Developing the Bioliteracy of School Children for 24 Years A Fundamental Tool for Ecological Restoration and Conservation in Perpetuity of the Área de Conservación Guanacaste, Costa Rica

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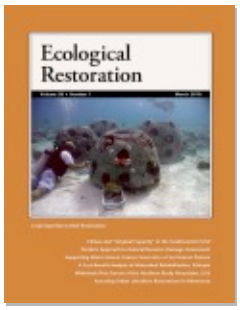

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Developing the Bioliteracy of School Children for 24 Years: A Fundamental Tool for Ecological Restoration and Conservation in Perpetuity of the Área de Conservación Guanacaste, Costa Rica

Rosibel Elizondo Cruz and Róger Blanco Segura

ABSTRACT

The Área de Conservación Guanacaste (ACG, Guanacaste Conservation Area) in northwestern Costa Rica in Central America was created to protect in perpetuity the rich natural diversity found there. The ACG contains an entire range of interconnected ecosystems from the Pacific coastal-marine zone, through dry and cloud forests, to the Caribbean rain forest. Generations of human pressures on the area, including ranching, agriculture, fires, timber extraction, and hunting, have degraded these ecosystems, which are now in a process of regeneration through protection from destructive human use. Although protection is an important part of conservation, the ACG's most potent tool for the long-term conservation of its natural resources is the "biocultural restoration" of its neighbors. The ACG's Programa de Educación Biologica (PEB, Biological Education Program) promotes the bioliteracy of local students, parents, and teachers through field-oriented workshops in its different ecosystems. Through the education of the surrounding community about its natural resources, PEB is restoring the biological understanding of its neighbors with the aim of creating a community that can make better-informed environmental decisions in the future.

Keywords: Área de Conservación Guanacaste, biocultural restoration, biodevelopment, bioliteracy, Costa Rica

The Área de Conservación Guanacaste (ACG) consists of one continuous biogeographic transect of protected area totaling 158,000 ha (Figure 1), extending from the marine area around the Islas Murciélago archipelago in the Pacific Ocean, to the Santa Rosa plateau, up to the summits of Orosí, Cacao, and Rincón de la Vieja volcanoes in the Guanacaste mountain range, and ending in the Caribbean lowlands of Costa Rica (Blanco Segura 2004). This unique biological corridor represents 2% of Costa Rica and contains approximately 335,000 species of terrestrial organisms, totaling 2.5% of the world's biodiversity.

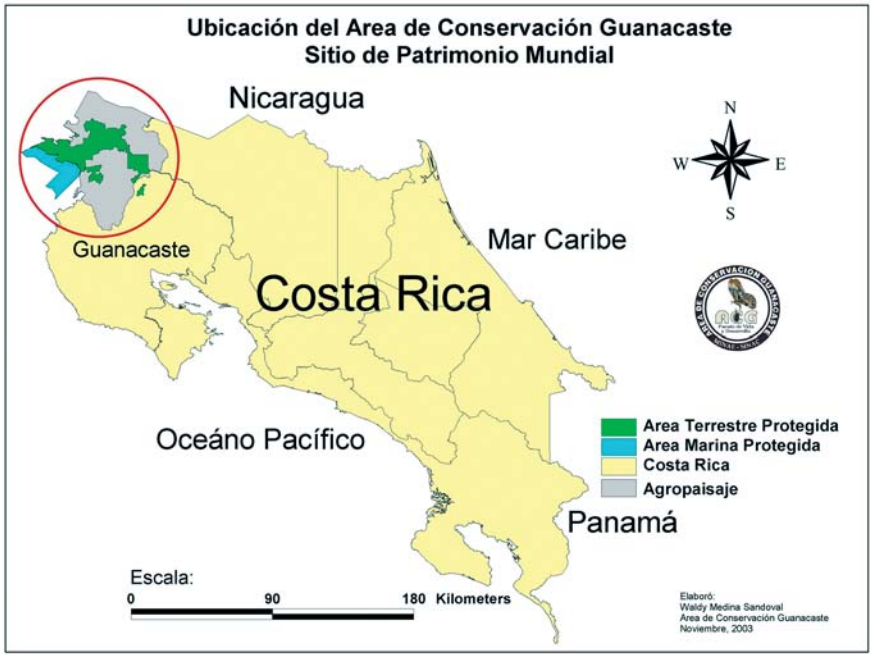

Figure 1. Location of Área de Conservación Guanacaste (ACG) in northwestern Costa Rica. Map created by Waldy Medina

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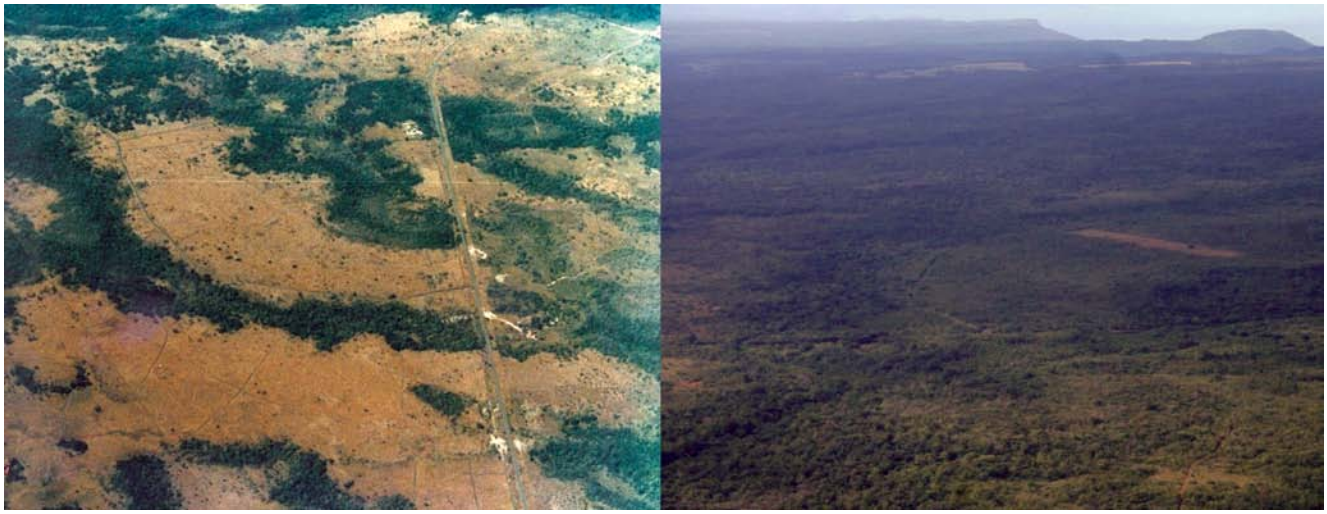

Figure 2. Main entrance to Sector Santa Rosa of Guanacaste Conservation Area (ACG) in Costa Rica showing the dramatic restoration of the jaragua (*Hyparrhenia rufa*) pastures in 1988 (brown patches, *left*) to forest by 2006 (*right*), brought about by the different dispersal agents from surrounding forest patches. Photos courtesy of ACG

The ACG became a World Heritage Site in 1999 because it is important for large-scale biological and ecological processes within terrestrial and marine environments (Blanco Segura 2004).

The process of creating the ACG began in 1986 with the 10,400 ha Parque Nacional Santa Rosa (formed in 1971) as its core, with the goal of restoring a complete dry forest ecosystem. Then about 74,000 ha of old livestock farms were acquired with the objective of protecting and restoring them through the processes of fire prevention and human impact mitigation (Janzen 1986) (Figure 2). With the expansion and consolidation of the protected area into surrounding lands, the ACG's objective became restoring and conserving in perpetuity a complete tropical dry forest ecosystem along with its adjacent cloud forest, rain forest, and costal marine ecosystems, thus representing four of the five principal tropical ecosystems in Central America. Restoration efforts are not limited to dry forest because adjacent ecosystems are also key to the survival of many dry forest organisms that migrate towards these wetter and cooler areas during the dry season. It became obvious that this larger goal was achievable only by integrating society with the ACG through what we call biodevelopment (non-destructive use).

Fire prevention, scientific research, forest restoration and silviculture, integration of the local society, and provision of environmental services are some of the experiences and innovative processes developed as part of the active management of the ACG that have been fundamental in reaching the goals of restoration and conservation. The most important of these innovations has been promoting the bioliteracy of school children in the communities that surround the ACG (Janzen 2001a, 2001b, 2002a, 2002b).

From the beginning, the ACG staff has recognized that along with efforts to consolidate, restore, and conserve ecosystems, we must also develop strategies to implement "biocultural restoration" of the society, especially the younger generations. We focus on young people because they will inherit in one way or another the power to make the decisions that will impact the ACG and the environment in their communities and the country. In order to reconnect people with nature, the environment, species and their natural history, ecological interactions, processes of ecosystem restoration, and basic biology, the ACG established the Programa de Educación Biológica.

History

The Programa de Educación Biológica (PEB) took its first steps in 1986, thanks to a donation by the Noyes Foundation (USA), making it possible to bring students from the neighboring Colonia Bolaños school to the dry forest for the first time. The program officially began one year later, in 1987, with 4th, 5th, and 6th graders from six neighboring schools, ranging in age from 9 through 12, who participated in the bioliteracy program along with their teachers. Then in 1988, PEB received legal standing with the school systems through an agreement signed by the Ministerio de Educación and the ACG, allowing it to legally take children from their classrooms to PEB's natural bioliteracy classrooms in a variety of habitats and ecosystems in the ACG.

Between 1994 and 1995, PEB was able to extend the program's outreach to more schools and communities thanks to a grant from the Danish government. Following this achievement, PEB won more funds from new private donors (Ecodesarrollo Papagayo, Escuela Agroecológica Hylton, Innocent Foundation) and also added funds from ACG's endowment and the Costa Rican government. The program now consists of eight bioeducators, three buses and drivers, four rural

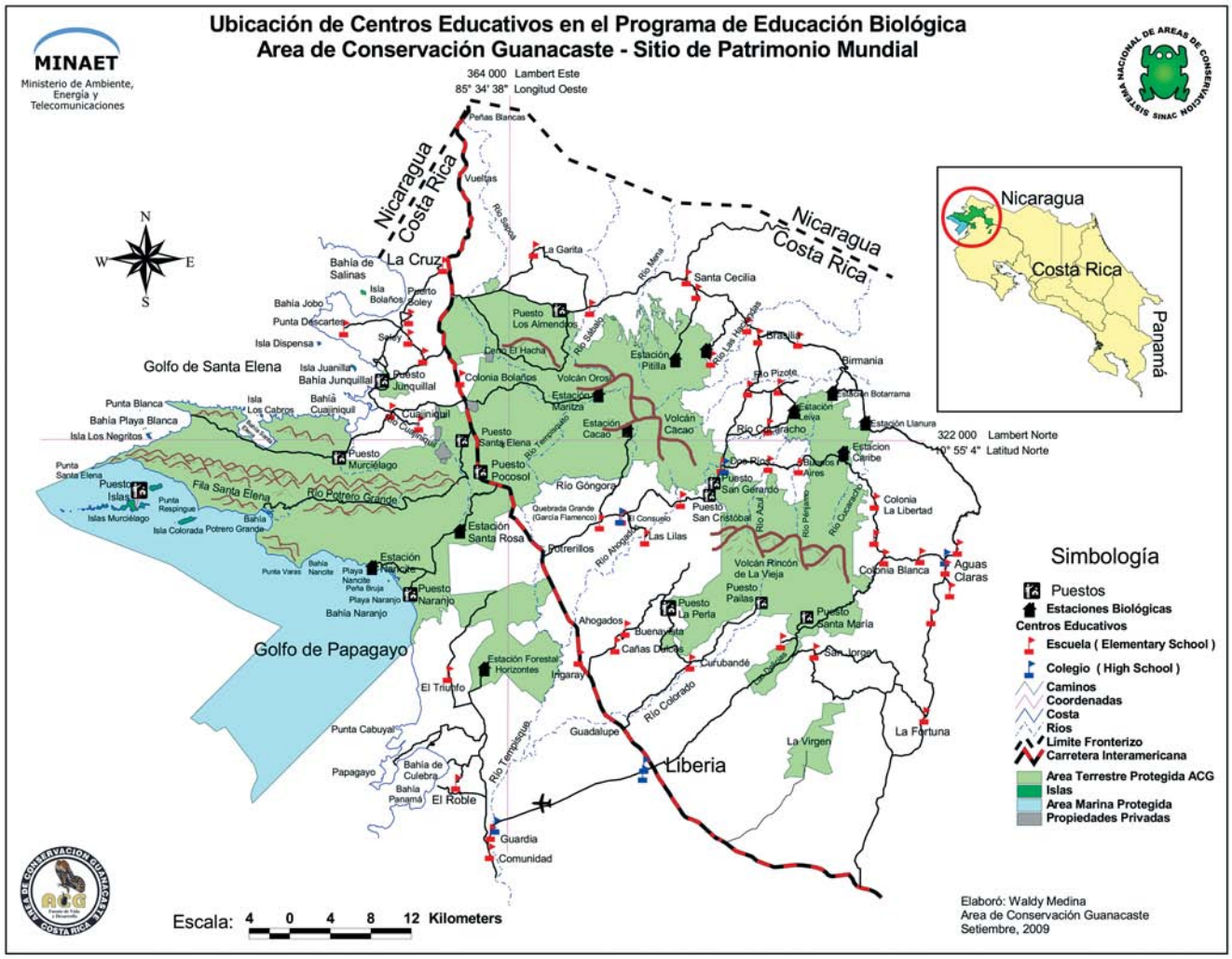

Figure 3. Education Centers in the Biological Education Program (PEB) of the Área de Conservación Guanacaste. Map created by Waldy Medina

vehicles, and four operating centers (one each in the dry forest and marine zone and two in the wet forest) and extends to 2,540 students from 52 schools (45 elementary and 7 middle schools) in 46 communities (Figure 3). The entire student population surrounding the ACG is now immersed in the process of biocultural restoration parallel to the conservation and restoration of the ecosystems.

What is Biocultural Restoration?

Biological education is teaching biology and ecology in the field utilizing species, forests, rivers, tide pools, mangroves, and all the ACG's habitats as labs where the students can see, feel, learn, experiment, and touch this living textbook. The students are then able to identify and comprehend through their own experience the dynamics of an ecosystem and the natural environment in which their community is immersed. This type of hands-on learning allows students gain a greater sensitivity toward environmental issues, thus developing better criteria for making environmental decisions in the future. The last goal of biological education is to change community attitudes toward natural resources; this social process is called biocultural restoration. Through the various activities, students also identify some human actions that alter the natural equilibrium of the forest and propose positive actions society can institute.

Traveling in the program's vehicles, students, teachers, and parents have the opportunity to visit the different ecosystems in the ACG, where

Figure 4. Students measure the diameter of a tree in a mature forest site, Sector Santa Rosa, Área de Conservación Guanacaste. Photo by R. Elizondo

bioeducators guide them systematically in the learning process through a series of field trips planned each semester. Each student has the opportunity to take at least four field trips each school year, with an average of 16 outings in the four years the student is involved in the program.

Figure 5. Students analyze the damage caused by fire in the control site (*left*) and compile an inventory of species present (*right*) in the regeneration site, Sector Santa Rosa, Área de Conservación Guanacaste. Photos courtesy of ACG (left) and by R. Elizondo (right)

Teaching Ecosystem Restoration through Biological Education

Field trips (7 a.m.–3 p.m.) are structured as a series of activities that expose the students to a range of topics from basic biological principles and species natural history to more complex themes such as dispersal, predation, connectivity and fragmentation, biogeography, and restoration. Utilizing educational materials (guides, note cards, games, and experiments) they've developed, the bioeducators guide student participation in activities according to the curriculum for each ecosystem.

One of the first field trips, for students beginning their study of the dry forest and the effects of hundreds of years of human use, is visiting two demonstration sites initiated in the 1980s by Dr. Daniel Janzen that document the process of restoring dry forest from jaragua (*Hyparrhenia rufa*) pastures through the suppression of anthropogenic fires. Jaragua, an African grass introduced by ranchers in 1940, is highly combustible, thus facilitating the spread of fires and suppressing forest regeneration, which is the principal problem facing the tropical dry forest (Janzen 1986). The control site is burned annually in the middle of the dry season (February/March), and the regeneration site is protected from fire. The control site remains covered in jaragua and a few other plant species, while wind-dispersed and later animal-dispersed plants slowly colonized the regeneration site, forming the 25-year-old secondary forest present today.

Students learn about the suppression of fires and the recolonization of the plants and animals through their various dispersal strategies and how the shade created by the new arrivals and the continuing suppression of fire eliminates the non-native species. To understand the differences between the two sites, the students complete a comparative table with the following instructions and questions (Figure 4): identify plants found in the site; describe how the trees look; are there fruits; are there animals or evidence of them; and what other organisms are there (Elizondo Cruz and Romero 2000). Afterward, the students visit dry forest sites in later stages of restoration to learn how the forest structure changes over time until reaching the most natural state possible.

In this way and through other activities, the students learn how natural succession occurs in the dry forest and come to appreciate the harm done by setting fires and the time it takes for the forest to recuperate (Figure 5).

Other Restoration-Related Education Efforts

Since 1989, Sector Horizontes of the ACG, headquarters of the Estación Experimental Forestal Horizontes and the Programa de Restauración y Silvicultura have conducted research on native dry forest timber species. Students are brought here to compare the establishment of tree plantations with the natural restoration process of the dry forest.

In the student activities in rain forest areas, PEB takes advantage of the ACG's efforts to consolidate territory and mitigate the effects of localized climate change caused by historical land uses, including higher soil temperatures and reduced river flows. Students also study the restoration of pasture to rain forest through the elimination of star grass (*Cynodon nlemfuensis*), an introduced African species. The well-studied and fast-growing gumhar tree (*Gmelina arborea*) is planted to create dense shade and kill the grass while also creating perches to attract birds and small mammals that disperse colonizing plant species from nearby forests (Figure 6).

Mangroves, intertidal zones, and other coastal habitats of the ACG are also studied. Again students learn about the species, ecological processes, human impacts, and natural restoration. For example, when visiting the mangroves, they learn that this ecosystem is a natural nursery for many economically important species and that they can benefit from these fisheries when they mature and disperse, as long as the protected area is maintained and the ecological equilibrium

Figure 6. *Gmelina arborea* plantation in the Rincón Cacao Biological Corridor in 1999 (*left*) and 2008 (*right*). Photos courtesy of ACG

is respected, thus providing an example of biodevelopment.

Throughout the ACG's history biological education has allowed students, through hands-on observations and investigations in the field, to understand the natural and anthropogenic activities that facilitate the recuperation of the ACG's ecosystems, which were altered by former generations who today are trying to restore them (Figure 7).

The ACG will continue to use biological education or bioliteracy as a fundamental tool for the biocultural restoration of the present generation of our Costa Rican neighbors, complementing our efforts of consolidation and ecological restoration of this World Heritage Site. The 24 years of the PEB have yielded important results. Schools involved with the PEB are participating in national science fairs with environmentally themed projects. Students who participated in the program have gone on to become employees of ACG. Local communities now inform ACG when problematic activities like hunting, burning, or timber harvesting occur in protected areas, and these activities have decreased over time.

Figure 7. A bat researcher interacts with students at a workshop on biodiversity in Sector Santa Rosa, Área de Conservación Guanacaste. Photo by P. Vazquez

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