



SUMMIT PROCEEDINGS

Outdoor Spaces and Nature-Based Programming in Public Gardens:

Building the Evidence for Early STEM Learning

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TABLE OF CONTENTS

Introduction.....	1
Summit Overview & Synthesis.....	1
Background and Purpose.....	1
Summit Participants	3
Summit Sessions	4
<i>Early Childhood Spaces and Programs Case Studies (Session 1).....</i>	<i>4</i>
<i>Research Updates (Session 2)</i>	<i>6</i>
<i>Program Evaluation (Session 3)</i>	<i>7</i>
<i>Building the Knowledge Base (Session 4)</i>	<i>9</i>
<i>Networks and Resources (Session 5).....</i>	<i>13</i>
Themes of the Day	15
Self-directed play	16
Design	16
Conservation.....	16
Whole Family Focus	17
Gaps.....	17
<i>Measurement.....</i>	<i>17</i>
<i>Teacher training.....</i>	<i>17</i>
<i>Diversity and inclusion</i>	<i>18</i>
Next Steps	18
Appendix	20
A. Summit Participants.....	20

INTRODUCTION

Nature-based learning (NBL) is increasingly being represented – and sought after – in early education. Across the United States, NBL opportunities are predominantly being developed and offered in nature-based spaces, such as arboreta, public gardens, forest preserves or forest preschools. While there is a growing research base on the benefits of exposure to nature in general, the effects of NBL, especially regarding the early years, are less well researched and understood. This is perhaps due to the fact that nature-based spaces develop and implement programs largely in isolation and have only recently begun evaluating them. In order to grow the NBL evidence-base, and to continuously support effective, high-quality NBL programming, efforts across the country need to be pooled through cross-space/program collaboration.

The Morton Arboretum (TMA) and NORC at the University of Chicago were in an ideal position to initiate and co-host a summit bringing together researchers and practitioners across a range of nature-based spaces and programs employing NBL. TMA is an internationally recognized global leader in tree science and educational programming. It is particularly well-known for its Children’s Garden, which incorporates ten themed gardens, each with interactive activities that provide children as young as 2 years of age with NBL opportunities through play, exploration, and preschool-aged programming. NORC is an objective international research institution that conducts rigorous research and program evaluation, with special expertise in developing early childhood research-practice partnerships. Together TMA and NORC combined their respective areas of expertise to facilitate knowledge exchange, encourage NBL community building, and help develop an agenda for future collaboration.

This report synthesizes presentations and discussions that occurred during the day-and-a-half long summit held at the Morton Arboretum in May 2018. It is intended to identify and describe major themes, including knowledge gaps that arose during the summit, in order to foster collaborative efforts among NBL practitioners and researchers, and to provide concrete next steps towards collectively building the evidence base for NBL.

SUMMIT OVERVIEW & SYNTHESIS

Background and Purpose

The goal of the *Outdoor Spaces and Nature-based Programs: Building the Evidence Base for Early Learning* Summit was to identify current research priorities and findings in the field of nature-based spaces and programs and provide a forum for discussing those priorities with researchers and practitioners, in particular those engaged with early learners – children from birth through preschool age. It is well known that children have a natural desire to explore the world around them and, in the process, acquire content knowledge and habits of mind as well as an affinity for the natural world^{1,2,3,4,5,6}. It was

¹ Ballantyne, R., Packer, J., & Hughes, K. (2008). Environmental awareness, interests and motives of botanic gardens visitors: Implications for interpretive practice. *Tourism Management*, 29(3), 439–444. <http://doi.org/10.1016/j.tourman.2007.05.006>

² Eberbach, C. and Crowley, K. (2009) From Everyday to Scientific Observation: How Children Learn to Observe the Biologist’s World. *Review of Educational Research*, 79, 39–68. <http://rer.aera.net>

³ Lohr, V., & Pearson-Mims, C. (2005). Children’s active and passive interactions with plants influence their attitudes and actions toward trees and gardening as adults. *HortTechnology*, 15(3), 472–476

⁴ Morgan, S. C., Hamilton, S. L., Bentley, M. L., & Myrie, S. (2009). Environmental education in botanic gardens: Exploring Brooklyn botanic garden’s project green reach. *The Journal of Environmental Education*, 40(4), 35–52

⁵ Wake, S. (2007). Designed for learning: Applying “learning-informed design” for children’s gardens. *Applied Environmental Education & Communication*, 6(1), 31–38. Available online: <http://doi.org/10.1080/15330150701318778>;

clear to TMA and NORC that practitioners' efforts to leverage these tendencies in the early learning years could be enriched through research-informed practices and through research, evaluation and collaboration. More robust evidence was needed about the ways in which NBL experiences (from unstructured play to intentionally designed programs) benefit learning and engender an affinity for nature. Key overarching questions that emerged in planning for the summit were:

1. Are the developers of children's gardens and nature-based programs seeking similar outcomes and, if so, what are they?
2. What are the characteristics of the evaluations being conducted and what can we learn from them? What impact(s) are they finding?
3. How can we categorize the similarities and differences in the range of nature-based spaces and programs across the United States and internationally?

Summit participants' expectations of the summit were largely in line with these key questions (see Table 1).

Table 1: Major themes from summit participants' responses to the question: *What do you want to get from the Summit?* (n=22)

Themes	Responses representing themes (%)
New knowledge around research and practice	9 (41%)
Evaluation	7 (32%)
Networking/Collaboration	4 (18%)
Diversity and Inclusion	2 (9%)

A key goal in planning the summit was to ensure that the wide-ranging types of nature-based spaces and programs were represented. To capture and represent this range, TMA, with input from NORC, developed a Nature-based Learning Continuum that identified defining features of nature-based spaces and programs. Among other benefits, the continuum established a baseline for using similar terminology and language in the discussions of commonalities and differences across NBL programs, gardens and their intended outcomes.

The continuum, shown in Table 2 below, represents a sliding framework spanning nature based spaces and programs with minimal to no guidance through full nature-based forest preschools/kindergartens. It is not intended to separate spaces and programs into distinct categories but instead enables spaces and programs to locate themselves on the continuum.

⁶ Worth, Karen. (2010). Science in early childhood classrooms: Content and process. Collected papers from the SEED (STEM in Early Education and Development) Conference held May 2010 at the University of Northern Iowa, Cedar Falls, Iowa. *Early Childhood Research & Practice*, 12(2). Retrieved November 2015 from <http://ecrp.uiuc.edu/beyond/seed/worth.html>.

Table 2. Nature-based Learning Continuum

<u>Nature Play Space</u>	<u>Children's Garden</u>	<u>Drop-in Nature Programming</u>	<u>Facilitated Nature Education Programming</u>	<u>Nature/Forest Preschool</u>
(Minimal or no guidance or interpretive elements)	(Interpretive Elements)	(Informal program often with open-ended start and end times)	(Enrolled short-term program/camp/guided field trip)	(Preschool with nature-based curriculum/significant nature-based elements)

Summit Participants

The N=40 participants who attended the summit represented the range of spaces and programs across the NBL continuum. While participants were not introduced to the Continuum prior to the summit, they were asked, *Which of the following categories best describe the spaces or programs that you work with for early childhood learners? Check all that apply.* Twenty-five participants responded. Their responses are listed in Table 3 below. Table 4 indicates the range of nature-based spaces and programs represented by all summit participants. A full list of participants and contact details is provided in Appendix A.

Table 3. Pre-summit participant self-identification of the types of spaces and programs they represented (n=25)

Space or Program Type	Number of responses (%)
Nature Play Spaces	16 (64%)
Children's Gardens	13 (52%)
Drop-in or Station-Based	10 (40%)
Non-Formal Classes	12 (48%)
Nature/ Forest Preschool	9 (36%)
Early Childhood Research	1 (4%)
Forest/ General Garden	1 (4%)
Children and Nature Network	1 (4%)
Outreach, PD for ECE and daycares	1 (4%)
Forest Program-elementary age	1 (4%)
Exhibit Design	1 (4%)

Table 4. Types of spaces and programs represented by all Summit participants based on professional affiliation (n=40)

Type of Space/Program	Number of Participants (%)
Botanical Garden	9 (22.5%)
Researchers/Educators	8 (20%)
Arboretum	5 (12.5%)
Arboretum & Forest	5 (12.5%)
Forest	4 (10%)
Arboretum & Botanical Garden	3 (7.5%)
Zoo	2 (5%)
Nature Preschools/Camps	2 (5%)

Park District	1 (2.5%)
Nature Museum	1 (2.5%)

Summit Sessions

The summit consisted of five individually themed sessions: 1) Early childhood spaces and programs case studies, 2) Research updates, 3) Program evaluation, 4) Building the knowledge base, and 5) Networks and resources. Each session is briefly summarized below, followed by a synthesis of emerging common themes, highlights, major findings, as well as identified gaps. Each section includes links to the referenced materials, if permission to share was given.

Early Childhood Spaces and Programs Case Studies (Session 1)

In the first session of the day, four case studies were presented: Bernheim Forest, Atlanta Botanic Garden, New York Botanical Garden, and Schlitz Audubon Nature Center. Please see Table 5 below, for an illustration of where each presenter falls along the NBL continuum, as well as for links to the presented materials.

Table 5. Case studies within the Nature-based Learning Continuum

Nature Play Space	Children's Garden	Drop-in Nature Programming	Facilitated Nature Education Programming	Nature/Forest Preschool
Bernheim Forest: Claude Stephens, Whitney Wurzel	Atlanta Botanic Garden (ABG): Tracy McClendon New York Botanic Garden (NYBG): Jaime Boyer	ABG, Bernheim, NYBG	ABG, Bernheim, NYBG	Schlitz Audubon Nature Center: Catherine Koons-Hubbard

The four case studies all served children (and their families) across the developmental spectrum, with a focus on early learners: pre-schools, playgroups with moms, family programs. Other audiences included field trip groups, homeschool groups and school programs more generally. Playful engagement with nature was at the heart of each program, whether structured, semi-structured or informal: free play, adventure play, risky play, or outdoor play.

Five themes emerged across the four case study presentations: teacher education/professional development, physical space (re)design, risky play, conservation/protection of programs' natural resources, audience engagement, and evaluation.

Teacher education arose as a common theme. Bernheim Forest offers an 18 hour teacher training for nature-based play education, which counts towards continuing education credit for the state of Kentucky. New York Botanical Garden offers guided tours for school groups. The guided aspect serves a purpose: most teachers are not trained as outdoor educators and do not feel confident leaving children on their own to explore nature. NYBG's teacher PD programs are therefore aimed at building teachers' confidence to take their students outside. At Schlitz-Audubon Nature Center, preschool teachers learn on the job, often

when outdoors with naturalists. Presenters noted that these programs often involve a lot of unlearning and learning new practices that support nature-based play.

The design of nature-based spaces emerged as another critical topic. ABG described the redesign of their original children's garden and the move away from exhibits that were built for one-to-one learning because child-adult interaction was not happening dichotomously as originally intended: most parents and caregivers visit with multiple preschool-aged children. ABG conducted intercept interviews with visitors and learned that parents desired more adventurous play, but specifically sought out the Garden's educational experience. NYBG is currently finishing up the development phase of their garden's redesign, which was informed by a listening session. The listening session included parent and teachers as well as cross-departmental NYBG staff, such as horticulture, government relations, development and education. NYBG learned that parents and teachers are looking for opportunities to get children outside, and that the desired space should be "wild", not manicured. Although parents in this location explicitly said they were not looking for more formal science education, they still wanted their children to engage in exploration and observation.

Another recurring theme was how to approach risk taking in order to facilitate more adventurous, risky, and independent play, especially in the context of rules and regulations. Bernheim Forest discussed their approach from multiple directions. There is a tendency to focus on risk at the expense of assessing potential benefits. For legal concerns, Bernheim Forest engaged the Public Health Law Center (<http://www.publichealthlawcenter.org/>) in Minnesota, which provides consultations and trainings on the difference between risk and danger, noting that nature places are not liable for the former. They also actively involve children in risk assessment (when designing nature spaces) and risk management (during use), arguing that if children are given responsibility, they will take it. Another way to approach risk and benefit assessment is the close examination of rules and regulations. There may be grey zones which allow for risk taking within the confines of rules and regulations. Another sub-theme within this area is that parents look to the facilitators of nature spaces and nature-based programming to "give permission" for their children to engage with nature and in more risky play. Bernheim Forest does so intentionally and thoughtfully in order to challenge assumptions around what risky behavior is, which may be unfounded in the first place. ABG echoed the need to give permission to children (and their parents) to explore and interact with the exhibits on their own. They started providing signage specifically allowing children to touch exhibits after noticing that parents would keep their children from interacting with them.

Discussions of risky play prompted discussions about a shared concern around the conservation of natural spaces. *Leave No Trace* training does not ensure that the destruction of natural habitats is prevented. Bernheim Forest argued for a balance between allowing children to play while being environmental stewards and pointed to an assessment of both costs and benefits. NYBG offered solutions involving the creation of artificial exhibits to provide exploratory space (e.g. artificial marsh) and diversion strategies to keep visitors away from plants that need protection. In general, at NYBG, there is an understanding that there will be damage and that exhibits will need to be replaced. ABG described their "sacrificial Venus fly traps," which the garden expects to be destroyed and whose frequent replacement are built into the annual budget. ABG has six pots of Venus fly traps in rotation, three pots are on display at any time, to be replaced by the other three when necessary. The pots are very popular with children and last about a month. Schlitz Audubon noted that one of their center rules is to be mindful of nature, and that environmental conservation practices are taught. The children are aware that while they are allowed to damage the nature spaces within their allocated play zone (fenced in), they must not do so when out on the trails.

Another key topic among the presented case studies was how to engage with the audience/visitors. ABG reported the creation of a new position, an educational horticulturist who is housed in both the education and horticulture departments. Part of her job description is to engage with visitors; she engages people in

the garden, facilitates dialogue, and encourages children to actively engage the garden by providing children with tools like rakes and shovels to use. The use of tools is supervised but not directed (i.e., without children's knowledge). A part-time horticulturalist supports the Senior Educational Horticulturalist as needed on horticultural tasks in order to allow the senior staff member unconstrained opportunities to engage with families. Cross-departmental Educational Horticulturalist positions are being replicated in other nature spaces as well. TMA reported having a similar position called a tree-ologist. Bernheim Forest, on the other hand, asked how they can reduce the role they play in facilitating children's engagement with nature, in order to allow for more independent play. Their goal is to reduce adult involvement in child-directed nature-based play. To that end they constantly revise what rules are minimally sufficient to keep children safe without undue adult interference.

The most common theme across all the case studies was the important and under-resourced need for evaluation of nature-based programming. While qualitative and quantitative evaluation is increasingly being built into nature-based programming, there are challenges in assessing the effectiveness of programs. Bernheim Forest discussed testing convergent versus divergent thinking. Convergent thinking leads to one solution, which is then easily testable. Divergent thinking, however, leads to many solutions, and it is less clear how to assess it, especially longitudinally. ABG pointed to the difficulty of evaluating informal programs, impeding their ability to improve programming, or to attract funding. Schlitz Audubon echoed the concern of how to evaluate play spaces and different programs, noting that they operate over the academic year, and offer 2, 3, and 4-day preschool, which may affect outcomes.

Research Updates (Session 2)

Session 2 broadly focused on research and evaluation on human exposure to nature. Dr. Cathy Jordan of the University of Minnesota provided an overview of research fundamentals, outlining the differences between research and evaluation, and associated design considerations. She described common pitfalls and pointed to the pathways that have been found to moderate and mediate effects found in NBL research and evaluation. Dr. Louise Chawla, of the University of Colorado, Boulder, then provided an overview of the many positive research findings around the benefits of nature experiences for young children. David Sobel of Antioch University, described qualitative research on Forest Days in Vermont public school kindergartens as well as quantitative research comparing a nature preschool to a regular preschool.

Presenters in Session 2 highlighted two major themes: First, while there are many studies highlighting the benefits of nature on children and adults, these findings are not consistent, especially for children. Second, low-SES populations benefit the most from exposure to nature.

Regarding studies showing benefits, Dr. Jordan pointed out that there are few experimental studies where a causal relationship between nature play and individual outcomes was found. A scarcity of longitudinal research means that it is not clear whether short-term gains are sustained over time. In studies to date, there is also a lack of understanding of dosage effects, making it difficult to ascertain how much exposure to nature results in desired outcomes. Further concerns are small sample sizes, evaluations that were not conducted by independent researchers or evaluators, failures to control for confounding variables and the lack of consistent definition of what is meant by nature. Dr. Chawla added that particular attention needs to be paid to studies involving adults, as it has become clear that adults benefit too. Program development should therefore include adults as target audiences.

With regard to moderated effects for low-SES populations, both Drs. Jordan and Chawla stressed the need for an equity lens on nature-based programming. SES is a moderator for observed effects, indicating that low-SES populations benefit the most. These populations, including racial and ethnic minorities, are the least likely to access nature spaces; they live in urban, hard-scaped, barren environments with many

barriers to accessing green space. Drs. Jordan and Chawla described a profound environmental and social justice issue. They stated that equitable access to nature is tantamount, and argued that equity in access could lead to equity in early learning, in particular STEM.

A key concern raised by participants was the need for generalizable causal findings and the possibility of working collaboratively to increase sample size. Jordan stressed the importance of comparability when pooling data, which is not very high across programs and measurement tools. The pooling of data requires the development of common outcomes and associated questions that apply across programs (in addition to questions specific to individual programs), as well as the use of qualitative methods that are particularly suitable for cross-program evaluation. All presenters highlighted the need for mixed-methods approaches.

Session 2's presentations illustrate that most of the research to date has focused on the effects of exposure to nature – a topic broader than NBL. This, in fact, confirms the need for more research and evaluation in this area. The general lack of studies that focus on this specific topic, and the lack of causal studies, substantiate the need for a robust program of research. This is especially true given the correlational evidence that nature-based practices or programs could have an impact on (early) learning outcomes.

Program Evaluation (Session 3)

In this session Dr. Marc Hernandez, of NORC at the University of Chicago, presented an overview of program evaluation. He described the four key phases of conducting an evaluation, and provided more detail on Phase 1: Prepare. Specifically, Dr. Hernandez described how to build a logic model, focusing on inputs, activities, outputs, and outcomes.

Group exercise: Common outcomes

Following Dr. Hernandez' presentation, summit attendants broke out into smaller groups organized to reflect the NBL continuum. Summit participants chose which of the five groups best aligned with their own program. The goal of this group exercise was to identify common and program-specific elements of success (outcomes).

Dr. Hernandez provided a definition of outcomes as “the expected changes in the population served that result from a program's activities and fall along a continuum, ranging from short to long term results:

- Short-term: changes in knowledge, skills, and/or attitudes (e.g., ↑ children's affinity towards nature)
- Medium-term: changes in behavior or action (e.g., ↑ independent outdoor activity)
- Long-term: changes in condition or status in life (e.g., ↑ environmental stewardship; health)”

Tables 6-8 show short-term, medium-term and long-term outcomes by program type.

Table 6. Short-term outcomes

Short-term Outcome	Children's Gardens	Facilitate d Nature Programs	Drop-in Programming	Nature-based Play Group	Nature Preschools
Sense of 'belonging in nature'			x		
Pleasurable experience/ comfort in nature/ enjoy nature		x	x		

Imagination/wonder	x	x		x	
Curiosity	x				x
Fostering independent play	x				
Caregivers supporting nature play/ Enthusiasm for nature play	x		x		
Exploration (move beyond arrival spots)				x	
Conversations among family about nature	x				
Parents report extension of the visit	x				
Children ask to come back, don't want to leave	x				
Children wanting to go out into nature more independently/ Time spent outdoors		x			
Outdoor ethics		x			
Reduce ecophobia		x			
Interest in nature/ botany		x	x		
Parents understand benefits of nature-based programming with regard to kindergarten-readiness				x	x
Environmental awareness/literacy	x				x
Improved empathy for natural things: plants, animals, general					x
Science inquiry/science understanding	x				

Table 7. Medium-term Outcomes

Medium-term Outcome	Children's Gardens	Facilitated Nature Programs	Drop-in Programming	Nature-based Play Group	Nature Preschools
Repeat visits/requests to visit	x			x	
• Child vs. adult initiation				x	
Volunteering at nature-based program/ youth volunteering				x	x
Kindergarten-readiness skills	x				x

Critical thinking skills					x
Socio-emotional skills					x
• Problem- solving with challenges				x	x
• Managing social interactions/team work				x	x
• Sharing					x
• Negotiating					x

Table 8. Long-term outcomes

Long-term Outcome	Children's Gardens	Facilitated Nature Programs	Drop-in Programming	Nature-based Play Group	Nature Preschools
Affinity/connection to nature	x	x		x	
Stewardship/advocacy/responsibility	x	x			x
Deeper connection between nature and art/creative outlet			x		
Life time learner - grow up to be parents who are engaged with nature				x	
Become adults that vote and advocate for nature		x			

The group exercise indicated that in the short term, virtually all types of programs hope to foster imagination and instill a sense of wonder in their audience. This was closely followed by finding comfort and enjoyment in nature, as well as promoting curiosity. Shared medium-term outcomes were varied, with commonalities around repeat visits and social-emotional development. In the long run, shared desired outcomes were an affinity toward nature as well as environmental stewardship and advocacy.

The selection of outcomes in tables 6-8 also highlights potential differences in desired outcomes between program types along the NBL continuum. Perhaps not surprisingly, nature/forest preschools were concerned with medium-term outcomes such as school readiness, including both cognitive and non-cognitive skills. Facilitated nature programs focused on increases in the time spent outdoors coupled with an interest in nature/ botany, outdoor ethics and reduced ecophobia. Children's Gardens sought extended visits and family conversations around nature, as well as support for independent nature play more generally. Nature-based playgroups shared outcomes of interest with all other program types.

Building the Knowledge Base (Session 4)

The goal of Session 4 was for participants to establish priorities for building the knowledge base around NBL. Sue Wagner and Megan Dunning from The Morton Arboretum facilitated the session which involved individual group discussions and share back as described below.

Wagner and Dunning began by introducing the Research Agenda Questions developed for publication by participants Dr. Chawla, Dr. Jordan, and David Sobel. The Research Agenda Questions were in press at the time of the summit and were used with the permission of the authors. Wagner and Dunning noted that the questions were developed following a survey of the literature on nature-based spaces and that the questions reflect the authors' views of where the field needs to go. The research agenda questions are categorized according to the following three priority topics:

1. Learning Outcomes and Differential Effects
2. Mechanisms of Influence
3. Implications for Policy and Practice

Following the introduction of the research agenda questions, participants remained grouped for discussion according to where their program fit along the NBL continuum. Each group was asked to consider the questions included in each of the three categories listed above and prioritize 2-3 questions under each topic that were “the most appealing or useful to them.” The groups were also tasked with discussing why they considered the questions to be critical and the methods they might use for evaluating outcomes. In the share out that followed, each group summarized the key points of its discussion and the reasons for prioritizing the questions it choose.

Tables 9 through 13 show the research questions each group prioritized.

Table 9. Nature Play Space		
Learning Outcomes and Differential Effects	Mechanisms of Influence	Implications for Policy and Practice
<p>What does nature play look like for families from different backgrounds?</p> <p>How do we measure ‘wonder’ and does nature elicit more moments of wonder than other play?</p> <p>How do nature play spaces bring together different learning outcomes?</p>	<p>How to develop effective research/ practitioner practices and/ or partnerships and how do we broaden them to be multidisciplinary and multi-ethnic?</p>	

Table 10. Children’s Garden		
Learning Outcomes and Differential Effects	Mechanisms of Influence	Implications for Policy and Practice
<p>Does NBL contribute to stewardship values or conservation behavior?</p> <p>Does technology serve an educational role in children’s gardens? In what way?</p>	<p>What are key elements of nature experiences that affect children?</p> <p>How might power hierarchies or social stereotypes based on race, ethnicity, culture, class, gender or age influence NBL?</p>	<p>What practices work best to support families adopting NBL?</p>

	How can we diminish barriers for all audiences?	
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Table 11. Facilitated Nature Program

Learning Outcomes and Differential Effects	Mechanisms of Influence	Implications for Policy and Practice
What is the range of learning outcomes influenced by nature? For all SES groups?	How do mediator variable and interpersonal dynamics influence NBL?	Who/ what defines a meaningful/ successful/ authentic NB experience?
What key elements of nature are important at different ages?	What does nature do to the brain?	

Table 12. Drop In Program

Learning Outcomes and Differential Effects	Mechanisms of Influence	Implications for Policy and Practice
How is NBL affecting special populations in terms of learning outcomes?	How do interpersonal dynamics influence NBL?	What are the NBL experiences most appropriate for different developmental stages of childhood?
What are the barriers to reducing the achievement gap?	What are the key elements of nature experiences that affect children?	Who defines success?
Are there individual differences in response to NBL and what determines why there are different outcomes with the same experience?	How can we steward the values we want?	
	How can we increase the adoption of NBL at home?	
	What is the impact of technology on NBL?	

Table 13. Nature/Forest Preschools

Learning Outcomes and Differential Effects	Mechanisms of Influence	Implications for Policy and Practice
Can NBL play a role in reducing the opportunity gap between children from more and less advantaged backgrounds?	What practices work best to support teacher adoption of NBL?	What practices and strategies support driving increased demand/market for NBL?
		How do we drive towards the growth of NBL as a practice and move the practice towards equitability?

Five key themes and challenges emerged during Session 4: 1) Equity/Inclusion/Diversity, 2) Evaluation and measurement, 3) Impact of Technology/ Effective Use of Technology, 4) Environmental stewardship, and 5) Adoption of NBL at home. Participants agreed that the increased interest in NBL made it all the more urgent to address these challenges. These discussions were an important contribution to building the NBL knowledge base by highlighting and providing a deeper understanding of shared and diverse concerns across the continuum of programs. Table 14 shows the number of programs that addressed each major theme in their prioritized research questions.

Table 14: Programs addressing each major theme/challenge

Theme/Challenge	Nature Play Space	Children's Garden	Facilitated Nature Program	Drop-In Program	Nature/ Forest Preschool	# of Programs addressing theme
Equity/Inclusion/Diversity	x	x	x	x	x	5
Evaluation & Measurement	x	x	x	x	x	5
Technology		x		x		2
Stewardship		x		x		2
NBL at Home				x	x	2

Equity/Inclusion/Diversity

The challenge of ensuring equity, inclusion and diversity in NBL topped the list of major concerns. As one participant noted, "Inclusion is the most important. It is a game-changer." The need to increase equity, inclusion, diversity, social justice and determine how NBL can play a role in reducing the achievement gap emerged in every group discussion. It was an important component of the discussions relating to technology and stewardship. The challenges of bringing more diverse populations to nature-based spaces and exposing them to NBL was noted throughout the discussions. This theme is reflected in each program's priority questions.

The theme of inclusion, in particular, was also discussed in the context of ensuring that visitors to nature-based spaces of all ages need to be able to engage in ways that fit their needs. Feedback from visitors was noted as the best way to understand the range of visitors' needs. This pertained to parents, caregivers, older or younger siblings and other family members.

Evaluation and Measurement

Evaluating NBL programs and spaces was a challenge acknowledged by all groups. The challenge of establishing research-practice partnerships as well as partnerships with other programs were discussed in the individual groups and in the larger group discussion at the end of the session. Participants agreed that the need for effective research-practice partnerships is a high priority challenge and that evidence demonstrating best practices and strategies that lead to positive learning and improved socio-emotional outcomes for children was critical for attracting funding to improve and grow programs. Participants' concern with evaluation and measurement can be seen throughout the priority questions under Mechanisms of Influence in the tables above.

One question that arose for participants was what constitutes a NBL experience? Are there experiences/practices that take place in an inside space or in the classroom that merit evaluation in the context of NBL? Participants were interested in how to measure the responses of young children to nature-based experiences, such as 'wonder' and 'awe' and then demonstrate the positive outcomes for children who experience wonder and awe.

The following methods were mentioned by researchers in the course of discussions. Longitudinal case studies were noted as optimal for understanding longer-term outcomes. Regarding measuring ‘wonder/awe’, a specific measurement suggestion was to develop a list of words, some of which represent these feelings, and have children choose from the list. Regarding how to measure NBL experiences that worked well, a continuum of words from ‘boring’ to ‘fascinating’ could be developed where children are asked to identify where they fell on the continuum. Older children could draw maps of the nature-based space they were in and mark where special experiences took place. These would not be intended as descriptive maps but as experiential maps. Children could also tell stories related to their experiences in a particular space. Finally, children could be video-recorded while moving through a nature space and talk about their experiences.

Impact of Technology/ Effective Use of Technology

Another common theme was how technology might enhance NBL. Technology is mentioned specifically in the priority questions for Children’s Gardens and Drop In programs. Many questions arose related to the ways in which technology can engage children of varying ages in NBL. One overriding question was the role technology could play for increasing NBL at home. Other questions included: What are the types of technology that enhance NBL? Does a game such as *Pokémon Go* serve as a meaningful nature experience in a botanical garden? Can technology help us to better engage children of varying ages “where they are at” developmentally? What is a quality experience – does a selfie with a flower demonstrate an appreciation of nature? The Nature Preschool Program mentioned an app (<http://citynaturechallenge.org/>) in which cities compete through photographs to see who can make the most observations of nature, find the most species and engage the most people in a worldwide city nature challenge. Participants wondered about the extent to which this qualifies as “a quality nature experience?”

Stewardship

Ensuring environmental stewardship and conservation behavior was mentioned in the discussions both directly and in the context of how we train those involved in nature-based spaces, such as teachers and others involved in working with children and families. Relatedly, participants discussed the need to train and not neglect ethnic minorities. Determining the practices that work best to support teacher adoption of NBL more generally was another issue that emerged during discussions. Stewardship for all, (taking into account the needs of diverse groups and populations), was considered a critical challenge. An important question was: Do the expectations associated with stewardship need to be adjusted for SES, minority, special needs, and other populations? And, if so, how? Stewardship is directly mentioned in the Children’s Gardens and Drop-In Program set of priority research questions and implied in other questions related to training.

Adoption of NBL at Home

Another theme that emerged in Session 4 was the need to encourage the adoption of NBL at home. The need to increase NBL at home is mentioned in the Drop-In Program’s set of priority questions and in the Nature Forest Preschool question- What practices work best to support families adopting NBL?

Networks and Resources (Session 5)

In the final session of the day, participants discussed resources and networks that could help begin answering the priority research questions with an eye towards incorporating and addressing emerging themes and issues in NBL.

A main concern was access to funding. Programs compete – intentionally or unintentionally – for funds, which may prevent unifying and standardizing practices. Much discussion following this concern revolved around building a stronger case for funding together. Working collectively to build a common rationale for NBL that draws upon other fields could broaden the resource base for NBL. NBL is a topic

of opportunity because it is multidisciplinary: in addition to education, NBL touches the fields of health (particularly mental health), environmental stewardship, and STEM learning. Especially in the health field, the funding pot is bigger, and tapping that resource means adapting to a model that is already more inclusive in terms of diversity and equity. NBL programs can join forces in a collaborative effort to broaden the narrative from education only to concerns of basic living and survival. Nature-based spaces and NBL impacts on the nation's health and wealth: healthier people are more productive.

An important caveat here is that the benefits from a connection with nature are not well known by the public and policy makers. Dissemination of findings is therefore an important step in pursuing funding. By communicating the benefits of nature-based programming to the public, support for NBL can be built from the ground up.

In a similar vein, NBL's narrative can also borrow from the field of economics by foregrounding the public economic value of nature-based spaces and related programming. For example, children who participate in NBL today grow up with fewer mental health issues, which leads to economic benefits to the public. Research has already shown the relationship between outcomes associated with nature-based programming and long-term economic and public health outcomes. What is needed now is evidence for linkages at early ages demonstrating the causal role of NBL.

Forest preschools and kindergartens may be a case in point here, by reducing the need for expensive forms of intervention later on. The economic value of early education is already the topic of much discussion. Dr. James Heckman at the University of Chicago has long argued that investing in early care and education (ECE) results in long-term economic gains (i.e., \$1 invested in high quality ECE yields a \$7 to \$12 return on investment later)^{7, 8}. This debate, in particular, centers on formal ECE programs, and nature kindergartens should be included.

Participants also discussed pooling resources around evaluation. One specific suggestion surfaced several times during the summit: an evaluation collaborative could be formed among organizations that have similar aspirations. This collaborative could hire a single evaluator, albeit with individual contracts, which enables cross-program evaluation. David Sobel of Antioch University reported that he had been part of such a collaborative in New England for a decade and that the learning experience was invaluable in terms of the knowledge that was generated. He noted that a regional network may be well suited to support cross-program evaluation.

In this session, participants also identified existing networks, or opportunities to network. See Table 14 for a list of these opportunities.

Table 14. Major Networks identified by participants during the Summit

Conferences	National Association for Regional Science Teaching (NARST) North American Association for Environmental Education (NAAEE) National Children and Youth Gardening Symposium (NCYGS) Children & Nature Network Leadership Summit (C&NN)
Networks focused on ECE	Children & Nature Network Nature Start Alliance (part of NAAEE)
Networks focused beyond ECE	Professional Development Networks (no specific network)

⁷ <https://heckmanequation.org/>

⁸ <https://www.impact.upenn.edu/our-analysis/opportunities-to-achieve-impact/early-childhood-toolkit/why-invest/what-is-the-return-on-investment/>

Self-directed play

Not surprisingly, one of the main recurring themes of the day revolved around *play*. Participants mentioned several different kinds of play, within the scope of play that is self-directed:

- Free play
- Independent play
- Adventure play
- Exploratory play
- Wild play
- Risky play
- Nature play

Bernheim Forest noted what was echoed by many other NBL programs: there is growing interest in play among parents, specifically in self-directed play in natural spaces. ABG noted that what brings parents to the garden is a desire for adventurous and risky play. David Sobel of Antioch University noted that play-based childhood programs are more predictive of elementary school success than academic programs. A question that arose during the day is how to facilitate self-directed play in nature-based spaces, specifically, how to limit the number of rules that are imposed on play and encourage risk-taking in a safe environment. In addition, participants believed that it is of critical importance to change perspectives on play. Bernheim Forest described that the average adult believed that play is usually what someone is engaged in when they are not doing anything important. As a field, NBL must put effort into building the language of play (i.e., publicizing its benefits for development). As an example of doing just that, Bernheim Forest and the Children at Play Network engaged a Developmental Psychologist and play advocate Peter Gray to disseminate key findings on this issue to their audience¹⁰.

Design

The design of nature-based spaces was another key theme that emerged over the course of the summit. ABG summarized the move away from Botanical Gardens as outdoor museums and Children's Gardens as spaces for one-to-one learning. Recent design choices for nature-based spaces are driven by what visitors want and how associated nature-based programming may reach the entire family, instead of just children. There is a notion of involving children in the design process, to give them responsibility and allow them to participate in risk management. Similarly, in order to create ownership, children may also want to leave something of their own creation in the nature space.

Human-centered design principles as well as audience engagement in development and use also feature in the design of nature spaces. For Botanical Gardens and Children's Gardens in particular, staff or volunteers are engaging with the audience to make a visit more meaningful. Staff direct families in the garden, they give parents permission to let their children touch and engage with exhibits (where otherwise parents discourage their children from touching exhibits), and they can facilitate NBL.

Conservation

Another topic of note that emerged during the day was conservation. Participants discussed how to balance NBL with the need to protect nature spaces. For example, some summit participants were concerned that children may destroy their collections as part of their exploration and play (e.g., pulling bark off trees, breaking branches during a tree climb, killing Venus fly traps by touching). Solutions to the

¹⁰ http://childrenatplaynetwork.com/wp-content/uploads/2017/10/17CAPnet_ideaFest.02.pdf

dilemma include planting collections for the express purpose of being used for play, creating artificial nature spaces, sacrificing parts of the collection or building replacements into the budget, removing sensitive exhibits from public access, as well as creating diversion strategies to protect sensitive spaces.

Shared outcomes of interest emphasized conservation as a priority area. Participants pointed to outdoor ethics, environmental awareness and mindfulness, as well as stewardship as key desired NBL outcomes.

Whole Family Focus

A topic that surfaced multiple times was the need to move away from the child as the only target audience, and toward focusing on the entire family. Several participants argued that the unit of change must be the family, and not just the child. For example, the family should be the frame of reference when designing nature-based spaces. ABG noted that caregivers often bring more than one child under the age of 5, which has an impact on how individuals in each group can engage with the space and the exhibits. Relatedly, caregivers may be looking for an opportunity to disengage from one-on-one play with their children. They are looking for spaces where their children can be engrossed in self-directed play, giving adults opportunities to rest, or socialize with one another. Finally, participants touched upon the need to stay relevant to children older than 5. Under 10s and pre-teens interact differently with nature, and nature-based programs should be responsive to their needs and interests in order to maintain engagement.

Gaps

The following section highlights topics that are of key importance to NBL, yet are not well fleshed out. These areas represent gaps in the field that would benefit from in-depth consideration in the near future in order to advance the field as a whole.

Measurement

With research and evaluation being a main focus of the summit, the topic of measurement arose frequently throughout the day. Measuring outcomes remains a challenge for the field of NBL. While some programs reported measuring pre- post changes, this was largely tied to formal programming, as well as teacher training. Informal learning is more difficult to assess. With less formal and less frequent programs (e.g. drop in programming, facilitated nature groups), it is not immediately clear what to measure, and how. Funding was a related concern. Dr. Chawla suggested collaborating with college students to conduct qualitative research. For example, even if direct observation is not possible, students can analyze transcripts for free.

Teacher training

The training of professionals for NBL constitutes a critical issue. Several participants noted that an early childhood education degree is not enough. Schlitz Audubon stated that they hire professionals that have either a degree in early childhood or a degree in environmental education. Then they work with staff on the area in which they do not have a background. Bernheim Forest echoed this concern and explained that they seek out three areas of expertise: 1) ECE, 2) play worker training, and 3) naturalist training. Training and certification in these areas is urgently needed.

Professional development (PD) is also needed for teachers that are not familiar with NBL. For teachers to be able to facilitate NBL experiences (e.g., trips to nearby arboreta or botanical gardens) they must feel confident to lead their students outdoors. However, teachers are not trained to be outdoor educators, and programming must be developed to fill that gap. Both Bernheim Forest and NYBG reported that they offer relevant PD opportunities.

Diversity and inclusion

One of the key themes that emerged during the summit was diversity and inclusion. Session 2 highlighted that the benefits of NBL are strongest among the groups that are least likely to access nature, based on either lack of means or interest/ knowledge about opportunities. Participants reported on programming that is already under way in order to address this disparity, but more of these efforts are needed.

Bernheim Forest described their involvement with a program that supports women to overcome addiction: Choose Well. Bernheim Forest works with mothers in the program by helping them to develop free play strategies, such as loose part play, for their children. Lee Coykendall from DC Botanical Garden reported in one of the breakout sessions that they developed programming to introduce urban youth to the natural world, as well as a weeklong programming for Title I children. In the same session, Jennifer Smith, from the Missouri Botanical Garden described their involvement with the Therapeutic Horticulture Crisis program, led by social workers, where the MBG “brings nature into those locations” and engages 0-12 year old children. MBG has a similar relationships with the Crisis Nursery in St. Louis. The need to take nature to where children are located was echoed by many participants at the summit.

A related topic that did not receive as much attention is the issue of inclusion and accessibility. Schlitz Audubon discussed that as part of their strategic plan, they are currently working to create wheelchair accessible trails and spaces to be able to include differently-abled children in their programming. Children with mental disabilities are already able to participate.

NEXT STEPS

Across all Summit presentations and discussions a consensus emerged around priority areas for the represented nature-based spaces and NBL programs. A recurring theme revolved around the need to collaboratively build the NBL evidence base. In order to facilitate this endeavor, immediate next steps should focus on the further identification and elaboration of shared outcomes. This involves creating agreed upon definitions for NBL terminology, such as *nature-based space*, *nature-based learning/experience*, and *nature play*.

The TMA-developed Nature-Based Learning Continuum is well suited to provide a framework for identifying key similarities and differences between nature-based spaces and programs, thereby supporting cross-space and cross-program collaboration, research and evaluation. The group exercise on outcomes, synthesized earlier in these proceedings, illustrated that theories of change and outcomes may differ along the continuum. Therefore, a fruitful next activity is the creation or expansion of logic models for individual programs, or clearly identifying short- to long-term outcomes as well as the inputs and activities that lead to these outcomes. Using an agreed upon terminology (definitions) will help identify commonalities across programs and theories of change, paving the way for cross-program evaluation and/or the comparability of findings. There are two potential approaches to logic model development. One, models could be created for the categories along the NBL continuum, which requires the identification and abstraction of similarities across programs within each category. The advantage of such an approach is that it results in higher-order abstractions across individual programs, which is a key activity in establishing unified terminology, theories of change and outcomes. However, for newer programs, and/or for those who are just beginning to build an evaluation portfolio, it may be more beneficial to create individual program-focused logic models first. Logic models help clearly identify a programs’ inputs, activities, outputs and expected outcomes, which is foundational to evaluation and further program development.

In support of these activities, a research and evaluation working group could be established, perhaps within an existing network, if this is feasible. This group could identify or develop evaluation methods that can be used to measure success across nature-based spaces and programs, in particular with an eye towards causal and longitudinal designs. As part of such a group, participants could work systematically to answer priority research questions, and identify ways of measuring less formal or lower touch programming, while building the NBL evidence base in an intentional way. As a result of such coordinated development and evaluation activities, the group will be able to make a stronger case for funding as well as engage funders outside the traditionally tapped resources.

Recognizing both the lack of programming for minority groups as well as the significant benefits of nature-based programming for populations of lower socio-economic status, the involvement of groups promoting diversity and inclusion in these next steps is of utmost importance.

APPENDIX

A. Summit Participants

Last Name	First Name	Email	Title	Institution
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