





Wilson Botanical Garden Las Cruces Research Station Apdo. 73-8257 San Vito, Coto Brus, COSTA RICA

Who We Are

The Las Cruces Research 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 Robert and Catherine 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, 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 that inhabit the Las Cruces reserve and the forest fragments in the immediate surrounding area. The bird list has registered 410 species, which is 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, especially 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 60s °F) at night. Mean annual rainfall is ~4,000 mm (157 inches)! The dry season runs from January to March and the rainy season from May to 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 1950s, 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.

We hope that you will be inspired to come and experience firsthand the splendid tropical diversity of the Las Cruces Research Station and Wilson Botanical Garden!

Please visit the Las Cruces website at https://tropicalstudies.org/portfolio/ las-cruces-research-station/ for more information or contact us directly by email at info@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: visit.ots@tropicalstudies.org or by telephone +506 2524-0607.

The North American OTS office is located at 408 Swift Ave, Durham, NC, 27705,

telephone: +1 (919) 684-5774 or email: info@tropicalstudies.org

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

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; and conducts environmental education programs. In addition, OTS maintains three field stations in Costa Rica: La Selva Research Station in the Atlantic lowland rain forest, Palo Verde Research Station in the Pacific deciduous dry forest, and Las Cruces Research Station in the premontane cloud forest near the Panamanian border. In addition, OTS maintains one field station in South Africa, the Skukuza Research Station located within Kruger National Park.

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Front Cover: View of the Pollination Garden, at the Wilson Botanical Garden. Photo by Henry Sandí.

Back Cover: Nest of a hummingbird found in the Pollination Garden. Photo by Alison Olivieri

Editorial Committee: Jennifer Kelley, Rodolfo Quirós F., Emilce Ramírez.

What's New at Las Cruces?

Talamanca Earth Snake found in Cerro Paraguas



Geophis talamancae, Cerro Paraguas. Photo Henry Sandí.

Last June, Jeisson Figueroa, naturalist guide at Las Cruces Research Station, together with Henry Sandí and Dionisio (Nito) Paniagua, found two Talamanca Earth Snakes, *Geophis talamancae*, in Cerro Paraguas. Though not far from the station, this place is 300m lower and about 40 km away from the site where the species was originally identified, at 1800 m elevation in the Las Tablas Protective Zone, near the border with Panama. The species was described originally as having dark body coloration, but the individuals found in Panama had red

scales along the sides of the body. The individuals Jeisson and team observed had the coloration of those found in Panama.

As naturalist guides, the group was interested in knowing if there were more individuals with that coloration in that area. They returned in July and only spotted one more individual between a patch of forest and a pasture area. In this case, what they found was better than expected. It was an albino* individual of the species with red spots along the body. Jeisson commented, "We were ecstatic to see so much beauty and rarity at the same time, as finding an albino snake in nature is rare."

*Note: the terms "albino" and "leucistic" refer to animals that lack different classes of pigments. This individual in particular apparently lacks melanin but has other pigments that produce the red-orange spots.



Geophis talamancae, Cerro Paraguas, albino individual. Photo Jeisson Figueroa.

General Management Plan for the Las Tablas Protective Zone

Since August, station personnel have participated in the process of developing the General Management Plan of the Las Tablas Protective Zone. This advisory process will produce the management plan and will generate a diagnosis on biodiversity, institutional management, and benefits generated by the Protective Zone. Management focal elements (EMFs), as well as alternatives to reducing threats to them, will also be defined and prioritized.

The Las Tablas Protective Zone (ZPT) is a protected wilderness area located in the Coto Brus County. It was established in 1981 and covers an area of 19,981 hectares (almost 50,000 acres). It borders La Amistad International Park (PILA) and the Panama border and is part of the La Amistad World Heritage Site and Biosphere Reserve.

Most of the area is covered by primary forest, preserving remnants of four ecological life zones. It also protects the basins of multiple creeks and rivers that



supply drinking water to the communities of Coto Brus County. Due to its conservation status, it is an important genetic bank of forest species, both plants and animals.

The development of the management plan will be carried out through the participation of officials from the La Amistad Pacific Conservation Area (ACLAP) and other key actors in civil society as well as governmental and nongovernmental institutions (NGOs), through the support, advice, and facilitation of the technical team of the National Parks Foundation (FPN).

Native tree species donated



Coinciding with the reopening of the Wilson Botanical Garden on June 30, we made the traditional donation of trees as part of the Environmental Month activities. Many thanks to the families, who participated in this activity. Around 600 trees of 30 species were distributed. The trees will be used to reforest around rivers, creeks, springs, altered forest patches, and agricultural areas; and they will provide food for birds and other animals.



Flora and Fauna

The Pollination Garden at the Wilson Botanical Garden

Holly Shimizu (hollyshimizu579@gmail.com)

s a member of the Las Cruces Advisory Committee (LCAC), my husband, Osamu Shimizu, and I were honored to be invited by LCAC leader Dr. John Kress to assist with design improvements at the Wilson Botanical Garden. Osamu, a renowned garden designer, and I spent the month of August 2016 at the garden. Our largest focus area was the creation of a hummingbird garden, because several researchers were currently studying hummingbirds at the station. Ultimately, the garden became the "Pollination Garden," which allowed the scope of the garden to broaden by including a wider range of plants known to be excellent attractors of multiple pollinators. We began working in the entire garden which gave us an opportunity to decide the best area to create the new pollinator garden. Our primary needs were to have full sun to ensure plentiful flowers in a location that would be convenient and alluring for visitors. Osamu chose a large open area near the Cactus House.

Osamu felt it was important that the new garden be separately located from other collections or gardens. He used his trained eye to determine the best angles to give all visitors visibility of a centrally located fountain from anywhere in the garden, a decision that led him to design a formal garden. After a thorough search of the Wilson Botanic Garden, we found an unusual, aged trough that would make a uniquely beautiful fountain. Thus, the trough became the central focus of the pollination garden.

At this formative stage, Osamu's primary consideration was the scale of the new garden. After careful measurements, he determined the bed sizes and placement. The importance of accurately proportioning the bed sizes within the overall space is critical to the success of any garden.



Visitors and gardeners need space to walk in and around the beds but also to feel intimately connected to the plants. Once he was satisfied with his measurements and his mental imagery of how the area should be divided, he created his drawings.

After completing his drawing of the garden, he laid it out with stakes and string. He used his mathematical calculations to set out the pathways and beds. Once he felt satisfied with his layout, he relied on the competent Las Cruces Garden crew to transplant many of the bulbs found at the site to a new location. Osamu then oversaw the improvement of the soil prior to any planting as well as the creation of a small garden pool for the fountain. With great effort, the trough was moved and set on a pedestal. In order to give the fountain a natural look, the crew covered it with epiphytic plants and mosses. And finally, to create a sense of coolness, the water

pressure was carefully calculated to give off a gentle, misty spray.

The design consists of a series of concentric circular beds with pathways leading into the center fountain. The taller plants were placed in the larger beds of the outer ring. As visitors move inward toward the central fountain, the plants decrease in height. Shorter plants were used where viewers walk around the fountain. In nearby beds, higher plants were placed in the middle of each bed. Osamu's key objective was to create a serene space for visitors to comfortably sit, enjoy the water sounds from the central fountain, and view the many pollinators doing their important work.

Implementation began with appropriate pollinator plants. The crew rounded up plants from the Las Cruces greenhouses and transplants from garden areas that had become too shaded or too crowded. Since Osamu and I had only 15 days left



The Garden laid out with stakes and string.



Osamu working on setting up the fountain.



The fountain is set in a created pool. From the top, a soft spray/mist of water is released.

of our stay at Las Cruces, we had to work quickly. The layout and initial planting were completed in two weeks, thanks to the excellent gardening crew led by Miguel. We were appreciative of many people, including Federico Oviedo Brenes, the Botanist/ Taxonomist for the station at that time; the Horticulturists Dave Janas, Greg Nace, and Rodrigo De Sousa for continuing its development; and Gail Hull, who provided plants and insights from her nearby garden. When we left Las Cruces, as is inevitable with new gardens, the Pollinator Garden was by no means beautiful. The small size of the plants and, in this case, the fact that many plants were yet to be located left it looking bare. However, the bones of the garden were laid out and it has prospered to become one of the most highly visited and loved areas of the Wilson Botanical Garden.



Partial view of the pollination garden.

"Walking the pollinator garden is always a soothing adventure. It is always full of insects -- butterflies are abundant as well as flies, bees, dayflying moths, beetles, a large number of birds and, of course, bats at night. The much sought-after White-crested Coquette has also been seen there". Alison Olivieri, San Vito Bird Club

^{*} Horticulturist Holly Shimizu is the Executive Director Emeritus of the U.S. Botanic Garden, Washington DC.

Research at Las Cruces

Around Las Cruces: Learning from forests and farms

Jeffrey Smith (jrsmith7@stanford.edu)

his twenty-year study has led to countless insights about Neotropical biodiversity and has helped to develop a scientifically grounded conservation strategy. Led by Dr. Gretchen Daily and expert ornithologist Jim Zook, this sampling design was set up to cover four distinct regions of Costa Rica (Guanacaste, San Isidro, Puerto Viejo, and Coto Brus) and four types of land use (forest, low-, medium-, and high-intensity agriculture). From this sampling design, we can better understand how birds respond to local cues, such as what crops are planted in a field, and landscape level cues, such as how much tree cover surrounds a farm. The relationships that we have formed with local farmers in the Coto Brus region has been essential, not only for collecting these data but also for discussions with farmers, who are able to provide insights about what may be driving the changes in biodiversity they have seen in their lifetime. We can discuss with local growers how they saw an influx of certain species, when they restored trees along a stream in their field, or during years, when the dry season was particularly long or intense.

In my recent work, I have been using this long-term dataset to understand how species have responded to land-use change and climate change. This is important, not only for getting a better understanding of basic ecology but also for making accurate projections about how species populations are likely to change with further land-use intensification and climate change. The most striking pattern we have found from this work is that standard models of biodiversity change may be underestimating the potential impacts of land-use change by half! This is because these types of models rely on coarse data that is aggregated over large spatial and temporal units. It clouds the relationships between habitat availability and bird



Male white-winged tanager. Photo Nicholas Hendershot.

abundance, which we know is sensitive to habitat availability at scales as small as 30 meters and is dynamic through years with land-use change.

Long-term research such as this is essential to understanding how humans are affecting biodiversity and what steps we can take to protect species now and in the future. The landscape around Las Cruces and the continuity of the station has enabled our group to learn so much about nature alongside the amazing naturalists, growers, and citizens of Coto Brus. We look forward to the day we can return to Las Cruces and continue to tackle these pressing environmental issues!



This photo shows many of the intersecting land uses of Coto Brus including pasture, forest cover, and urban areas. Photo Jeffrey Smith.

Young trees are more susceptible to insect herbivory in remnant than in restored tropical forests

Andy J. Kulikowski II (akulikow@ucsc.edu)

hether you love, hate, or simply tolerate them, most people recognize that insects are essential to ecosystem function. While familiar groups like the bees and butterflies that pollinate our crops are indeed important, it might come as a surprise that another group, the insect herbivores, are in large part responsible for the vast richness of plant species seen in tropical forests. And what is the key to such an important function? Picky eaters.

When a plant reproduces, its seeds often germinate close by, creating an abundance of seeds and young seedlings near the mother plant. These seeds and seedlings would possibly grow to dominate the area if not for insect herbivore specialists, which are insects that only eat one group or species of plant. These specialists eat and kill most of the abundant seedlings but ignore other less-palatable plants in the area. This allows many plant species to exist in one small area without a single species becoming dominant.

Unfortunately, human-caused fragmentation and deforestation can reduce insect herbivory, particularly that caused by specialist herbivores. Reductions in herbivory could tip the balance and weaken diversity-driving processes. Further, efforts to restore degraded forests may be hindered by altered patterns of herbivory leading to unexpected restoration outcomes.

Given this uncertainty, I set out to examine how insect herbivory affected plants in restored forests around Coto Brus. The restored forests I worked in consisted of native and naturalized trees planted only 15 years before the study began. In that short time, they developed a 15m tall canopy and already showed signs of recovery in the form of natural tree recruitment and the return of native birds. I was interested in whether plant mortality



Experimental set-up of the insect exclosures.



Seedling showing excessive herbivory that may lead to its death.

driven by insect herbivores was recovering in a similar manner or whether potential changes in herbivory were leading restored forests down a different recovery pathway than natural forests.

To answer this question, I used a field experiment in which I contrasted tree-seedling mortality caused by insects between restored forests and remnant forest patches on the landscape. I reared over 3,000 tree seedlings from eight different species. This included both pioneer species that colonize early in forest succession and late-successional species found in mature, primary forests. I planted seedlings in restored and remnant forests within either an insect-proof exclosure or out in the open. The seedlings remained in the forests for up to a year while I measured seedling mortality in and outside of the insect exclosures.

The results of the experiment were surprising. Tree seedlings in both restored and remnant forests experienced increased mortality outside of insect exclosures, showing that insect herbivory is indeed an important driver of seedling survival. Still, differences existed between the two forest types. Seedlings in restored forests experienced a smaller difference in mortality between the insect-excluded and open plots compared to remnant forests. Interestingly, this effect was most pronounced in late-successional seedlings. In other words, mature-forest tree species are killed by herbivores to a much greater extent in remnant than restored forests.

These results could be both positive and negative for forest restoration efforts. It's encouraging that mature-forest species were less-susceptible to herbivores in restored forests as these species are highly desirable from an ecosystem recovery standpoint. However, if seedling mortality does not increase as forests grow, restored forests may experience altered patterns of tree recruitment and reduced tree diversity compared to remnant forests. Long-term studies that measure seedling mortality as forests age and link mortality to insect herbivore communities are needed to determine the long-term impact altered herbivory may have on forest restoration efforts.

De la Comunidad

Actions for the development of a protected area with community participation

Rodolfo Quirós (rodolfo.quiros@tropicalstudies.org)

Around 20% of Costa Rica's territory is protected in national parks or reserves, including parks declared as World Heritage Sites by UNESCO. There are various kinds of protected areas. The scope covers public and private areas. Most are terrestrial, but there are several that are wetlands and marine reserves. Some are for absolute conservation and research, but others allow touristic activities and other kinds of development as long as it is controlled. Many are wildlife refuges and biological reserves. This is the spirit of the Costa Ricans, wanting to be surrounded by natural settings, but it is also our effort to preserve natural environments to be enjoyed by locals and foreign visitors.

The trend in conservation now is to involve the communities around the protected areas to participate in different activities. Members of the communities include residents in the vicinity, community leaders, several kinds of associations in which they participate, and local institutions such as schools. Government institutions that work in the area, as well as conservation, environmental, and educational nongovernmental organizations are included as participants in the development of the protected areas on a regional scale.

All these participants can respond in different ways to the question, How would you like to get involved in the development of a protected area? Here are examples of their answers. Which one is yours?

Establish alliances with various types of people to make the work representative and inclusive.

Jointly help to develop sustainable and environmentally responsible activities.

Raising awareness and community focus among neighbors about the importance to all of a highly healthy and diverse environment.

Establish a local conservation plan with the participation of local communities and other stakeholders.

Define a forest restoration program that works with owners and provides technical advice that identifies sustainable land uses in harmony with the natural environment.

Promote low-impact tourism that is sustainable, such as bird watching, and that incorporates community participation.

Promote volunteering among the neighbors of the protected area to collaborate in their protection and development.

 Define conservation objectives that facilitate research and technical training activities.



Design a local participatory research program for tracking species of interest and their threats.

Organize participatory projects with children and young people in the area, who are collaborators in research or who promote other sustainable activities.

Use the protected area as an invaluable resource for environmental education and to demonstrate environmental sustainability activities.



Hurricane Eta hits Coto Brus hard

Hurricane Eta was a devastating Category 4 hurricane with wind speeds reaching up to 240 km/h (150 mph), and it caused great damage in several parts of Central America in early November 2020. The indirect effects of this hurricane brought heavy rainfall to portions of Costa Rica with the heaviest rains concentrated along the Pacific coast. Multiple reports of flooding and landslides occurred all throughout this area.

In Coto Brus County, where the station is located, we had heavy rains for over four days. This image is part of the rain log from Tuesday, November 3, at 12:00 pm to Wednesday, November 4, at 10:00 am at the Wilson Botanical Garden. The steady rains added up to almost 260 millimeters of water in those two days. This data was collected with our automatic weather station that records data every 15 minutes and uploads it into a database, which can be accessed online.

There were countless reports of landslides on roads all over the county. There were three major ones near the Wilson Botanical Garden, as well as one that destroyed a nearby road and isolated our area. For several days, some of our personnel were not able to come to work at the station, because there was no access. Not far from the garden, a couple died when a landside covered their home. These were the only two casualties reported in Costa Rica as part of Eta's effects.

A major problem was that the county's aqueduct broke in the highlands, and a large portion of the population was without running water for more than a week. The delay was due to the severity of the damages, but primarily it was because the access to the area was blocked with multiple landslides, particularly at El Progreso, where a river brought so much water and debris that the road was destroyed and almost obliterated the town. Costa Rica's president, Carlos Alvarado, visited that area to evaluate



A major landslide destroyed the road from San Vito to Agua Buena, not far from the Wilson Garden. Photo Samuel Salas.



Landslide that killed two people near the Wilson Garden. Photo Claudio Murillo.



the damage and to talk to residents.

Fortunately, at the station we had no problems. Even though the water level in the soil was very high and you could see it flowing out of the hills and plant beds, only one tree was found to be fallen near the cabins by the forest after a thorough inspection of the buildings and different areas of the Wilson Garden.

Thank you so much to all our Amigos, who wrote or called asking how the garden was after this event.

New challenges, new hope

Emilce Ramírez (emilce.ramirez@tropicalstudies.org) / OTS Operations Manager



Las Cruces. Photo archive.

The year 2020 has been a year for us to learn how to do more with less. For many years, Las Cruces Research Station faced the challenge to run with the minimum possible resources, but we were successful. Nevertheless, that challenge could not compare to the one we are facing now due to the Covid pandemic. Due to a lack of visitors, the expression, "*run with the minimum possible*," has a very different dimension.

We had to implement several measures targeted at lowering the regular expenses of the station. These measures included decreasing the daily use of resources needed to maintain the station, reducing the work time of the personnel, and redistributing the functions of some of the personnel to ensure that we were able to cover the same, or more, work with less staff and time. At the same time, we put into place safety protocols, health standards, and a comprehensive response plan so that visitors can feel secure in our health and safety preparedness when they visit the station. OTS is committed to supporting our staff and creating a safe and welcoming environment for visitors and staff alike.

This situation has left us hoping that we can recover soon. Traditionally, high season for tourism starts in December, and we usually have a good number of visitors beginning in January. We know that the visitation numbers will not be at the same level as in previous years, but we trust that many tourists will be interested in spending time in a place that is safe, that maintains a large biodiversity, and where learning something new is a daily experience.

We are very thankful to the many Amigos of the station, who have helped us with various contributions. Their donations of all kinds are making it possible for us to do the work needed to ensure the station carries on receiving new, and some already known, faces in the coming months. Knowing that there are many Amigos who support us lights up new hope in this time of many new challenges.

As always, a big THANK YOU to you all!

Las Cruces Donors through November 2020

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Las Cruces. Photo archive.





Las Cruces Research Station & Wilson Botanical Garden Apdo 73-8257 San Vito, Coto Brus, Costa Rica.



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