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# Assessing Connections between Young Children's Affinity for Nature and Their Experiences in Natural Outdoor Settings in Preschools

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# **Assessing Connections between Young Children's Affinity for Nature and Their Experiences in Natural Outdoor Settings in Preschools**

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## **Abstract**

*The purposes of this research were to: develop a reliable measure of children's affinity for nature or "biophilia"; determine whether young children's biophilia was related to the "green-ness" of the outdoor play area of the preschool they attend; examine whether demographic variables are associated with children's biophilia; and determine whether demographic variables predict children's enrollment in nature-oriented programs. We recruited children from ten early childhood education programs—six that had outdoor play spaces with many natural elements and four that had few or none of these elements. One hundred fourteen preschool-aged children completed an 11-item measure of biophilia that included preferences for play locations (outdoors or indoors, during day and evening), enjoyment of sensory aspects of nature (viewing wildlife, listening to birds), exploring nature (digging for worms, examining insects), and curiosity about nature (learning about wild animals). Total biophilia scores of children attending preschools with and without natural playground elements were compared via ANOVA, which revealed no significant differences as a function of preschool playground type (nature, non-nature). Maternal education and family income were not associated with children's biophilia scores; however, children whose mothers completed more education and reported higher family income were more likely to be enrolled in programs with natural outdoor play spaces, suggesting that children who are disadvantaged in these factors may not have equal access to programs with natural play spaces.*

**Keywords:** biophilia, preschool-aged children, preschool outdoor settings, nature, play

## **Introduction**

The biologist E.O. Wilson (1984) conceptualized "biophilia" as an innate human desire to affiliate with life and life-like processes. Biophilia is an important construct to examine both for its potential benefits to human health as well as the potential benefits that a biophilic disposition may have for the health of the environment (e.g., Moore and Cosco 2000; Wells and Lekies 2006). Therefore, the purposes of this research were to: (1) develop a reliable measure of children's affinity for nature, or biophilia; (2) determine whether young children's affinity for nature was related to the "green-ness" of the outdoor play area of the preschool they attend; (3) examine whether demographic factors are associated with children's biophilia; and (4) determine whether demographic factors predict enrollment in preschools with nature-oriented outdoor play areas.

## **Literature Review**

### **Development of Biophilia**

Although hypothesized to be innate, researchers have posited that biophilia is also influenced by direct experiences with natural environments and mediated by culture (Bixler et al. 1994; Kahn 2002; Kellert 2002). Evidence documenting the development of biophilia is sparse but suggestive and provides a foundation for the current research. For example, research on landscape preferences with children and adults has revealed a tendency to prefer photographs of prototypical "savanna" to photographs of other types of biomes (Falk and Balling 2010). It has been hypothesized that humans evolved within a savanna ecosystem and adapted to its advantages, which include the ability to see long distances (which is helpful for both hunting and avoiding aggressors) as well as scattered trees that offer some shade, protection, and potential for food. To examine such preferences in children, Balling and Falk (1982) compared photographic preferences of younger and older children living in the eastern United States. Children rated their preferences for savanna, mixed hardwood forest (the biome with which they had the greatest direct experience), rain forest, boreal forest, and desert. The authors found that younger children preferred photographs of savanna, while older children preferred savanna and mixed hardwood photographs equally, consistent with the hypothesis that children seem to have an innate preference for savannah that becomes modified as children directly experience their own biome. The same authors reported similar results with samples of adolescents in three different ecosystems (agrarian with pockets of rainforest, an island with tropical rainforest, and urban) who showed a significant preference for savanna (Falk and Balling 2010).

Understanding development of biophilia can be informed by investigations of children's affinity or affective orientation toward nature. Cheng and Monroe (2012) designed a measure for fourth graders to measure children's connection to nature, and confirmatory factor analysis supported a four-factor model comprised of enjoyment of nature, empathy for creatures, a sense of oneness with nature, and a sense of responsibility for nature. Consistent with the conceptualization of biophilia as influenced by direct experience with nature and mediated by culture (which is proximally transmitted by family), fourth graders' connection to nature was positively correlated with their perception of their families' value of nature, previous

experience in nature, knowledge about nature, and proximity of nature to their homes. Path analysis indicated that children's connection to nature directly predicted their interest in nature-based activities, while family values, previous experience, nearby nature, and environmental knowledge indirectly predicted interest in nature activities. Larson, Green and Castleberry (2011) designed a measure of environmental orientation comprised of two factors, eco-affinity and eco-awareness. Eco-awareness was correlated with environmental knowledge in a sample of 6- to 13-year olds, but eco-affinity was not correlated with environmental knowledge. This underscores the importance of examining both cognitive and affective components of children's orientation towards nature.

Although biophilia is conceptualized as a positive orientation toward nature, it should be noted that nature is not universally benign. Some elements of nature bear caution, and consistent with an evolutionary perspective, Ohman, Dimberg and Ost (1985) hypothesized a critical period during which children become mobile and are less proximal to their parents, and learning about specific dangers is particularly efficient. Fear and disgust can be as adaptive as approach and affiliation when taking context into account. Thus, fear of snakes, spiders, and insects (in that order) is more common than fear of other animals, for children and for adults; the potential for venomous injury is greater, and the fears may also be socially mediated. However, given that fears of animals tend to have a relatively early onset (by 7 years of age) in comparison to other phobias (Ost 1987), taken together with research on early savannah preferences giving way to increasing preference for one's own biome, begins to suggest that early childhood may be a sensitive period in which affective, cognitive, and behavioral orientations toward the natural world are formed. Bixler et al. (1994) argue for early direct and positive experiences with nature that can support development of accurate perceptions of nature and its elements as a strategy for "inoculating" children against inaccurate representations and maladaptive fears of nature. Others argue compellingly for plentiful early positive experiences with nature in order to nurture children's healthy development as well as conservation attitudes (e.g., Wilson 1994; Moore and Cooper Marcus 2008; Nebraska Department of Education and World Forum Nature Action Collaborative for Children 2008).

### **Early Nature Experience and Adult Conservation and Activities in Nature**

There is substantial evidence of a link between daily nature experience in childhood and adult conservation behaviors and attitudes as well as propensity to spend time outdoors (Chawla 1998; 1999; Tanner 1980; 1998; Ward Thompson, Aspinall and Montarzino 2008). Chawla's (1998) review of several studies of antecedents to environmentalism demonstrated connections between early significant experiences in nature and adult environmental activism. A study of environmental professionals from Kentucky and Norway explored the origins of the commitment to adult environmentalism, and 70 percent of environmentalists cited childhood experience of natural areas and the influence of family and educators as major contributors to environmental predispositions and commitment as adults (Chawla 1999). These studies provide a foundation from which to build, however are limited by selection bias as a consequence of limiting the sample to adults with positive environmental dispositions. However, similar results have been reported in research without this

selection bias. Two studies in England and Scotland using adult samples representing diverse socioeconomic strata and drawn from a variety of communities ranging from urban to rural, reported that the frequency of childhood visits to green places was a significant predictor of adult frequency of time spent in nature and positive attitudes toward nature for both samples (Ward Thompson, Aspinall and Montarzino 2008). These findings are particularly powerful considering that the samples were selected to represent several communities, rather than selecting adults with a positive orientation toward nature. Wells and Lekies (2006) interviewed 2000 adults in the U.S. and found that spending time in both "wild nature" and "domesticated nature" during childhood was significantly associated with positive adult environmental attitudes; participation in wild nature activities was positively associated with pro-environment behaviors in adulthood, but participation in domesticated nature was only marginally related to pro-environmental behaviors in adulthood.

Early experiences in nature and knowledge about nature may each be necessary, but not sufficient conditions for the development of conservation behaviors, however (Kals, Schumacher and Montada 1999). Chawla and Derr (2012) synthesized research on conservation behaviors and proposed a model of influences on pro-environmental attitudes and behaviors. Their model includes knowledge derived both from direct experience and indirect experience or learning; this knowledge includes information about the environment and environmental issues as well as knowledge about actions that can have a positive impact on the environment. Knowledge is conceptualized in the model as having bidirectional associations with individual and collective efficacy and motivation to act on behalf of the environment. Motivation is conceptualized in the model as multi-faceted, and includes values, attitudes, empathy, sympathy, interest in taking action for the environment, and the expectation of successful outcomes. Chawla and Derr's (2012) model draws on Bandura's (1997) social learning theory to explicate the importance of opportunities to practice goal-directed behaviors, experience success, and reflect on the effectiveness of actions to develop self-efficacy. Vicarious learning through observation of models engaged in successful environmental actions also contributes to efficacy. Social mediation in support of environmental knowledge and conservation attitudes and behaviors can take several forms, for example when adults communicate value for nature, encourage children to spend time in natural environments and to engage in conservation behaviors (Chawla 2007; 2009; Chawla and Derr 2012).

### **Early Nature Experiences and Children's Development**

Many authors have described the importance of natural environments for promoting children's development (e.g., Louv 2006/2008; Rivkin 1995; Torquati et al. 2010). Rachel Carson (1956) highlighted nature's potential to nurture children's affective development, pointing to the mystery and excitement of the natural world that can elicit joy, curiosity, and "a sense of wonder." E.O. Wilson observed, "the natural world is the most information-rich environment we will ever encounter" (1993; cited in Kahn and Kellert 2002, 123). As such, natural environments can effectively promote cognitive development. Ruth Wilson (1993; 2012) has described the many ways that experiences in nature can promote children's holistic development,

including spirituality. Stephen Kellert has proposed that experience in nature is “an essential, critical, and irreplaceable dimension of healthy maturation and development” (2002, 141). Designing instruments for reliably assessing children’s thoughts and feelings about nature is an important step for investigating how children develop affinity for nature, and how that affinity influences their subsequent behavior and development.

A growing body of empirical data provides evidence of benefits to children’s development accruing from spending time in natural environments. For example, preschool children with daily access to a natural outdoor area demonstrated better motor skills, more focused attention (fewer symptoms of Attention Deficit Hyperactivity Disorder—ADHD), fewer illnesses, and engaged in more imaginative and social play than children with a man-made playground devoid of natural elements (Fjørtoft 2001; Grahn et al. 1997). The “green-ness” of children’s home environments has been associated with benefits to children’s attention and ability to cope with stress (Kuo and Faber Taylor 2004; Wells 2000).

A study on the “greening” of school grounds in Canada investigated 59 elementary schools that enhanced their outdoor environments in a variety of ways. The study reported that “green” school grounds support a wider variety of play opportunities that promote physical activity, especially for children who are disinclined to participate in competitive team sports; support more imaginative and constructive play; promote more prosocial behavior; and strengthen the link between play and learning (Bell and Dymont 2006). Another study of elementary school ground design found that the highest percentage of vigorous physical activity was observed on built equipment, and the highest level of moderate physical activity was observed in “green” areas (Dymont, Bell and Lucas 2009). The authors argue for increasing the diversity of design features to meet the needs of children with varying interests and abilities.

### **Diminishing Nature Experiences among Children**

Despite growing evidence regarding the benefits of nature for children’s development, several authors have expressed concern that children who do not spend sufficient unstructured time in natural settings during childhood may be at risk of never developing affinity toward nature or positive conservation attitudes and behaviors (e.g., Louv 2006/2008; R.A. Wilson 1994; 1996). It is commonly believed that we must first love nature, and then learn to care for it (e.g., Moore and Cooper Marcus 2008; Moore and Cosco 2000). Moreover, there is some concern that lack of contact with nature can lead to aversion, or “biophobia,” manifested as fear or disgust (e.g., Bixler et al. 1994).

Contemporary children have limited opportunities for interaction with natural environments. American children ages 6 to 8 years spent an average of 29 minutes per week in outdoor play in 1997, and children 9 to 12 years of age spent an average of 42 minutes per week in outdoor play (Hofferth and Sandberg 2001). Six years later in 2003, the average amount of time spent outdoors per week by children ages 6 to 12 years old fell to 15 minutes for boys and 34 minutes for girls (Hofferth 2009). Children’s lives are increasingly structured and scheduled, and for

contemporary children outdoor activities are often organized and supervised by adults in managed play spaces such as soccer or baseball fields (e.g., Skar and Krogh 2009). Because parents are concerned about safety (e.g., Veitch et al. 2006), children's "home range" has shrunk substantially, giving children even less access to nearby nature (Moore and Young 1987). In addition to children's decreasing direct contact with natural environments, research has documented decreased representation of nature in picture books for children over the past 70 years (Williams et al. 2011).

Pyle (1993) referred to children's decreasing experience in nature as "extinction of experience" (147). It is reasonable to wonder about the costs of this extinction for children and for natural environments. Children's limited time outdoors, combined with increasingly limited access to natural areas (e.g., Rivkin 1995), is a problem for children's health and development as well as for the future of conservation. Preschool-aged children spent an average of 37 minutes per week playing outdoors in 1997 while in the care of their parents (Hofferth and Sandberg 2001). Because so many preschool-aged children spend time in non-parental care arrangements, preschool outdoor environments present an opportunity for addressing children's limited access to nature. According to the U.S. Census Bureau, 63 percent of children under age 5 (12.7 million) were in some type of regular non-parental childcare arrangement in 2005 (Laughlin 2010). Forty-two percent of children under age 5 with employed mothers spent at least 35 hours a week in child care in 2002 (Capizzano and Main 2005). This suggests preschool-age children with both parents working outside the home may spend most of their outdoor time within preschool outdoor environments. Given the hypothesized importance of early experiences in nature for children's development of biophilia as well as the documented benefits to health, development, and learning accurate information about nature, an important research question concerns whether regular access to a natural outdoor environment in preschool can promote these benefits.

Preschool outdoor environments are often designed for large motor activity, and with safety and ease of supervision as primary objectives. However, with increasing interest in "re-connecting children with nature" among early childhood educators and the recognition of the myriad benefits of spending time in nature for children, more early childhood education programs are incorporating natural elements into their outdoor play spaces (e.g., Keeler 2008; Malone and Tranter 2003; Moore and Wong 1997; Nebraska Department of Education and World Forum Nature Action Collaborative for Children 2008). Outdoor play areas intentionally planned for nature experience are not considered natural ecosystems but are designed, programmed, and managed green spaces where direct contact with nature is limited to species adapted to a human-dominated environment (Kellert 2002). Within the constraints of early childhood education programs, play areas may be considered more or less "natural" according to the proportion of natural elements such as trees, plants, organic materials, water, and diversity of wildlife in relation to the proportion of synthetic materials and human-designed and built structures. Despite the increasing incidence of naturalized play spaces, systematic evaluation of the benefits of such play spaces is limited.

Demographic factors are important to consider because they may influence both the key variable of interest for this study, biophilia, as well as the parents' selection of child care program. Demographic factors may be directly related to biophilia through greater residential access to nature associated with family resources as well as through intentional provision of nature experiences by parents. Research has demonstrated associations between family demographic factors and selection of child care programs of varying quality and type (e.g., Dearing, McCartney and Taylor 2009; McCartney et al. 2007; NICHD Early Child Care Research Network 2006). In addition, if family resources are associated with children's access to nature within preschool programs, then the issue of equity must be addressed. In order to accomplish these objectives, a third purpose of this research was to develop a reliable measure of children's positive orientation towards the natural world—their biophilia.

### **Summary and Research Objectives**

This study aims to address some of the limitations of current research on children's development of biophilia by accomplishing the following objectives:

- Develop a reliable measure of children's biophilia.
- Determine whether young children's biophilia was related to the "greenness" of the outdoor play area of the preschool they attend.
- Examine whether demographic variables are associated with children's biophilia.
- Determine whether demographic variables predict children's enrollment in nature-oriented programs.
- Determine whether children's biophilia scores can be predicted from demographic variables and program type using multivariate analysis.

### **Methods**

#### **Sample**

Children were recruited from ten early childhood programs in Nebraska and California. Six programs had "outdoor classrooms" with many natural elements and were classified as "nature" for the purpose of this study ( $n= 68$  children), and four had more traditional play areas without many natural elements, classified as "non-nature" for the purpose of this study ( $n= 46$  children) (see Figures 1a and 1b). The "nature" and "non-nature" programs were equally distributed between Nebraska and California; these two states were selected to represent distinct bioregions and therefore to enhance the generalizability of results. The "nature" programs had participated in a specific program for enhancement of their outdoor play area to increase children's access to nature, which included participant involvement in the design process and teacher participation in training workshops about children and nature. The outdoor areas of the nature programs varied in terms of size and elements, but they had several features in common including vegetation, gardens, areas for digging in soil, sand, and "loose parts" such as sticks, poles, rocks, wood chips, seeds, pine cones and other naturally occurring objects that children used in their play. The nature programs also included built climbing structures and in some cases pretend play structures such as a boat or a playhouse. The outdoor areas of



the non-nature programs were composed primarily of pretend play structures, sand and/or wood chips, and paved surfaces for wheeled toys, and had few natural elements such as trees or grass.

**Figure 1a. Program with the highest biophilia score (“nature”)**



**Figure 1b. Program with the lowest biophilia score (“non-nature”)**



The preschools in this study were located in medium-density urban contexts containing a mix of single-family homes, businesses, and apartment homes near main vehicular arterials. The preschools were located along the urban-rural gradient where existing ecological systems including dependent wildlife have been affected by conversion of the land to human-dominated development (Alberti et al. 2003; Adams et al. 2009; Forman and Godron 1986). The material "nature" of the preschool outdoor play areas in the current study varied between programs of completely man-made and synthetic materials to almost entirely organic materials. Each play area varied by quantity of living plant species, varying percentages of living ground cover, ground surface composed of previously living material (wood chips, etc.), gardens, and water available for play and use by the preschoolers. The sample outdoor play areas varied by quantity of living plant species present within the overall area regardless of scale. As displayed in Table 1, the programs designated as "nature" programs had 0-75 percent "green" surface (assessed via satellite images), and the "non-nature" programs had 0-10 percent green surface. The one nature program with 0 percent green surface had 60 percent organic surface and seven trees. The nature programs had an average of six trees, while the non-nature programs had an average of two trees. Half of the non-nature programs had gardens, while five out of six of the nature programs had gardens, and one of them had two gardens.

Letters were sent home to parents with information about the purpose and procedures for the study, along with an informed consent form. Children whose parents consented participated in the study. Parents completed a demographic survey. The average age of the participating children was 56.4 months ( $SD=12.8$  months;  $range = 34-69$  months). More than half of the participants were Caucasian (53.8 percent), 22.1 percent were Hispanic, 6.7 percent were African-American, 8.7 percent Asian/Pacific Islander, 7.7 percent multi-ethnic or other, and 1 percent Native American. Mothers of participating children reported fairly high levels of education, with 35.9 percent having a master's degree or more, 34 percent having a bachelor's degree, 1.9 percent having an Associate's or other two-year degree, 2.9 percent having a technical degree or certificate, 13.6 percent having attended some college but without a degree, 8.7 percent having a high school diploma or GED, and 2.9 percent attending some high school but with no diploma. Family income was reported in \$5,000 increments up to \$85,000, but this metric lost quite a bit of precision because almost half (46.5%) of participants reported an annual income of \$85,000 or more.

**Table 1. Biotic characteristics of preschool programs and mean biophilia scores**

Preschool	1	2	3	4	5	6	7	8	9	10
Nature	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
State	CA	CA	CA	NE	NE	NE	CA	CA	NE	NE
Area in sq. ft.	6000	9900	35,000	29400	7500	14,000	7500	20,000	2500	2000
No. of trees-mature/saplings	0/1	7/0	8/0	20/0	5/4	0/9	3/0	4/0	0/0	1/0
% of total in green surface	5	0	75	50	35	35	2	1	0	10
% of total in organic surface <sup>1</sup>	95	60	20	0	0	60	0	2	0	85
% of total in non-organic surface	0	40	5	50	65	5	98	97	100	5
Water	0	0	0	1	1	1	0	1	0	0
Garden	0	1	1	1	1	2	1	1	0	0
Biophilia score	6.9	7.9	8.3	7.3	7.6	9.4	8.4	7.3	6.2	8.2

**Measures and Procedures**

Our measures included a semi-structured, role-playing interview using puppets to gather responses from children in each program. We designed an 11-item interview to assess children's biophilia, the degree to which they feel an affinity for nature (Table 2). Interview items assessed children's preference for being outdoors, enjoyment of sensorial aspects of nature (splashing in puddles, listening to birds), curiosity about nature (learning about wild animals), and interacting with nature (digging for worms, catching bugs, playing with sticks, leaves, and pine cones). Face validity was assessed by four faculty members in child development/early childhood education, landscape architecture, and environmental education. The interview was piloted with a group of 15 children and it demonstrated good face validity. This was determined through children's elaboration of their responses, in which they described an experience as an example (e.g., choosing "this boy likes to dig for worms" and stating "I dig for worms with my friend" and naming the friend). Three children chose to play our "game" a second time, and gave exactly the same responses the second time.

**Table 2. Biophilia interview items and proportion of children endorsing a biophilic response**

Biophilic Item	Non-Biophilic item	Percent Biophilic Responses
This boy* likes to play outside.	This boy likes to play inside.	77.5
This boy likes to dig for worms.	This boy doesn't like worms.	68.4
This boy likes to splash in puddles.	This boy doesn't like to get wet and muddy.	64.0
This boy likes to watch birds.	This boy doesn't like to watch birds.	77.0
This boy likes to catch bugs and look at them.	This boy likes to stomp on bugs and kill them.	69.6
This boy likes to watch animals like squirrels and rabbits.	This boy thinks it's boring to watch animals.	82.5
This boy likes to play in creeks and lakes.	This boy doesn't like to get wet and dirty.	62.8
This boy likes to play with sticks, leaves, and pinecones.	This boy thinks sticks, leaves, and pinecones are dirty.	68.8
This boy likes to listen to birds singing.	This boy thinks it's boring to listen to birds singing.	75.2
This boy likes to look at the stars and moon at night.	This boy would rather play indoors at night.	61.8
This boy likes to learn about wild animals.	This boy isn't interested in wild animals.	70.2

\* Substitute "this girl" when the respondent is a girl.

The interview items were presented to children for role-play using hand-held puppets. Previous research using puppets, pictures, and games with preschool and elementary-aged children has demonstrated good reliability and validity (e.g., Denham 2006; Eder 1990; Evans et al. 2007; Musser and Malkus 1994). We presented each participating child with two identical puppets, one with a "biophilic" attitude toward nature and one with a "non-biophilic" attitude toward nature. The same gender-neutral puppets were used for boys and girls (each was yellow with a smiley face) but the sex of the puppet as described in the story was matched to the sex of the participating child. For example, "This boy/girl likes to watch animals like squirrels and rabbits (biophilic) and this boy/girl thinks it's boring to watch animals (non-biophilic)." Next, the child was asked, "Which one is more like you?" Children were interviewed in a quiet area of their preschool that was separate from the

classroom. The puppet interviews took approximately ten minutes and were audio recorded and transcribed.

## **Results**

### **Plan of Analysis**

The first objective of this research was to develop a reliable measure of children's biophilia. Therefore, we present descriptive statistics and a reliability estimate. Next, we conducted preliminary analyses to determine whether biophilia varied by state (California and Nebraska) in order to ascertain whether state should be controlled in subsequent analyses. The second objective was accomplished by comparing children's total biophilia scores by program type (nature, non-nature) via one-way ANOVA in order to test the hypothesis that children attending child care programs with natural outdoor spaces would have higher biophilia scores than children attending programs without natural outdoor spaces. Third, we conducted one-way ANOVA analyses to determine whether demographic variables of maternal education or family income were associated with biophilia. The fourth objective was accomplished by conducting chi-square analysis to determine whether demographic factors predicted enrollment in preschools with nature-oriented outdoor play areas. The fifth objective was to test a multiple regression model in which any significant demographic variables, state, and program type would be included in predicting children's total biophilia score, however, neither the demographic variables nor program type were significantly correlated with children's biophilia, so the regression analysis was contraindicated.

### **Biophilia Measure**

Biophilic responses were assigned a value of one and non-biophilic answers were assigned a value of zero. A total biophilic score was computed for each child by summing the total number of biophilic responses ( $Mean = 7.7$ ;  $SD = 2.3$ ;  $Range = 3-11$ ). The scale demonstrated adequate reliability (Cronbach's alpha coefficient = .63). A biophilia score was calculated for each program by computing a mean of all children's biophilia mean scores (see Table 1). The measure was revised slightly to remove some statements that made the non-biophilic response more negative (i.e., "this boy/girl doesn't like to watch animals" instead of "this boy/girl thinks it's boring to watch animals) and subsequent validation of the measure in a separate sample of preschool-aged children ( $N = 57$ ) demonstrated better reliability (Cronbach's alpha coefficient = .69; see revised measure in Appendix A).

### **Preliminary Analyses**

Biophilia scores for children attending programs in California and Nebraska were compared via one-way ANOVA, and results indicated that children from the two states did not significantly differ in their biophilia scores ( $F_{(1, 112)} = 0.023$ ;  $p = 0.88$ ; Table 3). Therefore, the two states were combined in subsequent analyses.

**Table 3. Comparison of children's biophilia scores by state, family income, maternal education, and program type (nature, non-nature)**

State	Nebraska ( <i>n</i> = 59)	California ( <i>n</i> = 55)		<i>F</i>	<i>df</i>	<i>p</i>
Biophilia	7.7 (2.2)	7.7 (2.5)		0.02	112	0.88
Family Income	<= \$40K/yr ( <i>n</i> = 29)	\$40K - \$85K/yr ( <i>n</i> = 25)	>\$85K/yr ( <i>n</i> = 47)			
Biophilia	7.5 (2.4)	7.5 (2.4)	7.9 (2.4)	0.25	98	0.78
Maternal Education	< BA ( <i>n</i> = 31)	BA ( <i>n</i> = 35)	MS or more ( <i>n</i> = 37)			
Biophilia	7.9 (2.5)	7.8 (2.3)	7.3 (2.4)	0.80	102	0.45
Program Type	Nature ( <i>n</i> = 68)	Non-Nature ( <i>n</i> = 46)				
Biophilia	7.7 (2.3)	7.7 (2.4)		0.01	112	0.94

Note: Standard deviations appear in parentheses to the right of biophilia scores.

### Program Type

Biophilia scores for nature and non-nature programs were compared via one-way ANOVA. Children attending the two types of programs did not significantly differ in their total biophilia scores ( $F_{(1,112)} = 0.005$ ;  $p=0.94$ ). In fact, the means of the nature and non-nature programs were identical (Table 3).

### Demographic Variables

We examined whether family income or mother's education were related to children's biophilia scores or to attendance in a program with a natural outdoor space. Because the income scores were skewed due to the truncated scale on which 46.5 percent of the parents selected the highest income category, we collapsed income categories into three groups representing lowest income (less than or equal to \$40,000 per year; 28 percent of the sample), middle of the range (\$40,000 - \$85,000 per year; 24.8 percent of the sample), and highest income in the sample (greater than \$85,000; 46.5 percent). We then compared children's biophilia scores as a function of family income using ANOVA, and results indicated that children's

biophilia scores did not vary as a function of family income (Table 3). Next we compared the distribution of family income across program types (nature, non-nature) using chi-square analysis and determined that programs with natural outdoor areas had a higher proportion of higher versus lower income families enrolled ( $\chi^2_{(2,1)} = 25.36$ ;  $p < .0001$ ; see Table 4). Thus, it appears that in this sample, family income is associated with enrollment in a preschool program with access to an outdoor play area with natural elements, but family income is not associated with children's biophilia scores. It is important to note that the terms "low," "middle," and "highest" income refer to the distribution within our sample, and not to designations of income within the wider population.

**Table 4. Chi square analysis of distribution of family income across program type (nature, non-nature)**

Program Type	Family Income			$\chi^2$	$\phi$
	LT \$40K/yr	\$40-\$85K/yr	>\$85K/yr		
Non-Nature	21 (55.3%)	10 (26.3%)	7 (18.4%)	25.36	.50
Nature	8 (12.7%)	15 (23.8%)	40 (63.5%)		

We assessed mothers' education with an ordinal level scale with unequal intervals with different levels of meaning. For example, "some high school but no diploma" means something very different from "high school diploma or GED," although the two categories are one point away from each other on the scale. "Bachelor's degree" and "master's degree or greater" are also one point away from each other on the scale. Because these intervals cannot be interpreted equally, we constructed three groupings for education so that we could compare them categorically: less than a bachelor's degree (30.1 percent), bachelor's degree (34 percent), and master's degree or greater (35.9 percent). Children's biophilia scores were compared as a function of maternal education using ANOVA, and results indicated that children's biophilia scores did not differ by maternal education level ( $F_{(2, 100)} = 0.8$ ;  $p = 0.45$ ; Table 3). Chi-square analyses were conducted to determine whether maternal education was associated with enrollment in a program with nature, and results indicated that programs with nature had disproportionately more children whose mothers had bachelor's and master's degrees while programs without nature had disproportionately more children whose mothers' education was less than a bachelor's degree ( $\chi^2_{(1,2)} = 37.14$ ;  $p < .0001$ ). Thus, in this sample children with more highly educated mothers had greater access to programs with nature, but children with more highly educated mothers did not demonstrate greater biophilia (Table 5). We note that maternal education and family income are significantly correlated (see Table 6;  $r = 0.59$ ;  $p < .01$ ) and share approximately 35 percent of their variance. This indicates that while these variables are collinear, they are not redundant with each other and should be examined separately.

**Table 5. Chi square analysis of distribution of maternal education across program type (nature, non-nature)**

Program Type	Maternal Education			$\chi^2$	$\phi$
	LT BA	BA	MS or more		
Non-Nature	25 (65.8%)	8 (21.1%)	5 (13.2%)	37.14	.60
Nature	6 (9.2%)	27 (41.5%)	32 (49.2%)		

**Correlations among Program Type, Demographic Variables, and Children's Biophilia**

We conducted Pearson correlations to examine associations between program type (nature, non-nature), maternal education, family income, child age, and children's total biophilia scores in order to determine whether a multiple regression analysis was warranted. Only child age was significantly and positively associated with biophilia (Table 6). Therefore, we did not conduct the planned multiple regression analysis. However, because there was quite a bit of variability in the natural elements present in nature and non-nature programs (see Table 1), we conducted post-hoc exploratory analyses to determine whether any of the elements (e.g., number of trees, percentage of total green surface, percentage of total organic surface, presence of water, presence of garden) were associated with children's biophilia scores. None of the natural elements were significantly correlated with children's biophilia scores.

**Table 6. Correlations between children's biophilia scores, child age, family income, and maternal education**

	1	2	3	4
Child Biophilia		0.36*	0.03	-0.05
Child Age (months)			0.17	-0.02
Family Income				0.59**
Maternal Education				

*Note.* \* =  $p < .05$ ; \*\* =  $p < .01$  (2-tailed)



## **Discussion**

The purposes of this study were to design a measure of children's biophilia, compare biophilia scores for children attending early childhood programs with and without natural outdoor play areas, and determine whether demographic variables were associated with children's biophilia or enrollment in a nature-based preschool program. Children's biophilia scores were compared by state as a proxy for bioregion (California, Nebraska). The measure of preschool children's biophilia demonstrated adequate reliability, and children's biophilia scores overall were fairly high, averaging 7.7 on an 11-point scale. This suggests that perhaps, as Moore and Cooper Marcus (2008) proposed, children do have a relatively high propensity toward biophilia early in life, and these scores reflect the essential biophilic nature of children which is just beginning to be modified through experience and culture.

Contrary to our hypothesis, children attending programs with natural outdoor play areas did not have significantly higher biophilia scores than children attending programs without natural outdoor play areas. Therefore, in this study we cannot draw conclusions about how access to human-designed nature during preschool affects children's biophilia. However, limitations of the current study that may explain the lack of differences between types of settings are discussed below, with suggestions for future research.

Demographic factors are important to consider because they potentially influence both biophilia and parents' selection of child care program. Analysis of family demographic factors indicated that maternal education and family income were not associated with children's biophilia scores, however, both maternal education and family income were associated with program type, such that children with more highly educated mothers and higher family income were disproportionately represented in programs with natural outdoor play spaces. This is an important issue to consider because family demographic variables have been associated with child care quality, for example, with low-income children less frequently enrolled in better-quality programs than their more-affluent peers, and children with more-educated mothers enrolled in programs of better quality (e.g., Dearing, McCartney and Taylor 2009; Li-Grining and Coley 2006; NICHD Early Child Care Research Network 2006). Thus, just as low-income children are disadvantaged in terms of access to good quality child care programs in general, results of this study indicate that children who are disadvantaged in terms of family income and maternal education also do not have equal access to programs with natural play spaces. These findings are consistent with results reported by Crawford et al. (2008) and the National Recreation and Park Association (2011) documenting disparities in access to parks and amenities as a function of income, with great access in more affluent neighborhoods. Considering the growing body of literature documenting the benefits of nature for children's development, including mental and physical health as well as attention and ability to cope with stress (Fjørtoft 2001; Grahn et al. 1997; Kuo and Faber Taylor 2004; Wells 2000), it is important to consider whether children who are disadvantaged because of income, maternal education, or urban residence have adequate access to nature, and if not, how to address this deficit.

### **Limitations and Future Directions**

The first limitation pertains to features of the preschool outdoor areas that are used as criteria for differentiating "nature" from "non-nature" programs. For this study, we selected programs that had participated in a professional development program for enhancing natural play areas to increase children's daily access to nature, and which had designed and implemented natural outdoor play spaces to comprise the "nature" group. We then selected programs that we knew had few or no natural elements present in their outdoor play area to participate as the "non-nature" group. However, one of the highest scoring programs was assigned to the non-nature group, and while it was composed of human-made structures, plastic play houses, wheeled toys, and paved surfaces, upon further reflection we realized that the fence around the play area was surrounded by native grasses and some trees that provided partial shade within the play area. In addition, some of the teachers in the program use other natural areas in the neighborhood for programming activities. Future research on children's biophilia should further refine the definition of "green-ness" of outdoor areas, and investigate the utility of continuous as well as categorical measures of "green-ness." Future research should also include examination of time spent in natural areas beyond the schoolyard, as use of nearby natural spaces may be an effective strategy for programs lacking their own natural play space. Further, it will be important to include measures of time spent in such areas. The question of a necessary and sufficient "dose" of nature for benefiting children's development, including biophilia, will likely require multiple studies with diverse methodologies.

The second limitation pertains to the role of social mediation within the preschool setting. Researchers have posited that biophilia is influenced by direct experiences with natural environments and mediated by culture (Bixler et al. 1994; Kahn 2001; 2002; Kellert 2002). This is consistent with Vygotsky's (1978) conceptualization of socially mediated learning and research by Tanner (1998) and Chawla (1998; 1999) documenting the importance of significant adults in encouraging a love of nature for children. In the case of children's affinity for nature, in the present study we did not assess teachers' attitudes and beliefs about nature, nor did we observe their interactions with children about nature. It is quite possible that key adults play an important role in socializing children toward biophilia or biophobia, and it will be important to examine these processes in future research.

Parents are children's first and most important teachers, and therefore it will also be important for future research to examine the roles of parents' beliefs and attitudes towards nature, as well as the ways that they socialize their children toward biophilia or biophobia. Parents also manage children's access to nature, and it will be important to examine variability in the time children spend in nature in contexts other than preschool, as well as the kinds of natural areas in which they spend time (i.e., well-manicured parks, public lakes or beaches, nature centers, wilderness areas). This brings us back to the question of how much time in what kinds of natural contexts are necessary and sufficient for children to develop a biophilic disposition. This is an important question because research indicates that positive time spent in nature as a child is associated with propensity to spend time in nature as an adult and with having an environmental ethic in adulthood (Chawla

1998; 1999; Tanner 1980; 1998; Ward Thompson, Aspinall and Montarzino 2008). It is important to understand the processes by which biophilia develops in order to maximize the benefits of health and development for children as well as to nurture future stewards of the Earth.

Children who participated in the study are those whose parents returned the informed consent form and who were present on the days the interviews took place. We did not assess how long the child had been in the program, and presumably the presence of a natural outdoor play space can influence children only if they have had the opportunity to spend time in the area, observing and interacting with the natural elements. It will be important for future research to measure the length of time children have been enrolled in their child care program as well as how much time they spend outdoors each day while in child care, and whether they also visit any other nearby natural areas in order to get a more precise measure of children's experiences in nature. Additionally, extending investigation of nature experience and the development of biophilia for older children is an important line of inquiry.

Family income and maternal education were somewhat skewed in this sample, and this likely under-represents the experiences of low-income families and children with mothers who have less education. This is a limitation to generalizing results of this study to lower-income populations, and this limitation should be addressed in future research.

Similarly, sampling a broader range of programs that incorporate nature to various degrees, ranging from programs taking place in nature centers where children spend much of their day outdoors to more traditional child care programs in which children spend limited time outdoors in built settings will permit more complete examination of how variability in nature experience influences children's biophilia. Analysis of this sample indicated that programs with nature had disproportionately more families with higher income and maternal education enrolled, and that programs without nature had disproportionately more families with lower maternal education and lower family income enrolled. It will be important for future research to examine more precisely whether opportunities to experience nature are equitable for children with differing socioeconomic backgrounds. Robin Moore (1997) has argued that children need nature, for play and for healthy development, and as such nature is accorded the status of a right. This elevates nature to a social justice issue, and therefore examination of equity is imperative.

Despite these limitations, this research makes several noteworthy contributions. It is one of the first to develop and implement a measure of preschool children's affinity for nature, a construct about which many have written but few have systematically analyzed. This represents an important step in the development of measures to assess children's own thoughts and feelings about nature, and children's voices must be heard in this research. This study begins to examine the potential influence of natural outdoor play areas in preschool settings on children's development. Naturalization of play areas in early childhood programs is becoming more common, yet there are few systematic studies about how such play areas

may benefit children's development. Much more research is needed to examine how spending time in natural play areas can facilitate children's cognitive, social, emotional, and physical development.

This study also documents associations between demographic factors and children's enrollment in programs with natural play spaces. Although demographic factors did not predict children's biophilia, it is important to consider children's experience of nature in their proximal contexts (home, neighborhood, school) when examining access to nature. Future research should examine the role of access to nature at home and at school on children's development of affinity for nature, as well as on healthy development more generally.

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**Appendix A. Revised biophilia measure**

<b>Biophilic Item</b>	<b>Non-Biophilic Item</b>	<b>% Biophilic Response</b>
This boy likes to play outside	This boy likes to play inside	63.6
This boy likes to dig for worms	This boy doesn't like to dig for worms	79.5
This boy likes to splash in puddles	This boy doesn't like to splash in puddles	84.1
This boy likes to watch birds	This boy doesn't like to watch birds	75.0
This boy likes to catch bugs and look at them	This boy doesn't like to catch bugs and look at them	72.7
This boy likes to watch animals like squirrels and rabbits	This boy doesn't like to watch animals like squirrels and rabbits	84.1
This boy likes to play in creeks and lakes	This boy doesn't like to play in creeks and lakes	70.5
This boy likes to play with sticks, leaves, and pine cones	This boy doesn't like to play with sticks, leaves and pine cones	77.3
This boy likes to listen to birds singing	This boy doesn't like to listen to birds singing	84.1
This boy likes to look at the stars and moon at night	This boy would rather play indoors at night	61.4
This boy likes to learn about wild animals	This boy isn't interested in wild animals	84.1

Note: Items were revised so that the non-biophilic items did not include additional negative elements, such as "doesn't like to get wet and dirty" or "likes to stomp on bugs and kill them," and thereby can better assess preference and non-preference without introducing or suggesting additional confounding biases. The revised scale has demonstrated improved reliability (Cronbach's alpha = .69) in a sample of 57 preschool-aged children.