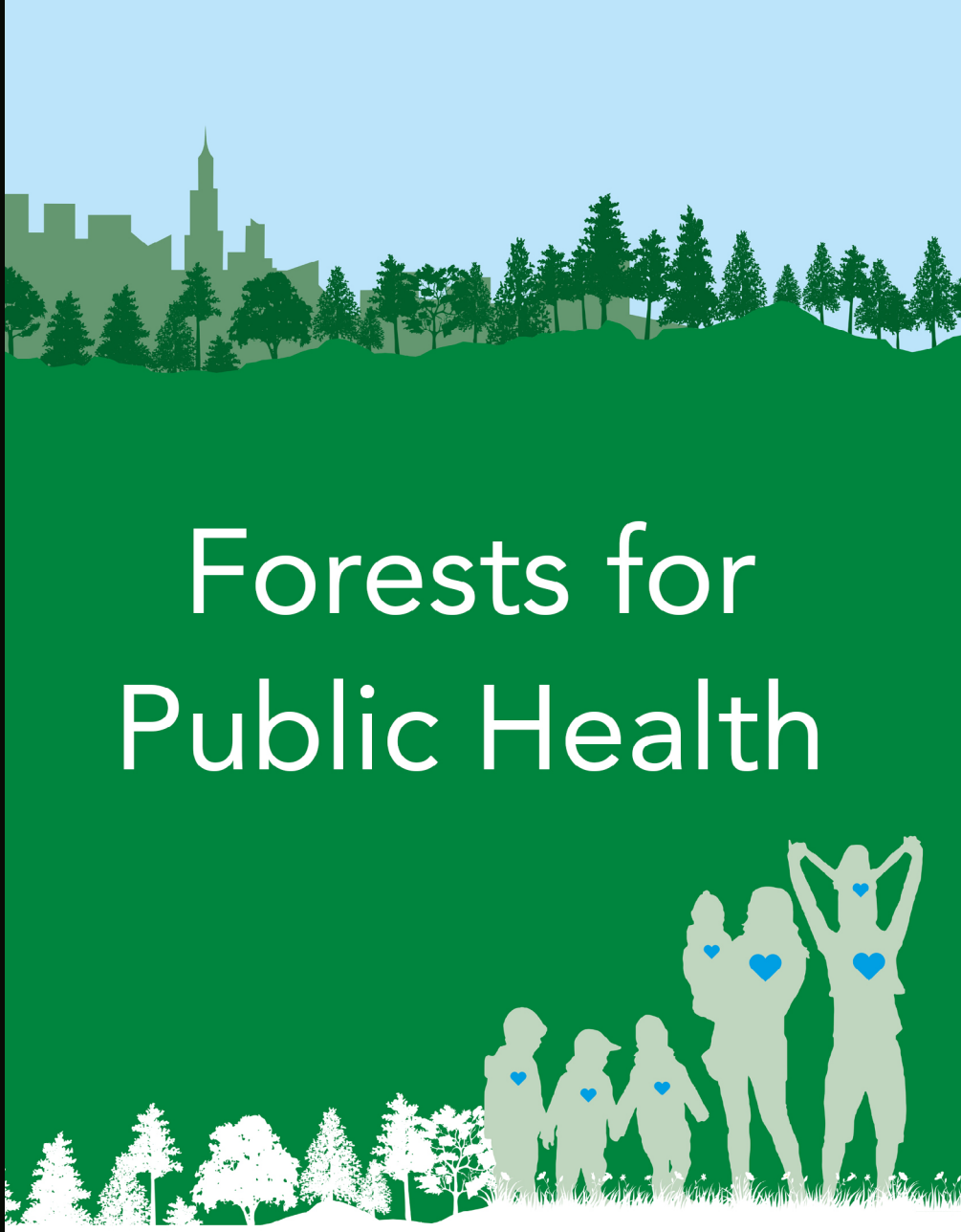

Forests for Public Health

Edited by

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Chapter Eleven

Re-Naturing Urban Childhood: A Sustainable Development Strategy[1]

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Nearly 50 years ago, for the first time in the history of the planet, we Earthlings arrived at the crossroads of deciding whether or not to care for our global future. One and a half generations later, the decision process is still underway but with evermore urgency to realign a path toward planetary survival. This chapter reminds us of prior struggles in the continuum for planetary justice and recognizes committed leadership bringing us this far. As part of the solution, we argue that childhood as a universal phase of human development and continuum of cultural transmission must be integrated into sustainability policy.

Childhood is the state of being a uniquely developing person from year zero through age 17.[1] Until a moment ago, in terms of human evolution, children grew up in nature. Now, cities are fast becoming the habitat of most children on our rapidly urbanizing planet. Nature is disappearing from children's lives. This new reality demands deep reflection framed by the broad sweep of human history. Previously, children worked as members of small hunter-gatherer groups, participating in the continuous search for sustenance and shelter wherever/whenever it could be found. Seventeen would have been close to half an average lifetime, with child-rearing responsibilities already underway. Material life was totally dependent on the offerings of nature, framed by seasonal cycles of resource access and availability. The discovery of fire and agriculture reduced the need for constant movement and supported more permanent settlement patterns. Domestic tools were fashioned from stone, then metal. Animal skin clothing was replaced by woven cloth. Mercantile

1 We limit discussion to western democratic countries, their space types and cultural traditions.

trade by sea and river, evolved using wind-driven (and too often slave-driven), wooden ships. Timber was the primary resource for construction, heating, and transportation. Primeval forests began to disappear.

Mechanical combinations of iron, water and timber (later replaced by coal), launched the industrial revolution and concomitant growth of cities, attracting people off the land to search for new urban opportunities for a better life (still underway in many parts of the world). Discovery of oil further accelerated mechanized movement and international trade. Deep-rooted societal tendencies rapidly emerged to exploit the new industrial potential. The landowning class, powered by privilege, literacy and numeracy, controlled the system, colonized places of economic value, and kept society divided into two groups: those with inherited power and access to education and those lacking both, with brawn their primary economic asset.

Welcome to the 21st Century

The digital age suddenly arrives and speeds the pace of daily life many-fold. Global economics becomes a real-time, nano-second system. Politics, a daily twitter cycle. A new serfdom of sterile cubicles, headsets, and screens conforms to the mass production image of *Modern Times*. While our heads are down, climate change is engulfing the planet. The clearest, strongest screams of alarm come from youthful humans, allied with life, well-aware of what they stand to lose, protesting lack of control over their future. Children and youth understand the human threat to planet Earth as a political/cultural crisis. Amazingly, to this day, examples of bygone child rearing practices still exist in remote reaches of the planet, where life is still utterly dependent on nature's offerings—contrasted with affluent urban living, as beautifully portrayed in the movie, "Babies."[2]

Two hundred years ago, couples produced as many babies as possible because most died long before they could help sustain the community. Fast-forward, western childbirth has become a planned event with high rates of survival. Even so, survival rates do not necessarily match national Gross Domestic Product (GDP). Paradoxically, the USA, with the highest GDP, is ranked 34th globally in infant mortality (OECD, 2019).[3] The one or two, sometimes more, babies that arrive in a family are invested with high hopes for success. For those with resources, success may be supported by privileged education systems and highly controlled extra-curricular activity, leaving no space or time for random life encounters that just a few decades ago defined childhood freedom. In families lacking sufficient

resources, options for enriching their children's extra-curricular lives likely will be diminished. On the other hand, beyond a certain age, freedom to roam may be greater, provided local crime rates are low. In the 1970s, free-range childhood was still a dominant theme as documented in Moore's studies of urban childhood in the UK and USA, conducted in the 1970s and 1980s (Moore and Young, 1978, 83–130; Moore, 1986).

In barely two generations, a pervasive, perplexing, illogical sense of fear has come to dominate adult-child relations. Parents struggling against this trend find themselves at odds with new social norms, even including law enforcement—at least in the USA.[4] Over-controlled "bubble-wrapped" kids, are growing up with low self-efficacy (Bandura, 1997),[5] an underdeveloped sense of agency (Moore, 2016),[6] and a strong sense of *external* (rather than *internal*) locus of control (Gale, Batty and Deary, 2008, 397–403).[7] As young adults, such persons may struggle with the challenges of daily life, particularly when leaving home for the rough seas of college (Schiffrin et al., 2014, 548-557).

A strong *internal* locus of control offers beneficial effects, as demonstrated by a cohort study of British children born in 1970 (Gale, Batty and Deary, 2008, 397–403). Those children with a strong internal locus of control at age 10, were less likely to be overweight at age 30, possibly because they felt they could influence conditions to support their own healthy behavior. If that be so, is it reasonable to assume that locus of control or agency is associated with the health-promoting effect of time outdoors? Outdoors, compared to indoors, is where children move more and experience increased levels of physical activity (Sallis et al., 1993, 390-398). Motivation to move is associated with diversity of immediate surroundings, including biodiversity (Cosco, 2006). The recent Canadian *Position Statement on Active Outdoor Play* (Tremblay et al., 2015, 6475-6505), as far as we are aware, is the most substantial, evidence-supported national statement advocating for the critical health-promoting function of outdoor play.

Time outdoors is a function of independent mobility, influenced by parenting styles as suggested by Pacilli et al. (2013, 377–393). Results of a study of 11-13 year olds, suggest a positive relationship between independent mobility and global agency. Parenting styles based on mutual trust may increase the likelihood of independent mobility; which, within the socioecological system of childhood, can be boosted by social relations with friends, while still being mediated by a sense of safety and parental warnings (motorized traffic being the most important tangible threat).

The presence of nature within the home range of independently mobile children may increase microclimate comfort, especially in summertime

when long days and warm temperatures lure children outside more strongly. That same nature, depending on context (park, playground, schoolground, greenway, open space, vacant lot, stream corridor, etc.), may afford interactive nature play, boosting agency while supplying additional child-centric ecosystem health promotion and child development services. In low-resource urban communities, nature is a crucial missing resource. To relink childhood to independent mobility, promote health, boost agency, and secure a sense of internal locus of control, policies that support renaturing in the multitude of cities denuded during the industrial revolution is a top priority. Re-establishing urban green infrastructure may rebalance natural equity to low-resource neighborhoods, offering a double-sided, synergetic health benefit to both children (White et al., 2019) and urban biosystems.

Figure 1. Re-naturing barren school sites makes them places for creative play and learning. Because children must legally attend school, society has an obligation to create attractive environments offering positive experiences for both children and teachers. Here, the native Longleaf Pine (*Pinus palustris*), was transplanted from adjacent woodland, with other species, to re-established the local ecosystem, including the endangered, endemic Red-cockaded Woodpecker (*Leuconotopicus borealis*). A school park evolved, helping students identify with their unique place on the planet. Blanchie Carter Discovery Park. Source: Authors.

Deep roots, spreading branches

Advocacy for caring for the Earth's natural resources appeared in print more than 450 years ago in *Sylva* (1662), where English writer, John Evelyn (1620-1706), urged landowners to reforest their land. During this same period, French statesman, Jean Baptiste Colbert (1669-1683), pursued the same forest conservation philosophy, supported by Louis XIV, by implementing ordinances to protect and renew neglected forest lands, recognizing the critical, national security role of timber. Forests and woodland were the primary source of energy in Europe prior to the industrial revolution and the accompanying rapid adoption of coal energy. Influenced by Colbert's policies, German accountant, administrator of mines, and son of a forest master, Hans Carl von Carlowitz (1645-1714), realized that reforestation for smelting was key to keeping the silver mines of Saxony economically viable. In support of silviculture, he wrote *Sylvicultura oeconomica* (1713), the first book addressing sustainable yield (*nachhaltiger ertrag*) by advocating conservation and cultivation of timber as a continuous, cyclical process critical for regional/national economic success.[8]

Skipping over the first and second industrial revolutions, imperial colonization, and the horrors of two world wars, recognition of human dependence on the natural world and the need for conservation, reemerged in the 1960s, now fueled by more solid science and framed by a new world order. An early voice was René Dubos (1901-1982), microbiologist and pioneer antibiotic researcher, who devoted thinking and writing to the never-ending, human adaptive processes of our constantly changing biological, built, and cultural environments—this, before the digital age. Appointed as advisor to the 1972 UN Stockholm Conference on the Environment, Dubos collaborated with British economist, Barbara Ward (and a huge, international group of consultants), to produce the classic, *Only One Earth: The Care and Maintenance of a Small Planet* (Ward and Dubos, 1972)—still a vital, humanistic guide to planetary conservation. Relevant to this chapter, Dubos insisted that environmental issues must be acted on locally, responding to the unique aspects of place, climate, and culture, but always considering the global context. The saying, "think globally, act locally," attributed to Dubos, is a valuable mantra today as ever. The United Nations Environment Program (UNEP or UN Environment), an outcome of the Stockholm Conference, was launched in 1972 with Canadian oil and mineral businessman turned environmentalist, Maurice Strong, as its founding director. The foregoing avalanche of global action gathered even more momentum from publication of the *Limits to Growth*

(Meadows et al., 1972), based on output from one of the first attempts to create a computer model of the future of planet Earth.[9] A 30-year update was published (Meadows, Randers and Meadows, 2004). A further volume projects the future to 2052 (Randers, 2012).[10]

Figure 2. Peripheral trail around school park offers a positive social time for children, healthy exercise, and learning opportunities before, during, and after school hours—and at weekends for local families. Blanchie Carter Discovery Park. Source: Authors.

A key figure from the same era was Kenneth Boulding (1910-1993), English-born, American economist, philosopher, and co-founder of general systems theory. Not insignificantly, Boulding was married to fellow Quaker and collaborator, Norwegian-born Elise Boulding (1920-2010), peace activist, founder of the first academic program on peace studies (Dartmouth College), advocate for children's rights (E. Boulding, 1979), and the participation of children, women, and family in building a "global civic culture" (E. Boulding 1988). In his influential presentation to a Resources for the Future Forum (K. Boulding, 1966) K. Boulding commented that "Spaceship Earth"[11] was obviously a biologically closed system but at the same time home to the open system of human influences and the rest of life, all participating in the "econosphere" of the coming "spaceman economy" (in contrast to negative impacts of what he called the "cowboy economy"). Emphasized, was the urgent need to account for the long tomorrow, quit discounting it, and understand the potentially cumulative impact for the future good of today's small actions (like Dubos). Relevant to this chapter, Boulding hoped that by working on immediate environmental problems "a learning process [could] be set in motion, which

would eventually lead to an appreciation of and perhaps solutions for the larger [problems of 'Spaceship Earth'] (K. Boulding, 1966, 13).

Children-environment relations as a proactive field. Fortunately for childhood researchers, the field of health promotion adopted the socioecological model of Russian-born developmental psychologist, Urie Brofenbrenner (1917-2005). Bronfenbrenner saw childhood and family-life-as-lived at the center of a holistic system, situated within layers of influence—like a Russian doll. The model identifies extended family, community, national, and international influence that impact daily life, offering a framework for conceptualizing intentional change to environment and associated behavior (Schnieder and Stokols, 2008, 85-105). The model is a useful tool for understanding environments of the youngest of our own species in the context of policy development aimed at ensuring optimum quality of habitat conditions for healthy development and well-being.

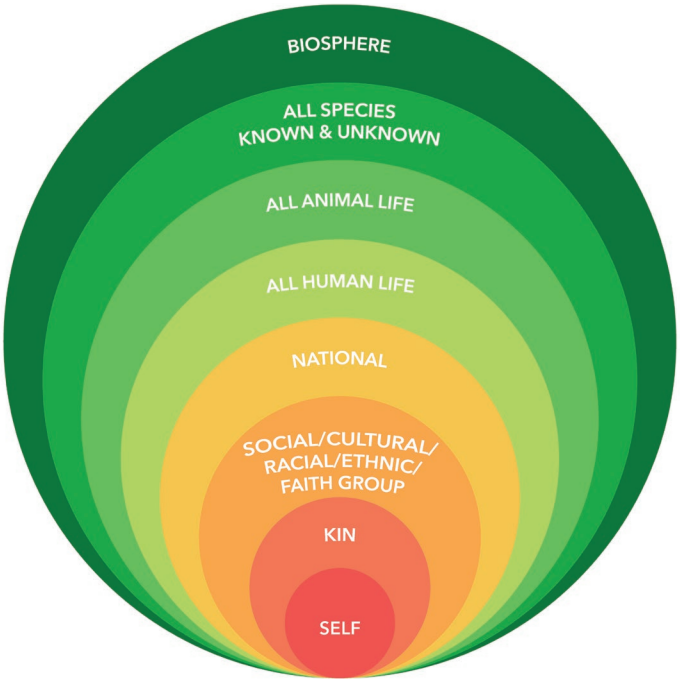

Figure 3. "Me and the Biosphere" Children and youth need to grow and develop in naturalized urban surroundings of everyday life, where they can identify with nature and see themselves as part of their community and culture, sharing our planet together. Source: Natural Learning Initiative.

The founding of *Childhood City* in the early 1970s, within the interdisciplinary ranks of the Environmental Design Research Association (EDRA),[12] was a first step towards recognizing children's environments as a serious scientific field. An eclectic mix of environment and behavior social scientists from environmental psychology, geography, child development, and related fields, began working together with design practitioners and researchers from architecture, landscape design, and urban planning. Similar interests grew in the European equivalent organization, nowadays the International Association for People-Environment Studies (IAPS).[13] Research topics shared at EDRA annual meetings focused on children's spaces in urban and rural contexts, including issues of empowerment of young people as participants in environmental design and decision making, which today is a well-documented, established area of international practice (Derr, Chawla, and Mintzer, 2018). Nonetheless, far greater effort is required before universal adoption by municipal agencies as an integral component of governance, becomes a reality. The emerging movement of youth and young adults protesting the lack of action and irresponsibility of elected leaders on climate change is both a hopeful sign and an intergenerational invitation to join forces in creating nature-based educational strategies (Walker, 2017, 72-83).

The *Childhood City Newsletter,* containing research summaries and field notes, was produced by volunteer colleagues until the *Children's Environments Quarterly* was launched in 1984 by a team of graduate students and faculty at the City University of New York Environmental Psychology Program. International connections began to grow. After several years, the journal moved to the College of Architecture and Planning, University of Colorado, Boulder, retitled, *Children Youth and Environments.* The journal, now published by JSTOR, is housed at the University of Cincinnati, College of Architecture and Urban Planning and College of Education. Children-nature relations is one of many topics attracting regular contributions (Moore and Cosco, 2014, 168-191).

Recognizing the critical role of children's play in healthy child development, the International Playground Association (IPA) was founded in Copenhagen in 1961 as an international voluntary organization, focused on adventure playgrounds and the playwork profession.[14] Launched in Copenhagen in the early 1940s, during Nazi occupation (see Kozlovsky, 2013, for a detailed account), innovative Danish ideas quickly spread to the UK due to the remarkable vision of landscape architect Marjory Gill (Lady Allen of Hurtwood).[15] IPA contributed a cluster of coordinated, national contributions to the United Nation's International Year of the Child (1979),

changed its name to the International Association for the Child's Right to Play, and lobbied strenuously for the "right to play," eventually embodied in Article 31 of the U.N. *Convention of the Rights of the Child* (CRC), adopted by the UN in 1989. The CRC contains 42 Articles covering rights to shelter, clean water, nutrition, health, education, legal standing, and many more, including the right to participate in decisions affecting children's lives (climate change being the most prescient).[16] The CRC has been ratified by all member nations, except the USA.

Global conservation is led by what is now the International Union for the Conservation of Nature and Natural Resources (abbreviated to IUCN), founded in 1948 (at the urging of British biologist, Julian Huxley, then the first Secretary General of UNESCO). IUCN was centrally involved in the Stockholm Conference and is now the leading, worldwide conservation organization working with other global conservation initiatives, a multitude of government and nongovernment organizations, and thousands of volunteer scientists and experts. Over time, IUCN has moved from a rigid "protection of nature" position to embrace sustainable development, including partnership with the private business/corporate sector (controversy not withstanding). Most recently, IUCN has embraced key issues of sociocultural equity and the rights of indigenous peoples in the use of natural resources. In 1991, in partnership with UNEP and the World Wide Fund for Nature (WWF), IUCN published a wide-ranging conservation strategy, *Caring for the Earth: A Strategy for Sustainable Living* (1991), which included children as co-activists in restoring degraded land and planting trees (p.54), along with stressing the importance of literacy and primary education. In 2018, in collaboration with Nature for All and the U.S. Children and Nature Network, IUCN published *Home to Us All: How Connecting with Nature Helps Us Care for Ourselves and the Earth* (IUCN, 2018), "dedicated to the children of the Earth, their brothers and sisters of all species" (p.1). Highlighting a focus on childhood and education, *Home to Us All* urges attention to the urban environment where the majority of humans now live, out-competing other life forms. In 2007, the rural-urban population balance was roughly equal. Since then, urbanization has been accelerating,[17] with attendant concern for biodiversity and ecosystem services (Elmqvist et al., 2013).

Figure 4. In a small, remnant, urban woodland, young children explore life on a piece of dead bark on the ever changing forest floor. An enthusiastic teacher asks questions and guides the conversation. First Environments Early Learning Center. Source: Authors.

Environmental justice and health equity for people and planet

While the above actions were underway, American marine biologist Rachel Carson (1907-1964), was painstakingly compiling the mass of evidence justifying her claims about the toxic effects of synthetic pesticides (that she felt should be termed "biocides") on wildlife and human life. Her efforts resulted in the highly influential book, *Silent Spring* (Carson, 1962, 2002), identifying the now blindingly obvious public health link between environmental health and human health. International recognition of this truth was reinforced by the *Ottawa Charter for Health Promotion* (WHO, 1986),[18] which included as fundamental prerequisites of health, "strengthen community actions" and "create supportive environments" as two of five "essential health promotion actions," along with peace, social justice, and equity.

More recently, the "Manhattan Principles (Wildlife Conservation Society, 2004) include: "Invest in educating and raising awareness among the world's

people and in influencing the policy process to increase recognition that we must better understand the relationships between health and ecosystem integrity to succeed in improving prospects for a healthier planet."[19] The WHO report, *Ecosystems and Human Well-Being* (Corvalán, Hales and McMichael, 2005), most recently underscores a growing understanding among policymakers that the health of humankind, animals, and the biosphere is interwoven in a single, interdependent system, termed "one health" (Barrett and Osofsky, 2013, 364-377). Although the operational challenges surrounding the concept are still evolving (Lee and Brumme, 2012, 778-785), global climate change dramatically underscores the conceptual reality.

Recognizing that environmental justice and social equity must go hand-in-hand, the Millennium Development Goals (MDGs) were established in 2000, including aims to end global extreme poverty and achieve universal primary education. This was prior to the UN summit recommending a broader set of Sustainable Development Goals (SDGs), which came into force January 1, 2016.[20] The SDGs reflect global awareness that ending poverty must partner with strategies to build economic growth and address social needs including education, health, social protection, and job opportunities, while at the same time acting on climate change and environmental protection. The SDGs call on all countries, poor, rich and middle-income, to promote prosperity, to protect the planet, and ensure that no one is left behind (Griggs et al., 2013; Kates et al., 2012, 8-21)

Decades, if not centuries of pondering human dependence on nature became defined in the *Millennium Ecosystem Assessment* (MEA)[21] as "the benefits people obtain from ecosystems," categorized as Provisioning Services, Regulating Services, and Cultural Services. Although the latter includes "education and science," links to early childhood and primary and secondary education, are surprisingly minimal. MEA was followed by the companion *Common International Classification for Ecosystem Services* (CICES), released in revised form in 2018 as a necessary tool for measuring, assessing, and accounting ecosystem services (Haines-Young and Potschin-Young, 2018). Human enjoyment of the "services" offered by nature is a double-ended equation. Equally, humans must care for, conserve, restore, and protect nature. Beginning in 2009, IUCN championed *Nature-Based Solutions* (NBS) as the use of nature for simultaneous benefits to biodiversity and societal well-being.[22] In 2016, members adopted a resolution defining NBS as "actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively – simultaneously providing human well-being and biodiversity benefits." Following several rounds of institutional and

public consultation, the final NBS Global Standard is due to be launched mid 2020. For more information, see Cohen-Sacham et al. (2016).

Connecting Sustainable Development Goals, Social Determinants of Health, and the Convention on the Rights of the Child. Once cures for communicable diseases had succeeded, it was not long before obesity, slowly building through the 1990s, attributed mainly to rapid, post-industrial lifestyle changes (sedentary habits and industrialized, high calorie foods), became an international crisis. In the U.S., active living/healthy eating, research-driven movements took off in the early 2000s, supported by major foundation funding.[23] Initially, empirical science, reflecting the epidemiological traditions of public health, drove the research agenda, focused on adult populations in low resource communities—occasionally including adolescent youth. Research interests gradually included younger age groups, finally reaching the daily life spaces of early childhood. This population, defined as children birth though seven years old, can be seen as a critical launching pad for individual life trajectories physically, mentally, emotionally, and socially. Although children can be remarkably resilient, occasionally surviving extreme adversity, sometimes to the extent of positively framing a successful, creative adult life; more likely, though, adverse childhood experiences (ACES) can have crippling, life-long negative health and wellbeing consequences. Growing up in green residential areas may have a protective effect (Engemann et al., 2019, 5188-5193). Even so, the unpredictability of individual life outcomes reflects new understanding of epigenetic effects (see *The Orchid and Dandelion,* Boyce, 2019).

During this period, the WHO *Commission on the Social Determinants of Health,*[24] 2005-2008, chaired by British social epidemiologist Sir Michael Marmot, published the second edition of primary papers (Marmot and Wilkinson, 2006). In 2008 final recommendations were delivered defining the social context for achieving health equity, including (significant to the discussion here), early childhood development, urban planning and design, the natural environment, community participation, research, training, and education.[25] See also *The Health Gap* (Marmot, 2015). International meetings in Adelaide, Helsinki, and Shanghai, produced the Health in All Policies (HiAP) Statement,[26] which were mapped over the Sustainable Development Goals,[27] which UNICEF also mapped over the Convention on the Rights of the Child, demonstrating multiple links between the Sustainable Development Goals and children's rights.[28] The result is a complex meshing of innovative, international cross-sector policies, which offer rich mix-and-match options for local policy initiatives and action plans connecting child development, health, and environment (Figure 5). Social Determinants of Health achievements continue to be reported (Donkin, Goldblatt and Allen, 2017).

Figure 5. Sustainable, equitable, global culture is supported by three realms of international policy. Foremost is the *Convention on the Rights of the Child* (inner ring), an international treaty with 42 Articles mandating basic child rights; *Social Determinants of Health,* defining 5 key areas influencing human health and equity; and 17 *Sustainable Development Goals,* 10 of which UNICEF is custodial for, including early childhood development. Source: Natural Learning Initiative, based on CRC and SDG icons.

Recognizing young children as critically significant for sustainable development. Until recently, environment and behavior research titles with the word "people" almost never included children under five years old; thus, early childhood research instruments and methodologies are more likely to be adapted versions of those used with school-age populations. Although relatively rare, school-age studies are advancing, particularly in health-related research. Explicit links to Sustainable Development Goals

have still to be achieved. A rare exception is discussed below. Studies with adolescent populations are more commonplace and will surely advance as the student climate change movement grows. Today, although the majority of extant scientific findings still come from adult studies, childhood research is growing fast. Results support what may be considered an obvious assumption, that engaging children with nature in the first years of life can offer a cost-effective, multifaceted, health-promotion strategy with beneficial effects for both people and planet. Of critical importance, early exposure and engagement with nature may support affective and cognitive impacts, so children become adults with deeply held nature-based values and unwavering commitments to caring for the planet (Chawla and Derr, 2007, 527-555).

Children's lack of engagement with nature is a consequence of larger cultural trends, which begs the question of where to find solutions with the greatest potential influence on bigger societal systems. New understanding of early brain development and a realization that early childhood is the most critical phase of life supports the need for nature conservation and interventions that re-nature the environments of everyday life. They include home, childcare, school, residential neighborhoods (Engemann et al. 2019, 5188-5193; Sullivan, Kuo and DePooter, 2004, 678-700), and the walking/biking flow spaces connecting them (Islam, Moore and Cosco, 2016, 711-736; Pacilli et al., 2013, 377–393).

In 2004 a significant stride forward occurred when the conference on education for sustainable development "Learning to Change Our World" was held in Gothenburg, Sweden. A second workshop, "The Role of Early Childhood Education for a Sustainable Society," occurred in 2007, which resulted in the UNESCO publication, *The Contribution of Early Childhood Education to a Sustainable Society* (Pramling, Samuelsson and Kaga, 2008). The three-point case presented in the introduction, succinctly summarizes arguments supporting the important role of early childhood education in sustainable development:

> "First, our societies urgently require new kinds of education that can help prevent further degradation of our planet, and that foster caring and responsible citizens genuinely concerned with and capable of contributing to a just and peaceful world. Second, these new kinds of education must be available to all—not only a handful of people—and take place in various settings, including families and communities. Third, they must begin in early childhood, as the values, attitudes, behaviors and skills acquired in this period may have a long-lasting impact in later life. Thus, early childhood education clearly has an important place in the efforts to bring about sustainable development." (9)

A summary of the workshop (35 participants, 16 countries) concludes with a *12-point action plan* reflecting the above (Pramling, Samuelsson and Kaga, 2008). A further giant step was taken by OMEP (World Organization for Early Childhood Education),[29] motivating them to conduct a World Project (2009-2014) to support the UNESCO decade on Education for Sustainable Development (2005–2014) with 28 participating countries, involving 44,330 children and 13,225 teachers (Engdhal, 2015, 347-366). Results showed:

> "Young children have significant knowledge about the Earth and important ideas about environmental issues, as well as knowledge of the responsibilities which individuals carry with respect to sustainability … it was strongly apparent that adults often underestimate the competencies of young children." (Engdhal, 2015, 347)[30]

If these early childhood strategies gain rapid traction and influence emerging adult generations to adopt pro-sustainability values, conservation behavior may drive a widening array of contributions to sustainable development. Actions such as urban re-forestation, creation of low-input urban food systems, advocacy for low-carbon and alternative energy industries, may be driven by citizens, taxpayers, voters, elected representatives or volunteers—all motivated by local action contributing to global sustainability goals. For this to happen fast enough to create the massive intergenerational change in values required to avert predicted, catastrophic climate change, implies a revolution in mandated childhood education. Noteworthy here is the OECD *Future of Education and Skills 2030* initiative, calling for new solutions that respond to the global digital age in the context of creating a new world order. Collaborative learning processes are required that help students gain the agency needed to navigate and respond to the potentials and challenges of an unknown future (OECD, Student Agency for 2030).[31] Humanistic values must be prioritized together with broad, problem-solving skill sets, beyond the instrumental, necessary for successful, planetary cultural evolution (OECD Learning Compass 2030).[32]

Children and nature as a socio-environmental "movement." Attention to children and nature rapidly became a social movement with the publication of *Last Child in the Woods* (Louv, 2005). The first national conference on children and nature took place in 2006 along with the founding of the Children and Nature Network (C&NN).[33] Biennial gatherings now register close to 1000 participants and mirror similar movements in other countries. Current issues include green schoolyards, cities connecting children to nature, and nature-based learning (Kuo, Barnes and Jordan, 2019).

Focus on the everyday settings of childhood still does not match the demographic global reality of the majority of children living in cities. In the US, approximately 80% of children are urban. Until recently, buildings rarely appeared in children and nature visuals promoting the out-of-doors in the early years. More often, photos focused on scenes beyond the urban fringe, in pristine nature. A focus on socio-economic equity inevitably draws attention to the denatured everyday surroundings of low-resource communities, where renaturing could have the greatest benefit to those who need it most. Heeding the call for design practitioners to participate in the restoration process, in 2009 the American Society of Landscape Architects (ASLA) voted to create a Children's Outdoor Environments Professional Practice Network (PPN), which grew rapidly as one of the largest, active groups. Nevertheless, design professionals with a passion for creating places where children can engage with nature still find themselves constrained by economic, legal, and institutional limitations. New, inter-professional, cross-sector, hybrid implementation models are required to expand progress.

Figure 6. Teardrop Park in high density Manhattan, NYC, offers a nature playground to children of all ages, including a miniature woodland that also gathers and purifies storm water. Design: MVVA. Source: Authors and Battery Park City Conservancy.

Engaging children and nature

The scientific study of human response to nature has a clear lineage beginning with Rachel and Stephen Kaplan, environmental psychologists at the University of Michigan, who started investigating people-nature relations in the in the 1970s. In 1989, they published the more academic of their two most influential books, *The Experience of Nature: A Psychological Perspective* (Kaplan and Kaplan, 1989). The second book, *With People in Mind: Design and Management of Everyday Nature* (Kaplan, Kaplan and Ryan, 2004), expertly illustrated by third author Robert Ryan, is geared toward practicing professionals and has influenced the education of several generations of landscape architects, motivating them to consider nature as a restorative experiential medium, modifiable through design. Studies of "nearby nature" suggest that small episodic dosage can be effective (Sullivan, Kuo and DePooter, 2004, 678-700). Although the Kaplan's did not study the effects of nature exposure on children, their pioneering work has helped spawn a second and third generation of researchers engaged in an ever-broadening range of people-nature studies. Other social scientists use the results to raise concerns about the negative consequences of childhood "extinction of experience" (Reed, 1996) and support for engagement with nature as a path to childhood health and wellness (Chawla, in press). To achieve this goal, innovative policy is urgently required in urban planning and education, to renature childhood in residential areas and schools (Soga and Gaston, 2016, 94-101).

Rapid advances in digital, real-time technology, have spawned a new wave of both lab-based and field-based human response to nature studies related to children, as referenced in this volume. Even though studies of children and nature are under-represented, possibly because of institutional review board constraints, study results necessary for informing policy innovation are appearing (Ward et al., 2016, 44-50), along with critical policy-sensitive studies on topics such as residential neighborhoods (Handy, Cao and Mokhtarian, 2008, 160-179) and parks (Cohen et al., 2016, 419-426; Loukaitou-Sideris and Sideris, 2010, 89-107).

The Natural Learning Initiative (NLI)[34] was founded in 2000, following through on earlier work, to create high quality evidence-based/informed environments for healthy childhood development in vulnerable communities, in the spaces of everyday life (homes, early childhood centers, schools, after-school programs, parks, special education centers, zoos, museums, botanical gardens, nature centers, and neighborhoods). Direction was set by the NLI mission: *Healthy human development and a healthy*

biosphere for generations to come. Using biophilic design strategies (Moore and Cooper Marcus, 2008), nature-based solutions integrate diverse activity settings with extensive site-level re-naturing. The ultimate aim is to influence childhood outdoor environment policy to emphasize health promotion factors, time outdoors, increased physical activity, and nature engagement, including fruit and vegetable gardening. Community/parental participation, professional development, and policy analysis and recommendations are keys to success. The goal is to create nature-rich environments that pull children and accompanying adults outdoors, to support healthy, joyful childhoods. Demonstration sites show educators, parents, and regulators how to expose children to the benefits of engaging with nature and avoid childhood obesity (which once it occurs is difficult to reverse).

Today's children and families face limited opportunities to connect with the natural world. Louv (2006) called this phenomenon "nature-deficit disorder" and opened eyes to the historic, beneficial effects of nature for generations to come. Also documented were the barriers that now limit children's experience of nature, including dramatic changes in contemporary family life. Even in early childhood, children spend more time viewing screens indoors than being physically active outside (Hesketh, Hinkley and Campbell, 2012). Childhood time is overly structured and parents are apprehensive about letting kids roam outdoors (Tremblay et al., 2015, 6475-6505). Families are eating more processed, high-calorie foods due to their busy schedules, which reduces opportunities for family time, and sit-down meals (Capizzano and Main, 2005).

Re-naturing increases biodiversity and positive human development by adding trees, shrubs, vines, and ground covers to barren spaces where nature has been removed. Typically, the outdoor spaces of early childhood facilities (childcare centers and schools) are bereft of nature because the land was cleared for building and not restored. Urban U.S. schoolyards inherited a legacy of asphalt, rolled out to reduce the maintenance burden but offering the poorest, most boring environments for children. What were they thinking of? In suburban schools, mown grass is the monoculture of choice—slightly less boring but similarly low in activity affordances per unit area. Lack of stormwater drainage and poor soil quality are endemic problems, directly in conflict with sustainable best practices. Soil quality requires remediation before redevelopment/renaturing can begin. Naturalization broadens the diversity of children's play and learning experiences, contributes to positive physical, social-emotional, and cognitive development, boosts human immune systems, calms and destresses, exposes children to living ecosystems and stimulates their

curiosity to explore the wonders of nature early in life (Chawla, Keena, Pevec and Stanley, 2014; Moore and Wong, 1997).

City-scale renaturing may also serve environmental equity by addressing the legacy of denatured neighborhoods created during the industrial era, especially in low income areas. Post-industrial development in the last few decades has seen many encouraging examples of nature restoration to barren urban lands. Although a new era of urban landscape restoration is underway, sites are often large, politically viable but located far from the daily lives of children. As the planet continues to urbanize, selected "nearby nature" or neighborhood common lands could be conserved or restored where children live, instead of becoming "urban infill" sites. Restoration of nature to the everyday spaces of early childhood is a nature-based solution, remediating a social determinant of health, offering hope to communities, supported by all who care about children's healthy development. A note of caution: the process of upgrading environmental quality, including re-naturing of living spaces, can easily lead to rising land values and gentrification that displaces the population intended to benefit (Maantay and Maroko, 2018). Solving this conundrum may well require government participation in the real estate market.

Figure 7. Cave-like places embedded within the surface of the Earth fascinate and shelter children and stimulate hide-and-seek games. Cincinnati Nature Center. Source: Authors.

Children need to spend more time outdoors playing and learning freely in natural settings. In *Free to Learn* (Gray, 2015), the evolutionary psychologist, Peter Gray, notes that human dependence on nature underscores a long list of psychological, physical, and social benefits afforded by free, spontaneous play, and stresses the negative consequences to children and society of "play deprivation." Nature as a context for acquiring conservation values, multi-faceted learning, and reduction of barriers to learning is strongly supported by a recent literature review (Kuo, Barnes and Jordan, 2019):

> "Over fifty studies point to nature playing a key role in the development of pro-environmental behavior, particularly by fostering an emotional connection to nature. In academic contexts, nature-based instruction outperforms traditional instruction. The evidence here is particularly strong, including experimental evidence; evidence across a wide range of samples and instructional approaches; outcomes such as standardized test scores and graduation rates; and evidence for specific explanatory mechanisms and active ingredients. Nature may promote learning by improving learners' attention, levels of stress, self-discipline, interest and enjoyment in learning, and physical activity and fitness. Nature also appears to provide a calmer, quieter, safer context for learning; a warmer, more cooperative context for learning; and a combination of "loose parts" and autonomy that fosters developmentally beneficial forms of play. It is time to take nature seriously as a resource for learning—particularly for students not effectively reached by traditional instruction." (Kuo, Barnes and Jordan, 2019, 1).

A related group within the U.S.-based Children and Nature Network, at the 2018 international meeting in Oakland, California, drafted the *Oakland Declaration on Nature-Based Learning,* recognizing recent events highlighting the interplay of global conservation and human health and the vital role of childhood learning in forging such links. The *Declaration* was published online in 2019, offering a general statement for international endorsement.[35] Together with the Canadian *Position Statement on Outdoor Play* (Tremblay et al., 2015, 6475-6505), these documents underscore the developmental importance of free play and potential for learning in natural settings that have been well documented in numerous research studies and publications (Chawla, 2015, 433-452). Creating habitats for plants and wildlife restores ecosystems while providing children with a health-promoting, learning environment affording multiple benefits summarized below.

Physical health benefits

Increases physical activity. Children who experience play areas with diverse natural settings are more physically active, more aware of nutrition, more civil to one another and more creative (Finn, Johannsen and Specker 2002, 81-85; Dyment and Bell, 2007, 463-477). Children engage in more vigorous activity outdoors than indoors (Raustorp et al., 2011, 801-808). Lush environments support increased levels of physical activity of preschool children by motivating free-play and hands-on learning experiences (Boldemann et al., 2015, 111-138). Levels of physical activity in young children attending childcare centers may be influenced by culture, geographic differences, and educational approaches (Boldemann et al., 2015, 111-138).

Improves nutrition. Children who grow their own food are more likely to eat fruits and vegetables (Cabalda et al., 2011, 711-715). Preschool gardening supports knowledge and consumption of fresh fruit and vegetables (Benjamin-Neelon and Evans, 2011; Castro et al., 2013, S193-S199).

Improves eyesight. More time spent outdoors is related to reduced rates of nearsightedness (myopia), in children and adolescents (Rose et al. 2008, 1279-1285; Wu et al., 2013, 1080-1085).

Reduces risk of asthma and other allergies. Increasing biodiversity and contact with diverse living organisms from all sources of nature (plants, animals, insects, bacteria) is associated with the balance of individual microbiota, boosting the immune system, which may reduce allergies including asthma (Haahtela et al. 2013). Contact with environments rich in microbes in childhood reduces the risk of developing atopic disease later in life (Riedler et al., 2001, 1129–1133).

Protects children from harmful sun radiation. Forty eight percent of North Carolina providers mentioned trees as an important means of sun protection for children in childcare centers (Natural Learning Initiative 2003 survey, N=328). Vegetation has a protective effect and supports longer stays outdoors. Naturalization is a cost-effective health promotion strategy (Boldemann et al., 2015, 111-138).

Figure 8. Small, urban woodlands with designated play settings and natural loose parts can be managed as creative play and learning spaces, attracting children to collaborate and create together. Cincinnati Nature Center. Source: Authors.

Social-emotional benefits

Improves social relations. Children will be smarter, better able to get along with others, healthier and happier when they have regular opportunities for free, unstructured play in the out-of-doors (Burdette and Whitaker, 2005, 46-50).

Improves self-discipline. Access to green spaces, and even a view of green settings, enhances peace, self-control and self-discipline for inner city youth, particularly in girls (Kuo and Sullivan, 2001, 543-571).

Reduces stress. Green plants and vistas reduce stress among children living under difficult circumstances. Locations with greater numbers of plants, greener views, and access to natural play areas show more significant effects (Wells, 2000, 775-795). Especially schoolgrounds, where children are mandated to be, should be considered as havens against stress (Chawla, Keena, Pevec and Stanley, 2014; Moore and Wong, 1997).

Supports mental health. A systematic review of literature by Tillman et al. (2018, 958–966) found "About half of all reported findings revealed statistically significant positive relationships between nature and mental health outcomes…"

Impacts positive behavior. After outdoor renovation, 68% of North Carolina center directors reported positive changes in children's behavior and 40% mentioned edible plant installations as their greatest success (Cosco, Moore and Smith, 2014, S27-S32).

Increases cooperation. Schoolyard studies found that children played more cooperatively (Dyment and Bell, 2007, 463-477).

Cognitive benefits

Supports creativity and problem solving. Studies of children in schoolyards found that children engage in more creative forms of play in green areas (Dyment and Bell, 2007, 463-477). Play in nature is especially important for developing creativity, problem-solving, and intellectual development skills (Kellert, 2005).

Enhances cognitive abilities. Proximity to, views of, and daily exposure to natural settings increases children's ability to focus and enhances cognitive abilities (Wells, 2000, 775-795).

Improves academic performance. Studies in the US show that schools using outdoor classrooms and other forms of nature-based experiential education support significant student gains in social studies, science, language arts, and math (American Institutes for Research, 2005).

Reduces Attention Deficit Disorder (ADD) symptoms. Contact with the natural world can significantly reduce symptoms of attention deficit disorder in children as young as five years old. The greener a child's everyday environment, the more manageable are their ADD symptoms (Faber Taylor, Kuo and Sullivan, 2001, 54-77; Faber Taylor and Kuo, 2009, 402-409).

Conservation benefits

Supports pro-environment attitudes and behavior in adulthood. Approximately 2,000 adults age 18–90 living in U.S. urban areas were interviewed regarding both their childhood nature experiences and current adult attitudes and behaviors related to the environment. Childhood participation in "wild" nature such as hiking or playing in the woods, camping, and hunting or fishing was positively associated with pro-environmental attitudes and behaviors. Childhood participation with "domesticated" nature such as picking flowers or produce, planting trees or seeds, and caring for plants was positively associated with pro-

environmental attitudes and marginally related to environmental behaviors (Wells and Lekies, 2006, 1-24).

Supports environmental protection behaviors. Positive direct experience in the out-of-doors, beginning in the pre-literate developmental stage (Chawla and Derr, 2012, 527-555), and being taken outdoors by someone close to the child—parent, grandparent, or other trusted guardian—are factors that most contribute to individuals choosing to take action to benefit the environment as adults (Heft and Chawla, 2006, 199-216).

Figure 9. Nonformal education centers such as botanical gardens can be designed to be integrated with nature as "green infrastructure," attractive to people of all ages to explore and enjoy together. North Carolina Botanical Garden. Design: Frank Harmon Architect. Source: Authors.

Dose response and children's need to *interact* with nature? To date, much of the literature on childhood relationships with nature includes undefined terms such as "contact," "in," "use," and "engaged." From the perspective of children, hands-on manipulation is the most meaningful relationship. The systematic review conducted by Tillman, Clark and Gilliland (2018, 199-216) identifies methods used to assess children's relationship with nature and groups studies in three broad measurement categories: 'accessibility,' 'exposure,' and 'engagement,' summarized below:

***Accessibility*—**refers to opportunities for encountering nature within a meaningful buffer area (walkable/bikeable distance) around a child's home, measured as a relative amount or density of green and/or blue (aquatic) space. Buffers may be circular or based on the network of potential access routes (streets, greenways, and trails) linking home to natural spaces (Oliver, Schuurman and Hall, 2007). Network buffers are more sensitive to physical reality by taking account of entrances to parks and other green spaces, and barriers such as rail lines, elevated highways, and off-limits private land, etc.

Circular buffers ignore such influences on movement. Furthermore, from the perspective of an independently mobile child, the type of individual patches of nature (mown grass vs woodland, vacant land vs park, etc.) may be "read" differently and thus influence use (Tillman, Clark and Gilliland, 2018, 199-216). Similar variables likely would impact green space use by children accompanied by adults. The "grain" of nature; i.e., many small patches vs large chunks vs linear elements such as natural stream corridors, greenways, and green streets may also affect perception and use. To our knowledge, such "distribution" variables have not appeared in research designs. Until now, with some exceptions (Lee, 2015), studies have tended to focus on quality of destinations rather than attributes of routes (including bio-attributes).

***Exposure*—**implies the possibility for direct encounter with nature rather than mere opportunity. Most studies measure exposure as use of a natural area or 'time spent in or near' nature. Again, focus has been on destinations rather than routes.

***Engagement*—**implies sustained involvement or intentional interaction (programs such as gardening and camping) (Tillman, Clark and Gilliland, 2018, 199-216). Some would argue that to fully appreciate nature, to acquire tacit knowledge, experience must be tangible and direct (Reed, 1996). For young children, hands-on play in and with nature affords depth of experience that stimulates the senses, provokes tacit learning, and provides opportunities for positive social interaction across age groups, cultural/ethnic/racial/religious backgrounds, and gender (Moore and Wong, 1997). Engagement with nature through spontaneous play is a traditional form that shrank dramatically in the last few decades (Natural England, 2009). However, engagement typically occurs in localized spaces where design and child-friendly environmental management could increase effectiveness.

Regardless of context, for young children, a small area of even mediocre biodiversity may offer rich bio-experiences. Ground surfaces are especially relevant as they are so close to the eyes and hands of preschoolers. Duff-covered woodland affords endless delight for young children as they convert fallen leaves and seeds into pretend dishes, scratch and dig dirt

with sticks or use them to construct fairy houses, sculpt pine needles into street systems in imaginary neighborhoods, convert those especially magical places between tree roots into worlds long forgotten by rational adults. Such activity can be appreciated by adults as joyful fun but for the child there are critical needs being met: social interaction, learning to cooperate with others to execute shared play scenarios that may change at any moment depending on who enters or leaves the space.

Diverse nature play activities stimulate creativity, support sensory and social integration, provide opportunities for acquiring agency, the gaining of tacit knowledge and understanding—how the world of things and people works. Open-ended play allows children to amplify their locus of control, enabling the construction of strongly rooted, confident knowledge that can only be gained through direct, unfiltered, undirected attention. Spaces can be intentionally designed with affordances that children activate to achieve predictable effects. If adults stay away, each child can exercise their unique talents and shape their own personality. This type of spontaneous activity, we call *informal play and learning,* where the child is obviously learning, even though ends and means are both open (Moore and Wong, 1997). Philosophically, the point is to be pointless. Children may say, "nothing," when asked what they are doing, because the experience resides in that magical, nonverbal domain of childhood imagination.

Formal classroom activity is the opposite. Both ends and means are fixed and explicit. Do this and you should achieve that! Somewhere in the middle is *nonformal play and learning* (Moore and Wong, 1997), which can happen in many types of venues and spaces. Traditional activity programming in parks fits this definition with the exception of organized sports. Highly relevant is the type of creative programming occurring in museums, zoos, and public gardens, employing fixed means (science-related equipment, garden exploration, animal-related artifacts) but relaxed ends with open-ended discussion. Playworkers are trained to engage with children in this nonformal sector. Progressive education approaches may mix all three experiential domains. Mandated, test-driven public education, it could be argued, operates too exclusively in the formal domain and would serve children more effectively by at least offering periods of outdoor informal activity—especially if bland schoolgrounds were renatured. A study by Kuo, Browning and Penner (2018) suggests that lesson plans combining outdoor activities in nature with indoor study ("refueling in flight"), may have a positive impact on the latter, helping children return indoors more able to concentrate.

Figure 10. Nature integrated into diverse, shady, play and learning places motivates young children to move! First Environments Early Learning Center. Source: Authors.

Evidence-based, built-environment design as a health promotion intervention in childcare facilities

The majority of U.S. children of working parents attend some form of childcare, often eight to ten hours per day. Childcare outdoor spaces are usually denatured, which makes naturalization an important cost-benefit strategy for children's overall healthy development. In the U.S., children must attend school at age five, increasingly accompanied by four-year-olds from low resource communities, supported by state programs. In public schools, outdoor spaces are larger and typically monocultures of manufactured play equipment, wood chips or rubberized play surfaces, mown grass, and with luck a few shade trees. Such spaces are boring, uncomfortable physically and socially, and overexpose children to harmful ultraviolet light. Even the most creative teachers cannot use such bland spaces to support outdoor learning.

Negative environmental conditions present an ethical issue. Legal obligations to attend school must be matched with a societal obligation to provide the best possible nurturing environments where children can develop their inborn talents and learn about human dependency on nature. The growing stream of early childhood environment-behavior research reported here, is surely sufficient to promote nature engagement as a required ingredient of children's daily informal and formal learning experience at school.

Renaturing outdoor play and learning spaces. Preschool offers outdoor spaces and programs where a mix of informal/formal/nonformal approaches to play and learning is a highly relevant strategy. In 2007, the Natural Learning Initiative (NLI) launched a built-environment, health-promotion strategy (Preventing Obesity by Design or POD), reflecting the North Carolina Department of Child Development and Early Education (DCDEE) adoption of "Outdoor Learning Environment" in the state licensing regulations for childcare centers. More than a decade later, POD reflects the U.S. Centers for Disease Control (CDC) focus on early childhood (0-8), and the social determinants of health.

POD is aimed at increasing early childhood physical activity, healthy eating, outdoor learning, social-emotional development, and daily contact with nature. The strategy is supported by evidence-based design assistance, professional development, higher education curricular modules, and resource dissemination. OLE implementation is driven by community engagement in participatory design processes using a repertoire of field-tested activity settings to create master plans that guide incremental development, implemented as funding and volunteer community assistance become available. Nature conservation through experiential learning is an underlying goal.

The theoretical framework applied by NLI combines the concepts of *behavior setting* (unit of analysis) (Barker, 1976), *affordance* (Gibson, 1979; Heft, 2001), *territorial development* (Hart, 1979; Moore, 1986), and *incremental development* (Moore and Cosco, 2014, p.175) as theoretical constructs linking design with applied research to continuously inform design thinking and related participatory community processes. Pre-post, mixed-methods (surveys of directors and parents, teacher daily journals, behavior mapping, and best practice indicators (BPIs)) are used to assess environment-behavior impacts. Measurement tools include POEMS (Preschool Outdoor Environment Measurement Scale – DeBord et al., 2005).[36]

The strongest objective study to date employed behavior mapping to investigate built environment characteristics in 30 childcare outdoor environments, with 6,083 behavioral observations gathered across 355 behavior settings. Results show that each setting adjacency may increase physical activity 6.4%-7.6% and central location of a setting may increase physical activity 13.8% – 16.1%. (Smith et al., 2014, 550-578).

POD surveys of center directors indicate that children attending naturalized childcare facilities spend more time outdoors across all seasons, rest more easily, see nature as a benevolent companion, adapt more quickly to healthy eating of fresh fruit and vegetables, and transfer enthusiasm to home. Directors report that those with respiratory problems appear to have reduced symptoms. Teacher journal posts (N=141) demonstrate how increased

biodiversity motivates outdoor time and engages children in active learning, including hands-on gardening, across all developmental domains.

Preschool physical activity levels are associated with the additive effect of the layout of the site, its components, and attributes, including pathways, play structures, open areas, and natural elements (Cosco, 2006). Diverse play areas, combining a range of setting sizes, are expected to be more active. Activity levels are associated with different types of behavior setting. Most active are likely to be wide, curvy, wheeled toy pathways (Cosco, 2006). The same type of setting with different attributes (i.e. circular versus straight pathways) and open areas with different ground surfaces (i.e. asphalt, compacted soil, woodchips, and sand) support different levels of physical activity.

Evidence-based design decisions are guided by findings (Moore and Cosco, 2010, 33-72; Smith et al., 2014, 550-578) demonstrating that outdoor physical activity can be improved by design. Compact settings support rich play and educational programs fostering social interactions that are likely to support sustained moderate and vigorous outdoor physical activity (Cosco, 2006), along with social-emotional learning. Landscape design with continuing technical assistance can impact preschool physical activity, healthy eating, and outdoor learning (Moore and Cosco, 2014, 168-191). Renatured outdoor play and learning spaces provide children with self-actualizing play and learning opportunities that teachers can build on to extend learning without necessarily having to initiate the process. Natural spaces almost effortlessly become harmonious places of shared, open-ended learning, reducing pedagogical pressure on teachers to be ever-present.

Best practice guidelines are derived from research findings that support evidence-based design (Cosco, 2006; Cosco, Moore and Islam, 2010, 513-519; Cosco, Moore and Smith, 2014, S27-S32). For example, site layout attributes, such as the form of pathways (i.e., ''single loop'' and ''double loop'' functioning as circulation routes and wheeled toy settings), are associated with higher levels of physical activity while teacher interaction is associated with decreased physical activity (evaluation of POD centers, using behavior mapping; Cosco, Moore and Smith, 2014, S27-S32).

The combined impact of renatured, preschool outdoor environments on physical activity and sun exposure, suggest that policies guiding implementation are critical for healthy development of children (Boldemann et al., 2011, 72-82). For example, lack of connectivity between outdoor learning areas (e.g., by installing internal fences) my limit opportunities for sustained physical activity of children motivated to explore (Cosco, Moore and Islam, 2010, 513-519).

Built environment, post-occupancy evaluations are a critical support for changes in childcare policy (Smith et al., 2014; Cosco, 2007). Environmental quality assessed using POEMS was higher after renovation. Three of five

POEMS Domains (Physical Space, Interactions, and Teacher/ Caregiver Roles) were positively associated with increased physical activity. Built environment renovation, coupled with teacher training, may support increased physical activity (Cosco, Moore and Smith, 2014, S27-S32). Inclusion of food gardens is a key to success for preschool health promotion (Cosco, Moore and Smith, 2014, S27-S32). The form of outdoor learning environments (number of activity setting adjacencies and activity setting centrality) facilitates higher levels of physical activity (Cosco, Moore and Smith, 2014, S27-S32). Use of moveable components such as wheeled toys and balls and small, loose parts supplied by nature support child-to-child interaction, fostering physical activity (more for boys than girls); whereas, a teacher's custodial actions limit physical activity. (Smith et al., 2014, 550-578).

Figure 11. Giant bamboo forest offers wild adventure play to older children, facilitated by playworkers. North Carolina Children and Nature – PlayDaze. Source: Authors.

Policy, and institutional change—the next frontier

The principal output of POD is the renaturing of typically barren preschool outdoor spaces of 3-5 year olds, so they contain a diverse mix of natural and manufactured components within a shady "microforest." To date, 120 model sites have been created across North Carolina, including those resulting from the 2011 adoption of POD as the built environment component of a statewide comprehensive health program (Shape NC), targeting childcare centers. Results from multiple POD studies, together with research findings by others,

provide compelling evidence to influence system-wide early childhood outdoor policy—to date adopted in three additional US states.

Engaging children with nature in daily life requires massive policy developments in key sectors, aligned with the social determinants of health, in concert with institutional changes required to implement policy, including education of new types of broad-based design professionals grounded in the social and biological sciences. Revised codes of conduct and realms of responsibility are needed to tackle old problems in new ways. An example is the design of secondary/residential streets as primarily flow space for pedestrians and cyclists. When children walk or bike to school, local carbon footprints are reduced, and dependence on four-wheeled mechanical conveyances is less likely to develop. Safe, attractive, shady, naturalized streets can become corridors of life crisscrossing the city, providing linear play spaces that can creatively engage children to 'play along the way' after school. A growing body of research evermore strongly supports the case for integrating diverse nature in built environment planning and design norms for residential areas as a health promotion strategy, including mental health (Engemann et al., 2019, 5188-5193).

Conclusions

Best practice design can restore nature to everyday places used by children and families, including child development centers, primary schools, and neighborhood streets, by incorporating trees, shrubs, vines, flowers, grasses, edible fruits and vegetables, together with a variety of built settings, features, and components. The goal is to create play and learning spaces that engage children with each other, to share diverse nature experiences every day (Moore with Cooper, 2014). Multiple studies by NLI suggest that site layout, number and diversity of settings, and natural shade for comfort and sun protection may increase health-enhancing behaviors (Boldemann et al., 2015, 111-138).

Situated within a bioecological model of bottom-up/top-down systems change, the naturalization of barren, denatured outdoor spaces can be conceived as a "modifiable health promotion factor." Using a microenvironmental, incremental design and management approach, childhood spaces can become sustainable, renatured, bio-rich, *salutogenic* experiences adapted to many types of play and learning. Renaturing adaptable biodiversity to early childhood education in urban facilities in low-resource communities offers an equitable health promotion strategy, supporting positive social determinants of health that can instill in young children the joy of engaging with nature. Here they may acquire conservation values that protect bio-health, from neighborhood

Figure 12. Small, everyday places, where young children can engage with nature together in harmony, are crucial and easy to provide. Bright Horizons Enrichment Center. Source: Authors.

to biosphere. Associated active living habits may track through adulthood to support continuing physical health. Research results can influence public policy and regulatory systems to intentionally support health-promoting design and management. Objective, detailed knowledge may guide built-environment design standards and related risk management protocols.

Further *early childhood* research is required to better understand the mechanisms and hierarchies of relationships between variables, including the impact of nature exposure on outcomes such as positive social-emotional relations, immune system support, stress reduction, executive functioning, and development of long-term conservation values. Replication is needed in diverse geographic regions and cultural contexts. Research opportunities across multiple disciplines offers potential for supporting the health of all children and the urban ecosystems they inhabit.

Human society has come a long way from hunter-gatherer communities with curtailed geographic knowledge but surely deeply embedded wonderment at the diurnal sky. The new, burgeoning digital world already provides vast realms of knowledge at the fingertips of young people as they simultaneously lose direct contact with nature. In spite of this apparent dichotomy, the young are awakening to the need for urgent action on behalf of the planet. As adults we honor this unique moment, join in solidarity, and enjoy the beginning of a new, hopeful era where people and planet may evolve in harmony.

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Notes

[1] Childhood and youth as a developmental stage is defined as birth through 17 years in the Convention on the Rights of the Child, UNICEF, ratified by every UN member country except the USA.

[2] Babies (2010). https://www.focusfeatures.com/article/focus15_babies_where-are-they-now Retrieved October 19, 2019.

[3] OECD 2019 infant mortality data by country https://data.oecd.org/healthstat/infant-mortality-rates.htm Accessed December 1, 2019.

[4] Visit Free Range Kids / Let Grow to sample the many extreme examples of over protection of kids in the USA.

[5] Self-efficacy is a theoretical construct, first proposed by psychologist Albert Bandura, defining the level of an individual's belief in their ability to overcome obstacles, achieve goals, etc.

[6] Agency is the feeling of being in control of one's actions, integrated with the sense of ownership of those actions. Recognizing oneself as the agent of a behavior is the way an individual builds a sense of being independent from the external world.

[7] Locus of control along an "internal" to "external" continuum refers to the degree to which individuals believe they personally control their lives or conversely, external forces beyond their control do so.

[8] Grober, U. (2007). Deep roots—a conceptual history of 'sustainable development' (Nachhaltigkeit). (Discussion Papers / Wissenschaftszentrum Berlin für Sozialforschung, 2007-002). Berlin: Wissenschaftszentrum Berlin für Sozialforschung gGmbH. https://nbn-resolving.org/urn:nbn:de:0168-ssoar-110771 Retrieved December 30, 2019.

[9] In 1968, a group of 30 scientists, educators, economists, humanists, industrialists, and national and international civil servants (the future Club of Rome), gathered at the instigation of the visionary Dr. Aurelio Peccei, to discuss what later became the "Project on the Future Predicament of Mankind," led by an international team of 17 experts based at MIT.

[10] If interested in tinkering with the World3 model, visit: http://bit-player.org/2012/world3-the-public-beta Retrieved, December 1, 2019.

[11] For historical details of the conceptual term, "Spaceship Earth," beginning with usage by progressive economist, Henry George (1839-1897), in *Progress and Poverty* (1879), see Kalen, K. (2010). Ecology Comes of Age: NEPA's Lost Mandate. *Duke Environmental Law & Policy Forum,* Vol 21: 113-163. The article provides a detailed history and background of the *National Environmental Policy Act* passage through the U.S. Congress (1970).

[12] Environmental Design Research Association https://www.edra.org/ Retrieved, December 1, 2019.

[13] International Association for People-Environment Studies. https://iaps-association.org/ Retrieved, December 1, 2019.

[14] The Playwork Foundation is an excellent source of up-to-date information about the playwork profession as practiced in the UK https://playworkfoundation.org/ Retrieved, December 1, 2019.

[15] Professionally, Lady Allen was a landscape architect with a passion for childhood freedom and how to protect and facilitate it. For more information on this remarkable woman, see Penny Wilson's finely honed summary at http://theinternationale.com/pennywilson/38-2/ Retrieved, December 1, 2019.

[16] "The Convention on the Rights of the Child is an international treaty that recognizes the human rights of children, defined as persons up to the age of 18 years. The Convention establishes in international law that obligates States Parties to ensure that all children – without discrimination in any form—benefit from special protection measures and assistance; have access to services such as education and health care; can develop their personalities, abilities and talents to the fullest; grow up in an environment of happiness, love and understanding; and are informed about and participate in achieving their rights in an accessible and active manner." https://www.unicef.org/child-rights-convention/frequently-asked-questions Retrieved, December 1, 2019.

[17] See Richie and Roser (2018) for easily navigable *Our World in Data* display. https://ourworldindata.org/urbanization#citation Retrieved, December 1, 2019.

[18] WHO (1986). Ottawa Charter for Health Promotion. https://www.who.int/healthpromotion/conferences/previous/ottawa/en/ Retrieved, December 1, 2019.

[19] Wildlife Conservation Society (2004). New York Symposium: Building Interdisciplinary Bridges to Health in a Globalized World. http://www.oneworldonehealth.org/ Retrieved, December 1, 2019.

[20] See https://sustainabledevelopment.un.org/?menu=1300 Retrieved, September 30, 2019.

[21] See https://www.millenniumassessment.org/en/About.html Retrieved, September 30, 2019.

[22] See https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions Retrieved, September 30, 2019.

[23] Active Living Research https://www.activelivingresearch.org/ Retrieved October 20, 2019.

[24] "The social determinants of health are the conditions in which people are born, grow, live, work and age. These circumstances are shaped by the distribution of money, power and resources at global, national and local levels. The social determinants of health are mostly responsible for health inequities—the unfair and avoidable differences in health status seen within and between countries." https://www.who.int/social_determinants/sdh_definition/en/ Retrieved October 20, 2019.

[25] Closing the Gap in a Generation, WHO, 2008. https://www.who.int/social_determinants/thecommission/finalreport/en/ Retrieved October 6, 2019.

[26] Adelaide Statement on Health in All Policies, WHO, 2010. https://www.google.com/search?q=adelaide+statement+on+health+in+all+policies&oq=adelaide+statement&aqs=chrome.0.69i59j69i57j0l2j69i61l2.7537j0j7&sourceid=chrome&ie=UTF-8 Retrieved October 6, 2019.

[27] Progressing the Sustainable Development Goals through Health for All Policies, WHO, 2017 https://www.who.int/social_determinants/publications/Hiap-case-studies-2017/en/ Retrieved October 6, 2019.

[28] Mapping the Global Goals for Global Development, UNICEF, 2016 https://www.unicef.org/sdgs

[29] OMEP http://www.worldomep.org/index.php?hCode=INTRO_01_01_04 Retrieved October 21, 2019.
[30] See also https://www.google.com/search?q=The+Role+of+Early+Childhood+Education+for+a+Sustainable+Society+Ingrid+Engdahl&oq=The+Role+of+Early+Childhood+Education+for+a+Sustainable+Society+Ingrid+Engdahl&aqs=chrome..69i57.354j0j7&sourceid=chrome&ie=UTF-8 Retrieved October 21, 2019.
[31] See https://www.oecd.org/education/2030-project/teaching-and-learning/learning/student-agency/ Retrieved November 30, 2019.
[32] See https://www.oecd.org/education/2030-project/teaching-and-learning/learning/ Retrieved November 30, 2019.
[33] Children and Nature Network: https://www.childrenandnature.org/ Retrieved November 9, 2019
[34] For more information on the Natural Learning Initiative (NLI) visit https://naturalearning.org/ Retrieved November 11, 2019
[35] *Oakland Declaration on the Vital Role of Nature-Based Learning* can be viewed and signed at https://naturalearning.org/OaklandDeclaration Retrieved November 11, 2019.
[36] Details of the Preschool Outdoor Environment Measurement Scale (POEMS) and its purchase is available from Kaplan: https://www.kaplanco.com/product/39502/preschool-outdoor-environment-measurement-scale-poems?c=29%7COL1030 Retrieved November 11, 2019.

Forests have diverse values and functions that produce not only material products, but also non-material services. The health functions provided by forests have been used for a very long time, but they have only been emphasized in many fields of society in recent years.

The rapid increase in urbanization and the problems of stress, sedentary occupations, and hazardous urban environmental conditions due to modern life may be factors that place great demand on forests' health functions. Scientific research has shown that there are various psychological and physiological human health benefits of exposure to forests, parks, and green spaces.

This collection of papers highlights up-to-date findings and evidence to reveal the beneficial effects of forests on human and public health. The findings provided here can be implemented in practice and policy using forests and nature for human and public health.

Dr Christos Gallis (Χρίστος Γαλλής του Θωμά) is the Research Director at the Forest Research Institute, Greece, with over 20 years' experience in research and lecturing on forests and human health worldwide. He is an IUFRO Scientific Officeholder and Research Coordinator and Vice-President of the International Association for Nature and Forest Welfare, Korea. He is also a Board Member of the International Society of Nature and Forest Medicine, Japan. His publications include *Forests, Trees and Human Health* (as co-editor; 2011) and *Green Care: For Human Therapy, Social Innovation, Rural Economy, and Education* (as editor; 2013).

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