Digital Technology’s Role in Connecting Children and Adults to Nature and the Outdoors
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OVERVIEW

This report is about finding ways to harness digital technology and apps for worthwhile and life-changing nature experiences. It contains research background and common sense guidelines for how handheld digital technology and applications (apps) can be designed and used to meaningfully connect children and adults to nature and the outdoors.

In recent years, American children have become indoor-bound and no longer spend major time playing and learning outdoors. This means that they are not getting the health benefits of outdoor time in nature and, importantly, they are not having enough of the experiences needed to develop a lifelong appreciation for and comfort with nature and the outdoors. Computer and entertainment technology is often blamed for causing today’s indoor child phenomenon but it is quite likely that, with the right software design features, such technology - smart phones, e-tablets, laptops and cameras - could actually help in reconnecting young people and their families to the natural world. This report explores how we get there.

This report also combines three distinct but related bodies of research: a) the available social science revolving around what actually creates a lifelong affinity for nature and the outdoors, b) what are the true familial and societal mores and barriers that are keeping children indoors, and c) a careful review of what kinds of digital technologies and apps can help shape a deep and lasting connection to nature.

We conclude that there is sufficient guidance in the social science research to know how to shape nature programming and activities for children that can actually make a lasting emotional connection to nature. And, we find that, despite the depth, strength, and prevalence of the societal barriers to children having more time outdoors in nature, there are strategies and approaches to overcome their being indoors so much. Lastly, the report finds that carefully-crafted digital apps can be a significant way to help children and families to connect with nature and the outdoors in meaningful and lasting ways. In Chapter IX, we suggest guidelines for how such digital programming can be shaped and deployed.
While many nature enthusiasts adopt a “just unplug” attitude on the use of digital technology and apps as nature connectors, most parents do not share that view. Current trends and research show that the use of mobile apps and related web platforms is actually an accepted part of modern parenting and family life. So there appears to be an active interest in melding digital technology and app use with outdoor and nature time rather than pursuing a ban.

The stakes around today’s indoor childhood are quite high. In this report we review data from health officials and child-development experts showing why connecting with nature and the outdoors is so important. We also offer guidance on how to shape an actual media plan for children, particularly the very young. And, we shine a spotlight on the costs of keeping children indoors and sedentary along with the many benefits of children having more time to move, play, and learn in nature.

In addition to a review of the available research literature, this report contains the results of a National Wildlife Federation supported field-based assessment of 19 child/caregiver pairs who, over a multi-week period, made use of two age-appropriate Ranger Rick-themed mobile apps that encourage children to go outdoors and engage in nature-based activities such as hikes, scavenger hunts, and outdoor games. Close observation by researchers and caregivers was supplemented by a design session where some of the study subjects were brought together to discuss hurdles, opportunities, and future design ideas based on their use of the Ranger Rick apps and all apps for that matter. The results of this study are likewise contained in this report, and they indicate a series of design principles that will be useful to digital app designers, parents and caregivers, educators, public interest organizations and agencies.

In conducting a review of the many studies, articles, surveys, and overall trends in this area we are hopeful that this report will confirm some of the existing thinking and approaches around the effective use of digital technology and apps to help children have positive and meaningful experiences in nature. We also hope that the report, and the design guidelines it contains, will significantly improve the way that mobile apps and related technologies are crafted to facilitate healthy, wholesome, and effective outdoor experiences that will contribute to America’s indoor generation developing a lasting affinity for nature and the outdoors.
BACKGROUND

Examining the subject of how digital technology, including mobile apps, hardware and related websites, can help children to better connect to nature and the outdoors can put many nature lovers in a bind. They want our children to spend more time playing, learning, and exploring in nature and they want the experience to be truly nature-focused. Consequently, thinking of technology as an actual aid in creating a meaningful nature experience can, for many, seem counter-intuitive. This is especially true when so many see the emergence of ubiquitous electronic entertainment technology in modern children’s lives as the very reason kids are staying indoors and away from the natural world. While the reasons children are spending increased daily time indoors are many, interconnected, and complex, it is quite common to lay the blame entirely at the foot of technology. But other forces are at work as well.

Most research indicates that children today are spending as many as eight daily hours engaged with some form of electronic technology (six to eight hours seems to be the agreed upon average for children ages 8 to 18). This means they really only have time left for sleep, organized activities (such as sports), school, homework, and meals. Their free time is spent with a phone, a tablet, watching television or on a computer. We have come to refer this new reality as the indoor childhood trend. Writer and nature time advocate, Richard Louv, describes this condition as today’s children having a “nature deficit.” Their lives are mostly within the four walls of their homes, childcare centers, schools, gymnasiums and vehicles. What outdoor time they do have is often spent on a ball court or sports field. They are living in a world that is otherwise largely virtual and mostly devoid of natural vegetation, green spaces, flowing streams, and the sounds of wildlife and wind through the trees. This modern indoor state contrasts dramatically with past times in America when children would spend their after-school time, weekends, and summers outdoors for seemingly endless hours.

Indeed, children’s lives today are filled with games and videos, television programming, texting, social media, and dozens of mobile applications (apps) that can entertain and even consume them. And, as noted above, these are mostly used indoors. Many who care about the future of American conservation hope our children and their families will learn to “unplug” and put their e-tablets, smartphones, and apps aside to enjoy the richness and simplicity of nature. But others see this as unrealistic, given how much technology is now infused in young peoples’ lives.
This report is about finding ways to harness digital technology and apps for worthwhile and life-changing real nature experiences. This is important at many levels. If we are able to have children and adults spending more time in nature, they are likely to be physically healthier, better students, and more emotionally upbeat. Having a strong nature connection is vitally important to the future of conservation as well. The future of American nature conservation is underpinned by research that finds that a lifelong connection to and affinity for nature actually comes from spending time outdoors in nature—a lot of time. Ask just about any professional conservationist, naturalist, park ranger, or wildlife biologist how they grew up to become who they are, and they are likely to tell you about experiences they had in the woods, at a farm, at a park, or even simply exploring the outdoors in their neighborhood as children. The research presented in this report backs this up.

Our point of departure will be to point out that the factors causing children to remain indoors, away from nature are powerful and widespread and are not confined just to the digital world. They are complex, family and society-driven, and involve more than an addiction to television, games, social media and texting. Our findings lead us to point to digital technology and apps as part of the solution for increasing the amount and quality of meaningful time that American children spend in nature and the outdoors. But, this will only happen if certain design features and uses are incorporated. Basically, to have a child outdoors staring at an electronic screen is not a solution. Instead we need technology and apps that deepen the relationship with real nature and open peoples’ minds to the beauty and magic that exists there.

In this report, we offer an assessment of how digital technology can be crafted and used to facilitate and support the development of a love of nature in young people. We examine many key questions:

- What is the status of the indoor childhood condition in American society and why does it matter?

- What are the most significant barriers to getting children more time outdoors in nature?

- What constitutes a nature experience (or set of them) that will create a lifelong affinity for and connection to nature and the outdoors?

- What are we likely to see in the future regarding children’s use of apps and related technology in their daily lives?
• What kind of limitations and guidelines should parents use regarding technology for their kids?

• What is the current status of nature and outdoor apps and related programs and technology and how well do they work?

• What are the best formulas and design elements for creating apps that foster a true love of nature and the outdoors?

Through this report we offer frames of reference for understanding the role of technology, particularly handheld or mobile apps used in tablets and smart phones, as a tool for meaningful nature experiences.
SUMMARY OF FINDINGS

THE PRESENCE OF TECHNOLOGY IN CHILDREN’S LIVES

The uses of technology, mobile apps and social media are growing in acceptance in American society. This is particularly true of handheld technology such as smart phones and tablets and is punctuated by the fact that between 2011 and 2015 there was exponential growth in the percentage of homes that own and use this technology (now three out of four) and a similar rise in the number of children using it. Mobile technology and social media are the most embedded with teenagers. But, younger children (ages 6 months to 6 years) are also using it with greater frequency and with high levels of parental acceptance.

Research shows that more than 80 percent of families have electronic media as a major part of their daily routines and that over 99 percent of families in the U.S. regularly use some form of electronic media. According to a useful set of statistics provided by a Northwestern University’s Center on Media and Human Development research study (Wartella et al. 2013), modern families fall into three categories:

- **Media-centric**, 39 percent of families. Parents in media-centric households consume an average of 11 hours of screen media a day. Eight in ten (81 percent) say they are “very” or “somewhat” likely to use TV to keep their child occupied when they need to get something done around the home and nearly half (44 percent) have a TV in their child’s room.

- **Media-moderate**, 45 percent of families. Parents in this group spend an average of just under five hours a day using screen media. While these families like TV, they are more likely to enjoy doing things together outside (56 percent compared to 46 percent among media-centric families).

- **Media-light**, 16 percent of families. These parents average less than two hours a day (1:48) with media. These families are less likely to enjoy watching TV or movies together “a lot” as a family activity (32 percent, compared to 53 percent of media-centric parents) and less likely to use TV when they are getting their child ready for bed.

The study also found that 78 percent of parents say their children’s media use is not a source of family conflict and 59 percent say they are not worried about their children becoming addicted to new media.
In 2001, a label came into common usage describing children of the time as “digital natives”—people who were growing up with technology. Parents and adults of the time were labeled as “digital immigrants” — people who grew up without technology but have learned to use it (Prensky 2001). In 2001, that was a useful construct but, in 2015, parents and adults are increasingly made up of a significant percentage of digital natives.

THE EMERGENCE OF CHILD MEDIA PLANNING

Also, fifteen years ago, the American Academy of Pediatrics and other health organizations had specific hourly guidelines for children’s use of technology. They recommended that parents limit television watching and computer use to a couple of hours per day and that very young children have almost no exposure. Today, in the face of technology being so pervasive, these organizations are making their guidelines more flexible and these are evolving into common sense, parent/child agreed-upon media plans.

The use of hourly limits as guidelines has proven to be less effective than more affirmatively tailored planning and guidelines. The American Academy of Pediatrics (AAP) now recommends that parents make a media use plan for their families that takes into account not only the quantity, but the quality and location of media used, and includes mealtime and bedtime curfews for media devices (2013).

More specifically, late in 2015, the AAP spelled out new modified guidelines as follows:

- **Set limits at every age:** Caregivers should provide children with clear guidance on media use rather than remain silent on the subject.

- **Avoid displacement:** Caregivers should consider what use of digital media is displacing, and strive to maintain protected time for conversation, play, and creativity.

- **Address digital etiquette:** Caregivers should counsel children that online interactions need to follow the same social guidelines as face-to-face encounters.

- **Engage in using digital media together:** Parents should let their children show them what they are doing online; this helps children feel empowered and helps the parent learn while both are engaged.

- **Create definitive media-free zones:** Set aside times such as meal times and bedtime, and set aside specific times as “media-free” periods. Parents should also eliminate background TV, which reduces conversation time with children.
• **Model media behaviors**: Caregivers need to be attentive to their own personal digital media use (or over-use). Parental behavior provides clear modeling for children’s behavior.

**MOBILE TECHNOLOGY’S ABILITY TO MOVE CHILDREN FROM THE INDOORS TO OUTDOORS**

The mere existence of a nature app will not make an otherwise indoor-bound child magically start interacting with nature. In this report we found:

• There is a role for mobile technology and other forms of technology in helping children to experience nature and to develop a lasting affinity for the natural world and the outdoors.

• Digital Apps and technology that encourage children and their caregivers to make the indoor/outdoor transition have particular value because they affirmatively try to bridge the gap between these two worlds.

• Technology by itself is not what is keeping a majority of American children indoors and away from nature. While digital technology, in all forms, is very evident in children’s lives, its causal effect in keeping children indoors is probably overshadowed by larger societal shifts in parental concerns over risk and safety and even the very definition of good parenting.

• Digital Apps need to more affirmatively account for and address the powerful and persistent barriers that exist in society for children to have more outdoor time. These barriers are complex and revolve around new definitions of safety and security of children who are outdoors. In the past 20 or more years, the definition of parenting and childcare giving has shifted toward high concern over hazards and threats, and a standard of vigilant supervision of outdoor children until they are teenagers.

**MOBILE TECHNOLOGY FORGING A TRUE AND LASTING CONNECTION WITH NATURE**

There is a growing body of social science and research that describes the ingredients for developing a lasting affinity for nature and the outdoors. These ingredients include spending regular and recurring time in natural settings and experiencing nature first hand. Understanding
this research and how it will shape the design, presentation and use of technology and apps will be crucial.

- The social science framework for what types of experiences truly create an affinity for nature in our children that lasts with them until adulthood is becoming clearer and more settled. It includes experiences that are: a) in nature; b) about nature; c) of sufficient duration; d) recurring; and e) are richly affirming to the child, often in the company of an adult.

- Mobile apps and technology and various related platforms can be a significant tool for connecting children with nature if employed in the context of established socials science. With the right design features and by being used in certain ways, apps can be effective ways to connect children with nature and the outdoors.

- Not every nature app or technology platform aligns with this social science research on the best way to connect children with nature. In fact, given the thousands of nature-oriented apps that exist, relatively few are designed to create a true and lasting affinity with nature.

**A GROWING ROLE FOR SCHOOLS, CHILDCARE AND ORGANIZED GROUPS**

- It will help for digital apps that connect children with the outdoors to be able to apply to educational and childcare settings as well because child-serving institutions are becoming an increasingly important factor in the provision of nature and outdoor time for children.

- The prevailing factors that make it difficult or uncomfortable for parents to permit their children to roam free outdoors will create a greater need for schools, park agencies, and other child-serving institutions to step up and provide nature and outdoor experiences.

- There are many classroom-based apps and instructional programs for children but there are far fewer apps designed for group-based outdoor education and play.
RECOMMENDATIONS AND MOBILE APP DESIGN GUIDELINES

What follows is a set of recommendations on the design and use of technology and apps to forge a true connection with nature and the outdoors.

MOBILE APP DESIGNS THAT TRULY CONNECT CHILDREN WITH NATURE AND THE OUTDOORS

Through our research, we have identified twelve (12) key features of technology and app design that connect children with nature:

1. **ACTIVATE THE SENSES AND EXPOSE THE CHILD TO NATURAL BEAUTY**

   Research shows that it would defeat the purpose of having mobile apps to get kids outdoors in nature if they do not directly engage the child in physically experiencing the natural world. Designers should develop digital apps that help children notice and directly experience things in the natural world—sight, smell, touch, taste, and sound. The more that digital technology and apps help to activate a child’s or adult’s senses and focus on nature and the real world, the more likely a bond with nature will be formed.

2. **A FOCUS ON ANIMALS IN NATURE**

   Children enjoy observing and even interacting with animals. Digital apps can be designed for the many wildlife observation opportunities for children close to home. Apps that attend to children’s natural fascination for creatures, particularly younger children, will make the outdoor experience richer and more fun.

3. **CREATE PERCEPTIONS OF NATURE SAFETY**

   Children can be quite fearful of things that are new and heretofore unknown in the natural world such as insects, plants, mammals, reptiles, and more. Mobile apps that also communicate concepts of safety such as safe-to-touch insects and plants can be helpful in giving them an understanding that nature is a safe and comfortable place to spend time.

4. **ENCOURAGE PHYSICAL ACTIVITY**

   Mobile apps and related technology should be encouraging outdoor physical activity. Children love being active and the outdoors gives them room to roam. Given how important it is for American children to improve their overall level of fitness, mobile app designers should be incorporating movement and physical activity into these programs. These can include, walking,
dance, games and more. Such activities will be the most fun for the children if they are linked to creative play such as role playing, adventures, and creative expression.

5. **FOSTER NATURE ADVENTURE SCENARIOS**

Research shows that once children get outdoors, they most often find amazing ways to use their own imagination. Mobile app design should consider “pump-primer” scenarios, such as a role to play or a goal to reach, as a way to get kids started but keep the scenarios open-ended to provide space for individual imagination.

6. **CONNECT CLOSE-KNIT SOCIAL GROUPS**

While many mobile apps are often designed for solo activity by a child, it is important that mobile app designers also provide for the ability for young users to share their experiences with family members and close friends. Mobile app design that has sharing and joint participation features would create improved experiences for the children and make these experiences more in line with social science research. Children get the most from activities that are connected to their own close-knit social groups - siblings, friends, parents, and caregivers.

7. **PROVIDE FOR CAREGIVER ROLES**

Digital apps and smart toys that engage both parents and children together are particularly important because children relish the company and attention of a close adult. As suggested in recommendation 6, instead of assuming there will be a solo experience, mobile apps should also offer some clear roles for caregivers including: facilitator, companion, and supervisor. Caregivers can also play an important role on the technology side of the experience. Children are not always as facile with their use of technology. It will be a less positive experience for the children if they do not know how to fully operate the smart toys, phones or apps themselves.

8. **PROTECT EQUIPMENT OUTDOORS**

In packaging and use, designers need to be thinking about outdoor-focused apps in light of how the hardware can be affected by dirt, rain, cold or even overheating. Moreover, if a phone or tablet is too easy to be lost or taken away from the child, there may be more of a potential for loss or theft. Successful use of technology and digital apps for outdoor connections will depend on keeping the hardware safe and protected.
9. EXTEND THE EXPERIENCE

Mobile app design and use should lead to other ongoing experiences. These could include seeking out excursions to new nature places, the construction of natural hiding places, making up new (non-app) games, social media connections, and more.

10. COLLECT AND STORE OBSERVATIONS

A large part of the technology and app experience is to encourage children to go outdoors and experience nature first hand in a way that encourages more interaction, fun and imagination. Smart technology also offers children the opportunity to bring their experience back inside for further reflection and enjoyment. It can be important to break down barriers between the indoors and outdoors in this way. This can be done virtually by taking photos and recording sounds and physically by collecting specimens and looking them up online for identification.

11. MAKE IT WEARABLE AND HANDS-FREE

Children need to be able to run free, climb, swing, and touch. Designing ways for hands-free outdoor use such as a cross-chest strap or harness would be advantageous as part of the mobile app-driven nature experience.

12. USE MOBILE SENSES AND ALL THE TECHNOLOGY FEATURES

Just as we want children to use all their physical senses and intelligences when outdoors, smart technology likewise has many capabilities that can be used to enhance the outdoor experience and connect children to nature including: photos, sound recording, geo-location, immediate identification, recording to databases, interfacing with social media and more. Digital apps that employ many of these features can offer significant opportunities to educate young people on how to use technology as an enrichment to the nature and outdoor experience.

RECOMMENDATIONS FOR SCHOOLS, CHILDCARE AND GROUPS

With parents and caregivers being less comfortable with children being outdoors on their own, there is more of a need for digital technology and apps that will connect children to nature in a school, camp, outdoor classroom, childcare center, or other group setting such as a scout outing. Schools and other child-serving institutions are placing greater emphasis on providing outdoor spaces that could serve as areas to employ nature-oriented apps such as school gardens, natural play spaces and overall campus greening to bring more nature to the instructional and play experience for children.
EDUCATIONAL SOFTWARE

Design technology and apps that serve a dual purpose of using outdoor spaces to educate children on such subjects as science and the environment and design those experiences so that children are having nature experiences that align with principles for truly connecting children with nature. Educational technology and apps that connect groups of children with nature should be designed combine the outdoors and nature with sound pedagogy.
I. THE STATUS OF THE INDOOR CHILDHOOD CONDITION IN AMERICAN SOCIETY AND WHY IT MATTERS

A GENERATION MOVED INDOORS

To understand the context for examining how apps and other technology can be employed to help children, adults and families appreciate nature and the outdoors, it is helpful to review the degree to which time in nature is vanishing from the modern American experience.

If you have any difficulty grasping the degree to which American childhood has moved indoors over the past 20 years, take a ride through your community on a Saturday morning in good weather. You will immediately notice that, except for organized sports, the streets, playgrounds, parks and backyards are nearly child-free. Thirty years ago these areas would have been teeming with free-playing children. The children that you may see outdoors are usually under some form of adult supervision such as sports. What you are surely less likely to see are bands of kids just playing -- a sight once so common in the U.S.

Thirty years ago, distinguished author and biologist Edward O. Wilson postulated that people have an innate attraction to nature and other living things. This he describes as biophilia. But he suggests that biophilia is a “weak genetic tendency that needs experience and socialization” to fully develop (Wilson 1986). For millennia, humans have been able to develop in close contact with nature. It was not until the industrial revolution and the dawn of large cities and long working hours that humans began to lose this connection. In past decades, most adults were, nonetheless, able to grow up with reasonable exposure to nature through simple outdoor play. The most common situation once was for children to complete their daytime school work or home chores and head outdoors to play with their friends each day. Many adults remember how absorbing that time was and how residential areas of all types offered parks, woods, play areas and more that were used for outdoor play and exploration.

In the mid-1990s something new and quite different began to occur in modern living. Children began to stay indoors more often. They were suddenly watching increasing amounts of television and playing on computers. They became less excited about going out to play and those roving bands of neighborhood kids once so common to the American neighborhood began to disappear. Importantly, parents were also becoming far less comfortable letting children play outdoors unsupervised. There was a growing perception that children of all ages were in peril from adult predators and that the outdoors had significant dangers including fast-moving traffic, bad
weather, and the possibility of physical injuries from playing in woods, fields, and streams. This was also a time when dangers from insects such as ticks carrying Lyme disease and Rocky Mountain spotted fever were frequently in the news.

Availability of play time also became more of a factor as children began to participate in more organized activities. Sports leagues had burgeoned across the United States prior to this time and other more formal and organized activities for children activities grew in popularity as well. The shift in American culture from daily outdoor unstructured play time to organized activities made the casual neighborhood “meet up” outside after school significantly less likely.

How much have things changed? There are two key ways of looking at this. Outdoor (non-sports) play time is, on average, a mere fraction of what it used to be. The studies on this subject, that exist, indicate that the average child gets about seven hours per week of outdoor play time or less. According to a study by the Nature Conservancy and Toyota (Nature Conservancy, 2011), this is down from many more hours per week in the past. This seven hours could be misleading, however, because surveys also indicate that a small percentage of kids play outdoors a great deal while many almost never go out. A corresponding set of research indicates what children are doing instead. The Henry J. Kaiser Family Foundation commissioned a study that showed that children ages 8-18 are spending 53 hours per week (nearly eight hours per day) using electronic entertainment media and devices (Kaiser, 2010). With school and other activities, this hardly leaves any free time for outdoor play and time to connect with nature.

While parents may not be taking much issue with their children’s use of technology, they seem to be concerned about the loss of this outdoor connection. In a follow-up survey, the Nature Conservancy and Disney found that parents (65%) are as concerned about their children not having outdoor time as they are about bullying, obesity and education. (Nature Conservancy, 2014). Parents seem concerned but are unsure about what to do.

THE HUMAN AND ECONOMIC BENEFITS

Besides forging deeper nature connections and creating stronger conservation mindedness, there are many reasons why outdoor nature time is good for children and beneficial to society. For starters, there is improved health.

Researchers know that today’s indoor children are, overall, less physically fit than were children in the past. Growing up “inside the box,” or within four walls, affects children’s bodies in dramatic and worrisome ways. Children raised mostly indoors, in a sedentary lifestyle, are at risk
for several serious health problems. The first of those is obesity. When it comes to obesity, the numbers are leaning heavily in favor of it being a childhood epidemic. According to the Centers for Disease Control (CDC), the prevalence of obesity among young children ages 6 to 11 has, over the past two decades, more than doubled to 17 percent and about tripled to 21 percent for adolescents ages 12-19. The odds of being obese are even higher in marginalized neighborhoods with few or no parks. African American youth experience an overall 22 percent obesity rate and Hispanic youth average 20 percent (CDC, 2012). Risks associated with being overweight and clinically obese include high blood pressure, diabetes, high cholesterol, asthma, sleep apnea, joint pain, and fatty liver disease—and most alarmingly, shortened life expectancy. Overweight and obese adolescents have a 70 percent chance of becoming obese adults (Gou, 1999, Freedman 2009).

FITNESS
Playing outside is an excellent way for children to live healthier and longer lives, since outdoor play is actually associated with higher physical activity levels than playing indoors. Outdoor play encourages activities such as climbing, jumping, and running and these promote muscle fitness and flexibility (Narvaez, 2014). To combat childhood obesity, the Centers for Disease Control recommends one hour per day of moderate physical activity for kids. Outdoor games that include running, jumping, and climbing, whether in the backyard, a neighborhood playground, or a city park, strengthen children’s cardiovascular systems and major muscle groups, helping them grow trimmer and stronger and to be more fit over their lifetimes.

A 2015 Vanderbilt University study looked at the role of adolescent exercise in lifetime fitness and made some startling findings about its longer-term importance. It found that exercise by young people had lasting affects over many decades and reduced mortality from cancer, cardiovascular disease and many other causes of early death. This is true independent of amounts of adult exercise (Nechuta et. al. 2015). The study basically found that children who established higher fitness levels would have a health base from which they could benefit for decades.

OUTDOOR EXERCISE IS MORE BENEFICIAL THAN INDOOR
Research also shows that children who engage in active play outdoors as compared to indoors, where they are more confined, are significantly more likely to be physically fit. The amount of moderate to truly vigorous physical activity in childcare settings increased from 1 percent indoors to as much as 11 percent outdoors. When outdoor play was child-led, the amount of time
in vigorous outdoor activity further increased to 17 percent. Children just seem more likely to be moving when they are playing outdoors (Schaefer, 2014).

**OUTDOOR TIME IMPROVES EYESIGHT**

Children who play outside also have better overall long-term eyesight. Several studies reveal that children who get outdoor time suffer less nearsightedness, reducing their need for eyeglasses. People with nearsightedness, also called myopia, have trouble seeing things at a distance. Myopia has become increasingly common among young children in recent decades, with indoor time spent reading up-close material, such as on an electronic screen, being identified as a potential cause. According to one study (Jones et al., 2007), a child’s chance of becoming nearsighted if he or she has two nearsighted parents is about six in ten for children who spend zero to five hours outside a week. But the risk drops to two in ten when outdoor time exceeds 14 weekly hours, reducing the myopia risk by two-thirds. A recent three-year study from China confirms this conclusion: finding that adding 40 minutes of outdoor activities daily was associated with lower rates of nearsightedness among school-aged Chinese children. (Minguang et al., 2015)

**ADDRESSES VITAMIN D DEFICIENCY**

Another surprisingly prevalent health problem arising from spending too much time indoors is vitamin D deficiency. Vitamin D is primarily produced in the skin after exposure to sunlight. With children spending less time outdoors, they receive limited doses of daily sunshine, leading to inadequate levels of vitamin D and setting them up for increased risk of bone problems, heart and cardiovascular disease, diabetes, and other health issues. In fact, a study of vitamin D levels in nearly 10,000 children found 9 percent of American children aged 1 to 21 were vitamin D deficient. This indicates that about 7.6 million U.S. children are vitamin D deficient and 61 percent are vitamin D insufficient, representing 50.8 million U.S. children (AAP, 2009).

**FIGHTS CHILDHOOD DEPRESSION**

Antidepressant use is on the rise according to a benchmark four-year study that examined antidepressant use among approximately two million children under the age of 18 (Gelenberg, 2004). Over the course of the study, antidepressant use increased by 49 percent, with the fastest growing segment of users found to be preschool children aged 0-5 years. Characterized by low mood, anxiety and loss of self-esteem, among other symptoms, childhood depression is a serious illness that outdoor time seems to help alleviate. An increasing number of experts are recognizing the valuable role of playing, including outside, in enhancing kids’ mental health. An
American Academy of Pediatrics 2007 report (AAP, 2007) on the importance of play points out that play protects children’s emotional development whereas loss of free time in combination with a hurried lifestyle can be a source of stress, anxiety and may even contribute to depression.

**ATTENTION SPANS ARE LONGER**

Researchers at the University of Illinois have found strong indications that exposure to natural, vegetated, settings in the course of educational activities may be “widely effective” in reducing attention deficit symptoms and improving concentration in children. In this study, (Kuo et al, 2004) the researchers surveyed the parents of 322 boys and 84 girls who had been diagnosed with attention deficit-hyperactivity disorder (ADHD). These parents reported on how their children performed after participating in a wide range of activities. Some of the activities were conducted indoors while others were conducted in outdoor spaces without much greenery, such as parking lots and downtown areas. Some activities took place in relatively natural outdoor settings such as a tree-lined street, backyard, or park. In a more controlled follow-up to this initial study, authors Andrea Faber Taylor and Frances Kuo investigated the impacts of three different outdoor environments on the attention of seventeen 7- to 12-year-old children diagnosed with ADHD. After a pretest that involved completing a series of puzzles that required focused attention, each child participated in a 20-minute guided walk in three different outdoor settings (an urban park, a downtown area, and a residential area). After each walk, the children completed a test of their concentration and responded to questions about their walking experience. The researchers found that children concentrated better after walking in a park setting as compared to either a downtown or residential setting (Taylor, 2008). This body of research makes a compelling case for how natural outdoor spaces -- groves of trees, natural play areas, school gardens, schoolyard wildlife habitats, local parks and wetlands -- add to a student’s desire to learn and ability to concentrate.

**COGNITIVE FUNCTION IMPROVES**

Outdoor time may improve a child’s ability to concentrate but it may also improve their actual brain function. A recent 12-month study of nearly 2,600 children in urban Barcelona suggests that regular exposure to natural vegetation and the outdoors actually improves a child’s fundamental cognitive development. It measurably improves memory and, importantly, “superior working memory” which is the ability to process and retain new information. It was also documented that attention spans are increased. All of these attributes are associated with higher IQ. This new research can be found in the *Journal: Proceedings of the National Academy of Science of the United States* (Davand et al. 2015)
EMOTIONAL HEALTH IS BETTER

A 2014 European study found a relationship between digital media use and emotional difficulties at an early age. It analyzed information from more than 3,600 children ages 2 to 6 years old, who the study followed for at least two years (Hinkely et al., 2015). Parents answered questions about their child’s well-being, including queries about the child’s self-esteem, social networks, emotional problems (being worried or unhappy) and peer problems (being picked on/bullied or being rather solitary). For girls in the study, each additional hour spent playing electronic games or using a computer on weekdays at age 4 was linked with a two-fold increase in the risk of emotional problems at age 6.

SLEEP IS HIGHER QUALITY

Outdoor time puts children in daylight and regular doses of bright, broad spectrum, natural light helps children stay more alert during the day. These daylight doses also elevate their moods and make it easier for them to sleep restfully at night. Exposure to outdoor light in the morning actually helps set their body clock for a better and earlier night’s sleep.

Parents need to remember that children are not particularly good judges of their own need for sleep. One study (Dement and Vaughan, 1999) found that children insisted they were not sleepy even when they had only had four hours of sleep at night. Research shows that kids with sleep deficits:

- Are harder to awaken in the morning
- Have greater difficulty concentrating on tasks
- Take inadvertent naps
- Have slow reaction times
- Experience unusual episodes of hyperactivity
- Often engage in defiant behavior

Sleep deprivation may also make children more moody overall. A study of healthy elementary school students found more intense emotionality was associated with sleep problems (El Sheikh et al, 2005). Researchers monitored children’s sleep with wrist actigraphs (which can detect the physiological signs of sleep) and parental reports. They found that the most emotional children in the test group got the least sleep and had the highest number of night awakenings.

As noted, there is a significant difference between indoor and outdoor lighting. Outdoor lighting is much brighter and covers a broader spectrum of light. Exposure to such light has been
documented to improve sleep quality because it helps to regulate the human body’s internal “sleep clock” or circadian cycle. Regular doses of bright natural light also help children stay more alert during the day. It elevates their moods and make it easier for them to sleep at night (Figueiro, 2010). The soothing dimensions of more time in nature seems to have a way of comforting children. It can take away stress and be a haven for kids who are otherwise feeling the pressures of school, family, and social demands.

VIDEO GAMES CAN LEAD TO STRESS RESPONSES
There have been many assertions over the years that video games can potentially lead children to become more violent and agitated but these assertions have not been materially supported by the research. That said, computer game playing has been assessed as a valid psychological stressor that induces notable physiological effects of stress, including changes in autonomic tone (heart rate and blood pressure), EMG (muscular activity), Galvanic Skin Response (skin conductivity) and cortisol levels (Sharma et al, 2006). Although one might assume that sitting in front of a television or using a game box means less exercise, screen-time has also been associated with metabolic syndrome (high blood pressure, blood sugar dysregulation, high lipids, obesity) in adolescents independent of physical inactivity (Kang et al, 2010).

INDOOR CHILDHOOD AND SEDENTARY LIVING ARE HUGE COSTS TO SOCIETY
The societal cost of sedentary lifestyles in children has not been fully calculated but it is easily in the billions. One interesting summation of the economic seriousness of health problems brought on by sedentary lifestyles comes from an unlikely source -- the multimedia financial-services company, Motley Fool (Motley Fool, 2013). While they are not a top-of-mind public health organization, they are highly skilled at monetizing societal concerns and risks in an active market including such public issues as the obesity epidemic. Here is what they summarized from available research:

- **$190 billion**—is the amount of added medical costs every year that are estimated by the public health community to stem from obesity-related problems. It is nearly 21 percent of total U.S. health care costs.
- **$66 billion**—Columbia University researchers say that if current trends don’t change, annual obesity-related medical costs in the U.S. could increase by this amount by 2030.
- **105 percent**—according to a study conducted by the Brookings Institution, this is the added amount that obese Americans pay for prescription drugs compared to individuals who are not obese.
- **$164 billion**—the Society of Actuaries estimates that U.S. employers are losing this amount in employee productivity each year due to obesity-related issues.

- **$580 billion**—The Robert Wood Johnson Foundation predicts that annual economic productivity loss due to obesity could hit this staggering amount by 2030 unless the current health situation changes and the average person becomes more active.

These numbers do not include the costs of adversely affected mental health, stress, loss of sleep, nearsightedness, educational impacts and other problems brought on the indoor childhood trend.

### WHAT TECHNOLOGY NEEDS TO DO TO ADDRESS THESE ISSUES

Clearly, the stakes associated with the modern indoor child phenomenon are very high. Public health professionals are now saying that today’s children may actually be headed toward life spans that are three-to-five years shorter than their parents’ due to their inactive, indoor lifestyles (Olshansky, 2005).

Recommendations to address this include more regular, active, unstructured play time outdoors, more exposure to green and vegetated settings wherever possible and, for schools, more outdoor education and activities. Most health and child development specialists, including those at the Centers for Disease Control and the American Academy of Pediatrics, are clear that parents and children who can integrate active play, including outdoor time, into their daily routine can counteract many of the adverse effects of the indoor childhood phenomenon. As noted above, the Academy of American Pediatrics report, *The Importance of Play in Promoting Healthy Child Development and Maintaining Strong Parent-Child Bonds*, points out that play protects children’s emotional development and notes that the hurried lifestyle some children have can be a source of considerable stress, anxiety and even depression for children (AAP, 2007). One part of the solution is to give children more overall time outdoors playing and learning in nature.

Assuming we can meet many children where they are – indoors and engaged with electronic media - perhaps we can deploy digital apps and other technology to encourage active outdoor time for children and families.
Summary: What More Outdoor Green Time Can Offer Children

1. **Stronger bones**: Today’s “indoor kids” don’t get enough sun and are becoming vitamin D deficient. Moreover, children who get more exercise benefit from greater bone density.

2. **Trimmer and healthier kids**: An hour of play a day is what the Centers for Disease Control says is a basic and necessary tool in the effort to ward off childhood obesity and diabetes.

3. **Improved eyesight**: Studies find that kids who get outdoor time have less nearsightedness and need for eye glasses. [http://www.nature.com/news/the-myopia-boom-1.17120](http://www.nature.com/news/the-myopia-boom-1.17120)

4. **Less depression and hyperactivity**: Outdoor time in a natural setting (sometimes even tree-lined streets) soothes kids and lowers their need for medications.

5. **Longer attention spans**: Children who stare at TV and video games all day have less patience and shorter attention spans. Children who spend time in natural settings such as parks have improved attention spans.

6. **Better at making friends**: Children playing together outdoors relate directly with one another, create games together, choose sides and improve their “people” skills.

7. **More creative**: Outdoor kids are more likely to use their own imaginations, inventions and creativity while playing.

8. **Less “acting out” at home and school**: Getting kids away from TV violence and video games helps them see that violent behavior does not always solve problems.

9. **Measurably better grades in school**: The healthy bodies and minds that come with outdoor play are better able to do well in school. Recent studies also indicate that outdoor time improves a child’s cognition and actually raises his or her IQ.

10. **A longer lifespan and a healthier adult life**: Doctors estimate that sedentary and obese children lose three to five years from their life expectancy.
II. WHAT ARE MOST SIGNIFICANT BARRIERS TO GETTING CHILDREN MORE TIME OUTDOORS IN NATURE?

A discussion of the indoor child phenomenon with anyone over the age of 40 will lead to reminiscing about the good old days when, as a child, he or she played outdoors on summer nights until the street lights came on and it was nearly bed time. The memories these people have include sunrise-to-sunset days of playing with friends, freely roaming the neighborhood, parks and woods and only reporting back home for meals and sleep. In addition to seeing how today’s children live in different circumstances, these adults are quick to blame technology for what is keeping kids indoors these days. But, though technology plays a role in the indoor child phenomenon, most assessments indicate digital technology use could be more of a symptom of the problem than a prime cause. We have surely seen revolutionary changes in the degree to which children use technology, but we are also witnessing broader societal changes that are, most likely, contributing more to the indoor child trend than any technology could.

One interesting way to look this subject is to examine parental tolerance for children to be on their own outdoors. There are many similarities between trends in the United Kingdom and trends in the United States when it comes to spending indoor versus outdoor time. A well-known 2007 look (Bird, 2007) at a family in Sheffield, England over many years found that the great-grandfather, George Thomas, who was born in 1911 walked, at age eight, miles from his home in every direction to go fishing and engage in other outdoor adventures around greater Sheffield. He often walked as many as six miles from home. His son, born in 1942, at age eight routinely walked to the local woods about a mile from the family home while his granddaughter at age eight would venture one-half of a mile from home to go to a local pool. Her son, great-grandson to George, is, at age eight not allowed to walk any further than his immediate block - about 300 yards at a maximum. The specific numbers may vary but many people older than 50 will tell you how they felt perfectly comfortable taking long unattended excursions through town on foot or on bicycle to explore interesting places, see friends or engage in outdoor activities.

So what is happening here? For starters, there has been a sea change in the concept of what constitutes good parenting. This has significant implications for modern children getting more outdoor time. We explore these reasons in some detail in the following sections. Our premise is that, even if we had more effective handheld apps and technology that helped children enjoy nature and the outdoors, their use would be limited by other profoundly held societal beliefs and concerns unless we can address them.
PARENTAL CONCERN AROUND HAZARDS

Today’s parents are almost universally less comfortable having their children go outdoors unescorted. It is pretty clear that modern parents worry more than previous generations that their children will be exposed to a range of hazards. Outdoor play and activities can, for example, lead to cuts, bruises, splinters and exposure to insect bites, stings and other mishaps. The great outdoors is also full of germs and this can come to the fore in an ever more germ-phobic society. Parents likewise worry more than ever about fast-moving road traffic. This is partly reflected in how few children today walk to school and how uncomfortable adults are with their kids crossing streets. The outdoors has other hazards, too, such as coming in contact with ponds and streams and related drowning worries, kids falling from trees, and kids running into unseemly strangers. These would have been considered fairly minor concerns in the past but today’s parents worry a considerable amount about such things. If there is an overall American attitude on this subject, it perceives children as being seriously at risk if they are out and about unsupervised.

PRESSURES FROM PEERS, NEIGHBORS, EVEN POLICE

The concern about risk has also become more generalized in society. There is more peer and neighborhood pressure than in past years. In 2012, a mother in La Porte Texas, near Houston, was removed from her home in handcuffs by the police when she permitted her children, ages six and nine, to play with their scooters unaccompanied by an adult in front of her home. She was reported by her neighbors and was charged with felony child abandonment and endangerment. She was jailed that day but later released and the charges were dropped when a more even-handed judge reviewed the case. She was the victim of this emerging American danger mindset and resultant hyper-watchful neighbors (Off the Grid, 2012).

In a more recent situation, Maryland parents dropped off their ten and six year olds at a park on a Sunday afternoon at 4:00 pm and told the children that, when they were done playing after two hours, to walk six blocks home to have dinner. The children did not appear by 6:00 pm because the police had picked them up and taken them to a child center after holding them in the patrol car for a while. Importantly, they never called the parents. These parents, residents of Silver Spring, have become famously identified as the “free range” parents because of their belief that outdoor time for children is a good thing and that children being on their own in certain settings, such as a park, teaches them independence and self-sufficiency (Maryland Free Range, 2013). In a similar case, a couple in suburban Virginia were questioned by police four
separate times and had two visits from the state social service office when they allowed their four children (ages five to 13) to play alone outdoors near their own home without adult supervision.

One might say these are extreme examples of nosy neighbors and overzealous law enforcement, but they mostly reflect a dramatically changed world view of parental responsibility regarding children being outdoors. These incidents would never have happened 30 years ago. The bottom line seems to be that a parent risks some form of child neglect accusation if his or her children venture off their home property for any reason that raises the eyebrows of another adult with ready access to a phone and 911. It is not so much that parents will actually be called to account by authorities for letting their children range free in nature, it is the idea that social mores have shifted so far from the days when children could leave the home on a summer day and be out of sight for many hours without any concerns being felt or raised. Handheld apps and other digital technology designed to help children connect with nature and the outdoors will need to either somehow involve families in the outdoor experience or create some sense of safety.

**ACTIVELY ADDRESSING THE PERCEIVED THREATS**

That modern American parents are too worried, too busy, and under too much societal pressure to feel okay about letting their kids play outdoors in nature is a barrier that will not be going away soon. There are, nonetheless, scores of common sense ways to mitigate these perceived threats. Basic to this is instructing children to avoid hazards such as traffic, water bodies, and strangers. But there are many smaller things that can be done too. These include:

- Basic bicycle safety such as wearing a helmet and wearing easy-to-see clothing,
- Knowing what to do if a bee stings or an insect bite occurs,
- Checking carefully for and removing any ticks that may hop on for a ride,
- Being able to identify and avoid contact with poison ivy and oak and other local plants that cause irritations,
- Practicing basic water safety knowing how to swim, staying with a buddy, and staying away from deep or fast running water,
- Being extremely careful when approaching roads and vehicle traffic,
- Finding a safe place if there are signs of lightening,
- Avoiding any dangers that may arise from local pets such as dogs, including not teasing animals,
• Staying “sun safe” with proper clothing and sunscreen,
• Staying weather safe by dressing appropriately for hot, cold or wet weather,
• Knowing (and sticking to) the basic rules of staying safe around strangers including avoiding contact, picking out safe places, and learning to call for help, and
• Making one’s whereabouts known at all times. This is surely one place where technology can help because there are so many excellent GPS trackers today. Many of these are specifically designed for use by children.

Interestingly, some feel that child supervision and hovering care-givers has become so pronounced in society that a new school of thought is emerging. It is that parents and caregivers should go on the offensive and encourage their children to do risky and somewhat dangerous things simply to help them become more prepared for the real world. In their book, Fifty Dangerous Things You Should Let Your Children Do, authors and educators, Gever Tulley and Julie Speigler feel that children who are always kept as safe as possible will not turn out to be very adventurous or very confident or resilient. Included in the fifty things are many outdoor activities such as learning to build a fire, climbing a tree, camping out, and even searching for a bee hive. The book sees these activities as preparing children for the future by giving them activities that require them to take risks while employing some common sense (Tulley, 2011).

THE NEW DOMINATION OF ORGANIZED ACTIVITIES

Quite apart from avoiding real or perceived dangers, American parenthood has also shifted toward a much greater emphasis on organizing a child’s time. Thirty years ago the norm was free play with bands of children running around the neighborhood and in local parks and wood fringes. Today, there is more emphasis on team sports, summer camps, after-school activities and other planned programming. The American Academy of Pediatrics assessed this modern situation and concluded that children are being put under too much stress and need some simple down time. The Academy now recommends that parents and caregivers provide their children with an hour per day of free time - time to be relaxed, creative and unscheduled. At the National Wildlife Federation, we recommend that these be seen as Green Hours during which children can have creative and relaxed playtime outdoors in nature.

A GROWING SENSE THERE IS JUST NO EXTRA TIME

A quite common complaint by parents today is they are too busy with organized activities to give their children free time outdoors. This is especially true because they believe they must accompany the child at all times. The experts know today’s parents are busy and that many feel
a need to keep a close eye on the kids. Even though there is a need for free, active outdoor play time they know how hard that can be. In an ideal world we would want kids to have lots of free outdoor play. The National Wildlife Federation surely likes the idea of a daily Green Hour. But, the world is more hectic now and a full hour may not be available especially if a parent feels their children must be supervised while outdoors. The following suggestions can help adults and their kids have some easy and pleasant outdoor time with less parental guilt and schedule anxiety.

1. **Playground “flash” visits:** A few minutes is all that is needed to build a quick park or playground stop into a busy day. Parents tell us how a five or ten minute stop at a park or playground lets the kids have some healthy fun.

2. **A quick after-school romp:** Most parents immediately load the kids in the car when they pick them up after school or daycare. Others have found that taking just a few minutes during pick-up times to let the kids run around outside the school is a relief for the kids and makes the trip home more upbeat and pleasant.

3. **A “team” dog walk:** Another 5 to 10 minute opportunity for many families is to go out together on the morning or evening dog walk. The busy parent and the kids can chat, get a little time outdoors and calm their nerves.

4. **Park and picnic:** Today’s parents will often pick up take-out food on the way home or serve a pre-prepared meal for the kids to save time. Weather permitting, you can take the family to a local park for a picnic or just take your meals outdoors at the house. It is always good to get the family together to talk and enjoy a little time outdoors.

5. **Nighttime stories in the yard or on the deck:** Also when the weather permits, why not have some of that special reading time outdoors?

6. **Pause to pick out cloud shapes:** Smaller children are fascinated by cloud shape games and other car games such as “I Spy.” Use of these games in the car or walking to and from the car, school or home is a simple way to get the kids to look up from their hand-held devices and see the real world.

7. **Block away school drops:** Instead of sitting in a car line outside of schools and daycare centers waiting to make a curbside drop, some parents recommend parking a block away and either letting the kids walk to the door or a parent accompanying them. It usually means no real lost time. It can save gas and, importantly, provide a little outdoor exercise.

8. **Babysitter instructions:** A responsible babysitter is invaluable and, whether one is retained on a regular basis to watch the kids or just for special occasions, it is easy to get them to walk the kids around the block or take them to a local park or playground. Without such instruction, the sitter may be happy parking the kids in front of the TV or letting them play on a computer.
9. **Green-time co-ops:** If you know a few impossibly-busy parents who might like to team up with you on getting their kids more outdoor play time, you can form a green time co-op. Each of you can take an hour per week to watch the kids as they play outdoors.

10. **Weekend outings:** Weekend days can be busy but they are not usually as crammed as weekdays. Planning an outdoor adventure for the kids could be good for you and them. The whole family can decompress a bit from the extraordinarily busy week.

When there are simply too few hours in a day, these smaller amounts of outdoor and nature activities and tactics can be very beneficial to children.

**DOES THE USE OF DIGITAL APPS AND TECHNOLOGY KEEP KIDS INDOORS?**

In 2016, there was considerable public enthusiasm around the Pokémon Go app that used geo-locating technology to offer users the option to digitally collect creatures by visiting indoor and outdoor locations. The app was praised because it encouraged people to get outdoors when compared to most apps. So how much is electronic media to actually blame for indoor childhood?

Researchers Vandewater, Rideout et.al published the results of a study in the *Journal of the American Academy of Pediatrics* in 2007 and made an interesting finding. Among other things, the study compared the amount of time very young kids (six months to six years) spent outdoors based on whether the parents were observing the media use guidelines put forth by the American Academy of Pediatrics or not. The thought was that children of parents who observed the guidelines, meaning less time watching television and looking at electronic screens, would spend more time reading or playing outdoors but this was found not to be the case. The children without media guidelines were spending the same amount of time as those who were making use of the guidelines. There was no difference in outdoor time spent (Vandewater, et al., 2007).

This seems to lend support to the idea that digital technology alone is not the reason children are staying indoors. From a parent’s perspective, they may want to make sure their children are indoors, nearby and safe, and are quite happy with how technology can keep the kids occupied. The research on parental attitudes on this subject are discussed more in depth, below, but show that most parents, even if they would like their children to get more exercise and outdoor time, are basically satisfied with their children’s use of technology. Moreover, digital technology that exposes children to many interesting and attractive entertainment outlets is a definite draw for the children.
III. WHAT CHILDHOOD EXPERIENCES CREATE A LIFELONG CONNECTION TO NATURE AND THE OUTDOORS?

THE PATHWAY TO A FUTURE FOR AMERICAN CONSERVATION

There is a commonly-used saying that you cannot love what you do not know. Louisa Chawla is a leading researcher and educator on the subject of children, nature, and the outdoors. She has, over many years, both developed and compiled a compelling body of evidence that indicates how spending time around trees, lush vegetation and natural areas is an essential element of how children become truly connected with nature (Chawla, 2015). And, she recommends that greening of spaces be broadly conceived of and include: landscaping around homes, schools and childcare centers, along with linked systems of urban trails, greenways, parks, and “rough ground” for children’s creative play. The importance of this and other related research to the development and deployment of handheld apps and technology to connect children with nature cannot be overstated.

Through her research findings, Chawla tells us about key ingredients for successfully connecting children and their families with nature. She finds, for example, there is an important role for socializers (e.g., influential family members, teachers, or other adult mentors) to play in helping children to develop an affinity with nature. This is consistent with other research that indicates that while physical spaces are important, a child’s positive interactions and experience while in those spaces is likewise a vital part of making a real nature connection. Her overall conclusion is that children come to value environmental actions and stewardship of nature through a variety of mechanisms such as fun, encouragement and affirmation, adult attention, learning and mastering new skills, getting answers to puzzling questions, having adventures and more. She also notes that helping children develop a sense of empathy and sympathy (such as for wildlife) are a foundation for the development of a caring for the natural world and adults can help children to see the world through this lens. Children who have some of the strongest emotional ties to nature are more inclined to want to protect the natural environment and species.

The effect of the right type of nature experience can be lifelong. In many cases this involves repetitive, long-term nature activities but it can also be related to experiences that more intensively immerse a young person in nature. In an important long-range study of 2,000 adults, researchers Wells and Lekies found that childhood participation in nature activities (e.g., hiking, camping, or playing in the woods), had a significant, positive effect on both adult environmental
attitudes and behaviors. People who participated in “wild” nature activities as children were more likely to have pro-environmental attitudes and behaviors as adults. They concluded that wild experiences as children are more likely to produce adults who have a lifelong commitment to nature conservation. Positive results were also seen from less wild activities such as planting flowers, but young people being more immersed in nature had the greatest results. (Wells, et al., 2006)

Is there some magic to direct experiences with nature? Why can’t children simply learn to love nature by seeing it on television or studying it? Duerden and colleagues investigated the relationship between indirect and direct nature experiences and children’s environmental knowledge and attitudes (Duerden at al, 2010). They examined a group of 108 middle and high school students who went off on an international field study program and used 49 students who did not participate in the program as a comparison group. They looked at knowledge and attitudes separately. They found that while the students were preparing for the field work there was good knowledge development but that it did not have much effect on improved attitudes toward conservation. During the direct nature experience (the international field workshop), both children’s environmental knowledge and attitudes developed about equally. The study concluded that direct experiences with nature (compared to indirect) had a greater impact on pro-conservation attitude development. The type of experience mattered as well. They, for example, discovered that the children perceived experiences to be more direct if they were afforded freedom and autonomy during the experience and were allowed to explore on their own.

In a European study, Muller et al. found that children who had an emotional affinity for nature were much more likely to want to protect it. This study looked at 400 high school students. They found that an emotional affinity grew significantly from positive and direct interactions with nature. The study indicated that there are four sought-after emotional senses that will create the strongest long-term bond with nature. They include experiences that create an appreciation and love of nature, feelings of freedom in nature, feelings of security in nature, and feelings of oneness with nature (Muller et al, 2009).

Larson, likewise found that affinity for nature increased with exposure to nature. Some 113 children (ages 6 to 13) participated in a five-day Eco Explorer camp (Larson at al, 2007). The Georgia-based camp had significant nature education programming and offered opportunities for students to have time in natural surroundings. The researchers found that students who participated in the camp had higher levels of eco-affinity than students who participated in a
regular after-school program. They found that younger children tended to have higher levels of eco-affinity development than older students and that there were no differences in gender. In talking with children about their camp experiences, the researchers found, not surprisingly, that the children preferred activities that involved physical activity. Having fun was also critical. Researchers further found some ethnicity differences, such as that white children were more than twice as likely to report having engaged in solitary nature-based activities than African American children.

Having a sense of connection to nature can make a significant difference in willingness to engage in environmentally friendly behaviors and practices. Judith Cheng and Martha Monroe used an extensive research literature review to develop a children’s connection to nature index. They then tested the index by having 1,500 fourth-grade students in Brevard County, Florida complete a survey after participating in an environmental education program (Cheng et al, 2012). In analyzing the data, they found there were four principal dimensions to children’s connection to nature: 1) enjoyment of nature; 2) empathy for creatures; 3) sense of oneness; and 4) sense of responsibility. They concluded that children’s interest in environmentally friendly practices was predicted by their sense of connection to nature, along with other factors such as their previous experiences in nature, family influences, and values concerning nature, and, importantly, the perception that their actions can make a difference.

In the United Kingdom, the Royal Society for the Protection of Birds made use of Cheng and Monroe’s index to rate the state of nature connectedness among children there. The study had 1,200 children respond to a 16 point questionnaire from which they could derive a score. They found that just 21% of kids in the U.K. evidenced a reasonable affinity for the natural world. The average score on the study’s index was 1.05 and the Society estimated that an adequate score would be 1.5. Girls (1.15) averaged significantly higher than boys (0.96) in their nature affinity rating. Perhaps the most significant finding of this study was less about the actual scores and more about the overall sense that U.K. children, like most industrialized nations, are losing a true connection to nature and are become less conservation-minded (RSPB, 2013). The Society has launched a major campaign to connect every child in the U.K. to nature and the outdoors.

In its most basic form, this translates to children having nature experiences that have a long-term effect if they are:

- **In nature** - Green areas including: backyards, gardens, parks, wooded trails with the idea that immersion in nature at some point is particularly powerful.
- **About nature** - The children are focused on the nature and not simply engaged in some unelated activity while sitting outside.
- **Recurring** - More than a one-off experiences several times a week is most beneficial.
- **Conducted over a significant period of time** - A year/school year/season
- **Richly affirming** - The child is learning skills, having fun and adventure, interacting positively with others, exploring and developing a sense of belonging and competence.
- **Supported by a caring adult** - Children can play on their own or in groups but they are particularly affected by the attention, guidance, enthusiasm and praise of significant adults in their lives.

The organization Children and Nature Network has compiled much of the available research on the subject of kids being connected with nature into a searchable online data base (Children and Nature Network, 2015). Their research center was built as a service to the broad community of practitioners in education, childcare, park and recreation administration, nature interpretation and more, and they encourage its free use and welcome any suggestions.
IV. WHAT ARE WE LIKELY TO SEE IN THE FUTURE REGARDING CHILDREN’S USE OF APPS AND RELATED TECHNOLOGY IN THEIR DAILY LIVES?

In the world of nature lovers, technology, in its many forms, (handheld apps, digital games, television, and social media) is considered to be a serious detriment to children becoming connected to nature. Great weight seems to be given to the idea that children should simply unplug and go outdoors and even that technology itself may have actually caused the nation’s indoor childhood problem because of its addictive nature, attractiveness and entertainment value.

We have noted, throughout this report, that the idea of kids going outdoors on their own is less of a common occurrence today than in the past. But, in Chapter III we saw there are many broader societal reasons for the indoor child phenomenon besides technology, including an overall redefinition of what it actually means to be a vigilant parent and changing perceptions of outdoor risks. In this chapter we address a simple question: How much will technology be a part of our lives and that of our children in the future?

In a 2013 Northwestern University study, Parenting in the Age of Digital Technology, a survey of more than 2,300 parents of children ages 0 to 8 years old, we see that there has been a significant shift in parental attitudes toward technology use and children (Northwestern University, 2013). There are many parents who place limits on children’s use of technology but this study tries to quantify actual parent’s attitudes in addition to documenting actual use. It finds that, in fact, most parents today are largely unconcerned about their children’s media use. And, a large majority of parents say that children’s use of media in not a source of family conflict. If parents have a commonly-reported concern it is about the impact of technology time on reducing children’s time for physical activity. Importantly, the study found that there are at least three basic types of family media environments and this presents us with a useful picture of what is happening across the nation. These three categories are quoted here. Families are:

- **“Media-centric,”** 39 percent of U.S. families. Parents in media-centric households consume an average of 11 hours of screen media a day. Eight in ten (81 percent) say they are “very” or “somewhat” likely to use TV to keep their child occupied when they need to get something done around the home. Half of these families (48 percent) leave the TV on in the home all or most of the time and nearly half (44 percent) have a TV in their child’s bedroom (compared to 26 percent of “media-light”
families). Children in media-centric families spend an average of more than 4.5 hours a day using screen media.

- “Media-moderate,” 45 percent of families. Parents in this group spend an average of just under five hours a day using screen media. While these families like TV, they are more likely to enjoy doing things together outside (56 percent compared to 46 percent among media-centric families). Children in media-moderate families spend just under three hours a day (2:51) with screen media.

- “Media-light,” 16 percent of families. These parents average less than two hours a day (1:48) with media. These families are less likely to enjoy watching TV or movies together “a lot” as a family activity (32 percent, compared to 53 percent of media-centric parents) and less likely to use TV when they are getting their child ready for bed (24 percent, compared to 42 percent among media-centric parents). Children in media-light families spend about an hour and a half (1:35) with screen media each day.”

The study also seems to indicate that we now have the first generation of parents who themselves grew up with electronic media as a larger part of their lives. Does all of this mean that children’s extensive use of electronic media is a trend that is here to stay? It seems that, based on a review of research literature and surveys, the answer would be yes. First, there are some lessons we can learn from the United Kingdom which has many parallels with what is happening here in the United States. According to the U.K. organization, Childwise, in its 2015 Connected Kids report, children in 1995 spent an average of 3 hours a day in front of an electronic screen (mostly television) (Childwise, 2015). Twenty years later that number has more than doubled to 6 and one-half hours a day. “Teen boys lead the way with an average of 8 hours a day in front of a screen, while 8-year-old girls spend 3-1/2 hours in front of a screen, the least of any group included in the study.”

This has been corroborated as being roughly the same situation in the United States via two reports by the Kaiser Family Foundation (2005 and 2010) that found that children 8 to 18 years old spent a total of 6.3 and 7.5 hours per day, respectively, using electronic entertainment media (Kaiser Family Foundation, 2010).

The Childwise study is indicative of what is happening in both nations in one major regard: “The main difference from the 1990s is that then television and magazines were the main ways for connecting kids to the media and now they have different devices from tablets, mobiles and
games consoles.” This, according to Childwise research executive, Matthew Nevard, who was quoted in a BBC article about the Childwise study.

The changes are not limited to teens and preteens either. Younger children have also been affected. Common Sense Media, in its 2013 report Zero to Eight found that three-fourths of all kids younger than eight have access to mobile devices. The report notes “there has been a five-fold increase in ownership of tablet devices such as iPads, from 8 percent of all families in 2011 to 40 percent in 2013. The percent of children with access to some type of “smart” mobile device at home (e.g., smartphone, tablet) has jumped from half (52 percent) to three-quarters (75 percent) of all children in the two years period” (Common Sense, 2013).

Key report findings are that between 2011 and 2013:

- Children’s access to mobile media devices was dramatically higher.
- Almost twice as many children used mobile media and the average amount of time children spend using mobile devices tripled.
- Time spent with “traditional” screen media such as television, DVDs, video games, and computers is down by 31 minutes per day.
- Television still dominated children’s media time, but new ways of watching made up a large portion of viewing.
- Access to mobile media devices and applications among poor and minority children was much higher than it was two years prior but a gap between rich and poor still persists.
- Television continued to be the most widely-used platform for children’s educational content.

**USED BY THE VERY YOUNG**

In the study, Zero to Eight - Young Children and Their Internet Use, (London School of Economics, 2013) we can see that children across Europe are going online at a younger and younger age. This is true in the U.S. as well.

The study’s core findings are:
• “Over the last five to six years (tracking back from 2013) there has been a substantial increase in internet usage by children under nine years old. This increase is not uniform across countries but seems to follow usage patterns among older age cohorts - in countries where more children overall use the internet, they also go online younger.

• The substantial increase in usage by very young children has not yet been matched by research exploring the benefits and risks of their online engagement, so there are many gaps in our knowledge.

• Children under nine years old enjoy a variety of online activities, including watching videos, playing games, searching for information, doing their homework and socializing within children’s virtual worlds. The range of activities increases with age.

• It has not been established that children under nine years old have the capacity to engage with the internet in a safe and beneficial manner in all circumstances, especially when it comes to this age group socializing online, either within age-appropriate virtual worlds or as under-aged participants in sites intended for teenagers and adults (Facebook, YouTube, etc.).

• Video sharing sites are popular with children in this age group and are one of the first sites very young children visit. As such, the ease with which children can access inappropriate video content is of concern.

• There is an emerging trend for very young children (toddlers and preschoolers) to use internet connected devices, especially touchscreen tablets and smartphones. This is likely to result in an increasing number of very young children having access to the internet, along with a probable increase in exposure to risks associated with such internet use.

• The variety of internet connected devices and apps available today risks compromising the privacy and safety of young children. Different operating environments complicate the use of security and safety settings on individual devices, and the numerous applications (apps) available for children tend not to disclose the company’s data collection and sharing practices. Nor do they usually provide easy-to-use opt-out options for parents or children.

• Children’s digital footprints are now taking shape from very young ages. Some parents are writing blogs, and parents and grandparents regularly post photographs and videos of babies and children. These digital footprints are created for children who are too young to understand or consent.” Another concern relates to parents who post pictures and videos of their children online.
THE PARTICULARLY RAPID RISE OF HANDHELD TECHNOLOGY

As might be expected, children’s use of smartphones and media tablets is outpacing their use of all other consumer electronic devices in U.S. households. This is established in the Kids and Consumer Electronics Report of 2014 by the NPD Group. This report notes that 71 percent of households with a child ages 4-14 reported owning a smartphone in 2014 (NPD Group, 2014). This is up from 55 percent in 2012. Likewise ownership of handheld media tablets doubled between 2012 and 2014. It grew from 21 percent to 43 percent in the same two years. Among those households with children in them, 35 percent said that their child uses a smartphone. This is up from 21 percent in 2012. For media tablets, the figure was 31 percent, which is up from thirteen percent in 2012.

In a study of 370 parents from mostly urban, low income minority communities, Dr. Hilda Kabali found that by age one, more than one-third said their babies had touched or scrolled on a mobile device. And, she found that by age 2 more than half had scrolled screens, watched a television show on the device, played video games or used an app. By 2 years, more than one-quarter of the children were using mobile devices for at least an hour a day. Why? Parents used the devices to calm them or to entertain them during busy periods. Some 60 percent of the parents said their children played with a smartphone or iPad-like tablet while the parent ran errands, and 73 percent gave their kids the phone while they did chores in the home. (Kabali et al., 2015)

THE APPEARANCE OF MILLIONS OF DIGITAL NATIVES AND ADDICTS

In May of 2013, venture capitalist and highly respected internet and technologies analyst, Mary Meeker, a partner at KPCB, cited an astonishing finding while presenting her acclaimed annual “Internet Trends” report (Meeker, 2014). She said: “The average mobile consumer checks their device 150 times a day.” This has led the firm of Flurry Analytics to begin to classify smartphone use and to define a “Mobile Addict” as a consumer who launches apps more than 60 times per day. By contrast, the average person launches about 10 apps per day. According to Flurry research: “The Mobile Addict segment is the fastest growing. This group has increased by 123 percent between 2013 and 2014.” Importantly, Flurry has found that people who are the most addicted are teens, college students and middle-aged parents.
For young people, who are growing up and developing with this technology, researchers are now observing changes to their brains. There is a need for more research on this subject, but experts, including those at Pew Research Center tend to agree that today’s youth are able to distinguish between competing facts more accurately and make decisions more quickly. They also show more flexibility and have heightened cognitive and analytical skills. Conversely, other experts including industry leaders, scientists and scholars, believe the intrusion of technology on our lives may hinder contemplative thought, conversation, patience and a sense of play enjoyed by previous generations. Shorter attention spans and a need for instant gratification can make it harder to concentrate on and solve complex problems, particularly if there are few social incentives for deeper engagement. An “always-on” environment can harm genuine human interaction among friends and family.

Marc Prensky, a writer on educational reform, placed a label on our younger, tech-savvy, people in 2001. This came after the emergence of the highly visual internet Apple and Windows platforms and during a time when many young people were learning to interact via the Web. He called them “digital natives.” He contrasted this with their parents and other adults who he describes as “digital immigrants” (Prensky, 2001). These immigrants are people who grew up in a non-technical world but have had to assimilate. In this report we see a response to the digital naïve phenomenon that calls for technology to become a more effective tool for getting kids outdoors because we support kids playing in and learning in nature but believe also that technology has an important role to play.

Teens surely represent a particularly interesting demographic regarding the use of technology, apps and electronic media. One in four teens goes online “almost constantly,” and this is now facilitated by the widespread availability of smartphones. Some 92 percent of teens report going online daily according to a study from the Pew Research Center. And, more than half (56 percent) of teens go online several times a day. Much of this access is facilitated by mobile devices. Nearly three-quarters of teens have or have access to a smartphone and 30 percent have a basic phone, while just 12 percent of teens 13 to 17 say they have no cell phone of any type. African-American teens are the most likely of any group of teens to have a smartphone, with 85 percent having access to one, compared with 71 percent of both White and Hispanic teens. These phones and other mobile devices have become a primary driver of teen internet use. Fully 91 percent of teens go online from mobile devices at least occasionally. Among these “mobile teens,” 94 percent go online daily or more often. By comparison, teens who don’t
access the internet via mobile devices tend to go online less frequently. Some 68 percent go online at least daily. African-American and Hispanic youth report more frequent internet use than White teens. Among African-American teens, 34 percent report going online “almost constantly” as do 32 percent of Hispanic teens, while 19 percent of White teens go online that often. Pew finds (Pew, 2015) that gaming consoles are available to four out of five teens. Gaming consoles, particularly for boys, are a major factor in children’s use of entertainment media.

**MOBILE TECH MAKES IT MORE DIFFICULT TO BE COPA COMPLIANT**

In addition to the challenges presented by mobile technology for children and families, public agencies are challenged, too. Recognizing the perils of children being on the Internet, the federal government created special privacy rules for children 12 and younger via the Children’s Online Protection Act (COPA). But COPA relies heavily on children accessing the Internet via laptop and desktop computers. The rapid increase of mobile technologies and the easier access to the Internet that they provide is exposing children 12 and under to many of the issues COPA was designed to prevent. Suggestions to reducing this exposure include: the development of internet safety education packages for parents, caregivers and childcare centers, and the integration of default privacy protections on smartphones, tablets and other mobile devices.

While the research indicates that a majority of parents are fine with their children using electronic media, a 2014 study conducted by the UCLA’s Department of Psychology revealed there can be costs over and above lack of physical activity or time outdoors in nature. They found the use of digital media seems to impede children’s social skills and it can end up hindering face-to-face interactions (Greenfield, 2014). The good news is the study also disclosed that five days of not using electronic devices can significantly improve a child’s ability to feel empathy or at least identify another person’s feelings. Dr. Patricia Greenfield, the study’s leader, identified decreased sensitivity to emotional cues and diminished ability to understand the emotions of other people as an outcome of digital media use. She says that, “the displacement of in-person social interaction by screen interaction seems to be reducing social skills.” The UCLA study was of 51 sixth-graders from an area public school who were asked to spend five days at the Pali Institute, a nature and science camp that prohibits the use of electronic devices.

Facebook remains the most used social media site among American teens ages 13 to 17 with 71 percent of all teens using the site, even as half of teens use Instagram and four-in-ten use Snapchat. As American teens adopt smartphones, they have a variety of methods for
communication and sharing at their disposal. Texting is an especially important mode of communication for many teens. Some 88 percent of teens have or have access to cell phones or smartphones and 90 percent of those teens with phones exchange texts. A typical teen sends and receives 30 texts per day.

And, teens are not simply sending messages through the texting system that the telecommunications companies offer. Some 71 percent of teens have access to smartphones and, among them, messaging apps have caught on. Some 33 percent of teens with phones in 2015 have such apps. And Hispanic and African-American youth with phones are substantially more likely to use messaging apps, with 46 percent of Hispanic and 47 percent of African-American teens using a messaging app compared with 24 percent of White teens. Teenage girls use social media sites and platforms, particularly visually-oriented ones, for sharing more than their male counterparts do. For their part, boys are more likely than girls to own gaming consoles and play video games (Pew, 2015).
V. WHAT GUIDELINES SHOULD PARENTS USE REGARDING TECHNOLOGY FOR THEIR KIDS?

There has been an evolution in thinking in recent years about the most useful and appropriate parental and caregiver guidelines for children’s use of electronic media. It has shifted from guidelines about the amount of exposure expressed in daily hours to the formation of a more active media plan and set of agreements between parent and child. In 1999, for example, the American Academy of Pediatrics (AAP) issued guidelines on children’s use of electronic media such as television watching and computers. At that time the Academy members recommended that a child’s daily media use be limited to two hours and that very young children (toddler age) should probably not have any media time in light of healthier options such as physical activity. This guideline has been interpreted to mean a strict ban for infants and toddlers but the AAP never intended the rule to be quite that strict.

In 2013, the Academy recognized that the actual media use by children these days is in excess of five or six hours and that it was more important to provide guidance that would help parents to more actively navigate the complex world of electronic media with their children and help them to find a balance with time for physical activity, creative play and more. Importantly, the Academy now recommends that parents and other caregivers have an actual plan for their children’s media use and recommends a goal of a healthy media diet. Suggestions as to what this plan might look like are consistent with common sense advice on knowing what one’s children are watching. They also suggest more active engagement such as watching shows together and discussing values.

The treatment of younger children continues to be a special focus of the guidelines. The AAP 2013 policy statement reaffirms the 1999 statement with respect to media use in infants and children younger than 2 years and provides updated research findings to support it. This statement addresses: the lack of evidence supporting educational or developmental benefits for media use by children younger than 2 years; the potential adverse health and developmental effects of media use by children younger than 2 years; and adverse effects of parental media use (background media) on children younger than 2 years. Here is an update:

1. The AAP still discourages media use by children younger than 2 years.
The AAP realizes that media exposure is a reality for many families in today's society. If parents choose to engage their young children with electronic media, they should have concrete strategies to manage it. Ideally, parents should review the content of what their child is watching and watch the program with their child.

3. Parents are discouraged from placing a television set in their child's bedroom.

4. Parents need to realize that their own media use can have a negative effect on their children. Television intended for adults that is on with a young child in the room is distracting for both the parent and the child.

5. Unstructured playtime is more valuable for the developing brain than any electronic media exposure. If a parent is not able to actively play with a child, that child should have solo playtime with an adult nearby. Even for infants as young as 4 months of age, solo play allows a child to think creatively, problem-solve, and accomplish tasks with minimal parent interaction. The parent can also learn something through the process of giving the child an opportunity to entertain himself or herself while remaining nearby.

The Joan Ganz Cooney Center is an independent research and innovation lab set up as part of the Sesame Street organization that focuses on the challenges of educating children in a rapidly changing media landscape. The Center conducts research on emerging educational technologies and collaborates with educators and media producers to put this research into action.

The Center recommends certain frames of reference in selecting media for children and these include addressing the following questions (Cooney Center, 2014):

- Does it allow your children to learn and grow?
- Does it encourage communication?
- Does it connect with different experiences?
- Does it allow doing things together - such as games and reading?
- Does it allow for connecting with distant family?
- Does it facilitate exploring the outside world?
- Does it make travel more fun?

The Cooney Center connects these questions/recommendations with simple educational idea in its Guide to Using Apps With Your Kids.
As with many things, there are two quite divergent schools of thought about children using apps and mobile devices to connect them with nature and outdoor experiences. There are some who feel, quite strongly, that our children should experience nature without any support from technology. They argue that the whole point of being in nature is to experience it purely, simply, and unfiltered by modern technology. Others would agree with that position if today’s children were more inclined to actually spend time outdoors in nature on their own instead of being so housebound. At the National Wildlife Federation, we support the concept of effectively integrating digital technology into a meaningful nature experience. We ask: a) Can it actually and consistently encourage children to move from the indoors to more of an outdoor nature setting?; and b) Can it help to sharpen a child’s focus on real nature without simply having them continue to stare at an electronic screen but just in a greener setting? In this chapter we will explore the pros and cons of various types of mobile apps and related technology and how well they do or do not connect children with nature.

Nature is a common theme for many digital apps. The number of apps that use images of nature and animals and include nature sounds is in the tens of thousands. They include games, ringtones, image portfolios, and more. Likewise there are many hundreds of digital apps and online programs that are intended to make children and adults more connected with nature. They represent different levels of connection to the real world and they have varying effects on truly connecting people to nature. But research would indicate that the overwhelming number of “nature apps” do not actually create a true nature connection. Remember that we are looking for an ideal nature and outdoor experience that is:

- In nature
- About nature
- Recurring and more than a one-off
- Conducted over a significant period of time - a year/school year/season
- Richly affirming to the child, and
- Supported by a caring adult

We need apps that facilitate these criteria in some meaningful and material way.

And, there are other child development factors to consider as well. The organization HealthyChildren.org sees a particular need to overcome the passive nature of TV and video
viewing (Healthy Children, 2004, 2015). Sitting in front of the TV causes children to give up on opportunities for more active intellectual, emotional, artistic, and physical growth. They say: “In general, while watching television, your child is probably not doing any of the following:

- Asking questions
- Solving problems
- Being creative
- Exercising initiative
- Practicing eye-hand coordination
- Scanning (useful in reading)
- Practicing motor skills
- Thinking critically, logically, and analytically
- Practicing communication skills
- Playing interactive games with other children or adults (helpful for developing patience, self-control cooperation, sportsmanship).”

Interestingly, these factors translate to criteria that good nature apps should also meet -- that is, to create a positive nature experience for children and they should be developmentally sound as well.
The most common way that technology is used to try connect children to nature is through e-books, films, games, and other programs that educate children about nature, animals, and the outdoors. But, these are usually experienced in indoor settings. There are many thousands of these apps, e-products, and programs. They mostly employ the tools of visual story-telling and, as such, can be quite effective in teaching young people about natural science, animal behavior, basic conservation activities and more. It seems, however, that the hope for these products is that by a child reading or hearing about nature or seeing it and its many features on an electronic screen, he or she will form a deep interest. When an interest is formed by such education and information tools, they can lead to important knowledge and understanding but are not likely to create an affinity or affection for nature.

National Wildlife Federation has a long standing commitment to this information and education concept as reflected, for example, in its Ranger Rick Periodical series. This series is read by more than 1 million young people each month. But its publishers also recognize its limitations. Interestingly, it is not unusual for an adult to credit their childhood experience as a Ranger Rick reader with instilling an interest in and curiosity about nature and wildlife. Ranger Rick, which has been published since 1967, has helped to educate over 50 million of today’s adults who have learned from its stories, puzzles, games and characters. But, when one probes more deeply, it is just as common to find someone who was already experiencing major time outdoors in nature and was attracted to the publication based on an already developing affinity.

There are many educational apps that can provide insight into creative ways that the app developers and educators have approached the simple task of educating children about nature and introducing them to wildlife and other natural features even though they are used indoors. Examples are listed here, not as any form of endorsement but simply to display the range of what is available through some of the more popular programs. These apps place emphasis on the virtual experience.

- MarcoPolo Ocean is an app that helps younger kids learn about the ocean. The child is presented with a virtual patch of ocean that is filled with animals and plants with which to play. The child can also build a virtual coral reef, a fish, an orca, a boat and a submersible. A voiceover teaches a number of ocean facts as the child moves through the program. There is no text to read, only visuals in this program.
- **Plants for iPad** is from nonfiction publisher, Kids Discover. It is a nature guide that lets kids explore the world of plants. Topics covered include: photosynthesis, biomes, unusual plants, the uses of plants, plants as art, and more. The app contains text, animations, interactive elements and activities. There are many digital nature guides for both children and adults.

- **Habitat the Game** asks users to help keep an endangered polar bear alive. Players do this by engaging in virtual and real-world activities that are designed to teach sustainability and actively encourage kids to reduce their impact on the planet. And for folks who worry about kids spending too much time indoors, the game also includes an element encouraging kids to get outside and also to swap news of where they've been with other kids. Because it has some outdoor elements, it leans in the direction of creating a true connection to nature but this app is mostly a virtual experience.

- **Gro Garden** is an app for younger kids that teaches the principles of organic gardening. Children plant seeds in the virtual vegetable patch and then help the plants grow with virtual sun and rain. After harvesting the vegetables, a child can feed them to virtual animal friends. The app also teaches young people how to recycle the food scraps in a virtual compost heap. The app is a good example of the use of visuals and hand/eye coordination as a teaching method.

- **Kid Weather** was developed by a six-year-old boy and his meteorologist father. The program uses avatars to teach children about local weather conditions so they know what to wear. And, they can read 400 trivia items and learn to plot changing weather patterns and understand basic climatology.

- **Toca Nature** allows the child to create virtual forests and learn about different animals that occupy different niches within the forest.

Each of these apps does a really fine job of informing and educating the children about aspects of the natural and physical world and to provide them with positive actions they can take to improve the environment. But, they do not, according to principles of social science, create a deep-felt affinity for nature largely because the young person is mostly not experiencing real nature.
APPS THAT ENCOURAGE THE LOCATING OF NATURE EXPERIENCES FOR CHILDREN, FAMILIES AND ADULTS

Some of the available mobile apps and some mobile-accessible online programs are aimed at helping people (mostly parents, caregivers and adults) to find nature places, trails, and events that will lead to true nature and outdoor experiences. They are largely designed for the adult who accompanies the child outdoors. They are highly useful for planned or casual outings and will help people find opportunities (such as an event at a local park) near them that they might have otherwise not known much about.

- **NatureFind** has a map locator for over 12,000 parks and other outdoor and nature places across the U.S. Importantly, its developers recognize that sometimes events will draw people outdoors, so the NatureFind team has curated and published information on over one million nature events such as talks, walks, rides, festivals and other outings. Each of those events has been filtered or reviewed by NatureFind staff. This program may be providing a view into the future of how adults will increasingly be helping connect children with nature because so many outdoor experiences for them will be in the company of an adult and will be more likely to be part of an organized outing.

- **All Trails** is an app that serves as a source for comprehensive information about 50,000 trails in the U.S. and Canada. It is for hikers, bikers and casual walkers. In addition to information about level of difficulty and scenery along the way, users have access to comments from other hikers. It covers urban areas and wild areas and is produced in a partnership with *National Geographic*. (Alltrails.com)

- **America’s State Park Passport app** is listed as “coming soon” and is being designed as a state park tour guide. There are thousands of state parks in the U.S. and many are highly accessible to urban populations. The passport program tells users about the park they are visiting, geo-location factors and includes weather conditions. When this app becomes operational, it will play a special niche role because of the unique role so many state parks play in connecting people with nature. Many of them are close to communities and are more accessible than, say, national parks or forests. Still, they are often large enough that they can provide camping, boating, fishing, hiking and many experiences that will immerse a young person and family members in a high quality nature experience.
• **Oh, Ranger! Parkfinder** links to a comprehensive database of every federal and state park in the United States. The database has information on thousands of national parks, state parks, national forests, wildlife refuges, public land conservation sites, national lakes and recreation areas and many more public lands. Each location contains information on the available activities, so users can search for nearby locations and see the activities there. Parkfinder is quite comprehensive and, as such, has scope and coverage similar to All Trails and NatureFind. There are several excellent choices in finding a digital nature-location program that suits an individual’s tastes.

• **Discover the Forest** not only lets users search for U.S. forests and parks, it also contains tips on preparing for trips, and activities for families to do in the forest. And, it contains background information about various forest types and ecosystems. There is significant value in programs like this that interpret nature for a young visitor or family members.

• **The National Parks Field Guide** is an interactive field guide to the wildlife and plants of 100 National Parks includes information and photos of the birds, mammals, reptiles and amphibians one can encounter while visiting a park and it helps the user to identify native trees and wildflowers. The guide also contains useful information about each park such as major sites of interest within it, directions, hours and fees, links, and phone numbers to make reservations or get more information.

• **Geocaching.com** is the largest online geocaching site, with over two million worldwide caches listed. Geocaching is a real-world, outdoor treasure hunting game using GPS-enabled devices. Participants navigate to a specific set of GPS coordinates and then attempt to find the geocache (container) hidden at that location. The basic service is free; alternatively, users can pay a monthly or yearly membership fee to access premium caches and get extra features. Geocaching.com has its own apps, both free and paid, but users can also get third-party apps like Geosphere that work with Geocaching.com’s database. This program is particularly well suited to children who enjoy a good search and find experience. While some children (most actually) are delighted just to be spending time outdoors, others do better with a goal and a secret quest. The children are also learning very specific information about how to find geo-coordinates and use them in real world settings. The wonderful news about geocache trails is that most of them were set up by nature lovers and children will have an adventure in some beautiful places.
• **Trailhead** is another example of an app that lets the user enter their location and it tells the user about nearby hiking opportunities. It is powered by EveryTrail.com which has 300,000 trail and biking routes listed. The program tells users about the trails and routes nearby and has a feature that lets the user track where they are on their journey with a real-time map.

**APPS THAT ENHANCE THE NATURE EXPERIENCE**

This category of apps is for direct use by the child in nature and they provide a more authentic nature experience because they are focused on nature observation and information collection. They often have the advantage of educating a child about nature in real time and providing incentives such as the pride of posting their observation to a legitimate database. They are, however, built around an assumption that the child is already outdoors and do usually address the tendency for the indoor child to stay indoors. Examples:

- **Project NOAH** (Networked Organisms and Habitats) is for recording wildlife sightings. The app lets children take photos of plants and animals, submit the data for use by researchers and earn badges. There is also support for classroom-based work on the Project Noah website. Digital programs such as Project NOAH focus a child’s attention of finding and observing real elements of nature. This gives the child a sense of accomplishment as they are able to locate, describe and photograph certain species. Because the program lets the kids submit their findings to a database, it adds to the sense of accomplishment when they realize their observation might help with a scientific program or support conservation. The badge feature makes the experience even sweeter for the child. See more at: [http://wilderness.org/blog/9-free-nature-and-wildlife-apps-kids#sthash.D6ohGsuz.dpuf](http://wilderness.org/blog/9-free-nature-and-wildlife-apps-kids#sthash.D6ohGsuz.dpuf)

- **Leafsnap** is an electronic field guide for identifying tree species from photographs of their leaves. These can also be uploaded and tagged onto a map. Scientists can then (as the database builds) use these data to monitor ecological changes. Leafsnap currently includes the trees of the northeast, which may be seen on a map of one’s area, and there are plans expand it to include all North American species. It is currently for iOS devices only, but an Android version also planned. See more at [http://wilderness.org/blog/9-free-nature-and-wildlife-apps-kids#sthash.D6ohGsuz.dpuf](http://wilderness.org/blog/9-free-nature-and-wildlife-apps-kids#sthash.D6ohGsuz.dpuf)

- **TreeBook** is a tree identification app for North America. It is offered for free, but in iOS only. It was produced by a veteran forester, and the application is a simple,
intuitive interface that provides a way to determine the type of tree one is looking at—with images, search, synonyms for trees, layman terms, and, for the more scientifically minded, detailed taxonomy.

- **iNaturalist** is a growing online community that records and shares sightings of species around the globe. Users can help identify plants and animals by using the ID Please! feature, as well as browse observations by species and region. There is an iNaturalist app for recording one’s own sightings, and the user can also start or join a project to help track specific ecosystems. iNaturalist places great emphasis on creating communities of nature observers and on making those observations useful to scientists.

- **iBird Lite** has pictures, maps of bird species ranges, details about specific species and audio files of bird calls to help junior ornithologists identify birds in their area. This app may only feature 32 types of birds, but it offers a free sample similar to other more pricey birding apps. Because there are so many bird watchers in America (tens of millions) the concept of encouraging children in their own bird identification makes perfect sense as part of a program that will shape a lasting connection with nature.

- **Merlin Bird ID** walks users through a step-by-step process for identifying birds. The results are filtered and sorted according to date and location to help make sure likely matches are relevant to where the app is being used. Merlin Bird App was produced by the scientists at the Cornell Ornithological Lab. The app encourages children to observe birds carefully and to focus in on a bird’s identity by answering five simple questions about appearance and behavior. The Cornell Lab has tremendous scientific expertise in birds and their ecosystems and behavior. Its ability to make this expertise accessible to young people through Merlin Bird ID demonstrates how the complex scientific concepts of nature can be simplified and made interesting.

- **Nature’s Notebook** helps users to record observed changes in plants and wildlife at a local site, such as a backyard, the neighborhood, or a local park. The app can help young people and adults to understand and track how climate, weather and other factors affect the timing of when plants bloom, insects hatch, birds migrate and more. Even slight changes in average temperature can have significant ecological effects and revealing these dynamics to young minds can appeal to their investigative and observational skills.
• **WildObs Observer** has more than 1,000 species of mammals, birds, snakes, and bugs. It lets the user record wildlife sightings and contribute these to a personalized database.

• **CreekWatch** helps observers to look at streams and track water levels, stream flow levels and pollution (including trash) in neighborhood streams. This can help researchers, farmers and planners to understand storm water runoff and can be used to improve water resource management.

• **The Lost Ladybug Project** allows children help track an at-risk species. They learn to submit photos of ladybug sightings and this helps biologists to track changing beetle populations in North America.

• **My Nature Animal Tracks** has a number of animal tracks, scat and sound information that can come in handy when the user comes across tracks on an outdoor excursion. It helps to measure the length of the track to assist in verifying what animal left it. Young people who learn to observe animal tracks and other wildlife signs become like detectives and also become aware of the presence of wildlife in an area even if they don’t actually see them.

These observation-oriented apps make use of digital technology to help children and families make more keen and informed sightings of nature and to focus on reality much in the same way that a birder or wildflower enthusiast would use a paper field guide book. One advantage of using digital technology is it can enhance the positive feeling that a child has toward nature and the outdoors by letting them immediately verify their observations and record them.

As noted, many of these apps and programs are linked to broader digital databases that are helpful to scientists who are studying species populations, ranges and phenology. Scott Loarie, co-director of iNaturalist, enjoys describing his assessments of some of the data sets they see being recorded during a bio-blitz event in a certain area and assume they must have been compiled by an adult scientist only to find later that it came from a nine year old. The skills and affirmation these apps provide to young people can be life-changing and the direct nature of these apps makes many of the observation accurate enough that they can be given a “research grade” – an observation that professional scientists can rely on.

**APPS THAT ACTIVELY ENCOURAGE THE TRANSITION FROM INDOORS TO OUTDOORS**

Evolving handheld digital technology including global positioning systems (GPS), smart phones, smart cameras, and more will undoubtedly change the face of field trips and field work at
Schools. U.S. Department of Agriculture Social Scientist, Deborah Chavez, of California investigated the role of such technology in supporting or enhancing children’s outdoor experiences. Two activities were technology-based (a camera safari and geo-caching for hidden treasure) and two activities were not technology-based (nature rubbings and a nature scavenger hunt). The participating children ranked the four activities on how much they liked each one. The survey found that the children enjoyed all of the activities but gave the highest scores to the technology-enhanced activities (Chavez, 2009).

So, while it fairly clear that digital technology is popular among children and that there are many programs designed to enhance the outdoor experience, there are still relatively few apps that can facilitate the actual transition between the indoors and outdoors. We see this as important because children spend so many hours of their day looking at electronic screens and feel it could be very helpful to have the digital program itself encourage children to go play outdoors and help them along the way.

In Chapter VIII we will look at two such apps in detail. They are both Ranger Rick “get outdoors” apps distributed as part of a smart toy package by Ubooly. These apps not only encourage the indoor/outdoor transition but are geared toward children experiencing local areas including in their neighborhood and backyard. Plums Photo Hunt, a PBS product, also encourages children to go from indoor environments to the outdoors and to use their cameras as tools for nature discovery and recording. Another program, Agents of Nature/Discovery, likewise encourages children to go and explore but at local “mission sites” that will be a fun and adventurous for the kids using a move-to-learn approach.

**THE PARTICULAR CHALLENGE OF VIRTUAL REALITY APPS AND EQUIPMENT**

Since 2015, three-dimensional virtual reality (VR) apps and accompanying equipment have emerged as widely popular in modern society. These apps give the viewer the experience of feeling that they are actually immersed in a particular place and a particular environment. The vast majority of these VR apps are built around video game technology and have an appearance that is both real and a bit unreal at the same time. Computer generated imagery (CGI) has reached a level of sophistication that makes the virtual experience border on one that is nearly real. This technology has been available for many years in electronic games and other applications but what is different, since 2015, is the way that the technology is more available to average users and how interacts with technical eyewear to make the user feel truly immersed.
In addition to the predominant use of CGI technology, a growing number of virtual reality programs rely on a form of 360 degree, up and down, filming that brings nature and a natural settings into the experience. There are now apps that can provide a CGI-based trip down parts of the Grand Canyon from a boater’s viewpoint and others using digital videos of the real world to provide an animal-eye perspective on a trip through a woods. Renowned British conservationist David Attenborough now works with Samsung and the BBC to develop virtual tours of ancient oceans and for modern-day looks at the Great Barrier Reef. These experiences offer a blend of CGI, such as depicting ancient and extinct sea creatures, and existing species swimming by, such as sharks. But, can virtual reality replace the real thing and become a tool for connecting people to nature in a lasting and effective way? Let’s look at the available evidence.

Probably the greatest difference between the virtual reality experience and simply viewing a video or computer screen is how the immersion experience can let the participant see things from another’s perspective. Some researchers refer to this as a sense of body or physical transfer. Even though you know it is not real, your brain reacts in a way that you feel more involved and this can make the experience more compelling. Nature-based VR experiences can, for example, offer the perspective of an animal living in its own environment and this can lead to more of a sense of closeness and empathy with that creature (Ahn, et. al.2016). Other research indicates the virtual experience creates more of a sense of overlap with nature. In essence, by becoming immersed in the nature experience virtually, you can identify your own being more in the same place as another, such as a wild animal. The body transfer concept is the principal difference between virtual reality and other forms of viewing nature scenes and situations.

Research indicates that virtual reality may be particularly helpful in explaining environmental problems or in creating more of a sense of empathy with nature and wild creatures, but it does not, in the final analysis, appear to induce a persistent sense that nature is a part of the self. Exposure to real nature does seem to give people a lasting affection and affinity for nature, as we have seen throughout this report, but it also provides major health and developmental benefits that the virtual experience cannot.

VR does show good promise to become a specialized tool of conservation. It can take people to see some places they would never otherwise see and increase their desire to protect them. The Nature Conservancy recognizes this opportunity and has created a virtual reality gallery as a way to foster visual experiences for their members and others that makes its work in distant places more accessible. Stanford University’s Virtual Human Interaction Lab is exploring the use of
virtual technology as a way to explain longer term and complex environmental subjects and issues such as climate change. The virtual experience also seems to support conservation more than simple films, narratives and photographs. Researcher say that virtual reality provides a greater mental connection to nature and, because of the power of the experience, it can lead to a greater willingness to protect nature or take pro-environmental actions. This is due to how the virtual experience makes one understand a problem. Stanford’s has been studying how virtual reality can support people developing a greater understanding of such distant and abstract phenomenon as ocean acidification and sea level rise.

Virtual reality programs, particularly when based on real life video formats and presented in immersive three dimensional forms, will offer important insights into nature and help people develop more of an understanding of complex subjects and see places they otherwise may never see. It will not likely create the kind of lasting affinity for nature that real life experiences provide and it surely will not offer the range of physical and mental health benefits offered by time in real world natural settings.
VII. THE ROLE THAT SCHOOLS, CHILDCARE AND AFTER-SCHOOL PLAY IN CHILDREN AND NATURE AND HOW THAT AFFECTS USE OF TECHNOLOGY

In previous chapters we have been addressing the role of technology in the context of family settings and the relationship between children’s use of technology, parenting and the outdoors. But, in our modern American society, there are many adults other than the parents who, over the past 30 years, have been playing a much greater role in caring for and guiding children in their growth and learning. They are the educators, childcare workers, and after-school providers of America who are largely in charge of our 70 million children for many hours of the day. Moreover there are summer-time service providers such as camp counselors, parks and recreation program staff, and others who spend significant time with children when they are not in school. These caregivers and educators play a significant role in how children connect to nature and almost all of them now use digital technology in their overall work with children.

Admittedly, schools and childcare centers are not automatically places of nature. As a general rule, school campuses are not very green. They are mostly built inexpensively on large open fields and typically feature extensive paved areas. But just having more trees, gardens and vegetation on the school grounds can help create an environment more conducive to learning. And, technology can help children to connect with that environment.

This is relevant, because schools that have some greenery would lend themselves to the use of supportive digital technologies to help students connect with nature and learn about the natural world. The academic potential of mobile learning devices is substantial and can enrich the learning process for students particularly in science education and in after school settings. Well-designed apps can be versatile, motivating, and active learning tools. Importantly, many schools are now more actively bringing handheld technology into the learning process.

As noted above, many of today’s nature apps encourage students to make observations of nature - insects, plants, birds, weather and more - and to record their findings. Technology can, indeed, help them with species identification and understanding of behavior and ecosystem niches in addition to a wide range of natural processes. With mobile applications, these can occur while the students are actually out in nature. Some of their findings can be entered into databases where they accumulate and add to the overall scientific knowledge base. School gardens, field trips, after-school excursions and other experiential learning activities can be significantly enhanced by the use of these handheld technologies.
Lai, et al. studied how handheld technology can support experiential learning (Lai, 2007). Experiential learning is a valuable tool for improved scientific education and life skill development because it places the educational experience in a real world context and guides the student on the pathway from learning a concept to being able to apply it. Their research involved two fifth grade classes. One class was assigned a Personal Digital Assistant device (PDA's) and the other class was not. Their work centered on a natural science class and a school garden. Findings indicate that students working with PDA's showed an increased level of new knowledge as they worked within the experiential context.

There are aspects of learning that go beyond students sitting in the classroom and listening to lectures, reading texts and repeating what they have learned. This more passive learning method has been identified as a significant weakness in the American education system. But, there are many reasons why technology can be used in schools and other child-serving institutions and agencies to connect children with nature in addition to improving their overall educational skills.

MULTIPLE INTELLIGENCES AND LEARNING STYLES

In 1983, Dr. Howard Gardener of Harvard University developed an educational theory that all children have at least seven “intelligences.” The exact definitions of the seven are sometimes debated but the fundamental idea is sound. Gardner described children as having: linguistic intelligence, logical-mathematical intelligence, spatial intelligence, bodily-kinesthetic intelligence, musical intelligence, interpersonal intelligence, and naturalist intelligence. Gardner asserted that educators should pay more evenly-distributed attention to students who show signs of being gifted in the arts, music, nature, design, dance, empathy, or other aspects of human achievement. This can include exposure to nature and the outdoors. This appears to represent significant opportunities for apps and mobile technology in the educational setting because proper app design can support flexibility in learning styles for kids (Overview of Learning Styles, 2015). In Chapter VIII we explore design features that make the most sense for connecting children and families with nature. It is critical that such apps support learning that encompasses these many intelligences in children.

APPS AND CONSTRUCTIVIST THEORIES THAT ARE COMMON IN ENVIRONMENTAL EDUCATION

Constructivist theory is based on the concept that students have a base of knowledge already in their head that can be brought out and added to through a well-crafted educational experience.
Though the field of environmental and nature education may have started out teaching children about problems with ecosystems and environmental pollution, educators soon learned that it offered students a richer and much broader educational backdrop. Today, outdoor education is usually based on the “constructivist” approach. As such, it focuses on the learner and his or her ability to piece together complex conceptual puzzles. An effective outdoor education program will not permit students to sit back and be passive in their learning. Environmental and nature education dynamically combines learning of the underlying science and principles of a subject with significant student-directed assessments and real-world applications (Hungerford et al. 2003). Handheld technologies and apps can be used as a significant part of the construction of new knowledge and skills.

**SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM)**

Modern STEM education has a very similar goal to constructivist-based environmental education because of the significant need to learn “science in action.” A recent manifestation of how important this strategy is can be seen in the body and content of the Next Generation Science Standards (NGSS) which were released in 2014 and developed in cooperation with 26 states, all of which are hoping to improve the effectiveness of the K-12 science education field in America. This means these standards are more in alignment with longstanding environmental education principles, especially through the relationship among core concepts and actual practices. Handheld technology and apps can support this applied STEM focus.

The National Science Teachers Association (NSTA) looks at the NGSS as having seven conceptual shifts that are mostly new and different from how science is currently being taught in many classrooms. App use can apply to all of them. They are:

1. K-12 science education should reflect the interconnected nature of science as it is practiced and experienced in the real world. The use of handheld technology and apps can assist with this goal.

2. The NGSS are student performance expectations, not curriculum. The practical applications found in many handheld programs can likewise support a higher level of scientific inquiry and applied performance.

3. The science concepts in the NGSS build coherently from kindergarten through 12th grade. Handheld apps for natural, environmental and earth science can likewise be delivered in ways that are consistent with scope and sequence of the NGSS.
4. The NGSS focus on deeper understanding of content as well as application of content. Inquiry-based learning and problem solving supported by handheld technology and apps can create this deeper understanding.

5. Science and engineering are integrated in the NGSS, from kindergarten through 12th grade.

6. The NGSS is designed to prepare students for college, career, and citizenship.

7. The NGSS and Common Core State Standards (English Language Arts and Mathematics) are aligned.

The applied and immediate focus of many natural science, earth science and related apps will be a significant aid to the implementation to the NGSS while also helping students to spend more time learning in natural environments and connecting with nature. Natural science investigations that align with the NGSS can be greatly enhanced by digital technology. As noted in Chapter VI, using such technology to observe and record findings is an effective way to create a focus on nature and it helps to students to develop higher proficiency in scientific method. Moreover, because many of these digital programs link to professional databases, the students can become actively involved with science by making and recording research-grade findings.

**REAL WORLD SYSEMS THINKING AND FUTURE SKILLS**

We noted earlier in this report that the widespread use of technology has the effect of changing the way that young people think and react. Their brains may actually change as a result of the mental processes that modern digital technology requires.

Robin Long and Marilyn Fenster outlined, for the Natural Start Alliance, what they see as a frame for connecting children with nature using technology and helping them to make systemic connection (Long and Fenster, 2014). Interestingly, their findings based on assessment of students in a school in Rochester, New York, show a propensity for the technology to encourage real world systems thinking. They actually used photography as a medium to educate first grade students on nature. They found that the student’s use of this technology:

- encourages “hybrid thinking” that blends technology and natural elements;
- empowers children to make personal connections and choices through the camera’s lens;
- provides material, in the form of photos, for sharing in the classroom or with the wider world;
• provides a level of responsibility not often given young children by putting the care of cameras into their hands;
• introduces an aesthetic component to STEM; and
• provides record-keeping capabilities for inquiry-based learning.

In discussions of ways that handheld and other digital technology can connect children with nature, we would be remiss in not examining how it also related to educational theory and practice. While there is great value in children simply spending more time in nature, it is clear from the social science that these experiences are made more powerful and lasting through learning and skill development.
VIII. SHAPING PRINCIPLES AND GUIDELINES FOR MOBILE APP DESIGN FOR CONNECTING CHILDREN AND FAMILIES TO NATURE

To gain additional insight into how digital apps can be used to enhance the nature experience, the National Wildlife Federation supported an observational field study of 19 families with young children. These families deployed a smart toy called Ubooly and two Ranger Rick Get Outdoors apps designed for 5 to 10 year olds. The study was conducted with children and their parents in Philadelphia, Pennsylvania, and Reston, Virginia. The Intuitive Company of Philadelphia designed and directed the study with Federation staff support. The Intuitive Company was retained because it is made up of researchers, designers, technologists and strategists who specialize in assessing and designing user experiences for public and private sector firms including websites, programs, apps, and more. The study required specific expertise in assessing the effectiveness of mobile apps in connecting children with nature and the outdoors and understanding the full range of effects this technology can have on children.

The Federation helped create a set of Ranger Rick-themed play activities for Ubooly which is an unusual combination of a plush toy and mobile phone carrier. The Ubooly toy is a fuzzy creature with a sweet child’s voice and face that comes to life when you slide a mobile phone into its pouch. NWF, working with the Ubooly Company, created the Ranger Rick activities, called play packs, to encourage kids to actually go outside and connect with the natural world near their homes. Both of these packs feature hours of activities to help kids to get outdoors with the goal of their truly appreciating nature. The activities contained in the apps include scavenger hunts, nature hikes, mindfulness games, and physical exercise. The children can also engage in arts and crafts such as making collages, drawings, paintings and necklaces inspired by their outdoor experiences.

The format for the Ubooly/Ranger Rick apps is for the phone-loaded toy to verbally greet the child and suggest that they go outside and play. The activities are designed for the child to have an adventure or outdoor experience and to observe and learn about nature in the process. Importantly, these apps were designed to encourage a child who is indoors to take the phone-
loaded toy outdoors. In this way, the apps have two features that seem desirable in creating a relationship with nature. The first is helping with the indoor/outdoor transition and the second is to foster outdoor activities with a focus directly on the natural world blended with imaginative play. But how well do these goals work in practice? The field study was designed to examine this question.

The 19 families were selected from the Northern Virginia area around the National Wildlife Federation headquarters office in Reston and from Philadelphia which is the location of the Intuitive Company. This proximity made study implementation much more practical.

Our overall finding was that the Ubooly/Ranger Rick inspired apps helped children to get outdoors and connect with nature concepts and nature in meaningful and positive ways.

The study was principally based on a two-week diary study. This was the main method to collect the families’ experiences using pictures, videos, drawings and audio recordings. In addition to the diary-based field study, there was also an active design session with the families to directly discuss their children’s use of the Ubooly/Ranger Rick apps and their ideas on developing app and toy designs for the future.

**METHODOLOGY**

There was a questionnaire administered to the participating families to set a baseline on background of the participants. It included the identification of child and caregiver participants and other family members and information on the physical setting in which the children lived. It also asked the participants to describe the nature areas (yard, parks, etc.) near the home.

The study used a diary approach and tracked the children over a two-week period. Each child was paired with a caregiver and the caregiver actually maintained the diary. There were 19 child/caregiver pairs in Northern Virginia and Philadelphia (8 boys and 11 girls) participating as the study got started. There were 19 pre-survey adult responses collected and 15 post-survey adult responses collected as some of the pairs were unable to complete the study.

The informing use results are as follows:

*Please describe your child’s attitude toward playing with the Ubooly/Ranger Rick play packs over the course of the study. Did you see any differences as time went on?*
Overall attitude:

- Enthusiastic - n-16
- Curious - n-4
- Not interested - n-4

Comment: The children in the study were excited to have the new toy and also by the fact it was talking to them and suggesting things they could do. A review of the commentary by both the children and the caregivers noted that the toy and the apps created significant initial enthusiasm for going outside. Later, as the child focused on the nature activities contained in the apps, there was a shift to greater enthusiasm for the actual experience.

Change in Attitude:

- Increased interest - n -4
- Consistent - n-2
- Decreased - n-4
- Not specified - n-5

Comment: Many of the participants were from families that already engaged in outdoor activities. Responses to this question showed that the increased interest seemed to reflect interest in the outdoors while decreased interest seemed to reflect the wearing off of the play pack’s novelty.

*What, if anything, do you think led to changes in your child’s attitudes toward playing with the Ubooly/Ranger Rick play packs over the course of the study?*

Encouraged:

- Tracking progress - n-6
- Opportunity to use imagination - n-6
- Not specified - n-6
- Using technology - n-2
- Novelty - n-2

Maintained:

- Repetition - n-1

Discouraged
Comment: There were many positives to the use of the play packs but there were also some difficulties that came out in the study such as the toys being hard to carry while kids were engaging in the activities, the toys getting dirty, and some technical issues such as the apps sometimes not working. Because it is a phone-based app, there were even situations where incoming phone calls interrupted the play experience. It is noteworthy that the children did seem to enjoy the ability within the app and the study to track their progress and to use their imagination. The app designers emphasized the kids using their own creativity and tried not to make the activities too prescribed allowing room for individual interpretation. In this sense, the apps acted as a pump primer by suggesting an initial activity, such as role playing, but the children went far beyond that initial frame on their own.

Activities: Please share a few of the most memorable outdoor activities that you and your child did over the course of the study. Why were they the most memorable? Please provide as much detail as possible.

- Adventure games - n-7
- Plant ninja - n-6
- Nature games - n-6
- Social interaction games - n-3
- Physical games - n-2

Why memorable?

- Seeing imagination in action - n-6
- Not specified - n-5
- Seeing joy - n-2
- Search and find (discovery process) - n-2

Comment: It seems as though exploration and adventure were the main factors in enjoyment by child and parent. While it may seem obvious that children like to explore, the app design that encouraged them to do so in a role playing mode or as a described adventure stimulated considerable interest and helped them be thrilled by the experience. Having fun and experiencing things that are fascinating is an obvious ingredient in a successful app that helps a
child to connect with nature. The going-on-an-adventure format in the apps seemed to support the kids’ excitement about using the app. Importantly, activities that generate such enthusiasm are consistent with broader social science that finds that children feel more connected to nature when they are learning, feeling competent, and having a richly affirming experience.

**How were these activities similar or dissimilar to activities they do typically?**

Without Ubooly/Ranger Rick

- Physical activity - n-9
- Spend time in nature environment - n-6
- Imaginative activities - n-4
- Social activities - n-3

With Ubooly/Ranger Rick

- Nature activities - n-5
- Imaginative activities n-4
- New spin on old activities - n-3
- Structured play - n-2

Comment: Many of these families already engaged in outdoor activities so the main impact of the play packs seemed to be getting them more focused on nature and related adventures. The apps created a framework for the kids to enjoy the outdoors thorough the various adventure-framed activities offered.

**Since the beginning of the survey how, if at all, do you think Ubooly/Ranger Rick has encouraged your child to connect with nature?**

- Didn’t influence - n-7
- Provided structured activities - n-6
- Engaged imagination - n-5
- Sparked curiosity - n-4
- Increased observation of nature - n-4

Comment: As noted, these families were fairly inclined to be interested in the subject of their kids’ relationship to nature and to offer their kids more outdoor time so it is not too surprising that the apps were not much of an influence for about half of the participants. There does seem to be some indication that they saw an advantage in having actual structured nature activities to
use outdoors. The kids’ imagination and curiosity was engaged and, it seems, a few became more observant of nature.

*Over the course of the study where did you and your child go when your child wanted to connect with nature?*

- Locally - n-11
- Yard - n-8
- Parks - n-8
- Wooded area - n-6
- Other (barn garden, trail, street) - n-6

Comment: As expected, the play packs contributed to a close-to-home experience. In Chapter VI we noted that availability of digital technology can help people to find parks and nature areas that are within driving distance. But it seems there is a place for apps that are designed to be used anywhere including immediately outside the home, and in this way can be of use in making the indoor/outdoor transition. It would be intuitive that close-to-home experiences lend themselves to more frequency.

*Were any of these places new to you or your child?*

- No - n-12
- Yes - n-3

Comment: This supports the idea that the play pack use was less about finding new places as compared to having new experiences in well-known places. This might indicate that a benefit of using apps as part of the nature and outdoor experience is seeing old places in a new way whether through role-playing, adventures, or even by species identification. App designs that open a child’s perspective could be highly valuable in making positive, real world, connections to nature.

*With whom did your child use Ubooly/Ranger Rick most often over the course of the study?*

- Alone - n-8
- Siblings - n-6
- Parent - n-5

Comment: Many of the children used the apps alone (or with caregiver) but this also showed how apps that offer a shared experience with siblings and families will be used. It certainly raises the
point that, unlike many individual-based games and digital products, outdoor app design should consider pairs and groups (such as families) in their activities. Social science research does, indeed, suggest that children enjoy companionship, adult attention and sharing their experiences with others. While not scientifically researched, there does seem to be a leaning toward most nature-connection apps being designed around a solo experience.

*If you were designing an app to get kids outdoors to explore nature, what features would you include?*

- Game-like - n-6
- Storing capabilities - n-5
- Interactive GPS - n-4
- Facebook - n-4
- Accessibility - n-3

Comment: The idea that an app offers a fun and interactive game-like experience for the children is established but these responses also show how families could be looking for greater connection to hardware, the internet, and the overall digital world. Digital apps have the capability of putting many tools in a child’s hands as a way to enhance the overall outdoor experience including saving observations, communicating their discoveries with friends and more.

**DESIGN DAY**

As an important part of the study, this was a two hour session with 5 boys and 3 girls in Philadelphia who participated in the study to explore, in depth, some of their improvement suggestions and new ideas for future apps and toys that would help kids get outdoors and truly connected with nature. The digital design process often makes use of such sessions to review the facts and to distill principles for future work. In this study, we compiled some of the broader social science research on how to connect children and families with nature, how technology is becoming a greater factor, and have even looked at the various ways that app designers and others have approached the use of technology and mobile apps as a way to connect people with nature. The design session offered the opportunity for a closer look and for the study participants to reflect on their own use of the Ubooly/Ranger Rick app and to discuss its use in detail. Being able to drill down into the actual user experience is a way to further understand the ins and outs of how technology can become a useful tool in providing young people with a true and lasting affinity with nature.
The session revealed and confirmed a number of critiques that the study managers were seeing hints of during the course of the two-week field study. There were several aspects to the critique that could be translated directly into design principles that the Intuitive Company and National Wildlife Federation would recommend. They are what follows in Chapter IX.
IX. TWELVE PRINCIPLES FOR DESIGNING SMART TOYS AND APPS THAT CONNECT PARENTS AND KIDS WITH THE OUTDOORS AND NATURE

What follows are proposed guidelines for designing and using mobile apps that will truly connect children and families to nature.

These guidelines are based on cross-comparisons among three bodies of research that include: 1) social science studies of what connects children and families to nature and creates an affinity for nature; 2) an assessment of the ways to overcome some of the key reasons that children are spending so much time indoors; and 3) specific suggestions, based on our field study, of effective design principles for digital apps that truly connect children and families to nature.

1. ACTIVATE THE SENSES AND EXPOSURE TO NATURAL BEAUTY

A constant concern with the use of mobile technology in outdoor settings is the fear that the children will pay more attention to the virtual world of the app itself than to the natural world around them. Research shows that this would, indeed, defeat the purpose of having mobile apps that get kids outdoors in nature. Designers should develop digital apps that help children to directly notice and experience things in the natural world - sight, smell, taste, touch, and sound. Using the Ubooly/Ranger Rick play packs, for example, the children in the study took special note of things they would not have otherwise experienced if they were indoors. For instance, one child noticed acorn caps, birds, and clover including some that were tinted red. She wrote about the red clover. There are many apps that guide young people in their observations of nature and that can enhance the overall nature experience. Apps that are too screen-focused might inform a child about nature but they almost certainly will not make a strong and lasting heartfelt connection.

2. ANIMALS IN NATURE

Animals are somewhat of a secret weapon in the fight to get kids connected to nature. Children enjoy observing and even interacting with animals. Surveys show that children, particularly very young children, have a passionate interest in animals of all kinds. Nature apps that help children to see and understand wildlife and animals in the outdoor setting will go far to make the outdoor experience a positive one for children. This can be as simple as looking for squirrels and birds or looking more closely at insects in their yards. In the field study, the children, once outside, became very interested in pointing out the wildlife (such as birds on a roof) that they saw. There
are many wildlife observation opportunities for children close to home and their natural fascination for creatures makes the outdoor experience richer.

3. PERCEPTIONS OF NATURE SAFETY

There are children in our modern world who are unused to nature experiences and may find them a bit scary. Children are often warned of stinging insects, told about avoiding animal bites, advised to stay out of “bad” weather, and can even be fearful of wooded areas. The more they experience nature, the more at ease they feel with the interaction. Nonetheless children can be quite fearful of natural things. Apps and smart toys that also communicate concepts of safety such as safe-to-touch insects and plants can be helpful in giving them an impression that nature is a safe place to spend time.

4. PHYSICAL ACTIVITY

The field study seems to indicate that the Ubooly apps encouraged children to engage in physical activities such as dancing and somersaults that they did not usually do. Encouraging physical activity can be a useful function of handheld apps. One study parent noted that her child did these activities willingly even though she would not have done them if asked by the parent. The apps’ activities did seem to have an overall encouraging effect on physical activity. Given how important it is for American children to improve their overall level of fitness, mobile app designers should surely be incorporating movement and physical activity into these programs. The Ubooly/Ranger Rick play packs suggest that such activities will be the most fun for the children if they are linked to creative play such as role playing, adventures and creative expression.

5. ADVENTURE SCENARIOS

Research shows that once children get outdoors, they most often find amazing ways to use their imagination. The Ubooly/Ranger Rick play packs suggest scenarios for the kids to dream about. One includes flying in a hot air balloon to explore the world. The parents, in the study, often noted that once the children started with a “pump-primer” scenario, their own imagination took over. Children in the study drew pictures of themselves surrounded by trees, while others drew pictures of faces on rocks to help them personify nature. Personification was popular among the children. Designers should think about offering scenarios as way to get kids started but keep them open-ended to provide space for broader, real world, imagination.

6. CONNECT WITH A CLOSE-KNIT SOCIAL GROUP
Many mobile apps are designed for solo activity by a child. They reinforce a paradigm of the lone child off in their own corner of the world. But, the study revealed that the ability for the kids to share their experience with family members and close friends proved to be important. Children enjoy social experience and feedback. One child spoke of how much she enjoyed sharing her Ubooly/Ranger Rick outdoor experience with her little sister who is a very important person in her close-knit social group. App design that has sharing and joint participation features could create improved experiences for the children and make them more in line with social research that says children get the most from activities that are connected to their own close-knit social groups - siblings, friends, parents, and caregivers.

7. INCORPORATE CAREGIVER ROLES

The role of parents and caregivers can be very important to the child’s outdoor experience. Apps and smart toys that engage both parents and children somehow together are a good idea. This is particularly important for a child who is playing in nature by themselves because they relish the company and attention of an adult. Many apps assume that children are outdoors on their own and are having individual experiences that are isolated from others. The researchers in this study saw how these were not typically single-person experiences. And, that parent and caregivers had important roles to play. There were several clear roles for them in the way that the Ubooly apps and smart toys were used to connect children to nature and the outdoors. They saw some distinct roles in helping with the nature connection including: facilitator, companion, and supervisor. One parent noted how his kids enjoyed doing the Ubooly activities outdoors but liked it more when he was there sharing the experience with them and explaining some of the science around what they were seeing. Another parent responded to questions her child raised about the identity of birds and leaves by going inside with her and looking up information on the internet. They were learning together. Parents and caregivers can also play an important role on the technology side of the experience. It will not be a positive experience for the kids if they do not know how to operate the smart toys, phones or apps themselves.

8. PROTECTION OF EQUIPMENT OUTDOORS

While it may seem obvious, many of the parents in the study noted that the smart toy and phone could, without the right protections, be exposed to damage from dirt, rain, or even overheating.
Moreover, there were concerns that a child using a smart phone with an attractive toy outdoors might experience theft. This led to a number of suggestions about ways to protect the devices and toy. These included special containers for the hardware and something other than tucking the phone in a plushy toy likely to get dirty outdoors and making the phone unusually hot. Making the technology safe from the elements, including rain and moisture, was also recommended.

9. EXTEND THE EXPERIENCE

In an ideal world, the app would lead to other experiences. These could include seeking out excursions to new nature places, the construction of natural hiding places, making up new (non-app) games, social media connections and more. Digital app designers seeking to connect children to nature and the outdoors should be mindful of the role that technology can play in taking the child’s experience and linking it to the larger world such as recording a wildlife observation to a database or sharing a photo of some interesting outdoor feature with friends and encouraging them to come outside and see it too. Older children are particularly prone to seek peer approval for their activities.

10. COLLECT AND STORE

A large part of the app experience, as noted, is to encourage children to go outdoors and experience nature first hand in a way that encourages more interaction, fun, and imagination. Smart technology also offers children the opportunity to bring their experience back inside. This can be done virtually by taking photos and recording sounds and physically by collecting specimens. The idea that the indoor and outdoor worlds can become more connected via collect and store activities is valuable concept in digital app designs that connect children with nature.

11. WEARABLE AND HANDS FREE

The participants in the study noted that children need to be able to run free, climb, swing and touch. The smart plush toy involved with the Ubooly format had a somewhat inhibiting effect on the activities according to parents and children. They strongly recommended designing for hands-free outdoor use such as a cross-chest strap or harness. This was more than a recommendation based on the specific use of the Ubooly toy in the study. It is true that children making use of apps to enjoy the outdoors will likely be using phones. Hands-free use, or at least the ability to tuck the instrument away in a safe place while playing, would be a valuable feature.
12. EMPLOY THE FULL MOBILE SENSES AND ALL THE TECHNOLOGY FEATURES

Just as we want children to use all their physical senses and intelligences when outdoors, smart technology likewise has many capabilities that can be used to enhance the outdoor experience and connect children to nature, including: photos, sound recording, geo-location, immediate identification, recording to databases, interfacing with social media and more. Apps that employ many of these features can offer significant opportunities to educate young people on how to use technology as an enrichment to a nature experience.

CONCLUSIONS:

This report connects several bodies of research and investigation under one conceptual framework to provide context and guidance for those who wish to use digital apps and other forms of technology to forge a true connection to nature by individuals. Our basic sense is that digital technology can, indeed, become a significant aid in connecting young people to nature and the outdoors. But, it can only accomplish this if the apps have the right design features as discussed in Chapter XI.

The good news is that there is greater clarity and understanding of the types and scope of activities that create a true nature and outdoor connection and that digital technology can be crafted to support them. It is also more clear that the tendency to blame digital technology for keeping children indoors and away from nature needs to be seen in the broader context of modern society and adults’ views on childhood risks and safety. It is quite likely that, even if digital technology were not such a pervasive part of modern American living, parents and adults would still be disinclined to let their children (especially younger children) roam free and unsupervised outdoors.

It is also clear that digital technology has features and capabilities that could significantly enhance a nature and outdoor experience rather than degrade it. The National Wildlife Federation and Intuitive Company field study was highly valuable due to its ability to suggest design features for digital apps that can truly connect children with nature and the outdoors in a way that will have a lasting effect. These guidelines will be circulated and discussed with leaders in the children and nature communities and in the digital design communities with the idea of forging a positive relationship and creating more digital products that strengthen the long term connection between children and nature.
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