



## **Puerto Rico's Rainforest 2010 FIELD REPORT**

**Principal Investigators:**

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**Country:**

Puerto Rico

**Research site / region:**

Las Casas de la Selva

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**Period covered:**

12 Mar 2010 to 5 Jan 2011

**Report completed by:**

Thrity Vakil ("3T")



*Las Casas homestead. Photo by Thrity Vakil.*



*Measuring Mahoe trees. Photo by J. Q. Loo*

Dear 2010 Earthwatchers,

Thank you for your contribution towards our research aims at The Rainforest Project, Puerto Rico! We greatly appreciate your decision to come here and help us accomplish our goals towards sustainable management of this forest. With the data we have been gathering we are able to evaluate the needs and direction of further studies, and implement relevant strategies and land management plans. It has been exactly ten years since we began our collaboration with Earthwatch, and we have all learnt by doing, especially the practical details of measuring hundreds of trees, and the physical limitations of steeply sloping land and wet, wet weather! Our 2010 season saw a total of seven Earthwatch Teams, including two teenage teams, with volunteers from all over the world, ready, willing, and able to jump straight into all our ongoing studies. These included lizard studies, fungi studies, and ongoing thinning assessments in Mahogany and Mahoe timber plantations. If crawling around on the forest floor in the daytime wasn't enough, night-time frog studies added to the sense of adventure in this beautiful rainforest of Puerto Rico.

Good news to share! Our biodiversity study, "The Impact of Hardwood Line-Planting on Tree and Amphibian Diversity in a Secondary Subtropical Wet Forest of Southeast Puerto Rico" has been published in the *Journal of Sustainable Forestry*, 29(5):503-516. Hot on the heels of this success, we recently submitted our tree growth paper "Enriched secondary subtropical forest for sustainable timber production", to the journal *Bois et Forêts des Tropiques*. Over thirty acres of trees surveyed over the last ten years and a final three acres this year, helped to bring this data and analysis to completion, an important step towards management of our timber stands and current and potential wood production. Puerto Rico is currently approximately 57% forested, mostly by young secondary forest. It is crucial that we understand the ecology of this type of forest, if we are to utilize its timber and other forest products in economically and ecologically viable ways.

In December 2010, Thrity Vakil and Andrés Rúa were invited to present Tropic Ventures Sustainable Forestry Project at the 13th Caribbean Urban & Community Forestry Conference in Ponce, PR. This was an inspired collaboration with mentor and forester Dr Frank Wadsworth, who also presented his latest paper "Conserve Puerto Rico with Forests for Wood". The paper details potential timber producing areas and forests on the island, and is an

important document as Puerto Rico begins to assess its potential for sustainable timber production. After being a taboo subject for almost a decade, trees for timber is finally a subject that is being discussed again.

Our research with Earthwatch volunteers makes it possible for us to think and talk with increasing intelligence about this particular forest biome and 2010 has shown an increase of collaborations and potential partnerships, all dealing with issues of sustainable natural resources.

Aside from the valuable collection of data, the team here at Las Casas de la Selva appreciates the opportunity to share lives and experiences with diverse humans from around the planet. We all learn something profound about ourselves and each other after spending such concentrated time on an expedition together. We have thoroughly enjoyed the company of all who have trekked through the forest with us, identifying, collecting, and measuring, and equally enjoyed homestead social interactions at the end of a long day.

After completing expeditions here, realizations about what is beneficial for our biosphere have seen many volunteers alter the course of their studies or careers. This is one understated benefit of an Earthwatch Expedition.

We encourage everyone to come and visit again. Keep in touch with us and with our ongoing work by checking into the website and newsletter <http://www.eyeontherainforest.org/>.

Gracious thanks for involving yourselves in learning about our biosphere with us.

High Regards,

3t Vakil, Mark Nelson, Norman Greenhawk, Patty Boyko, Molly Robertson, and Andrés Rúa.  
Lead Earthwatch Scientists



*Earthwatch volunteers with Lead Scientist Dr. Mark Nelson. Photo by Thrity Vakil.*

## SECTION ONE

### Top highlight from the past field season

1) During the leaf-litter survey started in April of 2010, Earthwatch volunteers captured, measured, and released two specimens of the Puerto Rican Galliwasp (*Diploglossus pleei*). The galliwasp is a small skink-like lizard. The only representative of its genus in Puerto Rico, it is considered rare and secretive, as it spends most of its time in the leaf litter, hidden from view.

2) On the fungi study in the 2010 field season, Earthwatch volunteers found, collected, and described a species of Cordyceps, only about 1mm broad, growing out of an unidentifiable insect. Cordyceps species are endoparasitoids, infecting an insect, growing throughout the insect and feeding on its tissue, and eventually killing it and producing a fruiting body that comes out of the insect. Some species of Cordyceps are known to actually alter the behavior of its host before killing it, such as making it clamp tightly to a leaf or twig (effectively rooting the fruiting body), or making the host climb to the highest part of a tree (from which the spores will have a wider range when released). It was very exciting to see this strange fungal process occurring in our forest!

3) On the coqui study in the 2010 field season, Earthwatch volunteers on a teen team witnessed the hatching of a clutch of *Eleutherodactylus wightmanae* eggs. This particular species are direct developers meaning that tiny baby frogs are born from the clutch. This is a rare and exciting event to witness in the field for teens and provided them the opportunity to observe the diversity of amphibian life cycles firsthand.



*Earthwatch lizard study. Photo by Patty Boyko.*



*Mahoe Trees. Photo by J. Q. Loo.*

### **Non-technical overview of results**

Since the second half of the 20th century, Puerto Rican forest cover has gradually increased, from a low of about 7% in the late 1940s, to 35% in 1985, due to socioeconomic policies resulting in the widespread abandonment of agricultural land and activities, immigration to urban areas, and an increase in industrial production. The abandonment of agriculture and increased forest cover was further promoted by the ability of residents of Puerto Rico to immigrate to the U.S. and Puerto Rico's forest area increased by about 4,000 ha annually between 1980 and 1985. The period of economic and cultural change from the 1950s to 1990 in Puerto Rico is seen as proportionally resulting in the largest event of forest recovery anywhere in the world. Puerto Rico is currently approximately 57% forested, for the most part by young secondary forest (forest that has re-grown following a major disturbance).

Established in 1983, "Las Casas de la Selva" an experimental sustainable forestry and enrichment project, was undertaken with the goal of developing ecological approaches to timber production on lands that are unsuited to long term agricultural use. If successful, this may encourage similar practice resulting in sustainable, productive use of these properties throughout Puerto Rico and may be applicable for secondary rainforest in other tropical countries as well. Understanding how ecosystems function, how human societies relate to the natural environment, and how interaction can be mutually harmonious, leads to establishing meaningful balances; fulfilling the needs of people and maintaining healthy, natural ecosystems. The broadness of such objectives necessitates equally wide views on studies and approaches, and a wide variety of emphases. All of the studies at this project aim to increase our understanding of the biome (regional ecosystem characterized by distinct vegetation, animals and microbes) we live in and of ourselves within it.

### *Thinning & Liberation Study*

A potential option to boost income from forestry management is to increase use of currently, under-utilized and less well-known hardwood species. At Las Casas de la Selva, the secondary forest is approaching a stage of recovery that could support sustained removals of useful timber from selected areas and moreover, the opportunity to develop silvicultural (the care and cultivation of trees) methods to improve the value of timber stands; techniques that increase growth rates and the amount of marketable wood produced, with minimal impacts to the local ecology. If successful, such techniques could be widely applied, as an increasing percentage of the land in Puerto Rico consists of such forest which is generally thought to be unworthy of silvicultural treatment because of the excessive time it takes for commercial trees to develop to harvestable size with the unrestricted tree density and competition in unmanaged secondary forest.

#### *Mahogany Thinning study:*

In December 2007, two adjacent quarter acre plots of line-planted Mahogany were set up to begin a long term study evaluating the effectiveness of thinning techniques on Mahogany growth rates. With the help of Earthwatch volunteers, initial measurements were taken on all Mahogany trees which had been selected to remain in the two plots. These measurements included diameter at breast height (1.3m), total height of tree, commercial height of tree, commercial diameter, canopy diameter, and canopy class. In March 2008, 19 Mahogany trees were thinned in one of the quarter acre plots, leaving the adjacent plot to serve as a control. In December 2008, a second reading was taken on all trees in both the thinned plot and control plot, for a total of 56 trees. Given that one year growth data provides minimal insight into the effectiveness of thinning, the plots will be monitored at one to two year intervals for a minimum of five years.

In summer 2009, a second thinning study commenced to evaluate the effectiveness of thinning on Mahoe growth rates. Earthwatch volunteers set up and measured a quarter acre plot containing a total of 110 Mahoe trees. Measurements taken were the same as outlined above for the Mahogany.

During the 2010 field season, a second set of readings were taken on the 110 Mahoe trees. Although the plot has yet to be thinned, these readings will provide valuable growth data for future comparisons post-thinning. In December 2010, Earthwatch volunteers collected a third set of readings on the thinned and control plots set up in 2007.



*Earthwatch volunteer measuring trees. Photo by Thrity Vakil.*

### *Baseline anole population study*

While the baseline anole population study is not yet complete, all data collected to date indicates that *Anolis stratulus* (St. Thomas Anole) and *Anolis gundlachi* (Yellow Chinned Anole) are the most common anoles found at Las Casas de la Selva. The grass anoles, *A. Pulchellus* (Grass Anole) and *A. Krugi* (Krug's Anole, Olive Bush Anole), the two species known to utilize open habitats of grass and small shrubs, tend to be found only in areas of no forest cover, such as along the forest road. *A. Christatellus* (Garden Lizard) and *A. Evermanni* (Emerald Anole) were rarely seen in the forest, and are more common around the homestead. Continuation of the baseline study will potentially yield information about seasonal population fluctuations, microhabitat utilization, and relationships between *Anolis* spp., predator/prey interaction, habitat, and human activity in the forest.

Other herpetological surveys- the Anole Microhabitat Survey, the Leaf Litter Survey, and the Nocturnal Transect Survey have only recently been implemented; there is not yet enough data to draw conclusions. However, it is worth noting that during the Leaf Litter Survey, Earthwatch volunteers observed *Diploglossus pleei* and a species of *Sphaerodactylus* gecko not previously known to exist at Las Casas. Further surveys will need to be conducted in order to draw accurate population data.

### *Macrofungi study*

Fungi, particularly in the tropics, are poorly known and understood. It has been estimated that there are 1.5 million species of fungi worldwide, of which we have described less than 5 percent. Fungi play a vital role in forest ecosystem processes. Ectomycorrhizal fungi have a symbiotic relationship with plants that helps them obtain nutrients from the soil. Parasitic fungi attack plants and insects, aiding in population control and creating gaps in the forest which increase biodiversity. Saprophytic fungi have a great importance as decomposers, especially with the high plant growth rates and low soil fertility of tropical and subtropical forests.

In the 2010 Earthwatch season, we began a general survey of fungi at Las Casas. The teams went out to different areas in the forest and looked for mushrooms, 'fungal foray' style. Working in small groups, when a mushroom was found the group photographed it, described it, and made a collection. Upon returning from the field, each group more thoroughly described their collections, looked at microscopic features when applicable, and searched through the literature for potential species identifications. Identified species were added to our ongoing fungi observation list, and photos and descriptions are used to aid in future identification. Some of the fungi of Las Casas de la Selva can be found on Mushroom Observer, [http://mushroomobserver.org/observer/observations\\_at\\_location/1381](http://mushroomobserver.org/observer/observations_at_location/1381).

### *References*

1. Gilbert GS, Sosa WP. 2002. Host specialization among wood-decay polypore fungi in a Caribbean mangrove forest. *Biotropica* 34:396 -404.
2. Hawksworth DL. 1991. The fungal dimension of biodiversity: magnitude, significance, and conservation. *Mycol Res* 95:641-655.
3. Lodge DJ. 1993. Nutrient cycling by fungi in wet tropical forests. In: Issac S, Frankland JC, Watling R, Whalley AJS, editors. *Aspects of tropical mycology*. British Mycological Society Symposium Series. Vol. 19. Cambridge: Cambridge University Press. p. 37-58.



*Fungi study. Photo by D. Croad*

#### *Vine study*

Volunteers in 2010 continued to measure the growth of liana seedlings, which were staked and measured beginning in 2009. The study concluded in summer of 2010 with one year of growth data on three liana species.

*Securidaca virgata* seedlings showed a wide range of growth rates over the year, ranging from death or zero growth to up to 92 cm. Three of the fifteen seedlings died over the course of the study, and only four showed a growth of over 20 cm. The average growth over all surviving seedlings was 23.4 cm. *Schlegelia brachyantha* responded well to the transplanting treatment. Of the twelve seedlings transplanted, two died over the year. The growth rates recorded also vary greatly for this species, from zero growth to 71.5 cm. Half of the surviving seedlings grew over 20 cm in the year, with an average growth over all surviving seedlings of 25 cm.

*Marcgravia rectiflora* did not respond well to transplanting. Of the ten seedlings planted, only three survived for the year. All of the dead seedlings died within the first month of transplanting. Two of the three surviving seedlings grew a mere 5.5 cm, and the third died back by 11.5 cm.



*Earthwatch volunteers doing a lizard study. Photo by D. Croad.*

## SECTION TWO: TECHNICAL REPORT

### 1. REPORTING AGAINST RESEARCH OBJECTIVES



*PI Thrity Vakil in mahogany plantation. Photo by Andrés Rúa.*

**Objective 1:** To examine the effectiveness of thinning techniques in our current plantings of Mahoe and Mahogany and to examine the effectiveness of liberation thinning on maturation and volume of tree crops in secondary forest areas.

#### **Progress toward/against Objective 1:**

A) In early 2009 work commenced on a Liberation study with Earthwatch volunteers. Five 20 x 30 meter plots were selected in an area of second growth forest on the Las Casas de la Selva property, within the line-planted mahogany areas. Plots were selected where there has been minimal success of the mahogany plantings, but other desirable crop trees at about 10-25 cm DBH are present, and in areas that were accessible by the forest road. All five plots have similar tree density and species composition.

The first group measured out and marked the boundaries of the five 20 x 30 meter plots in which to conduct the study, followed by a second group that tagged, measured and aided with identification of all trees in the five plots. Once this work was done, Tropic Ventures staff selected future crop trees and removed competitor trees in the three experimental plots to begin the experiment. The wood has been milled and some of it turned into products. In December 2009, Earthwatch volunteers did the first re-measurement of all the trees, as well as creating tree maps showing the locations of all trees in the five plots. These plots were re-measured in December of 2010 by Earthwatch volunteers and preliminary analysis shows that crop trees in the liberated plots have had a 2cm increase of DBH, compared to 1cm of un-liberated crop trees in control plots.

B) During the 2010 field season, a second set of readings was taken on 110 Mahoe trees in a plot that has been surveyed since 2007. Although the plot has yet to be thinned, these readings will provide valuable growth data for future comparisons post-thinning.

C) Mahogany Thinning Study: In December 2010, Earthwatch volunteers collected a third set of readings on the thinned and control plots set up in 2007.

D) In 2010 over 250 mahoe trees were tagged and surveys began for ongoing thinning assessments.



*PI Patty Boyoko and Earthwatch volunteer on fungi study. Photo by D. Croad*

**Objective 2:** To conduct herpetological studies focused on identifying which species of reptiles and amphibians are present at Las Casas de la Selva; to determine the population density, population fluctuations, microhabitat utilization, and the effects of forest management on the herpetofauna of the forest.

**Progress toward/against Objective 2:**

Island ecosystems are typically characterized with high species diversity and high specialization within those species. These factors contribute to the fragility of island biodiversity- of the 724 recorded animal extinctions in the last 400 years; half were island species. Island ecosystems also tend to have a high diversity of reptile and amphibian species. With regards to the Caribbean, reptile and amphibian diversity tends to be high in species, but low in genus. For example, of the 170 species of frogs endemic to the Caribbean islands, 80% belong to the genus *Eleutherodactylus*. This pattern is the result of adaptive radiation, the evolutionary process by which several new species evolve from a pioneer species to fill all available niches in a given environment. Puerto Rico is home to nearly 100 species of native and introduced reptiles and amphibians.

This long-term project will both augment our previous work on studying the effect of our forest plantation activities on the animal component of the ecosystem and provide us with a useful baseline data set for future monitoring of the herpetofaunal populations.

Currently, known types of herpetofauna at Las Casas de la Selva can be classified into the following categories:

- Lizards of the genus *Anolis*
- Lizards of the genus *Sphaerodactylus*
- *Diploglossus pleei*
- Frogs of the family Leptodactylidae

To properly assess herpetofauna populations, several studies are underway. For all studies, long term field data will be analyzed to obtain information on species richness, abundance, population densities, habitat preferences, insulation, and behavior. The overall goal of the herpetological studies at Las Casas de la Selva is to provide a baseline inventory of what species are found in the forest and where. This information will then be used to establish monitoring programs as needed.

#### *Anole population survey*

The baseline period of the anole population survey is nearing completion. Two years of data have been collected, several times a year, in 30 plots on the property. Within these plots, *A. gundlachi* and *A. stratulus* are the two most common anole species, with the former preferring areas of shaded canopy cover, and the latter preferring areas with less cover, but not entirely lacking in forest.

In 2011, the survey will move into a monitoring program, with detailed notes describing human activity within the plots (tree planting/removal, etc) kept on each of the 30 plots. During the baseline period of the survey, no human activity aside from the survey itself has taken place in the plots. When activity occurs, it will be recorded as an event, and a population count will be conducted in the plot prior to, two weeks after, and then three, six, nine months after, and then one year after said event. If event is ongoing (long-term tree removal), then the plot will be counted every three months. If needed, additional areas/plots will be added to the study over time to ensure even coverage of the entire property.

*Methodology.* The current methodology for the survey will continue as follows:

10m x 10m (100m<sup>2</sup>) quadrants (plots) will be established. Each area will be described in terms of vegetation, canopy cover, ecotones (if applicable), and topography. Plots will be marked off using PVC piping for plot corners and florescent plastic flagging tape for plot borders.

Before the study begins, the following information will be compiled for each plot:

- . Elevation
- . General Habitat description (What kind of forest, open, with or w/o streams, topography, etc)
- . All species of trees in each plot
- . All species of undergrowth shrubs in each plot

Each area will be counted a minimum of 4 times per year. During a population count, volunteers will record the following information in each plot: Start/End time, Start/End temperature, Start/End humidity.

In each plot, *Anolis* lizards will be observed during an approximate 30 min. period. Readings will be repeated six times a year, with at least two in the summer months and two in the winter months. For each observation the following will be noted:

- . Species
- . Gender
- . Total Length
- . Snout to vent (SV) length
- . Behavior
- . Microhabitat
- . Insulation
- . Interaction with other species (if applicable)
- . Position

#### *Anole microhabitat survey*

Anoles have evolved to occupy certain niches in primary forest. Although specialized in morphology, anoles will fill other niches when the opportunity allows. Therefore, this study has been set up complementary to the population count in order to determine how anoles utilize the microhabitats available in second-growth tropical forest. This survey is relatively new, having been started in November 2010. Therefore, there is no significant data to report.

#### *Methodology:*

The methodology for this survey is similar to that of the Anole population survey, with the following differences:

- The plots are 5m x5m in size;
- There are no current plans to use these plots in long-term monitoring surveys;
- The main focus of this study is to see how anoles utilize microhabitats in secondary forests. As such, the description of the microhabitat will be more in-depth than that of the Anole population count, including perch diameter, tree DBH (when applicable), and height from the ground.

#### *Leaf-litter survey:*

Started in May of 2010, the leaf litter survey is in its infancy. The purpose of the survey is twofold:

1. Determine which species of terrestrial reptiles and amphibians are present at Las Casas de la Selva and,
2. Determine the effect, if any, of leaf litter composition on species richness.

#### *Methodology:*

Based on environmental factors such as elevation, inhabiting tree species, and leaf litter depth, several 6x6 M plots will be selected for survey. Plots will be marked with PVC piping as transect corners, with bio-degradable twine and plastic flagging tied from one piece of piping to the next to mark the plot boundaries. Each plot will be surveyed at least 4 times per year by Earthwatch volunteers, and during each survey volunteers will record the following information:

- Elevation
- Inhabiting tree species
- Start/End Temperatures
- Start/End humidity
- Soil type
- Estimated amount of rock coverage

Volunteers will also draw a small map of the plot to illustrate plot features, and allow monitoring of said features over time. Once the start time has been recorded volunteers will line up along each plot border and begin picking up, examining and placing leaf litter into large bags. As volunteers move forward slowly they will be conducting a visual eye survey for herpetofauna. When a specimen is discovered volunteers will attempt to capture it and then place it into a sample bag to be measured at the end of the survey. Volunteers should eventually meet in the middle of the plot with all the leaf litter in bags. After the plot has been successfully surveyed and all captured specimen have been bagged, volunteers will assist in identifying, sexing and measuring the snout to vent length of all captured samples. The survey will be completed once all data has been recorded and all bags of leaf litter have been emptied and scattered back over the plot.



*Earthwatch volunteers on anole survey. Photo by Norman Greenhawk.*

### *Nocturnal transect survey*

In addition to the ongoing coqui transect survey, which is conducted twice yearly at the same 100meter transect to record long-term data on population fluctuations, short term surveys will be carried out throughout the 1,000 acre property. The purpose of these short term surveys is to obtain an overall assessment of which species of Leptodactylidae frogs are present in different areas of the forest. Research in the nearby forest of “Charco Azul”, a forest preserve owned by the Commonwealth of Puerto Rico, has shown that the species *E. cooki* utilizes rock crevices in waterfalls as habitat. However, Charco Azul is not known to historically contain *E. cooki*. Therefore, it is likely that this and other to-date unobserved species of amphibians inhabit the forest in areas not yet surveyed.

### *Methodology:*

Based on environmental factors such as elevation and leaf litter depth, several 1x10 meter transects will be selected for survey. Transects will be marked with PVC piping as transect corners, with bio-degradable twine and plastic flagging tied from one piece of piping to the next to mark the boundaries. Each plot will be surveyed at least once by Earthwatch volunteers, although a transect may become used in a monitoring program at a later date.

Time, temperature, and relative humidity will be recorded for every transect at the beginning and end of the survey. For every specimen found, volunteers will record the genus and species, as well as if the individual is an adult or juvenile.



*An Earthwatch volunteer. Photo by R. Kimball.*



*Fungi study. Photo by S.Carpenter.*

**Objective 3:** Spatial and temporal variation in litter agaric fruiting over an elevation gradient - A baseline study for the monitoring of climate and environmental change.

**Progress toward/against Objective 3:**

Macrofungi have been used in studies to learn about forest nutrient cycling (Lodge 1993), to understand and better manage forest ecosystem functions, and as bioindicators of climate change (Kausrud 2008). There are very few resources in Puerto Rico and in other tropical areas which can be used to identify fungi to easily conduct such studies. There have been few fungal surveys conducted in Puerto Rico. One project in the Greater Antilles (including Puerto Rico) surveyed Basidiomycetes over four years, and approximately 20% of the species found were not previously described (Lodge et al. 2002). In order to conduct mycological studies at Las Casas de la Selva, it is important to first know what fungi we have here, and to create material which will aid in identification of the fungi.

The objective of this study has changed over the course of 2010. Because very little of the fungi at Las Casas are known, all of the fungi we collect and document will help to make future fungal studies possible with short term volunteers. The objective of this study is now to discover what species of macrofungi are found in different areas of Las Casas de La Selva, and to document, describe, and photograph the fungi. From this we can create material that will aid in fungal identification for future studies in biological monitoring, fungal fruiting patterns, and ecological roles.

### *Methods*

Study area -- Fungi were collected from different areas of the property at Las Casas de la Selva, including planted and non planted areas and a variety of microhabitats.

Collection --Volunteers assisted in the collection and description of the mushrooms. Teams of 2-4 volunteers worked together to collect all fungal sporocarps (mushrooms) which are in reasonable condition for proper description and identification (not too young or old, and not extensively damaged). Each sporocarp collected was assigned a unique collection number, described, and photographed in the field by the volunteers. Each collection was then placed in a container with its identification number for transport back to the homestead.

Description --Volunteers described in detail each collection upon returning from the field, including taking spore prints and looking at microscopic features when possible.

Identification --Collections were identified to species when possible with available resources, otherwise to genus or family. Descriptions and photographs will be made available to a community of mycologists for comments and suggestions.

Fungi species found at Las Casas to date, November 2010:

- *Amauroderma* sp.
- *Auricularia auricula* (Hook.) Under.
- *Auricularia delicata* (Fr.) Henn.
- *Auricularia mesenterica* Pers.
- *Auricularia polytricha* (Mont) Saccardo
- *Cookeina sulcipes* (Berk.) Kuntze
- *Coprinellus disseminatus* (Pers.: Fries) J. E. Lange
- *Cordyceps* sp.
- *Cyptotrama asprata* (Berk.) Redhead & Ginns
- *Dacryopinax spathularia* (Schweinitz) Martin
- *Earliella scabrosa* (Pers.) Gilbn. and Ryv.
- *Ganoderma australe* (Fr.) Pat.
- *Gymnopilus imperialis* (Speg.) Singer
- *Gymnopus* sp.
- *Hygrocybe chloochlora* (Pegler & Fiard)
- *Hygrocybe nigrescens* (Quel.) Kuhn., var. *brevispora* Dennis
- *Lentinus crinitus* (L.) Fr.
- *Lentinus* sp.
- *Lepiota* sp.
- *Leptonia caeruleocapitata* (Dennis) Pegler
- *Leucocoprinus cretaceus* (Bull.:Fr.) Locq.
- *Marasmius* sp.
- *Mycena* sp.
- *Mycena holoporphyrata* (Berk. & Curt.) Sing.
- *Mycena spinosissima* (Singer) Desjardin
- *Phillipsia domingensis* (Berk.)

- *Pisolithus tinctorius* (Pers.) Coker and Couch.
- *Pleurotus djamor* (Rumph.) Boedijn
- *Polyporus tenuiculus* (Beauv.)
- *Trametes elegans* (Spreng.:Fr.)Fr.
- *Tremella fuciformis* Berk.

References:

1. Kauserud H, Stige LC, Vik JO, Okland RH, Hoiland K, Stenseth NC. 2008. Mushroom fruiting and climate change. PNAS 105:3811-3814.
2. Lodge DJ. 1993. Nutrient cycling by fungi in wet tropical forests. In: Issac S, Frankland JC, Watling R, Whalley AJS, editors. Aspects of tropical mycology. British Mycological Society Symposium Series. Vol. 19. Cambridge: Cambridge University Press. p. 37-58.
3. Lodge DJ, T J Baroni, and SA Cantrell. 2002. Basidiomycetes of the Greater Antilles Project. Tropical Mycology 1:45-60.



*Fungi study. Photo by D. Croad.*

**Objective 4:** To evaluate commercially valuable crops that can be grown in conjunction with the line planted mahogany

**Progress toward/against Objective 4:**

A) 101 plants of *coffea arabica* were planted in 2008, in mahogany plantation areas. The study was consulted by Edrick Marrero, agronomist and coffee expert at the Adjuntas Agricultural Extension Station that collaborates with the University of Puerto Rico in Mayaguez.

Approximately 10 oz of cow-manure and 3oz of limestone were applied in the plantings. Measurements were taken on all the plants and data collected regarding conditions of the plant's leaves and stalks, and apparent diseases, fungi and others.

The coffee trees planted within the mahogany plantations will continue to be monitored, but due to an absence of leguminous trees close by, chronic leaf disease, and possibly too much shade, the young seedlings are not doing well. We are removing this study from our scientific objectives, but will continue to plant coffee in optimal areas.

B) The objective with *Artemesia Annu*a, was to carry out trial studies to see if this commercially valuable plant will flourish and produce plants with adequate Artemisin content under the conditions at Las Casas de la Selva. Artemesia seedlings were raised in the nursery and at around 15cm high, with the help of Earthwatch volunteers, 267 plants were planted out in the field on three different plots. Initial plantings suffered due to heavy rainfall and cooler temperatures, resulting in stressed plants that flowered at a small size.

The Artemesia did not fare well in the areas chosen for planting. Heavy rains and extremely humid weather in early plantings proved detrimental to the plants. We had hoped that the Artemesia would flourish in the forest environment, but the clay soil does not promote optimal growth. Homestead trials in full compost and full sunlight show successful growth, but the objective was to grow it in the forest, in and near Mahogany & Mahoe plantations. We are removing this study from our scientific objectives, but will continue to grow Artemesia for local consumption.

**Objective 5:** To evaluate the availability and abundance of non-timber forest products that are of economic importance on the property, commencing with vines which are a source for fiber used in weaving and handicrafts.

**Progress toward/against Objective 5:**

There has been little research done to date on the assets supplied by forest products in Puerto Rico. Such products are generally used by micro-enterprises that can be an important source of employment in the economy of their communities. They are recognized as a major source of job growth especially for women, minorities and the economically disadvantaged. More than 80% of all businesses in the Caribbean are defined as micro-enterprises. Evaluation of available assets and promotion of their use is an important area of investigation for this project, as it could become a significant element in an overall plan for sustainable forest management. Non-timber products used on the island include calabash, bamboo, coconut, seeds, vine and palm fronds for weaving. There was also some use in rural areas of herbal products for medicinal and personal care, wild fruits and wild honey. With the current resources of the project it is not possible to investigate all these elements at one time. The first stage was to research and evaluate the vine species currently growing on the property, and to estimate growth rates in the forest, with a view of possible future harvesting marketing and cultivation. In 2010 the liana growth rate study was concluded with one year of data. The liana growth rate study was started in the summer of 2009. *Securidaca virgata*, *Pinzona coriacea*, *Marcgravia rectiflora*, and *Schlegelia brachyantha* were initially chosen to be growth study subject species. In June, 15 *S. virgata* seedlings of comparable length (45-95cm long) were located, measured (total straight length from base) in situ, and attached to a stake for support. Three unsuccessful

trials (of 10-20 cutting each) were made at propagating *P. coriacea*, so it was decided to exclude *P. coriacea* from the growth study until a suitable propagation method can be developed. In August, *S. brachyantha* and *M. rectiflora* cuttings (10 and 12 individuals of each, respectively) were rooted and planted under a partial canopy, each measured and provided with a stake for support.

### Results

*Securidaca virgata* seedlings showed a wide range of growth rates over the year, ranging from death or zero growth to up to 92 cm. Three of the fifteen seedlings died over the course of the study, and only four showed a growth of over 20 cm. The average growth over all surviving seedlings was 23.4 cm. *Schlegelia brachyantha* responded well to the transplanting treatment. Of the twelve seedlings transplanted, two died over the year. The growth rates recorded also vary greatly for this species, from zero growth to 71.5 cm. Half of the surviving seedlings grew over 20 cm in the year, with an average growth over all surviving seedlings of 25 cm. *Marcgravia rectiflora* did not respond well to transplanting. Of the ten seedlings planted, only three survived for the year. All of the dead seedlings died within the first month of transplanting. Two of the three surviving seedlings grew a mere 5.5 cm, and the third died back by 11.5 cm.

Because the growth rates varied so greatly between individuals, no conclusive estimate as to an average liana growth rate can be drawn from this data. It was observed that some can grow nearly a meter in one year, although not all will. *Schlegelia brachyantha* was found to be a good candidate for transplanting and cultivation, whereas *Marcgravia rectiflora* mostly did not survive the transplanting. The great variance in growth rates could be because all the lianas included in this study were seedlings under a forest canopy, and had not yet made it to the top of the canopy where they can receive adequate light to grow. More consistent results may be found if the lianas are transplanted to a location in full sun, simulating the top of the canopy where they can achieve optimum growth, or if the diameters of the lianas recorded in the first stage of this study (which have already reached the canopy) are re-measured after several years.



*Fungi specimen. Photo by Patty Boyko.*

### **Updates to objectives**

#### **Update:**

Objective 3, 'Spatial and temporal variation in litter agaric fruiting over an elevation gradient - A baseline study for the monitoring of climate and environmental change.' has been changed to 'To inventory, describe, and photograph the macrofungi of Las Casas, to create material which will aid in future fungal studies.'

After several field trials of surveying litter agarics with groups, it was determined there is insufficient material available to conduct such a study accurately with untrained, short term volunteers. Therefore the focus of the study has been shifted in order to create material that will make future fungal studies possible.

Full project proposal follows:

Inventory of the Macrofungi of Las Casas de la Selva

Patricia Boyko

Tropic Ventures Research and Education Foundation, Patillas, Puerto Rico

#### *Introduction*

Fungi, particularly in the tropics, are poorly known and understood. It has been estimated that there are 1.5 million species of fungi worldwide, of which we have described less than 5 percent (Hawksworth 1991), however these estimates tend to vary greatly between sources (Gilbert and Sousa 2002). Fungi play a vital role in forest ecosystem processes.

Ectomycorrhizal fungi have a symbiotic relationship with plants to help them attain nutrients from the soil; parasitic fungi attack plants and insects, aiding in population control and creating gaps in the forest which increase biodiversity; saprophytic fungi have a great importance as

decomposers, especially with the high plant growth rates and low soil fertility of tropical and subtropical forests. In one study of litter fungi in a wet forest of El Verde, Puerto Rico, it was found that fungi comprised up to 1.7% of the litter layer mass (accounting for one to two thirds of the total phosphorus), and probably play a significant role in regulating forest soil fertility (Lodge 1993).

Macrofungi have been used in studies to learn about forest nutrient cycling (Lodge 1993), to understand and better manage forest ecosystem functions, and as bioindicators of climate change (Kausrud 2008). There are very few resources in Puerto Rico and in other tropical areas which can be used to identify fungi to easily conduct such studies. There have been few fungal surveys conducted in Puerto Rico. One project in the Greater Antilles (including Puerto Rico) surveyed Basidiomycetes over four years, and approximately 20% of the species found were previously undescribed (Lodge et al. 2002). In order to conduct mycological studies at Las Casas de la Selva, it is important to first know what fungi we have here, and have material that can be used to aid in identification of the fungi.

The objective of this study is to discover what species of macrofungi are found in different areas of Las Casas de La Selva, and to document, describe, and photograph the fungi. From this we can create material that will aid in fungal identification for future studies in biological monitoring, fungal fruiting patterns, and ecological roles.

#### *Methods*

**Study area** -- Fungi will be collected from different areas of the property at Las Casas de la Selva, including planted and non planted areas and a variety of microhabitats.

**Collection** --Volunteers will assist in the collection and description of the mushrooms. Teams of 2-4 volunteers will work together to collect all fungal sporocarps (mushrooms) which are in reasonable condition for proper description and identification (not too young or old, and not extensively damaged). Each sporocarp collected will be assigned a unique collection number, described, and photographed in the field by the volunteers. Each collection will then be placed in a container with its identification number for transport back to the homestead.

**Description** --Volunteers will describe in detail each collection upon returning from the field, including taking spore prints and looking at microscopic features when possible. All collections will be checked by the PI or trained staff to ensure all important features are included in the description.

**Identification** --Collections will be identified to species when possible with available resources, otherwise to genus or family. Species will be determined using a combination of keys, descriptions, and professional advice. Descriptions and photographs will be made available to a community of mycologists for comments and suggestions.

#### References:

1. Gilbert GS, WP Sosa. 2002. Host specialization among wood-decay polypore fungi in a Caribbean mangrove forest. *Biotropica* 34:396–404.
2. Hawksworth DL. 1991. The fungal dimension of biodiversity: magnitude, significance, and conservation. *Mycol Res* 95:641-655.
3. Kausrud H, Stige LC, Vik JO, Okland RH, Hoiland K, Stenseth NC. 2008. Mushroom fruiting and climate change. *PNAS* 105:3811-3814.
4. Lodge DJ. 1993. Nutrient cycling by fungi in wet tropical forests. In: Issac S, Frankland JC, Watling R, Whalley AJS, editors. *Aspects of tropical mycology*. British Mycological Society Symposium Series. Vol. 19. Cambridge: Cambridge University Press. p. 37-58.
5. Lodge DJ, T J Baroni, and SA Cantrell. 2002. Basidiomycetes of the Greater Antilles Project. *Tropical Mycology* 1:45-60.

#### Resources:

- Fungi at Las Casas de la Selva
  - [http://mushroomobserver.org/species\\_list/show\\_species\\_list/147](http://mushroomobserver.org/species_list/show_species_list/147)
- Basidiomycetes of the Greater Antilles
  - <http://facultyweb.cortland.edu/NeoTropicalFungi/>
- Fungi of Ecuador
  - <http://www.mycology.com/Ecuador.html>
- Fungus Flora of Venezuela by RWG Dennis
- Mushrooms Demystified by David Arora
- Mushrooms of Hawai'i by Don E. Hemmes & Dennis E. Desjardin

#### Update:

Monitoring both Growth Rate and Seedling Abundance of Naturally Occurring Hardwoods in Secondary Forest at Las Casas de la Selva, Patillas, Puerto Rico

This proposed study is now part of the Liberation study as described in Objective 1.

#### Update:

Objective 5, 'To evaluate the availability and abundance of non-timber forest products that are of economic importance on the property, commencing with vines which are a source for fiber used in weaving and handicrafts' has been discontinued as of late 2010 upon the completion of the liana survey and growth rate study.

#### Partnerships

Global Ecotechnics owns and oversees the management of this 1000 acre rainforest land, known as Las Casas de la Selva, which is operated and managed by Tropic Ventures. The forestry program was developed by The Institute of Ecotechnics, (founded 1973), to develop and practice the discipline of ecotechnics: the ecology of technics, and the technics of ecology. Tropic Ventures provides the infrastructure and carries out the land management objectives. Tropic Ventures Education and Research Foundation hosts Earthwatch volunteers to carry out all the scientific work on the land.

The International Institute of Tropical Forestry provides technical support and advice and in particular, eminent forester, Dr. Frank Wadsworth, now 95 years old, continues to advise us on forestry protocols and discusses future management objectives and policies with us.

The Department of Natural Resources, PR, provide technical assistance and advice, and have collaborated with us in tree selection training and practice.

#### Contributions to conventions, agendas, policies, management plans

- **National or regional**

In collaboration with The Department of Natural Resources, and the USDA, Tropic Ventures' Sustainable Forestry Stewardship Management Plan is currently in review by the stewardship committee. All of our silvicultural methods and data collected in the field by Earthwatch volunteers are part of this important, evolving document. This plan will assist in creating greater visibility for the project locally, and its work within the forestry community of the US and globally, and help connect us to invaluable scientific and technical assistance. The project has

become a demonstration in a new model of approaches to secondary forest management in Puerto Rico and the Caribbean.

December 2010, 13th Caribbean Urban & Community Forestry Conference in Ponce, PR. Thrity Vakil and Andrés Rúa presented Tropic Ventures Sustainable Forestry Project at the 13th Caribbean Urban & Community Forestry Conference in Ponce, PR. The presentation was a collaboration with Dr Frank Wadsworth who presented his latest paper "Cuida Puerto Rico con Bosques para Madera" to the same audience on the same afternoon. The paper detailed potential timber producing areas and forests on the island, and this map is an important document as Puerto Rico begins to assess its potential for sustainable timber production and the future management of secondary forest. The audience included individuals from the Puerto Rico Urban and Community Forestry Council, the USDA Forest Service, the International Institute of Tropical Forestry, the University of Puerto Rico in Ponce, the Puerto Rico Department of Natural and Environmental Resources, the US Virgin Islands Urban and Community Forestry Council, and the Department of Agriculture of the US Virgin Islands.

Chris Nytch, of the Institute for Tropical Ecosystem Studies, University of Puerto Rico is working with Senior Lecturer Prof. Walter M. Poleman of the University of Vermont to prepare a parallel service-learning project in both Vermont and Puerto Rico. The key lies in identifying the right partnerships in both places, and cultivating an authentic exchange of ideas, graduate students, faculty, and research. Chris proposes to design a place-based landscape analysis course that fits in with the curriculum at UVM and allows graduate students involved in field science and ecological planning the opportunity to learn a variety of natural resource inventory and ecological assessment methodologies while working on a real-world environmental consulting project. His vision is to offer the course as a comparative landscape analysis between Vermont and Puerto Rico. Chris and Walter met with the team at Tropic Ventures in July 2010.

One of the exciting opportunities associated with this undertaking is that there are very real possibilities for developing long-term partnerships between Vermont and Puerto Rico. By linking the trip to comparable projects happening in Vermont, Vermont's leadership in small-scale sustainable forestry and value-added forest products could prove quite useful to emerging initiatives like ours at Tropic Ventures. In particular, some valuable interchange could develop between Las Casas, UVM's Jericho Research Forest, and Shelburne Farms, a nonprofit farm and environmental education center that practices rural land uses that are environmentally, economically and culturally sustainable.

- **Local**

Tropic Ventures has shared many forestry meetings and seminars over the course of the last several years with Prof. Sheila Ward. There has been a lack of university courses for students interested in tropical forestry in Puerto Rico, and she has been putting together a 2011 syllabus on "Tropical forest resources and their management", for the University of Puerto Rico Biology graduate program & Environmental Sciences graduate program. Tropic Ventures will provide presentations on all research work, and some out of the lab and hands on experience in forestry. (Course description: Forest as resources, including for wood and non-timber forest products, carbon storage, climate effects, water, soils and minerals, recreation, wildlife habitat; management of natural forests and plantations; patterns of ownership and stakeholder interests. The course will be presented from the perspective of sustainability, integrated management, and forest planning.)

## Dissemination

### *Printed:*

#### Journal publications:

- Nelson, M., S. Silverstone, P. Burrowes, R. Joglar, M. Robertson and T. Vakil, 2010. The Impact of Hardwood Line-Planting on Tree and Amphibian Biodiversity in a Secondary Wet Tropical Forest, Southeast Puerto Rico, *Journal of Sustainable Forestry* 29(5):503-516.
- M. Nelson , S. Silverstone, K.C. Reiss, T. Vakil, and M. Robertson. Enriched secondary subtropical forest for sustainable timber production
  - Has been submitted to the journal, *Bois et Forets des Tropiques*.

#### Our latest newsletter!

<http://www.eyeontherainforest.org/rfnewsletter262010.php>

The newsletter is published 4 times a year and details the work of all Earthwatch groups at the project.

### *Visual:*

- 3t Vakil, continues a life-long pursuit of painting at the project, and all of the forestry research finds its way into an ongoing series started in 2006 entitled "Eye On the Rainforest". Becoming a forester, collecting data, understanding the data, and the realizations of the importance of secondary forest management and sustainable timber production are all captured on large detailed canvases.  
[www.eyeontherainforest.org/wanderwoman3t.php](http://www.eyeontherainforest.org/wanderwoman3t.php)
- An archive of images on the fungi of Las Casas de la Selva, serves as an educational reference and handy guide:  
[http://mushroomobserver.org/observer/observations\\_by\\_user/2328](http://mushroomobserver.org/observer/observations_by_user/2328)
- TWENTY MINUTE MOVIE: Images and original music from Las Casas

### *Digital:*

- An Earthwatch team member from the company ALCOA compiled some choice moments of a 2010 Earthwatch Expedition into a video diary.
- Earthwatch Team member blog <http://blogs.straitstimes.com/2010/12/17/stepping-out-of-our-comfort-zones>
- A multimedia piece documenting the learning experience of four young people from Singapore who won the HSBC/NYAA Environmental Award. The prize was a trip to Las Casas on an Earthwatch expedition in August 2010. <http://vimeo.com/16606423>
- Website: <http://www.eyeontherainforest.org>
- Newsletter: <http://www.eyeontherainforest.org/rfnewsletter262010.php>
- Presentation by 3t Vakil & Andrés Rúa, on the history of the ongoing forestry work at Tropic Ventures.
- Presentation by Norman Greenhawk on Anoles of Puerto Rico
- Presentation by Patty Boyko on Agarics
- An archive of images on the fungi of Las Casas de la Selva, serves as an educational reference and handy guide.  
[http://mushroomobserver.org/observer/observations\\_by\\_user/2328](http://mushroomobserver.org/observer/observations_by_user/2328)
- Images and original music from Las Casas. 20 MINUTE MOVIE
- Presentation by Molly Robertson on Coqui Frogs
- 3t Vakil, continues a life-long pursuit of painting at the project, and all of the forestry research finds its way into an ongoing series started in 2006 entitled "Eye On the Rainforest". Becoming a forester, collecting data, understanding the data, and the realizations of the importance of secondary forest management and sustainable timber

production are all captured on large detailed canvases.  
[www.eyeontherainforest.org/wanderwoman3t.php](http://www.eyeontherainforest.org/wanderwoman3t.php)

#### *Mass media:*

- 18th December 2010: "Give our trees a chance" article about Las Casas within a broader picture of forestry in the tropics, in The Straits Times, Singapore, by Jessica Cheam, editor.
- November 2010: "Las Casas de la Selva: model of sustainable forest development" Article in Prensa Comunitaria (Community Press), author Luis Francisco Baerga Colón
- November 2010: The same article was published in 80grados, a charity organization that supports courses in writing and journalism, allied with Community Press, to promote citizen media in PR.
- September 2010: A travel site The Scurvy Dog's Puerto Rican Blog, aka- Roberto's Puerto Rico featured a lively article about Tropic Ventures.
- April 2010: Tropic Ventures featured in Puerto Rico's main newspaper: El Nuevo Dia, Sunday 4th April, 2010
- "Me and The Biospheres" by John Allen co-founder of Tropic Ventures Forestry Project. This book chronicles the early days of the Institute of Ecotechnics and the establishment of this rainforest enrichment and sustainable forestry project, as well as the sister projects around the world. The book was the 2009 Winner of the New Mexico Book Awards, Green Book Festival and in 2010, won the Benjamin Franklin Award for best biography/memoir

#### *Meetings and conferences:*

December 2010, 13th Caribbean Urban & Community Forestry Conference in Ponce, PR Thrity Vakil and Andrés Rúa presented Tropic Ventures Sustainable Forestry Project at the 13th Caribbean Urban & Community Forestry Conference in Ponce, PR. The presentation was an inspired collaboration with Dr Frank Wadsworth who presented his latest paper "Cuida Puerto Rico con Bosques para Madera" to the same audience on the same afternoon. The paper detailed potential timber producing areas and forests on the island, and this map is an important document as Puerto Rico begins to assess its potential for sustainable timber production.

The audience included individuals from the Puerto Rico Urban and Community Forestry Council, the USDA Forest Service, the International Institute of Tropical Forestry, the University of Puerto Rico in Ponce, the Puerto Rico Department of Natural and Environmental Resources, the US Virgin Islands Urban and Community Forestry Council, and the Department of Agriculture of the US Virgin Islands.

- November 2010, "A lifetime of Forestry Experience" a seminar by Dr. Frank Wadsworth, 95, and eminent forester of Latin America, and mentor. At the International Institute of Tropical Forestry, Conference Room, South Botanical Gardens.
- November 2010, First Congress of Sustainability: Model of Development for Local Production, at the Fine Arts Center in Caguas. Attended by Thrity Vakil, Andrés Rúa, Norman Greenhawk and Patty Boyko.
- November 2010, Committee from First Congress of Sustainability meet with Thrity Vakil and Andrés Rúa at Las Casas de la Selva for an afternoon of lively discussions covering Tropic Ventures' research work, forest resources, and definitions of sustainability in PR.
- September 2010, Andrés Rúa gave a talk about the history & work of Tropic Ventures to over 100 students (7th-12th Grade) at Colegio Nuestra Señora del Carmen, Trujillo Alto, Puerto Rico.

- September 2010, Thrity Vakil and Andrés Rúa talk about timber production: harvesting process and marketing at a Department of Natural Resources Council Meeting entitled "Forestry Resources of Puerto Rico".
- September 2010, Andrés Rúa presents Tropic Ventures to a group of kindergarten teachers and their kids from Escuela Quebrada Arriba del Real, Patillas, with a digital presentation and a walk in the forest.
- February 2010, Thrity Vakil and Andrés Rúa host a group from the Puerto Rico Sierra Club with a talk and tour in the mahogany plantations, and a tour of the homestead, sawmill and workshop facilities.
- May 2010, Thrity Vakil and Andrés Rúa host a group from the biology department of University of Mayaguez on an educational day visit.
- January 2010, Thrity Vakil & Bridget McNassar are invited by The Institute for Tropical Ecosystem Studies of the University of Puerto Rico for a three day seedling survey and stay at the El Verde Field Station, in the Luquillo Experimental Forest (LEF) which has been a center of tropical forestry research for nearly a century and is home to the Luquillo Long-Term Ecological Research Program (Luquillo LTER).
- January 2010, Thrity Vakil & Bridget McNassar attend the AGM of the Luquillo Long-Term Ecological Research Program (Luquillo LTER). Long Term Ecological Research (LTER) Network is a collaborative effort involving more than 1800 scientists and students investigating ecological processes over long temporal and broad spatial scales. Twenty-six research sites around the world constitute the LTER Network at present.

### **Developing Environmental Leaders**

- Volunteer Bridget, who came here as an Earthwatcher in 2008, changed the course of her life and is currently working on a Master's of Science in Forest Resources at the University of Idaho.
- Meagan Thomas who worked with Norman Greenhawk in the summer of 2010 on herpetological studies, has applied for a herpetological internship at The National Aquarium in Baltimore, Maryland
- Jon, a former Earthwatcher, worked in taxonomy at Kew Gardens Herbarium and has applied for an MSc in Botanical Conservation at Plymouth University, UK.

### **Long term impact of project**

- **Habitats enhanced, restored or maintained**

The goal of the project is to enhance the secondary wet tropical forests of Puerto Rico by planting of valuable and adapted hardwood species. If an economic alternative to forest destruction and conversion to agricultural use is demonstrated, it will also help maintain forest land in Puerto Rico and in other similar tropical climates.

The project has held approximately 300 hectares of rainforest land as a wilderness preserve for the last twenty-three years. This area is undisturbed apart from minimal access for scientific investigation and hiking. Two of the watersheds that feed Lake Patillas (the local water reservoir serving 250,000 million people) are in this area. Demonstrating that this type of terrain can be used economically without clear-cutting it or destroying the ecology may encourage conservation of similar areas.

- **Ecosystem services enhanced, restored or maintained**

The project has had a Wastewater Garden since 2004, and all visitors and volunteers are made aware of this important way in which household wastewater is treated, ensuring that no

contaminants are released into the waters of this area, a critical watershed that leads to a reservoir, Lake Patillas, that feeds 250,000 people in this region.

Maintaining and enriching forest on 400 hectares, including 300 hectares on which human impact is not permitted, of erosion-prone mountain land in Puerto Rico is important for preservation of crucial habitat and to prevent pollution of Lake Patillas.

The overall objective of this project is to find ways to grow native hardwoods (and some introduced hardwoods) without negatively affecting the ecosystem. Puerto Rico currently imports nearly all of its timber from the US and Canada, but a large percentage of that could be grown in Puerto Rico. This would also provide income to rural undeveloped areas such as Patillas (project location), where unemployment can be as high as 40%. The clearing of secondary rainforest in the local area has been done mostly to accommodate agriculture and livestock grazing. As much of the land in this area is on very steep slopes this results in severe erosion and production is poor without heavy use of chemical fertilizers. The project demonstrates sustainable management of timber production, utilizing line-planting techniques that ensure the maintenance of biodiversity, and conservation of the soils.

- **Cultural heritage enhanced, restored or maintained**

The culture of the "jiberos" - the mountain culture of Puerto Rico - has been severely impacted by lack of local economic opportunities and movement of population to the cities. Demonstrating economic options in the mountain forest area can assist in the return of jiberos to the area, which has been occurring because of disillusionment with urban life. Las Casas has benefitted from the friendship and local knowledge of the jiberos, some of whom have been invaluable in assisting the realization of our long-term project.

- **Livelihood assets enhanced, restored or maintained**

Tropic Ventures has an open invitation to friends and members of Frente Ambiental, (Friends of Nature), an environmental group, who have managed to get vulnerable lands, such as mangrove areas in Patillas, protected from development. We encourage visitations especially during adult group expeditions for dinners and presentations, so that our volunteers get to meet more local people and exchange ideas and ways of life.

Frente Ambiental are a team of dedicated people, and as a result of social collaborations with this group, Tropic Ventures is getting more and more known, not just locally, but island-wide, for watershed maintenance, forestry work, and hands-on volunteering. Tropic Ventures was featured in an online Community Press Magazine, which is very high profile in Puerto Rico. November 2010: Article in Prensa Comunitaria (Community Press), author Luis Francisco Baerga Colón.

The project definitely needs more community outreach and this is being worked on.

- **Any other actions or activities that enhance natural and social capital**

We work with many teen groups to clean local beaches, rivers and roads.