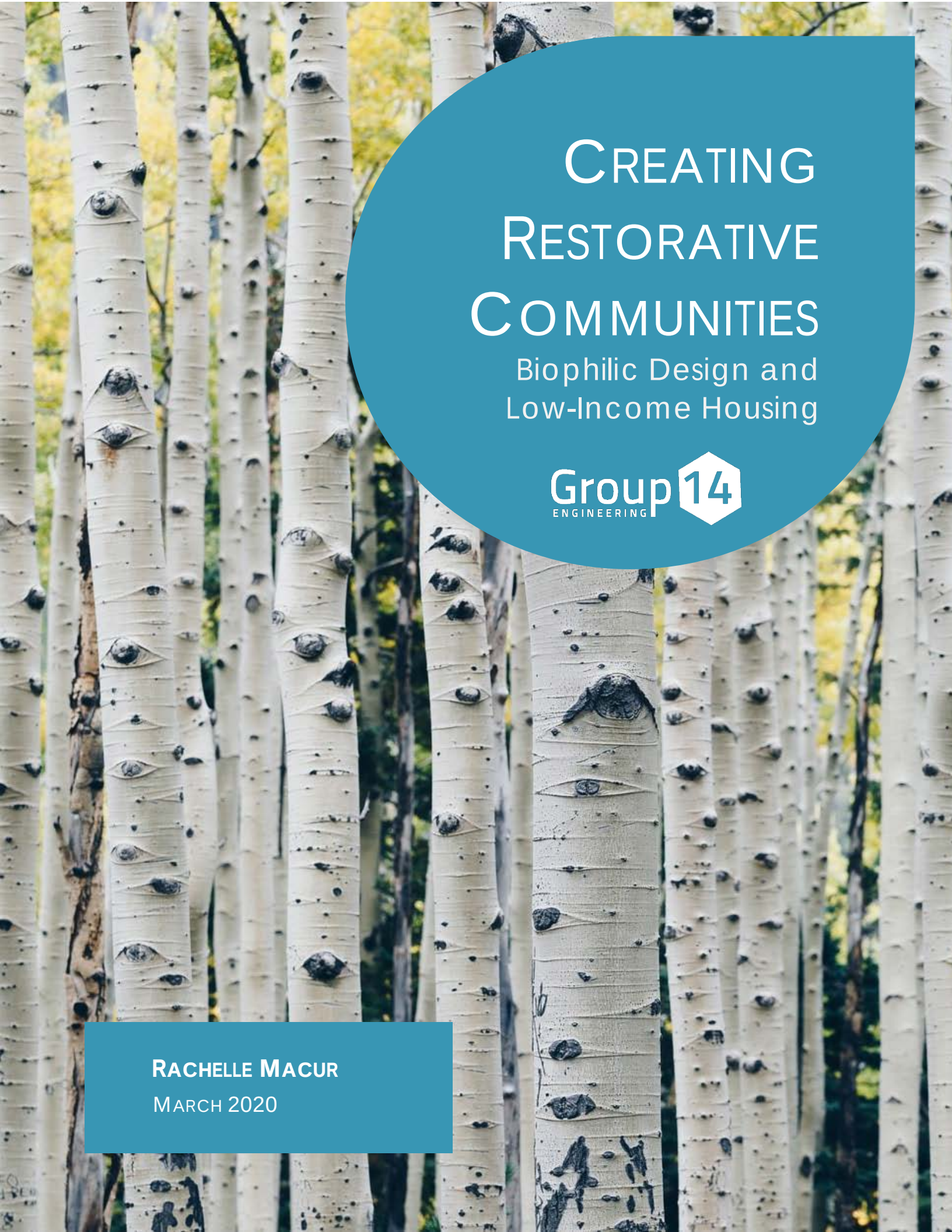

Creating Restorative Communities

Biophilic Design and Low-Income Housing

Group 14 ENGINEERING

Rachelle Macur

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WHAT IS BIOPHILIA?

Biophilia is the instinctive bond between human beings and living systems. It is our innate urge to affiliate with other forms of life. The term literally means “love of life” and was coined by psychoanalyst Erich Fromm in 1973. The biologist Edward (E.O.) Wilson later popularized the term stating that:

“Biophilia is the innately emotional affiliation of human beings to other living organisms.” (Wilson, 1984).

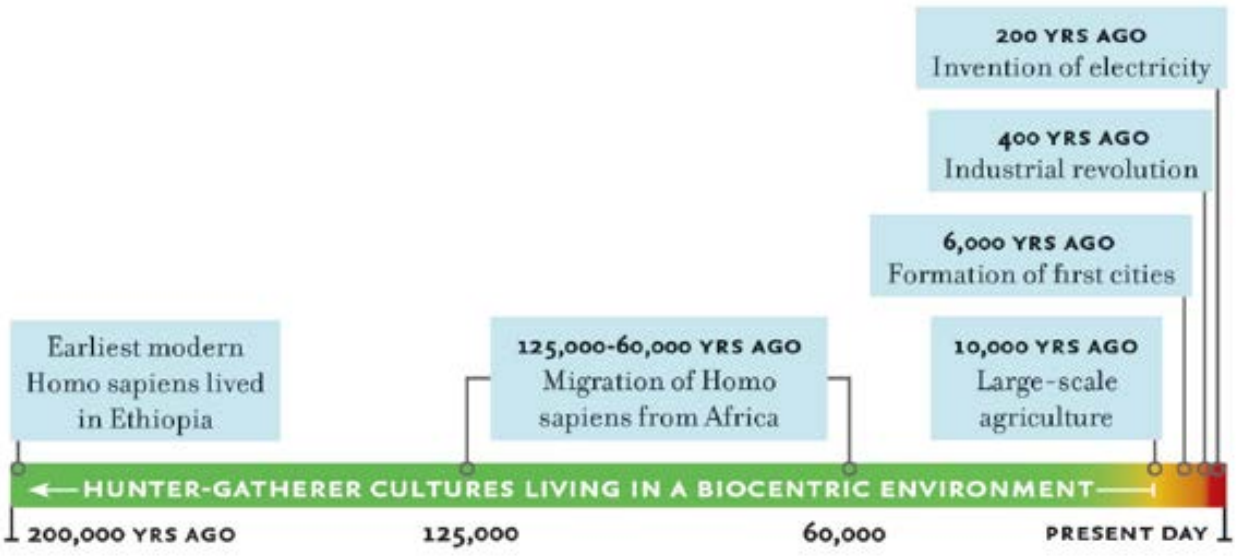
Since Wilson’s book was published, interest in humanity’s instinctive love of nature has grown tremendously – especially in the built environment industry. For the design community, the recognition of nature’s significance in our lives is becoming increasingly important as our species is gradually moving more and more indoors and into urban areas. Spending so much of our time in spaces often void of nature-immersive experiences, there is a desire to be intentional about how we can bring the benefits of nature into our daily lives. This is especially crucial for those living in low-income and supportive housing communities, where the opportunities to reap the health and social benefits of nature immersion are critical, and access to quality outdoor experiences in often limited.

EVOLUTION AND NATURE DEFICIT DISORDER

To begin to appreciate why nature is so critical in our lives, we must step back and understand our evolutionary past.

Humans are well adapted to a natural environment. Our physiology, psychology, and sociology all evolved in nature – and through evolution became finely attuned to excel in a bio-centric environment. Historically, we were dependent on our senses and an awareness of our surroundings for our survival. Overtime, our reactions and interactions to those surroundings led to the physical and mental traits we now experience.

Because of this, our evolutionary past has created a "hardwired" preference for certain characteristics in the natural environment that align with a greater chance for our survival, comfort and wellbeing. "Habitat preferences are found in all animals, and most biologists would agree that they are adaptive, since fitness is likely to be higher in a preferred habitat" (Falk and Balling, 2010). In other words, we thrive in those environments we are best adapted to.



In the last 200,000 years, over 99.9% of our existence was spent in a bio-centric environment, and it's only very recently where we have had to adapt to increasingly man-made environments.

Essentially in the span of a handful of generations, we have drastically altered our surroundings and our daily activities. We've transitioned out of being in a natural habitat 100% of the time to now doing the exact opposite, and spending over 95% (McLennan, 2019) of our time indoors. This shift is a result of our search for comfort, stability, productivity, and precision. But, with this movement towards "prosperity" we haven't actually, as a society, really stopped to think about how this impacts us as a species – as an animal of the world.

Despite being incredibly innovative and adaptive – proving ourselves capable of inhabiting almost all corners of the globe - experience and science is showing us that the nature-oriented existence hard-wired into humanity isn't quite prepared for the over stimulating habitats we've carved out for ourselves.

And though it is no longer the case where we need to have keen awareness of the natural elements to meet our basic human needs, perhaps we still need it to thrive.

Richard Louv has referred to the negative impacts of our modern day disconnect as "Nature Deficit Disorder (NDD)". Louv lays out in his books the "Last Child in the Woods" and "the Nature Principle" that our lack of routine contact with nature has its psychological, physical, and cognitive costs. Nature deficit disorder is not a formal diagnosis, but a way of describing the impacts of human alienation from nature, particularly for children in their vulnerable developing years. Essentially, Louv says, "we have entered a new era of suburban sprawl that restricts outdoor play, in conjunction with a plugged-in culture that draws us indoors" (Louv, 2008) resulting in a whole slew of concerns such as attention problems, obesity, anxiety, and depression.

This is most obvious when we look at some of the facts regarding our youth today.

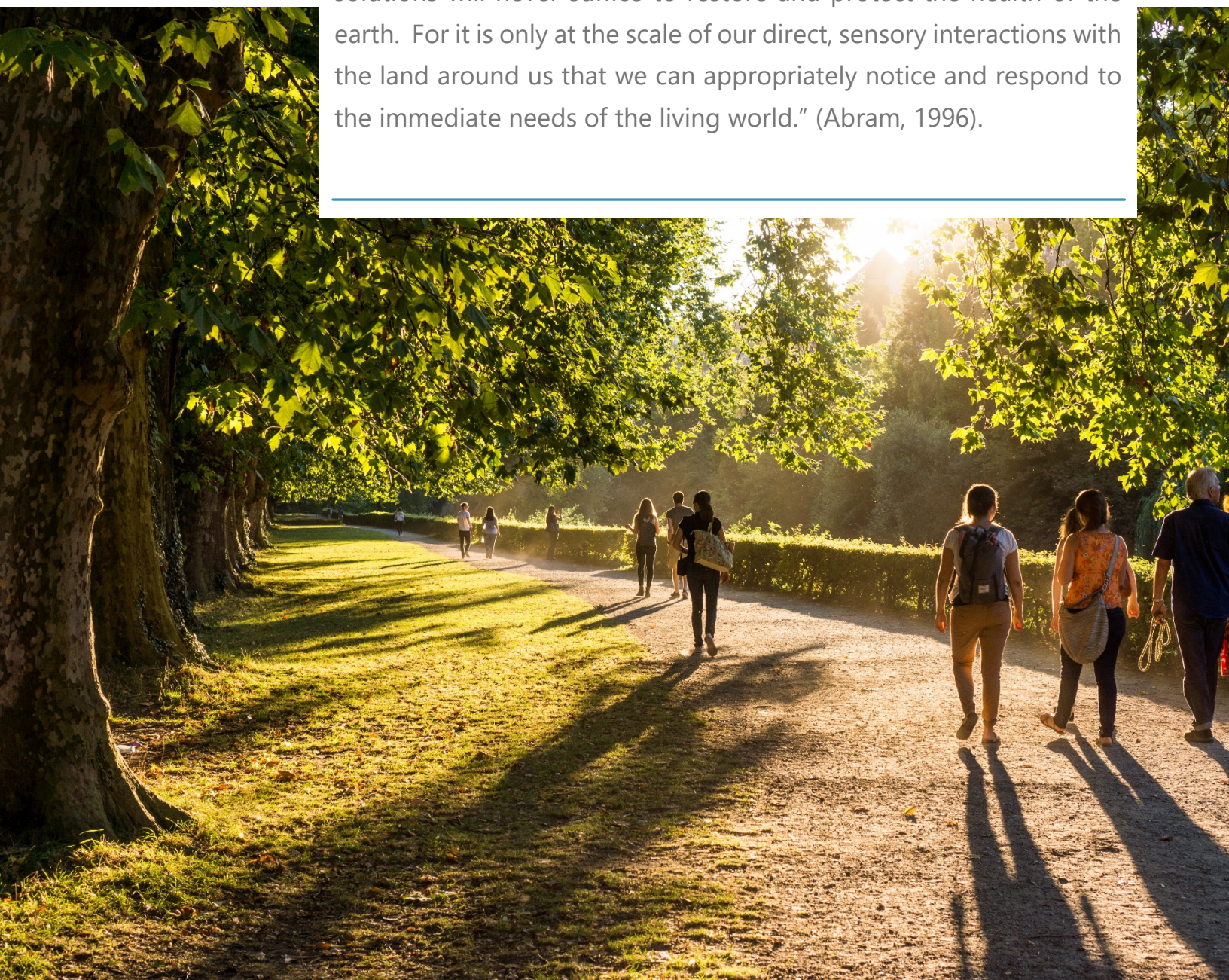
- Children today spend less time outdoors than any other generation, devoting only four to seven minutes to unstructured outdoor play per day while spending an average of seven and a half hours in front of electronic media (NRPA, 2017). That's less than an hour of outside time per week and over 52 hours per week in front of screen.
- Teenagers experience 50% more diagnosable depression in 2015 vs. 2011, and the number of children and teens hospitalized for suicidal thoughts or self-harm doubled between 2008 and 2015. (Twenge, 2017)
- For ages 6 to 17, researchers found a 20 percent increase in diagnoses of anxiety between 2007 and 2012. (NSCH, 2016)

These statistics are not just truths of our youth, but are prevalent in adults as well. While some people are able to adjust better than others, we are all showing the signs of the impact that modern society has on us. The steady drip of stress that is experienced by all age groups in urban settings leads to higher cortisol levels, a depression of our parasympathetic system, disappearance of our alpha brain waves, and an increase in low level chronic diseases such as strokes and heart attacks (Louv, 2011; UChicago, 2008).

The impact is felt on a societal level as well. Our disconnect with nature has often caused us to either fear or romanticize it - neither of which is centered in reality. We have created an urban-oriented environmentalism that is not rooted in actual experience, but instead rooted in metrics, data, and theories. This leaves a gap in our ability to truly address issues such as climate change, contamination, and habitat loss. Our solutions to these issues are not based off of an intimate knowledge and valuing of the land & spaces we're working to protect, but are based off of theory and concepts.

This is furthermore a concern as younger generations are spending less and less time in nature, organically studying it through experience. Studies have shown that we can identify 25 percent more pop culture brands than we can wildlife species. This trend starts as young as 8 years old. (Balmfold et al, 2002). How can we possibly know about, connect with, care for, or even value what we cannot name?

"There is an intimate reciprocity to the senses; as we touch the bark of a tree, we feel the tree touching us; as we lend our ears to the local sounds and ally our nose to the seasonal scents, the terrain gradually tunes us in turn. The senses, that is, are the primary way that the earth has of informing our thoughts and of guiding our actions. Huge centralized programs, global initiatives, and other "top down" solutions will never suffice to restore and protect the health of the earth. For it is only at the scale of our direct, sensory interactions with the land around us that we can appropriately notice and respond to the immediate needs of the living world." (Abram, 1996).



SCIENTIFIC FINDINGS

Fortunately, for all the negative impacts of our lack of routine contact with nature, there are even more positive outcomes when we do connect with it.

We are a product of biological evolution and it is no surprise that science tells us that we are positively impacted by the elements of nature…. And the evidence is growing. Cognitive functioning, psychological health, and physiological well-being are all positively impacted by attuning our senses to natural elements.

One of the earliest studies pointing to these beneficial impacts was done with regard to access to natural daylight. A hospital in Pittsburgh did a study with patients after surgery and split them up with one half of the group in rooms located on the brightest / day lit side of the building and the other half of the patients with rooms whose daylight was blocked by an adjacent building. The patients with brighter rooms used less medicine and reported less stress and pain. This resulted in a cost savings and shorter stays. (Walch et al, 2005)

EO Wilson's studies (1984) have shown benefit to hospital patients when exposed to simple images of nature. He found that individuals experiencing stress recover quicker when shown photos of nature than when shown urban scenes. This was also demonstrated with a hospital study where patients were randomly assigned different posters – an open landscape with a view of water, an enclosed forest scene, an abstract painting, and no poster. Those with the open landscape and a view of water reported the least post-operative anxiety (Ulrich, 1983). Perhaps reflecting on our evolutionary preference for savannah landscapes.

Countless other studies from 2005 to the present day have shown that exposure to nature and natural elements…

- Increases fantasy, make-believe, & sense of wonder
- Creates more egalitarian and social community
- Reduces anger and resentment
- Decreases violence and criminal activity
- Enhances alertness and mental stamina
- Improves focus, productivity, performance, & cognitive functioning
- Causes better physical awareness
- Increases confidence and trust in oneself
- Quickens recovery in health
- Lowers blood pressure and stabilize our nervous system
- Improves learning rates

- Reduces anxiety and depression
- Offers stronger feelings of calm & "happiness"

The table below from Franklin et al.'s 2017 *Nature Contact and Human Health: A Research Agenda*, begins to highlight the breadth of proof we have for these benefits.

Table 1. Summary of evidence-based health benefits of nature contact.

No.	Health/well-being benefits	References
1	Reduced stress	Berto 2014; Fan et al. 2011; Nielsen and Hansen 2007; Stigsdotter et al. 2010; van den Berg and Custers 2011; van den Berg et al. 2010; Ward Thompson et al. 2016
2	Better sleep	Astell-Burt et al. 2013; Grigsby-Toussaint et al. 2015; Morita et al. 2011
3	Improved mental health:	
	Reduced depression	Astell-Burt et al. 2014c; Beyer et al. 2014; Cohen-Cline et al. 2015; Gascon et al. 2015; Kim et al. 2009; Maas et al. 2009b; McEachan et al. 2016; Nutsford et al. 2013; Sturm and Cohen 2014; Taylor et al. 2015; White et al. 2013
	Reduced anxiety	Beyer et al. 2014; Bratman et al. 2015a; Maas et al. 2009b; Nutsford et al. 2013; Song et al. 2013; Song et al. 2015
4	Greater happiness, well-being, life satisfaction	Ambrey 2016; Fleming et al. 2016; Larson et al. 2016; MacKerron and Mourato 2013; Van Herzele and de Vries 2012; White et al. 2013
5	Reduced aggression	Bogar and Beyer 2016; Branas et al. 2011; Kuo and Sullivan 2001a, b; Troy et al. 2012; Younan et al. 2016
6	Reduced ADHD symptoms	Amoly et al. 2014; Faber Taylor et al. 2001; Faber Taylor and Kuo 2009; Faber Taylor and Kuo 2011; Kuo and Faber Taylor 2004; Markevych et al. 2014b; van den Berg and van den Berg 2011
7	Increased prosocial behavior and social connectedness	Broyles et al. 2011; Dadvand et al. 2016; de Vries et al. 2013; Fan et al. 2011; Holtan et al. 2015; Home et al. 2012; Piff et al. 2015; Sullivan et al. 2004
8	Lower blood pressure	Duncan et al. 2014; Markevych et al. 2014a; Shanahan et al. 2016
9	Improved postoperative recovery	Park and Mattson 2008; Park and Mattson 2009; Ulrich 1984
10	Improved birth outcomes	Reviewed by Dzhambov et al. 2014
11	Improved congestive heart failure	Mao et al. 2017
12	Improved child development (cognitive and motor)	Fjørtoft 2001; Kellert 2005
13	Improved pain control	Acutely (Diette et al. 2003; Lechtzin et al. 2010) and chronically (Han et al. 2016)
14	Reduced obesity	Bell et al. 2008; Cleland et al. 2008; P. Dadvand et al. 2014a; Lachowycz and Jones 2011; Sanders et al. 2015; Stark et al. 2014
15	Reduced diabetes	Astell-Burt et al. 2014a; Bodicoat et al. 2014; Brown et al. 2016; Thiering et al. 2016
16	Better eyesight	French et al. 2013; Guggenheim et al. 2012; He et al. 2015
17	Improved immune function	Li et al. 2006; Li et al. 2008a; Li et al. 2008b; Li et al. 2010; Li and Kawada 2011
18	Improved general health:	
	Adults	Brown et al. 2016; de Vries et al. 2003; Kardan et al. 2015; Maas et al. 2006; Maas et al. 2009b; Stigsdotter et al. 2010; Wheeler et al. 2015
	Cancer survivors	Ray and Jakubec 2014
	Children	Kim et al. 2016
19	Reduced mortality	Coutts et al. 2010; Gascon et al. 2016b; Hu et al. 2008; James et al. 2016; Takano et al. 2002; Villeneuve et al. 2012
20	Asthma and/or allergies (studies show both improvements and exacerbations)	Andrusaityte et al. 2016; Dadvand et al. 2014a; Fuertes et al. 2014; Fuertes et al. 2016; Lovasi et al. 2013; Lovasi et al. 2008; Ruokolainen et al. 2015

Note: ADHD, attention-deficit hyperactivity disorder. The references in Table 1 are illustrative rather than exhaustive; they include both recent reviews and research reports and older, widely cited publications.

Some of the most impressive studies pointing at the outcomes of nature exposure are highlighted by Dr. Qing Li's work with forest bathing (shinrin-yoku) – where, in Japan, they have been writing prescription for time in nature and creating designated nature therapy forests.

Li's studies point out that even five minutes of exposure to nature can start to bring some of these benefits. Studies show that after 3 days in nature, people's Natural Killer (NK) cells are boosted by 50%. Natural killer, or NK cells, are a type of lymphocyte (white blood cell) that are an essential part of our innate immune system (Li, 2018). A healthy body produces NK cells to respond early during infection, killing cells with a given virus. Early signs of research are indicating that time in nature helps increase these NK cells, preventing and fighting off cancers. In addition, this boost to our NK cells lasts long after nature exposure. Up to 30 days later, they are still 25% above our baseline. (Li et al, 2009).

BIOPHILIC DESIGN

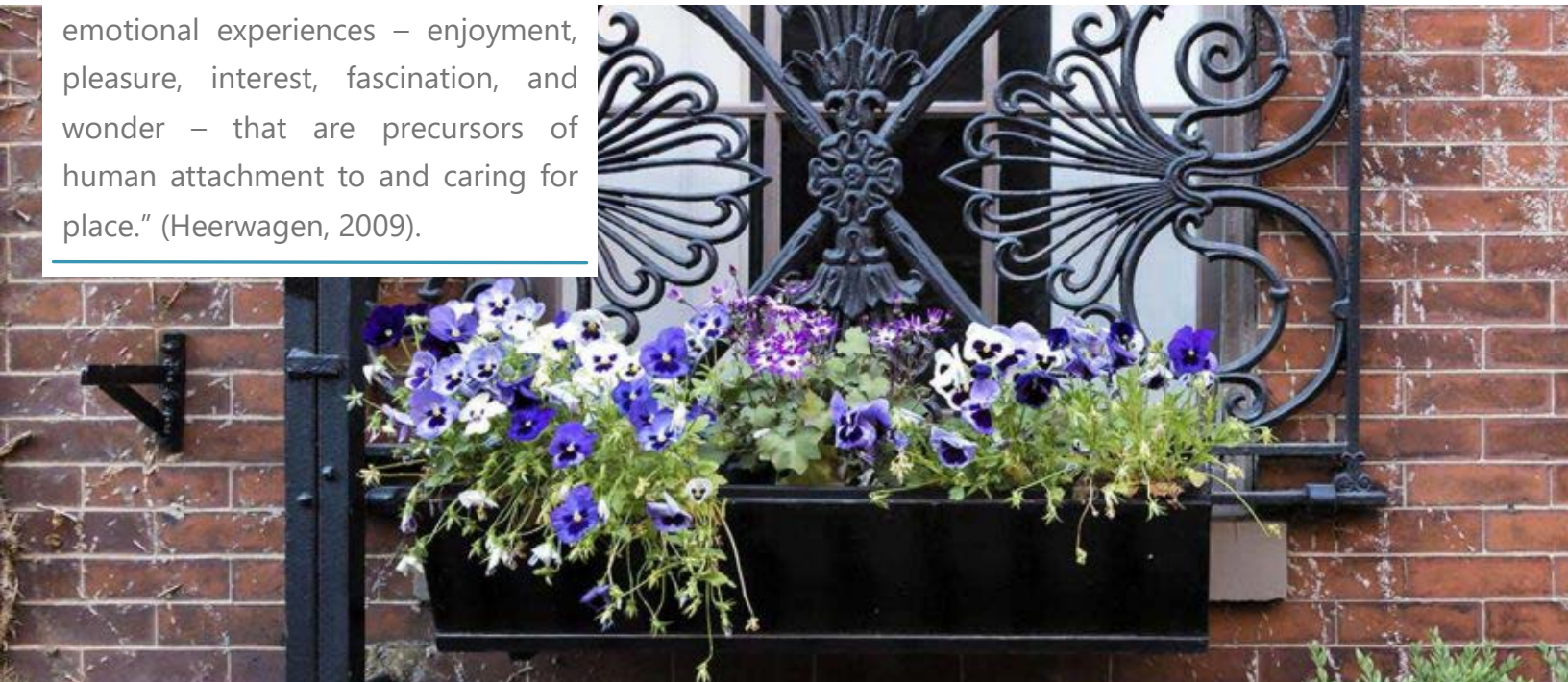
So, we know that different natural attributes can impact our wellbeing. But, with more and more people moving to urban centers every day and with less and less time outdoors, how can we start to reverse nature deficit disorder and reinvigorate our biological roots?

Well, the answer is in:

- Spending passive time outdoors in nature – sitting, listening, hiking, exploring, etc.
- Recreating outdoors – trail running, skiing, rock climbing, kayaking, etc.
- Being in open space parks / nature-oriented manicured environments
- Getting outside - no matter the environment
- Providing access to elements of nature while inside

While the importance of spending time outdoors (manicured or not) is essential to our wellbeing and cannot be overstated, this article is focused specifically on how we can provide access to the elements of nature while in and around our built environments. We refer to this as *biophilic design*.

> "The goal of biophilic design is to create places imbued with positive emotional experiences – enjoyment, pleasure, interest, fascination, and wonder – that are precursors of human attachment to and caring for place." (Heerwagen, 2009).



The biophilic design industry is specifically interested in: What is it about nature that brings benefit?; What are the specific elements that make the biggest impact?; How do they work together?; Can we harness them and design better spaces to bring about social, psychological, emotional, and physical benefit?

Many great resources have come out in the past years targeting these exact topics and furthering our understanding of biophilia and the built environment. Some of the more notable resources are Stephen Kellert's "Biophilic Design" and International Living Future Institute's "Creating Biophilic Buildings".

These resources help us to understand, for example, why it is that we prefer the booth seats at the edges of the room rather than flat top tables in the center of the restaurant or library (...it gives us a perception of safety and security improving our concentration and attention). Or, how having a material connection with nature such as wood or stone decreases blood pressure and improves creative performance. Or, how listening to flowing water reduces stress, increases feelings of tranquility, and lowers our heart rate.

Terrapin Bright Green's 14 Patterns of Biophilic Design is another great resource. They outline 14 design strategies that are categorized into "nature in the space", "natural analogues", and "nature of the space". They furthermore outline how each of the patterns contributes to social, emotional, cognitive, and even economic benefits.

	14 PATTERNS	•	STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE
NATURE IN THE SPACE	Visual Connection with Nature	• • •	**Lowered blood pressure and heart rate** (Brown, Barton & Gladwell, 2013; van den Berg, Hartig, & Staats, 2007; Tsunetsugu & Miyazaki, 2005)	**Improved mental engagement/ attentiveness** (Biederman & Vessel, 2006)	**Positively impacted attitude and overall happiness** (Barton & Pretty, 2010)
	Non-Visual Connection with Nature	• •	**Reduced systolic blood pressure and stress hormones** (Park, Tsunetsugu, Kasetani et al., 2009; Hartig, Evans, Jamner et al., 2003; Orsega-Smith, Mowen, Payne et al., 2004; Ulrich, Simons, Losito et al., 1991)	**Positively impacted cognitive performance** (Mehta, Zhu & Cheema, 2012; Ljungberg, Neely, & Lundström, 2004)	**Perceived improvements in mental health and tranquility** (Li, Kobayashi, Inagaki et al., 2012; Jahncke, et al., 2011; Tsunetsugu, Park, & Miyazaki, 2010; Kim, Ren, & Fielding, 2007; Stigsdotter & Grahn, 2003)
	Non-Rhythmic Sensory Stimuli	• •	**Positively impacted heart rate, systolic blood pressure and sympathetic nervous system activity** (Li, 2009; Park et al, 2008; Kahn et al., 2008; Beauchamp, et al., 2003; Ulrich et al., 1991)	**Observed and quantified behavioral measures of attention and exploration** (Windhager et al., 2011)	
	Thermal & Airflow Variability	• •	**Positively impacted comfort, well-being and productivity** (Heerwagen, 2006; Tham & Willem, 2005; Wigö, 2005)	**Positively impacted concentration** (Hartig et al., 2003; Hartig et al., 1991; R. Kaplan & Kaplan, 1989)	**Improved perception of temporal and spatial pleasure (alliesthesia)** (Parkinson, de Dear & Candido, 2012; Zhang, Arens, Huizenga & Han, 2010; Arens, Zhang & Huizenga, 2006; Zhang, 2003; de Dear & Brager, 2002; Heschong, 1979)
	Presence of Water	• •	**Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure** (Alvarsson, Wiens, & Nilsson, 2010; Pheasant, Fisher, Watts et al., 2010; Biederman & Vessel, 2006)	**Improved concentration and memory restoration** (Alvarsson et al., 2010; Biederman & Vessel, 2006) **Enhanced perception and psychological responsiveness** (Alvarsson et al., 2010; Hunter et al., 2010)	**Observed preferences and positive emotional responses** (Windhager, 2011; Barton & Pretty, 2010; White, Smith, Humphryes et al., 2010; Karmanov & Hamel, 2008; Biederman & Vessel, 2006; Heerwagen & Orians, 1993; Ruso & Atzwanger, 2003; Ulrich, 1983)
	Dynamic & Diffuse Light	• •	**Positively impacted circadian system functioning** (Figueiro, Brons, Plitnick et al., 2011; Beckett & Roden, 2009) **Increased visual comfort** (Elyezadi, 2012; Kim & Kim, 2007)		
	Connection with Natural Systems				**Enhanced positive health responses; Shifted perception of environment** (Kellert et al., 2008)
NATURAL ANALOGUES	Biomorphic Forms & Patterns	•			**Observed view preference** (Vessel, 2012; Joye, 2007)
	Material Connection with Nature			**Decreased diastolic blood pressure** (Tsunetsugu, Miyazaki & Sato, 2007) **Improved creative performance** (Lichtenfeld et al., 2012)	**Improved comfort** (Tsunetsugu, Miyazaki & Sato 2007)
	Complexity & Order	• •	**Positively impacted perceptual and physiological stress responses** (Salingaros, 2012; Joye, 2007; Taylor, 2006; S. Kaplan, 1988)		**Observed view preference** (Salingaros, 2012; Hägerhäll, Laike, Taylor et al., 2008; Hägerhäll, Purcella, & Taylor, 2004; Taylor, 2006)
NATURE OF THE SPACE	Prospect	• • •	**Reduced stress** (Grahn & Stigsdotter, 2010)	**Reduced boredom, irritation, fatigue** (Clearwater & Coss, 1991)	**Improved comfort and perceived safety** (Herzog & Bryce, 2007; Wang & Taylor, 2006; Petherick, 2000)
	Refuge	• • •		**Improved concentration, attention and perception of safety** (Grahn & Stigsdotter, 2010; Wang & Taylor, 2006; Petherick, 2000; Ulrich et al., 1993)	
	Mystery	• •			**Induced strong pleasure response** (Biederman, 2011; Salimpoor, Benovoy, Larcher et al., 2011; Ikemi, 2005; Blood & Zatorre, 2001)
	Risk/Peril	•			**Resulted in strong dopamine or pleasure responses** (Kohno et al., 2013; Wang & Tsien, 2011; Zald et al., 2008)

© 2014 Terrapin Bright Green / 14 Patterns of Biophilic Design

While these 14 patterns offer an excellent guideline of how to think about incorporating biophilia into our built environments, it is crucial that we don't fall victim to treating these opportunities like a checklist - where the elements are specified and installed without any real sense of cohesion or place-based awareness. We must ensure we are creating places that are reflective of the community, culture, movement, and relationships of the present and future humans and ecology that will inhabit the space. Through this lens, we can create meaningful places that allow for some of our most vulnerable communities to heal and thrive. The opportunities are especially impactful for urban, low income neighborhoods.

STATE OF LOW-INCOME HOUSING

We know that in urban settings (vs rural settings), individuals' pulse rates are higher (4-6%), their systolic blood pressure is increased (19.4%), they have higher cortisol levels (13-16%), their parasympathetic activity is increased (56%), and their immune functioning is lower (Ulrich, 1983).

For those living in low-income housing, life conditions can be even more taxing on one's biological functioning. Daily stressors and chronic mental fatigue are more extreme due to lack of reliable transportation, limited financial surplus, being underinsured, rent & utility costs, access to quality food, safety concerns, etc. If we add to this the experience of current or historical trauma (as many in low income housing suffer from), one's ability to cope with life situations becomes increasingly difficult. These stressors combined with limited access to nature creates a serious social and health disadvantage.

Residents in low-income housing are also more vulnerable to sudden life changes and without a trusting network or financial surplus, one's cushion is drastically depleted. As Kuo points out "even a minor temporary trauma such as a child's illness can have far-reaching effects, eventually necessitating major readjustments in life, family, and work domains. Making these adjustments requires sustained, high levels of mental functioning" (Kuo, 2001). Mental fatigue is one of the biggest battles experienced by low-income residents on a daily basis.

In addition, many of the low income residents that housing providers serve are dealing with more than just mental fatigue. They may also be working with various levels of trauma in their lives - such as our veterans, formerly homeless, victims of abuse & violence, and those experiencing mental illness. In these cases, the need to create places for people to have control, safety, comfort, and an opportunity for mental, social, and physical health becomes even more essential.

Access to quality nature in low income neighborhoods has historically been limited. While some studies show that access to parks for low income neighborhoods is equal to or better than those in non-low-income neighborhoods, use and perception of quality and safety is lower. And, for more immersive experiences in nature – such as visits to state/national parks or refuges - the barriers are much higher due to awareness of opportunities, financial means (entry fees and travel/transportation costs), and the time and mental freedom

to enjoy the experience. "Some residents may be less likely to focus on getting outdoors because they are more concerned with paying bills and feeding their families." (US Fish and Wildlife, 2016)

This lack of access to nature can compound the already inherent negative stressors experienced by those living in low-income and/or permanent supportive housing. While, on the other hand, access to nature and natural elements can offer reprieve from some of the symptoms of mental fatigue and trauma.

Kuo's studies carried out in urban public housing give us compelling signs of what even a little bit of greenery can do for an individual and a community.

Her studies show that people living in urban public housing with greenery around them have less mental fatigue and report less experiences of aggression and violence than individuals living in barren buildings (Kuo & Sullivan, 2001).

In addition, after controlling for crowding, noise, income level and other factors, those households that have access to greenery (even as little as a few trees and some turf) show great benefits, including:

- Better performance on measures of attentional functioning
- Lower drug and crime rates
- Better concentration and self-regulation in children
- Improved management of life issues and increased ability to cope
- Greater self-acceptance
- More positive relations with others

This research is supported by other studies as well. A 10-year study by Branas et al. (2011) indicated that greening may reduce crime while promoting health. And, Maas and colleagues (2009) concluded that green space in people's living environment is associated with enhanced feelings of social safety.

In addition, Kuo has found that in greener settings, "people are more generous and more sociable. We find stronger social ties and greater sense of community, more mutual trust and willingness to help others" (Kuo, 2001).

Isn't this something we all want for our lives? To have greater mental strength and emotional regulation? To live in communities free of drugs and crime? To know and trust our neighbors? One could argue this is a fundamental right. It is simply a humane way to live.

OPPORTUNITIES FOR RESTORATION

Attention Restoration Theory (developed by Kaplan and Kaplan) states that when people don't have access to nature, they are more mentally fatigued. When one is mentally fatigued, it becomes difficult to make good life decisions. One is more irritable, has greater difficulty with conflict, and is more aggressive.

Kaplan (1995) has noted that many situations and tasks in modern life draw on our capacity to focus and pay attention. The demands of everyday life – traffic, phones, conversations, problems at work, and complex decisions – all take their toll leading to mental fatigue. Throughout the day and over time, these conditions simply build up and complications can easily arise.

In contrast, natural settings and stimuli such as landscapes and animas seem to *effortlessly* engage our attention. Being in and around nature gives us an opportunity to simply relax, rest, and get reprieve from our disturbing emotions and daily demands.

Time in and around nature helps those who have experienced heightened stress and trauma to develop the toolkit they need to heal, and eventually, to thrive. It helps individuals to gain awareness of their thoughts and emotions and to get distance from those thoughts and emotions they don't find to be useful. It furthermore helps people with their physical self-confidence & awareness and their desire to be sociable, kind, and generous. There is an ability for people to relax, open up, and to heal.

As Florence Williams points out, "Simply talking about traumatic memories doesn't fully work, because it engages only those neural pathways associated with logic and speech. Healing involves both separating fearful emotions from bad memories and bringing the nervous system back to the safer, quieter present". For this, we need nonverbal therapies. We know practices of mindfulness and time with natural elements can do just this.

One of the biggest opportunities is with gardening. Ulrich (1983) and Kaplan & Kaplan (1989) have both brought attention to the use of gardening for soldiers and victims of war to maintain mental wellbeing and for "the disenfranchised to become involved in acts of defiance resisting not only environmental difficulty but also social psychological, political, or economic conditions" (Tidball 2012). According to Ulrich, the gardens are more effective at alleviating stress and improving personal resiliency if they are rich in foliage (plants and flowers) have water features, and promote the sounds of nature such as birds chirping. As neurologist Dr. Oliver Sack's states, "In many cases, gardens and nature are more powerful than any medication" (Sacks, 2019).

> "When talking to 'red zone' [crisis or disaster] survivors—whether they be war refugees beginning a new life in Dearborn, Michigan; residents of New Orleans' 9thWard after Hurricane Katrina; or homeowners struggling to hang on in a largely vacated Detroit—we often hear stories about how the act of planting has been critical to emotional survival and to engendering hope for the future," writes Tidball and Krasney.

It Takes a Village Garden at the Renaissance Village Apartments in Detroit is a great example of a community garden being integrated into a low-income housing community in need of healing. According to Mary Tischler – CFO of Ginosko (the developer), the area was "what we call an urban prairie" just a year ago. "There was nothing here but rusty playground equipment. It was just weeds."

Today, the weeds are no more. The 2.9-acre garden includes 30 raised garden beds. Each bed is adopted by individuals or community groups from the neighborhood who harvest and eat the food themselves. More than two acres of the property features an array of whimsical design elements seeking to integrate people and nature.

"It's a natural playground," says Tischler. "It's a place in the middle of an urban area where people can go to garden and botanize and see plants that haven't been in this neighborhood for over a century."

Providing outdoor developed facilities, such as picnic tables and play equipment, with natural elements around is another important element for connecting communities with nature. In a survey done by the US Fish and Wildlife (2016), the use of urban parks and nature oriented spaces varied between racial, ethnic, and income groups. For African American, Latinos, and low-income urban residents, social interaction and leisure were a key motivators in spending time outdoors.

The Box District Community in Massachusetts and La Brea Housing in Los Angeles are great examples of this. They are providing rich spaces that offer a variety of opportunities while enjoying nature and the outdoors, including: personal respite, recreation, and community gathering. The inviting spaces encourage residents to spend time outdoors in a secure and welcoming space.


Box District Community (left) and La Brea Housing (right)

Many individuals living in poverty who have experienced abuse, neglect, or routine moving suffer from attachment disruption which is neuro-developmentally based. They often have trouble trusting others, forming positive relationships, and regulating their emotions. They also often demonstrate lower cognitive ability and lack social skills (Bona and Courtnage, 2012). Creating spaces that help increase one's sense of security and reduce one's anxiety & stress is essential in order to start managing emotional responses and having the inner surplus needed to make positive life changes.

MetroWest Housing Solutions in Lakewood, CO designs spaces in their housing complexes for relaxation, contemplation, and creativity that offer access to refuge, prospect, and the outdoors.


Another example is Colorado Coalition for the Homeless (CCH)'s Stout Street Lofts, which includes housing and a clinic for homeless and formerly homeless individuals. According to Jennifer Pearlman, CCH's coordinator of trauma-informed care, nearly all of the Stout Street's residents have experienced the "trifecta" of trauma, poverty, and addiction and they are highly attuned to perceptions of mistreatment.

To make residents and visitors feel more comfortable, CCH has offered many private spaces for people to retreat to. They also make ample use of soothing paint colors, wood, and plants. “I often think that’s why some homeless patients who’ve experienced trauma stay outside. Nature is oftentimes more comfortable,” says Perlman.

By taking an authentic and holistic approach to biophilic design, we can reduce the negative impacts and increase the positive benefits of biophilia for one of the most vulnerable populations in our society. We can create restorative environments that help ease discomfort, stress, and trauma.

I am not arguing that the answer to all of the stressors that effect low-income residents or those suffering from trauma can be cured through the use of biophilic design, but we do know that mental fatigue inhibits people’s ability to thrive and to flourish. If we can create spaces that assist in recovery and creating connection, we can help dissolve some of the suffering experienced.

BIOPHILIC DESIGN FOR LOW-INCOME HOUSING

Whether the social and health concerns experienced by those in low-income housing is caused by a lack of nature exposure or the lack of exposure simply exacerbates other issues is not entirely clear at this point. Yet, we know the positive benefits to be true – and the solutions are simple, low-cost, and beautiful.

We can bring nature into our spaces by providing daylight, access to fresh air, and natural landscapes. We can incorporate water features, plants, and fire - creating hearth-like spaces that also provide opportunity for community building. A great example of this is MetroWest Housing Solution CityScape at Belmar community room which includes expansive views of the outdoors, natural materials, a fireplace, plants, and biophilic-inspired interior decoration.

Other examples are NYC Housing Authority's Green Wall in the lobby and the water feature in Bray's Crossing courtyard.

NYC Housing Authority
Green Wall

Brays Crossing
New Hope Housing

We can incorporate nature, images of nature, natural materials, and natural colors into our common areas. These opportunities are beautifully expressed at Bjark Housing, Ryman Lofts, and the Orchards at Orenco.

Bjark Affordable Housing in Copenhagen

Ryman Lofts in Nashville, TN

The Orchards at Orenco Affordable Housing, Hillsboro Oregon

> Having animals in a space, especially for communities serving housing veterans or those with mental illness have shown immense benefits. In studies deriving the health and healing benefits of pets on formerly homeless individuals, it has been demonstrated that a "systolic and diastolic blood pressure, as well as heart rate, decreased after a stressor if an animal was present" (DeMello 1999).

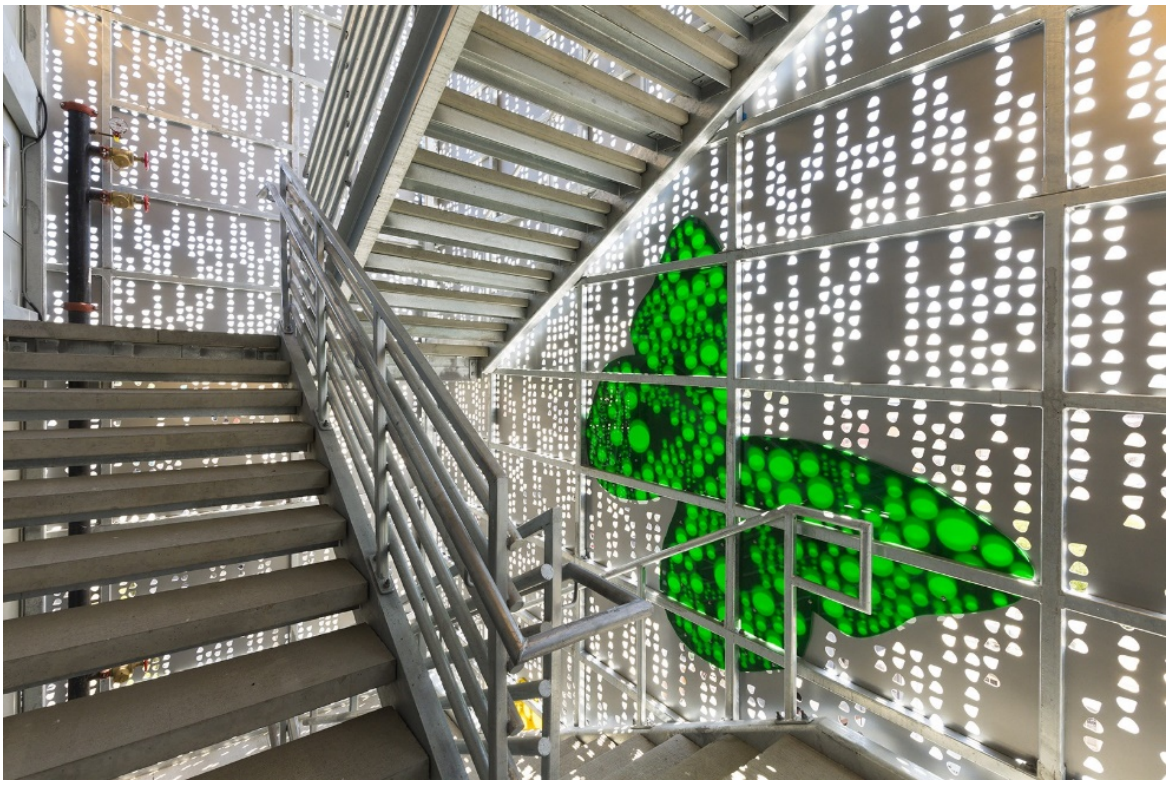
Pets have also been shown to improve the quality of life for vulnerable population by reducing the use of drugs and the number of arrests. We are finding that youth increase their self-respect and worthiness as they want to be able to give their pet a better quality of life (DeMello 1999). The power of pets helps fulfill some of our basic, biological human needs. Though having pets throughout a common space requires careful programming, if worked out it can be especially beneficial for communities suffering from trauma. Community Access in NYC has integrated animals into their housing to assist residents in recovery and rehabilitation and Mountain House in Santa Barbara has integrated chickens into their programming by having coops on site for residents to care for and connect with.

Community Access in NY (left) and Mountain House in Santa Barbara (right)

Providing places for prospect and refuge may be one of the most beneficial elements to incorporate for those experiencing a lot of stress and mental fatigue. Good viewpoints offer feelings of expansiveness and security while places of refuge provide protection and comfort. Constance Street Affordable Housing in Australia integrates both these opportunities.

Constance Street Affordable Housing

We can also incorporate organized complexity and fractals throughout the building – as interior window coverings, as part of the flooring design, or as part of the façade. Repeated designs, like fractals, provide mental stimulation and a sense of inquiry & awe. Denver Housing Authority's Mariposa Neighborhood, Broadway Affordable Housing in Santa Barbara, and Filgram Housing in France have incorporated fractals into their building designs.



Denver Housing Authority's Mariposa Neighborhood

Broadway Affordable Housing Santa Monica

Filigrane Housing, France

Also important is integrating natural light, shadows, and the witnessing of change throughout our spaces. This helps align our circadian rhythms and body processes with the time of day and seasons – for optimal physical and mental health. Savonnerie Heymans Public Housing and Raze Cazenaeve Housing have created indoor/outdoor connections that allows for daylight to pour into the building and for playful shadows to fill the space. These elements also allow residents to notice and participate in the fluctuations of the natural elements - such as sunlight, wind, and rain.

Raze Cazenaeve Housing, San Francisco

Savonnerie Heymans Public Housing, Brussels

Essential to any quality design is including place-based elements that reflect the history, ecology, and culture of the community – this creates a sense of grounding and an attachment to place that residents can value and feel ownership of.

Yesler Terrace's public art was inspired by the organization's four core values: social equity, economic opportunity, environmental stewardship and sustainability. This is reflected in the mosaic work throughout the site.

Yesler Terrace, Seattle Housing Authority

Glasgow-based visual artist Nathan Coley was commissioned to make new artwork for the site. His large steel and gold leaf rooftop sculpture references the forms of an apple tree, referring to the Bramley that gave its name to a group of squatter residents on the site in the 1970s. Nathan made 112 smaller versions of the sculpture as a house warming present to each of the new homes.

Silchester Community (mixed-income), London

Once the site of the Pillsbury A-Mill, the largest flourmill in the world for 40 years, the A-Mill Lofts integrates the historical industrial elements of the site with artistic pieces throughout – beautifully celebrating the history and current culture of the place.

A Mill Lofts – Affordable housing for Artists in Minneapolis.

Cedar Crossing offer residents housing stability with attention to traditional Native American values. Residents seeking healing from trauma, addiction, and other challenges meet several times a week in the Patina Wellness Center's talking circle room.

Cedar Crossing, AZ.

In addition to providing interior biophilic elements, one of the most important things we can do is to provide spaces in the outdoors that are safe, secure, welcoming, and sociable. As McLennan points out, "any design that can get people outside, for as long as possible – using porches, covered walkways, courtyards, balconies, etc. – will always greatly outdistance anything that can be done inside a building. These types of design features prolong our exposure to nature, drawing down that 95% [of time spent indoors]. No amount of interior architectural biophilic design intervention will ever negate our need to spend time outside in nature, so the highest order of business for the biophilic designer – and truly society – is to create spaces that draw people out and keep them there for more than a few minutes each day" (McLennan, 2019).

Via Verde in NYC and DHA's Mariposa Neighborhood have award-winning spaces that do just that – with the inclusion of community gardens, natural playscapes, and places for prospect and refuge.

Via Verde Housing, NYC

Denver Housing Authority's Mariposa Neighborhood

MOVING FORWARD TOGETHER

Dr. Corey Keyes points out in his lifetime of research that there are many people who are not necessarily mentally ill or depressed, but they don't have mental health either. They are not flourishing. Biophilia and biophilic design offers an opportunity for people to begin to flourish. "I'm convinced it's not just the things that are in nature, but it's something about how those things are arranged that get us interested in and connecting with other forms of life.

Social well-being is all about connection. Flourishing is, first and foremost, about when we feel at home and connected to the world around us. This is when we feel good and feeling connected to nature is one of the greatest ways to flourish" (Keyes, 2018)

A holistic and reflective approach to low-income and supportive housing is to find ways to heal and restore individuals by healing and restoring their connection to the earth.

The challenge for anyone working in low-income and/or supportive housing – whether they are an owner, architect, engineer, contractor, consultant, service provider, financer, or passionate citizen – is to find ways to inspire and create homes that are not only affordable and accessible, but that nourish and allow people to flourish. We need to create places where people can make meaningful connections with others, with the environment around them, and with their biological self.

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