

COURSE REPORT

Ecosystem Services and Tropical Forest Restoration

ELTI Permanent Training Site
Agua Salud Project, Province of Colon, Panama
February 13-18, 2017

A field course organized by:
The Environmental Leadership & Training Initiative (ELTI)
and the Smithsonian Tropical Research Institute (STRI)



Saskia Santamaría - ELTI



Background: As a result of its geological history, Panama possesses an extraordinary biodiversity. As the last part of the Central American isthmus to emerge from the sea some 3.5 million years ago, the country became a natural bridge that has allowed the exchange of living organisms from North and South America. However, Panama has suffered extensive deforestation, which has been driven by an economic model and policies that promote the transformation of forests into cultivated land as well as for urban, mining and infrastructure development. Therefore, disappearing with Panama's forests are a wide range of ecosystem services of great importance for supporting life on the planet. In recent years, there has been an increase in forest restoration initiatives; however, restoration activities often fail, because practitioners do not account for the diverse biophysical and socioeconomic conditions found in human modified land-

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scapes. In addition, restoration initiatives have often simply focused on reforestation with exotic monocultures, which provide limited ecosystem services, especially in terms of biodiversity and traditional uses of non-timber forest products. Therefore, understanding of the principal ecological processes that govern the functions of forests' ecosystems in addition to advances in forest ecology are critical to inform land-use decision makers on how to facilitate sustainable restoration strategies.

One approach to forest restoration capacity building is through intensive field-based courses situated in diverse biophysical and socio-economic landscapes. Field-based courses provide participants with the opportunity to actively engage in field-exercises that illustrate the importance of integrating scientific investigation into the development of adequate restoration strategies. Since 2013, ELTI has taken this approach by developing focal training sites in both wet and dry tropical forest ecosystems in Panama, where the Yale School of Forestry and Environmental Studies (F&ES) and STRI conduct long-term forest restoration research and experiments.

This training was offered to fourteen international environmental professionals from throughout Latin America, who were interested in strengthening their forest restoration knowledge and practical skills. Over a period of six days, course participants learned the technical skills necessary to design and implement strategies to increase forest cover and ecosystem services in modified, multiple-use landscapes, with particular focus on watersheds. Special attention was given to understanding the socio-economic drivers of forest degradation and potential for restoration. Additionally, participants had the opportunity to learn and exchange experiences, concepts and practical tools with ELTI facilitators, international experts and other professional peers.

Objectives: The overall objective of the course was to introduce participants to the important role that forests play in providing ecosystem services, including the scientific advancements and applied experiences that are proven to restore ecological function in multiple-use landscapes.



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In addition:

- To present the fundamentals of tropical forest ecology and the scientific advancements to quantify ecosystem services in multiple-use landscapes of the seasonal tropics.
- To demonstrate the basic principles of forest disturbances, environmental degradation and its consequences on the integrity of ecosystem services, natural regeneration and forest restoration.
- To inform participants of the range of forest restoration options and to guide decision-making by evaluating both biophysical and socio-economic variables associated with their unique contexts.
- To provide participants from throughout Latin America with the opportunity to meet and establish contacts for collaboration, technical assistance and to generate projects that can be supported through ELTI's Leadership Program.

Field-Course Format: This course took place at ELTI's wet tropical forest training site that is located in STRI's Agua Salud Project (referred to as Agua Salud). Agua Salud is an ideal setting for field-based forest restoration courses, as the site attempts to understand and quantify the ecological, social and economic services provided by multiple-use landscapes in the Panama Canal Watershed (PCW). Course themes were taught via classroom lectures that included discussions and case studies. Field visits to Agua Salud consisted of demonstrative lectures, observations and active group exercises. ELTI's on-line clickable presentations covering themes of the three modules were also sent to participants two weeks before the course in order to better prepare participants.

• **Day 1:** Jacob Slusser and Saskia Santamaría (Panama Coordinator and Neotropics Program Assistant, respectively) started the course with an initial presentation about ELTI and the objectives and format of the course. Dr. Matthew Larsen, Director of STRI, provided opening remarks about STRI's one-hundred years of scientific research in Panama. Dr. Jefferson Hall, Director of the Agua Salud Project, presented on STRI's Agua Salud Project and its mission to understand the provision of ecosystem services on multiple-land uses within the Panama Canal Watershed. After lunch, Jacob Slusser delivered an introductory presentation about the importance of



managing forests for multiple ecosystem services. Afterwards, Dr. Dylan Craven, a researcher from the German Centre for Integrative Biodiversity Research (iDiv), provided a theoretical basis for the following day's demonstration plot visits by presenting on both forest ecology and forest stand dynamics. Participants then took a short field trip to visit the Pedro Miguel Locks of the Panama Canal, where ELTI Staff discussed the importance of upper watershed management for Canal operations. Each day concluded with brief presentations where participants described the forest restoration efforts they conduct in their own countries as well as the skills they hope to obtain from the ELTI course in order to implement informed restoration activities.

- **Day 2:** Participants received an introduction to the day's activities before departing to Agua Salud. Upon arriving, Dr. Hall and site manager Adriana Tapia provided an introduction at a hilltop overlook illustrating the micro-watersheds and the different types of restoration experiments being conducted. Following this visit, participants traveled to the ELTI Permanent Forest Plot, located in a mature forest. Jacob Slusser and Dr. Craven utilized the area to illustrate various themes on ecosystem services and forest ecology. Mario Bailon, STRI Botanist, provided a brief demonstration on the best practices for forest measurements. Participants divided into groups and were tasked with quantifying multiple ecosystem services in the forest plot by conducting forest measurements, observations of soil and forest structures, analysis of macro-fauna in soils and construction of species area curves.

After the exercise, participants visited the research area of Dr. Mario Bretfeld, Postdoctoral researcher at STRI's Agua Salud Project, who is studying the water cycle in forests by specifically testing sap flow in in-

dividual trees. This research illustrates how different aged forests regulate their water use. In the afternoon, participants visited ELTI plots in a young secondary forest to compare differences in structure, composition and function with the mature forests. Participants completed group exercises comparing the differences in leaf toughness and macro-fauna in the young and mature forests, to demonstrate different stages of forest



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succession and recuperation of ecosystem services. Participants also visited an assisted natural regeneration (ANR) plot where different strategies were used to accelerate succession in a young secondary forest, demonstrating passive and therefore more economic methods for restoration. The field-day was completed with a visit to a teak (*Tectona grandis*) plantation to illustrate the poor growth due to inadequate conditions, while native species such as *amarillo* (*Terminalia amazonia*), which has similar growth rates and timber quality characteristics as teak, grows well in the same conditions.

- **Day 3:** The day began with an analysis of the data and observations recorded during the exercises during the prior day's field visit. Furthermore, Dr. Craven demonstrated which types of open-access computer programs could be utilized to analyze forest data and create simple graphics and charts to illustrate results.

Participants then received a guided tour of the Biomuseo, which celebrates the biodiversity created by the emergence of Panama and the formation of a terrestrial connection between North and South America. As a result, Panama has had incredible influence upon regional and global biological evolution.

In the afternoon, Dr. Craven presented on the effects of forest degradation, focusing on the loss of ecosystem services. Jacob Slusser presented on a conceptual model for conducting forest restoration and the range of forest restoration strategies that can be implemented in productive landscapes. The day finished with a case study, presented by Jacob Slusser, regarding the importance of integrating social science research into capacity building and restoration initiatives conducted in agricultural landscapes.

- **Day 4:** Participants returned to Agua Salud and began the day by utilizing the conceptual model for restoration to conduct a site diagnostic of an area degraded by conventional cattle ranching practices. Afterwards, Dr. Carolina Mayoral, Postdoctoral researcher at STRI's Agua Salud Project, described the different native species plantation treatments and how soil conditions and interactions between species influence growth and mortality. Participants then worked in groups and

conducted measurements in four different plots with unique species and treatments, comparing their growth according to soil conditions, aspects and species compositions.

In the afternoon, Jorge Batista, STRI's Agua Salud Field Technician, led a walk on the ELTI trail, illustrating the experiments being conducted to study the water cycle in different micro watersheds. Jorge showed examples of how to measure water infiltration, runoff and streamflow, which are utilized to demonstrate a forest's "sponge effect" and the loss of this service in degraded landscapes.

The day concluded with a visit to the Madden Dam, which impounds the Chagres River and forms Alajuela Lake, a reservoir that is a key part of the Panama Canal Watershed. The dam was built to mitigate Chagres River storm flows upstream of Gatun Lake and to control the level of water in the lake during the dry season. ELTI Staff explained how water from the reservoir is also used to generate hydroelectric power and to supply Panama City's fresh water, further illustrating the importance of forest restoration/conservation in the watershed. Upon returning from the field, Dr. Craven and Jacob Slusser facilitated a session to review and analyze the data collected during the plantation measurements exercise. Each group understood the differences in growth according to the plots' different biophysical and treatment contexts.

- **Day 5:** This day focused on the social aspects of forest restoration, specifically accounting for the complexities of social values and how restoration can promote positive opportunities in rural communities. Arturo Cerezo, Manager of the Panama Canal Authority's (ACP) Soil Conservation Division presented a case study on the ACP's Environmental Economic Incentives Program (PIEA), which educates and incentivizes rural landowners within the Panama Canal Watershed to partake in sustainable land-use decision making. After the presentation, the group visited a local tree nursery established by a women's community group called the Gatuncillo River Agroecology Producer's Association (known by its Spanish acronym as APARGA). APARGA members presented



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on the history of the group, the challenges of facilitating a community organization, establishing and managing a nursery, and best practices for propagating native tree species.

To continue the theme of social perspectives of restoration, the participants visited a silvopastoral system established at Agua Salud as a replicate of the type of system the ACP's PIEA is promoting. Jacob Slusser led the visit, articulating the different components of the system as well as how the integration of trees into pasture systems provides environmental, productive, economic and social benefits. Celestino Jaén, a traditional cattle rancher from the area who continues to graze his cattle on the system, explained his experience and the perceived benefits of changing from conventional to more sustainable practices via silvopastoral systems.

Finally, participants visited a degraded area near Agua Salud and were divided into groups that represented varying objectives of potential (fictional) buyers of the property. Each group was required to conduct a rapid assessment, develop a restoration analysis based on the buyer's restoration objective (timber, biodiversity, forest connectivity or production) and provide the buyer with different strategies to meet their goals.

- **Day 6:** The final day of the course focused on each group presenting their restoration strategy, according to their individual objectives. The exercise reinforced the importance of making decisions based upon well-researched, site-specific biophysical and socio-economic information before implementing a restoration strategy. Many participants listed the informative ELTI training materials, demonstration area examples and field-based techniques they had learned as methods to conduct efficient restoration strategies and monitor results. Saskia Santamaría presented on ELTI's Leadership Program, which provides support to ELTI Alumni to conduct restoration activities or receive further professional development. The course concluded after participants submitted a course evaluation and were presented with certificates of completion.



Jacob L. Slusser - ELTI



Participants: This course was designed to convey advances in applied forest restoration ecology to professional practitioners from Latin America. The fourteen individuals selected to attend the course represented a number of organizations including: (1) the government; such as the Ecuadorian Ministry of Agriculture, Cattle Ranching, Aquaculture and Fisheries (MAGAP), Pro Romeral Corporation for the Recovery and Preservation of Micro-watersheds (Colombia), the Colombian Federation of Cattle Ranchers (FEDEGAN) and the Panamanian National Assembly; (2) autonomous government entities such as the Panama Canal Authority (ACP); (3) NGOs including; The Peregrine Fund, the Helvetas Swiss Intercooperation's Andean Forest Program, the Inkaterra Association (Peru), the Nature Foundation and Guayacanal Foundation (Colombia) and the Panamanian Society of Biology and Biodiversity; (4) educational institutions; the City of Knowledge (Panama), the National University of Colombia (Medellin) and the State University of the Amazon (Peru); and (5) the private sector; Minera Panamá.

Instructors: The course was facilitated in Spanish by experts from STRI, ELTI and other local partners as listed below:

- Dr. Jefferson Hall, Smithsonian Tropical Research Institute (STRI), United States
- Dr. Dylan Craven, German Centre for Integrative Biodiversity Research (iDiv), United States
- Dr. Carolina Mayoral Pérez, Smithsonian Tropical Research Institute (STRI), Spain
- Dr. Mario Bretfeld, Smithsonian Tropical Research Institute (STRI), Panama
- Mario Bailon, Smithsonian Tropical Research Institute (STRI), Panama
- Jorge Batista, Smithsonian Tropical Research Institute (STRI), Panama
- Jacob L. Slusser, M.Sc., Environmental Leadership and Training Initiative (ELTI), United States
- Saskia Santamaría, Environmental Leadership and Training Initiative (ELTI), Panama

Outcomes and Follow-up: Participants were actively engaged in learning about the ecology and restoration of wet tropical forests throughout the course. Participants provided brief presentations highlighting their professional work related to restoration, which facilitated further exchange of knowledge and the potential for collaboration amongst peers. Course evaluations received high ratings (average 4.7 out of 5). An alumni assessment will be implemented in six months to gauge the course's impacts and alumni interest in participating in the Leadership Program.

This event was possible thanks to Arcadia Fund, whose Environmental Conservation grants support programmes that protect and enhance biodiversity, and provide field training and academic research.