NECTANDRA INSTITUTE

Jan 2016, Vol. 16 No. 1

Emerging Forests, Emerging Land Stewards

Not too long ago, I paid a visit to the very first piece of land purchased by one of our community partners. The purchase was made thanks to our Eco-Loan Program, an initiative by which Nectandra Institute has offered land-acquisition financing to local community water management associations and similar organizations for almost nine years. Our community partners use these loans to buy important watershed land and restore it to forest. Their primary motivation is protection of freshwater springs and groundwater recharge areas. In lieu of paying monetary interest on these loans, Nectandra's partners pay ecological interest—the time, financial, and other resources they put into ecological land restoration and protection, as well as educating their community about its importance. Exploring that first eco-loan financed property recently, I was reminded of the first time I saw it: 27 acres of steep slopes with extremely compacted and deteriorated soils of a former cattle ranch. That initial visit served as the inspiration for my original contribution to Nectandra's newsletter series. In our June 2008 edition, I described how difficult and physically demanding it was to traipse around the property in order to mark out the most suitable areas to begin restoration efforts, before planting a single tree. I remember feeling not only exhausted after that work, but also overwhelmed and somewhat disheartened at the thought of the long road ahead, aware that a forest takes decades to restore. Even then, it is never the same as what was originally cut down. My impatience made it difficult for me to think beyond the immediate future, and I wondered whether I would get to see any tangible restoration progress at this or any of the other properties purchased by our first eco-loan partners.

For the first few years after that, the slow and mostly imperceptible changes didn't do much to make a dent in my original sense of discouragement. However, more recent visits to eco-loan financed lands have inspired a different feeling in me. Coming across trees that have grown several meters (see photo) since they were planted as seedlings barely a few centimeters tall, looking out at what was once cropland now covered in a thick blanket of naturally occurring vegetation, and learning about newly discovered springs at some of the sites (perhaps as a result of the land's improved capacity to absorb precipitation), all make me feel that although the road ahead continues to be long, the journey is most certainly underway. The destination is a little closer than it was when we began.

The emerging forest on these community-managed lands seems to parallel a growing sense of environmental stewardship in our community partners. That is fortunate, because Nectandra Institute's conservation work depends heavily on these local partners, both individually and collectively.

Sept 2015: Nectandra Institute's community partners tagging a tree on the property purchased with the first eco-loan in 2007

An ecologically-aware, engaged public is key to the long-term sustainability of these conservation efforts, which ultimately have to be locally led to ensure success. It is critical that the important relationship between well-protected forests and healthy water resources be well understood by the general public and not just a few people. Nothing is achieved if Nectandra Institute helps local leaders acquire land for conservation, only to have those efforts neglected or deprioritized when the reins are handed over to new decision-makers. Our task is made much more difficult, given that our conservation work is carried out primarily in Costa Rica's upper Balsa River watershed, an area that has been severely deforested. The competition for land use, particularly from agriculture and dairy farming, makes setting aside land for protecting or restoring forests a tough proposition. For this reason, our Eco-Loan Program has always been carried out in conjunction with our Education and Outreach Program. Through this two-pronged approach, Nectandra Institute achieves our mission of promoting cloud forest conservation: firstly, by contributing directly to real, on-the-ground conservation projects and secondly, by employing various educational and awareness-building strategies to build a local citizenry that values and upholds these projects not only now, but well into the future.

As the signs of progress are becoming evident at our community partners' restoration lands, there are also signs that our public is becoming more receptive to our Education Program's message of watershed protection and forest conservation, and also more fluent in it, as well. An example of this is the evolution of our New Culture of Water Month, now heading into its ninth year. This annual educational festival (detailed below in the "recent news highlights" section) started out in 2008. That inaugural edition consisted of three or so small events conducted primarily by Nectandra Institute staff. In subsequent years, the festival has grown larger and our community partners have increasingly taken on more responsibility for its planning, fundraising and sponsorship, and carrying it out. Organizers, presenters, and participants are mostly local folks. Sponsorship for the festival comes largely from community water management associations, the area's co-ops and businesses, as well as local government. In one festival event, sixth graders showcase their knowledge of ecology, the environment, and watershed science in a friendly competition among the region's elementary schools.

Sept 2015: Costa Rican singer-songwriter Olman Briceño, whose music touches on the themes of conservation and cultural preservation, performs during New Culture of Water Month

Nectandra Institute welcomes the idea of taking a back seat to our community partners as they increasingly take on some of the initiatives we have introduced to the area and make them their own. This is exemplified by the Liga CUENCA, a consortium of local water management associations that came into being with support from Nectandra. Liga CUENCA is now the umbrella organization for New Culture of Water Month and some of other projects that originally sprung from our Education and Outreach Program. The consortium is also on the verge of starting its own eco-lending initiative and has obtained seed funding to do so. With upcoming information and results from a hydrogeological study commissioned by the Liga CUENCA for the upper Balsa River watershed and surrounding areas, forest restoration and conservation efforts will become more targeted to the lands that hold the highest hydrological value.

As I observe the parallel progression of ecological restoration and our partners' sense of environmental stewardship, I get the impression that they are feeding off each other. Just as I have become increasingly encouraged by growth of the nascent forest on the lands undergoing restoration, so have the local people we work with. This feeling of encouragement seems to be accompanied by added motivation and a sense of pride in the restoration of the land. Outside individuals and organizations are now regularly expressing interest in coming to the upper Balsa River watershed to see what is happening, and our community partners are eager to present their work. The motivation inspired by these encounters and from simply taking stock of restoration progress leads them to implement even more conservation measures, which result in more ecological dividends and so on. With a little luck, the cycle will continue.

— *Luis Villa* —

Poisonous Snakebites

Over the last decade, the number of poisonous snake encounters at the Nectandra Cloud Forest Preserve has gone up noticeably. While the risk of snake-bite is low for our trained crew or cautioned visitors, it is not zero. There are at least five species of poisonous snakes that keep us vigilant when we are outdoors, on the trails, and occasionally even indoors. Four are pit vipers (jumping pit viper, fer-de-lance, stripe palm pit viper and eyelash pit viper) and one a coral snake. We know their appearance, their behavior and where they are usually found. For example, the thick-bodied jumping pit viper (*Atropoides picadoi*) has always been the most common on our trails. They are often tightly coiled and nearly invisible under the heavy leaf litter. When sensing a source of heat (such as one of our hikers' bare legs) or threat, it rears up half of its thick but short body, gapes its mouth wide, and wait for further threat. More often, jumping pit vipers are seen immobile (probably digesting) sometimes for days in the same position in the same spot. In those cases we would flag the spot and ask everyone to work around it. The next most common sighting is a coral snake (*Micrurus nigrocinctus*) on the move. The colorful red, yellow and black rings give them away, hence easily avoidable. Coral snakes are by nature more reticent to bite with their small fangs. However, unlike the vipers that eject its victim after biting, the coral snake injects its neurotoxin while holding on to its prey and gnawing its teeth to work in its venom. The two arboreal vipers, the green-colored stripe palm pit viper (*Bothriechis lateralis*) and the eyelash pit viper (*Bothriechis schlegelii*), are both very colorful yet perfectly camouflaged against the foliage and tree trunks. I have seen many pairs of the palm vipers near the ground during the mating season but the eyelash viper only on trees. The one snake that causes us the most anxiety, of course, is the large fer-de-lance (*Bothrops asper*). It was previously an uncommon viper at the preserve, but is increasingly seen in the last five years. Fast moving, excitable, unpredictable and aggressive, its venom can cause rapid and irreversible tissue necrosis. It is the most feared and is responsible for almost half of the snake-related hospitalization in the country. But do more sightings mean more snakes? Or are they simply more active during the day with climate change, hence more chance of our seeing them? According to the monitoring at the neighboring Alberto Brenes Mora Biological Reserve located 30 km north of us, the increase is real. Their

catch-and-tag experiment showed that the number of jumping pit vipers within their study plots has indeed increased over the last few years. In our rural county of Alajuela, the reported incidence of snakebites is now up to ~50 snake bites per 100,000 people annually (*L Chavez et al, Science Adv. Sept 11, 2015*).

At Nectandra, we stock lyophilized, polyvalent anti-Bothrops serum, as well as anti-Micrurus (coral) on hand for emergencies. So far, we have had to use only the anti-coral serum and only once. Our guest investigator's accidental bite took place at night, which was fortunate as the nearest public hospital was not at all crowded. The time interval between the snakebite and the time of arrival at the hospital emergency entrance was less than 30 min. This was also fortunate, as the coral neurotoxin can cause irreversible damage after two hours. We got help well within that time limit. Once there, the hospital staff worked swiftly and effectively. They first administered one tenth of the total dose of antiserum, waited for two hours to check for adverse reactions to horse serum, then infused the rest of the dose intravenously over the next 4 hours. The patient was discharged the next morning, sent to a larger hospital in San Jose for a more thorough consultation and several days stay at a nearby inn while under observation. The patient recovered uneventfully. Since we provided our own antivenom, the local emergency room did not charge any fees for their treatment.

Had the same accident occurred in the US, the experience would have been far more costly financially. In the US, the price of a vial of anti-viper serum is around $2300 wholesale. Multiplied by the 4-6 vials needed per treatment, plus a hospital stay, the total treatment bill reported can be well into the 5-6 digits! The unimaginable charge of $2300/vial is attributable to the lack of anti-venom producer in the US. In fact there is only one FDA approved commercial source (BTG Plc) of anti-viper venom available currently, and none for anti-coral. The last producer of anti-coral (Wyeth) quit the market thirteen years ago and the stockpile has expired. The FDA has recently (finally) approved the products of a Mexican firm (BioClon at one tenth the price of the US competitor) whose products are not available in the US until 2018.

The manufacturing of antivenom has not changed substantially since 1890 when Albert Calmette developed anti-snake serum while working in Vietnam. That year, a flood near Saigon flushed out cobras that promptly bit 40 people causing 4 deaths. Inspired by his professor Louis Pasteur's work on the anthrax and rabies vaccines, Calmette injected horses with increasing but non-lethal doses of cobra venom until the horses became immune to the effects of the venom. The serum from the vaccinated horses, in turn, provided passive immunity in humans after snakebites. The same procedure is still used today. What has changed is that the work is no longer done in a single geographic location nor in a single facility. The production of the antitoxin sold in the US starts in Utah where the snakes are housed and milked for their venom. The milk is shipped to Wales to be processed, then to Australia to be injected into sheep (in lieu of horses). The sheep serum is flown to England to be purified into antivenom. Finally the therapeutic grade antiserum circumnavigates back to the US to be sold and used. However, the cost of all this represents only 0.1% of the final $2300/vial cost, as other costs such as clinical trials (2%), licensing, regulatory/legal fees (27 %) and hospital markup (70%) have to be figured in.

By comparison, at the Insituto Clodomiro Picado of the University of Costa Rica, one of a few antivenom producers in the world, the snake farming, the horse husbandry, venom collecting, processing, quality control testing and research are all done at the same location. In 2014, it produced 90,000 vials of high quality human and veterinary antivenom, half of which is used domestically. The other half is exported to other Central and South American countries, plus Africa where most of the world snakebite fatalities occur. The cost per vial is $20 as of our last purchase.

If one is to be bitten by a poisonous snake, Costa Rica must be among the best countries where it could happen!

— *Evelyne Lennette* —

Nectandra Institute (NI) Recent News Highlights

**** Reported by Luis Villa ****

July: Liga CUENCA, the consortium of community water - management associations that NI helped create, put on a successful cattle auction to raise funds for the ongoing hydrogeological study commissioned for the upper Balsa River watershed. The study's technical information on the state and vulnerability of the area's water resources should give Liga CUENCA and NI a better framework to maximize the protection of forest and local groundwater recharge zones and springs.

July: NI and community volunteers completed annual tree-measurements on restoration plots within several of the properties purchased with eco-loan assistance. The annual tree growth data offer valuable information regarding the future choices of native species trees for restoration.

August: Young community volunteers worked with NI staff to collect aquatic macroinvertebrates along streams and rivers in the upper Balsa River Watershed. We have been monitoring these organisms semiannually since 2009 in >20 stream locations. Some of these organisms are known to be tolerant to organic pollution, while others are not. By analyzing the mix of insects found at each site, we can infer something about the quality of the water at that stream location.

August: Tree planting work continued during this year's rainy season on eco-loan financed properties. Residents of La Palmita joined efforts with volunteers from the consulting company, Accenture Costa Rica, planting over 200 trees on two plots within the property purchased in 2008. The steep terrain on this 11 ha property has been particularly challenging to reforest.

September: Student volunteers from University Studies Abroad Consortium learned to work with the samples of macroinvertebrates obtained last month from various points

along streams and rivers in the upper Balsa River Watershed. They classified the specimens by family. A water quality score is calculated using a formula that takes into account the level of tolerance to contamination of each type of organism.

September: NI and its eco-loan partners celebrated the 8th annual New Culture of Water Month, which promotes the importance of protecting water resources, forests, and watersheds. Popular holdover events from prior festivals were a part of this year's edition, including the inaugural celebration, the New Culture of Water Queen Pageant, featuring candidates wearing dresses made from recycled materials and responding to questions on environmental or conservation-related topics, and the CRECER competition, which tests the ecological knowledge of teams of students from several of the watershed's different grade schools in an academic decathlon-type format.

September: The E. Ann Gallie Nature Sanctuary and Persea Reserve, the most recent additions to the 390-acre Nectandra Cloud Forest system of reserves received approval under the country's innovative Payment for Environmental Services (PES) program. Owners of properties under the PES scheme receive an incentive payment for protecting and/or restoring forest cover on their land. Costa Rica's PES program, created in the mid-1990s and financed primarily by a tax on fossil fuels, is a federal mechanism to curb the country's deforestation.

September: Liga CUENCA obtained official corporate legal status. Although the organization has been active for five years, it can now qualify for financing opportunities allowing it to achieve its objectives and goals—to protect local water resources, forests, and watersheds, and to administer its own eco-loans through a grant from the InterAmerican Foundation. NI expects Liga CUENCA and other consortiums of water management associations will play a key role in scaling the eco-lending initiative.

October: NI hosted students from the University of Costa Rica studying eco-tourism for a visit to two eco-loan financed restoration sites. One of the sites was Finca Ocotea, a 250-acre partially deforested property acquired in 2009 by AFAMAAR, a local conservation organization. Finca Ocotea is at the very top of the Balsa River watershed in NI's priority geographic program area.

November: NI staff biologist, Manrique Esquivel, and university student volunteer, Paola Solano, appeared on local television to discuss the latest findings of the stream water-quality monitoring project. The television time was part of the eco-interest contributed by the community-owned station.

Water resources management students from Costa Rica's National Technical University toured an eco-loan property purchased in 2008 by the community water management association of Tapezco. The students wanted to see results of the rural community's 6-year effort to restore the watershed above the town's piped freshwater spring, from agricultural land to emerging forest.

December: Michelle Gonzalez completed her NI internship to satisfy the final graduation requirement of the Colegio Técnico Profesional Piedades Sur, a nearby vocational high school. During her two months with us, Michelle provided invaluable assistance with the promotion of our amphibian-monitoring project. She created online publicity videos, made announcements on social media, and spread the word in general about our Amphibian Citizen Science project. Residents in the nearby cantons of Zarcero, San Ramón and Naranjo are encouraged to send in photos of frogs, toads, and other amphibians and to share them on Nectandra's Facebook page along with the date and location where it was taken. Our staff biologist then identifies the species and enters the sighting report in a database for future analysis.

December: Tex Hawkins, an old friend of Alvaro Ugalde, NI's late founding president, paid us a special visit. Tex was a Peace Corps volunteer in Costa Rica in the late 1960s and worked with Alvaro during the early development of the Santa Rosa National Park, the country's first. Tex graciously contributed his words to *Alvaro Ugalde: A Retrospective*, a special website created to honor Alvaro's memory and serve as a reminder of his conservation legacy. The website, accessible via www.nectandra.org, includes anecdotes from Alvaro's friends, family and colleagues, Alvaro's personally narrated oral history, several of his writings, and videos featuring him.

December: NI helped organize the sixth annual Conteo Navideño del Bosque Nuboso de Occidente (an Audubon Society-sanctioned Christmas bird count in the San Ramón area of Costa Rica). NI is a founding organizer of this yearly event together with the Fundación Bosque Nuboso de Occidente. This year, approximately 60 birdwatchers participated in groups of three to four people each, spread out over almost 20 different routes, one through Nectandra Cloud Forest Preserve and another through the first eco-loan financed property. The official 2015 results are still being tabulated, but the 2014 edition resulted in 318 species of birds and 5391 individuals observed during a 24-hour period. This represents over a third of the almost 900 avian species found in all of Costa Rica. Birds play a very important role as seed dispersers in forest restoration projects.

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