

# BIODIVERSITY AND PEACE: WHERE TECHNOLOGY AND MONTESSORI COME TOGETHER IN THE CHILDREN'S ETERNAL RAINFOREST, COSTA RICA

by Jeff Norris

*Jeff Norris, initially shocked by the Montessorians who are calling technology into question, states that technology can offer a means of development for the child who is concurrently supporting and learning from the rich and overpowering biodiversity of the rainforest. He speaks for the Children's Eternal Rainforest citizen's science as well as the combined visit to the United Nations' University for Peace offered by the Montessori Institute for the Science of Peace. He extols the three-period lesson and independent group research as useful, interpretive-learning approaches that awaken the interest of each student.*

I was thrilled and honored by the opportunity to participate in the NAMTA sponsored conference "A Montessori Integrated Approach to Science, Mathematics, Technology, and the Environment." Admittedly, I attended neither being specially trained in Montessori nor

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technology. However, over the past three years, I've been working to combine both as I work deep within a special block of protected rainforest in Costa Rica. My first impression from the conference was one of relative amazement. To some degree I was shocked that the inclusion of technology into the Montessori educational environment was even being discussed by the speakers and the conference attendees. As a fifteen-year veteran of more traditional or mainstream high school biology classrooms (e.g., International Baccalaureate Organization [IBO]), I have always been accustomed to the idea that using technology in the classroom, especially the science classroom, is not only a good thing, but the more you use the better: It is "encouraged throughout all aspects of the course in relation to both the practical program and day-to-day classroom activities" (IBO 2014). Even one US Dept. of Education (USDOE) website shows overwhelming support for the overall inclusion of technology in academic programs.

Technology infuses classrooms with digital learning tools, such as computers and hand held devices; expands course offerings, experiences, and learning materials; supports learning 24 hours a day, 7 days a week; builds 21<sup>st</sup> century skills; increases student engagement and motivation; and accelerates learning. Technology also has the power to transform teaching by ushering in a new model of connected teaching.

At this point I think it is necessary, as it was clearly stated by the conference presenters and participants, that the major issue in Montessori education is not necessarily the use of technology *per se* but the flooding of society with screen-based digital media. This distinction is important. Many presenters shared anecdotes or quotes taken directly or interpreted from Montessori's teachings in support of science, discovery, investigation, and the tools required in these pursuits as part of the prepared environment. By the end of the conference, no one seemed inherently against technology, but most agreed in the prepared environment there should be particular guidelines for the use of screen-based digital technology. Moreover, these guidelines impressively went as far to suggest restricting or limiting the use of digital technology in the first and second planes until students had completed their sensorial development. From a historical perspective, this debate of incorporating novel technolo-

### **Box 1. The Children's Eternal Rainforest: The Heart of Conservation in Costa Rica**

Per unit area (km<sup>2</sup>) Costa Rica contains more species than other larger, megadiverse countries like Brazil, Colombia, Indonesia, and Australia (Obando-Acuna 2002). Plus, with over 25% of its land under some form of protection from development (Valerio 1999), Costa Rica often sits at the center of most discussions of global conservation (figures 1a and 1b). This being the case, then the Children's Eternal Rainforest (CER) and the other protected forests surrounding nearby Monteverde (such as Green Mountain) should therefore be considered the heart and soul (see box 2) of conservation in Costa Rica. Today there are five principal organizations each with their own protected tracts of forest in an area known as the Arenal-Monteverde Protected Zone (figures 2a and 2b). Nadkarni and Wheelwright (2000) and Chornook and Guindon (2007) provide a considerable amount of historical background on how an original 554 hectare tract in Monteverde in 1951 increased almost 100-fold in a span of less than 50 years. The largest and most central piece towards conservation in this region now belongs to the CER.

Given its central position within the protected zone, you can appreciate the CER's literal role as the heart of conservation in the region and for Costa Rica as well. Its 23,000 hectares protects seven of Costa Rica's twelve different life zones. By covering so many life zones, the CER in general protects over 50% of the species in most groups of plants and animals. For example, there are approximately 450 species of birds found in the CER. This represents about 50% of the total for Costa Rica and about 4.5% of the total species of birds for the entire planet! What makes this even more incredible is when you consider the CER only covers 0.45% and 0.00016% of Costa Rica's and the Earth's land area respectively. All of North America north of Mexico contains about 910 species of birds, about the same as Costa Rica even though it's 357 times smaller.

Without the CER there is an approximate loss of 45% of the land dedicated to conservation in the region and the other four protected areas become literal "forest islands" amid a sea of anthropogenic development. While each individual forest island will still retain some of its scenic and emotive charms, the eminent tropical ecologist Dan Janzen rightly claims such fragmented habitat islands will eventually end up being "biologically dead" (Andren & Nygren). Over time each fragment will lose species and many of the interspecific and trophic connections taking place between its inhabitants. These dynamic interactions over large areas are necessary for the proper functioning of tropical forests in perpetuity, and thereby provide resilience in a changing environment. Without large, relatively undisturbed tracts of forest like the CER, or at least connections to them, forest islands become reduced, vulnerable versions of what they historically represented biologically. With this in mind, as societal pressures continue to invade on the borders of protected areas, the CER continues to seek donations for additional land purchases to increase and strengthen its conservation value and to make this particular, special tract of forest truly eternal.

gies in the prepared environment is not necessarily new. At lunch our first day, long-time practitioners shared with me that during training in Italy in the 1970s there were similar discussions about the role or proper use of typewriters in Montessori education!

Digital media, like any other tool, has both appropriate and inappropriate uses, especially within the learning environment. Often too much importance or trust is put into the benefits of using technology (Louv). MacDonald (2015) outlined how mechanical tools can cause significant physical harm, but nowadays with digital applications the harm can extend into psychological and emotional realms of the student. John McNamara, during his (2016) conference presentation, rightly stated that the use of “technology needs to be based on the development of the person, and not necessarily the task.” Such statements echo the thoughts of Montessori:

Everything that concerns education assumes today an importance of a general kind, and must represent a protection and a practical aid to the development of man that is to say, it must aim at improving the individual in order to improve society. (*From Childhood to Adolescence* 59)

While I don't dare disagree with John McNamara and his decades of experience, or with the direct teachings of Montessori, in the paragraphs that follow I hope to outline how technology can be used for some tasks, actually required for others, and how the use of such equipment can be used appropriately to aid the personal development and growth of the student. Furthermore, I will attempt to show how a variety of technological tools can combine in synergistic fashion with Montessori training to engage in practical, real-world science and generate much needed data for many unanswered questions about tropical ecology. I will also argue that the Children's Eternal Rainforest in Costa Rica, one of the most biodiverse tracts of rainforest on the planet (see box 1), is not only a great place to learn and practice scientific skills but also a *practical aid* for personal development.

When put in such terms, a scientific exploration of the Children's Eternal Rainforest (CER) may seem like a daunting task for even the most seasoned scientist, let alone a Montessori student. However, by shifting the focus somewhat from the task to the student

(McNamara), I would argue that well-trained Montessori students are exactly the people we want spending extended periods of time in the CER. Imagine a group of fifteen Montessori students from either the upper second plane or third plane programs. Fifteen students would bring fifteen independent ideas and questions that would be investigated and analyzed in meticulous detail using a variety of approaches and technological tools until a pattern or answer emerged. Krumins-Grazzini talked in her presentation how there is no end to learning if the student is interested (the *lightning strike* as McNamara spoke of). With so many species in the CER interacting in one place and at the same time, there is limitless potential for student learning and development. Because of this, I always address each group on the first morning after arriving in the CER with the simple, yet profound reality that in the cosmic view of life no one else in the history of time will be in *this* forest today on trial X at Y time making Z observation. I let them know that their contribution will be unique and meaningful. It's an explicit invitation or push (somewhat literally) on to the trails of the CER so that each student may advance a little bit farther down their own path of personal growth and development.

The experience we offer in the CER is a large part of a program titled "Biodiversity and Peace" ([www.biodiversityandpeace.org](http://www.biodiversityandpeace.org)). This program has its roots in two US based, nonprofit organizations. The first, Friends of the Rainforest (FoR, [www.friendsoftherainforest.org](http://www.friendsoftherainforest.org)) has been sending visitors to the CER and the surrounding Monteverde area and raising tax-deductible donations for the Monteverde Conservation League (MCL, the organization that runs the CER, see box 2) for the past fifteen years. The second organization is the recently incorporated Montessori Institute for the Science of Peace (MISP, [www.constructingpeace.org](http://www.constructingpeace.org)) with the unique vision to nurture human development with the adolescent's commitment to peace. In 2013 FoR and MISP approached the author and a colleague to develop a curriculum with both a local classroom component (Eisenberger & Norris) as well as a site-based, inquiry science experience (Norris & Eisenberger).

The original program design for the experiential learning trip to Costa Rica also includes a one- to three-night visit to the United Nations mandated University for Peace ([www.upeace.org](http://www.upeace.org)). At

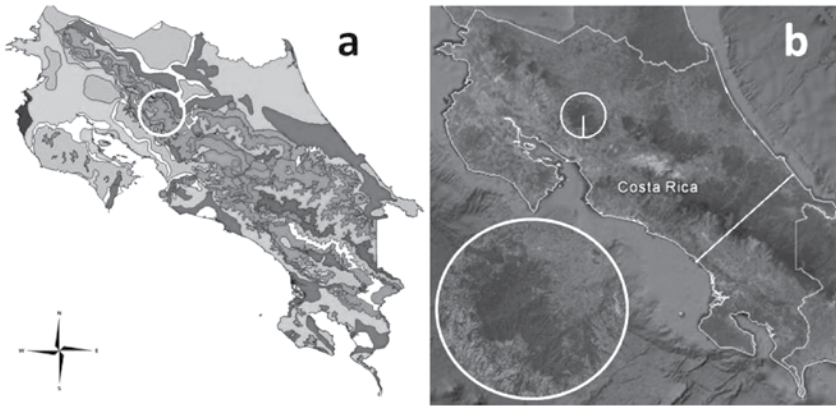


Figure 1. a) Shows the distribution of Costa Rica's 12 different life zones in different colors). Each life zone has distinct environmental conditions that in turn support a particular biotic community (Hartshorn 1983). b) A satellite image of Costa Rica. Dark green areas represent areas of forest. Lighter green areas indicate areas of decreased tree coverage and include agricultural areas (e.g., plantations, pastures). Gray areas show the location of urban centers. In this image only one major urban area, the capitol city San Jose and greater metropolitan area, is visible. Over 55% of the country's population lives in the GAM. In both images the white circle covers approximately 128,000 hectares (radius of 20km) and includes the Children's Eternal Rainforest (CER) and most of the Arenal-Monteverde Protected Zone (AMPZ, see figure 2). In b) the embedded image is a close-up of the CER and AMPZ. The yellow line that runs NE to SW and crosses the southern portion of the country is only 75 km long. However, this line traces changes in elevation from sea level, to about 3,800 meters and back down to sea level. Such changes on both Atlantic and Pacific slopes greatly influence the environmental conditions and the diversity of species that can be found there and is a major driving factor of Costa Rica's biodiversity.

Sources : a) Soto and Ortiz 2004; b) Google Earth Pro 2016

UPEACE students can stay with host families (i.e., cultural and Spanish language immersion), be part of lessons and workshops at UPEACE, and visit a variety of socially responsible NGOs to complement the peace portion of the experience. The remainder of the experience is ideally scheduled for five to seven nights of inquiry science in one of the two biological stations in the CER (San Gerardo or Pocosol). However, modifications have been made to the amount of time spent at each place to accommodate the needs and schedules of each school. Despite the variety of ways in which individual schools modify the trip to Costa Rica, the Biodiversity and Peace experience is not designed as a vacation from school but a *change of occupation*. The site-based experience in the CER, which is the focus of this article, has as its main goals for Montes-

sori students to 1) gain real world science experience, 2) generate much needed baseline data for the CER, and 3) establish a greater connection with nature as part of their individual development towards independence and peace.

The entire CER experience is broken into three periods following a modified experiential learning process (Kolb), or the three-period lesson common to Montessori. The first period is comprised of the first 24-48 hours at the station where students are *invited* to experience the rainforest with interpretive walks led by local ecologists and scientific guides. It's also during this time that they are introduced to some of the technological tools available, their proper use, observation and note-taking techniques as well as the projects or research that the local ecologists conduct in the forest (figure 3). These first few days are crucial to awakening the interest of each

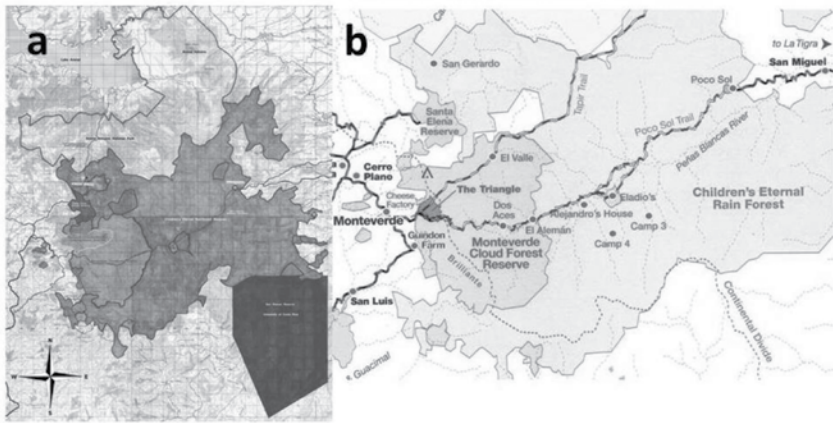


Figure 2. a) Shows the extent of the protected forest sections that make up the Arenal-Monteverde Protected Zone in 2013. Yellow indicates the distribution of the Arenal National Park and is run by the Costa Rican Ministry of the environment. The purple block is the Alberto M. Brenes Biological Reserve and is run by the University of Costa Rica. The pink section is the Monteverde Cloud Forest Reserve MCFR and is owned and managed by the Tropical Science Center. The small blue area is the Santa Elena Cloud Forest Reserve and its run by the Santa Elena Technical High School. The large central green portion is the Children's Eternal Cloudforest (CER) and is owned and managed by the Monteverde Conservation League. The small orange sections are private lands that the CER has not yet been able to purchase. b) A close up view of the CER and MCFR that shows some of the stations, trails, rivers, and their relationship to the Monteverde area. Note the area "The Triangle" is part of the 554 hectares originally set aside by the Quakers in 1951 to protect their watershed.

Source: a) and b) both courtesy of the Monteverde Conservation League

## **Box 2. Monteverde and The Children's Eternal Rainforest: The Soul of Conservation in Costa Rica**

The beginnings of the local conservation movement in Monteverde date back to 1951 when twelve Quaker families from Alabama settled in the area and set aside 554 of the 1400 hectares of land they purchased to protect their watershed (Chornook & Guindon; Nadkarni & Wheelwright). This piece of steep mountain forest became known as *Bosqueterno* (eternal forest), and in the early 1970s it became the cornerstone of the protected Monteverde forests recognized by the Costa Rican government. Eventually this initial investment in nature expanded to approximately 50,000 hectares today, with the Children's Eternal Rainforest's 23,000 hectares laying at the heart of conservation in the region (figure 2a). What makes the story of the CER even better is that the majority of the funds raised to purchase the land came from schoolchildren in forty-four countries. The name for the CER is based on the *Children* who raised and donated the largest portion of funds, and *Eternal* is a reference to the Quaker's original commitment to protect their watershed *Bosqueterno* (Chornook & Guindon).

In 1985 there was a real fear that a road would open up from Monteverde down into the Penas Blancas river valley where there were hundreds of small farms and land claims (Nadkarni & Wheelwright). These land-owners had been after the government for a road that would help get needed materials to help them develop the region. Not wanting to see the relatively pristine Atlantic slope of the mountains suffer the same deforested fate as the Pacific slope, a mix of eight local residents (Quakers, Costa Ricans, US scientists) formed the *Asociación Conservacionista de Monteverde* (Monteverde Conservation League, [www.acmcr.org](http://www.acmcr.org)). With the mission to "conserve, preserve, and rehabilitate tropical ecosystems and their biodiversity" (ACM 2016), their first plan was to protect the forests of the Atlantic slope below Monteverde. While initial funds came from local initiatives like slide shows at the nearby hotels, and international conservation organizations like the Nature Conservancy and World Wildlife Fund; the biggest push to the funding campaign came from Fagervik School in Sweden in 1987 (Nadkarni & Wheelwright).

Sharon Kinsman a US biologist doing research in Monteverde visited Eha Kern's first and second grade classroom at Fagervik late in the year of 1987 (Nadkarni & Wheelwright). She shared with the students a slide show about the amazing diversity of plants and animals in the forests around Monteverde and the potential human development threatening their continued existence in the region. Determined to save the forest and its inhabitants, the students put on skits, shows, sold some of their creative works, and started a letter writing campaign (Hoose).



### Box 2, continued

Initially they made enough to purchase six hectares (Nadkarni & Wheelwright) and before the end of the school year their donations reached \$1,400 with nearly another \$100,000 coming in from other schools in Sweden and the Swedish government (Hoose). In year two, students at Fagervik raised another \$25,000 (Hoose). To help organize fundraising efforts Eha's husband Bernd created the organization Barnens Regnskog (Children's Rainforest [www.barnensregnskog.se](http://www.barnensregnskog.se)), and by 1992 they had raised \$2 million aided by grants from the Swedish International Development Agency (Nadkarni & Wheelwright). Throughout this period other similar student groups popped up in the UK, Japan, Germany, and in the US where Sharon Kinsman had started her own group (Chornook & Guindon; Nadkarni & Wheelwright). Thirty years later this initial spirit that led to the formation of CER can be seen on the face of each student who gets the opportunity to spend time in this special forest.

student. Even after a few hours of initial exposure to the forest, students naturally start asking their own questions and making their own observations. Whether focusing on the known and unknown aspects of the forest, or their own initial role or place within it, these initial questions or feelings are the driving force behind their engagement for the remainder of the experience.

The second period is where most of the time for experiential learning is dedicated. Ideally there are at least three, preferably five or six, full days in the rainforest where students individually, or in small groups, get the opportunity to experiment with their ideas, seek answers for their questions, and to look for significant patterns or processes in the rainforest. It's also during this time that the students start to modify their view of themselves and their relationship to the forest, an essential component during the third period. Work cycles of 3-4 hours each are offered both in the morning and the afternoon. Students get the opportunity to be scientists and collect important data working on projects led by local ecologists or projects they come up with themselves. The variety of occupations is virtually endless. The students learn how different technological tools and scientific approaches can help answer questions they, or others may have about the forest. Better yet, this is also the part of the experience where students start to develop a *pedagogy of place* (Orr) or *foundations of place* (Gruenewald) providing them with greater context for their lives.

Working on both specialist-led projects and their own independent or small group projects, students get real-world experience with identifying questions and how to design a practical method that generates the appropriate collection and analysis of the data that will lead to a conclusion or answer. Nonetheless, many of the discoveries lead to additional questions as opposed to definitive conclusions, a realization that actually mimics the scientific process. At a minimum, we ask all students to share their observations and pictures in the trip computers before the final night at the station. This information is an important part of their experience and reflective process during the third period, but it is also essential to generate the needed baseline data for the CER. These individual personal contributions collectively gain value over time as more and more students participate in the Biodiversity and Peace Program. As such, all of these experiences and observations are being used to build a

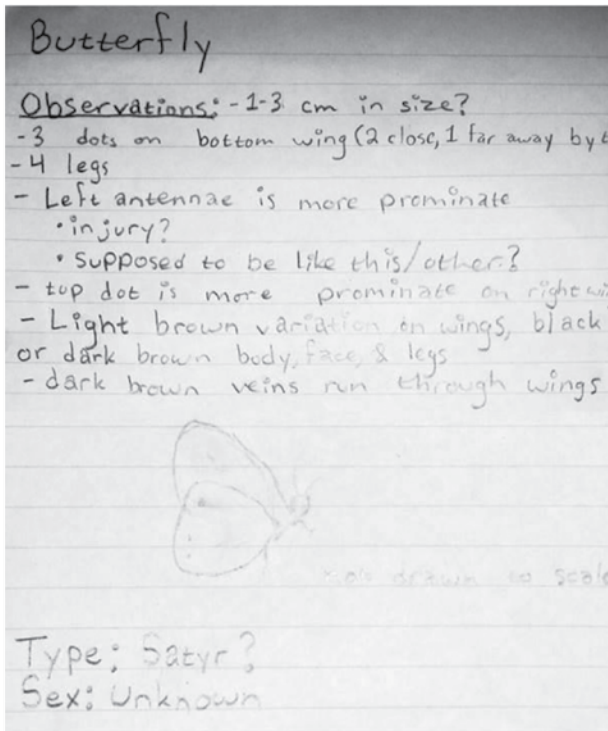


Figure 3. Notes from a third-grade (age 13-14) student's notebook relating to a butterfly she had observed.



Figure 4. Two, upper-second-plane students (age 11) identifying a diurnal moth (*Zegara* sp.) they caught. See inset for a close-up image. The local ecologist working with them determined that this was the first time this species had been documented in the Penas Blancas Valley in 5 years of collecting.

database and interactive maps of what's being documented, where, and when. "Maps tell stories" (Fitzpatrick), and we are simply just trying to tell the story of the CER.

The technological tools employed throughout their time in the CER range from simple mechanical tools like butterfly nets (i.e., a mechanical extension of the arms with large, soft mesh bags that can move quickly through the air as levers) to digital devices like computers and the programs they run, sound recorders, cameras, and GPS units (figure 4). Binoculars were among the first pieces of equipment purchased as they allowed optical magnification of any observation whether 2 or 200 meters away. These simple tools bring each observation or encounter 8 times closer to the observer. The morning ritual of bird surveys or just leisurely bird watching thereby becomes more meaningful as students can see the gradation of colors between groups of feathers and at times the barbs of individual feathers themselves. Digital recorders (both normal and ultrasonic) with sound analysis software allow students to *see* bird,

bat, and frog vocalizations as auditory signals are converted into spectrograms (figure 5). Better yet, the use of this technology allows us to detect the presence of species in the forest even if we cannot see them. However, the technological advance that has most of us

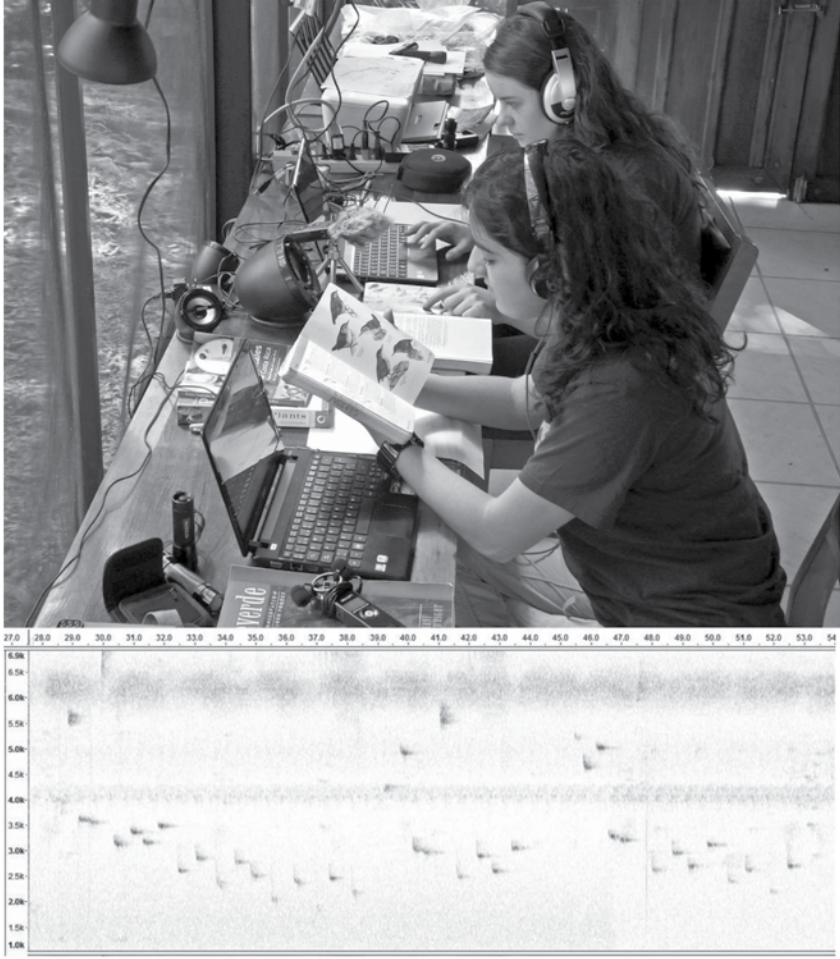


Figure 5. Two, upper-third-plane students identifying and archiving bird vocalizations they recorded earlier that morning. The spectrogram below the picture is from a Nightingale Wren they recorded. It's a bird that's relatively common to the CER; however, it's rarely seen. Creating digital recordings of their vocalizations not only allows us to document their presence, but we can "see" the patterns in their vocalizations using special software. The nightingale wren's call is characterized by single notes that travel up and down the scale between 2,000-6,000 kHz. The gray lines across the spectrogram at 4,000 and 6,000 kHz are insects.

on the edges of our seats every morning are the camera traps that use motion and infrared detection circuits to identify when animals are passing in front of the camera then take images or video of whatever that animal might be. Such specialized technology allows us to detect 24 hours a day all the secretive and nocturnal creatures we share the forest with (figure 6).

As a scientist I get really excited over the possibilities of data that each student and each group generates for the CER. However, as an educator and conservationist the projects that tend to have a disproportionate impact on me are those that demonstrate a deep personal connection with the forest. When a student generates a specific data point, or documents X number of observations, the information generated is likely more important as a piece of the CER puzzle than it is to the development of the student; *unless* the work or effort that went into the task created memories or evoked emotions that take on greater meaning or importance in the life of



Figure 6. A sample of the elusive or nocturnal animals that we usually know of their presence in the CER because they are “captured” with our trail cameras. a) Puma or Cougar, *Puma concolor*; b) Paca, *Cuniculus paca*; c) Great Curassow, *Crax rubra*; d) Collared Peccary, *Tayassu tajacu*; and e) Ocelot, *Leopardus pardalis*.

the student. These moments may be enhanced through technology: like the binoculars that bring the experience of seeing a toucan or monkey visually closer; the wonderment of how a handheld GPS unit communicates with satellites thousands of miles away to know your exact time and location on the Earth; or the student who used digital recorders to quantify that the acoustic impacts of himself and his peers waking along the trails essentially make them 20 meters wider! Furthermore, digital cameras and recorders can save the experience in perpetuity as images, videos, or sound files. These digital reminders could help students revisit their emotions and experiences even after being separated from the forest by great distances and time. Better yet, with such digital files students can easily share the experience with others.

Unfortunately though, seeing the forest through a digital image, video, or recording only invokes one or two of the senses of that experience (even the best photos can't capture the smell of the forest). A picture of a showy flower, a cryptic lizard, or idyllic rainforest scene will not mean as much to someone who has yet to live the rainforest experience. Even I become acutely aware of how my experiences while actually in the forest change when it starts raining or if my batteries run out. It's at times like these I stop experiencing the forest through the filter of a digital barrier. Being in the forest and only equipped with my senses generates a different experience than when actively trying to capture those moments digitally. Trying to capture memories or observations digitally in essence redirects the focus of my primary experience away from my senses and interaction with the forest (Louv). If you think about it, while in the forest, the forest can respond or react to your presence; pictures can't. Your feet slip and leave marks in the soil; a nectaring butterfly flies off as you cast a shadow over its flower. These interactions are the simplest expression of a relationship, mutual exchanges that are only partially generated with digital media, if at all. In the end there are benefits and trade-offs to experiencing the forest with and without technological devices, and such experiences will likely vary with each individual. In fact, it may be the Montessori training and the students' awareness of their interaction with the forest that fuels their personal development independently of the use of technological tools or not.

Finally, it's really only during the last or third period of the experience when we start to view the full value of the program. We bring everyone back together to reflect upon and share with the others their results of what they found or discovered. We often ask everyone to first share those discoveries, patterns, observations (data, information) that they'll leave with the CER and for the next visitors. Secondly we ask everyone to also reflect on a more personal level as to what they will be taking with them, or how they themselves have changed (i.e., emotions experience, lessons learned). It's along this latter approach that I think some of the most meaningful interactions manifest themselves. One student during our first, pioneering group wrote a beautiful reflective piece documenting the personal changes and growth in how she perceived the forest and related to it between the first and last day of her week-long visit to the CER. This was such a strong and moving piece of prose that our curriculum overview (Norris & Eisenberger 2013) is broken into four sections to match her four stages of development, using them as introductions to each section. Then, just this past year, one student asked if his independent project could be to create a reflective, meditation piece others could use during their visit to the CER. The best part of this was that in order to fuel his reflective spirit, he sat in places he liked in the forest and read passages from Darwin's *On the Origin of Species!*

The oneness of this place I can feel through the flux of matter in everything from the earth to the plant to the animal and in every combination thereof. Also through Darwin and education I feel a oneness of life. Darwin focused on the similarities of life when so many focus on the differences.

This trip has made me ponder my place in the world because like anyone who is refreshed by the vastness of nature the more they wonder how I fit into it all. My lessons from this place that I will try to weave into my life are all related to balance and harmony. (Thomas Adams, Montessori High School, Cleveland, OH, 2016)

Students like these are the ones who I know have formed deep connections with the forest and will likely be our best ambassadors for supporting the CER in the future. Like Thomas states above,

“balance and harmony.” As I write I’m realizing that these should be kept in mind for all participants of the Biodiversity and Peace Program. We need to find the balance in how the time is spent in the forest. Should I work on explicitly collecting data and observations or just focus on having a personal experience? Should I use any particular equipment or will my senses suffice? With the conclusion of the third period of the experience, the data, information, or personal contributions students leave behind for the CER or its future visitors may or may not have been influenced by technology. The same goes for the personal experiences and memories they will carry with them once they return home. We recognize that the biodiversity and peace experience in the CER is wholly an individual endeavor, with no one right way of doing it. Our final goal is that all participants will reach that harmony with the forest, with nature, and with oneself by seeking balance in their daily occupations or work cycle. In the end, the best way to experience the CER is with a first-hand visit, but don’t just take my word for it.

There is no description, no image in any book that is capable of replacing the sight of real trees, and all the life to be found around them, in a real forest. Something emanates from those trees which speaks to the soul, something no book, no museum is capable of giving. The wood reveals that it is not only the trees that exist, but a whole, interrelated collection of lives. And this earth, this climate, this cosmic power are necessary for the development of these lives. The myriads of lives around the trees, the majesty, the variety are things one must hunt for, and which no one can bring into the school. (*From Childhood to Adolescence* 19)

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