Amigos Newsletter

No. 75, May 2011

Who We Are

The Las Cruces Biological Station is one of three tropical field stations owned and operated by the Organization for Tropical Studies (OTS) in Costa Rica. Along with the Wilson Botanical Garden, Las Cruces was acquired in 1973 and is a hidden jewel that offers natural history visitors and researchers alike an extraordinary place to visit and conduct research.

Far from the noise and bustle of the country's capital city San José, Las Cruces is located in the remote southwestern corner of the country between Corcovado National Park on the Osa Peninsula, and the enormous La Amistad Biosphere Reserve (472,000 hectares) that spans south-central Costa Rica and western Panama. In 1983, UNESCO declared Las Cruces and the Wilson Botanical Garden part of the Reserve due to its incredible diversity and proximity to La Amistad.

The Wilson Botanical Garden, founded in 1962 by Catherine and Robert Wilson, is arguably the most important botanical garden in Central America and a "must see" stop on the itineraries of plant lovers, birders, and other natural history groups. It is famous for its worldwide collection of tropical plants which include palms, aroids, bromeliads, gingers, marantas, heliconias, and ferns. More than 3,000 exotic species of plants can be found in the 10-hectare (~ 25-acre) garden, including one of the largest collections of palms in the world.

There is an incredible diversity of animals at Las Cruces, and in the immediate area surrounding the station. The most recently updated bird list includes 410 species; close to half the number of birds found in all of Costa Rica. There are also over 100 species of mammals, of which 61 are bats. Some of the more commonly sighted mammals include agoutis, white-faced capuchin monkeys, kinkajous, olingos, and tayras. Reptiles and amphibians also thrive in this moist, cloud-laden habitat and there is an impressive diversity of insects, and in particular moths and butterflies.

Las Cruces protects over 200 hectares of primary forest (home to over 2,000 native plant species) and several smaller adjacent areas that are in various stages of forest recovery. The forest is surrounded by a mosaic of mixed-use agricultural fields and forest patches, and it is this fragmented setting that makes Las Cruces an ideal place to study the effects of forest fragmentation and isolation on animal and plant communities. The landscape surrounding Las Cruces is also ideally suited for research on biological corridors and restoration ecology; key fields of research that are of ever increasing importance. Part of our mission at Las Cruces is to continue to purchase land for reforestation and, in doing so, expand our protected areas and connect some of the isolated forest fragments around the station. For further information on this campaign please visit our website.

At approximately 1,200 meters elevation (3,900 feet), the prevailing temperatures at Las Cruces are cooler than one might expect. Temperatures range from 21-26 °C (70-80 °F) during the day and 15-21 °C (low 60's) at night. Mean annual rainfall is ~4,000 mm (157 inches)! The dry season runs from January – March, and the rainy season from May – November. Most visitors and researchers come during the dry season.

The station is well known for its visitor-friendly amenities: comfortable private sleeping quarters, delicious meals, knowledgeable and enthusiastic staff, and a well-maintained network of paths and trails. We also provide internet access to overnight visitors who bring a laptop computer.

The nearest town is San Vito, the capital of Coto Brus County. It was settled in the 1950's by Italian immigrants and to this day there is a strong Italian presence. There is an excellent pizzeria, and the Dante Alighieri Italian-Costa Rican Community Center provides language instruction. Indeed, Coto Brus is the only county in Costa Rica where Italian forms part of the elementary curriculum!

We invite you and your family and friends to come visit us for an afternoon, an overnight stay or a week to see and experience firsthand the splendid tropical diversity of the Las Cruces Biological Station and Wilson Botanical Garden.

For more information please visit the OTS website at http://www.ots.ac.cr/ or contact us directly by email: lcruces@ots.ac.cr. Postal mail can be sent to: Estación Biológica Las Cruces/Jardín Botánico Wilson, Apdo. 73-8257, San Vito de Coto Brus, Costa Rica. Telephone (from the U.S.): 011 (506) 2773-4004.

Reservations can also be made by contacting the OTS office in San José by email edu.travel@ots.ac.cr, postal mail: ESINTRO/OTS, Apdo. 676-2050, San Pedro de Montes de Oca, Costa Rica, or by telephone (from the U.S.): 011 (506) 2524-0607.

The North American OTS office is located at Duke University, telephone: (919) 684-5774 or email: nao@duke.edu.

The Organization for Tropical Studies is a nonprofit consortium of universities and research institutions in the U.S., Costa Rica, Peru, Mexico, South Africa, and Australia.

Founded in 1963, OTS is dedicated to providing leadership in education, research and the responsible use of natural resources in the tropics. To this end, OTS offers graduate, undergraduate and professional education, facilitates research, participates in conservation activities, conducts environmental education programs and maintains three fields stations in Costa Rica: La Selva Biological Station in the Atlantic lowland rain forest; Palo Verde Biological Station in the Pacific deciduous dry forest; and Las Cruces Biological Station in the premontane cloud forest near the Panamanian border.

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Front Cover: A couple of spooning *Coprinus disseminatus* spotted on the Río Java Trail. Photo Ellen Woods (see What's New section for further information on Ellen).

Back Cover: Curly sporangia lurking on the underside of a fern leaf. Photo Ellen Woods.

Director's Keys and Notes

The old so-called 'bat house' that is about to undergo a major renovation. Photo Zak Zahawi.

Zak Zahawi/zak.zahawi@ots.ac.cr

Bats. Those furry little creatures of lore that have found themselves on the wrong side of too many tall tales and horror stories, have become a new (well, not really new anymore) passion of mine. I am honestly not sure what it is that catapulted me into bat-fever -- perhaps it was a bat-induced bite, but that is unlikely. I am a plant aficionado at heart and ever since I entered the biology profession I have always been very plant centered. So what happened?

It started with a bat biologist (of course) who wanted to set up a sampling scheme in our restoration research sites. My main collaborator and I thought it a good idea and so my job, by virtue of being close to our research sites all year round, was to help her get set up. And so out I went for a mist-netting session in the dark. I had done birds before and enjoyed the experience; scrambling around in the dark staring at mist-nets seemed an odd twist on the practice but I was nonetheless curious. Of course I couldn't take them out of the nets – not having the practice of doing so and more importantly, lacking any rabies vaccinations. Instead I began as a helper to the helpers – shining more light on hapless bats in nets, pulling twigs out, and then carrying a few back to the processing station once they had been removed from nets and 'safely' stuffed into cloth bags. Or so I thought. On one such return to the processing station, one bat managed to squeak out a bite of a finger through the bag! Actually it was more like a nip than a full on bite… but it hurt and of course bled a little. What ensued were a couple of unsettling weeks wondering whether I would/should get rabies shots. In the end I didn't. Based on the culprit species, the probability that it would have rabies was even less than that of a house cat – theoretically possible I was told but in reality 0% chance.

Since that first night, however, I have never been the same (!) and I have slowly upped my participation in successive bat outings and equipped myself with all the

…and the new state-of-the-art cozier bat-condominium. Photo Zak Zahawi.

necessary shots and resources that one should have in order to work with bats. I now pull bats out of nets with great gusto (if I may say so myself), and I can sit down at a makeshift processing station in the middle of nowhere and take measurements and data – of critters that move and chomp and chat away… but that also look at you at times with the cutest boogly eyeballs imaginable. And sometimes (if they get a little chilled), they'll just choose to have a little cling to you (upside down of course) until they decide it is time to head out again [the big bat project at Las Cruces that is run by a crew from Stanford University bring a cooler with a hot water bottle in it that heats them up again and in no time they are ready to dash out into the night].

The bat saga has taken an odd twist recently with the latest infrastructure improvement grant for the station. Part of the grant called for the overhaul of the white house down by the main forest entrance. The house, that has been abandoned for more than 10 years now, is home to a huge colony of bats and is often dubbed the 'bat house' by researchers and station staff. Much debate has ensued over what to do with these furry LC residents, as the house needs to be completely gutted in order to be fixed. Worse still is that regardless of this initial disturbance they will not be allowed to return as residents once the house is all fixed up. So, given that plants and animals have priority here, we built a new (state-of-the-art) bat house for the white house residents and as a 'transition' stuffed the new house inside the old in the hopes that they will start to colonize it. A few weeks later we set the new house out in the forest near the old house and now hope that they will make it their new home. I am quite sure many people would come to the conclusion that we have completely lost it at Las Cruces – or at least I have at any rate. Never mind. We will of course be calling the newly remodeled residence *'Artibeus'*, a good bat genus given its history.

There are a total of 61 species of bats registered in the greater Las Cruces area - incredible diversity to be sure. To highlight that point, another way of saying it is that more than half of the mammals found here are bats! They play prominent roles in many ecosystem services – ridding us of many a biting insect, pollinating flowers, and dispersing all manner of fruit under cover of darkness. Although there are specialist pollinators and frugivores, most species vary their diet depending on the resources available in the surrounding landscape. Then of course there are those that are big enough to catch a mouse or other rodent – in short an incredible array of specializations in just one group of animals. Pretty impressive in my opinion, and all too frustrating that they get the short end of the stick for all their many endeavors and environmental services – certainly when they are sized up against birds, the daytime winged group that has a much bigger global fanbase than do their furry nocturnal cousins. My tendency in life has always been to support the underdog so perhaps that only adds to my pique in interest!

Perhaps I didn't get rabies on that first bite (or nip as it were) by a little bat in a bag all those years back – but that nip might have been what set me off into a rabid obsession from which I have never emerged. As long as there are active bat projects in the region, I plan on going out regularly to trundle around in the dark and see which, of these 61 little furry cuties, we might encounter. There is something to be said for doing biology in the middle of the night!

Saludos,

Zak

What's New at Las Cruces?

Zak Zahawi/zak.zahawi@ots.ac.cr

Las Cruces Growing Pains Update

As we go to press again the many projects slated for construction in the last edition of the newsletter have gotten underway. The fourth researcher cabin is now complete and has had its first set of guests; renovations to the 'white house' down by the entrance to the forest (aka the 'bat house') have begun; the Las Cruces Canopy Tower broke ground in February and the foundation was poured –we anticipate completion sometime in May; the expansion of the laboratory and the cold storage rooms is well underway; the second floor of the herbarium was completed in late December, and we are eagerly awaiting the arrival of the new storage cabinets; and, finally, improvements in IT were initiated in February and a second phase of improvements will be done in May once the physical infrastructure improvements are completed. Hopefully by the time of the next edition of the Amigos newsletter the dust will have settled and we can be showing off all our new wares to Station visitors. In the meantime, we have five construction crews active at the station at the same time; surely a record for this field station!

The freshly dug pit from which the Las Cruces canopy tower will soon emerge! Photo Zak Zahawi.

More on Our Databases

Our databases continue to grow at a steady pace. The database that likely has expanded the most is the herbarium, which now has more than 2200 accessions. Around 1500 have a high-resolution image on our digital website (www.ots.ac.cr/herbarium). The Wilson Botanical Garden database has also taken shape nicely. We now have all accessions from 1991-2011 entered and have also entered 1962-1964 (www.ots.ac.cr/jbw). In all more than 1500 accessions, or around 10% of all entries have been made – obviously we still have a ways to go. Finally, we do have other baseline data for the station including species lists for trees, mammals, birds, and amphibians and reptiles. All these checklists can be downloaded from our website (http://www.ots.ac.cr/lc-species). I hope you are making use of all these great resources!

Florula Las Cruces

We'll soon be adding a new database to the afore mentioned ones. On our wishlist for quite a while has been a Las Cruces Digital Florula site. This would complement the herbarium and botanical garden sites by providing photographs of native species in their natural setting and, more importantly, images that capture detail that points out the key identification characteristics of a particular species. In fact, we already have several thousand images of different species just waiting for their new home to appear on the web. Aiding us with these images is Ellen Woods, a volunteer photographer who has been cataloging thousands of images in and around the Las Cruces area since last September. To date she has taken more than 2,000 images and both the cover and back of this edition of the newsletter are examples of her work. Many more of her fantastic images will be uploaded to the Las Cruces Florula once the site becomes available – in the meantime you can browse some of her photographs at: http://www.flickr.com/photos/ellenwoods/.

Research at Las Cruces

Can we Restore Nutrient Cycling Function? Restoring Tropical Forest for Biodiversity and Litterfall

Danielle Celentano / danicelentano@yahoo.com.br

The beautiful scene of leaves and flowers calmly falling like a dance from the trees to the forest floor inspired Vivaldi in *Autumn.* But, more than an artistic inspiration, litterfall is part of a key ecosystem function: the terrestrial nutrient cycles. When we think about tropical deforestation, the idea of plant and animal extinctions scare us. But, the *unseen* effect of deforestation on the cycle of nutrients is also catastrophic. Remember that all chemical elements and molecules operate in a closed system on Earth. All elements are being recycled constantly; this mechanism occurs at different scales and elements can be accumulated for long ("reservoirs") or short periods ("exchange pools"). Forests are considered exchange pools for almost all elements. The most famous is carbon, since it is already affecting our climate. However, the cycle of several other key elements (e.g. P, N, S, and Fe) has also been altered due to human activities and it can drastically affect the Earth's long-term carrying capacity.

Litterfall is a fundamental process in nutrient cycling as it represents the main transfer of organic matter and mineral elements from above-ground vegetation to the soil surface. Litterfall decomposition involves a series of interactions between organic matter, soil microbial (fungi and bacteria) and invertebrate communities. This simple process sustains a chain of life. When biomass decomposes in or on the soil, nutrients may either remain in the soil in mineral form, be incorporated into soil biomass or soil organic matter (immobilization), be taken up by plants, or be lost from the system by leaching or as a gaseous form. It was to demonstrate the importance of this process that the scientists from the Millennium Ecosystem Assessment, called nutrient cycling a *life support ecosystem service.* It means that this is one of the processes that sustain life on Earth.

So, what can we do? Tropical forests and their *ecosystem services* are still threatened from logging, agricultural expansion and other direct and indirect drivers of deforestation. At the same time, huge areas of degraded lands are being abandoned in the tropics. This was my concern when I left the Brazilian Amazon in 2008 to do my Msc. studies at CATIE in Costa Rica. I wanted to learn about the Costa Rican experience of conservation and focus on restoration of forests. Once in Costa Rica I learned that most forests here are secondary and that the restoration of these areas was the result of land abandonment due to beef and coffee market crash.

Secondary forests play an important role in mitigating human impacts. In addition to providing habitat, conserving biodiversity, and supplying material goods, they restore ecological processes such as nutrient cycling. However, the recovery of tropical forests can be strongly limited by a range of biotic and abiotic factors. Lack of seed dispersal in the landscape (mainly birds), seedling competition with introduced pasture grasses, and decreased soil nutrient availability have been identified as important barriers. Natural succession was part of my interests, but I also wanted to learn strategies to overcome these barriers and to actively restore degraded lands. This is how I met Dr. Rakan (Zak) Zahawi from the Las Cruces Biological Station.

Dr. Zahawi and his colleague Dr. Karen Holl from the University of California were carrying on an innovative project on tropical forest restoration that compares natural regeneration to two active restoration strategies (uniform mixed-tree

plantation and tree islands) as models for restoration that may be applicable in other tropical regions, such as the Amazon. I fell in love with the "tree island" restoration method. It mimics the natural regeneration process known as nucleation, where patches of successional vegetation create microhabitat favorable to late-successional species. Considering the restricted budget for restoration initiatives in tropical countries like mine, this method may represent a more cost effective and feasible restoration strategy.

More than restoring habitat for biodiversity, these restoration strategies potentially accelerate the reestablishment of ecosystem functions, such as nutrient cycling when compared to natural succession. I addressed this assumption carrying out a one-year field research on litterfall dynamics, decomposition and soils. Treatments were plantation (entire area planted with a mix of species); islands (planting six tree islands of three sizes); and control (no planting or natural regeneration). The species used in the plantation and island treatment were two native timber-producing hardwoods (*Terminalia amazonia* and *Vochysia guatemalensis*) intercropped with two nitrogen-fixing species *(Erythrina poeppigiana* and *Inga edulis)*. The restoration plots were 4 years old when I started my project. To evaluate if these systems really accelerate the reestablishment of nutrient cycling, I also sampled young secondary forests (7-9 year growth) as a fourth treatment.

Danielle in the field taking a few measurements.

The results of my research show that litter production was much higher in the two active restoration strategies studied (uniform mixed-tree plantation and tree islands) as compared to areas under natural regeneration (controls) after five years. Plantations showed higher litter production than islands due to higher tree density and canopy cover. Actually, litter production in the plantation treatment was similar to secondary forests that were 3-5 years older! However, secondary forests had higher litter quality (greater nutrients concentration and lower C-to-nutrient ratios) and higher input of all nutrients to the forest floor except N when compared to the plantation plots. Different species composition and plant diversity is most likely driving the differences we found between plantations and secondary forests in terms of nutrient quality. This suggests that biochemically, plantation and secondary forest do not function in the same way – even if they produce similar amounts of litter. Indeed, litter decomposed faster in secondary forests than other treatments.

A few leaves hanging out. Photo Danielle Celentano.

Tree planting is the most widespread strategy to restore tropical forests and there is an increasing focus on planting a diversity of native species. However, as in our case many restoration efforts rely on a small number of commercially-available species. Our results show that planting a small number of fast-growing trees to facilitate tropical forest recovery promotes the development of a rapid canopy cover that shades out grasses and provides large amounts of litterfall, similar to more diverse secondary forests. However, high-density large-scale plantings of a few species can result in lower litter quality, depending on the species selected. Accordingly, restoration strategies with more heterogeneous planting designs, such as tree islands, are less resource intensive and promote a faster increase in litter diversity and more spatial heterogeneity, which can accelerate the rate of nutrient cycling and facilitate forest recovery. Another strategy to promote higher species diversity and better litter quality would be to plant a larger number of species at the outset or once the canopy has established and site conditions are appropriate for later-successional species, but this approach implies higher costs.

Climate Driven Change in Species Composition of Tropical Forests

Shafkat Khan / shafkat1@uga.edu

The extent to which anthropogenic climate change will affect tropical forest composition and function is hotly debated in the scientific community. The United Nation's International Panel on Climate Change conservatively predicts an increase of 3-5 degree Celsius in tropical regions over this century, and there are a number of theories about what this increase in temperature will do to tropical forests globally. There is an increasing understanding among climate change ecologists that changes in precipitation associated with temperature shifts are likely to be crucial to how tropical forests respond to climate change. However, we have inadequate empirical knowledge of how these changing climatic factors will affect tropical forest composition. Like any good scientist, yours truly grabbed this opportunity to examine how different tropical tree species respond to variable climatic factors such as temperature and precipitation.

There is widespread consensus among climate change scientists and ecologists that tropical landscapes will experience considerable effects of climate change. We know from predictive climate models that precipitation in the neotropics will be strongly affected by changes in global temperature with a predicted 10-20 percent (possibly up to 30 percent locally) decrease in annual precipitation. Coupled with a 3-5 degree Celsius increase in mean annual temperature, change in climate will result in forests that are very different in composition and function than the forests of today. Tropical forests store one-fourth of global terrestrial carbon in living biomass as well as in the soils. Accordingly, there is reason for genuine concern if these forests were to stop sequestering carbon and even worse, start to release stored carbon as a result of higher respiration rates associated with higher temperature and less photosynthesis from drought stress. However, we simply do not know whether tropical forest species can prevail at higher temperatures and lower precipitations and if they can, how their growth is affected by such changes. These are questions central to my study at and around Las Cruces Biological Station.

A typical transplant day at higher elevation plots (with me bossing around and Claudio working hard).

You may recall from your visit to Las Cruces the mosaic of pasture, agriculture and forest fragments that span the landscape. This is not very different from other parts of the tropics: more than 60% percent of tropical areas do not have primary forest cover anymore. However, with economic development and migration to cities throughout the tropics, post

agricultural landscapes are becoming much more common. We have set up our plots in abandoned pasture sites to address this increasing need to understand how forests will grow on these post agricultural lands with climate change.

We are examining whether tree seedlings from a cooler, moister environment can grow in a warmer, slightly drier environment. We are also examining tree species that are found at both ends of this climate continuum (from cool and moist habitat to warm and drier areas) to see if individuals from a cooler environment can survive and grow as well as individuals of the same species from a warmer environment. Instead of experimentally warming the soil and air (very expensive to do), we are using an elevation gradient near Las Cruces to mimic projected changes in climate. In our study we have selected an elevation range from ~600 to 1400 meters that spans about 22 kilometers across the landscape. The lower elevations in this gradient are on average 4-5 degrees warmer than the higher elevation sites, with more episodic precipitation patterns as predicted by climate models. We also have reduced cloud covers at lower elevations, which mimics the future drier, and less cloudy environment of the higher elevation sites. In essence, lower elevation plots very effectively mimic future climate for higher elevation in this elevation gradient.

On the same experimental plots, my colleague Fern Lehman is examining how insect herbivory on leaves of the tree seedlings varies in response to climate change. Coupled with data on plant growth, the herbivory study will give us a clearer picture of how plant-insect interactions will be affected by climate change.

So far we have seen higher mortality of species from high elevations planted in the warmer climates of lower elevations. We have not seen a major effect of climate yet on the seedlings of species that span the whole elevation gradient. To clearly elucidate the effects of climate change on our chosen experimental species, we transplanted a couple of thousand additional seedlings in the summer of 2010. We are hoping that during the summer census of 2011, we will be able to measure and predict with more certainty the effect of a warmer growing environment on plant seedlings.

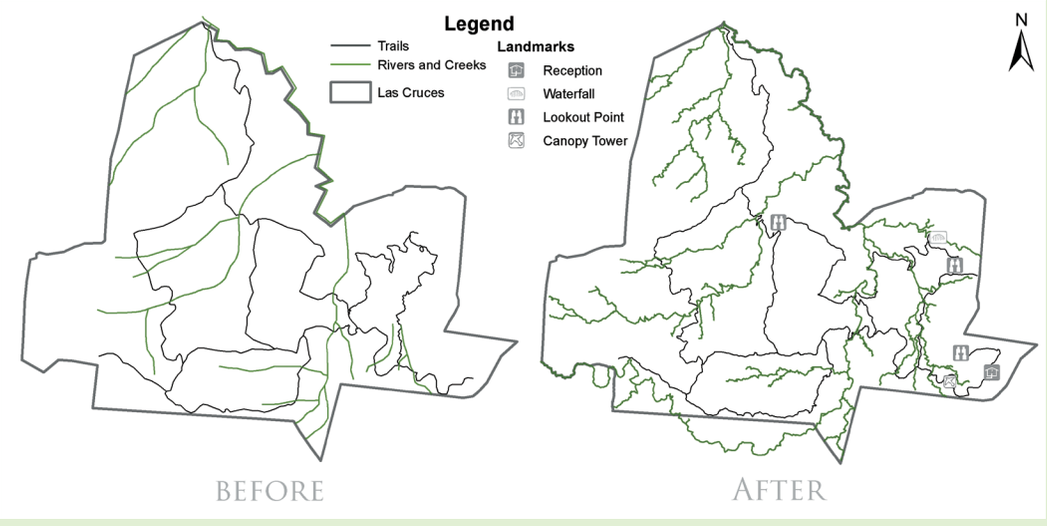
With the findings based on this project, our lab at UGA is hoping to improve our scientific understanding of how climate change will affect tropical tree species and tropical forest composition in general. We are also hoping that this study will spawn other studies based at Las Cruces to gain a more comprehensive understanding of climate change on tropical forests.

A low elevation plot. Both photos are taken around the same time of the day. Typically, the higher elevation plots are much cooler and cloudier than the lower elevation plots throughout the day.

"We are hoping that during the summer census of 2011, we will be able to measure and predict with more certainty the effect of a warmer growing environment on plant seedlings."

GIS Corner

GIS Updates at Las Cruces



The newly mapped watershed network of Las Cruces.

Mauricio Sarmiento / mauricio.sarmiento@ots.ac.cr

In the last newsletter, we talked about updates that were underway to the basemap of the Station. Well, now we have finished: the northern and southwestern limits of the Station were updated and all watersheds within the property boundaries were mapped with a GPS device.

With respect to the boundary of the Station, the upgrade involved modifications to the area of the Las Cruces Biological Station, which now has a total of 326.49 ha (806.78 acres). In terms of watersheds, we have a total of 22.4 km between permanent rivers and creeks, however, in the rainy season this value could increase. The greater watershed of Las Cruces is made up of 17 creeks and 5 rivers, including the Java River, which is the main waterway in our forest. The watershed has many attractive areas typically associated with beautiful waterfalls, however at present only one is accessible from the Water Trail. In the future we would like to connect additional waterfalls to our trail network.

In addition to mapping the entire watershed, all trails were updated and Las Cruces now has 12.7 km of trails in different types of forest, including the Java Trail's newest fork that leads to the Canopy Tower that is currently under construction. We continue to debug and document cartographic metadata, and information on boundaries, land use, and contours of the Las Cruces Biological Station will soon be ready.

Manual and automatic capture of meteorological data continue, and we have completed the analysis of precipitation and temperature with respect to water balance. We can say that 2010 was the warmest of the last five years, with a maximum mean record in March (21.17°C), and coldest months with minimum mean temperatures in November and December (18.24°C – 18.28°C, respectively). The years 2008 and 2010 are notable, because in general these were the coldest years, 2008 being the colder with an average temperature of 19.41°C. However, in general the temperature pattern remains the same: the first four months are warmest; June, July and August have average temperatures; and the three last months are coldest.

The precipitation pattern is similar: the three first months are dry, then the rains begin and remain for the rest of the year with extreme values in October and November. December typically marks the beginning of the dry season. To compare precipitation over the last five years we find that 2010 was the wettest year (4942 mm/year) and 2009 was the driest (3060 mm/year). Historically, February is the driest month with a minimum record in 2010; November is the wettest month with extreme records in 2005 and 2010, however May 2007 had an extreme record of 895 mm.

Finally, we have obtained the information and data that relates to the AMISTOSA Biological Corridor from CATIE (Tropical Agricultural Research and Higher Education Center). We hope this project will resume this year and that we can make technical contributions to its development with the help of Dr. Fábio Suzart de Albuquerque of the Centro Andaluz de Medio Ambiente in Universidad de Granada – España.

Flora and Fauna

Knocking on Establishment Doors: The Fate of the Plants at the Wilson Botanical Garden

Rodolfo Quirós F. / rodolfo.quiros@ots.ac.cr

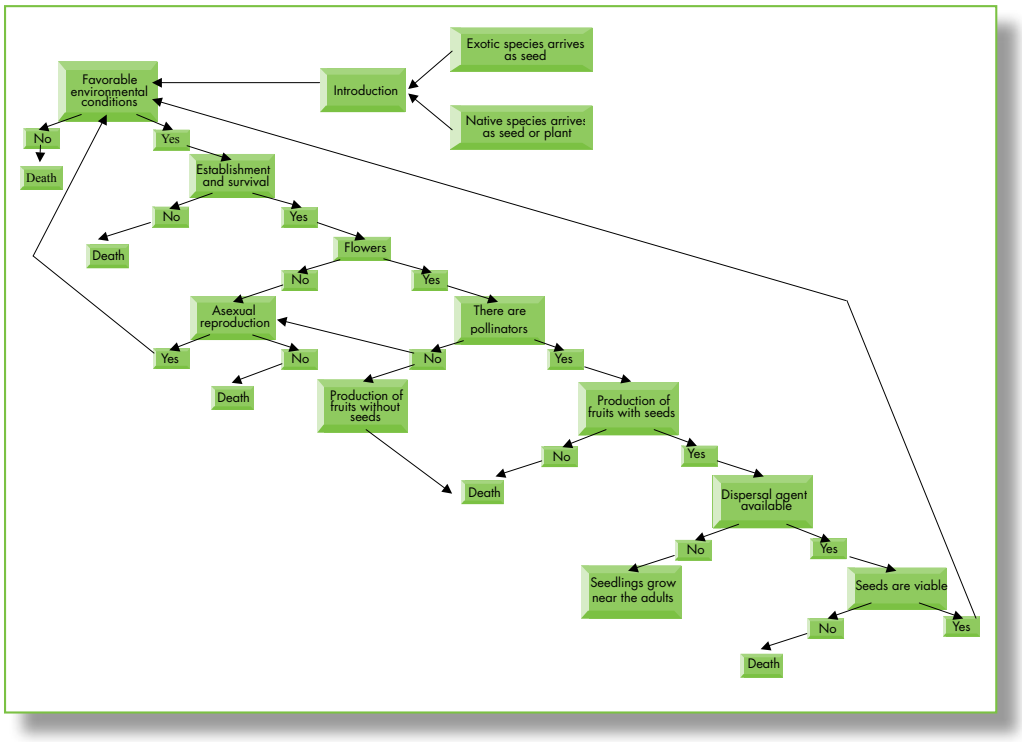
The plant collection at the Wilson Botanical Garden is very dynamic in its development and relations with other organisms. After 50 years of the establishment of the Garden, many of the introduced species show signs of adaptation to the prevailing ecosystem, both in relation to environmental conditions (climate, soil), and in their relationships with animals. Even though the records indicate a large number of species introductions (Amigos Newsletter No. 72, November 2009), in practice many of these species have encountered barriers and have not survived or had limited success.

The accompanying figure summarizes the barriers found by the plant species for their establishment and development in the Wilson Garden – I call these barriers "doors" that the species have to knock on to enter the next level of development. The diagram is based on approximately ten years of observations, and shows different phases that occur in the development process for it to be successful. For each phase, there is a negative and a positive outcome. The species die in most of the negative situations, with the exception of those plants that have the ability of reproducing asexually. On the other hand, if the outcomes are positive in each case, the species grows adequately and continues until one cycle is successful; thus, after several successful cycles the final result is the establishment of the plant in place. Actually, among the plant collection at the Wilson Garden you can find species in the different phases of this process.

Many of these species have not crossed some of those barriers –"open the door"- so their establishment is not successful. But most of the species find appropriate environmental conditions and survive. This, in part, is facilitated by the fact that most of the species are originally from tropical environments similar to the one at Wilson. Furthermore, in many cases the incoming species are nourished in the shadehouses prior to their exposure to the open field where they will thrive after being planted. Once they have survived in the environment, the next step is flower production. The main problem for establishment is the availability of pollinators, for the exotic species not always finds the right pollinating agent. Some species find a pollinator due to the fact that there may be similar species as in the place of origin, or because they are generalist species in relation to pollinating agents.

If pollination occurs, the next step is the production of fruit with seeds. The barrier here is the presence of dispersal agents for the fruit. In the case of the Wilson Garden and its surroundings (mainly the forest protected by the Las Cruces Biological Station and its neighbors) there are enough birds and bats (see "Who We Are" on page 2 of this issue) that can act as potential long-distance dispersal agents for these plants. The last barrier in the process is the viability of the seeds. If they are viable, the species will survive with a population that will adapt better to the prevailing environmental conditions in the new place.

This description is true for any kind of plant in any environment; however, an exotic plant in the native natural forest of Las Cruces (or anywhere) may take a few or many years to get established.



De la Comunidad

Let's Travel with "Eco-Teaching Suitcases"

Andrea Montero & Ariadna Sánchez
andrea.montero@ots.ac.cr / ariadna.sanchez@ots.ac.cr

In view of the accelerated loss of natural resources and the rapid growth of the human population, there is an urgent need to increase awareness on the importance of conservation of our natural resources. Environmental education is a critical tool to convey and interpret information about how to implement solutions for the environment.

Since 1982, the Ministry of Public Education (MEP) in Costa Rica has integrated environmental issues in the academic program (1). This is a cross-curricular topic that should be taught in four basic courses. Although this initiative has had positive results, there are still limiting factors that create obstacles in the teaching process, especially in the remote areas of the country. Lack of training for teachers in environmental topics, and a lack of materials to work with are two of these obstacles. Recent studies on Costa Rican education indicate that many schools in Coto Brus (Las Cruces is part of this group) have limited resources for academic instruction and also present one of the highest dropout rates nationwide (2).

The mission of the OTS Outreach and Environmental Education Program (OEEP) is to work together with local communities to develop an understanding of the environmental issues in the region, the country, and the world. The OEEP at Las Cruces has been working with different audiences over the past few years, (decision makers, groups of women, indigenous groups, school children, and others) and has determined the need to focus on one of the more strategic audiences: educators. Educating teachers is an effective way of creating a multiplier effect on students of all ages, and we think that this is more likely to happen if they become masters in innovative didactic techniques. Accordingly, the OEEP has designed a project that will offer greater opportunities for school teachers and local leaders through the facilitation of didactic tools to help in the teaching of science and environmental education.

Example of an Eco-Teaching Suitcase. Photo Ariadna Sánchez.

Thanks to the financial support of the HB Fuller Foundation, the project of *"Eco-teaching Suitcases"* will now be possible! This project will offer greater opportunities for teachers through the use of didactic tools for school children in this remote region of Costa Rica and will be accomplished through a fun, interactive, and participatory process with kids that fosters a responsible and positive attitude towards the natural resources of the region.

The first stage and main outcome of this project is the development of a handbook or manual for teachers in charge of educational cycles I and II (7 -12 year old students) within the national education program (Ministerio de Educación Pública: MEP). This manual will contain different topics related to environmental conservation and will offer guidelines for the development of student activities. The manual could be used as part of any school curriculum where the teachers are able to apply the tools, but will most likely focus on science and social studies. It includes education activities for different environmental topics (waste management, water resource conservation, biodiversity, climate change, sustainability practices) in accordance with each educational cycle. Each activity will describe objectives, procedures, materials,

Once the first suitcase is produced, it will be distributed to schools in the area.

Example of some of the materials contained in an Eco-Teaching Suitcase. Photo Ariadna Sánchez.

time period, suggestions for school projects, useful links, and other topics.

The second stage is the creation of an *Eco-Teaching Suitcase,* which will contain the didactic materials and tools needed to facilitate the teaching-learning process. The list of school supplies, materials and equipment includes not only daily work items for each student in a classroom (crayons, glue, scissors, etc.), but also board games, models, CDs, videos and more. Each suitcase can vary in the amount and type of materials according to the educational cycle and the environment issues.

Each *Eco-Teaching Suitcase* will include a manual and suggestions for teachers. Some of the initiatives proposed are the incorporation of the MEP's *Bandera Azul* Program ("Blue Flag"), how to establish school gardens, participating in local recycling collection centers, or reforestation projects, which would benefit not only the educational community, but also members of the community in general, and thereby increase the audience that would benefit from this project.

Once the first suitcase is produced, it will be distributed to schools in the area. Teachers will "borrow" the suitcase and use it for a period of time, which can vary (between 2-4 weeks) depending on the size and remoteness of the school. The suitcase will travel to at least four different schools, and have an impact on hundreds of children and their teachers.

Some activities suggested by the Eco-teaching suitcase need to be performed *in situ* in natural ecosystems. Las Cruces Biological Station represents the largest forest fragment in this region and is the only protected area neighboring many schools. OTS will open its doors to schools during this process to attend and carry out these activities with advice from the developers of the suitcase.

This campaign requires the hiring of a part-time assistant in order to help with the design and implementation of the project and will follow dissemination strategies that will cover information about the project and OTS OEEP in order to achieve greater financial and technical support for financial sustainability. By making eco-suitcases accessible to this community, the possibilities of having informed, responsible members of the community will increase exponentially as will the possibilities of an improved quality of life.

References

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Breaking Ground for the Canopy Tower, back row from left to right, Contractor Juan Araya, Architect Felix Villalobos, SVBC Members Doug Wilson, Michael Olivieri, Dave Woolley, Linda Wilson, Lydia Vogt and Fred Schroeder. Front row, Construction Expert Isidro Murillo, Las Cruces Station Manager Emilce Ramírez, SVBC Members Jean Schroeder and Alison Olivieri, Las Cruces Director Zak Zahawi and SVBC Member Julie Girard. Photo by Harry Hull.

Donations, Please!

Alison Olivieri / maoawo@gmail.com

Between the relatively newly-batty director and the renovations, new construction, and technical upgrades going on around here please allow me to register this complaint officially -- there is hardly space to turn around. Nearly every building is full of tools, drills and construction detritus. As a result, volunteers and staff are all a little discombobulated. What is truly amazing, however, is Station Manager Emilce Ramirez who is in charge of all of this yet calmly keeping her desk from disappearing under the work orders, invoices and receipts!

Where this leads is, inevitably, to exhortations, pleas and politely-worded but urgent requests for help from you, our *Amigos* newsletter readers.

As you may have gleaned from the Director's Notes and Keys, those bats need a new home, our intrepid human researchers need housekeeping services and three "squares" a day, the plant collections need constant attention, and so do the trails and gardens. It's a daunting business running a Research Station, a botanical garden, and a hotel and we need your generous help with operating support (times 10) to keep us going!

This brings me to our two outstanding special projects:

The Canopy Tower fundraising efforts are 90% complete. We need $4,000 more to move from the poured concrete platform to a Ribbon Cutting Grand Inauguration ceremony. The accompanying photo shows us in a semi-giddy state on February 15 when some resident and vacationing San Vito Bird Club members and donors showed up to help our contractor Juan Araya and his work crew captain Isidro Murillo get that festooned shovel in the ground! We have since regained our senses and realize we must ask you for your support yet again to bring this project from ground level up to the trees.

The Biological Corridor-Land Acquisition Campaign: our director may be batty by night but he is determined by day to connect the 326 ha Las Cruces Forest to the Ngöbe-Buglé Reserve, 8 km to the west. The corridor concept is not new but it is based on logical, practical science. Please help us add acreage to our Biological Station that will in turn help more wildlife survive, thrive and repopulate a regenerating landscape. As repatriated North Americans, many of us are doing everything we possibly can on our beloved fincas to plant trees for wildlife and nurse them along to maturity. Zak, as a professional reforester, is overseeing projects wherever and whenever possible to test methods and improve results on various tracts of property nearby as well as that owned by OTS/Las Crues. Now we ask that you take part – participate with us by donating to the Land Acquisition Campaign. We need your help and we are counting on your support with this vital project.

As always a big THANK YOU to you all!

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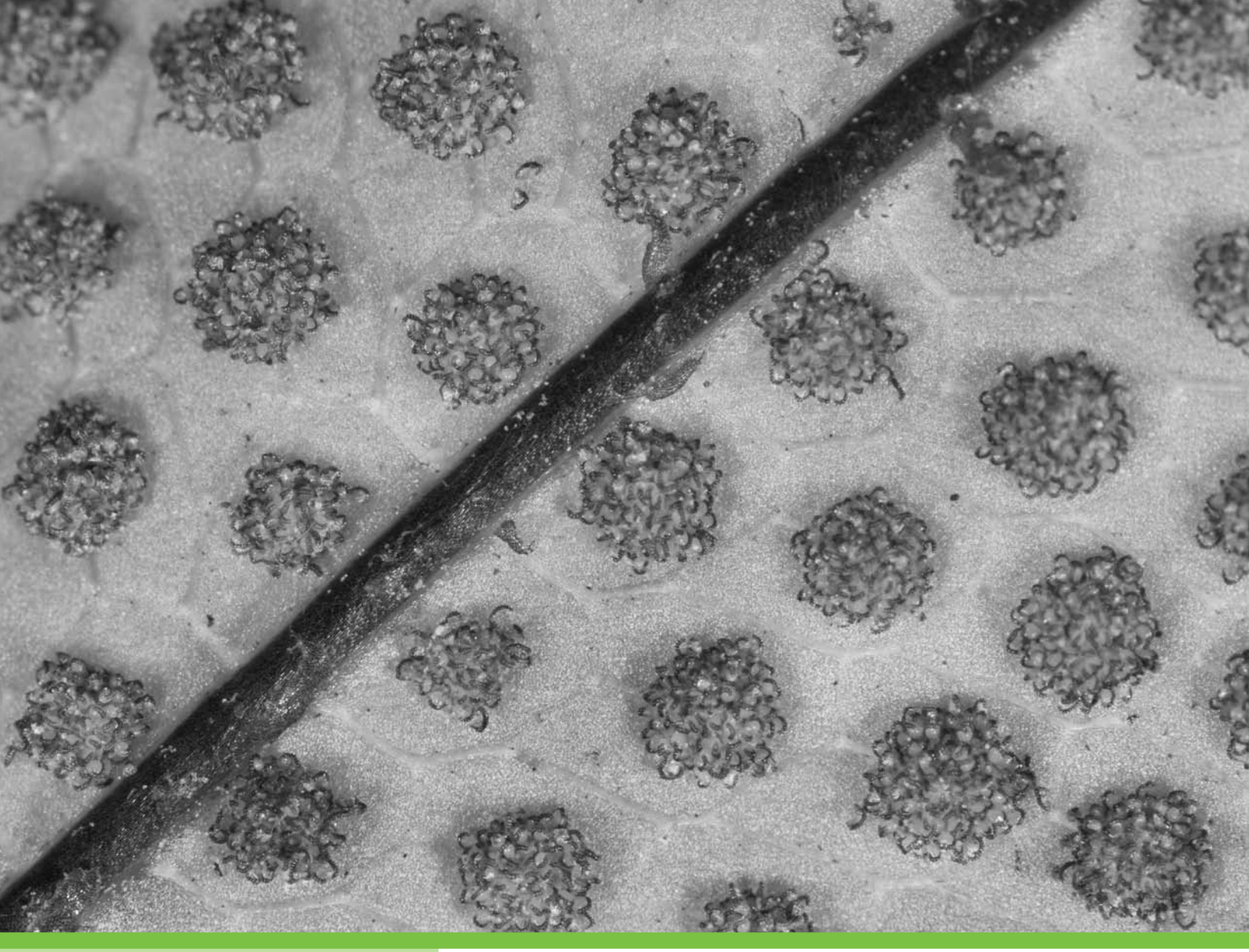

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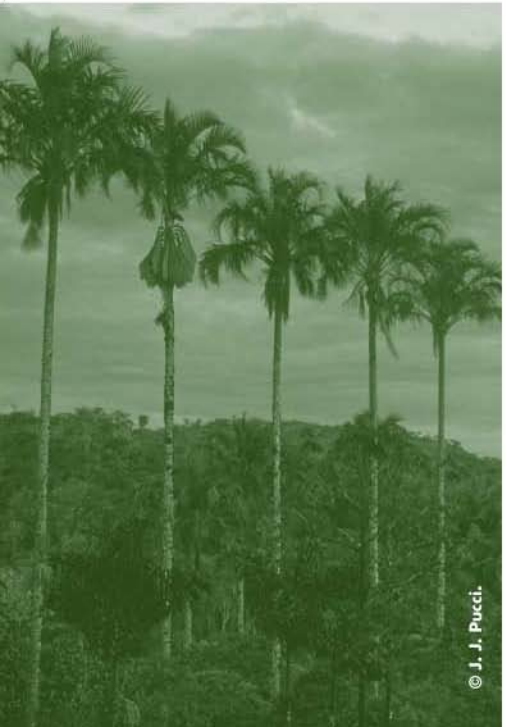

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