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Green schoolyards as havens from stress and resources for resilience in childhood and adolescence

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ABSTRACT

This paper investigates how green schoolyards can reduce stress and promote protective factors for resilience in students. It documents student responses to green schoolyards in Maryland and Colorado in the United States under three conditions: young elementary school children's play in wooded areas during recess; older elementary school children's use of a naturalized habitat for science and writing lessons; and high school students' involvement in gardening. Drawing on ethnographic observations and interviews, it describes how the natural areas enabled students to escape stress, focus, build competence, and form supportive social groups. These findings have implications for theories of resilience and restoration and school interventions for stress management.

1. Childhood stress, resilience, and access to nature

This paper connects the study of stress, resilience, and contact with nature by showing the potential of green schoolyards to reduce stress and enhance protective factors for resilience in children and adolescents. It summarizes observations and interviews in the United States that explored the value of green school grounds for young people: a wooded area for recess play in an elementary school (ages 6–12), an outdoor classroom for older elementary school students (ages 9–13), and gardening programs for high school students (ages 14–18). From the extensive ethnographic data gathered, a finding that emerged across all sites was that natural areas served as places where young people could find refuge from stress and develop protective factors for resilience in the form of supportive relationships and a sense of competence.

There is a current movement to naturalize school grounds through woodlands, gardens and spaces for nature-based play and learning (Banning and Sullivan, 2011; Danks, 2010; Keeler, 2008; Kiewra et al., 2011; Moore and Wong, 1997; Rivkin and Schein, 2014; Warden, 2012). In contemporary urbanized societies, where few children have opportunities to encounter nature in forests, fields and gardens through free-ranging play and exploration, schoolyards are increasingly seen as sites where children can develop knowledge and care for the natural world (Louv, 2008). Proponents of schoolyard greening also point to evidence that the hands-on study of nature can improve academic achievement across the curriculum (Smith and Sobel, 2010; Williams and Dixon, 2013). Bell and Dyment (2008) reviewed research on health benefits of naturalized school grounds, and found better conditions for physical activity for students of all abilities (not just those who excel at team sports), social health because of the cooperative and creative play that natural areas afford, and mental health in the form of reduced stress and enhanced self-confidence. They argued that health promotion must extend beyond interventions that target individual behavior to a more comprehensive, ecological model that addresses the settings of people's lives, including schools. What is not yet reflected in this literature is the evidence that children under conditions of hardship and stress often seek refuge in nature for restoration and healing (Chawla, 2014).

Through its focus on ways that contact with nature can help children and adolescents cope with stress and anxiety and build protective factors for resilience, this paper brings together three fields of inquiry that are rarely connected. In part, the failure of research on stress and resilience to acknowledge benefits of contact with nature may be explained historically. Since the early 20th century, stress has been an important topic in medical and psychological research (Cooper and Dewe, 2004). The 1970s were

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marked by major studies of how children cope with stress and develop resilience (Masten and Reed, 2002). Research on the benefits of contact with nature in places of everyday life is more recent. The first studies with adults were published in the 1980s (Frumkin, 2008), but studies with children did not begin to appear until the 1990s (Faber Taylor and Kuo, 2006). Therefore major ideas related to stress and resilience in childhood were already established before evidence about the importance of contact with nature began to accumulate. The lack of cross references among these three literatures may also be explained by the fact that they emerged in different disciplines: the study of stress primarily in medicine and clinical psychology, childhood resilience in medicine and developmental psychology, and contact with nature in environment and behavior studies that draw from diverse disciplines such as human ecology and landscape architecture.

1.1. Stress and anxiety in childhood and adolescence

Most theoretical and empirical work on stress and anxiety has been done with adults, but research indicates that children too can experience high levels of stress and anxiety (Humphrey, 2004; McNamara, 2000). In the early 20th century, Cannon (1928), a physiologist, extended interest in mechanical stresses on the body to emotional stresses such as fear and worry (Cooper and Dewe, 2004). Since this time, "stress" has referred broadly to physical wear and tear and emotional strain (often distinguished as stressors), and resulting physiological reactions or subjective feelings. Anxiety defines a specific form of stress: fear and worry over an impending event, or vague apprehension that something negative is about to happen (Ghinassi 2010).

Lazarus (1966) emphasized the subjective dimension of stress, as a relationship with the environment that people appraise as exceeding their resources and endangering their well-being. He noted that people evaluate levels of harm, loss, threat and challenge differently, and respond with different coping mechanisms and degrees of success. Although many studies support his psychological model, recent research indicates that even when people may not consciously evaluate a situation to be stressful, biomarkers may show that they are reacting physiologically (Campbell and Ehlert, 2012). In a comprehensive model to study stress in young people, McNamara (2000) includes objective stressors, perceived stressors, short-term responses, long-term outcomes, and moderating factors such as social support and perceptions of control.

Research on stress and anxiety in young people typically involves self-ratings, parents' reports, or medical diagnoses based on behaviors that children present. Comparisons of similar measures over time in Western nations indicate that levels of stress and anxiety in young people are increasing (Collishaw et al., 2010; Eckersley, 2008; Twenge, 2000; Twenge et al., 2010). It could be objected that these trends reflect contemporary constructions of "childhood in crisis" and increased efforts by adults to diagnose stress and mental illness in young people (Wyness, 2000); but studies by Twenge et al. in the United States (Twenge, 2000; Twenge et al., 2010) suggest that rising rates of worry and anxiety in young people reflect real changes in their sociocultural environment, including less social connectedness, less valuing of meaning in life, greater materialism and individualism, and environmental threats such as crime and fear of war.

Young people with high measures of stress and anxiety are at increased risk for mental disorders, suicide, headaches, gastrointestinal disorders, respiratory disorders, and compromised immune systems (McNamara, 2000). Therefore it is important to find ways to reduce the stress and anxiety that young people experience. Twenge (2000) recommended creating conditions where young people can feel safe and connected to others, but programs that aim to reduce stress in schools or teach students skills for stress management typically emphasize individual approaches. A meta-analysis of evaluations of 19 school programs found that primary strategies were social–emotional training, problem-solving, deep breathing, muscle relaxation and mental imagery (Kraag et al., 2006).

1.2. Protective factors for resilience

Balancing the study of stress and anxiety, a large literature explores resilience in children, defined as their capacity to overcome challenging stressors such as poverty or illness to become competent, confident and caring individuals (Benard, 2004). Resilience can take different forms (Masten and Obradovic, 2008). It includes resistance, when someone continues to function well during a crisis, recovery of normal functioning after an initial decline, and transformation, when someone shows personal growth through positive adaptations to challenges.

Resilience is promoted by protective factors: qualities in a person, the person's context, or interactions with the environment that predict better outcomes despite risk (Garmezy and Masten, 1991; Wright and Masten, 2005). As characteristics of the child, protective factors include social competence, problem-solving abilities, initiative, a sense of self-efficacy, and a sense of positive meaning and purpose in life. These internal strengths, however, do not develop independently of protective factors in the child's environment, such as supportive social relationships, effective schools, social services, and prosocial youth organizations. Therefore resilience reflects an interactive process that occurs when children exhibit personal strengths by reaching out to find care and support, and people and places around them provide the resources they need (Benard, 2004). Consequently resilience can be enhanced through strategies that focus on the child or the environment: reducing risks (such as a child's impulsive behavior, or bullying at school), building assets (such as a child's concentration, or a more engaging school curriculum), and mobilizing human adaptational systems (such as friendships and supportive adults) (Masten and Reed, 2002).

The importance of supportive contexts has led to interest in collective resilience, the ability of groups and communities to prevent, minimize or overcome the damaging effects of adversity (Norris et al., 2008). Historically, resilience research focused on individuals and social systems, but recent socioecological models acknowledge that the well-being of individuals and communities is embedded in larger processes of ecosystem resilience – the adaptive capacity of natural systems to maintain biodiversity and life-sustaining functions despite change (Masten and Obradovic, 2008). These processes are interactive when people work to conserve and restore ecosystems from which they derive physical, social and psychological benefits (Tidball and Krasny, 2014).

1.3. A missing element in resilience research: access to nature

For the most part, the literature on coping and resilience has failed to reflect the importance of positive human connections with the natural world (Besthorn, 2005; Chawla, 2014; Masten and Obradovic, 2008). A rapidly growing number of studies with adults indicate that access to green spaces predicts restoration from stress, lower levels of mortality and illness, higher levels of physical activity outdoors, greater social capital, more positive emotions, and an improved sense of well-being (Wells and Rollings, 2012). Physiologically, when people have trees and other vegetation around them in contrast to built surroundings, biomarkers show lower blood pressure (Hartig et al., 2003), better neuroendocrine functioning (van den Berg and Custers, 2011; Ward Thompson et al., 2012), better immune system functioning (Li, 2010), and brain wave patterns associated with meditative calm (Aspinall et al., 2013).

Two main theories have been advanced to explain these results. According to the psychoevolutionary theory of Ulrich (1983), humans are biologically hard wired through evolution for immediate positive responses to safe natural settings associated with survival, such as trees, other vegetation, and water. Under these conditions a sense of restoration is not only experienced consciously with the emotions, but automatic physiological reactions are activated that provide rapid short-term recovery from stress. According to the attention restoration theory of Kaplan and Kaplan (1989), many activities require effortful attention, and under these conditions people experience mental fatigue. People's capacity for attention recovers in restorative environments, including natural environments, that offer qualities of "fascination," "being away," "extent," and "compatibility."

Findings from studies of young people's contact with nature parallel results with adults. Young people with green views or opportunities for activity in green spaces show more focused attention and better coping with stressful life events (Faber Taylor et al., 2002; Wells, 2000; Wells and Evans, 2003), reduced symptoms of attention deficit and hyperactivity disorder (Faber Taylor et al., 2002; Faber Taylor and Kuo, 2009; Kuo and Faber Taylor, 2004), and lower rates of depression (Maas et al., 2009). Several of these studies have been conducted in schools. After a day in a forest school versus a day inside classrooms, young adolescents report a greater sense of energy and happiness and less stress and anger, and students with records of poor behavior benefit most (Roe and Aspinall, 2011). Preschool children with access to large integrated areas of trees, shrubbery and hilly terrain for play, versus areas with less integrated vegetation, have lower measures of forgetfulness, difficulty in listening, hyperactivity and impulsivity (Martensson et al., 2009). High school students with window views of trees and shrubbery, versus large empty lawns and built features like parking lots, have significantly fewer criminal behaviors and significantly higher graduation rates, merit awards, and student plans to attend college (Matsuoka, 2010). All of these studies held sociodemographic variables constant or statistically controlled for family income and other potentially confounding factors.

Evaluations of children's gardening, primarily in school programs, show that in addition to a greater likelihood of eating fresh fruits and vegetables and academic advantages like higher scores on science tests, students who garden are more likely than control groups to show gains in social and emotional skills (see reviews by Blair, 2009; Ozer, 2006; Robinson-O'Brien et al., 2009; Williams and Dixon, 2013). Simply adding plants at the back of a classroom has been found to significantly increase students' feelings of comfort, preference and friendliness and reduce absences for illness and records of misbehavior, relative to a control class (Han, 2009).

Most of these studies of children and nature involve naturalistic experiments or large correlational designs. They have established that young people can derive significant benefits from contact with nature, but there is a need to better understand what young people do in green spaces and how they describe their experiences. Experimental and quantitative studies have documented *that* contact with nature can benefit young people. The qualitative research reported in this paper suggests *why*. It adds to other studies based on observations and interviews, which have found that preschool and elementary school students congregate in greatest numbers in natural areas versus on asphalt or manufactured play equipment when they are given a choice, that natural areas afford cooperative and imaginative play, and that young students associate these spaces with nature discovery, diverse affordances for action, an affinity for wildlife, a sense of freedom and happiness, and opportunities to face and overcome challenges (Bell, 2001; Dutt, 2012; Kraftl, 2013; Lucas and Dyment, 2010; Moore and Wong, 1997; Nedovic and Morrissey, 2013; Ridgers et al., 2012; Tranter and Malone, 2004). This paper is unique in extending observations and interviews about the value of green school grounds beyond elementary and middle schools to high schools as well.

1.4. Theoretical framework: social and environmental affordances on school grounds

The research reported here spans early childhood through adolescence and three different ways of providing contact with nature. At the first study site, young children in an elementary school chose a pine grove or a second-growth woodland with a creek as locations for recess play. At the second site, older elementary school children used a naturalized habitat as an outdoor classroom for the study of science and writing. At three high school sites and one after-school program, teens engaged in gardening. Across these diverse samples and settings, the research was unified by the use of ethnographic observations and interviews and a reliance on the theoretical framework of ecological psychology, which seeks to understand how affordances of a place facilitate or constrain people's opportunities for action and experience (Gibson, 1979).

Gibson (1979) defines an affordance as a relational property between an organism and its environment, determined by the capabilities of the organism and the physical features of the environment. A narrow ledge affords balancing, for example, only for a child with the height to climb up on it and agility to walk its surface. Affordances that matter depend on children's interests and abilities. Ecological psychology asserts that the environment has intrinsic meaning and value, in the sense of opportunities for action and experience that it provides or thwarts, but society also plays a shaping role (Reed, 1996). People around a child physically alter the environment, invest it with cultural meanings, selectively direct attention, and encourage some forms of interaction with the environment but forbid others.

Barker (1968) added the concept of behavior settings: standing patterns of behavior that a society establishes at scheduled times in places that are adapted to this purpose, such as recess in a schoolyard. As Heft (2001) has noted, behavior settings can be analyzed in terms of the physical affordances and social interactions that they provide. Consistent with these concepts, the research at all six sites identified affordances in natural areas of schoolyards, as well as the outdoor behavior settings that schools established through school philosophies, rules, programs and activities.

Ecological psychology exemplifies a transactional paradigm, as it investigates a field of interdependent relationships that involve individual capacities and intentions, sociocultural contexts, and physical properties of the environment in dynamic interaction (Heft, 2012). It does not separate nature from culture, because wherever people go, they bring their personal and social history, and they modify the world according to their intentions, whether they build a child's tree house or a city. At the same time, material elements and other living creatures have intrinsic properties to which people have to adapt. In this respect, ecological psychology is consistent with a recent work on geographies of nature (Hinchliffe, 2007) and the "vital materialism" of Bennett (2010). Hinchliffe notes that some cultures and scientific approaches consider nature to be something distinct from the social world, some a socially constructed idea, and some a coproduction, with nature and society connected to each other by interdependent histories. This paper adopts the third perspective. For children, important properties of natural elements include responsive affordances that immediately show the consequences of their actions (such as sand or water), loose parts for construction and creative play, graduated challenges, inexhaustible opportunities for discovery, and recurring patterns combined with ever-fresh sensory novelty (Chawla, 2007).

2. Research questions

Guided by the concepts of affordances and behavior settings, research at each site pursued an open-ended question: *How do students experience natural areas on their school grounds?* (At one teen site, this question applied to gardening in an after-school program on city property.) In the language of ecological psychology, this question can be stated as: *What values do students find in these natural areas?*

3. Methods

3.1. Settings and samples

The research settings and samples are described in Tables 1 and 2. At each site, the researcher "zoomed in" from observations of the site as a whole to a focus on the experience of individual students. Researchers obtained parent consent forms and student assent to being observed and interviewed, except in the case of 18-year-old high school students, who could give independent consent. The research protocol was approved by the researchers' university review boards at the Antioch University New England for the Maryland research, and at the University of Colorado at Denver for the Colorado research. Consistent with review board policies, all student names in this paper are pseudonyms. For detailed descriptions of research at each site, see Stanley (2010, 2011), Keena (2011) and Pevec (2011).

3.1.1. Site 1: elementary school in suburban Baltimore

The Jemicy School in suburban Baltimore was a private school established to meet the needs of children with dyslexia and other language-based learning difficulties. Given studies that show that children with learning difficulties can focus better after play in natural areas (Faber Taylor et al., 2002; Faber Taylor and Kuo, 2009; Kuo and Faber Taylor, 2004), it was particularly important to understand the value of recess in nature for the population that these students represented. The Lower School, which enrolled about 80 students in grades 1–5, provided an ideal location to study children's play choices and experiences, as the grounds included an athletic field, a built playground, and two acres of woods: a patch of deciduous second-growth forest with a creek running through it, which was open for play from spring through fall; and a pine grove which was available for play year-round. During afternoon recess and after-school programs, children could choose their play setting.

Research began with observations of the first to seventh grade population as a whole to determine the locations that students chose for recess play and understand the larger context of play behavior. Between 2006 and 2010, an average of 152 students were observed annually. In 2008, 11 Lower School students were randomly selected for focused observations and interviews from criterion groups that represented diversity in age, gender, race, ethnic background, and length of school tenure. Nine of the 11 were committed to woods play and two preferred the playground. Their age range was 6–12, with an average age of 8.5 years. Because children between 6 and 9 are in the process of learning to differentiate and verbalize their feelings (Aldwin, 2007), 10

Table 1
Playing and learning in two elementary schools: settings, samples and data sources.

Setting 1: the Jemicy School – lower school grounds of a private school in suburban Baltimore established to serve students with language-based learning difficulties	
Samples	11 Students in grades 1–6
	--9 Woods players, 2 playground players
	--6 M, 5 F; 10 European-American, 1 African-American
	--Ages 6–12, mean age 8.5
	24 Alumni survey respondents, with 8 selected for interviews
	10 Parent interviews
	5 Teacher interviews
	5 School administrator and staff interviews
Data sources	Videos by researcher
	Student-made videos
	Photography
	Participant observations + field notes
	Reflective interviews with children
	Interviews with alumni, parents, teachers, school administrators and staff
	Alumni survey
Setting 2: schoolyard habitat on grounds of a public elementary school in suburban Denver	
Sample	106 Students in grades 4–6
	--45 M, 61 F; 97 European-American, 8 Hispanic, 1 African-American
	--Ages 9–13; mean age 10.5
Data sources	Participant observations + field notes
	Video, photography
	Memory maps, science notebooks
Representative subsample drawn from the 106	56 Students
	--31 M, 25 F; 52 European-American, 3 Hispanic, 1 African-American
	--Ages 9–13, mean age 10.5
Additional data sources	Event maps
	Interviews
	Focused observations
	Child-made photos
Representative key actors drawn from the 56	20 Students
	--11 M, 9 F; 17 European-American, 2 Hispanic, 1 African-American
	--Ages 10–13, mean age 10.8
Additional data	Go-along interviews
Other data sources	School archive of videos, photos and records about the habitat
	Interview with teacher who created the habitat

Table 2
High school gardening: settings, samples and data sources.

Setting 3	Private prep school in rural town in western Colorado
Sample	16 Students who selected gardening for their required school service hours --5 M, 11 F; 14 European-American, 2 Asian --Ages 15–19, mean age 17.2
Data sources	Interviews with students and gardening teacher Participant observations + field notes Youth-made photographs
Setting 4	Public high school in the same western Colorado town
Sample	24 Students enrolled in an agricultural biology elective --13 M, 11 F; 10 European-American, 12 Hispanic, 1 Asian, 1 Pacific Islander --Ages 16–18, mean age 17.3
Data sources	Interviews with students, agricultural biology teacher, school principal Participant observations + field notes Youth-made photographs
Setting 5	Alternative public high school in the same river valley in western Colorado
Sample	5 Females in a required horticulture science class for teen mothers --5 Hispanic --Ages 16–17, mean age 16.6
Data sources:	Interviews with students, horticultural science teacher, school principal Participant observations + field notes Youth-made photographs
Setting 6	After-school urban gardening program on Colorado's Front Range
Sample	7 Teen leaders who volunteered for the program --3 M, 4 F; 5 European-American, 2 Hispanic --Ages 14–17, mean age 16.0
Data sources	Interviews with students, gardening program director Participant observations + field notes Youth-made photographs

parents and 5 teachers were also interviewed about these individuals' play and recess history. In addition, 24 school alumni were interviewed about their childhood memories of recess play, and 8 were selected for follow-up interviews. To understand the school's philosophy, history, and rules governing recess, 5 school administrators and staff were also interviewed.

3.1.2. Site 2: elementary school in suburban Denver

The second site involved students in grades 4–6 in a public elementary school in suburban Denver. The school served approximately 500 students from a range of socioeconomic backgrounds, from families in subsidized apartments to residents of new high-end developments. The school building was surrounded by asphalt parking, a built playground, a large grass field, and on one edge, a remnant of a scrub oak forest. When the landscape behind the school was disturbed in 2003 to make way for a new library wing, a fourth grade teacher and his class decided to abate the damage by restoring a one-quarter acre ecological habitat to create an outdoor classroom for science and other subjects, following the guidelines of the National Wildlife Federation Schoolyard Habitat program. The school subsequently established an annual "legacy day" when students and teachers add new plantings, trails, signage and other improvements. At the time of research during the 2010–2011 academic year, the habitat included a butterfly garden, a pond surrounded by cattails and willows, a few tall ponderosa pines, a picnic table, an amphitheater created from large flat stones, and trails that led students to patches of scrub oak, a seasonal stream and an open meadow. Although these last areas were not officially part of school property, they were open to students when they were taken to "the habitat." In 2009, the school district designated the school a model site for science and inquiry.

About half of the students in the fourth, fifth and sixth grades – 106 out of 207 – gave assent and consent forms to participate in the study. This sample was 42% male and 58% female, ages 9–13 with an average age of 10.5 years. Student backgrounds represented the school's limited diversity: 97 European-Americans, 8 Hispanics, and 1 African-American. From this sample of 106, the researcher selected 56 children for more extensive observations and conversational interviews, drawings, and photographs about their habitat experiences. This subsample was chosen to represent different classrooms, both sexes, ethnic and socioeconomic diversity, and long-term and short-term enrollment in the school. Twenty "key actors" from this group were selected for more focused observations and "go-along" interviews (Carpiano, 2009; Trell and van Hoven, 2010). In addition to being representative of the school, these 20 were chosen to illustrate a variety of stories about children's interactions with the habitat.

3.1.3. Sites 3–6: high school and market gardening in Colorado

High school samples experienced nature under four different conditions at four locations: a private college preparatory school on a former cattle ranch in western Colorado, where students could choose gardening as their form of school service; a public high school in the same town, where they could elect to enroll in an agricultural biology class; a public alternative school in the same river valley, where horticultural science was a required class for teen mothers; and a voluntary after-school and summer gardening program to grow food for a farmer's market and homeless shelter on Colorado's Front Range. The researcher immersed herself in each site in sequence during the period 2006–2010.

The combined sample of 52 students was composed of 31 females and 21 males. The time that they spent gardening ranged from 1.5 h a week for the teen mothers enrolled in the one-semester horticulture and nutrition class, to about 2 h a week for 2 semesters in the agricultural biology class, to 2 h twice a week for 2.5 months for students on the private school work crew, to 30 h a week in the summers and 6 h a week during the school year in the market garden after-school program. The gardens at the private school and after-school program were well established and grew food for hundreds of people, whereas the public and alternative high school gardens were newly planted and grew smaller amounts of food. In addition to giving interviews, the high

school students took pictures of special places and things in their gardens, which they then discussed.

3.2. Data collection and analysis

The primary methods at each site were ethnographic observations, recorded through field notes, video or photography, and open-ended, semi-structured interviews that asked students about how they experienced the natural areas at their school. (see Tables 1 and 2). At each site, the researcher began by embedding herself in the outdoor program for extended observations. At the two elementary schools, the researcher was a science teacher at the school who had a background in natural history, including training in field observations. At the Jemicy School, she supervised the children's woods play during recess, which enabled her to stand at a site overlooking the woods or join selected groups of children for more focused observations. In suburban Denver, the researcher took a part-time position as science coordinator for the year of data collection, freeing her for part-time research without instructional responsibilities. At the teen gardening sites, the researcher worked alongside the students as a volunteer. At the program for teen mothers, she also presented some gardening curriculum activities as a service to the science teacher. Students at each site became accustomed to the researcher's presence, and when they gave interviews, they had shared worlds to discuss. The researchers at each site followed each other's work, used the same theoretical framework and similar methods, and came together to compare and share their results at several academic and professional conferences and symposia.

Data analysis was guided by Miles and Huberman's (1994) methods for coding material, writing memos, and scrutinizing interpretations for validity. All interviews were transcribed and the transcriptions, field notes, and videos were repeatedly reviewed, with attention to repetitive refrains, recurring patterns of behavior, and resonant metaphors. By triangulating data from interviews and observations, researchers tested whether similar themes emerged from different sources and searched for discordant data that challenged assumptions. At the Jemicy School and suburban Denver school, researchers used "portraiture," a type of ethnographic case study described by Lawrence-Lightfoot and Davis (1997), to tell the story of individual students and their places. Given the large number of interviews at the teen sites, the qualitative software program Dedoose was used to generate keyword counts, semantic relationships (Spradley, 1979), and associations between sensory experiences and feelings. At all sites, professional colleagues checked the coding of data samples, with high levels of agreement, and reviewed narrative interpretations for accuracy and authenticity.

No researcher asked directly about stress, anxiety, resilience, or nature as a refuge. Nor did school administrators or teachers discuss the natural areas as places for refuge because they contained nature. At the elementary school in Maryland, one administrator described recess in general as "an exhale moment," and children, alumni, and teachers viewed the woods as a place where students could "get away" and find "freedom," but this was because the woods enabled children to create their own play culture. In suburban Denver, the habitat was legitimized by the school and district as a "science classroom" and "lab." In the teen gardening programs, adult mentors and teachers talked about the food system and health issues – although a few staff recognized that students found peace while gardening. Themes of stress, restoration, and opportunities to experience competence and positive social relationships emerged spontaneously at each site. These themes are examined in the sections that follow.

4. Recess in the woods in early elementary school

As research on children's developing abilities to express and analyze emotions would predict (Aldwin, 2007), the young elementary school students at the Jemicy School shared their feelings for their play areas in brief and general terms. Therefore this summary of findings at the Jemicy School relies heavily on observations of students' behavior during recess, showing how woods play enabled children to enjoy a sense of competence that was more difficult to achieve in the classroom, and encouraged cooperative play. The students' remarks about their experiences are supplemented by parents' and teachers' observations and alumni memories.

Students in grades 1–4 voted for their choice of woods play with their feet. During three fall seasons, 96% of the students in these early grades were observed to head for the woods as their regular recess location. By grade 6, almost all students had migrated out of the woods to the athletic field or playground. When the 9 students who preferred woods play were interviewed, 8 noted that the natural areas were places for either unfettered physical independence, supportive social relationships, or both. In the words of Mark (11 years old), the woods were a place "where I can just be my own self… just create anything I want to. I can just go down there, be wild." When Tricia (10) was asked about playing in the woods, she explained, "When you're in class, it's school – you can't relax, you have to work. But when you go to the woods, it's a different place, and you can relax with your friends."

The wooded areas afforded opportunities for activities that captured the children's interest in the way that Dewey (1916, p. 126) described as "being absorbed, wrapped up, carried away." The woods offered a nearly endless variety of "loose parts" (Nicholson, 1971) that children could investigate and manipulate, in contrast to the playground's and athletic field's static forms. Children used sticks, rocks, water, dirt, fruit, leaves and other found objects in creative ways, and hunted for frogs, salamanders and other small animals. In the early elementary grades, ages 6–7, they primarily engaged in exploratory and sensory-based play such as wading, splashing, digging, and smashing rocks. At ages 8–10, they organized their activities within a fort culture that involved role-playing and other imaginative processes such as crafting shelters, tools, and play structures. In the second growth forest, they inherited a culture of fort making that extended back to the school's origins. During the course of the study, at a parent's request, the pine grove was opened for year round play to compensate for the closing of the forested area and creek during the icy months of winter. Over the period of a year, children learned how to construct forts using boughs and pine needles and dig holes to find rocks for an economy of exchange – effectively creating a new behavior setting that extended the school's fort culture into a new realm. According to their teachers, for 5 of the 9 woods players, the sustained level of attention that they showed during these play "tasks" was uncharacteristic in the classroom.

The woods promoted cooperative alliances, autonomy, and competence. The youngest children worked together to negotiate the uneven terrain of the wooded hillside and creek bed and encouraged each other to explore new places and sensations, such as going on stream walks together while classmates scouted out new territories ahead and announced visits to upcoming forts (see Fig. 1). For 8–11 year olds, the fort culture was fundamental to their positive experiences (see Fig. 2). Lincoln (8), who was immersed in fort construction and negotiations and the barter of products like chipped stones and wild apples, reflected: "For me, it's like making my own business or small country. I think it gives you a sense of power. And maturity…. And it's definitely a good way to make friends." When Mark (11) was asked his favorite things about the woods, he listed the waterfalls and dams in the

Fig. 1. During recess at the Jemicy School, children in grades 1–2 primarily engaged in sensory exploration and discovery. Photo by Emily Stanley.

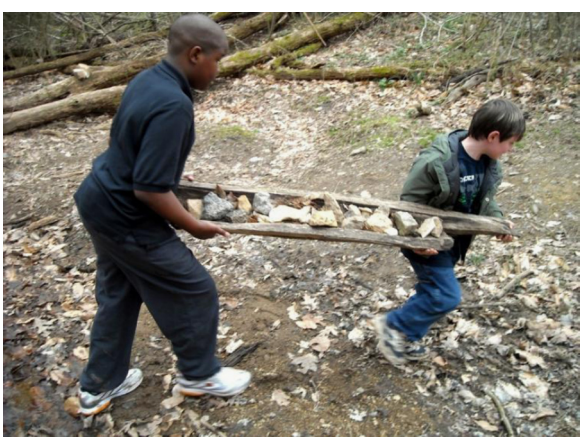

Fig. 2. Jemicy School students in grades 3–5 developed an elaborate fort culture during recess which required creative and cooperative work – such as these boys who are trading found objects between forts. Photo by Emily Stanley.

creek, animals, rocks, and other things to explore, but summed it up by saying: "Just the main territory that you have for yourself. Freedom. And independence."

Parents also commented on the importance of the woods as a setting for physical and social competence, where children could explore and cooperatively create a fort culture of "work" with peers, away from expectations prescribed by adults. A mother with an extremely dyslexic daughter observed that, "So much is hard for her. *This* – being in the woods – isn't hard. She loves it." She noted that when her daughter was making discoveries and meeting challenges in the woods, "She knows a LOT." As a result, "I think for her it levels the playing field," and "it's a safe place to test out different roles down there." Another mother also described the woods as a "safe haven" for her son socially. "When they closed for the winter, his anxiety rose."

When 8 alumni were interviewed about their experiences as students, 7 recalled how their frustration with academic failure in previous schools was replaced by a sense of acceptance at Jemicy. A father who attended Jemicy himself as a student and later enrolled his own children there attested to thriving on "free-form learning" that was exemplified by recess in the woods. A woman observed that in the woods, "It's like a carefree area" where children "are not as nervous," where "they're able to escape their fear." A woman who became a psychologist said, "It felt like just me and my little group of friends, and that was our whole universe." Regarding this experience of absorption in the woods, she added, "I really think it helped me return to the classroom with better focus."

Because most of the current students transferred into Jemicy from other grade schools or kindergarten and preschool programs, they were able to draw comparisons. When they were asked, "How did recess at your previous school compare to the recesses you have now at Jemicy?" all 11 students expressed negative reactions to recess at their previous schools, and parents described previous recess settings as highly constrained and lacking in diverse play elements. Elizabeth (8) recalled, "It felt like torture, cause there was nothing to do. I just hung around with my friends." Her mother agreed: "Mostly, kids just stood around on the asphalt." When Elizabeth transferred to Jemicy and entered the woods on her first day, she exclaimed, "How did this place get to be so *amazing*?" Maria (8) recalled that at her previous school, "You could just bounce a ball." "Now," her mother said, "recess is all she talks about – the forts and playing in the woods." Brian (11) remembered the urban school that he previously attended, where play was restricted to a heavily used grass field once a week and on other days, a small asphalt space where running and ball playing were prohibited, and his verdict was, "What a rip-off!" "The kids complained a lot," his mother noted. Alex (9) recalled the slide, monkey bars and big plastic dragon at his previous school and summed it up as, "BORING!" In contrast, all 11 students described recess at Jemicy as a positive and stress-free setting. There, they felt: "Happy! Really, really happy!" "I can just be myself there!"

The two students who did not frequent the woods appreciated having freedom to make their own play choices. Abby (8) preferred to stay on the playground with a best friend, in a setting that she described as "not as messy." She stated, "I'm just not a woodsy kind of person," and she confided that she was afraid of ticks and other insects. (In her fourth year at Jemicy, after her science class studied a vernal pool in the woods by the stream, she became an enthusiastic woods player.) Brian (11) exemplified the transition that students made when they migrated out of the woods to the playground or athletic field by grade 6. His mother observed that he had become more self-conscious: "He would think the *little* kids are down in the woods, and he's too old for that." Brian recalled when he "used to play forts and stuff," "because when I was little I liked the woods, but now I'd rather play sports with my friends." Because the wooded areas at this school were used intensively by students in the early elementary grades, they became defined as places reserved for "little kids." The few older children who stayed in the woods typically moved into leadership roles, helping to monitor and mentor the younger children.

5. A naturalized habitat for interdisciplinary learning in grades 4–6

Although students in suburban Denver entered the naturalized area on their school grounds to do class assignments rather than to play, they also found it an escape from classroom stresses, and they could articulate this outcome with greater self-awareness

than the younger children in Jemicy. When the sample of 106 students was asked to draw the habitat from memory and write three words that described it, 25% wrote the words "peaceful" or "calm." The 56 students who gave interviews also used these words repeatedly. When Marissa (10) was asked how she felt after spending time in the habitat, she replied: "I feel at peace, and because just being outside calms me down…. I feel calm and I feel relaxed because it's like you don't have to worry about upcoming tests. You don't have to worry about problems you are having. You can just be outside enjoying the time you have out there." She later referred to this feeling as "zooming out." Similarly, Michael (9) observed: "It feels like it is the only time I can be alone and at peace without anything to bother me. I just forget everything and relax and just think happy thoughts and rest for awhile…. When I am inside and all that, it's like all the work is hitting me and I have a lot to worry about." Sapphire (12) said, "It makes me feel like I'm somewhere I can be, and not be angry at other people like the boys in my class, because those boys infuriate me. Sometimes those boys will say mean things to me…So I like to come out here and I go somewhere where no one is, like up the hill." Student descriptions of how they felt in the habitat included phrases like, "It is the same feeling as being in a museum," "soothing and relaxing," "you want to spend all of your time out here," and "like I can do anything I want to." In contrast, students reported many stresses inside school walls: academic anxieties like worry over upcoming tests, grades and homework; and social conflicts like bullying, teasing and name calling.

Students were able to protect their peace and calm because they could move freely through the habitat. For example, when a girl resented nearby classmates raising their voices, she escaped by moving to a different pocket of the landscape. The one-quarter acre of the habitat was so varied in structure that children could select places for tranquility or active adventure. This freedom to choose their location also contributed to their sense of safety. In the scrub oak woods, they could feel a sense of enclosure, or they could choose the open clearing that afforded a clear line of sight up and down the hill. They also found safety by being in groups. Sophie (10) explained that she got scared easily but she felt the habitat to be safe because she was with people she trusted.

The diversity of the habitat also contributed to feelings of respite because the ever changing variety of information that it contained enabled students to select locations that held their fascination and attention. Seasonal variations provided a different experience each time that they went outdoors: a quality that Moore and Young (1978) call "sufficient unpredictability" and that Chawla (2007) associates with the deep attention that nature play and discovery evoke. The pond was the center of activity for many students (see Fig. 3). They found winter ice as appealing as the small green leaves of duckweed that coated the water in warmer weather. In every season, there was a group of students lying on their bellies on the dock with their heads and arms hanging off the edge, faces close to the surface of the water. The woods appealed to a smaller number, but they attracted students who found adventure and imagination in the tangled branches of the scrub oak. The butterfly garden provided a colorful space that changed with the seasons. There were two steep hills that students climbed with long lunging steps up and short cautious steps down (especially in the snow), where they found sunny perches for nature journaling and niches for snake hunting. This diversity enabled individual students to select whatever they found most appealing.

Teachers reinforced the sense of peace and calm by a ritual called "two minutes of silence." The first thing that every class did on arriving in the habitat was to sit on the rock steps facing the pond for 2 min in silence. The intention of the ritual was to allow students to settle in and select what they wanted to pay attention

Fig. 3. In the schoolyard habitat, the dock by the pond was a favorite place for science observations and quiet reverie. Photo by Kelly Keena.

to on that day. Students reported an appreciation of the routine. Tyler (12) described coming to an understanding that he was too connected to electronics. He explained, "I think it was when we were doing two minutes of silence…I started to realize that this is a really beautiful place to be right now."

Teachers learned to take advantage of the diverse affordances. One teacher took her class to the habitat for science journaling once a week, allowing students to fan out and select whatever information appealed to them individually for their sketching and writing. Teachers also enabled students to enjoy a sense of adventure that is rarely promoted in schooling, sometimes letting them explore paths in the woods made by wildlife or build forts in the trees. Some teachers gave an assignment called the Small World Principle (Sobel, 2008) that challenged students to imagine that they were only 2 in. tall and then create ways to survive in the habitat. This activity engaged students in lively conversations and determined team work to create small shelters and tiny simple machines to carry water or food. These opportunities to choose areas of interest and to solve challenges encouraged a sense of efficacy. Occasionally, teachers used the habitat as a deliberate respite from classroom pressures, such as when a sixth grade teacher gave his students free time breaks in the habitat in the midst of a rigorous three weeks of standardized testing. During these and other observations, students appeared visibly relieved to be able to move freely in ways not allowed inside the building.

A notable dimension of the habitat was not only what was directly observed, but what was *not* observed. Inside the building, students often engaged in arguments and rude, aggressive exchanges; but during more than 700 h of observations in the habitat, not a single incidence of such behavior was seen. In the habitat, students expected that others would respect their autonomy and sense of peace. When classmates were too loud, their peers asked them to lower their voices, and when students noticed a pattern they called "messing around," they held their classmates accountable or asked for the help of a teacher. In the habitat, respect and cooperation characterized relations between students and teachers and among students.

6. Gardening programs for high school teens

By adolescence, students were able to reflect at length about their experiences of gardening on their school grounds or in an after-school program as they raised vegetables, fruit, herbs and flowers. The heart of research with this age group was an open-ended interview of about half an hour, done one-on-one at each student's garden site. Students were asked to close their eyes and

Table 3
Feelings reported in response to gardening: frequency counts of key words.

Key words for feelings	Urban after-school program $N=7$		Private school program $N=16$		Public high school class $N=24$		Teen mothers class $N=5$		Totals $N=52$	
	Word count	# Of persons	Word count	# Of persons	Word count	# Of persons	Word count	# Of persons	Word count	# Of persons
Happy, joy, enjoy	19	5	15	8	56	17	9	4	99	34
Calm, peaceful	12	5	35	13	46	13	4	2	97	33
Relax, relaxed	16	3	15	5	48	12	10	4	89	24
Good, nice, cool	44	6	30	6	11	2	12	2	97	16
Love	3	2	2	2	16	4	0	0	21	8

share what came to mind about first being in a garden, followed by questions about what they saw, smelled, heard, tasted and felt with their hands while gardening, how they felt during and after garden work, whether they noticed a greater capacity to pay attention after time in the garden, whether gardening connected them to other people, and the meaning of gardening for them.

The interview analysis included a count of key words. Table 3 displays key words and frequency counts based on teens' responses to the questions, "How do you feel while gardening?" and "How do you feel after gardening?" In all four programs, youth reported feeling calm, peaceful, and relaxed. This result cut across age, ethnic origin, socioeconomic status, whether gardens were new or mature, and whether students gardened by choice or as a school requirement. None of the students described negative feelings. Together, the words "calm," "peaceful," "relax" and "relaxed" were used 186 times by the 52 respondents. Other positive emotions, such as happiness, joy, feeling good, and love, were mentioned 217 times. In sum, 186 out of 403 uses of key words, or 46%, referred to calm, peace and relaxation.

Teens gave four main reasons for the calm and peace that they felt during and after gardening: being outdoors in fresh air in nature; feeling connecting to a natural living system; caring for living things successfully; and having time for quiet self-reflection. Because the first three reasons are closely related, they will be presented together, followed by the teens' remarks about self-reflection. The youth were also asked, "Do you notice any greater capacity to pay attention to other things once you are done with gardening?" Because a state of mindful awareness is characteristic of a sense of peace and calm, and the ability to focus is necessary for successful school achievement, their responses to this question are also reviewed. To distinguish each gardening program, young people's statements will be followed by their age and program initials: the urban after-school program (U), private school program (PS), rural public high school class (RH), and class for teen mothers (TM).

6.1. Being outdoors and caring for a living system

Some students appreciated the garden because of qualities it shared with other natural places. As Antonio (18, RH) said, "I feel like it's like a picture of being like in a forest, you know, nature…. It's just like being there, being calm, enjoying nature." Others drew peace from feeling part of nature's cycles. Georgia (18, PS) felt serenity in the garden because, "Simple things are there, and they grow, and they die." In the words of Aaron (17, RH): "I like it because I know it all works together, just a big old complete cycle. It calms me down. It makes me feel relaxed, at ease. It reminds me of who I am, and I don't have to worry about anything else."

A few students noted that when they went hiking or camping, they were told to leave nature untouched and not to harm it. In contrast, gardening invited them to participate in nature's processes through caring actions (see Fig. 4). One of the teen mothers, Natalie (17, TM), elaborated on this connection: "It makes me feel good inside, all fresh, good… I enjoy touching the soil, the plants. You can feel them…I feel part of them…Yes, it makes me feel that I can care more about things… Being more gentle, caring more, the plants are like people." All five teen mothers described parallels between caring for a garden and caring for their babies. As Virginia (17, TM) expressed it: " I like to touch the soil and feel the plants…It feels good because you are helping a plant to grow. So it feels like you are helping someone to grow." Compared to parenting, however, she found gardening "a little more relaxing, not so stressful."

Fig. 4. Many teen gardeners had pictures taken of their hands at work, expressing their sense of agency. Photo by permission of Barclay (16).

Several teens who were not parents also compared gardening to caring for children. Tom (17, PS) had worked with preschoolers for a prior school work crew and found parallels in "caring for them, caring for like a little community or nature." Others found the garden a place where they could engage in a reciprocal relationship of doing good and receiving good. As George (17, U) said: "It all connects one way or another, so I figure that I'm helping the environment, it's helping the garden, I'm helping myself. It's not that everything is about me, it's that everything is about everything else." Jessie (16, PS) echoed him: "If I take care of them, they'll take care of me!"

Marie (15, U) observed that gardening is particularly meaningful because it is essential.

> It brings us back to where we are all from. Because you just get caught up in all this technology…, but gardening is like this essential thing that has to be done by somebody…. In that way it's a very essential part of life. Sometimes we don't see that, we just go to the grocery store and buy it. But then actually being able to say, "I made food, or I grew food for myself," it just brings it all back together, and I think that's why I think that it is peaceful and enjoyable.

These activities in the garden contrasted with sources of stress that students associated with other parts of school, including

grades, homework, an enforced schedule, sitting for long periods inside, and pressure to win in competitive sports.

6.2. Time for self-reflection

Time to reflect, get centered, and let go of school stresses permeated these young people's conversations about gardening. Michaela (17, RH) enjoyed the garden so much that she became a garden intern for independent study in her senior year after taking the agricultural biology class in her junior year.

> Everything just seems a lot more peaceful… Just for it to be semi-quiet is like, I really think is important in a garden. My school day is really not quiet or relaxing or peaceful at all. That's why it's so nice to come out here and be out in nature and kind of like center yourself again.

Ana (17, RH) saw gardening as a distraction from sources of stress: "Gardening for me would kind of fit into a stress release, because you're doing something that will distract you maybe from things that stress you or things that make you feel bad. So if I go out and garden it will make me feel so much better when I am done." Diana (17, U) explained that the physical work involved in gardening both gave her mind a focus and left it free for problem solving.

> It gets your mind off things. You have time to reflect on your life, but then like you're busy, it's not like you're sitting at home thinking. You kind of work them out because you're doing more physical work. So yeah, there's things like you come to a solution, but not an actual solution, but in your mind, but who cares, you reach a kind of peace.

Several youth described their garden as a "sanctuary."

Gina,15, a member of the garden work crew at the private school, described this combination of physical work with time for contemplation as meditative.

> It's almost like meditation, like my body is present but my mind just kind of drifts off and goes someplace else, and thinks about things…It's brainless tasks most of the time, so it's also like zenful, so you get to listen to things…I think about stuff, so I don't have to go home and think about it right before bed, so instead I can just go to sleep and stuff. I just feel happier in a way, and more at peace.

These feelings were so common in her work crew that the school nicknamed the gardeners the "meditation crew." A few staff recognized these benefits. One of the girls said that when she went to the school nurse with a stress related issue, the nurse told her to go garden because it would make her feel better. At the public high school, Bernardo, 16, noted that the garden could be a refuge for any student, not just those in the gardening class. "Cause if they are having a test or something and they want to escape, just for five or ten minutes, they can go to the garden…to have a time of silence to reflect."

6.3. Focusing

Out of 51 students who were asked whether their capacity to pay attention to other things changed after gardening, 50 (98%) replied that their capacity to focus improved and that it positively impacted their ability to do school work. Rodrigo (16, RH) commented about coming to the garden: "It's like taking a little break….You come here and work and learn. You come back to class more refreshed, more into work."

Two students self-identified as having Attention Deficit Disorder. For them, gardening made a noticeable difference. Julieta (18, RH) commented on the effects of her agricultural biology class on the class that followed: "You know I got to spend the whole other class outside so now in the next class I can kind of calm down and relax a little bit and put the energy that I got into my other work, into my other class." Laurel (17, PS) observed that after time on the garden work crew: "I'm able to complete my homework faster, because I'm in a better place to do other things, because I just spent an hour not worrying about my homework and my grades and my timing for anything, because there's no deadline here."

Rose, (16, U), a student who revealed that she suffered from clinical depression, described gardening as her "self-therapy".

> It helps me focus and like slows everything down. It makes me able to concentrate on one thing, not several things at a time like I have to at school, like due dates, and tests, and stuff like that. It brings, it just kind of lets me slow down and focus on one particular thing that needs to get done, and when I do it I move on to the next thing, and I focus on that for however long I need to.

She found that this ability to focus and complete work gave her temporary relief from depression. Barclay (16, U) was a high performing student who did not suffer from depression or ADHD, but he summed up the emotional benefits of the garden for himself and other students: "I've had some hard days at school, but it's nice here. People are laughing. I think it's a great input and output of energy. I think it outputs stress but inputs positive energy, so it balances it out, so positive energy pushes out that negative energy when you are here."

7. Discussion

The findings reported here add to existing evidence that when students have natural landscapes for play, learning and green views, they show positive moods and reduced stress, anger, inattention and problem behavior (Martensson et al., 2009; Matsuoka, 2010; Roe and Aspinall, 2011). The results are also consistent with evidence that access to nature around the home and neighborhood decreases children's symptoms of ADHD (Faber Taylor et al., 2001; Faber Taylor and Kuo, 2009; Kuo and Faber Taylor, 2004) and rates of depression (Maas et al., 2009), and facilitates coping with stress (Wells and Evans, 2003). In addition, the observations and interviews at these six sites suggest processes that underlie these outcomes, as students find many opportunities for discovery, immerse themselves in positive sensory experiences, and engage in constructive, creative, and cooperative activities.

The degree to which students could articulate these benefits varied across the three age groups. Younger elementary school children in the Jemicy School expressed the value of naturalized playscapes primarily by voting with their feet, by choosing wooded areas for recess rather than the built playground or athletic field. It was mostly parents and alumni who articulated the value of the woods as a "safe space," "safe haven" and "carefree area," in contrast to social and academic pressures that students faced in classrooms. Older elementary school students in the public school in Colorado talked frequently about the peace and calm that they experienced in their naturalized habitat. High school students not only spoke about peace, calm and relaxation in their gardens, but they analyzed reasons for their feelings. These increasing references to peace and relaxation may be partly explained by different numbers in the studies' samples: 9 "woods players" were interviewed at Jemicy versus 56 students in suburban Denver and 52 teen gardeners. Yet these differences are to be expected, given children's developing capacity to differentiate and talk about their feelings as they move from early childhood to

middle childhood and adolescence (Aldwin, 2007). These results suggest that when research explores the meaning of natural play areas for young children, it is important to supplement child interviews with reflections from parents and teachers, behavioral observations, and when possible, reminiscences by alumni, as research at the Jemicy School did.

What the younger elementary school students often expressed was the value of free movement and free choice during recess. Freedom of choice, a great variety of objects for discovery, and loose parts that children could use imaginatively appeared to be integral dimensions of the woods' function as a "safe haven," as these qualities of woods play enabled children to select roles and activities in which they felt comfortable and competent. It could be objected that free choice characterizes any recess wherever it is located; but children and parents at Jemicy drew stark contrasts between play in the woods and recess at previous schools, where students were bound by restrictive rules in barren environments with hard surfaces, flat grassed fields, and playgrounds with rigid equipment. This finding is similar to observations by Lucas and Dyment (2010) of outdoor recess at a primary school that combined areas of asphalt, manufactured play equipment, and native grasses and trees. There too, the native landscape attracted the most students, for similar types of cooperative, imaginative play.

This paper cannot claim that nature-based activities made the students in its samples more resilient, as resilience involves positive adaptations to stressors and challenges over the long term. Therefore it must be investigated through longitudinal studies (Benard, 2004). It is appropriate to note, however, that the natural areas at the six sites facilitated the development of important protective factors for resilience in the form of feelings of competence and supportive social relationships (Garmezy and Masten, 1991; Wright and Masten, 2005).

White (1987, p. 52) defined competence as "all those actions, at first playful and exploratory, later more serious and focalized, which tend to increase fitness, capacity, and skill in dealing with the environment"; and he noted that competent functioning produces two consequences: *effectance* as people see that they can have a visible impact on their environment, and a *sense of efficacy* that includes feelings of mastery and self-esteem that develop through repeated experiences of successfully meeting challenges (White, 1959). Experiences of these kinds characterized all six study sites. At the Jemicy School, nature play enabled children to set their own markers for graduated levels of competence where they could exercise their current abilities and set increasingly challenging goals, such as heavier rocks to lift or more complex techniques for fort construction. In the schoolyard habitat, older elementary school students were given assignments that allowed them to choose areas of the habitat that captured their interest, and by selecting their own subjects for investigation, they were able to set and meet their own objectives for accomplishment. In the teen gardening programs, students appreciated opportunities to "help" nature in its processes of growth, as well as engage in the essential act of producing food.

Supportive social relationships were facilitated because the students' freedom to choose from a variety of potential activities gave them control over social interactions and roles. As a mother at the Jemicy School remarked, the woods provided "a safe place to test out different roles." Similarly, students in the Colorado habitat could gravitate to the pond, scrub oak or other areas, which involved different social groups as well as settings. At both schools, the natural areas afforded cooperative activities that encouraged civility.

Another theme that emerged from these sites is that the natural areas motivated attention and focusing. According to teachers at the Jemicy School, the sustained attention that students gave to their activities in the woods was uncharacteristic of the majority of the 9 woods players when they were in the classroom. Teachers at the suburban Denver school took advantage of the great sensory richness of the habitat by letting students choose their object of focus during assignments, and students gave intent attention to these tasks. When teen gardeners were asked whether their capacity to pay attention changed after gardening, 50 out of 51 reported that they felt that it improved. Teens also described the garden as a place for centering and self-reflection.

In some respects, these findings in the woods, natural habitat and gardens reflect aspects of Attention Restoration Theory (Kaplan and Kaplan 1989). Students' statements and researchers' observations are consistent with the qualities of "fascination," "being away," "extent" and "compatibility" that the Kaplans associate with settings that promote attention restoration. These natural areas contained abundant objects of fascination, enabled students to get away from daily hassles and concerns, gave them extent to become immersed in their experiences, and provided compatibility with their goals.

In other ways, the claim of Attention Restoration Theory that "directed attention" is a limited resource that leads to mental fatigue, which is restored by "involuntary attention," introduces terms that are more confusing than enlightening in these school settings. The Kaplans define directed attention as "forcing oneself to pay attention to something that is not particularly interesting" (p. 179), in contrast to involuntary attention "that requires no effort at all, such as when something exciting or interesting happens and we look to discover what is going on" (p. 179). The children's attention was not "directed" in this specialized sense, but it illustrated normal usages of the word in the sense of sustained attention to a task, which was frequently assigned by a teacher. Students engaged intently in fort building and other play "tasks" that they set for themselves in the woods, immersed themselves in the assignments they were given in the habitat, and gave their focus to assigned garden work in ways that enabled them to center meditatively. If Attention Restoration Theory were applied to explain why they felt happy, peaceful or calm after these activities, it would say that their attention was involuntary and required no effort at all – which is not a phenomenologically accurate description of what occurred.

This paper's results are more compatible with the psychoevolutionary theory of Ulrich (1983), who claimed that exposure to natural areas that are perceived to be safe is inherently restorative because such settings were associated with survival during humanity's long evolutionary history. Therefore physiological levels of stress drop in safe natural settings and feelings of well-being rise. Although the research reported here did not include biomarkers of students' stress levels, the positive emotions and opportunities to relax that young people expressed at all six sites are consistent with this theory.

8. Implications for research and practice

Access to nature at these six sites was not part of any deliberate program to reduce stress and anxiety and build protective factors for resilience, yet it created conditions for the three strategies to enhance resilience that Masten and Reed (2002) identify reducing risks (such as inattention and aggression), building assets (such as concentration and a sense of competence), and mobilizing human adaptational systems (such as cooperative friendships). These findings suggest that the basic theory and research on resilience need to consider access to nature as a protective factor in its own right, similar to safe neighborhoods and youth organizations. Correspondingly, programs for stress reduction and stress management should find ways to include nature-based interventions.

Schools that incorporate schoolyard greening are well suited to serve as laboratories for basic research on the effects of nature contact for children and youth. Whereas a number of studies with adults include physiological measures of nature benefits, there has been no comparable research with children. School grounds that contain natural areas as well as built playgrounds and asphalt surfaces provide opportunities to assign children to different areas and measure physiological responses. Children can also be tracked with repeated measures as they move from a classroom into a natural area or built outdoor space and back into the classroom. LeGendre (2003) successfully used cortisol swabs to study levels of stress associated with group sizes and space in preschools: this appears to be a measure adaptable to outdoor settings as well. Given that students and parents at this paper's sites were never asked directly about stress and anxiety and yet they volunteered the value of these sites for refuge and restoration, more qualitative studies are also needed to probe this aspect of the meaning of naturalized schoolyards.

Another approach to the study of mental health benefits is exemplified by Wells and Evans (2003), who investigated the effects of nature around children's homes. They correlated parents' reports and children's self-perceptions of psychological health, children's reports of stressful events in their lives, and independent measures of levels of nature. In schools, similar assessments of children's psychological health could be related to levels of nature in classrooms and outdoors, time spent in green schoolyard activities, and whether school-based stress management programs include nature components or not. Schools also present excellent sites to study the effects of nature contact on focusing. Faber Taylor and Kuo (2009) used the digit span backwards test of concentration after taking children on walks down built streets or through a park, with significantly better performance after time in the park. Using a test of this kind, or measures of success at school-related tasks, students could be tested for their ability to concentrate after time outdoors in built playgrounds or natural landscapes.

Although it is important to know whether schoolyard greening benefits students' physiology and focusing, with potential outcomes for health and school achievement, this paper demonstrates that young people's perceptions of the value of natural areas speak to an outcome of no less consequence: their happiness here and now. According to Dewey (1916), the highest aim that schools should serve is to help students achieve a good life and build a society where others can enjoy good lives as well. These students' experiences of deep engagement in action and sensory awareness and their creative and cooperative relations with other people and the environment constitute elements of Dewey's vision of a good life. At the Jemicy School, promoting "the good life in childhood" was the school's explicit mission, and the principal identified students' freedom to choose nature play as one of its expressions.

At every site, however, students discovered values in the wooded areas, habitat and gardens that they were never taught by the adults who supervised them. At the Jemicy School, they created their own woods play culture, where teachers rarely ventured except to mediate a dispute. In the natural habitat and gardens, they talked about their experiences in terms that transcended their schools' discourses that these were places for learning science or doing service. The students' discoveries of the value of these spaces are consistent with the principle of ecological psychology that the environment has qualities and meanings of its own that people can perceive (Gibson, 1979; Reed, 1996) and the arguments of Hinchliffe (2007) and Bennett (2010) that nature has an "otherness" that is constituted by the "ecologies of action" of many species and elements in addition to the human.

In *Geographies of Alternative Education*, Kraftl (2013) examined how the more-than-social materiality of natural processes in forest schools and farm-based schools created settings for children's autonomous learning and transformation. Future research on schoolyard greening and health will benefit by articulating theoretical frameworks that recognize the interdependence of humans and larger ecologies of life, such as Gibson (1979), Reed (1996), Hinchliffe (2007), Bennett (2010) and Kraftl (2013) offer. These frameworks are consistent with the advice of Bell and Dyment (2008) that health promotion needs to extend beyond individual behaviors to address the settings of people's lives, as well as socioecological models of resilience (Masten and Obradovic, 2008; Tidball and Krasny, 2014) that embed people in the ecosystems on which they rely. These frameworks will encourage researchers and practitioners to see green schoolyards as sites where people have the potential to create more healthy and sustaining conditions for themselves, their communities, and the ecosystems on which life depends.

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