

Amigos

Newsletter

No. 86, November 2016



**Organization for
Tropical Studies**

Wilson Botanical Garden

Las Cruces Biological Station

Apdo. 73-8257 San Vito, Coto Brus, COSTA RICA

Who We Are

The Las Cruces Biological Station is one of three field stations owned and operated by the Organization for Tropical Studies (OTS) in Costa Rica. The station was acquired in 1973 and, along with the Wilson Botanical Garden, 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 southeastern corner of the country between Corcovado National Park on the Osa Peninsula, and the enormous La Amistad International 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 Biosphere 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 that include palms, aroids, bromeliads, ginger, 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 that inhabit the Las Cruces reserve, and the forest fragments in the immediate surrounding area. The bird list has registered 410 species; close to half the number of birds found in all of Costa Rica. There are also more than 100 species of mammals, of which 60 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 more than 200 hectares of primary forest (home to some 2,000 native plant species) and ~150 additional hectares that are in various stages of forest recovery. The reserve 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 the Las Cruces 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, excellent meals,

knowledgeable and enthusiastic staff, and a well-maintained network of paths and trails. The nearest town is San Vito, the municipal capital of Coto Brus county. It was founded by Italian immigrants in the 1950's and to this day they have a strong presence in the community. For example, a Dante Alighieri Italian-Costa Rican Community Center provides Italian language instruction and Coto Brus is the only county in Costa Rica where Italian forms part of the elementary curriculum! But enough said here! We hope that you will be inspired to come and experience firsthand the splendid tropical diversity of the Las Cruces Biological Station and Wilson Botanical Garden!

Please visit the Las Cruces website at <http://www.tropicalstudies.org/lascruces> for more information or contact us directly by email at lcruces@tropicalstudies.org or telephone at: +506 2773-4004. Postal mail can be sent to: Estación Biológica Las Cruces/Jardín Botánico Wilson; Apdo. 73-8257; San Vito de Coto Brus, Puntarenas; Costa Rica.

Reservations can also be made by contacting the OTS office in San José by email: threepaths.reservaciones@tropicalstudies.org or by telephone +506 2524-0607.

The North American OTS office is located at Duke University, telephone: +1 (919) 684-5774 or email: ots@tropicalstudies.org

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 field 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.

Director's Keys and Notes

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Front Cover: The newly revamped point at the entrance to the Wilson Botanical Garden. *Photo Zak Zahawi.*

Back Cover: Boy Scouts of Coto Brus planting in the new Pollinator garden during the 2016 Ecocultural festival that was held at Las Cruces and the San Vito Fair Grounds (where this photo was taken).

Editorial Committee: Alison Olivieri, Rodolfo Quirós, Zak Zahawi.

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Looking at a satellite image of the region around Las Cruces, the impression that emerges is one of complexity. Small agricultural fields and pastures are divided by fence lines of trees, a scattering of houses that here and there cluster together into towns; there is the occasional remnant patch of dark green forest surrounded by rock-surfaced road. To the southwest, the land is heavily dissected, dropping off steeply into lowlands dominated by oil palm plantations and pastures that run towards the shore of the Golfo Dulce. To the northeast, rises the crest of the Talamanca, one of the highest and wildest mountain ranges in Central America. The peaks bear the remnants of a volcanic archipelago that three million years ago merged to form a bridge between South and North America, the convergence of these two land masses creating one of the most species-rich places on earth. The landscape viewed from above brings up many associations: deforestation, agriculture, development, connectivity, diversity, succession, change. For me, one of the many associations is 'home'.

When my family settled in Coto Brus around the time that the Italian colony founded what would become the town of San Vito, the region was nearly entirely undeveloped and covered by dense rainforest. Many years later, my sisters and I came along just in time to register dramatic changes as ever steeper and more marginal lands were cleared for agriculture. The outcomes of deforestation and subsequent land degradation were becoming evident to those of us growing up on a working farm. Some of the less visible details of change were pointed out by a growing flow of visitors who talked about things like agroecology, soil science and conservation. These conversations were often centered at the residence of one of our most interesting neighbors, the Wilsons, who occasionally tolerated a youngster like me to help plant 'flowers' in the botanical garden. By the



Incoming Station Director Rebecca Cole processing samples.

time I left Coto Brus as a young teen, I had the beginnings of a lifelong concern and curiosity about the workings of tropical landscapes.

Despite the seeming inevitability of becoming a tropical ecologist given these roots, I managed to take numerous professional side trips as a landscaper, field technician, ski instructor, and public school teacher among others. I finally settled down to graduate school at the University of California at Santa Cruz to work with Dr. Karen Holl on the promise of returning to my home community to study ways to restore forest to degraded lands. About this time, we were joined by Dr. Zak Zahawi who would go on to direct a decade of positive changes at the Las Cruces Biological Station. Nearly twelve years later, the experimental set of forest 'islands' we established are still generating new and encouraging details on forest recovery.

Following my PhD work, the next stop was on Hawaii Island, where I worked with Dr. Creighton Litton and others at the University of Hawaii at Manoa to set up a project measuring ecosystem responses to the removal of nonnative animals such

What's New at Las Cruces?

Zak Zahawi / zak.zahawi@tropicalstudies.org

as feral goats, sheep, and pigs. On arriving to the island, I was shocked to find that much of the remaining natural area was confined within fences intended to keep out large populations of nonnative animals that browsed, rooted and grazed their way through the last remaining individuals of native species. On top of this were a myriad of nonnative invasive plants that quickly filled spaces created by disturbance and had the potential to overrun entire forests. The prospects for ecosystem recovery seemed relatively daunting but six years later we have an ongoing large-scale project monitoring changes across multiple ecosystems and testing intensive but promising restoration methods, like altering soil properties to favor native plant recovery.

In quick succession, two other opportunities came up to do science in diverse and exciting tropical locations. I received a NSF Postdoctoral Fellowship to go to the University of Colorado at Boulder in Dr. Alan Townsend's lab. There, we studied patterns in forest succession and the environmental and topographic drivers of carbon and nitrogen distribution across Costa Rica's Osa Peninsula, a spectacular region that boasts one of the most productive and diverse tropical forests in the world. Among the highlights for me of this project was leading an intense campaign to map and climb 60m-high emergent trees to collect canopy leaves in the remote interior of the peninsula.

Then, in 2011, I saw a call for volunteer scientists with alpine mountaineering experience to spend a few summer weeks in the Peruvian Andes collecting environmental data on high-elevation peaks. After that first expedition, and seeing the extraordinary need and potential for continued work, four of us co-founded a non-profit organization, the American Climber Science Program, to bring together

scientists and outdoor enthusiasts to do research and conservation in remote and mountain environments globally. Wedging this undertaking into our vacations and weekends, we build a program to measure the impacts of pollution on glaciers across the Andes, study the impacts of grazing and climate change on high elevation grassland, and support restoration research on endangered alpine forests. Among our more memorable annual research expeditions was a coast to coast crossing of Costa Rica, including a 10-day hike through a very remote and extraordinarily beautiful section of La Amistad International Park.

Although I feel fortunate to have worked across a fair variety of tropical landscapes, one of the main things I have taken away from these experiences is something many of you already know: that southern Costa Rica is a special place to work. Not only does the extraordinary diversity of the landscape lend itself to endless learning possibilities, but the human elements that underpin where and why research, conservation and testing of novel ideas are possible are some the best anywhere. The complex landscape around Las Cruces is an ideal place to engage a new set of research ideas, a vocabulary that now includes terms like global change biology, natural and human system dynamics, restoration ecology, and biogeochemistry among many others. Taking up the role as the new director of Las Cruces is at many levels, a return home for me, and I look forward to the challenges and opportunities ahead. The past ten years at Las Cruces under the direction of Dr. Zahawi have brought a long list of positive changes to the station. I am both excited and honored to step into these very large shoes and work with the broad community associated with OTS and Las Cruces to continue the momentum forward.

You may be wondering – didn't Zak leave already seeing as in the last edition of Amigos he said his farewells?! The answer is not so! As Rebecca was not able to start until mid-October, I agreed to oversee this edition of the newsletter and put together all the components. But Rebecca, as incoming Director, wrote the Keys and Notes. The next edition will be overseen entirely by her!

A Kickstarter Campaign!

We have joined the ranks of the kickstarter world and partnered up with Mitch Aide (University of Puerto Rico) and colleagues in order to raise funds to install a bioacoustic monitoring station at Las Cruces. The *Automated Remote Biodiversity Monitoring Network* as the project is called is a way to passively capture biodiversity information in a particular area by simply making automated periodic recordings of acoustic information over a period of time. Data will then accumulate over time and serve as a repository of current and historic information that can be analyzed by experts who can identify species based on their call. Furthermore, data will be made freely available to researchers for analysis and interpretation – much like we already do with our meteorological data. Las Cruces was chosen as one of three field stations to initiate this project, with the eventual goal of installing monitoring stations in strategic locations all around the world. More information on the project, and on how to donate, is available at this link: <https://www.kickstarter.com/projects/arbi-monstations/103818918?token=01a9b72d>. Please support this unique initiative for Las Cruces!

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Main Entrance Overhaul and New Hummingbird Garden

Since the last edition of the Amigos newsletter much change has taken place at Wilson! Both of these garden-based overhauls were done under the supervision of Holly and Osamu Shimizu. Holly, a horticulturist and the former Executive Director of the US National Botanic Garden, and Osamu, a renowned landscape designer, spent the better part of a month at the Wilson Botanical Garden in a volunteer capacity, redesigning areas and training the gardeners in new techniques and horticultural methods. Probably the most striking difference of note is the change in the main entrance, which went from a rather drab gated entryway to an elegant tree fern lined promenade! The understory was planted with one of the botanical garden's choice bromeliad species and the planter beds were outlined with a stone border (see front cover photo). The change is fantastic and the 'chatter' in the community has been overwhelmingly

positive. The other major overhaul of note (there were several minor changes as well) is the establishment of a huge hummingbird garden and flower display located behind the arid plants collection. The centerpiece of this garden is an old water fountain that was installed by Robert Wilson near the Wilson house. That fountain had stopped being functional a long time ago and was completely buried by vegetation. It caught Osamu's eye on one of our walks in the garden and the massive stone water bath, and even more daunting base stone pedestal, were hauled across the garden by the gardeners and installed in their current location. Hundreds of flowering plants that attract hummingbirds were planted in a concentric pattern around the water display and once they grow and start to flower, this central piece should be a big attraction to hummingbirds and other nectarivores. Holly and Osamu's stay was hugely successful and it is hoped that



The new water display in the hummingbird garden that will be the centerpiece of this collection. Photo Zak Zahawi.

they will be able to return periodically as expert consultants and help us in our efforts to continue to re-invigorate the Wilson Botanical Garden!

Introducing 'Wall-E' – The Plastic Chomper



Wall-E waiting for a delivery of recyclables. Photo Fabian Cambronero.

As some of you already know, Las Cruces has long had a recycling center which serves as a collection depot not only for the station but also for many of you out there in the community. The center is so successful that it is often overflowing with recyclables just a few weeks after a pickup. This presents a space and logistics problem as more frequent pickups are not really feasible and space is always at a premium. So Fabían (sustainability dept.) along with Yuva and Mauricio (maintenance dept.) came up with a home-made compacter! 'Wall-E', as the device has been named, is a plastic (or aluminum) squishing machine that reduces the volume of recyclables by some 50-60%! The device is essentially a metal box with a hydraulic press that can be manually applied once the receptacle has been filled with recyclables. The compacted units not only take up less space, they can be tied up and later stacked onto a truck in a much more efficient way, thus saving on time and transportability! So when you next bring your recyclables over don't forget to have a look for Wall-E!



A compacted block of plastic bottles ready for shipment! Photo Fabian Cambronero.

Research at Las Cruces

Tracking the Clay-colored Thrush in the Las Cruces Forest

Luis Arias / luis.arias@mail.utoronto.ca

Tropical deforestation continues to be a major global conservation concern. It is estimated that from 1990 to 1997, tropical forests were lost at a rate of 5,800,000 hectares per year, primarily driven by conversion to agriculture. Latin America and Southeast Asia present the highest deforestation rates of tropical forests, losing approximately 2,500,000 hectares per year. As a result, ecosystems are being divided in fragments which are surrounded by non-forested areas, such as pasture, agricultural lands and urban areas. This fragmentation of ecosystems can affect species that inhabit them and disrupt important ecological processes on which they depend. Therefore, it is important to understand how this rapid change in the landscape is affecting tropical biodiversity.

Living organisms do not exist in isolation from one another, but interact with other species in their environment. An example of these kinds of crucial interactions occurs between plants, pollinators and seed dispersers. Animal pollinators provide directed pollen delivery to flowers of different plants, while animals that consume plants' fruits often deposit the seeds far away from the mother plant. Both plant-animal interactions are important for the maintenance of plant populations. On the one hand, pollination helps to maintain high genetic diversity in plant populations by moving pollen between organisms that are genetically different. If plants receive pollen from individuals genetically similar, seed production and genetic diversity can decrease. In turn, seed dispersers can transport seeds to long distances, allowing for the colonization of new areas with individuals from different populations. Consequently, if either of these plant-



Photo 1. Red-twist heliconia (*Heliconia tortuosa*) with fruits in the tropical forest. Photo Luis Arias.

animal interactions are modified, plant populations may be affected, threatening their persistence within disturbed landscapes. Conversely, disruptions in one of these processes might be counteracted by continued efficiency of the other.

Current research from the University of Toronto and Oregon State University is focusing on understanding how ecological processes are affected by tropical forest fragmentation. Our work examines how the processes of pollination and seed dispersal are combining to affect the populations of the red twist heliconia (*Heliconia tortuosa*) (Photo 1) in fragmented landscapes surrounding the

Las Cruces Biological Station. Earlier work has shown that hummingbird movements are restricted by open areas resulting in lower rates of seed set in fragmented landscapes. But the capacity of seed dispersers to compensate for this potential seed deficit in small isolated forest fragments by maintaining directed long distance seed dispersal is unknown. To be able to model the dispersal process we need two key pieces of information: 1) the pattern of disperser movements across the forest fragmentation gradient, and 2) the length of time a disperser carries a seed after fruit consumption before depositing the seed at a new site. With these two crucial pieces of information

Photo 2. Radio transmitter mounted on a *Turdus grayi* individual. Photo Luis Arias.



Photo 3. Receiver and Yagi antenna used for tracking birds. Photo Adam Hadley.

we can model seed dispersal probabilities under various landscape change scenarios.

The Clay colored thrush (*Turdus grayi*) is the main seed disperser of this heliconia species. We are tracking the species movements in landscapes across a fragmentation gradient to examine how they move through different landscape contexts. We have been capturing individuals of this species with mist nets and mounting them with backpack transmitters (Photo 2). Using receivers and Yagi antennas (Photo 3), we are able to locate individuals by receiving the signal emitted by the transmitters attached to them. In addition, we are feeding some of the captured birds with red twist heliconia

fruits to determine the time it takes for them to defecate or regurgitate the heliconia seeds. By combining movement probabilities with gut passage time we will be able to predict where seeds are likely to be dispersed in the landscape. Finally, we have been monitoring populations of red twist heliconia and conducting seed germination experiments since 2013 to examine survivorship, growth, mortality, predation and herbivory rates in patches with different sizes and amount of forest around them. Altogether, this information will help us understand the effect of fragmentation on the movement behavior of pollinators and seed dispersers and how this could affect these heliconia populations.

The relevance of this research lies in understanding how two different animal-plant interactions are affected by forest fragmentation and the implications for plant populations. Red twist heliconia is an important nectar source for hummingbirds and has been suggested as a “bridging species” that allows hummingbirds to persist during periods where resources are otherwise limited. Therefore, understanding how fragmentation affects heliconia populations could have important indirect effects for the broader pollinator community. This research will help inform management decisions to optimize functional connectivity for plant populations in future conservation projects.

Do Hummingbirds use Living Fence Rows as Corridors?

Urs Kormann / urs.kormann@agr.uni-goettingen.de

“More people*more per capita consumption = danger for biodiversity”. This formula is the crux of the current biodiversity crisis, and driving the transformation of many formerly pristine regions into heavily modified patchwork landscapes. The common denominator of these patchwork landscapes is that areas with high biodiversity value tend to be broken up into smaller and smaller pieces, that are further and further away from each other, making it difficult for many species to persist in these novel environments.

This process also affects plant reproduction, particularly for plant species that depend on animals to set seeds. Worldwide, 9 out of 10 vascular plants species require animals for pollination, and rates in the tropics are even higher with 19 out of 20 species animal pollinated. Given the dominance of animal-pollination, failure of these plant-pollinator interactions in patchwork landscapes is of high importance for the future persistence of biodiversity.

Having pollinators such as bees or hummingbirds in a site is one thing – but for plants, often the quality of the pollen they receive is also important. For example pollen that stems from plants that are further away may result in higher reproductive success, but such high quality pollen may be restricted in landscapes where habitat fragments are too far apart. For the maintenance of pollinator and plant populations in such patchwork landscapes, it is thus important that pollinators and the pollen they transport can move freely around in the landscape. So how can pollination in such landscapes be maintained and restored in a cost effective way? This was the question I investigated in Las Cruces, but only after some initial struggles.

It all started in autumn 2011. At that time, I was a first year PhD student at the

University of Gottingen in Germany where I was studying the effects of agricultural expansion and habitat fragmentation on insects and pollination. My study system at that time was dry calcareous grasslands in the very center of Europe, a habitat potentially contrasting with tropical rainforests as much as coral reefs. Unfortunately (or fortunately), some students from my University had just trampled some rare endangered plants on one of “my” grasslands during a University field course. As a consequence, the responsible State authority informed me that University members (and thus also me), would not be given permission to access any of these grasslands again during the next five years. This was definitively not good news at that time! So I decided to do the most appropriate thing for such a situation – I went on vacation.

In ended up visiting a remote and picturesque bird banding station in the Swiss Alps and that’s where the unexpected coincidence happened, which initiated my future scientific trajectory. With snow-covered mountain tops surrounding me, and the sound of cowbells in the background, this was the first time I met Adam Hadley, at that time a PhD student at Oregon State University. We were both assigned to the same team to extract birds from nets, and so I told Adam about the unlucky news I had gotten recently, and the work I was doing in general. It turned out that he was doing really exiting work on how forest fragmentation affected hummingbirds and hummingbird-pollinated plants in Costa Rica, so basically something similar as my work but in a tropical setup. Long story short: four months and some discussions with my supervisors later, I was still investigating pollinators and plants, but this time in Las Cruces!

In Las Cruces, I focused on rows of



An artificial hummingbird feeder with a visitor. Photo Urs Kormann

trees, “narrow woody corridors”, that farmers use to delimit their pastures. In fact, these fence rows are among the most common landscape elements in tropical regions with cattle farming. During previous work in Belize, I had seen hummingbirds flying along these structures, so I was wondering if these simple structures could be an efficient tool to boost hummingbird-mediated pollination. In particular, I investigated if these woody strips could facilitate hummingbird movement and pollen transfer between forest fragments, increase hummingbird availability in forest remnants, and finally, increase pollination success in *Heliconia tortuosa*, a hummingbird-pollinated banana-like plant.

To test whether corridors were facilitating hummingbird movement across patchwork landscapes, I determined how eager hummingbirds were to visit small artificial feeders and plants that we placed in cattle pastures, either along living fencerows or completely exposed

GIS Corner

within the pasture. Sure enough, my field assistants and I observed forest specialist hummingbirds visiting the fencerow feeders, but feeders in open pasture remained largely untouched. Similarly, I found that hummingbirds also transported more pollen between forest fragments when they could move along these corridors. In contrast, pasture appeared to be a near-complete barrier for pollen transfer.

This experimental exercise showed that living fencerows were indeed movement conduits for hummingbirds and the pollen they transported. But at the end of the day, would more corridors also translate into more hummingbirds and higher pollination rates? For this, we assessed hummingbird presence and pollination success in small forest remnants that were connected to nearby forest by corridors compared to equivalent sites lacking in these connections.

The results were striking. Fragments with corridors had more Green Hermits, a forest dependent hummingbird and the main pollinator of *Heliconia tortuosa*. The Green Hermit was usually completely absent from corridor-less forest patches. In addition, *Heliconias* faced a complete pollination breakdown in patches without corridors, but their pollination success steadily increased the more corridors there were.

Overall, these results are very promising. They show that simple changes in landscape structure such as a lines of trees between forest remnants can have a dramatically positive effect on pollination in the tropics. Importantly, this spring, Theodora Panaydes from Imperial College in London showed that farmers are generally positive about living fencerows. This clearly highlights a real opportunity for conservation actions in tropical patchwork landscapes.

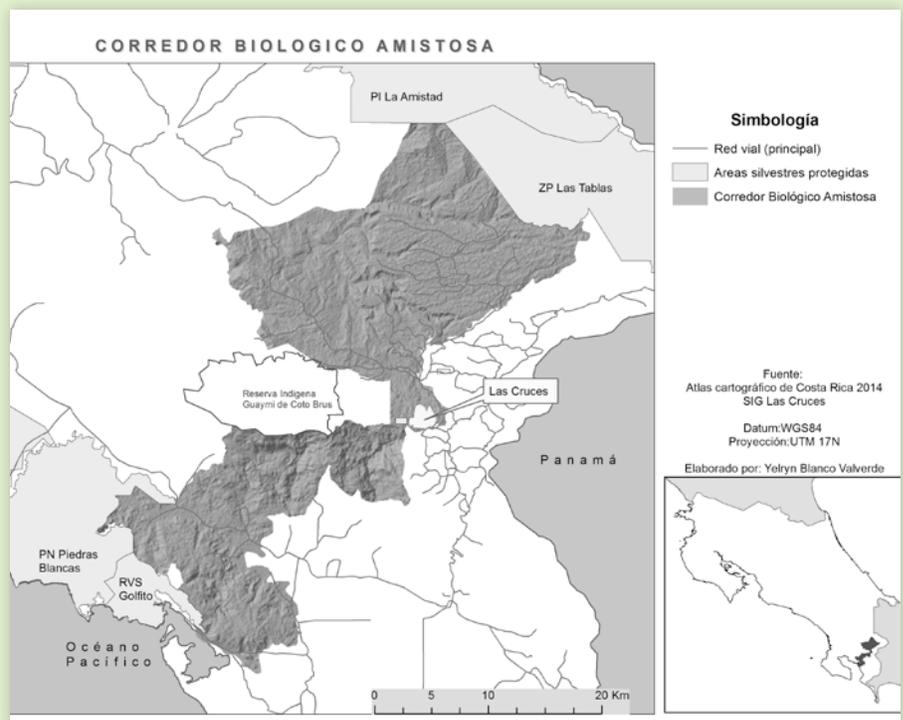
Kormann, U., Scherber, C., Tschamtk, T., Klein, N., Larbig, M., Valente, J. J., Hadley, A.H. & Betts, M. G. (2016). Corridors restore animal-mediated pollination in fragmented tropical forest landscapes. *Proc. R. Soc. B.* <http://dx.doi.org/10.1098/rspb.2015.2347>.

A New Met Station and Updates on the Amistosa Corridor

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The Las Cruces Biological Station works diligently to insure that all data provided to our users is of the highest caliber. In keeping with this ideal we recently purchased a new meteorological station, with high precision sensors to collect climatic data. Among the new instruments are sensors to collect minimum, maximum and ambient temperature; a rain-gauge, barometer, wind gauge, relative humidity meter, and others. This new meteorological

station collects data every 30 minutes and sends the information directly to our website where they are made accessible to everyone. These data can be sorted by date and accordingly, can be arranged according to the interests of a particular user. We also have a manual meteorological station, which was also upgraded in March of this year. We purchased manual temperature thermometers, relative humidity gauge, barometer, and rainfall gauges. Manual data are collected everyday at 8AM and serve as a backup to the automated data.



The Amistosa Biological Corridor (see continuation of GIS section on next page). Note that the area immediately surrounding the Guaymí indigenous reserve (not shaded) forms part of another biological corridor which is why it is excluded in this one. Map by Yerlyn Blanco.

Flora and Fauna

Land Use Change in the Las Cruces Region

Zak Zahawi / zak.zahawi@tropicalstudies.org



Some of the kids that participated in the event we held at Sabanillas in July. Photo Yerlyn Blanco.

The other update in this edition focuses on the AMISTOSA Biological Corridor. The GIS lab at Las Cruces assists in this process by providing cartographical expertise and also participates as part of the local representative committee for the corridor. In July, we organized an event in support of the watershed and natural spring source within this corridor. This was held in conjunction with the water festival celebration in the nearby town of Sabanillas. Schools visiting the festival were provided with information on the importance of biological corridors, as well as information on the importance of watersheds and springs. We held interactive games with environmental themes, short presentations, and the planting of native trees that help in water conservation and provide habitat for fauna, as well as beautify the landscape. The main purpose of this activity was to raise awareness as to the existence of a biological corridor in our community, and inform the community how they can become part of this initiative. In addition, the idea was to inform the general public about the ecosystem services that are provided by our natural environment, and why we should strive to protect it. We as part of the Las Cruces community are actually located within the boundaries of this corridor, and as a field station we should actively participate in uniting our community to help in its conservation.

As many of you are aware and some have seen first-hand, Coto Brus county is made up of a mosaic of habitats that include riparian corridors, forest patches, pastoral and agricultural areas, and a few small urban regions. But we know that it wasn't always like this – in fact (and I have written about this many times in the past) the region has a relatively recent history of deforestation, comparatively speaking. Of interest to researchers is trying to piece together a more exact timeline of this transformation, and develop a better understanding of how this all came about. Understanding land use change, as it is known in a more formal sense, goes a long way toward helping us determine patterns of change (such as where deforestation tends or tended to occur), gives us an understanding of how long ago a particular area was deforested and what it is being used for, and by implication how long it may take a particular area to recover in a very relative sense (in other words the longer it is used for agricultural purposes, the slower the recovery process with land converted to pasture one of the slowest to recover). There are naturally many aspects to look at that affect the rate of recovery or a particular area. Of course when one looks at land use change at the landscape or regional level, it can help us develop an understanding of what the implications are for both fauna and flora.

Interestingly, the idea of determining a historical chronology

of this region came to mind in my early years as Director, but only recently was I (along with two co-author colleagues Guillermo Duran and Urs Kormann) able to complete this task, and publish a solid overview of the history of land use change in and around Las Cruces over the past 67 years. The article was published last year in PLoS One, an open access scientific journal and for those of you interested in reading the entire document, you can access it in full at the following link <http://dx.doi.org/10.1371/journal.pone.0143554>. But for those who just want a summary version, just read on!

The area around Las Cruces was heavily deforested over the last 60 or so odd years. In all, a little more than ¼ of the area we included in the study remains forested (we used a 13 km radius around Las Cruces and a <700 m elevation cutoff as the study region, as we considered lower elevation habitats subject to different land use pressures). This marks a dramatic decline in forested cover as the same area was >98% forested in 1947 which was when the 1st flyover of the region took place (Figure 1). Most of the deforestation occurred in the years between 1960-1980 when a whopping 40% of forest habitat was lost. Thereafter forest loss slowed considerably but there has been a continuous decline in habitat loss up to the present day. What is more insidious perhaps is the fact that of the remaining forest in the area today, roughly one third of it is secondary regrowth. Stated another way, there is less than 20% of the original old-growth habitat remaining in the region. The (thin) silver lining in these statistics is that the third of forest cover that is secondary forest is habitat that has regenerated naturally after the area was cleared. In other words there is some recovery going on which is critically important, but what is even more

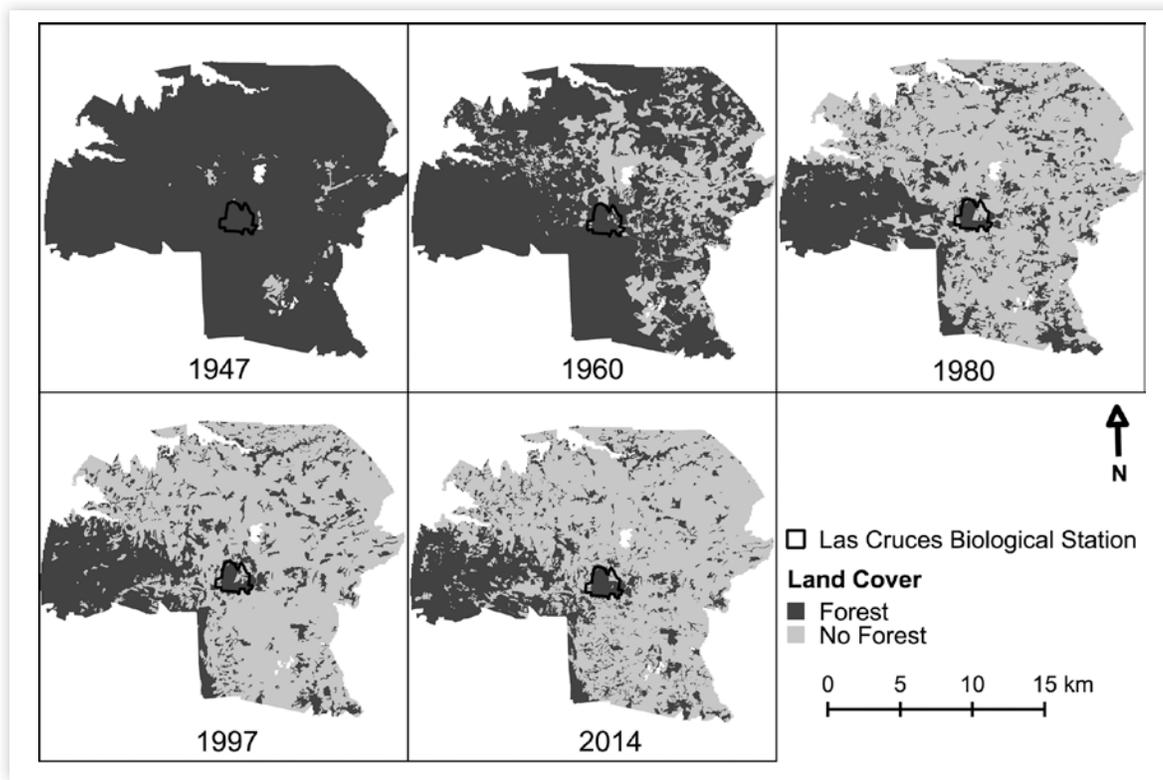


Figure 1. Land use change at five time slices showing extent of forested and non-forested habitat in a 13 km radius around the Las Cruces Biological Station.

essential is that we prevent the further loss of original habitat. Most of these original forest patches are relatively small and scattered throughout the study area. Primary forest patches include the Las Cruces reserve and the Ngöbe indigenous reserves, as well as a few additional private protected areas. The other good news (insofar as fauna are concerned) is that there is good connectivity amongst these patches via a network of riparian corridors, live fences, rows and some more fauna-friendly agricultural land-uses such as coffee farms. So certainly not all is lost and there is much work to be done to try and protect what remains as well as promote the reforestation of certain key areas in the region to improve connectivity and consolidate forest patches – much as we have been doing at Las Cruces for decades.

So one question I did not address then is what drove most of this deforestation? In Coto Brus, unlike most of Costa Rica during this period where forest was cleared to create pasture, the deforestation in our region was largely geared toward coffee

establishment. This because the county was largely inaccessible by road at that time and so material goods (in this case coffee) was easier to ship to market by air than meat or dairy products (indeed Coto Brus used to have daily flights to San José whereas today there are none, a rather odd statistic I would say). An additional driver for the clearing of land in the early years of this study was as a means to lay claim to property in a part of the country where land titles did not exist as yet. In this regard cleared land was an indication of right to ownership, much more so than forested land, which at the time was considered ‘unclaimed’. Later on, towards the end of the 1980s, a switch in land-use came about as a result of the collapse of the coffee market when many desperate farmers switched to cattle production. This despite the poor climatic and adverse terrain (read steep) in the region that makes cattle agriculture a poor choice in terms of both environmental concerns (erosion, compaction) and productivity.

Today the region retains some coffee production as the quality is good (2nd

only to the Dota area in my opinion), but it is far less widespread than it used to be. Most of the agricultural land is under pasture cultivation, though there is some farming of crops such as chayote – which is a type of squash, tomatoes, and a few other typical vegetables. But what the region is most suited to, from an agricultural perspective, is coffee and a bit of a renaissance has occurred due to the shift in global market economics – especially in terms of the higher end gourmet market. In terms of forested habitat, a decline continues to occur although it is much less than during the height of regional deforestation. That said most of the rest of the country is witnessing an increase in forest cover so it is disappointing that that has not come about in Coto Brus as yet – although trend is heading in that direction. So that’s a brief summation of what is in the article – there are a couple of other themes I discuss so if you are interested please do download the article but as far as *Amigos*, I think I will stop here for now!

De la Comunidad

An Update from the Outreach and Environmental Education Program

Carla Azofeifa / carla.azofeifa@tropicalstudies.org

Returning the Ecocultural Festival to Life

Since April 2016, as the new head of the Outreach and Environmental Program, one of my first projects was to bring the Ecocultural Festival back to life. This year it was celebrated as a prelude to the commemoration of environmental month, and was held at the Las Cruces Research Station on May 27 and 28. The Las Cruces Outreach and Environment Education Program (PEEA-LC) started this initiative back in 2008 as a way to generate a space for the exchange, dissemination, and analysis of current environmental issues, and as a means to explore solutions through educational, artistic, and cultural activities that are geared towards the general public. Even though we went two years without a festival, the response from the public was very positive. More than 180 people, including children, teenagers, and adults participated in the 2-day event. Activities on Friday May 27 were held at Las Cruces, where children, adolescents, and adults enjoyed natural history tours, educational workshops, lectures, a cinema forum, and concerts. Among the workshops was one entitled “The Way of Water”, where our partners from UCR-CRUSA provided participants with an interactive space to learn about the water cycle by means of a theatrical play and the visual arts. The UNED ecological group, which has always been present at our festivals, highlighted the importance of reuse and waste reduction through the development of piggy banks. Agriculture and healthy living were presented by the La Buena Vida Project. Elsewhere, parents found out about the paths followed by hummingbirds in our landscape thanks to a talk by Oregon State University. Likewise, Stanford University



Photo 1. Collecting recyclable and non-recyclable waste in the Coto Brus community. Photo Carla Azofeifa.

was present with an interactive presentation on biogeography in agricultural landscapes, certainly very well known among our young field assistants who work on the project. In the afternoon we had a puppet show performed by two teachers from the Barrio Canadá School who are participating in the EcoMaletas Project and wanted to share their knowledge with a presentation on consumerism and waste. Immediately after, we had the opportunity to view a documentary entitled “Racing Extinction” by the Costa Rican Film Centre and Film Production, a film that made us quite contemplative. Finally, and as the day came to a close, the CEMA – Sinem Camerata from Coto Brus made a gala presentation, to close with a flourish that filled us with energy to continue next day.

On Saturday, May 28, the Festival was held at the San Vito fair grounds, where the farmer’s market of Coto Brus is held. The farmer’s market takes place every Saturday and seeks to strengthen the exchange of local products and increase fair trade in our community. That day began with hands on the ground in conjunction with the Coto Brus Scouts Group planting native plants in order to attract wildlife and embellish an area of the fair grounds, that we named the Pollinator Garden. This is the first of many approaches from PEEA-LC that we hope to have with this group of young people who were quite excited about the future development and continuity of these activities. Elsewhere, at the Community hall, artisans and producers

had simultaneous workshops of puppets, masks, and creating mandalas under the supervision of *Pies en el Aire*, Li Perrender and Lucia Boscolo, respectively. For those who wanted to learn to use wood more efficiently, friends of the “Finca Los Patos Suertudos” showed us the rocket stove. In the afternoon an African percussion group move the people from their chairs with their ancestral sounds. As it was a living class many people had the opportunity to learn and feel the rhythms by playing the instruments themselves. Informative stands were present and I would like to give special recognition to Paula Mesén who was present all day in a voluntary capacity with an exhibition on birds, mammals and insects that was received with great interest by many curious people. In the afternoon, a folkloric dance group from UNED delighted us with their colors and smiles, an expression that characterized the joy felt from the rhythm of their cheerful tunes and presentations. As the night was coming to a close, a light was prepared to be shared among participants using reused cans and recycled oil, thanks to the participants of the Salverde. The lamps lit up the night, and gave a warm closing to the event as a concert by locals Cold Coffee, and Li Perrender from San José, filled the space with music. We want to thank all the people who attended and enjoyed the Festival, as well as those who organized and developed the activities. Finally, our deep gratitude to Bitácora Abierta Producciones for the production of a video with an overview of the activities developed through the VII Eco-Cultural Festival. You can see the video at the following link (<https://www.youtube.com/watch?v=Wdh7BlrUMyE>).

Collaborative work with the Municipality

PEEA got back in touch with the municipality of Coto Brus where activities have included monthly meetings with institutions and groups that form the Environmental Committee. In addition, communal activities related to the national Blue Flag program and the Campaign for Waste Management were supported in three localities of the county (Pittier, Limoncito and Agua Buena) with a total of 2,262.6 kg of recyclable waste collected (Photo 1).

Solid waste collected during the County Campaign (28th, 29th and 30th June).

Location	Recyclable waste (kg)	Non-recyclable waste (kg)
Pittier	1,210	93.6
Limoncito	782	105.3
Agua Buena	270.6	66.8
TOTAL	2,262.6	265.7

EcoMaletas Project

The major project of PEEA continues to move ahead and is now in its 2nd phase. We are currently working in 18 schools of the county with a total of 42 participating teachers from all 5 districts (San Vito, Agua Buena, Sabalito, Pittier, and Limoncito). The training process was highly successful (a total of 15 sessions with 2 groups of teachers were completed) and at present we are conducting follow-up visits with the participating schools with 50 visits realized thus far. During these classroom visits we help teachers with the use of the EcoMaletas. Unfortunately, two schools left the project, one in the 1st year and another during the 2nd year of implementation (hence 18 participating schools and not 20). With the two remaining suitcases we decided to expand our program and engage in collaborative work by sharing the EcoMaletas with NGOs and government entities who work in Environmental Education around Coto Brus. We did this with the express objective of enhancing environmental education actions and



Photo 2. Participants in the new EcoMaletas training program.

not replicating efforts that are already in place. Right now we are in the middle of the training process with a total of 12 participants from the Ministry of Health, Coto Brus Municipality, Universidad Estatal a Distancia (UNED) and ASCONA (Photo 2). At the end of the training period we are planning to hold a workshop in a school to assess the skills and learning approaches of our new partners in this project.

Our Donors

Donations Update – Embracing Change!

Alison Olivieri / sanvitobirdclub@gmail.com

In the early 1970's David Bowie encouraged us to, "... turn and face the strange ch-ch-changes ..." in a song that was such a big hit with his fans, it even surprised him. That song, called "Changes", comes to mind now as a new Director takes charge here at Las Cruces.

As you read this issue of the Amigos newsletter, Dr. Rebecca Cole will be settling in at her new post, stretching her legs on the Rio Java Trail and dodging raindrops – all the while undoubtedly having déjà vu, a return to her roots in the Coto Brus valley. This is not a "strange" change but a wonderful and welcome one for all involved.

Now, we need you -- our 'queridos amigos' -- to help us make Rebecca feel right at home with your generous and thoughtful support for all the facets of her new job – from housekeeping to research assistance to natural history traveler information; from accounting to sustainability to environmental education outreach. Let's face facts: our new director will not have a moment to herself in the months to come. To help counter this frenzy, we ask you to make as expansive a donation as you possibly can. What could make Dr. Cole's first few months in the director's chair better than contributions arriving by mail from far-flung supporters who wish her all the best?

In the meantime, we'd like to hear from you! Please send your queries, comments and suggestions to my email (above) or to Rebecca directly at rebecca.cole@tropicalstudies.org. If you decide to contact me, please write *Amigos* in the "subject line" and I promise to respond with alacrity. We enjoy your contact with us. And, yes, of course, that's because often you send a nice vote-of-support-check. But, it's also because when we think about you in California, Maine, Indiana, Florida



The Las Cruces forest from a distance. Photo Alison Olivieri



Parakeets peeking out of their palm tree near the Reception office. Photo Jeff Worman.

or wherever you are, a little piece of the amazing Wilson Botanical Garden is there with you.

Please send your donation today and, in the meantime, here is a photo of the Las

Cruces forest in the rainy season, taken from the grounds of neighboring Casa Botania B&B and a second photo of two very special resident "Amigos" peeking from their palm tree.

**As always a big
THANK YOU to you all!**

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**A Violet Saberwing in flight
(see hummingbird article under
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