

PUERTO RICO'S RAINFOREST

SAVING THE RAINFOREST THROUGH SUSTAINABLE USE



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REVERSING A GREAT LOSS

Tropical rainforests are disappearing at a breakneck pace. Each year, 13.7 million hectares of tropical forest vanish, destroyed by either blaze or blade. This is equal to an area roughly the size of the state of Alabama—a vast amount of rainforest, disappearing annually. The impact of this loss on global **biodiversity** and local economic viability is catastrophic. Slash-and-burn practices are pushing the global environment to the point of no return, stripping rainforest communities of an irreplaceable natural and economic resource. Finding a sustainable alternative to this wholesale destruction is critical.

Sally Silverstone, of Tropic Ventures Education and Research Foundation, with the assistance of Dr. Mark Nelson, of the Institute of Ecotechnics, is searching for just such an alternative, and they're looking to the rainforest itself for inspiration. For the last 23 years, the staff of Tropic Ventures have worked on a **holistic** approach to forest management in Patillas, Puerto Rico's 1,000 acre Las Casas de la Selva forest. Silverstone believes that local communities can pull enough profit out of the forests to sustain themselves without diminishing their biodiversity,



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richness of species, or total **biomass**. Given the increasing worldwide trends of clearing forest for one-time timber sales, **monocultural** plantations, and cattle-grazing, such a solution is critical.

Silverstone and Nelson are testing a unique method of harvesting rainforest trees, one that promotes biodiversity and provides local people with sustainable income. The technique, called "line planting," aims to mimic a natural process: reproducing the damage done by a medium-sized tree falling and creating a gap on the forest floor. In order to evaluate the success of this technique, Silverstone and Nelson are studying its effect on Puerto Rico's national symbol: a tiny tree frog known as the coqui.

THE DAMAGE IS DONE

Over the last few centuries, human activity has extensively damaged most of Puerto Rico's mature forests. Agriculture, coffee plantations, livestock grazing: Each has made an impact. Since the 1930s, though, improved living conditions and increased industrialization have led to a decline in the use of land for agriculture. Secondary forests, like that found at Las Casas, are filling in many areas, left untended until the trees there are once again large enough to be profitably harvested. Even so, the rate of deforestation is still increasing, feeding an ever-growing demand for timber, paper pulp, and other wood products.

At the same time, many of the island's **amphibian** populations are showing severe decreases in numbers. Some may have been driven to extinction. Amphibians are top predators in the tropical **ecosystem**, and their loss could have a serious effect on a variety of plants and animals, particularly certain species of insects.

Because they make up a large part of terrestrial ecosystems, amphibians are also very useful as monitors of overall environmental health. Like the legendary canary in the coal mine, they can serve as an early-warning system for more serious threats to the environment.

Line planting involves cutting long slots (or lines) through the rainforest. The lines are separated by broad sections of intact forest, giving the effect of a canopy tree collapsing and clearing away the ground beneath it. This opens the ground to the sun. When tree seedlings are planted in each line, they grow towards the canopy and can be harvested later without disturbing the surrounding forest.

Silverstone and Nelson originally designed their line planting experiment at Las Casas to test whether they could use the technique in a secondary growth rainforest and still maintain species diversity. Now, after 16 years of research, they want to determine which planting sites are working as predicted, and assess the impact of this project on the rainforest ecology. In 2004, they also began to explore the effects of line planting on the coqui tree frog.

By studying these amphibians at Patillas, Silverstone, and Nelson hope to gain insight into the current status of line planted areas within the forest research site. Establishing baseline data for local populations of coqui in line planting areas will help with future research. The health of the coqui—illustrated by their numbers—will help to assess the impact of this new technique the forest's biodiversity.

MEASURING THE RAINFOREST

The scientists are concentrating on four species of *Eleutherodactylus* tree frogs during this study—*E. coqui*, *E. portoricensis*, *E. wightmanae*, and *E. richmondi*—all of which are declining in other areas of Puerto Rico. As part of the coqui study, Silverstone is also planning to investigate populations of **anoline** lizards. These lizards make up an important part of the food web. Studying them will provide a more balanced database from which to assess the impact of line planting on the entire ecosystem.

To prepare the research area, project staff cut three-meter wide slots into the forest floor at various locations, keeping 30 meters of undisturbed forest between them. Within these lines, scientists planted native mahogany and mahoe seedlings, leaving larger trees and valuable native timber species in place. This closely resembles the forest gap caused by the fall of a medium-sized tree, which leaves forest floor litter and soils undisturbed but removes above-ground plant competition, as well as some of the **overstory**. The resulting increase in sunlight and daily maximum ground temperature provide an ideal environment for the seedlings' growth and survival.

The project staff initially created 12 study plots of 40 trees each, and evaluated the growth of different species based on the conditions at each site. To augment data gathered at these sites, Silverstone established 22 new plots of one acre each. She chose the new sites by transferring a map of the entire research area onto a one-acre

grid, giving each one-acre plot a number, and then selecting study sites randomly.

Once chosen, the research team located the southeast corner of each plot on a map displaying exact Global Positioning System (GPS) coordinates. Using GPS equipment, the team located plots in the field, marking them with numbered poles, and, with a compass and tape measure, laid out each plot on a North-South, East-West grid. By regularly monitoring these sites, they will be able to determine if previous trends are continuing, and whether or not growth rates under different site conditions are holding steady.

Silverstone is also establishing ten additional plots to evaluate new planting strategies, using native hardwood trees planted in suitable habitat within the plots. For surviving trees found in the study plots, the researchers are measuring total height (toht) and diameter at breast height (dbh at 1.37 m). They will also measure potential commercial height (coht, determined by the plant's lowest major fork or branch) and the canopy cover. To check growth and mortality rates, Silverstone's team will compare plots with each other, and also against previously-collected data.

In order to assess the impact of this program on plant biodiversity, Silverstone's team has to identify plant species found within the line planting plots, and compare them with the variation in plant species found in similar, undisturbed areas in Las Casas. For this study, Silverstone established fourteen 10 meter by 10 meter plots for comparison. Half of these are **silviculture** plots, cleared for line planting; the other half are in comparable areas of untouched secondary forest.

For every plant with a stem width greater than 3 centimeters, the team is measuring diameter at breast height (dbh), plant height, and canopy cover. They will then use the **Shannon biodiversity index** to determine relative species biodiversity. The researchers will also compare the number of species found in each plot to see if line planting had any effect on the forest's existing diversity.

To determine the economic viability of line planting, the team will compare associated production yields and costs with those of other enrichment studies, as well as clear-cutting. Silverstone will also include estimates of fair market price and demand for both untouched native timber and the newly-planted mahogany and mahoe.

For the amphibian study, Silverstone's team first set up **transects** at two different sites—disturbed forest (containing line plantations) and undisturbed natural wilderness—in Las Casas. Each transect is 3 meters wide and 20-50 meters long, depending on the terrain. Silverstone plans to survey transects at least three to four times a year, separated by intervals of three to four months. During peak activity time for the tree frogs (between 7 and 11 p.m.) the project team will run surveys of each transect, locating individual animals through a combination of acoustic and visual contact. Along each transect, the team will count all **anurans** they discover, identifying their species and categorizing them by age and sex. Whenever possible, the team will collect individuals, assessing their general health and taking tissue samples to test for diseases. Silverstone will employ time-series analysis to identify population trends for each species over time.

MANAGING A RAINFOREST ECONOMY

Research into the effective management of tropical timber production—particularly in secondary rainforests—can provide a method of sustainable, profitable use of the rainforest while also preventing complete loss of the forest ecology. As such, this work can make invaluable contributions to the preservation of rainforest habitat and species—both locally and internationally.

The results of Silverstone's sustainable rainforest study have the potential to greatly enrich Puerto Rico's economy. Each year, Puerto Rico imports \$130 million worth of timber from the United States and Canada. In the past, scientists have suggested that Puerto Rico's secondary forests could be used to produce 48 percent or more of this timber by themselves, without the need to touch any existing agricultural land.

In addition to saving money by reducing the need for imported timber, local production would provide almost \$20 million in employment—a particularly helpful benefit for undeveloped areas of the island, where unemployment can reach as high as 40 percent. Although line planting requires a long-term commitment to be successful, it is clearly sustainable. Once established, it can produce a valuable crop and create regular income for the local community well into the future.

In June and December of 2002, Tropic Ventures—with the support of a U.S. Department of Agriculture challenge grant



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program—held two workshops on sustainable forest management and secured a commitment from the local Department of Natural Resources to provide 1,000 native hardwood seedlings for line planting. A year later, researchers presented this study through a poster exhibit at the Caribbean Forestry Conference. The project staff also hosts regular workshops in the local community to discuss results and explain specific aspects of the study.

Furthermore, Silverstone's Tropic Ventures is now registered with the Auxiliary Forest Program of Puerto Rico, and is well-positioned to serve as a model for anyone interested in the conservation of tropical rainforests. In particular, the project team is planning to provide its findings to Puerto Rico's Department of Natural Resources for use as a foundation for other rainforest enrichment programs on the island. Expanded awareness of the line planting technique should encourage further interest in other ecologically beneficial practices as well as renewable rainforest harvesting.

FIND OUT MORE

Publications

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Finally, the results of the coqui tree frog study will help scientists understand how **vertebrate** populations respond to habitat disturbance. By identifying the key factors affecting distribution, abundance, and diversity of amphibians at the research site, Joglar and Burrowes can recommend appropriate forestry management strategies for other forested areas of Puerto Rico. Disease testing and environmental monitoring will also help identify conditions causing specific population trends. The sight of a familiar image—Puerto Rico's national symbol—associated with this research may also increase public interest in maintaining sustainable rainforests.

Silverstone, Nelson, Joglar and Burroes plan to share the results of this research with the local community in Puerto Rico as well as the scientific community. Through her continued research at Las Casas, Silverstone hopes to show that rainforest conservation and economic utilization need not be mutually exclusive.

Myers, N. 1992. *The Primary Source: Tropical Forests and Our Future*. New York: W.W. Norton.

Web Sites

Homepage for Tropic Ventures Education and Research Foundation
www.eyeontherainforest.org/

Homepage of the Food and Agricultural Organization of the United Nations
www.fao.org

Key Words

rainforest, sustainable use, line planting, slash and burn agriculture, secondary forest, timber harvesting

Volunteers have joined this project through Earthwatch Institute. Read more about this study and other scientific field research at www.earthwatch.org.

GLOSSARY

amphibian: an animal living both on land and water, but unable to breath under water.

anoline: related to the family of insect-eating lizards that can change the color of their skin.

anurans: any amphibian belonging to the order made up of frogs and toads.

biodiversity: the variety of plants and animals found within a specific region.

biomass: the total amount of living material (animals and plants) in a defined area.

ecosystem: a system of relationships in a local environment between different organisms, and between organisms and the environment itself.

holistic: complete.

monoculture: the use of land for growing only one type of crop.

overstory: the uppermost layer of tree growth in a tropical rainforest

silviculture: the cultivation of forest trees; forestry.

Shannon Biodiversity Index: a practical measure of the biological diversity in the system. The more species there are, the greater the diversity.

time-series analysis: a type of forecast in which data relating to past and current results are used to predict future results.

transect: a cross-section of the vegetation of an area, usually growing along a narrow strip.

vertebrate: an animal that has a backbone.



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