OCTOBER 2026

The Economic Value of Greening Early Care and Education Outdoor Spaces

Rob Grunewald, Economics and Public Policy Consultant

Rob Grunewald Consulting LLC



Photo by Jeremy Ball

About the author

Rob Grunewald is an independent economics and public policy consultant and former economist at the Federal Reserve Bank of Minneapolis, where he worked from 1993 to 2022. He has authored over 200 articles and reports on topics ranging from regional economic conditions and banking to education and early childhood research and policy, including a widely cited 2003 paper with Arthur Rolnick, *Early Childhood Development: Economic Development with a High Public Return*. He holds an M.S. in Applied Economics from the University of Minnesota and a B.A. in Economics and Religion from St. Olaf College. In this report, Grunewald draws on his professional expertise in economics and early childhood research and policy as well as his longstanding interest in nature. Grunewald lives on a rural homestead in northwest Wisconsin with his wife and daughter.

Acknowledgements

I am grateful for the many conversations, assistance with data collection, and feedback on drafts that made this report possible. Early feedback on a proposal that served as a project blueprint was provided by Priya Cook, David Beard, Cathy Jordan, Danielle Tornquist, Erica Phillips, Yesenia Robles-Brown, Eboni Delaney, Khari Garvin, Hester Paul, Tara Schroder, Kara Ficke, Andrew Moore, Kit Harrington, Nilda Cosco, Robin Moore, Amber Fyfe-Johnson, and members of the Outdoor and Nature-Based Early Care and Education Collaborative: Facilities and Environments Working Group (convened by the Children & Nature Network). Project partners Eric Bill, Erin Bishop, and Stefan Dindayal at Autocase Economic Advisory conducted economic analysis of environmental sustainability effects related to greening early care and education outdoor spaces and provided valuable input throughout the project. Four site-based study partner organizations provided data, photographs, survey responses, and feedback on report drafts. These included Audacious Foundation (Catherine Brozowski and Adrianna Foss) and First 5 Santa Barbara County (Michelle Robertson); Early Childhood Health Outdoors, a core program at Playing and Learning in Adaptable Environments (Rebecca Colbert, Amanda Knight, Brandon Dupree, Ellen Warfield, and Sydney Belyayev), together with National Wildlife Federation (Liz Houston); Low Income Investment Fund (Elizabeth Winograd and Sean Doocy); and Nature Explorer (Heather Fox and Jill Primak). Sandra Bishop at Child Care Aware of America and Yasmina Vinci at the National Head Start Association provided data and reviewed related calculations. David Beard, Kit Harrington, Cathy Jordan, Janice LaFloe, Kathleen Lockyer, Nicole MartinRogers, Sherri Seelye, Bethany Stangel, and Sheila Williams Ridge commented on report drafts. Special thanks to Audacious Foundation and First 5 Santa Barbara County for funding the project, and to the Children & Nature Network for editing and producing the final report.

Table of Contents

Executive Summary 4

SECTION 1
Introduction 8

1.1 Similarities between greening ECE outdoor spaces and elementary schoolyards..... 9

1.2 Differences between greening ECE outdoor spaces and elementary schoolyards..... 10

1.3 The economic case for investing in ECE 11

1.4 Elements of greening ECE outdoor spaces and connecting children with nature 12

Sidebar What ECE programs can learn from nature-based preschools 13

Sidebar Greening outdoor spaces in the context of cultural communities 13

SECTION 2
Child Development and Health 16

2.1 The role of nature in child development.. 17

2.2 How nature supports children's learning and development 18

2.3 Effects on children's physical and mental health..... 19

SECTION 3
Site-based Study of Project Components, Costs and Environmental Sustainability Effects 22

Sidebar Study partner organizations 23

3.1 Project components and costs 25

Sidebar Loose parts and child development..... 26

3.2 Professional development: Facilitating children's nature connection 27

3.3 Pre- and post-construction site-level characteristics..... 28

3.4 Environmental sustainability effects 34

SECTION 4
A Compelling Case for Investment 37

4.1 Future school performance and health.... 38

4.2 Early educator job satisfaction 39

4.3 Attracting families to enroll in ECE programs 40

4.4 Property value appreciation 40

4.5 Environmental sustainability effects..... 40

4.6 Benefits across multiple domains..... 42

SECTION 5
Next Steps 43

5.1 Study limitations and future research 44

5.2 Cross-sector collaboration and policy development..... 44

Sidebar Caregivers' nature connection supports children's nature connection 45

5.3 Nature as collaborator..... 46

Source List 47

Appendices 53

Appendix A Additional information from project components and costs study..... 53

Appendix B Estimates of aggregate size of U.S. ECE outdoor spaces 55

The Economic Value of Greening Early Care and Education Outdoor Spaces

Executive Summary

Green early care and education (ECE) outdoor spaces are a small but growing segment within the ECE sector.[1] These spaces often include age-appropriate loose materials such as stumps, logs, wood mulch and sand. Whether the project involves new construction or renovation, many green ECE outdoor spaces include trees, vegetation and vegetable gardens. In addition, greening ECE outdoor space projects include professional development for early educators on how to incorporate natural elements into children's activities and learning.

Green ECE outdoor spaces can produce benefits related to children's development and health, educator job satisfaction, ECE program financial stability, community development and environmental sustainability. These concentric circles of benefits begin with children and ECE providers, and spread into the community.

Child development & health effects

For children, nature-filled outdoor spaces inspire movement and imaginative play which help develop sensory processing, motor, social-emotional and learning skills. Research shows that children attending ECE programs with green outdoor spaces are, on average, more physically active[2] and tend to exhibit increased cooperative behavior, focus and creativity.[3] Whether at an ECE center or home-based family child care (FCC) provider, green outdoor spaces can help children prepare to succeed in school.[4] In addition, several studies note links between nature-based environments and children's health, including physical activity, healthy eating, gut microbiome and immune function, extreme heat mitigation, and mental health (see Section 2).

Effects on early educators and ECE programs

While green ECE outdoor spaces benefit children, they can also improve early educator job satisfaction and likely retention. Professional development and intentionally designed outdoor spaces help early educators more effectively engage with children and feel comfortable outside. Green outdoor spaces can support calm, focused and prosocial behavior among children and reduce educator stress.[5]

A recent sharp increase in nature-based preschools indicates that families are demanding more nature access for their children.[6] If this trend applies to the broader ECE market, green outdoor spaces could help attract families to individual programs and to the ECE sector overall. Industry observers note that ECE programs with green outdoor spaces report more consistent enrollment and that

[1] As used in this report, ECE programs refers to licensed nonprofit and for-profit child care centers, Head Start and Early Head Start centers, public school district preschool programs, and licensed home-based family child care (FCC) providers. Licensing requirements for centers and FCC providers vary by state, especially the latter. See National Center on Early Childhood Quality Assurance. (2022). *Family Child Care Home Licensing Trends for 2020: Brief #2*. (Office of Child Care, Administration for Children and Families). While the scope of the report is limited to licensed providers, information likely applies to child care providers exempt from licensing.

[2] Moore, R., & Cosco, N. (2014). Growing up green: Naturalization as a health promotion strategy in early childhood outdoor learning environments. *Children, Youth and Environments, 24*(2), 168–191.

[3] Dennis, S.F., Wells, A., & Bishop, C. (2014). A post-occupancy study of nature-based outdoor classrooms in early childhood settings. *Children, Youth and Environments, 24*(2), 35–52.

[4] Kuo, M., Barnes, M., & Jordan, C. (2019). Do experiences with nature promote learning? Converging evidence of a cause-and-effect relationship. *Frontiers in Psychology, 10*.

[5] Dennis, S., Castiblanco, E., & Kiewra, C. (2023). *Nature Explore Outdoor Classrooms in LAUSD Early Education Centers*. Los Angeles Unified School District and Dimensions Educational Research.

[6] North American Association for Environmental Education (NAAEE). (2023). *Nature Preschools in the United States: 2022 National Survey*.

Executive Summary

openings fill faster. Enrollment attraction and retention are financial incentives to renovate ECE outdoor spaces.

Property values associated with ECE programs also likely appreciate as outdoor improvements are reflected in the value of the ECE center or, for home-based family child care (FCC) providers, the residential property. These gains may spill over to neighboring properties by marginally increasing valuations and local government tax revenue.

Environmental sustainability benefits

Greening projects have positive effects on environmental sustainability by sequestering carbon, removing air pollutants, capturing stormwater and reducing air temperatures. These benefits include slowing warming trends, reducing the frequency and severity of extreme weather events, decreasing illnesses related to air pollutants, improving water quality, and mitigating urban heat islands (see Section 3).

To estimate environmental sustainability benefits, data were collected from four study partner organizations that assist ECE programs with designing and converting traditional outdoor spaces to green outdoor play and learning environments.[7] Based on pre- and post-construction data, the average net present value (NPV) of environmental sustainability benefits across a sample of 11 ECE center projects over a 25-year period totals $8,100.[8]

Although these effects are modest individually, across the ECE sector they are relatively substantial. Aggregating the size of outdoor spaces at child care centers, FCC providers, and Head Start and Early Head Start centers throughout the country produces a conservative estimate of 32,000 acres. If similar greening projects were implemented at all these locations and adjusted to reflect U.S. average temperatures and rainfall, the estimated net present value of environmental sustainability benefits over a 25-year period would total more than $1.2 billion.[9]



FACES Bayview, San Francisco, CA, Photo by Maria Durana

[7] Study partner organizations include the Audacious Foundation and First 5 Santa Barbara County, Early Childhood Health Outdoors, Low Income Investment Fund, and Nature Explore. All of these organizations lead initiatives to green ECE outdoor spaces and provide professional development on incorporating nature into children's activities and learning. See Section 3 for descriptions.

[8] Technical report by Autocase Economic Advisory. (2026). Economic Analysis for Enhanced Early Care and Education Outdoor Space Valuation.

[9] Public school-based preschool programs are not included in this estimate.

Executive Summary

A compelling case for investment

Research on the effects of nature-based play and learning environments across these domains offers several possible pathways for producing economic value. While more research is required to fully quantify the value of benefits relative to costs, current evidence makes a compelling case for investing in greening ECE outdoor spaces and related professional development (see Section 4).

Child development effects related to social-emotional development and student achievement link to research showing pathways to later success in school and positive adult outcomes, including education attainment and employment. Nascent research on early educator effects shows that green ECE outdoor spaces are associated with improvements in job quality. While research is needed to better understand enrollment and property value appreciation effects (a search of the literature did not find studies specifically related to ECE programs), they are plausible, especially the latter for FCC providers.

Meanwhile, the environmental sustainability study design for the outcomes detailed above produces causal, rather than merely correlational, estimates, which increases confidence in the results. At the same time, these effects are considered incidental because project designers did not identify environmental sustainability as a primary objective. As discussed in Section 4, intentionally designing for environmental sustainability benefits alongside other objectives could substantially increase overall project value.

While the evidence highlighted in this report will likely continue to spur investment by ECE programs, government, philanthropy and the private sector, further research could clarify the impact of greening ECE outdoor spaces and inform cost-benefit analyses (see Section 5). As observed with early childhood education, more detailed return on investment (ROI) results could encourage more investment.

Closing gaps and cross-sector collaboration

This report builds on *How Green Schoolyards Create Economic Value*, which documents the benefits of converting paved schoolyards at elementary schools to nature-filled green schoolyards.[10] Section 1 discusses similarities and differences between greening ECE programs and elementary schoolyards. Regarding similarities, children who attend ECE programs or elementary schools in low-income neighborhoods as well as those in racially and ethnically diverse neighborhoods have less access, on average, to nature via parks, forests and other natural spaces compared with children in more affluent neighborhoods.[11] Therefore, bringing natural elements into outdoor spaces at ECE programs and schools in low-income or racially and ethnically diverse neighborhoods reduces gaps in children's access to nature and produces a larger societal ROI.

In addition, many of the benefits accrue not only to the children who attend ECE programs and schools with green outdoor spaces, but to society as a whole, a condition that generally leads to underinvestment.[12] This creates an opportunity for government, philanthropy and the private sector to invest in green outdoor spaces so society can realize these benefits.

[10] Grunewald, R. (2024). *How Green Schoolyards Create Economic Value*. Rob Grunewald Consulting LLC. Commissioned by the Children & Nature Network.

[11] Zeno, S., Rashid, M., Rowland-Shea, J., Bailey, K., & Payan, R. (2026). *The Nature Gap: Communities of Color and Those With Low Incomes Are Bearing the Brunt of America's Nature Loss*. Center for American Progress.

[12] When benefits of a product or service spill over to external parties, markets will produce too little relative to the societal benefits associated with the product or service.

Greening ECE outdoor spaces also touches on several key issues within the ECE sector, including creating enriching environments that support child development, attracting and developing the ECE workforce, and boosting financial stability for ECE providers. As with green schoolyards at elementary schools, because the benefits of greening ECE outdoor spaces span several sectors, developing mechanisms to facilitate cross-sector collaboration could produce more societal value.

Table 1. Prospective Economic Effects of Greening ECE Outdoor Spaces

Domain	Prospective effects
Children's learning and health	Support children's readiness to succeed in school
	Improve children's short-term and long-term physical and mental health
ECE programs and community development	Attract and retain early educators
	Attract and retain families
	Increase property values and local tax revenue
Environmental sustainability	Sequester carbon
	Increase stormwater capture
	Remove air pollutants
	Reduce air temperature
	Increase pollinator habitat
	Increase children's long-term sustainability behaviors

Introduction



Photo by Jeremy Ball

Lucy C. Kwok, San Francisco, CA,
Photos Courtesy of Low Income Investment Fund





Introduction

This report weaves together the economic case for investing in early care and education (ECE) with research on the benefits of connecting young children with nature. For more than two decades, economists have demonstrated the societal value of investing in high-quality ECE programs, especially those serving children living in low-income communities. Benefits include improved school performance, reduction in crime, and increased earnings as adults – all of which produce a strong public return on investment (ROI).[13]

Recent research shows the benefits of making nature accessible to children and supporting children's connection with nature. For ECE programs, this includes integrating natural materials into outdoor spaces and professional development for early educators on incorporating nature into children's activities and learning. Children are more physically active in green outdoor spaces and child-directed play with loose natural materials supports social-emotional and cognitive development.

This report builds on *How Green Schoolyards Create Economic Value*, which documents the benefits of converting paved schoolyards at elementary schools to nature-filled green schoolyards, including boosting children's learning, enhancing environmental sustainability, and supporting community development and health.[14] Statistical estimates show that 60 cents are returned to the community for every dollar spent, based on environmental sustainability outcomes and local property tax increases. Applying scenarios informed by other research, gains in both high school graduation rates and community health could boost the return to over $3 returned for every dollar invested. Because the benefits extend across several sectors, the ROI doesn't depend on gains in only one domain to achieve robust value.

1.1 Similarities between greening ECE outdoor spaces and elementary schoolyards

Considering how the green schoolyard analytical framework applies to ECE programs, there are several similarities between them. First, whether making small, low-cost adjustments or larger scale changes through landscaping, planting trees or building structures, greening projects in both settings incorporate natural elements and diversify children's play spaces to encourage

[13] Grunewald, R., & Rolnick, A.J. (2003). *Early Childhood Development: Economic Development with a High Public Return*. Federal Reserve Bank of Minneapolis.

[14] Grunewald, R. (2024). *How Green Schoolyards Create Economic Value*. Rob Grunewald Consulting LLC. Commissioned by the Children & Nature Network.

exploration and growth. Spaces typically include age-appropriate loose materials such as stumps, logs, wood mulch and sand as well as play features built with natural or synthetic materials. Shade structures are often added to reduce air temperatures and many greening projects include vegetable gardens.

Not all "green" or "naturalized" outdoor spaces are literally green, particularly in dry regions where natural elements are more likely to comprise rocks, sand and desert plants.[15] Therefore, this report defines green spaces broadly, based on how ECE programs incorporate nature into outdoor play and learning areas.

Second, a common theme across greening ECE programs and elementary schoolyards is that they not only provide enriching developmental experiences for children but also produce environmental sustainability benefits. When outdoor play spaces are treated as ecological systems, statistical models can estimate how trees, vegetation and permeable surfaces reduce air temperature, remove air pollutants, sequester carbon and capture stormwater runoff—each of which produces measurable monetary values.

Third, children who attend ECE programs or elementary schools in low-income neighborhoods as well as those in racially and ethnically diverse neighborhoods have less access, on average, to nature via parks, forests and other natural spaces compared with children in other neighborhoods.[16] Therefore, bringing natural elements into outdoor spaces at ECE programs and schools in low-income or racially and ethnically diverse neighborhoods can reduce gaps in children's access to nature as well as gaps in education outcomes and community investment.

Fourth, many of the benefits accrue not only to the children who attend ECE programs and schools with green play areas, but to society as a whole, a condition that generally leads to underinvestment.[17] Finally, alongside societal benefits, green spaces can provide direct benefits to ECE programs and schools by helping attract and retain families and children who prefer green outdoor spaces, as well as educators who find that children tend to be more self-regulated and cooperative in natural environments.

1.2 Differences between greening ECE outdoor spaces and elementary schoolyards

In contrast, several differences between greening projects at ECE programs and elementary schools have implications for ROI. First, unlike public schools, the ECE sector represents a diverse set of program types that include licensed nonprofit and for-profit child care centers, licensed home-based family child care (FCC) providers, and Head Start and Early Head Start centers, in addition to public school-based preschool programs.

Second, with a wider range of program types, ECE programs also have a wider range of outdoor space sizes and initial conditions compared with elementary schools, which often start with paved surfaces and traditional play equipment.

Third, while some child care providers serve school-age children, ECE programs primarily serve infants, toddlers and preschoolers. These age groups represent particularly

[15] Yin, J., Bratman, G.N., Browning, M.H.E.M., Spengler, J.D., & Olvera-Alvarez, H.A. (2022). Stress recovery from virtual exposure to a brown (desert) environment versus a green environment. *Journal of Environmental Psychology, 81*. This study shows that adults who live in a desert region recovered from stress more effectively when exposed to a desert environment than a green environment or office setting.

[16] Zeno, S., Rashid, M., Rowland-Shea, J., Bailey, K., & Payan, R. (2026). *The Nature Gap: Communities of Color and Those With Low Incomes Are Bearing the Brunt of America's Nature Loss*. Center for American Progress.

[17] When benefits of a product or service spill over to external parties, markets will produce too little relative to the societal benefits associated with the product or service.

sensitive periods for child development and therefore relatively more potent periods for investment and ROI.

Finally, while many elementary school play areas could serve as both a schoolyard and a neighborhood park by opening to the community after school hours, for several practical reasons, most ECE program outdoor spaces are not available for community use. This reduces the effect on community health and neighboring property values.

1.3 The economic case for investing in ECE

Before unpacking the economic value of greening ECE outdoor spaces, let's step back and consider the broader economic case for investing in ECE. For over two decades neuroscience and longitudinal evaluations of ECE programs have identified many benefits to children, families and society from investing in high-quality ECE. Several of these benefits translate to monetary values that demonstrate a large ROI, especially when reaching children in low-income neighborhoods.[18]

The ROI in ECE is rooted in the science of child development, which shows that the first few years of life are a period of rapid development when the brain quickly adapts to stimulation in a child's surroundings.[19] A primary mechanism for healthy development is responsive interactions with caregivers that help young children feel a sense of belonging and value.[20] As these and other enriching experiences add up, a child's brain adapts to an environment that is conducive to learning. Conversely, when children do not receive responsive interactions or face persistent adversity such as neglect or abuse, these stressors impair learning with potentially long-term implications.[21]

Research from decades-long studies demonstrates that high-quality ECE programs targeted to children in disadvantaged circumstances, such as poverty, can increase high school graduation rates, reduce crime, and increase future earnings and tax revenue. Analysis by Nobel Laureate James Heckman and his colleagues show benefits that range from $7 to $12 for every dollar invested.[22] A key finding from these studies is that while children and their families benefit, well over half of the total benefits accrue to non-participants—taxpayers.[23] Benefits that spill over to society generally lead to underinvestment. This means that government, philanthropy and the business sector have opportunities to invest in ECE and accrue a large ROI for society.

ECE programs yielding the largest benefits tend to have relatively well-paid and well-prepared teachers, low child-teacher ratios, and a research-based curriculum. Research suggests that the quality of child-teacher interactions and relationships is the most important factor in supporting child development.[24] Facilities and outdoor spaces also matter because they shape the context

[18] Grunewald, R., & Rolnick, A.J. (2003). *Early Childhood Development: Economic Development with a High Public Return*. Federal Reserve Bank of Minneapolis.

[19] Nelson, C.A. (2000). Neural plasticity and human development: the role of early experience in sculpting memory systems. *Developmental Science, 3*(2), 115–136.

[20] National Scientific Council on the Developing Child. (2004). *Young children develop in an environment of relationships*. Working Paper No. 1.

[21] National Scientific Council on the Developing Child. (2005/2014). *Excessive stress disrupts the architecture of the developing brain*. Working Paper 3. Updated Edition.

[22] Heckman, J.J., Moon, S.H., Pinto, R., Savelyev, P.A., & Yavitz, A. (2010). The rate of return to the High/Scope Perry Preschool program. *Journal of Public Economics, 94*(1–2), 114–128; Garcia, J.L., Heckman, J.J., Leaf, D.E., & Prados, M.J. (2020). Quantifying the life-cycle benefits of an influential early childhood program. *Journal of Political Economy, 128*(7).

[23] Heckman, J.J., Grunewald, R., & Reynolds, A.J. (2006). The dollars and cents of investing early: Cost-benefit analysis in early care and education. *Zero to Three, 26*(6), 10–17.

[24] Hamre, B., Hatfield, B., Pianta, R., & Jamil, F. (2014). Evidence for general and domain-specific elements of teacher–child interactions: Associations with preschool children's development. *Child Development, 85*(3), 1257–1274.

for teacher-child relationships and children's experiences.[25]

ECE access not only supports children's development but also facilitates parental employment. About 70% of American children under the age of five need non-parental care, due to their parent(s)' employment. That translates to an estimated 12.3 million children.[26] Therefore, ECE-related public policy and market effects on non-parental care settings can have large societal and economic implications.

Both greening outdoor spaces and supporting educators in facilitating children's connection with nature hold promise to augment ECE quality and ROI. Given the key role ECE plays in child development and in the economy, even incremental improvements in ECE quality can produce large aggregate effects.

1.4 Elements of greening ECE outdoor spaces and connecting children with nature

Based on the premise that nature is everywhere and children learn and develop in relationship with it, the starting point for greening ECE outdoor spaces and connecting children with nature is awareness and spending more time outdoors. Several national and local organizations are involved with disseminating information about how educators can support children's connection with nature.

From awareness and spending time outdoors, there is much to build on. First, professional development boosts ECE program directors and educators' capacity and knowledge to integrate nature into children's learning (see Section 3.2). Second, while nature is everywhere, investments in ECE program outdoor spaces make natural elements more accessible. From relatively small low-cost adjustments to full-site design and implementation of outdoor learning environments, suitable ECE outdoor settings can better foster children's connection with nature.

Play area renovations and new-space designs depend on climate, child age and ECE program curriculum and goals. For example, adding umbrellas or shade elements increases comfort and usable space, especially in warmer climates. Also, replacing static synthetic structures with natural materials and age-appropriate loose materials such as stumps, logs, rocks, wood mulch and sand brings nature closer to children with open-ended possibilities for play. Moore and Cosco note in *Growing Up Green: Naturalization as a Health Promotion Strategy in Early Childhood Outdoor Learning Environments* that access to hands-on, interactive and affordance-rich spaces[27] that children can manipulate in multiple ways serves several developmental outcomes.[28] Even a few low-cost changes can expand children's engagement with nature.

Full-scale design and renovations of ECE outdoor spaces expand possibilities for nature connection and the amount of space children use. Native plants and vegetable gardens increase children's connection with vegetation and soil, while planting trees increases shade. Removing concrete, asphalt or other heat-absorbing materials and replacing them with natural surfaces can reduce temperatures and foster more tactile contact with natural materials (see Section 3).

---

[25] Tracey, S., Rosen, S., & Smith, L.K. (2021). *Moving Towards Quality: Model Improvement Standards for Existing Center-based Child Care Facilities*. Bipartisan Policy Center.

[26] U.S. Census Bureau, American Community Survey. *Age of Own Children Under 18 Years in Families and Subfamilies by Living Arrangements by Employment Status of Parents*. Table B23008. 2024 1-Year Estimates Detailed Tables.

[27] Affordances refer to features that offer opportunities for exploration and play. See Gibson, J. J. (2014). *The ecological approach to visual perception*. Hove: Psychology Press.

[28] Moore, R., & Cosco, N. (2014). Growing up green: Naturalization as a health promotion strategy in early childhood outdoor learning environments. *Children, Youth and Environments, 24*(2), 168–191.

Introduction

What ECE programs can learn from nature-based preschools

According to the *Nature-Based Preschool Professional Practice Guidebook*, nature-based ECE programs use nature as a central organizing theme and children spend a significant portion, and in some cases all, of the instructional time outdoors.[29] While not exclusive to nature-based preschools, curriculum typically emphasizes following children's interests, experiential learning and play. In the 2022-23 school year there were an estimated 800 nature preschools in the United States serving 25,600 children, a 300% increase since just after 2010 when the programs began rapidly expanding.[30]

Although this report focuses on greening outdoor spaces in the broader ECE market and incrementally increasing the time children spend outside, nature-based preschools offer insights into facilitating young children's engagement with nature such as outdoor gear for various weather conditions and curriculum with activities for connecting children with nature. Study partner organizations[31] note that along with professional development, outdoor gear and nature connection curriculum should be considered essential components of greening ECE outdoor spaces.

Photo Courtesy of Leech Lake Early Childhood Development



Greening outdoor spaces in the context of cultural communities

Outdoor, nature-based learning has unique applications for cultural communities, particularly in the case of Native American communities, which prioritize cultivating children's connection with nature.[32] Indigenous communities often incorporate nature into children's early experiences as part of Indigenous cultural practices and approaches to child development. Furthermore, principles from Indigenous knowledge can inform best practices for designing outdoor spaces and connecting children with nature.[33]

For example, members of the Leech Lake Band of Ojibwe in northern Minnesota developed the Megwayaak trail (an Ojibwe word meaning "in the woods") on three acres for children attending Head Start,

[29] Natural Start Alliance. (2019). *Nature-Based Preschool Professional Practice Guidebook: Teaching, Environments, Safety, Administration*. North American Association for Environmental Education.

[30] North American Association for Environmental Education (NAAEE). (2023). *Nature Preschools in the United States: 2022 National Survey.*

[31] Study partner organizations include the Audacious Foundation and First 5 Santa Barbara County, Early Childhood Health Outdoors, Low Income Investment Fund, and Nature Explore. All of these organizations lead initiatives to green ECE outdoor spaces and provide professional development on incorporating nature into children's activities and learning. See Section 3 for descriptions.

[32] Pagani, S. (2025). *How lessons from Traditional Ecological Knowledge can support kids – and stave off climate anxiety*. Children & Nature Network.

[33] The team at Early Childhood Health Outdoors (ECHO), one of the study partner organizations featured in Section 3, noted that professional development and shared learning with Indigenous communities is bi-directional and that the staff at ECHO recently benefited from taking the 4 Seasons of Indigenous Learning course, taught by Indigenous teachers through the Outdoor Learning School & Store (based in Canada).

Introduction

Early Head Start, or child care at the Maajiigin Family Center.[34] Children at other nearby ECE programs also occasionally visit the site. The space includes a wooded trail, nature play areas, an herbal medicine garden and opportunities to identify and harvest healthy traditional foods. Educators are supported by a learning guide that integrates Ojibwe language, and children have access to boots, rain suits and other gear to enjoy the space in a variety of weather conditions.

Leech Lake early childhood program leaders say that the outdoor space gives children the sensory experiences they need for healthy development and opportunities to use their imagination. Furthermore, they report that young children who regularly use the Megwayaak trail cooperate with each other better and are more likely to take an afternoon nap.

Montessori American Indian Childcare Center, located near the border of Saint Paul and Roseville, Minnesota, is an example of an urban program that applies an Indigenized and culturally unique nature-based curriculum for children aged 3 to 6.[35] Another urban example is the Wahohpi, the Dakota Language Immersion program at the University of Minnesota in Minneapolis that features a nature-based curriculum and where children spend half or more of their day outdoors. While there are many other examples of nature-based ECE programs in Native American communities outside Minnesota, these programs show that children can be comfortable in a wide variety of weather conditions year-round, including during cold and snowy winters.

Connection to nature may also be prominent within other cultural communities, including recent immigrant groups. For example, hunting, fishing and gathering edible plants are important cultural and economic activities for Hmong communities, an ethnic group with a large diaspora community in Minnesota.[36]

Communities of color have diverse relationships with nature, farming and wilderness areas, and as noted above, have, on average, less access to nature. Data from a 2022 survey of nature-based preschools show that white children (78%) are overrepresented relative to the population of white children in the United States (47.3%) while Latino and Black children are substantially underrepresented.[37] Incorporating cultural context and family perspectives when designing outdoor spaces, professional development, and nature-based curriculum can create experiences that are more relatable and comfortable for children.[38]

[34] Donahue, M. (2021). *A journey in the woods with Leech Lake Early Childhood Development's Megwayaak Project*. University of Minnesota Extension.

[35] Beaven, L., Aasen Floyd, C., & Turner, L. (2023). *Nurturing All Children in Nature: Ideal Learning in the Natural World*. Trust for Learning, 14–15.

[36] Bengston, D. N., Schermann, M. A., Moua, M., & Lee, T. T. (2009). Listening to neglected voices: Hmong Americans and public lands in Minnesota and Wisconsin. *Society and Natural Resources*, *21*(10), 876–890.

[37] North American Association for Environmental Education (NAAEE). (2023). *Nature Preschools in the United States: 2022 National Survey*.

[38] Foglesong, S. (2018). *Building cultural empathy and celebrating diversity in nature-based early childhood education*. Natural Start Alliance; Blue Sky Funders Forum. (2023). *Culturally-inclusive nature programs that honor culture, explore justice, and unearth joy*. rethink outside.

Introduction

MNC Mission Bay, San Francisco, CA



Photo Courtesy of Low Income Investment Fund



Photo by Maria Durana

Child Development and Health



Photo by Jeremy Ball

Child Development and Health

2.1 The role of nature in child development

A young child's sensory, emotional and cognitive systems are prepared to develop in relationship with their caregivers and environments.[39] For millennia nature provided the environmental context for child development, but now modern societies often buffer children from the immediacy of soft grass, cool dirt, leaves rustling in the wind and other nature-based sensory experiences. Children increasingly face stimulation from indoor mechanized environments and technology, including flashes and beeps from screens. Although children learn and develop in a variety of environments, spending time in nature with a responsive caregiver offers developmental advantages for infants, toddlers and preschoolers.

In *Wild Inside: How Nature Protects Your Child's Mental Health and Restores Yours*, Kathleen Lockyer describes how nature engages a child's senses through a complex tapestry of sensory experiences through which the brain can organize into coherence.[40] Unlike the random flashes and beeps offered by modernity, nature presents a symphony of relationships that fosters meaning and integration for a child's sensory experience. As an occupational therapist, Lockyer has supported hundreds of children facing sensory integration disorders through facilitated nature connection experiences.

For over two decades neuroscience has shown that sensory and relational experiences during the first few months of life are essential for healthy development. Recent research based on neuroimaging shows that infants as early as 2 months old start to organize visual stimuli into categories, an indication of more complex functions at work in an infant's visual cortex than previously understood.[41]

With support from a responsive caregiver, nature offers the stimulation that an infant's neurobiology craves. *Wild Inside* offers stories of infants who experience stimulation from nature, such as a gust of wind or bright colors in a flower, and who have their experience acknowledged and engaged with by a caregiver. The serve-and-return interaction between caregiver and child and the child's engagement with nature cultivates brain development.

Nature's role in child development changes as children grow older—for example, when toddlers walk on uneven ground or preschoolers climb boulders or trees, which promotes physical and motor development through balance (vestibular) and proprioception (body position). Nature also offers opportunities for developmentally appropriate risky play where children can learn about their physical capabilities, assess risk and problem-solve. Since natural materials embody multiple affordances, children can lead with open-ended possibilities. Outdoor spaces and natural materials also offer more social and relational play opportunities with other children. ECE program outdoor spaces can be designed to foster a range of developmental outcomes by increasing children's meaningful connections with natural elements.[42]

---

[39] National Scientific Council on the Developing Child. (2004). *Young children develop in an environment of relationships*. Working Paper No. 1.

[40] Lockyer, K. (2025). *Wild Inside: How Nature Protects Your Child's Mental Health and Restores Yours*. Otter Play Publishing.

[41] O'Doherty, C., Dineen, Á.T., Truzzi, A., King, G., Zaadnoordijk, L., Harrison, K., D'Arcy, E.L., White, J., Caldinelli, C., Holloway, T., Kravchenko, A., Diedrichsen, J., Tarrant, A., Byrne, A.T., Foran, A., Molloy, E.J., & Cusack, R. (2026). Infants have rich visual categories in ventrotemporal cortex at 2 months of age. *Nature Neuroscience, 29*(3), 693–702.

[42] Craig, D., Trina, N. A., Monsur, M., Haque, U. T., Farrow, G., Hasan, M. Z., Tasnim, F., & Akinbobola, M. S. (2024). Effective nature-based outdoor play and learning environments for below-3 children: A literature-based summary. *International Journal of Environmental Research and Public Health, 21*(9), 1247.

Child Development and Health

2.2 How nature supports children's learning and development

Similar to research on the effects of incorporating nature into outdoor learning environments for school-age children, several studies demonstrate a positive relationship between nature-based environments and early childhood development, including effects on sensory integration, social-emotional development and cognitive skills.[43] A systematic review of qualitative research shows that nature-based environments improve the quality of play experiences for children (age 2 to 8) by increasing play diversity and duration when compared with play in non-nature-based environments. Children also use different cognitive skills during nature-based play.[44] In addition, nature offers hands-on, sensory learning experiences which support children's learning, including emerging STEM skills.[45]

A review of 36 studies of nature-based early childhood education programs in several different countries found positive associations with improved social skills and social and emotional development. Qualitative findings suggest the improvements may be related to diversified play, increased creativity and imagination, and prosocial interactions with peers and teachers.[46]

In another study, researchers found that children attending an early childhood education center that implemented an outdoor classroom exhibited increased cooperative behavior, focus and creativity and were more relaxed after the outdoor classroom was implemented.[47] During the recent pandemic, a study found that preschool classrooms with full or partial nature-based approaches had a greater impact on resilience (child's initiative, self-regulation and attachment) than traditional classrooms.[48]



Photo: iStock

[43] Ernst, J., & Stelley, H. (2024). Supporting young children's self-regulation through nature-based practices in preschool. *Behavioral Sciences, 14*(11), 1013.

[44] Prins, J., van der Wilt, F., van der Veen, C., & Hovinga, D. (2022). Nature play in early childhood education: A systematic review and meta ethnography of qualitative research. *Frontiers in Psychology, 13*.

[45] Dewar, G. (2016). Learning by doing: How outdoor play prepares kids for achievement in STEM. Natural Start Alliance.

[46] Johnstone, A., Martin, A., Cordovil, R., Fjørtoft, I., Iivonen, S., Jidovtseff, B., Lopes, F., Reilly, J.J., Thomson, H., Wells, V., & McCrorie, P. (2022). Nature-based early childhood education and children's social, emotional and cognitive development: A mixed-methods systematic review. *International Journal of Environmental Research and Public Health, 19*(10).

[47] Dennis, S.F., Wells, A., & Bishop, C. (2014). A post-occupancy study of nature-based outdoor classrooms in early childhood settings. *Children, Youth and Environments, 24*(2), 35–52.

[48] Ernst, J., Juckett, H., & Sobel, D. (2021). Comparing the impact of nature, blended and traditional preschools on children's resilience: Some nature may be better than none. *Frontiers in Psychology, 12*.

Considering longer-term effects, a study in Norway assessed the relationship between time spent outdoors during child care and outcomes in adolescence accounting for several background characteristics and found a positive association between outdoor time and attentional control, and an indirect pathway linking outdoor time to academic achievement via enhanced working memory in early childhood.[49]

Observational studies show that green outdoor spaces support a variety of play types and physical activity among children. According to a study of "The Backyard" play space at the Santa Barbara Museum of Natural History, children engaged in a variety of play—with physical and exploratory the most prevalent types—with natural loose parts highly involved in most play types.[50]

Another observation study of four renovated child care play spaces in San Francisco, which included professional development for educators,[51] found that based on pre- and post-renovation measures, children increased physical activity, positive risk taking, play diversity and child-led play, while peer conflict decreased. Play was more distributed across the outdoor spaces and children utilized a greater proportion of each space. Early educators were more tolerant of risk during children's play and more confident in children's safety outdoors. Their concerns about children getting dirty while playing outdoors were almost eliminated.[52]

A contributing factor to developmental outcomes is an increase in physical activity observed in nature-based play and learning areas which is associated with increased attention and task-based inhibitory control after children return to the indoor classroom.[53] Among 26 ECE centers in North Carolina that participated in Natural Learning Initiative's Preventing Obesity by Design program, increased time outside was reported for all seasons and almost 70% of center directors reported positive changes in children's behavior.[54]

2.3 Effects on children's physical and mental health

Several studies note relationships between nature-based environments and children's health including physical activity, healthy eating, gut microbiome and immune function, mitigating the health effects of extreme heat, and improving mental health. A systematic review of 296 studies related to nature and children's health (not just early childhood) found the strongest evidence for the beneficial health effects of nature was related to physical activity (32% of studies) and cognitive, behavioral or mental health (25% of studies).[55] Increased physical activity is a key concern given that 13% of U.S. children aged 2 to 5 are classified as obese by the CDC.[56]

[49] Ulset, V.S., Borge, A.I.H., Vitaro, F., Brendgen, M., & Bekkhus, M. (2023). Link of outdoor exposure in daycare with attentional control and academic achievement in adolescence: Examining cognitive and social pathways. *Journal of Environmental Psychology, 85*.

[50] Loebach, J., & Cox, A. (2022). Playing in 'The Backyard': Environmental features and conditions of a natural playspace which support diverse outdoor play activities among younger children. *International Journal of Environmental Research and Public Health, 19*(19).

[51] The child care providers participated in a design and professional development cohort led by Low Income Investment Fund, one of the four study partner organizations featured in Section 3.

[52] Loebach, J. (2025). *Impacts of ECEC outdoor playspace renovations on children's play. A comparison study of 4 childcare centers in San Francisco*. DECALab, Human Centered Design, Cornell University.

[53] Koepp, A.E., Gershoff, E.T., Castelli, D.M., & Bryan, A.E. (2022). Preschoolers' executive functions following indoor and outdoor free play. *Trends in Neuroscience and Education, 28*, 100182.

[54] Moore, R., & Cosco, N. (2014). Growing up green: Naturalization as a health promotion strategy in early childhood outdoor learning environments. *Children, Youth and Environments, 24*(2), 168–191.

[55] Fyfe-Johnson, A.L., Hazlehurst, M.F., Perrins, S.P., Bratman, G.N., Thomas, R., Garrett, K.A., Hafferty, K.R., Cullaz, T.M., Marcuse, E.K., & Tandon, P.S. (2021). Nature and children's health: A systematic review. *Pediatrics, 148*(4).

[56] U.S. Centers for Disease Control and Prevention. (2026). Childhood Obesity Facts.

Child Development and Health

Outdoor activities in nature can support obesity reduction and overall children's health.[57]

Gardens are often a feature of greening ECE outdoor space projects that can promote healthy eating. Research shows that families participating in community gardens have greater availability and consumption of fruits and vegetables, which can support obesity reduction.[58] While gardens at ECE programs are not community gardens, children and families are often offered the opportunity to help tend them.

Aside from influences on behavior, nature-based settings can expose children directly to microbiota that foster immune system development. For example, researchers in Finland compared children attending standard, nature-based, and intervention daycares, the latter of which was augmented with segments of forest floor, sod, planters for growing annuals and peat blocks for climbing and digging. Data show that children attending the nature-based and intervention centers had more diverse gut and skin microbiota and enhanced immunoregulatory pathways compared with children attending the standard daycares.[59] Just as exposing children to nature can improve immune function, as discussed in Section 3, vegetation and trees filter pollutants which can lower aggravating factors for asthma and other respiratory illnesses.[60]

The benefits of children connecting with nature can be compromised during periods of extreme heat or poor air quality. Extreme heat can have more severe effects on infants and young children than it does on most adults because children's smaller bodies heat up faster and have less capacity to release heat via sweating, according to a working paper by the Early Childhood Scientific Council on Equity and the Environment.[61]

Adding trees, shade structures and surface materials that are less likely to absorb heat make ECE outdoor spaces more accessible and comfortable during periods of extreme heat. As detailed in Section 3.3, pre- and post-renovation comparisons across 11 greening child care center projects show that the average number of trees increased from five to 15 and shade structure coverage more than doubled to an average of 7% of outdoor space up from 3%. Furthermore, many projects converted surface materials to those that absorb less heat.

Regarding mental health, nature appears to have a beneficial effect on children's mental health and well-being.[62] For example, researchers found that children aged 7 to 12 years old diagnosed with ADHD concentrated substantially better after a 20-minute walk in a park than a walk in a downtown or neighborhood area.[63] Meanwhile, Touloumakos and Barrable consider how nature may serve as a

[57] McCurdy, L.E., Winterbottom, K.E., Mehta, S.S., & Roberts, J.R. (2010). Using nature and outdoor activity to improve children's health. *Current Problems in Pediatric and Adolescent Health Care, 40*(5), 102–117.

[58] Castro, D.C., Samuels, M., & Harman, A.E. (2013). Growing healthy kids: A community garden–based obesity prevention program. *American Journal of Preventive Medicine, 44*(3) [Supplement 3], S193–S199.

[59] Roslund, M.I., Puhakka, R., Grönroos, M., Nurminen, N., Oikarinen, S., Gazali, A.M., Cinek, O., Kramná, L., Siter, N., Vari, H.K., Soininen, L., Parajuli, A., Rajaniemi, J., Kinnunen, T., Laitinen, O.H., Hyöty, H., Sinkkonen, A., & ADELE research group. (2020). Biodiversity intervention enhances immune regulation and health-associated commensal microbiota among daycare children. *Science Advances, 6*(42).

[60] Rogin, A., & Junod, A. N. (2023). *Paved Land Area, Access to Green Space, and Children's Health and Well-Being*. Urban Institute.

[61] Early Childhood Scientific Council on Equity and the Environment. (2023). Extreme heat affects early childhood development and health: Working Paper No. 1.

[62] Lomax, T., Butler, J., Cipriani, A., & Singh, I. (2024). Effect of nature on the mental health and well-being of children and adolescents: meta-review. *The British Journal of Psychiatry, 225*(3), 401–409.

[63] Taylor, A.F., & Kuo, F.E. (2009). Children with attention deficits concentrate better after walk in the park. *Journal of Attention Disorders, 12*(5), 402-409.

protective factor for children exposed to adverse childhood experiences (ACEs) given nature's documented therapeutic potential for many psychopathologies and mental health difficulties.[64] Activities in nature are also an alternative to and can mitigate the negative effects of screen time on children's mental health.[65]



Harding University Partnership School, Santa Barbara, CA
Photos by Kirsten Haugen.



[64] Touloumakos, A.K., & Barrable, A. (2020). Adverse Childhood Experiences: The protective and therapeutic potential of nature. *Frontiers in Psychology, 11*.

[65] Children & Nature Network Research Digest. (2025). *Screen time and green time*.

Site-based Study of Project Components, Costs and Environmental Sustainability Effects

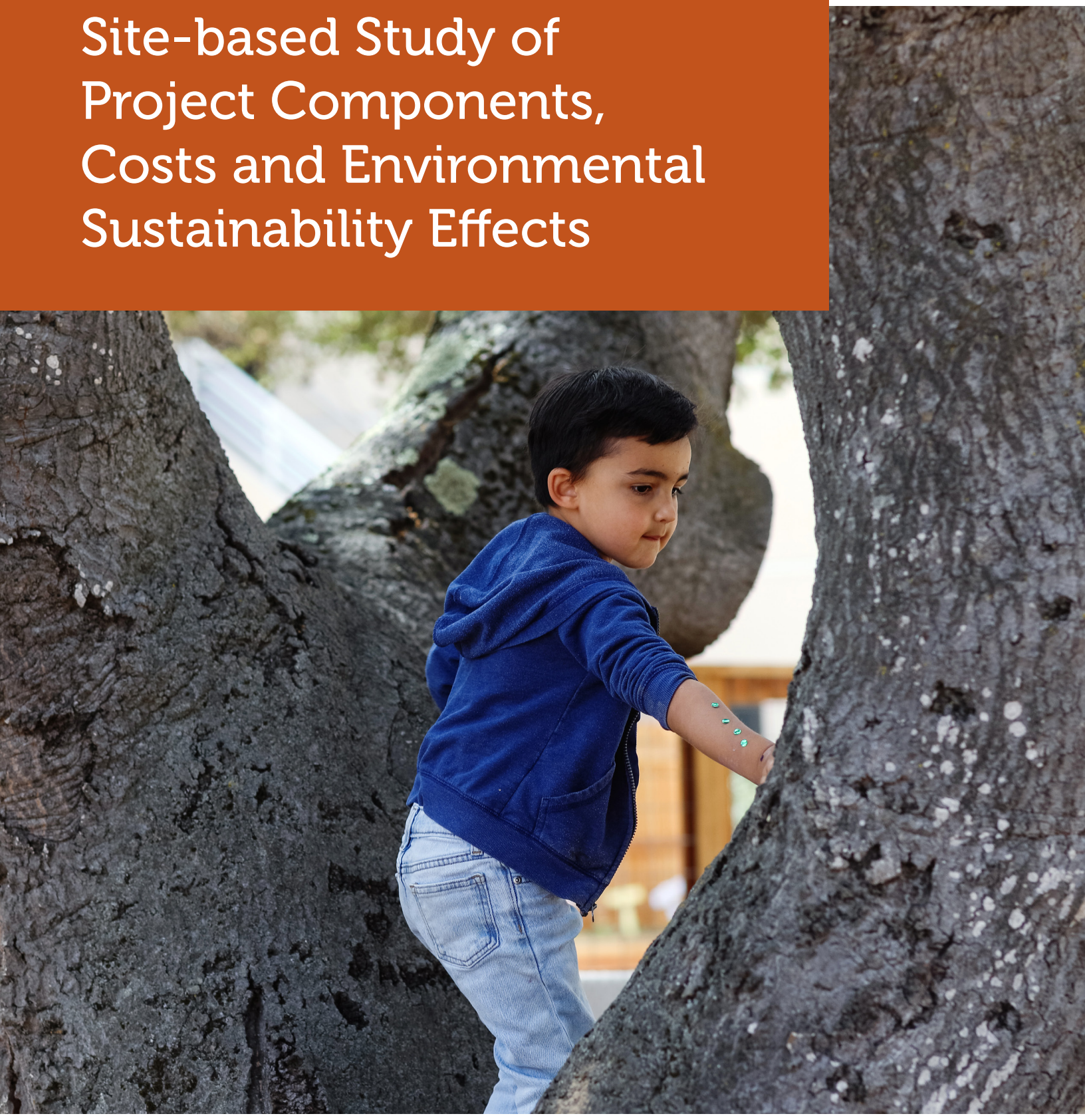


Photo by Jeremy Ball

Site-based Study of Project Components, Costs and Environmental Sustainability Effects

Greening ECE outdoor space projects combined with related training programs is a small but growing area within the ECE sector. To date, however, relatively little attention has been focused on how greening ECE outdoor spaces affects ecology and environmental sustainability.

This study analyzes data from four study partner organizations that assist ECE programs with designing and converting traditional outdoor spaces to green outdoor play and learning environments (*see Study partner organizations sidebar*). As noted in Section 1, adding loose natural parts and making other modest and low-cost alterations to ECE outdoor spaces can make a meaningful impact on children's environments. However, this study focuses on projects at licensed child care centers and FCC providers that make more substantial renovations to outdoor spaces.[66] The sections below highlight findings on project components and costs, professional development activities, pre- and post-construction site-level characteristics, and environmental sustainability effects.

Study partner organizations

The study partner organizations all lead initiatives to green ECE outdoor spaces and provide professional development on incorporating nature into children's activities and learning. These organizations include the Audacious Foundation and First 5 Santa Barbara County, Early Childhood Health Outdoors, Low Income Investment Fund, and Nature Explore.

Over the past 18 years, the **Audacious Foundation** (preceded by the Orfalea Foundation), in partnership with **First 5 Santa Barbara County** and Santa Barbara County (CA), has funded outdoor greening projects at 80% of ECE programs in the county by creating enriching nature-based outdoor learning environments. Over the last six years First 5 Santa Barbara County has invested over $1.5 million to build outdoor learning spaces at Transitional Kindergarten[67] programs. Since 2003, the Orfalea and Audacious Foundations have hosted no-cost annual retreats for ECE leaders and teachers that foster peer collaboration and support the integration of nature-based learning into curriculum and daily activities. Transitional Kindergarten leaders were incorporated into the retreats beginning in 2024.

Early Childhood Health Outdoors (ECHO, a core program at Playing and Learning in Adaptable Environments) combines customized design solutions and professional development opportunities to support caregivers in engaging young children in the benefits of wonder and time spent outdoors. ECHO uses its national platform to elevate the needs of young children and their caregivers and to advocate for policies and resources that support the fundamental right for all children to benefit from time outdoors from birth. ECHO has partnerships and projects around the country including a statewide initiative in Colorado and a five-year initiative with the South Carolina Departments of Social Services and Public Health to design nature-

[66] While the site-based study focuses on licensed child care programs, results likely at least partially generalize to Head Start and Early Head Start programs and public school-based preschool programs, albeit the latter are often considerably larger than outdoor spaces at child care programs.

[67] California's public school-based program for all 4-year-olds.

Site-based Study of Project Components, Costs and Environmental Sustainability Effects

based outdoor learning environments and provide professional development to ECE programs.

Low Income Investment Fund (LIIF), with funding from the San Francisco Department of Early Childhood, and in partnership with the San Francisco Recreation & Park Department and SF Children & Nature, annually supports a cohort of San Francisco child care centers and FCC providers in designing and implementing green outdoor spaces for children. This support includes grant funding for design and construction of the natural outdoor spaces and a year of professional development and coaching for early educators in the cohort on best practices in nature-based early childhood education.

Nature Explore designs outdoor classrooms and applies research-based, field-tested design principles to create nature-rich outdoor spaces for schools, child care centers, parks or other community locations. Nature Explore combines design services with interactive professional development opportunities that support teachers in incorporating nature-based learning into daily activities. Among projects across the country, Nature Explore is designing outdoor classrooms for Los Angeles Unified School District's early education centers.

The following sections synthesize information from these organizations, beginning with the components and costs of greening projects.

Miss Carrie's Child Care, Arvada, CO,
Photos Courtesy of Early Childhood Health Outdoors





Site-based Study of Project Components, Costs and Environmental Sustainability Effects

3.1 Project components and costs

Based on a survey of the four study partner organizations, median costs for ECE greening projects range from about $80,000 to $300,000 at centers and from $20,000 to $60,000 at FCC providers. Costs vary widely by project scope. Small projects may cost just a few thousand dollars, while large projects can reach from $400,000 to more than $1 million for centers and from $80,000 to more than $150,000 for FCC providers.

Project components

The study partner organizations identified several common components across their project portfolios which generally fall into the following categories: site preparation, surface materials, vegetation, play features, furnishings and enclosures.

Pre-construction components include play area design and construction permitting, while site preparation may involve demolition, earthwork and grading. Site preparation costs are often proportionately smaller at FCC providers. Some center projects may also require retaining walls, drainage or other civil engineering solutions. A project may also include utilities such as electricity access or potable water to outdoor sinks or drinking fountains. However, drainage and utilities are typically not included, and if they are, only at centers.

Hardscape surface materials include stone pavers, rocks, concrete, wood and decking. While permeable versions are available, these surface materials are typically impervious to rainwater and create runoff. In contrast, Corkeen (a patented natural cork-based play surface), decomposed granite, engineered wood fiber, gravel, sand and wood mulch are permeable and reduce runoff. Some surfaces, including artificial turf and rubber surfaces such as poured-in-place rubber or tiles, may be either impervious or permeable depending on the material and the surface beneath it. Dirt can be relatively impervious or permeable depending on conditions. For example, dirt compacted by young children's play creates a hard surface that is less permeable to rainwater.

For trees, shrubs or other plants, cost depends on soil requirements, mulch, plant size, spacing and maturity. New grass areas may require sod installation, while new gardens may include structures such as raised beds.

Center-based projects may include play features such as climbing structures, balance beams and swings, while FCC providers often install residential play equipment. Many projects prioritize natural, wood-based structures with a variety of play features over traditional synthetic play equipment. Activity settings may include sand play, a mud kitchen, or other loose parts and sensory-related items.

Projects may include freestanding furnishings, such as tables, chairs, benches, child-size storage units, or care stations. Permanently installed furnishings may include art panels, instruments and arbors.

Other items include large storage areas; shade structures made of metal, wood or fabric; and fences, walls or gates that surround the yard. Manufactured and natural loose parts are an essential component of an outdoor learning environment but are relatively low cost (see sidebar). Across all categories, using natural and synthetic non-toxic materials that are safe for children is essential for protecting children's health and development (see Children's Environmental Health Network for more information).

Site-based Study of Project Components, Costs and Environmental Sustainability Effects

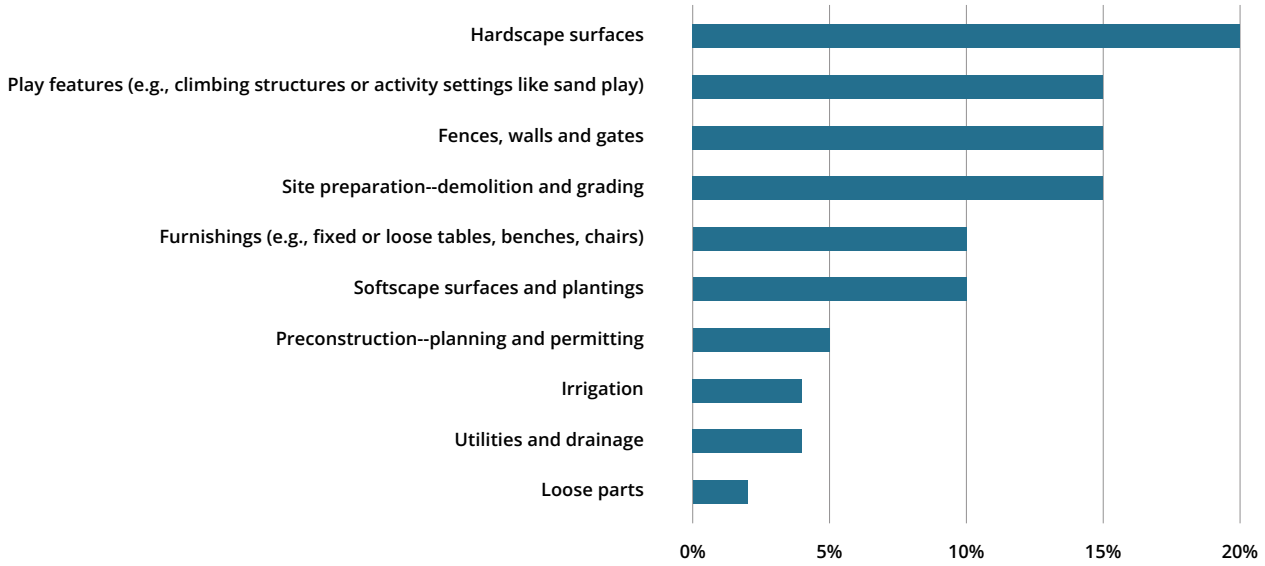
Additional cost considerations include ADA requirements and accessibility enhancements, equipment and machinery access, and demolition disposal costs.

Figure 1 shows the categories and relative cost shares across all survey responses.

Since respondents' answers referred to different category schematics, some categories were combined and rough averages were estimated. This information is weighted toward centers and is less representative of FCC providers.

Figure 1.

Greening ECE Outdoor Space Project Expenses
Percent of Total Cost Estimates



Based on aggregated responses from the study partner organizations

Loose parts and child development

The Theory of Loose Parts by Simon Nicholson states that, "in any environment, both the degree of inventiveness and creativity, and the possibility of discovery, are directly proportional to the number and kind of variables in it."[68] Loose parts can be moved, carried, redesigned, lined up, taken apart and put back together in many ways. They can also be used alone or in combination with other materials.[69] In green ECE outdoor spaces loose parts comprise any number of natural objects such as sticks, grasses, leaves, pinecones and seeds. They can also be used alongside or in combination with synthetic materials including buckets, fabric or tools and recycled items such as cardboard boxes. As discussed in Section 2, loose parts facilitate children's self-directed open-ended play, experimentation and learning. While loose parts comprise a small portion of greening project budgets, they are an essential aspect of green ECE outdoor learning environments.

[68] Nicholson, S. (1971). How NOT to cheat children: The theory of loose parts. *Landscape Architecture Magazine, 62*(1), 30–34.

[69] Better Kid Care, PennState Extension. (2025). *Loose parts: What does this mean?* The Pennsylvania State University.

Primary project cost drivers

Survey respondents reported that depending on the project, demolition and grading, surfacing and pathways, play features, shade structures, fencing, and decking are typically high-priced items. Permeable and heat-resistant surface materials that replace asphalt, concrete or rubber offer many advantages but are typically more expensive. One organization uses Corkeen's heat-resistant system appropriate for fall zones to replace poured-in-place rubber, which is more heat absorbent and less permeable. Alternatives to concrete pathways include decomposed granite—granite that has been weathered into small particles—or commercial products such as Granitecrete or Addaset.

Maintenance costs climb moderately after greening construction

ECE programs often face a new set of maintenance requirements following greening construction. Survey respondents noted that ECE programs with new green outdoor spaces need to periodically replenish mulch, loose parts and sand; add plant material; prepare and weed gardens; maintain irrigation systems; and repair or replace worn-out furnishings. Some aspects of greening projects, however, can reduce costs. For example, mulch reduces weeds and improves moisture retention, which can decrease watering frequency. Shaded areas protect surfaces and outdoor materials from sun exposure, and more efficient irrigation systems typically reduce water costs. Even with these potential savings, maintenance costs seem to increase overall after greening construction. Survey respondent estimates range from $100 to $300 per month in maintenance cost increases for centers. Out-of-pocket cost increases for FCC providers often depend on whether the owner conducts maintenance or hires someone to do it.

To contain maintenance costs and further integrate nature into children's activities, one survey respondent encourages ECE programs to incorporate light maintenance into daily routines with children. An ECE program in Santa Barbara, CA, noted that staff regularly work with children on gardening tasks such as pruning and watering plants. In addition, community or parent clean-up days in the spring and fall cover several seasonal maintenance needs. Survey respondents noted that very few programs, if any, hire contractors to maintain green outdoor spaces except for lawn maintenance.

See Appendix A for additional information on project components and costs.

3.2 Professional development: Facilitating children's nature connection

Professional development supports ECE program leaders and early educators in building the capacity and knowledge to integrate nature into children's learning. Based on survey responses from the study partner organizations, group training and coaching often begin with educators reflecting on their own relationship with nature and building familiarity with natural environments. Other topics include the role of nature in child development, children's engagement with natural materials and loose parts, and strategies for creating learning environments that encourage children's curiosity and questioning. Training also supports educators in facilitating risky play, through which children develop physical skills, explore their capabilities, assess risk and practice problem-solving.[70]

One format is ECHO's cohort model, which serves groups of five to 10 child care centers over 12 to 18 months. The model begins with a four-session monthly group training series. LIIF's "Connecting Children to Nature" program

[70] Steiner, A., Karabon, A., & Litz, L. (2023). Eliminate barriers to risk taking in outdoor play. *Teaching Young Children, 16*(3).

includes cohorts of up to 10 ECE programs, including both centers and FCC providers. The program includes six months of group training followed by six to 12 months of site-based coaching. In Santa Barbara County, the Audacious Foundation partners with Explore Ecology to provide professional development for ECE programs covering garden education and nature-based learning practices. Depending on their interests, participants attend between four and 24 hours of training per year.

Across the four organizations, professional development costs range from about $1,000 to $2,500 annually per ECE program.

While training on using outdoor spaces to support child development is making inroads, there is still room to expand. According to a survey of state-funded preschool programs by the National Institute for Early Education Research, 20 states and the District of Columbia (42% of state-funded preschool programs) conducted or offered support for professional development activities for staff specifically designed to promote effective outdoor learning experiences.[71]

3.3 Pre- and post-construction site-level characteristics

This section analyzes detailed site-level pre- and post-construction data from projects that convert traditional outdoor spaces to green play and learning areas. Each of the four study partner organizations provided data for two to four typical greening projects at child care centers (11 total) or FCC providers (five total). For completed projects, data are derived from pre- and post-construction documentation. For projects not yet completed, data are based on pre-construction conditions and blueprints. Each organization chose programs intended to reflect a typical greening project, while recognizing that every project has unique characteristics.

The estimated average licensed capacity for the sample centers and FCC providers is slightly larger than the national average (see Appendix B) and skews toward ECE programs that serve children from low-income families.[72] The average share of children by age (infants/toddlers, preschoolers and school-age) for both samples is similar to the percent of children served by age nationally.[73] Among centers, six are in California and the remaining five are in Colorado, Massachusetts, Michigan, Nebraska and South Carolina. Among FCC providers, two are in California and one each is in Colorado, Michigan and Washington, D.C.

The study partners provided data on changes in pre- and post-construction surface types, number of trees, and shade structure coverage. Survey respondents were also asked whether the greening projects included stormwater management features, such as a system to collect, store and/or infiltrate water on-site so it can be reused, evaporated or allowed to recharge groundwater instead of becoming runoff. None of the sites incorporated stormwater management features; survey respondents noted that greening projects do not typically include them.

The remaining data are presented by program type, beginning with centers and then turning to FCC providers.

[71] Jost, T.M., Barnett, W.S., & Hodges, K. (2024). *State Policies and Guidance Relating to Outdoor and Nature-Based Experiences in Preschool*. National Institute for Early Education Research. For example, the Minnesota Department of Children, Youth and Families hosts an Outdoor and Nature-based Learning webpage that includes resources for early educators. The nonprofit National Association for the Education of Young Children has several publications on its Outdoor webpage.

[72] Author's calculations based on data from Child Care Aware of America.

[73] Author's calculations based on data from the 2019 National Survey of Early Care and Education.

Site-based Study of Project Components, Costs and Environmental Sustainability Effects

Centers

Average center outdoor space size in the sample is 9,228 sq. ft.,[74] or about one-fifth of an acre. On average there is 125 sq. ft. of outdoor space per child.[75] Among the 11 centers, six are in Metropolitan Statistical Areas over three million in population, and five are in Metropolitan Statistical Areas below 500,000 in population. Compared with the nation, the sample draws from more densely populated areas. On average, centers in smaller MSAs have more square feet per child than centers in larger MSAs, suggesting that centers in less densely populated areas have greater access to outdoor space.[76]





Kristy's Child Development Center, Detroit, MI, Photos Courtesy of Early Childhood Health Outdoors

[74] Minimum 5,400 sq. ft., maximum 14,000 sq. ft.

[75] Minimum 30 sq. ft., maximum 242 sq. ft. Children attending the same center do not necessarily use the outdoor space at the same time.

[76] Across 10 of the 11 centers there is a positive relationship between the number of children served and the size of outdoor space (one outlier was removed since the outdoor space per child was much smaller than the other locations and it had a larger share of school-age children). The linear slope across the 10 locations suggests an additional child is associated with 74 more sq. ft. of outdoor space. However, the relationship between the number of children and size of outdoor space is influenced by other factors such as neighborhood population density and access to land; therefore, the relationship may be nonlinear at some or possibly all points along the distribution.

Site-based Study of Project Components, Costs and Environmental Sustainability Effects

Average pre- and post-construction changes in surface type, number of trees, and shade structure coverage are calculated across the 11 centers. Averages are based on aggregate information from all the projects but don't necessarily characterize a typical greening project.

For example, in Figure 2 the average surface composition before and after ECE greening projects includes all surface types recorded in the 11 projects; however, any individual project recorded less than half of these.

Figure 2.

Average Surface Composition Before and After Greening ECE Outdoor Spaces

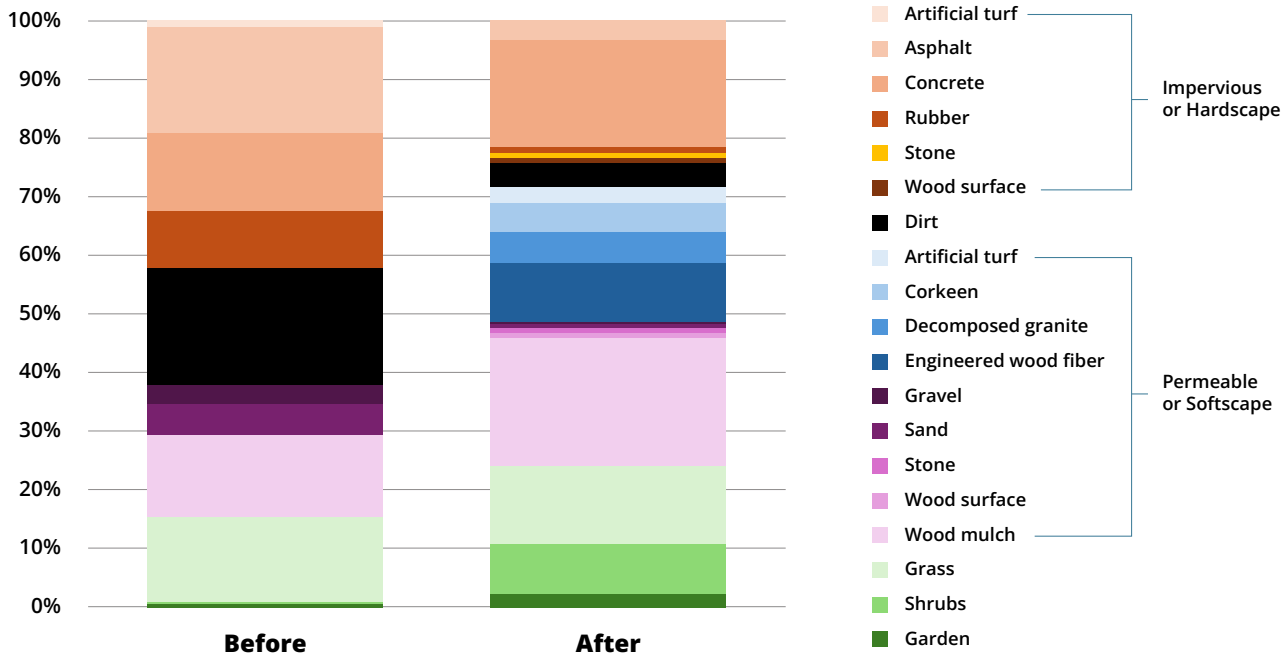


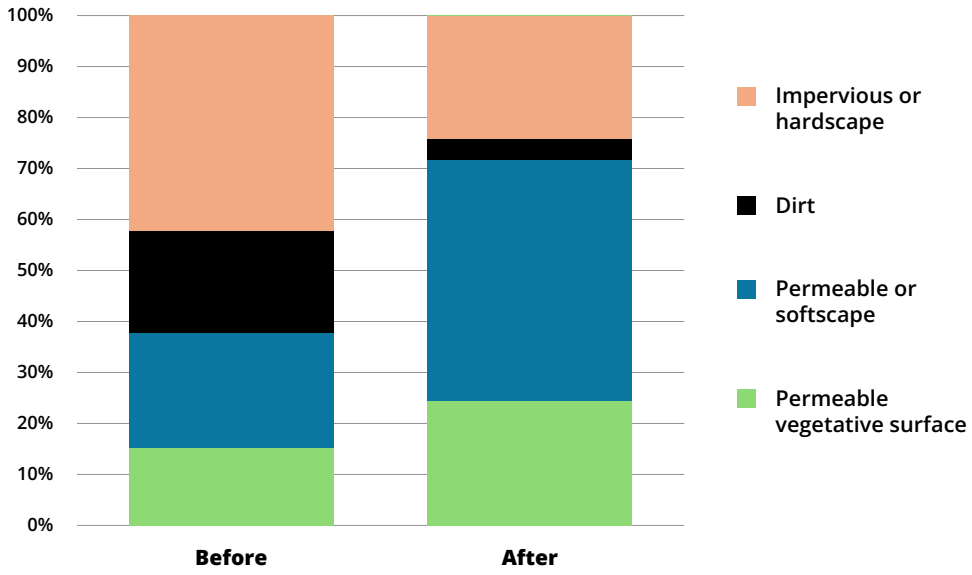
Figure 3 summarizes these surface types by permeability and vegetative surface categories. Before construction, impervious or hardscape surfaces comprised 42% of outdoor space on average. Dirt, which has both partially impervious and partially permeable characteristics[77] comprised 20%; permeable or softscape surfaces 23%; and permeable vegetative surfaces 15%. After construction, impervious or hardscape surfaces dropped to 24% and dirt to 4%, while permeable or softscape surfaces increased to 47%, and permeable vegetative surfaces increased to 24%.

[77] Survey respondents noted that dirt was either compacted from children's play, which creates a hard surface, or the area was mostly unused and therefore more permeable.

Site-based Study of Project Components, Costs and Environmental Sustainability Effects

Figure 3.

Average Surface Composition Before and After Greening ECE Outdoor Spaces

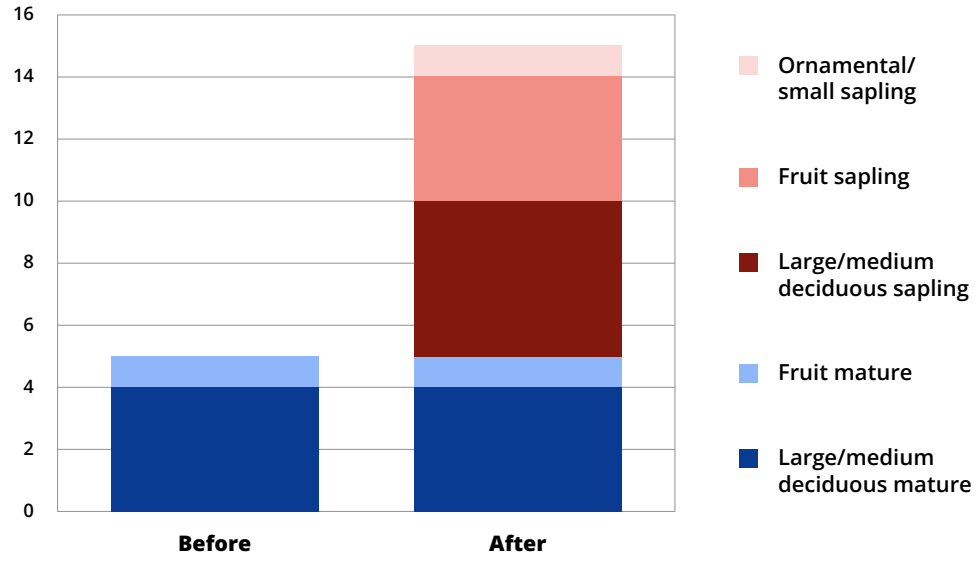


Trees

Prior to construction ECE outdoor spaces included, on average, one mature fruit tree and four mature large or medium deciduous trees. During construction, on average, ten saplings were planted, including five large or medium deciduous trees, four fruit trees and one ornamental or small tree.

Figure 4.

Average Number and Types of Trees Before and After Greening ECE Outdoor Spaces

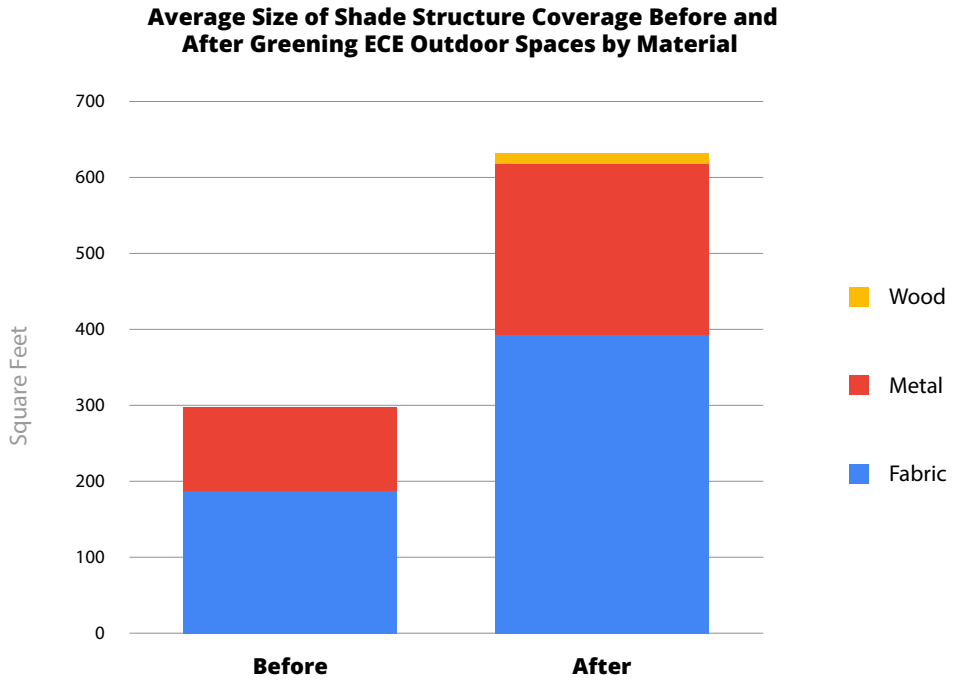


Site-based Study of Project Components, Costs and Environmental Sustainability Effects

Shade structures

Before construction, shade structure coverage comprised an average of 3% of outdoor space. After construction shade structure coverage more than doubled, to an average of 7% of outdoor space. Projects used fabric, metal and wood structures to increase shade coverage.

Figure 5.



FCC providers

The average FCC provider outdoor space size in the sample is 3,043 sq. ft.[78]—about 7% of an acre. On average there is 284 sq. ft. of outdoor space per child.[79] All five FCC providers in the sample are in Metropolitan Statistical Areas over three million people. As with centers, the FCC provider sample draws from more densely populated areas than the nation as a whole.

Average changes in pre- and post-construction by surface type, number of trees, and shade structure coverage are calculated across the five FCC providers.

[78] Minimum 843 sq. ft., maximum 5,948 sq. ft.

[79] Minimum 89 sq. ft., maximum 639 sq. ft.

Site-based Study of Project Components, Costs and Environmental Sustainability Effects

Figure 6.

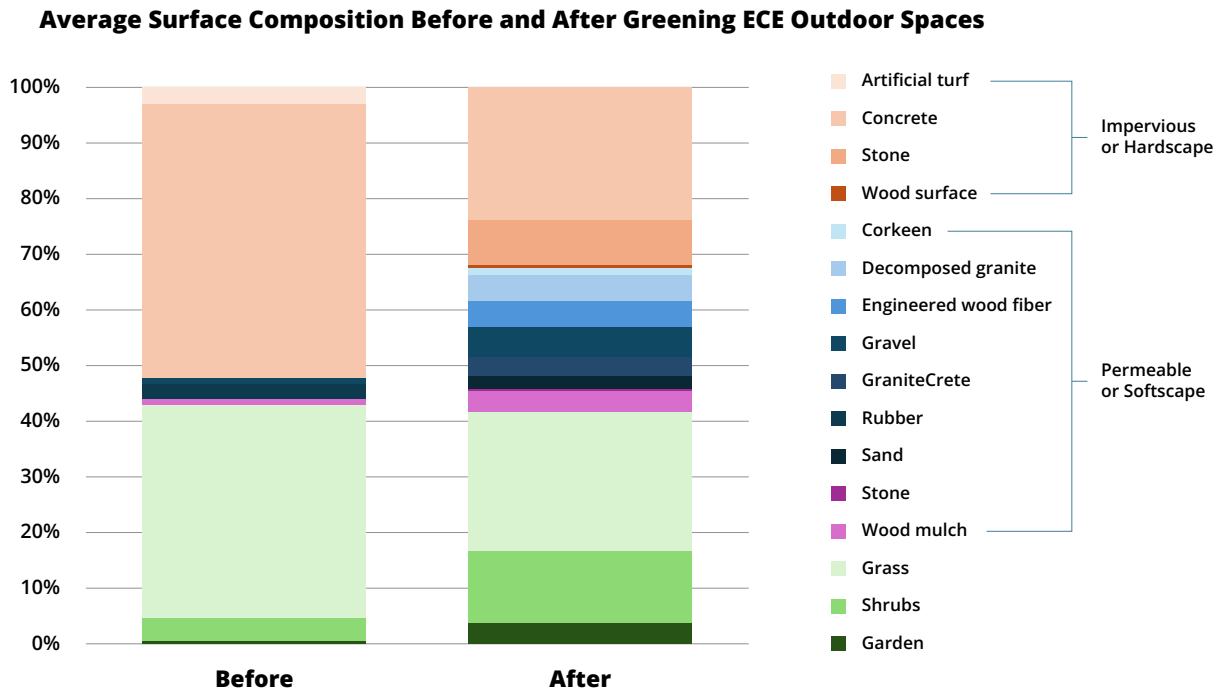
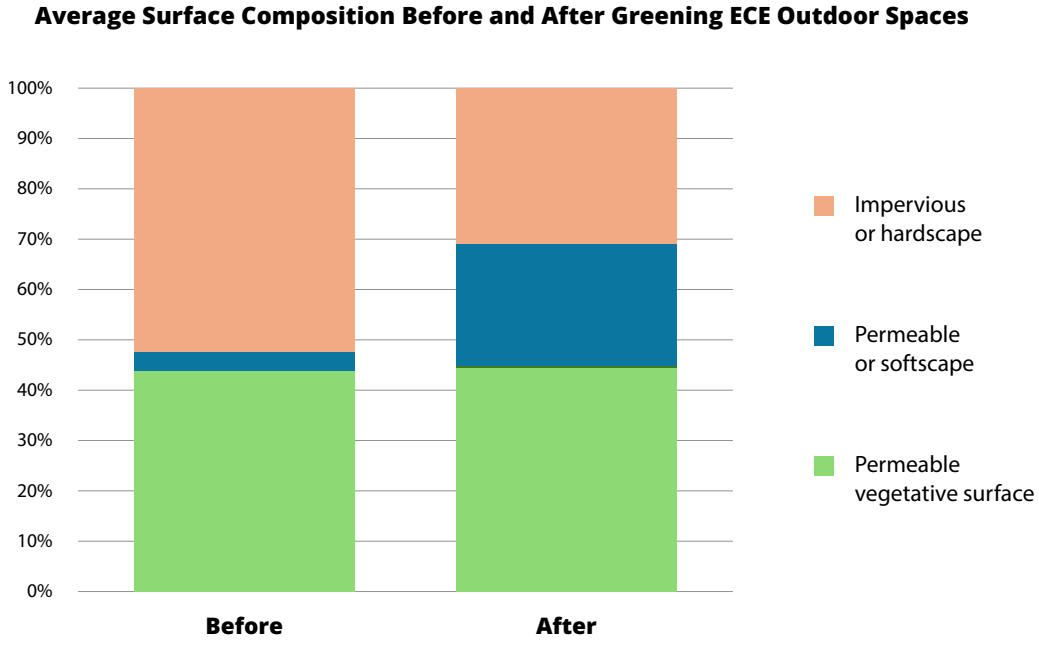


Figure 7 groups surface types by permeability and vegetative cover. Before construction impervious or hardscape surfaces on average comprised 52%, permeable or softscape surfaces 5%, and permeable vegetative surfaces 43%. After greening project construction, impervious or hardscape surfaces dropped to 32%, permeable or softscape increased to 26%, and permeable vegetative surfaces decreased slightly to 42%.

Figure 7.



Site-based Study of Project Components, Costs and Environmental Sustainability Effects

Trees and shade structures

Across all five projects sampled, four mature trees were removed and three saplings were planted—on net one fewer tree. On average, projects added 84 sq. ft. of shade structures, covering 5.3% of total outdoor space. This more than doubled the existing 76 sq. ft. of shade structures, which covered 2.5% of total outdoor space. Projects used fabric, metal and wood structures to increase shade coverage.

Together, the center and FCC provider data show how greening projects can shift surface composition, tree cover and shade coverage. The next section estimates the environmental sustainability effects associated with these changes.

3.4 Environmental sustainability effects

Although the primary goal of greening ECE outdoor spaces is to support child development, these projects also have positive effects on environmental sustainability by sequestering carbon, removing air pollutants, capturing stormwater, and reducing air temperatures. ECE outdoor spaces are relatively small individually, but collectively they represent a substantial amount of land.

Autocase Economic Advisory estimated environmental sustainability effects for child care centers using detailed site-level pre- and post-construction data. These data were entered into models that estimate the quantitative effects on carbon sequestration, air pollutant removal, water quality improvement, and air temperature reduction and were then translated into monetary values.[80]

- **Carbon sequestration.** Carbon dioxide comprises 80% of greenhouse gasses, which refers to gasses that trap heat in the atmosphere.[81] Trees and other vegetation reduce carbon dioxide through the accumulation of carbon in above- and below-ground plant biomass and in the soil beneath the vegetation as soil organic carbon. Benefits include slowing trends in warming temperatures and frequency of extreme weather events that cause increases in energy and food prices as well as property and insurance costs.[82]

- **Air pollutant removal.** The same biological mechanisms that sequester carbon can also remove air pollutants, which supports health, ecology, visibility, and the built environment. Health outcomes are categorized into mortality, reflecting loss of life and morbidity, or indicating a decline in quality of life due to diseases or illnesses, especially related to respiratory ailments.[83]

- **Water quality.** Features such as vegetative surfaces, permeable pavers, and green infrastructure, such as rain barrels or infiltration basins, improve water quality by capturing and treating stormwater runoff and reducing pollutant loads.[84] As noted earlier, while surface permeability changed during renovations, stormwater management features were not included in the projects studied.

[80] FCC provider results are not reported due to the small sample size and unique pre- and post-construction characteristics.

[81] U.S. Environmental Protection Agency. (2025). Overview of Greenhouse Gases.

[82] Clausing, K.A., Knittel, C.R., & Wolfram, C. (2025). Who Bears the Burden of Climate Inaction? *Brookings Papers on Economic Activity*, The Brookings Institution, 371–428. They write, "Although we consider only a subset of climate costs over recent decades, we find an aggregate annual cost averaging between $400 and $900 per household [in the United States]; in 10 percent of counties, costs exceed $1,300 per household. Costs vary significantly by geography, with the largest costs occurring in some western regions of the United States, the Gulf Coast and Florida. Climate costs also typically disproportionately burden lower-income households."

[83] Technical report by Autocase Economic Advisory. (2026). *Economic Analysis for Enhanced Early Care and Education Outdoor Space Valuation*.

[84] Ibid.

Site-based Study of Project Components, Costs and Environmental Sustainability Effects

- **Urban Heat Island mitigation.** UHI refers to higher temperatures in urban areas than in surrounding rural areas. These higher temperatures are largely driven by human activities and heat-retaining surfaces such as asphalt and concrete. Mitigation measures such as implementing grass, gardens, permeable surfaces, and trees reduce heat-related illnesses and mortality.[85] Urban low-income neighborhoods and communities of color are more likely to be in heat islands.[86]

Using pre- and post-construction data and related models, the estimated average net present value for the 11 ECE center projects totals $8,100 over a 25-year period.[87] Table 2 summarizes the estimated average net present value by benefit category over 25 years applying a 2% discount rate.

While individual benefits are modest, if implemented across all child care centers in the United States they reach $892 million (see Table 3). This estimate is based on per unit values applied to the estimated aggregate land of all centers (23,319 acres) and adjusted for differences in average annual rainfall and temperatures between the study location and national averages.[88] Table 3 applies per-unit values nationally across estimated child care center outdoor space by benefit category.

Table 2. Child Care Center Summary Results

Average net present value over 25 years, 2% discount rate, 2026 U.S. dollars

Benefit	NPV
Carbon sequestration	$4,900
Water quality	$1,900
Air pollutant removal	$ 900
Urban Heat Island mitigation	$ 400
Total NPV	**$8,100**

Table 3. National Aggregation Across Child Care Centers

Average net present value over 25 years, 2% discount rate, 2026 U.S. dollars

Benefit	NPV
Carbon sequestration	$539,369,000
Water quality	$209,143,000
Air pollutant removal	$ 99,068,000
Urban Heat Island mitigation	$ 44,030,000
Total NPV	**$891,610,000**

[85] Ibid.

[86] U.S. Early Years Climate Action Task Force. (2023). *Flourishing Children, Healthy Communities, and a Stronger Nation: The U.S. Early Years Climate Action Plan*. Capita Social, Inc. and the Aspen Institute.

[87] Technical report by Autocase Economic Advisory. (2026). *Economic Analysis for Enhanced Early Care and Education Outdoor Space Valuation*.

[88] Ibid.

Site-based Study of Project Components, Costs and Environmental Sustainability Effects

The study design supports causal, rather than merely correlational, estimates, which increases confidence in the results. At the same time, these effects are considered incidental because project designers did not identify environmental sustainability as a primary objective. As discussed in Section 4, intentionally designing for environmental sustainability benefits alongside other objectives could substantially increase overall project value.

As noted in Appendix B, aggregate outdoor spaces at licensed FCC providers are estimated at 6,861 acres and Head Start and Early Head Start centers at 2,090 acres. Applying an assumption that the effects of greening outdoor spaces on FCC providers[89] and Head Start and Early Head Start centers[90] are similar to child care centers, environmental sustainability effects total $262 million and $80 million, respectively. Added to the child care center effects, the total estimated net present value over a 25-year period reaches more than $1.2 billion. This estimate does not include outdoor spaces at school-based preschool programs which, at the individual level, are often larger than other ECE program types.

Additional environmental sustainability benefits

As discussed in *How Green Schoolyards Create Economic Value*, greening children's outdoor spaces affects several other aspects related to environmental sustainability that are not included in this analysis. For example, increased vegetation coverage and tree canopy can have a positive effect on pollinator habitats. Researchers at the University of Pittsburgh and Penn State University estimate that the economic value of insect pollinators was $43 billion in the United States in 2012 based on crops that depend on insect pollination.[91] Additionally, long-term environmental conservation is likely related to children's early exposure to and connection with nature. Research indicates that children's connectedness to nature has a positive relationship with sustainable behaviors.[92]

[89] The National Association of Family Child Care has an initiative on Protecting Children's Health in a Changing Climate.

[90] The National Head Start Association sponsors the GroMoreGood Garden Grants in partnership with Scotts Miracle-Gro Foundation and KidsGardening.

[91] University of Pittsburgh. (2021, February 3). The business of bees: The economic value of insect pollination services is much higher than previously thought in the US. *ScienceDaily*.

[92] van Heel, B.F., van den Born, R.J.G., & Aarts, N. (2023). Nature experiences in childhood as a driver of connectedness with nature and action for nature: A review. *Ecopsychology, 15*(4), 354–367; Barrera-Hernández, L.F., Sotelo-Castillo, M.A., Echeverría-Castro, S.B., & Tapia-Fonllem, C.O. (2020). Connectedness to nature: Its impact on sustainable behaviors and happiness in children. *Frontiers in Psychology, 11*; Hughes, J., Richardson, M., & Lumber, R. (2018). Evaluating connection to nature and the relationship with conservation behaviour in children. *Journal for Nature Conservation, 45*, 11–19.

A Compelling Case for Investment



Photo by Jeremy Ball

A Compelling Case for Investment

Across the domains of children's development and health, ECE programs, community development, and environmental sustainability, the evidence highlighted in this report points to a compelling case for investing in green ECE outdoor spaces and related professional development. Monetary values of benefits across these domains would seem to return more than enough to pay for the cost of a project.

To substantiate this claim, cost-benefit analysis (CBA) requires intervention research that demonstrates causal links to measurable outcomes with economic implications, assigns dollar values to those outcomes, and compares the resulting benefits with the cost of the intervention. Among the domains studied in this report, evidence related to environmental sustainability achieves this threshold of evidence. For the other domains more research is required to calculate CBA estimates, but as discussed in Section 5, there are opportunities to produce that evidence. First, this section reviews the greening ECE outdoor space outcomes that have economic implications and provides context for potential ROI.

Baseline costs

Greening ECE outdoor space projects face a wide range of costs, based on the information from the cost and site-based studies in Section 3. Given available data, $150,000 is the average estimated cost for project design, construction, ongoing maintenance and professional development at a child care center.

4.1 Future school performance and health

From Section 2, several studies indicate that greening ECE outdoor spaces creates an enriching environment for child development that fosters school readiness. As noted in Section 1, when children arrive at kindergarten prepared to succeed, they are more likely to thrive in school and beyond with positive economic benefits for children and society, particularly when reaching children in low-income neighborhoods.

Pulling from both sets of research—nature-based learning and early childhood studies—there are plausible pathways that connect greening ECE outdoor spaces to economic benefits such as reductions in grade retention or remedial education, reduced social service costs, and increased future earnings and tax revenue.

First, from Section 2, nature-based play and learning environments have positive effects on children's social-emotional development. Research establishes associations between measures of social-emotional skills in kindergarten and young adult outcomes related to education, employment, criminal activity, substance use and mental health.[93]

Second, research on the relationship between children's learning in nature-based settings suggests a likely impact on student achievement and related test scores.[94] To the extent that greening ECE outdoor spaces impacts school readiness and achievement scores in elementary school, research shows that early achievement is predictive of high school graduation.

[93] Jones, D. E., Greenberg, M., & Crowley, M. (2015). Early social-emotional functioning and public health: The relationship between kindergarten social competence and future wellness. *American Journal of Public Health, 105*(11), 2283–2290.

[94] Kuo, M., Barnes, M., & Jordan, C. (2019). Do experiences with nature promote learning? Converging evidence of a cause-and-effect relationship. *Frontiers in Psychology, 10*. They write, "Until recently, claims outstripped evidence on this question. But the field has matured, not only substantiating previously unwarranted claims but deepening our understanding of the cause-and-effect relationship between nature and learning."

For example, a meta-analysis of 22 experimental and quasi-experimental studies conducted by McCoy et al. shows that ECE programs lead to reductions in special education placement and grade retention, and increases in high school graduation rates.[95]

Shifting the trajectory of one high school dropout to that of a high school graduate produces strong economic value. Present value estimates of public benefits associated with an additional high school graduation are estimated at $107,000 while private (individual) benefits from increased earnings are estimated at $287,000.[96] Given the baseline cost estimate of $150,000, the value of shifting the trajectory of two or three children from dropping out of school to graduating from high school across a 10-year period could exceed project costs.

Regarding future health benefits, Section 2 highlights several studies that discuss the relationship between nature-based environments and children's physical activity, healthy eating, gut microbiome health and immune function, extreme heat mitigation, and mental health. Each of these outcomes has the potential to produce substantial economic value related to future health outcomes. According to the Centers for Disease Control and Prevention (CDC), 90 percent of the nation's $5.3 trillion in annual health care expenditures are for people with chronic physical and mental health conditions.

While more research is needed to confirm long-term effects, some studies point to potential pathways. For example, a 21-year study that tracked physical activity from childhood to adulthood in Finland reveals low to moderate correlations between physical activity in childhood and physical activity in adulthood.[97] As noted in Section 2.3, incorporating gardens and related activities into green ECE outdoor spaces supports positive early eating habits that foster healthy weight.

4.2 Early educator job satisfaction

While green ECE outdoor spaces benefit children, they can also improve early educator job satisfaction. Comfortable sitting and standing spaces and supply storage help early educators more effectively engage with children and feel comfortable outside. Early educators also benefit from access to a wide array of enriching activities for children and the children's more calm, focused, and prosocial behavior.

Attracting and retaining early educators is challenging for individual programs and across the ECE sector. Despite the value ECE produces, child care workers are some of the lowest paid in the labor force and typically are not offered benefits such as health insurance. The median hourly wage for child care workers is about $15 per hour—lower than many other service jobs, such as wait staff, cleaning staff, and retail salespersons.[98] Low wages contribute to relatively high turnover rates at ECE programs.[99]

While wages primarily drive early educator attraction and retention, working conditions also matter. A qualitative study of Nature Explore outdoor classrooms in Los

[95] McCoy, D.C., Yoshikawa, H., Ziol-Guest, K.M., Duncan, G.J., Schindler, H.S., Magnuson, K., Yang, R., Koepp, A., & Shonkoff, J.P. (2017). Impacts of early childhood education on medium- and long-term educational outcomes. *Educational Researcher, 46*(8), 474–487.

[96] See Vining, A.R., & Weimer, D.L. (2019). The value of high school graduation in the United States: Per-person shadow price estimates for use in Cost–Benefit Analysis. *Administrative Sciences, 9*(4), 81. Public or external benefits include reducing participation in crime, improving consumption and fertility choices, and enhancing intra-family productivity, among others. This estimate draws on several studies to specify a range of external benefits expressed as a fraction of total compensation; range is estimated between 0.13 and 0.42, modal value is 0.37. Values adjusted for inflation (2019 to 2025) using the Consumer Price Index for all urban consumers (CPI-U).

[97] Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O., & Raitakari, O. (2005). Physical activity from childhood to adulthood: a 21-year tracking study. *American Journal of Preventive Medicine, 28*(3), 267–273.

[98] Butcher, K., Kepner, E., Marquardt, K., & Smith, B. (2024). *The labor market for childcare workers. Chicago Fed Insights*.

[99] Grunewald, R., Nunn, R., & Palmer, V. (2022). *Examining teacher turnover in early care and education*. Federal Reserve Bank of Minneapolis.

A Compelling Case for Investment

Angeles Unified School District's early education centers shows that calm outdoor environments reduce teachers' stress and enhance their ability to be present and support children's learning.[100] In addition, based on a sample of K-12 teachers in Texas, preliminary results indicate that teachers who spend more time outside during the school day report lower stress, greater well-being, and less burnout.[101] Green outdoor spaces could help ECE reduce costs related to recruiting and onboarding early educators.

4.3 Attracting families to enroll in ECE programs

As noted in Section 1, the sharp rise in nature-based preschools indicates that families are demanding more nature access for their children. Presuming that this trend applies to the broader ECE market, green outdoor spaces could help attract families to individual programs and the ECE sector. Industry observers note that ECE programs with green outdoor spaces report more consistent enrollment and that openings fill faster. Enrollment attraction and retention are financial incentives to renovate ECE outdoor spaces.

4.4 Property value appreciation

While investments in green ECE outdoor spaces produce value for children, families, ECE providers and society, property values related to ECE programs also likely appreciate as outdoor improvements are capitalized into the value of the ECE center or in the case of FCC providers the residential property. For many ECE programs increased property valuation is a benefit to the program through a larger capital gain at the time of sale and increased leverage in applying for financing or in the case of nonprofits applying for grants. A tradeoff is potentially larger annual local tax payments—a cost to the program but a gain to the local tax base.[102]

Increases in property valuation can help stabilize ECE program financial balance sheets. For FCC providers who own their homes and serve children in low- and moderate-income (LMI) neighborhoods, an investment in outdoor spaces can support a public ROI and LMI family wealth creation, a goal of Community Development Financial Institutions and some other nonprofits and government agencies. In addition, property valuation gains may spill over to neighboring properties by marginally increasing valuations and local government tax revenue.

It's unclear the magnitude of property valuation increases relative to the size of investments in outdoor spaces (a search of the research literature did not find a study related specifically to ECE programs), but in the case of residential property gains could arguably appreciate at least as large as the investment, particularly with landscaping and tree planting. Survey-based studies indicate that landscaping can increase residential property values by 5% to 13%.[103] Meanwhile, a study conducted by the University of Nebraska-Lincoln's Bureau of Business Research, found that the collective value trees add to private home properties amounts to more than $31.5 billion annually nationwide.[104]

4.5 Environmental sustainability effects

As noted in Section 3.4, greening projects have positive effects on environmental

[100] Dennis, S., Castiblanco, E., & Kiewra, C. (2023). *Nature Explore Outdoor Classrooms in LAUSD Early Education Centers*. Los Angeles Unified School District and Dimensions Educational Research Foundation.

[101] Kolster, V. (2026). *Outdoor learning linked to gains in literacy, well-being for children and teachers, Texas A&M study finds*. Texas A&M Stories.

[102] For a discussion on property value-local tax payments tradeoffs see page 26 in Grunewald, R. (2024). *How Green Schoolyards Create Economic Value*. Rob Grunewald Consulting LLC. Commissioned by the Children & Nature Network.

[103] Niemiera, A.X. (2009). *The Effect of Landscape Plants on Perceived Home Value*. School of Plant and Environmental Sciences, Virginia Tech.

[104] Arbor Day Foundation. (2021). *Study: Trees Have a $31.5 Billion Impact on Home Values*.

sustainability by sequestering carbon, removing air pollutants, capturing stormwater and reducing air temperatures. Based on pre- and post-construction data and related models, the average net present value across the 11 ECE center projects over a 25-year period totals $8,100.[105] Relative to the baseline cost estimate of $150,000, environmental sustainability benefits represent 5% of total costs.

While the value of benefits relative to costs is modest, the benefits are considered incidental because project designers did not identify environmental sustainability as a primary objective. In contrast, an environmental sustainability analysis of a relatively large greening project at the public school-based Jefferson Early Learning Center (JELC) in southwest Houston, TX, shows that landscaping; planting trees; and adding water management infrastructure such as cisterns, constructed wetlands, a dry retention pond, and an infiltration trench on two acres[106] of the center's 17-acre campus produced environmental benefit values as high as 150% the size of project costs.[107] That is, based on environmental sustainability benefits alone, the project benefits far exceeded costs. The JELC study suggests that intentionally designing for environmental sustainability benefits alongside other objectives could substantially increase overall project value.

As noted in Section 3.4, applying results from the site-based study to the estimated total outdoor space at child care centers, family child care (FCC) providers, and Head Start and Early Head Start centers nationwide yields an estimated net present value of $1.2 billion in environmental sustainability benefits over 25 years.



Photo by Jeremy Ball

[105] Technical report by Autocase Economic Advisory. (2026). *Economic Analysis for Enhanced Early Care and Education Outdoor Space Valuation*.

[106] Equivalent to 10 child care center outdoor spaces in the site-based study; see Section 3.3.

[107] The center's location in a high rainfall area contributed to relatively large water quality benefits. See McMacCx & Autocase Economic Advisory. (2021). *JELC Triple Bottom Line Cost Benefit Analysis – Technical Memo*. Prepared for The Nature Conservancy.

A Compelling Case for Investment

4.6 Benefits across multiple domains

Table 4 summarizes the prospective effects of greening an ECE outdoor space by domain. Next, Section 5 discusses research opportunities that can further reveal the ROI from investing in green ECE outdoor spaces.

Table 4. Economic Effects of Greening an ECE Outdoor Space

Domain	Prospective effects	Monetary value of benefits
Children's learning and health	Support children's readiness to succeed in school	More research needed to estimate
	Improve children's short-term and long-term physical and mental health	
ECE programs and community development	Attract and retain early educators	More research needed to estimate
	Attract and retain families	
	Increase property values and local tax revenue	
Environmental sustainability	Sequester carbon	$4,900*
	Increase stormwater capture	$1,900*
	Remove air pollutants	$900*
	Reduce air temperature	$400*
	Increase pollinator habitat	More research needed to estimate
	Increase children's long-term sustainability behaviors	

***Average net present value over 25 years, 2% discount rate, 2026 U.S. dollars**

Next Steps



Photo by Jeremy Ball

Next Steps

5.1 Study limitations and future research

While the evidence highlighted in this report will likely continue to spur investment by ECE programs, government and philanthropy, further research could clarify the impact of greening ECE outdoor spaces, including which components are most effective. Study results could inform CBA and help guide funding decisions. As observed with early childhood education, more detailed ROI results could encourage more investment.

Although several studies show positive associations between nature-based learning environments and child development, and observational studies document how children use these spaces, the research literature does not yet isolate the causal impact of greening ECE outdoor spaces on near- or long-term outcomes. Study designs that apply random assignment or quasi-experimental methods with clearly defined comparison groups[108] could analyze data from an upcoming or previous rollout of greening ECE projects that incorporate professional development.

Researchers could include measures such as child development and health, early educator job satisfaction, ECE program enrollment, and property value estimates. As a follow-up to the site-based study on environmental sustainability, researchers could study projects intentionally designed to improve environmental outcomes and identify best practices to achieve those results alongside other benefits.

Because greening ECE outdoor spaces is still an emerging field, establishing a research agenda can help guide its expansion toward practices that produce the greatest ROI.

5.2 Cross-sector collaboration and policy development

In addition to advancing the research agenda above, next steps include exploring cross-sector collaboration and incorporating nature into ECE policy development. As with green schoolyards at elementary schools, because the benefits of greening ECE outdoor spaces span several sectors, developing mechanisms to facilitate cross-sector collaboration would be valuable. Potential collaborators with ECE programs include ECE-related government agencies and nonprofits, philanthropic organizations, community development organizations, environmental sustainability-related government agencies and nonprofits, and local businesses and banks.[109]

Although greening ECE outdoor spaces is emerging in ECE policy discussions, nature-based play and learning environments and related professional development are typically not high priorities. Yet, greening ECE outdoor spaces touches on several key issues within ECE, including creating enriching environments that support child development, attracting and developing the ECE workforce, and boosting financial stability for ECE providers. Placing greening ECE outdoor spaces higher on the priority list could help address several ECE issues simultaneously.[110]

---

[108] For example, the Denver Public School green schoolyard study takes advantage of rolling implementation over 12 years (2000 to 2012) to compare school-level trends prior to implementation with trends post-implementation against data from unconverted schools over the same period. Applying this research design to ECE programs requires access to administrative data tied to converted ECE programs and the children attending them as well as a group of unconverted ECE programs for comparison. See The Big SandBox, Inc., & Autocase Economic Advisory. (2023). *An Analysis of Learning Landscapes: Lessons Learned for a National Movement*. Grant report commissioned by the Children & Nature Network.

[109] A bank contribution or grant to a greening ECE outdoor spaces project that serves low- and moderate-income families may qualify for Community Reinvestment Act consideration. Also see Investment Connection, a forum hosted by the Federal Reserve Bank of Kansas City that connects organizations with community and economic development proposals to potential funders, including financial institutions, government, corporate enterprises and community foundations.

[110] *Nature in Early Childhood: A Toolkit* produced by the Children & Nature Network and KABOOM! is a resource for integrating nature into ECE activities and policy discussions. The Toolkit addresses infrastructure, programming and family or caregiver engagement, workforce capacity and professional development, and public policy and funding.

Next Steps

One consideration for greening projects is how child care and preschool policies and guidance affect nature-based environments, play features, and the amount of time children spend outdoors. Policies can either expand or limit young children's outdoor and nature-based experiences through requirements for outdoor spaces, minimum outdoor time, weather-based restrictions, and standards for outdoor play.[111] State administrators can assess how outdoor-space regulations balance child development benefits with health and safety risks, and how training can help early educators mitigate those risks (see Section 3.2).[112]

As discussed in Section 4, it's likely family demand for nature-based ECE settings will spur some amount of green outdoor space expansion. However, because many benefits spill over to society—especially when programs serve children from LMI families—broad expansion of green ECE outdoor spaces will require investment from government, philanthropy and the private sector.

Caregivers' nature connection supports children's nature connection

As discussed in *Wild Inside*, nature connection supports children's development as well as adult health and well-being.[113] The relationships parents, grandparents, early educators or other caregivers cultivate with nature can also help children connect with nature.[114]

Children take cues from their caregivers' actions, emotions and attention. Mirror neurons can play a role in this process by helping people internally mirror what they observe in others.[115] In this way, caregivers influence a child's response to nature through their own comfort, curiosity and responsiveness to the living world around them. For example, when a caregiver turns their head in the direction of a nearby bird's song, the child may look, too, and understand that the sound has meaning.

The influence also works in the other direction. When a caregiver observes a child's response to nature with attention and curiosity, the caregiver helps support that connection. For example, when a child is drawn to hold a stick, dig in the soil or watch a bird flying in the sky, a caregiver can notice the child's interest and join them.

[111] Jost, T.M., Barnett, W.S., & Hodges, K. (2024). *State Policies and Guidance Relating to Outdoor and Nature-Based Experiences in Preschool*. National Institute for Early Education Research. For FCC providers see National Center on Early Childhood Quality Assurance. (2022). *Family Child Care Home Licensing Trends for 2020: Brief #2*. Office of Child Care, Administration for Children and Families.

[112] Natural Start Alliance. (2025). *Recommendations for Licensing Outdoor, Nature-Based Early Learning and Child Care Programs*. North American Association for Environmental Education. This resource provides a holistic and detailed collection of outdoor nature-based program licensing policy and practice options to inform state regulations of child safety and healthy development in outdoor settings. While focused on nature-based preschool licensing and regulations, several elements apply to the broader ECE sector.

[113] Lockyer, K. (2025). *Wild Inside: How Nature Protects Your Child's Mental Health and Restores Yours*. Otter Play Publishing.

[114] See Nature and Health Alliance.

[115] Jaffe, E. (2007). Mirror neurons: How we reflect on behavior. *Association for Psychological Science*.

Next Steps

Wild Inside, along with books written by Richard Louv[116] and Jon Young,[117] offer several ideas for cultivating connection with nature. A variety of activities bring us and the children in our lives into direct experience with nature, including gardening, hiking, hunting, fishing, camping, wild food foraging, nature photography and traditional skills like fire-building and basket-weaving. Any of these activities and many others open opportunities to engage our senses and creativity with nature.



Photo by Jeremy Ball

5.3 Nature as collaborator

Greening ECE outdoor play and learning spaces is a collaboration with nature, from design details to scalable programs. Indigenous perspectives that emphasize respect for, relationship with, and reciprocity with nature offer opportunities to learn from nature's regenerative cycles when designing projects and policies.[118]

Reflecting nature's abundance, many of the resources cited in this report—and many others—are free or available at low cost. ECE providers and early educators can start with simple, low-barrier steps, that comply with regulations, such as adding a few natural materials to outdoor spaces and creating opportunities for children to connect with nature. Government and philanthropy can provide incentives to seed these efforts.

Nature offers rich opportunities to support children's development, just as children are innately ready to engage with nature as part of their own growth and learning. Our work is to open the door and support children as they step outside to grow a lifelong friendship with nature.

[116] See these books by Richard Louv: *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder*, *Vitamin N: 500 Ways to Enrich the Health & Happiness of Your Family & Community*, *The Nature Principle*, *Our Wild Calling*, and just released, *Noticing: Intimate Encounters with the Natural World*.

[117] See these books by Jon Young: *What the Robin Knows: How Birds Reveal the Secrets of the Natural World* and *Coyote's Guide to Connecting with Nature* (with Ellen Haas and Evan McGown)

[118] Pagani, S. (2025). *How lessons from Traditional Ecological Knowledge can support kids – and stave off climate anxiety*. Children & Nature Network.

Source List

Arbor Day Foundation. (2021). *Study: Trees Have a $31.5 Billion Impact on Home Values*.

Barrera-Hernández, L.F., Sotelo-Castillo, M.A., Echeverría-Castro, S.B., & Tapia-Fonllem, C.O. (2020). Connectedness to nature: Its impact on sustainable behaviors and happiness in children. *Frontiers in Psychology, 11*.

Beaven, L., Aasen Floyd, C., & Turner, L. (2023). *Nurturing All Children in Nature: Ideal Learning in the Natural World*. Trust for Learning, 14–15.

Bengston, D. N., Schermann, M. A., Moua, M., & Lee, T. T. (2009). Listening to neglected voices: Hmong Americans and public lands in Minnesota and Wisconsin. *Society and Natural Resources, 21*(10), 876–890.

Better Kid Care, PennState Extension. (2025). *Loose parts: What does this mean?* The Pennsylvania State University.

Blue Sky Funders Forum. (2023). *Culturally-inclusive nature programs that honor culture, explore justice, and unearth joy*. rethink outside.

Butcher, K., Kepner, E., Marquardt, K., & Smith, B. (2024). *The labor market for childcare workers*. Chicago Fed Insights.

Castro, D.C., Samuels, M., & Harman, A.E. (2013). Growing healthy kids: A community garden–based obesity prevention program. *American Journal of Preventive Medicine, 44*(3) [Supplement 3], S193–S199.

Children & Nature Network Research Digest. (2025). *Screen time and green time*.

Clausing, K.A., Knittel, C.R., & Wolfram, C. (2025). Who Bears the Burden of Climate Inaction? *Brookings Papers on Economic Activity,* The Brookings Institution, 371–428.

Craig, D., Trina, N. A., Monsur, M., Haque, U. T., Farrow, G., Hasan, M. Z., Tasnim, F., & Akinbobola, M. S. (2024). Effective nature-based outdoor play and learning environments for below-3 children: A literature-based summary. *International Journal of Environmental Research and Public Health, 21*(9), 1247.

Dennis, S., Castiblanco, E., & Kiewra, C. (2023). *Nature Explore Outdoor Classrooms in LAUSD Early Education Centers*. Los Angeles Unified School District and Dimensions Educational Research Foundation.

Dennis, S.F., Wells, A., & Bishop, C. (2014). A post-occupancy study of nature-based outdoor classrooms in early childhood settings. *Children, Youth and Environments, 24*(2), 35–52.

Dewar, G. (2016). Learning by doing: How outdoor play prepares kids for achievement in STEM. Natural Start Alliance.

Donahue, M. (2021). *A journey in the woods with Leech Lake Early Childhood Development's Megwayaak Project*. University of Minnesota Extension.

Source List

Early Childhood Scientific Council on Equity and the Environment. (2023). Extreme heat affects early childhood development and health: Working Paper No. 1

Ernst, J., Juckett, H., & Sobel, D. (2021). Comparing the impact of nature, blended and traditional preschools on children's resilience: Some nature may be better than none. *Frontiers in Psychology, 12*.

Ernst, J., & Stelley, H. (2024). Supporting young children's self-regulation through nature-based practices in preschool. *Behavioral Sciences, 14*(11), 1013.

Foglesong, S. (2018). *Building cultural empathy and celebrating diversity in nature-based early childhood education*. Natural Start Alliance.

Fyfe-Johnson, A.L., Hazlehurst, M.F., Perrins, S.P., Bratman, G.N., Thomas, R., Garrett, K.A., Hafferty, K.R., Cullaz, T.M., Marcuse, E.K., & Tandon, P.S. (2021). Nature and children's health: A systematic review. *Pediatrics, 148*(4).

Garcia, J.L., Heckman, J.J., Leaf, D.E., & Prados, M.J. (2020). Quantifying the life-cycle benefits of an influential early childhood program. *Journal of Political Economy, 128*(7).

Gibson, J. J. (2014). *The ecological approach to visual perception*. Hove: Psychology Press.

Grunewald, R. (2024). *How Green Schoolyards Create Economic Value*. Rob Grunewald Consulting LLC. Commissioned by The Children & Nature Network.

Grunewald, R., Nunn, R., & Palmer, V. (2022). *Examining teacher turnover in early care and education*. Federal Reserve Bank of Minneapolis.

Grunewald, R., & Rolnick, A.J. (2003). *Early Childhood Development: Economic Development with a High Public Return*. Federal Reserve Bank of Minneapolis.

Hamre, B., Hatfield, B., Pianta, R., & Jamil, F. (2014). Evidence for general and domain-specific elements of teacher–child interactions: Associations with preschool children's development. *Child Development, 85*(3), 1257–1274.

Heckman, J.J., Grunewald, R., & Reynolds, A.J. (2006). The dollars and cents of investing early: Cost-benefit analysis in early care and education. *Zero to Three, 26*(6), 10–17.

Heckman, J.J., Moon, S.H., Pinto, R., Savelyev, P.A., & Yavitz, A. (2010). The rate of return to the High/Scope Perry Preschool program. *Journal of Public Economics, 94*(1–2), 114–128

Hughes, J., Richardson, M., & Lumber, R. (2018). Evaluating connection to nature and the relationship with conservation behaviour in children. *Journal for Nature Conservation, 45*, 11–19.

Jaffe, E. (2007). Mirror neurons: How we reflect on behavior. *Association for Psychological Science*.

Source List

Johnstone, A., Martin, A., Cordovil, R., Fjørtoft, I., Iivonen, S., Jidovtseff, B., Lopes, F., Reilly, J.J., Thomson, H., Wells, V., & McCrorie, P. (2022). Nature-based early childhood education and children's social, emotional and cognitive development: A mixed-methods systematic review. *International Journal of Environmental Research and Public Health, 19*(10).

Jones, D. E., Greenberg, M., & Crowley, M. (2015). Early social-emotional functioning and public health: The relationship between kindergarten social competence and future wellness. *American Journal of Public Health, 105*(11), 2283–2290.

Jost, T.M., Barnett, W.S., & Hodges, K. (2024). *State Policies and Guidance Relating to Outdoor and Nature-Based Experiences in Preschool*. National Institute for Early Education Research.

Koepp, A.E., Gershoff, E.T., Castelli, D.M., & Bryan, A.E. (2022). Preschoolers' executive functions following indoor and outdoor free play. *Trends in Neuroscience and Education, 28*, 100182.

Kolster, V. (2026). *Outdoor learning linked to gains in literacy, well-being for children and teachers, Texas A&M study finds*. Texas A&M Stories.

Kuo, M., Barnes, M., & Jordan, C. (2019). Do experiences with nature promote learning? Converging evidence of a cause-and-effect relationship. *Frontiers in Psychology, 10*.

Lockyer, K. (2025). *Wild Inside: How Nature Protects Your Child's Mental Health and Restores Yours*. Otter Play Publishing.

Loebach, J. (2025). *Impacts of ECEC outdoor playspace renovations on children's play. A comparison study of 4 childcare centers in San Francisco*. DECALab, Human Centered Design, Cornell University.

Loebach, J., & Cox, A. (2022). Playing in 'The Backyard': Environmental features and conditions of a natural playspace which support diverse outdoor play activities among younger children. *International Journal of Environmental Research and Public Health, 19*(19).

Lomax, T., Butler, J., Cipriani, A., & Singh, I. (2024). Effect of nature on the mental health and well-being of children and adolescents: meta-review. *The British Journal of Psychiatry, 225*(3), 401–409.

McMacCx & Autocase Economic Advisory. (2021). *JELC Triple Bottom Line Cost Benefit Analysis – Technical Memo*. Prepared for The Nature Conservancy.

McCoy, D.C., Yoshikawa, H., Ziol-Guest, K.M., Duncan, G.J., Schindler, H.S., Magnuson, K., Yang, R., Koepp, A., & Shonkoff, J.P. (2017). Impacts of early childhood education on medium- and long-term educational outcomes. *Educational Researcher, 46*(8), 474–487.

Source List

McCurdy, L.E., Winterbottom, K.E., Mehta, S.S., & Roberts, J.R. (2010). Using nature and outdoor activity to improve children's health. *Current Problems in Pediatric and Adolescent Health Care, 40*(5), 102–117.

Moore, R., & Cosco, N. (2014). Growing up green: Naturalization as a health promotion strategy in early childhood outdoor learning environments. *Children, Youth and Environments*, *24*(2), 168–191.

National Center on Early Childhood Quality Assurance. (2022). *Family Child Care Home Licensing Trends for 2020: Brief #2*. Office of Child Care, Administration for Children and Families.

National Scientific Council on the Developing Child. (2004). *Young children develop in an environment of relationships*. Working Paper No. 1.

National Scientific Council on the Developing Child. (2005/2014). *Excessive stress disrupts the architecture of the developing brain*. Working Paper 3. Updated Edition.

Natural Start Alliance. (2019). *Nature-Based Preschool Professional Practice Guidebook: Teaching, Environments, Safety, Administration*. North American Association for Environmental Education.

Natural Start Alliance. (2025). *Recommendations for Licensing Outdoor, Nature-Based Early Learning and Child Care Programs*. North American Association for Environmental Education.

Nelson, C.A. (2000). Neural plasticity and human development: the role of early experience in sculpting memory systems. *Developmental Science, 3*(2), 115–136.

Nicholson, S. (1971). How NOT to cheat children: The theory of loose parts. *Landscape Architecture Magazine, 62*(1), 30–34.

Niemiera, A.X. (2009). *The Effect of Landscape Plants on Perceived Home Value*. School of Plant and Environmental Sciences, Virginia Tech.

North American Association for Environmental Education (NAAEE). (2023). *Nature Preschools in the United States: 2022 National Survey*.

O'Doherty, C., Dineen, Á.T., Truzzi, A., King, G., Zaadnoordijk, L., Harrison, K., D'Arcy, E.L., White, J., Caldinelli, C., Holloway, T., Kravchenko, A., Diedrichsen, J., Tarrant, A., Byrne, A.T., Foran, A., Molloy, E.J., & Cusack, R. (2026). Infants have rich visual categories in ventrotemporal cortex at 2 months of age. *Nature Neuroscience, 29*(3), 693–702.

Pagani, S. (2025). *How lessons from Traditional Ecological Knowledge can support kids – and stave off climate anxiety*. Children & Nature Network.

Source List

Prins, J., van der Wilt, F., van der Veen, C., & Hovinga, D. (2022). Nature play in early childhood education: A systematic review and meta ethnography of qualitative research. *Frontiers in Psychology, 13*.

Rogin, A., & Junod, A. N. (2023). *Paved Land Area, Access to Green Space, and Children's Health and Well-Being*. Urban Institute.

Roslund, M.I., Puhakka, R., Grönroos, M., Nurminen, N., Oikarinen, S., Gazali, A.M., Cinek, O., Kramná, L., Siter, N., Vari, H.K., Soininen, L., Parajuli, A., Rajaniemi, J., Kinnunen, T., Laitinen, O.H., Hyöty, H., Sinkkonen, A., & ADELE research group. (2020). Biodiversity intervention enhances immune regulation and health-associated commensal microbiota among daycare children. *Science Advances, 6*(42).

Steiner, A., Karabon, A., & Litz, L. (2023). Eliminate barriers to risk taking in outdoor play. *Teaching Young Children, 16*(3).

Taylor, A.F., & Kuo, F.E. (2009). Children with attention deficits concentrate better after walk in the park. *Journal of Attention Disorders, 12*(5), 402-409.

Technical report by Autocase Economic Advisory. (2026). *Economic Analysis for Enhanced Early Care and Education Outdoor Space Valuation*.

Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O., & Raitakari, O. (2005). Physical activity from childhood to adulthood: a 21-year tracking study. *American Journal of Preventive Medicine, 28*(3), 267–273.

The Big SandBox, Inc., & Autocase Economic Advisory. (2023). *An Analysis of Learning Landscapes: Lessons Learned for a National Movement*. Grant report commissioned by The Children & Nature Network.

Touloumakos, A.K., & Barrable, A. (2020). Adverse Childhood Experiences: The protective and therapeutic potential of nature. *Frontiers in Psychology, 11*.

Tracey, S., Rosen, S., & Smith, L.K. (2021). *Moving Towards Quality: Model Improvement Standards for Existing Center-based Child Care Facilities*. Bipartisan Policy Center.

Ulset, V.S., Borge, A.I.H., Vitaro, F., Brendgen, M., & Bekkhus, M. (2023). Link of outdoor exposure in daycare with attentional control and academic achievement in adolescence: Examining cognitive and social pathways. *Journal of Environmental Psychology, 85*.

University of Pittsburgh. (2021, February 3). The business of bees: The economic value of insect pollination services is much higher than previously thought in the US. *ScienceDaily*.

U.S. Early Years Climate Action Task Force. (2023). *Flourishing Children, Healthy Communities, and a Stronger Nation: The U.S. Early Years Climate Action Plan*. Capita Social, Inc. and the Aspen Institute.

Source List

U.S. Centers for Disease Control and Prevention. (2026). Childhood Obesity Facts.

U.S. Environmental Protection Agency. (2025). Overview of Greenhouse Gases.

van Heel, B.F., van den Born, R.J.G., & Aarts, N. (2023). Nature experiences in childhood as a driver of connectedness with nature and action for nature: A review. *Ecopsychology, 15*(4), 354–367.

Vining, A.R., & Weimer, D.L. (2019). The value of high school graduation in the United States: Per-person shadow price estimates for use in Cost–Benefit Analysis. *Administrative Sciences, 9*(4), 81.

Yin, J., Bratman, G.N., Browning, M.H.E.M., Spengler, J.D., & Olvera-Alvarez, H.A. (2022). Stress recovery from virtual exposure to a brown (desert) environment versus a green environment. *Journal of Environmental Psychology, 81*.

Zeno, S., Rashid, M., Rowland-Shea, J., Bailey, K., & Payan, R. (2026). *The Nature Gap: Communities of Color and Those With Low Incomes Are Bearing the Brunt of America's Nature Loss*. Center for American Progress.

Appendix A.

Additional information from project components and costs study

Project location affects cost

Projects of similar size and characteristics may face different labor and materials prices depending on the location. Projects in large urban areas are generally more likely to face higher materials prices and labor costs than those in rural areas. Furthermore, a survey respondent noted that projects in rural communities tend to have more access to skilled volunteers than in large cities. However, availability of materials and labor can be challenging in some rural areas, especially remote places. Another survey respondent found less predictable differences in rural and urban prices; instead, prices depend more on the market for local contractors and their experience with working on outdoor learning environments.

Strategies for containing costs

Survey respondents identified several ways to contain project costs. One survey respondent said they work closely with project managers to contain costs, especially during initial design, contract bidding and construction. Survey respondents noted that they select materials that produce the most value in terms of quality, durability and safety relative to cost. Sometimes ECE programs can repurpose existing surfacing or furnishings or seek out low-cost, recycled or donated materials such as tree stumps, upcycled electrical spools and recycled tires. A survey respondent noted that ECE programs can reduce contractor overhead charges by purchasing furnishings directly. Finally, if needed, implementing projects in stages over time can spread out costs.

Skilled labor does most of the work

Most of the labor for greening projects is performed by skilled workers coordinated by licensed contractors, especially for complex components such as earthwork, decking, surface coverings and irrigation. One survey respondent noted that projects often include at least a small amount of volunteer support and another respondent observed that contractors who focus on outdoor learning environments have led productive volunteer workdays. Volunteers assist with less technical aspects such as mulching, planting, or assembling freestanding furnishings. However, two other respondents indicated that volunteers were not part of their greening projects.

Project management approaches

Across the organizations surveyed, project management depends on the scale and design of the project. ECHO and Nature Explore advise on design and construction while project management is often led by the ECE program's contractor. LIIF contracts with a project management firm that manages budgets, coordinates with key stakeholders and ensures timely project completion. Projects that the Audacious Foundation funds in Santa Barbara County are mostly led by a landscape contractor who collaborates with the ECE program to design and implement renovations.

A variety of funding sources support greening projects

Project funding sources vary based on organizations' relationship with philanthropic and government funding sources. In San Francisco, LIIF administers pass-through grants on behalf of the San Francisco Department of Early Childhood (DEC). Among these programs, some nonprofit ECE providers received an additional state grant from Cal Fire's Urban and Community Forestry program which covers roughly 80% of project expenses with the DEC grant covering 20%.

Appendix A.

Additional information from project components and costs study

ECHO and Nature Explore report that the ECE programs they work with often match or exceed the amounts they receive from philanthropic or government grants by investing their own funds or soliciting volunteer labor or materials donations. First 5 Santa Barbara County and the Audacious Foundation note that philanthropic and government grants tend to cover all project costs for nonprofit ECE centers and public-school based Transitional Kindergarten programs while for-profit ECE center project expenses are typically split between the ECE program and philanthropy (including parent donations).



Photo by Jeremy Ball

Appendix B.
Estimates of aggregate size of ECE outdoor spaces in the US

Table B1. Aggregate Size of Outdoor Spaces at Child Care Programs

Licensed Child Care Programs, 2024

	Center	FCC
Number	110,945	109,012
Average number of spaces per program	84.9	10.5
Study sample average number of spaces per program	86.8	11.6
Study sample average size (sq. ft.)	9,228	3,043
Adjusted average size (sq. ft.)	9,156	2,742
Aggregate size in acres	23,319	6,861

Source: Child Care Aware of America and author's calculations

According to Child Care Aware of America data, there were 110,945 licensed child care centers and 109,012 FCC providers[119] in the United States in 2024. The average number of licensed spaces per program is the sum of center and FCC licensed spaces divided by the number of programs, respectively.[120] The average number of licensed spaces per program is slightly smaller than the study sample for centers and FCC providers. The average size of sample ECE outdoor spaces is adjusted lower to reflect the sample's slightly larger average number of licensed spaces per program compared with the nation. Multiplying the number of centers and FCC providers by the adjusted average outdoor space size produces national aggregate estimates of 23,319 acres of outdoor spaces for centers and 6,861 acres of outdoor space for FCC providers. For comparison, Moore and Cosco (2014) estimate 30,000 acres of aggregate child care center outdoor space based on 114,000 centers (2012 data), which they note is 35 times the size of New York's Central Park.[121]

[119] FCC data were not available for Louisiana and Mississippi. The average ratio of FCC/Centers among bordering states (Alabama, Arkansas, Tennessee and Texas) was used to interpolate the number of FCC homes in Louisiana and Mississippi.

[120] Calculation is based on states with available data. Center space data was not available for Alabama, Mississippi and New Jersey, and FCC space data was not available for Alabama, California, Louisiana, Massachusetts, Mississippi and New Jersey.

[121] Moore, R., & Cosco, N. (2014). *Growing up green: Naturalization as a health promotion strategy in early childhood outdoor learning environments*. *Children, Youth and Environments, 24*(2), 168–191.

Appendix B.

Estimates of aggregate size of ECE outdoor spaces in the US

Table B2. Aggregate Size of Outdoor Spaces at Head Start and Early Head Start Centers

Number of centers	**14,373**
Average number of spaces per program	**47.7**
Study sample average size (sq. ft.)	**9,228**
Adjusted average size (sq. ft.)	**6,333**
Total size in acres	**2,090**

Source: National Head Start Association and author's calculations

According to data from the National Head Start Association, there are 14,373 Head Start and Early Head Start centers nationwide with 685,296 funded child spaces. The average number of children per program is 47.7; however, there is considerable variability in center size. Furthermore, some Head Start classrooms are incorporated into other programs such as public schools and some Early Head Start programs operate in partnership with a child care center. Without accounting for this complexity and applying the overall average, HS/EHS centers are 39 child spaces smaller than the sample average. Therefore, average outdoor space is adjusted to 6,333 sq. ft.[122] with an aggregate outdoor space estimate of 2,090 acres.

Estimate limitations

As noted in Section 3.3, the sample centers are in more densely populated areas than the nation as a whole. As a result, the sample's average outdoor space size is likely smaller than the actual national average. Rather than adjusting the sample average downward, it may be more appropriate to adjust it upward, which would move the aggregate estimate closer to the Moore and Cosco estimate.

[122] Calculation applies 74 sq. ft. per space assumption; see Section 3.3 for details.