of contact with the natural world: *"The natural environments in which children are immersed need not be areas referred to as 'wild spaces' or even the wilderness found in state or national parks. Nature, in this context, can refer to the small (if not tiny) pockets of plant and animal life that can be found in urbanized areas, the green spaces in suburban developments, or the landscapes of rural areas...essentially, nature is everywhere though we often fail to attend to its presence in our daily lives." (Nicole L. Migliarese, 2008, p. 3.)*[37]

Providing a Place for Play

The prevalence of obesity among children has more than tripled since 1970, with obesity now affecting one in six children and adolescents in the United States.[38] The factors that cause obesity—including physical inactivity—put these children at a greater risk for bone and joint problems, sleep apnea, social stigmatization and poor self-esteem, and Type 2 diabetes, a condition once only found in adults.[39] According to the Centers for Disease Control and Prevention, the **lack of safe and appealing places for play or activity is a significant contributing factor to childhood obesity** in many communities.[39]

A study of 250 pre-school-aged children in the Cincinnati metropolitan area found that time spent playing outdoors was significantly, positively correlated to direct measures of physical activity.[40] The relationship between outdoor play and physical activity is also significant among older children; a cross-sectional study from the Deakin University Center for Physical Activity and Nutrition Research in Australia found each additional hour spent outdoors was associated with an additional 20 to 27 minutes of moderate and vigorous physical activity per week among children between the ages of 10 and 12 years old. A three-year follow-up study showed the prevalence of obesity was 27-41% lower for those spending more time outdoors.[41]

Promoting Positive Youth Development

Nearby nature provides a variety of educational benefits, having positive effects on attentional capacity, impulse control, and overall cognitive development. A study led by The Nature Conservancy, along with researchers from Stanford University and the University of California, Santa Cruz, analyzed the effect of school green space in relation to other key factors like race and poverty using fifth grade standardized test scores from nearly 500 California schools, and found the positive effect of nearby nature was even larger than the negative effect of poverty.[42]

The benefits of nature for learning are partially due to its positive therapeutic effects on attentional capacity. A study examining the impacts of different environments on attention in children with Attention Deficit Hyperactivity Disorder (ADHD) found that children between the ages of 7 and 12 years old diagnosed with ADHD concentrated better following a 20-minute walk in an urban park than after equivalent walks in other urban settings, including downtown and residential areas.[43]

Natural environments have also been found to have a beneficial effect on impulse control and overall cognitive development among children. In a study of 169 inner-city children, researchers found a significant positive relationship between views of urban nature from home and three measures of self-discipline among girls—including concentration, inhibition of initial impulses, and delaying gratification.[44] A separate study involving over 2,500 primary school children between the ages of 7 and 10 years old found nature surrounding school boundaries, commuting routes, and students' homes is associated with enhanced progress in working memory and improved attentiveness.[45]

City- and neighborhood-scale greening initiatives are often the ideal platform to ensure children are getting the exposure to nature they need. Researchers at The Nature Conservancy, Stanford University, and University of California, Santa Cruz found increased tree and shrub cover between 750-1000 meters from schools has a positive effect on student performance, indicating nature-based solutions at a neighborhood scale may be the optimal intervention for cost-effective educational benefits.[42]

Instilling Environmental Stewardship

"What is the extinction of a condor to a child that has never seen a wren?" (Robert Michael Pyle)[46] There is a growing body of literature indicating **interactions with nature during childhood greatly motivate concern for the environment** and efforts to protect it in adulthood. A survey of adults in the U.S. found childhood interaction with nature was linked to adult behaviors such as recycling and voting for pro-environment candidates.[47,48] In the midst of pressing pragmatic and ethical reasons for environmental protection, survey data consistently points to personal childhood experiences as the reason why environmental leaders and activists have chosen to dedicate themselves to the protection of nature.[47]

Nature in our daily lives enhances the strength of social ties among neighbors by encouraging use of common spaces.

"A cohesive society is one where people are protected against life risks, trust their neighbors and the institutions of the state and can work towards a better future for themselves and their families. Fostering social cohesion is about striving for greater inclusiveness, more civic participation and creating opportunities for upward mobility. It is the glue that holds society together." (United Nations Department of Economic & Social Affairs, 2012)[49]

The characteristics of neighborhood common spaces play a substantial role in the development of social ties among neighbors, enabling and motivating individuals to connect with their fellow community members in an increasingly global world.[50,51] Studies have found that vegetation levels in common spaces can predict the usage of common space, and are related to a sense of neighborhood safety and adjustment. One observational study looked at 59 outdoor common spaces in residential neighborhoods, 32 of which were relatively barren, while 27 had more greenery; results showed higher levels of social activity in common spaces with more greenery. The presence of nearby nature appears to enhance the strength of social ties among neighbors by encouraging use of common spaces, contributing to the creation of healthy neighborhoods.[52,53]

Similar results were found in an observational study of two Chicago public housing developments. **Residents were more likely to use the immediate space outside an apartment building when the building common area had nature**, such as trees, compared to barren space. These green areas attracted both a greater number of people and a more diverse mix of youth and adults, suggesting that natural infrastructure facilitates opportunities for the development of social ties and shared supervision of children in inner-city neighborhoods.[54]

Youth in cohesive communities are less likely to participate in behaviors such as smoking, drinking, gang involvement, or drug use, as close-knit communities are better equipped to provide guidance and model behaviors.[55] These communities also provide better environments for the elderly; when elderly individuals have strong social ties, they experience lower rates of mortality, reduced suicide rates, reduced fear of crime, and better physical health.[56,57,58,59,60,61,62,63,64,65]

IMAGE BY ERIC HIGBEE

IMPROVING NEIGHBORHOOD SAFETY

Nature in residential areas is generally associated with a greater sense of social safety—except in places where residents may view the reduced visibility caused by the presence of vegetation to be a safety concern.[66,67] Recent studies demonstrate how green space in urban areas may actually decrease the amount of violent and property crimes in residential neighborhoods. One study comparing 98 apartment buildings in an inner-city neighborhood indicated that **residents with higher amounts of nearby nature reported fewer violent and minor crimes, and fewer incivilities**.[68] A similar survey of an urban California community found 90% of property crimes occurred in areas without vegetation, with only 10% occurring in green spaces.[69] In Chicago, a study found residents reported fewer incidents of vandalism, incivility, and illegal activity in places containing urban nature.[70] In Tallahassee, the frequency of property crimes diminished significantly near houses with higher levels of vegetation.[71]

Vacant lots have been the focus of several recent studies, as unused parcels in cities can become places of undesirable uses and activity. In a study in Philadelphia, vacant lots were cleaned of trash and illegal dumping, planted with grass and trees, and had a small wooden fence built around the perimeter. The greening activity was associated with reductions in certain gun crimes and improvements in residents' perceptions of safety.[72] A related study in Philadelphia found study participants who walked by a 'greened' vacant lot showed decreased heart rate, a sign of reduced stress, compared to a control group.[73]

Crime behavior can be influenced by social situations. Strong community relationships increase the likelihood that individuals will work together to achieve common goals, exchange information, and maintain informal social controls.[74] This leads to cleaner and safer public spaces, discourages crime, and can have a positive impact on public health. Communities where residents express high mutual trust and reciprocity have been linked with lower homicide and crime rates.[75,76,77] Conversely, neighborhoods lacking social cohesion experience higher rates of social disorder, anxiety, and depression.[55,78,79,80]

Green space in urban areas may actually decrease the amount of violent and property crimes.

Nature can offer a vital buffer against pollution and other environmental stressors.

INCREASING ENVIRONMENTAL EQUITY

Nature is unevenly distributed across urban communities, with pervasive disparities in access based on income, race, ethnicity, age, gender, and disability.[81] With increased understanding of the importance of exposure to nearby nature for human well-being, more equitable access has become a focus of public health research and a greater priority within city planning.[82] Nature can offer a vital buffer against pollution and other environmental stressors, especially in **the urban communities experiencing the highest levels of exposure to unhealthy conditions, which frequently also have the lowest levels of access to nearby nature**.[82] In other words, the communities that could most benefit from nearby nature are often those without adequate trees, parks, and gardens.

However, investments in green infrastructure can create a dilemma in "park-poor" neighborhoods. While implementing nearby nature is an important facet of addressing environmental inequity, it can trigger gentrification when the addition of natural amenities makes neighborhoods more attractive—and subsequent rising property values may lead to displacement for poorer residents.[81] To ensure the installation of natural infrastructure helps the communities it is intended to, **it is important to involve community members in decision-making and investment strategies**, to focus new developments towards the needs and desires of the community, and to ensure sufficient and sustainable funding for maintenance and programming.[81,82]

IMAGE BY MIG / SvR

{ *Thriving Economies* }

While natural infrastructure contributes to our health and well-being, community cohesiveness, and the livability of cities, these essential—but intangible—benefits do not always translate in land-use and capital investment decision-making, as they are not directly quantifiable in monetary terms and are difficult to capture in market values. However, the need to articulate the benefits of natural infrastructure in economic terms is important to ensure sufficient representation in public decision-making.[83] Non-market valuation methods, such as hedonic pricing, are increasingly used to estimate the economic value of nearby nature in terms of its direct influence on market prices.

BOOSTING THE RESIDENTIAL HOUSING MARKET

Hedonic pricing analysis is often used to estimate the value of green infrastructure in relation to residential property values. Using actual market prices, hedonic studies apply statistical regression to demonstrate how various natural elements are valued in residential property markets. Time and again, studies show **green space and tree canopies considerably boost the market value of homes**, **thus providing important contributions to the overall property tax base in cities.**

An analysis of the relationship between tree presence and residential property values found a **seven percent (7%) average price increase among properties with trees over comparable properties without trees**.[83]

Green space & tree canopies considerably boost the market value of homes, thus providing important contributions to the overall property tax base in cities.

The presence of trees can also have a positive effect on the value of neighboring properties; a study led by U.S.D.A. Forest Service researchers analyzed the effects of tree-lined streets on the sale price of houses in Portland, Oregon and found that, on average, **the presence of trees adds nearly $9,000 to a house's selling price**—equivalent to adding 129 finished square feet to a house. Additionally, tree-lined streets were found to positively influence the selling price of houses within a 100 foot range. Applied to all houses in Portland, the effect of tree-lined streets amounts to a total value of $1.35 billion—**which translates into a potential increase of $54 million per year in property tax revenue for the city.**[84]

There is consistent evidence in the real estate market that home buyers are willing to pay a higher price for a home located close to parks and open space. The higher value of properties near green amenities leads to higher property taxes paid by their owners—representing a capitalization of park land and open space. This process is known as the "proximate principle," and is significant for investments in natural infrastructure because, in some cases, **the aggregate amount of increased property taxes associated with a particular park or green space may be sufficient to cover the costs of acquiring and developing the natural amenity.**[85]

Over 30 studies analyzing the effect of parks and open space on residential property values support the proximate principle, with property values up to 20% higher for homes adjacent to parks and open spaces than equivalent homes without proximate natural amenities.[85] For example, researchers at Texas A&M University found greenways have significant positive impacts on the sales price of adjacent properties, with particular greenways associated with between 12.2% and 20.2% average increases in home values. To put these findings into a city-wide economic context, the study found **the increased property values associated with a single greenbelt in Austin amounted to approximately $13.64 million in additional property tax revenue** in just two of the several proximate neighborhoods.[86]

The positive effects of green space on residential economics are particularly evident in dense urban areas. An analysis of home transaction data from the Minneapolis–St. Paul metropolitan area shows the value of proximity to open space is substantially higher in dense neighborhoods that are near a central business district, with the value of proximate neighborhood parks nearly three times higher in neighborhoods that are twice the average density.[87]

There is strong economic evidence to support investments in the conversion of vacant or abandoned urban land to natural infrastructure. Researchers in Philadelphia found homes near vacant property experience approximate gains in value of 18% to 21% following the conversion of a vacant lot into maintained green space, with a median gain of $34,468 in housing wealth over five years among affected households.[88] This means that **for every dollar spent to convert and maintain a vacant lot, there is an estimated $7.43 gain in additional property tax revenues.**[88]

Shoppers claim they are willing to spend 9-12% more for goods and services in central business districts that have high-quality tree canopy.

ENHANCING COMMERCIAL ACTIVITY

The act of shopping today has become both a leisure activity and an entertainment experience.[89] With the proliferation of online merchants, people can choose to shop by clicking a link rather than visiting brick-and-mortar stores. Those who go out of their way to visit business districts containing natural infrastructure do so because they seek a pleasant shopping experience, not simply to purchase the goods they need. Research shows that pedestrian-oriented retail areas experience a 20% to 40% increase in foot traffic and a 22% increase in retail rents.[90]

A series of studies about trees in business districts around the U.S. found consistent responses from central business district visitors.[83,91,92] Shoppers claim they are willing to spend 9-12% more for goods and services in central business districts that have high-quality tree canopy. Subconsciously, shoppers' behaviors are influenced by whether they find a storefront pleasing; the perception of value, quality of products, and service tends to be more positive in forested places. **Shoppers also indicated they are willing to travel for longer amounts of time and over greater distances to shop in retail environments that contain trees, and spend more time there once they arrive.** More time spent shopping means increased revenue for business owners. Additionally, the trade area radius expands when people are willing to travel further for a better experience, leading to thousands more potential customers.

Quality of life, including outdoor recreation amenities, is ranked as one of the main factors when deciding to take a job or relocate a company.

ATTRACTING ECONOMIC PLAYERS

"Wherever talent goes, innovation, creativity, and economic growth are sure to follow." (Richard L. Florida, 2005, p. 4)[93]

With the global growth of knowledge-based industries, a city's competitive advantage rests on its ability to attract a talented workforce.[94] Highly educated workers choose cities based on economic, cultural, and lifestyle considerations, and integrated green space is part the urban environment they seek.[95] **A survey of 1,200 technology workers found quality of life in a community can increase the attractiveness of a job by 33%**.[96] Retaining local university students to enhance a city's talent pool continues to be an important attraction strategy. A survey of university students and recent graduates in Michigan found quality of life factors, including **scenic beauty, gathering places, and trails and parks, were ranked among the most important attributes of preferred places to live.**[94,97]

While workers have historically chosen places to live based on existing employment opportunities, this relationship has shifted in today's economy, with companies siting their operations according to a location's ability to attract talent.[94] A poll of 50 senior executives of Fortune 500 companies found **quality of life, including outdoor recreation amenities, is ranked as one of the main factors considered when choosing company location**—second only to the availability of talent.[98] Quality of life factors are also important attributes that draw small businesses to an area. A survey of decision makers from 174 businesses that had relocated, expanded, or launched in Colorado over a five-year period found quality of life was the chief reason for locating their businesses there—with parks, recreation, and open space amenities ranked as the most important quality of life element.[99]

Nearby nature can also contribute to the increased productivity and job satisfaction of employees. Employees with window views of nature have been found to experience higher job satisfaction and feel better about their job performance.[100] The performance of employees depends in part on their physical and mental well-being, which, as discussed in previous sections, can be directly associated with the presence of accessible natural infrastructure. One study found desk workers with a window view of nature reported 19% fewer ailments in the preceding six months than indoor workers with no view of nature.[101] In short, **nearby nature makes for healthy employees, and healthy employees make for better business.**

IMAGE BY DEVAN KING

{ *Looking Forward: Natural Infrastructure for Resilient Cities* }

The Puget Sound region, like much of the developed world, faces complex challenges and tight budgets as it grows. Cities are challenged by the expanded infrastructure needed to accommodate a growing population, and many face significant costs related to the replacement of aging infrastructure.[102] According to the World Business Council for Sustainable Development, infrastructure spending is equivalent to 3.8% of global GDP, or $2.6 trillion in 2013, and infrastructure spending needs will increase to $3.4 trillion per year by 2030.[103] These investments may certainly be a heavy burden for communities, but can also provide wonderful opportunities if done well.

Investments in natural infrastructure are a cost-effective, sustainable, and socially beneficial solution—and generate a broader range of benefits in comparison to traditional grey infrastructure.[104] An example of this value comes from the City of Philadelphia in their evaluation of two infrastructure options designed to meet the same stormwater needs, but offering vastly different benefits; a 50/50 green/grey infrastructure project versus a 100% grey infrastructure project. The net present value of the social, environmental, and economic benefits provided by the green infrastructure option was estimated at $2.85 billion (including increased recreational opportunities, increased property value, wetland services, reduced heat stress mortality, improved water and air quality, energy savings, and reduced emissions) while the benefits from the traditional grey stormwater management option were estimated at only $122 million over the same period.[105,106]

Investing in nature-based solutions can help us create resilient, adaptable cities, while also helping us prepare for and mitigate the impacts of unprecedented population growth as well as extreme events related to increased temperature, greater frequency and intensity of weather episodes (including heavy rain and drought), and sea level rise projected to become more frequent in the Puget Sound region.[107]

BUILDING WITH NATURE FOR CLIMATE RESILIENCY

The frequency of flooding in the Puget Sound region is expected to increase due to a combination of heavier and more frequent rainfall, rising sea levels, and declining snowpack.[108,109,110] **Natural infrastructure**

Investments in green infrastructure generate a broader range of benefits in comparison to traditional grey infrastructure.

reduces flood risks by increasing in-place infiltration, decreasing the volume of stormwater flowing into local waterways, and enhancing the natural function of floodplains.[111] A study in Beijing calculated that an integrated community-level green infrastructure approach, including increasing green space area by 10%, constructing a storage pond, and converting 50% of impervious area into porous surfaces, reduced the volume of runoff by between 85% and 100% and lessened the peak rate of discharge by between 92.8% and 100%.[112]

Nature-based solutions also offer cooling benefits that can help mitigate extreme temperature increases in urban areas with large expanses of pavement and hardscape—a phenomenon known as the "urban heat island" (UHI) effect. One study in Portland, Oregon estimated that 100% green roof coverage in a neighborhood has the potential to reduce UHI effects by up to 90%.[113] Another study on the cooling effect of parks shows parks are, on average, about 1°C cooler than non-green urban sites during the day.[114] Providing opportunities for residents to escape summer extremes will become increasingly important, as current climate models indicate extreme heat days (when the temperature hits 97°F or above) will become more frequent across the Puget Sound region, increasing the risk of adverse health outcomes requiring hospitalization or emergency medical service.[108,109]

CREATING SUSTAINABLE SOLUTIONS

To protect long-term growth prospects, urban areas will need to integrate environmental thinking into economic and urban planning models, and augment investments in grey infrastructure with sustainable and productive nature-based solutions.[115] Cities throughout the Puget Sound have the potential to **create innovative models for nature-based solutions that can be replicated across the globe by planning and building infrastructure that makes better use of existing and scarce resources**, including existing infrastructure, energy, water, and land.[116]

Natural infrastructure can help mitigate health issues while supporting vibrant, beautiful, and ecologically resilient communities. Equitable distribution of high-quality natural environments and programs will enable people to experience nature, and can help address environmental and social justice concerns in our region. Such investments can be planned and designed to optimize opportunities for human interaction with accessible and high quality parks, gardens, and green space, while simultaneously addressing the largest landscape problems of the Puget Sound region and producing the nearby pockets of nature that provide respite, healing, and community support.

Most of the studies reported here have been conducted in other locations, even other nations. That does not diminish the applicability of the research, for many of the study settings and participants resemble the people and urbanized places of the Puget Sound region. Nonetheless, additional research can be a useful contribution to better understand key questions about the specific needs of the region. A collaborative scientific community composed of university, nonprofit, and agency scientists can explore carefully crafted questions to better understand how natural infrastructure can boost the health and wellness of everyone, from individuals to communities.

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