Department of Natural and Environmental Resources
Forest Service Bureau

Forest Stewardship Program

Sustainable Forestry Stewardship Management Plan for the Tropic Ventures Private Forest, Bo. Muñoz Rivera and Mulas, Patillas, Puerto Rico.

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I. *BACKGROUND*

FOREST STEWARDSHIP PROGRAM:

The Forest Stewardship Program was established by the United States Federal Government based on the 1990 Food, Agriculture and Conservation Act and financed by the Department of Agriculture of the United States Forest Service. This federal program, along with others directed towards natural resource conservation, has as its legal foundation the improvement and agricultural reform law of 1996, known as the Farm Bill law.

The program provides technical assistance to private forestland owners, through the elaboration of a guide or plan for the sustainable use, restoration, protection and conservation of their natural resources.

The objective of this document is to promote actions directed to the protection and conservation of natural resources and, at the same time, help land owners in the process of applying for economic benefits that might derive from the recommended practices presented in this management guide. These practices may be incentivized with technical and or economic assistance by the different programs that owners can apply for.

Management plans provide non-industrial forestland owners useful information for the implementation of sustainable management techniques. The Forest Service Bureau of the Department of Natural and Environmental Resources, in coordination with the International Institute of Tropical Forestry of the US Department of Agriculture, are the entities responsible for the implementation of this program.

PUERTO RICO FOREST RESOURCES ASSESSMENT AND STRATEGIES:

In 2008 the Congress of the United States of America enacted the Food, Conservation, and Energy Act (a.k.a. 2008 Farm Bill) which amended the Cooperative Forestry Assistance Act of 1978 to require each State and Territory to provide a Statewide Assessment of Forest Resources and a Statewide Forest Resources Strategy to the Secretary of Agriculture. These reports are a prerequisite to participation in USDA Forest Service cooperative technical and financial assistance programs.

The Farm Bill established national goals for forest conservation. Statewide strategies are expected to contribute to the national goals. Each year state and territory requests for program funding will be evaluated against their contribution to progress on these national goals:

1) **Conserve working forest landscapes**- conserve and manage the functional areas of the forest for multiple uses and values

2) **Protect forests from harm** - identify, manage and reduce threats to the forest, such as storms, floods, insects, diseases, invasive species and fire.

3) **Enhance benefits from trees and forests** - implement conservation and management actions that contribute to the continuous enjoyment of benefits such as air and water quality, soil conservation, biodiversity, carbon storage, maintain and promote the economic benefits of forest through planned use of forest products, and renewable energy production, and others.

Requirements of the statewide assessment are as follows:

1) Describe forest conditions on all ownerships in the state or territory

2) Identify forest-related benefits and services

3) Identify threats to the forest resources

4) Highlight issues and trends of concern

5) Delineate high priority forest landscapes

The strategic component will ensure USDA Forest Service Cooperative Forestry Programs can provide an efficient and effective allocation of resources to meet the national goals. It considers other plans such as the Comprehensive Wildlife Conservation Strategy in order to maximize the leverage of information and implementation resources among agencies, organizations, and individual stakeholders.

The following table identifies the national goals and the objectives for Puerto Rico:

Table 1: National Goals and Objectives for Puerto Rico.

Goals and Objectives of Puerto Rico Statewide Assessment and Strategies for Forest Resources	
National Goals	**Objectives for Puerto Rico**
1. **Conserve working forest landscapes**- conserve and manage the functional areas of the forest for multiple uses and values	1. Identify and conserve high priority forest ecosystems and landscapes in Puerto Rico currently under private control; 2. To manage private forested land actively and sustainably.
2. **Protect forests from harm** - identify, manage and reduce threats to the forest, such as storms, floods, insects, diseases, invasive species and fire.	1. Identify, manage and reduce threats to forested ecosystems health; 2. Reduce risks of wildfire impacts.
3. **Enhance benefits from trees and forests** - implement conservation and management actions that contribute to the continuous enjoyment of benefits such as air and water quality, soil conservation, biodiversity, carbon storage, maintain and promote the economic benefits of forest through planned use of forest products, and renewable energy production, and others.	1. Protect and enhance water quality and quantity; 2. Improve air quality and conserve energy; 3. Assists communities in planning for and reducing forest health risks; 4. Maintain and enhance economics benefits and values of trees; 5. Protect, conserve and enhance wildlife and fish habitat; 6. Connect people to trees and forests, and engage them in environmental stewardship activities 7. Manage trees and forests to mitigate and adapt to global climate change.
Data:Puerto Rico Statewide Assessment and Strategies for Forest Resources. Table: The Forest Service Bureau, DNER. By: MSued, 2011	

II. INTROUCTION

HISTORY of "Las Casas de La Selva"

Established in 1983, the land known as "Las Casas de la Selva" is the home of the Tropic Ventures Sustainable Forestry and Rainforest Enrichment Project.

The Institute of Ecotechnics initiated this unique project in Patillas, Puerto Rico, pioneering experiments in sustainable rainforest ecology, through line-planting of valuable timber trees. The aim of the project is to maintain the biomass and biodiversity of the ecosystem while the land is utilized, to a degree, for enough profit to encourage local caretaking of the forest. Using this approach, 230 acres of the almost 1000-acre property approximately have been planted with over 40,000 native and exotic hardwood trees with extremely promising results, working in cooperation with the Puerto Rico Department of Natural and Environmental Resources, and The International Institute of Tropical Forestry of the US Department of Agriculture Forest Services..

The valuable contribution of this method to the environment has seen "Las Casas de la Selva" recognized as an auxiliary rainforest in the US National Park system of classification.

"Las Casas de la Selva" is owned and operated by Tropic Ventures (a joint venture between Global Ecotechnics Corporation and Decisions Team Inc.) Tropic Ventures Education & Research Foundation was incorporated in 1998 as a non-profit corporation in Puerto Rico to support research and education activities.

The 929.9 acre (376.3 hectare, 957.5 cuerdas) forest is located on steep slopes at an average elevation of 600 m (2,000 ft), receiving an average annual rainfall of 3,000 mm (118 in). It is characterized as subtropical wet in the Holdridge life zone system (Ewel and Whitmore, 1973), and is known locally as "tabonuco forest" with candletree *(Dacryodes excelsa* Vahl*)* being a dominant tree. The project has worked with a total systems approach for utilizing this forest, and the forestry enrichment project was undertaken with the goal of developing ecologically sound approaches to timber production on lands unsuited to agricultural use. If successful, this may encourage similar practices in secondary rainforest in other tropical countries.

III. SUSTAINABLE FORESTRY STEWARDSHIP MANAGEMENT PLAN

3.1 General Information.

The following table describes other general information on the property and adjoining properties.

Table 2: General Information of the Tropic Ventures Land

Facts	Description
Owner's name	Tropic Ventures
Number of farms	6
Total capacity[1]	929.9 acres 957.5 cuerdas 376.3 hectares
Physical address	Carr. 184 km 15.9, Sector Miraflores, Bo. Muñoz Rivera, Patillas, Puerto Rico, 00723.
Geographic location	18° 4' 0"N 66° 2' 30" W
Boundaries	At north with Bosque Estatal de Carite At south with Barrio Mulas (Patillas) and Barrio Marín (Patillas) At east with Barrio Muñoz Rivera (Patillas) At west with Barrio Marín (Patillas) and San Lorenzo

[1] This information was analyzed according to the Parcel database of the Puerto Rico Municipal Income Collection Center (Centro de Recaudaciones de Ingresos Municipales, CRIM) (2011). According to the Deed of Tropic Ventures the total of the land is 932.36 cuerdas.

3.2 Main Forest Stewardship Program Objectives:

- To promote conservation of soil, water, wild flora and fauna by means of effective management of existing forests in private lands.

- To promote larger participation of private landowners in various programs, and involve them in actions directed to adequate management of high priority conservation areas under sustainable use of the forest and its natural resources.

- To develop projects that can serve as models for new initiatives directed to improve water quality by means of protection and conservation of river basins and forested zones.

- To support, among program participants, the establishment and development of community organizations dedicated to conservation and planned management of forest and natural resources.

- Conserving working forest landscapes

- Protect forests from harm

- Enhance public benefits associated with trees and forests

3.3 Owner's Goals:

- Maintain as a natural rainforest reserve, approximately 675 acres, (273 hectares, 695 cuerdas) of secondary growth forest land at Tropic Ventures "Las Casas de la Selva " project site.

- Implement sustainable management strategies for the use and conservation of the private forest resources, including timber on the remaining 250 acres of the property.

- Protect, conserve and enhance wildlife, water quality and quantity, improve air quality, and conserve energy.

- Implement conservation and management actions that help mitigate or eliminate possible risk of wildfires and their impacts both inside and outside the forest boundaries, and maintain the health of the forest ecosystem.

- Continue to promote education and scientific research projects on ecosystems and timber forest resources to promote rainforest conservation and sustainable forestry practices. This includes hosting

local, Puerto Rican and international students and volunteer organizations to give an opportunity for real-time, hands-on participation in sustainable forestry management.

- Integrate and connect people on the conservation and management activities to work together environmental issues and possible effects of climate change.

- Identify economic alternatives and viability of rainforest communities, and sustainable use of rainforest resources.

- Develop, implement and evaluate methods to reduce degradation of the forest's water resources which help protect the downstream water reservoirs of the Patillas region. These include ecological methods of sewage treatment and appropriate land use to minimize pollution of the forest's waterways.

- Share the results of the work at Las Casas de la Selva with the local Puerto Rican and international community through conferences, public presentations, on-site ecological tours, through local and international media, and through publication of research results in scientific journals.

3.4 Management Objectives

1. **Production zones:** To develop and sustainably manage timber producing forest; traditional and non-traditional agro-forestry systems: shade coffee (traditional) and other, non-traditionals systems like combinations of trees, bushes and herbs having fruit, ornamental, medicinal and culinary qualities.

2. **Wildlife habitat.** To protect and conserve more than 675 acres (273 hectares, 695 cuerdas) in forest reserve that will assist the spreading and the flow of wildlife in these regions, including Carite State Forest.

3. **Water quality:** To conserve the present forest on this property for the protection of three important systems of permanent streams and rivers that flow into the Río Grande de Patillas. and are part of the watersheds that supply water to Lake Patillas providing drinking and irrigation water to the communities in this municipality.

4. **Recreation:** To develop ecotourism and educational activities, while promoting recreation, rest, meditation and enjoyment of nature.

5. **Other:** Creating practical strategies for plantations and small diameter forest products, by developing additional economic options within sustainable contexts for both producers and artisans.

6. **Threats or Harm Management Strategies** : To identify, manage and reduce threats to forested ecosystems health to prevent or eliminate the risk of the following issues:
    a. Fire
    b. Insect pests and diseases
    c. Ecosystem fragmentation
    d. Climate Change
    e. Hurricanes/storms
    f. Drought (sequía)
    g. Invasive plants and animals

3.5 Geographic and Biophysical Description

3.5.1 **Geographic Location**

Tropic Ventures Forest is located in the mountainous area of the South Coastal Plain of the Municipality of Patillas, adjacent to Carite State Forest. It has an area of 957.5 cuerdas (929.9 acres) of land and an is integral part of the watershed of the Río Grande de Patillas. The same is located between latitudes 18 ° 4 '0 "N and longitude 66 ° 2 ' 30" W. The three (3) districts that limit their adjacencies are Muñoz Rivera, Mulas and Marín. (See map1: Geographic Location Map)

3.5.2 **Biophysical Description**

The forest area within these private lands presents a continuous matrix of nearly 310.24 hectares (766.64 acres; 789.45 cuerdas) from a total land area of 376.3 hectares (929.9 acres, 957.5 cuerdas). This area is classified as subtropical wet forest under Holdridge's Life Zone Systems, and classified as very humid evergreen montano tropical forest by Walsh System. The land elevation fluctuates between 300 and 600 meters (980-1970 ft).

3.5.3 **Climate:**

According to the DNER Water Plan (2004), the climate of the Río Grande de Patillas is primarily subtropical moist forest and subtropical very moist forest, with frequent heavy rains in the Carite Forest most of the year. Rainfall varies in the basin in a similar pattern to the rest of Puerto Rico, with a relative dry period from January to April, heavy rains in May, a second period of lower rainfall from June to August, and the season of heavy rains until December. The average annual rainfall in the basin is 81 inches (2.05m), ranging from 56 inches on the coast to 105 inches (2.66 m) in the Carite Forest. In years of severe drought, the average annual rainfall inches the basin can be reduced to 57 inches. Evapotranspiration consumes 60% of the rainfall over the basin, about 48 inches per year (43 inches in dry years). The balance between rainfall and evapotranspiration averages 33 inches, which becomes runoff or seeps into the ground.

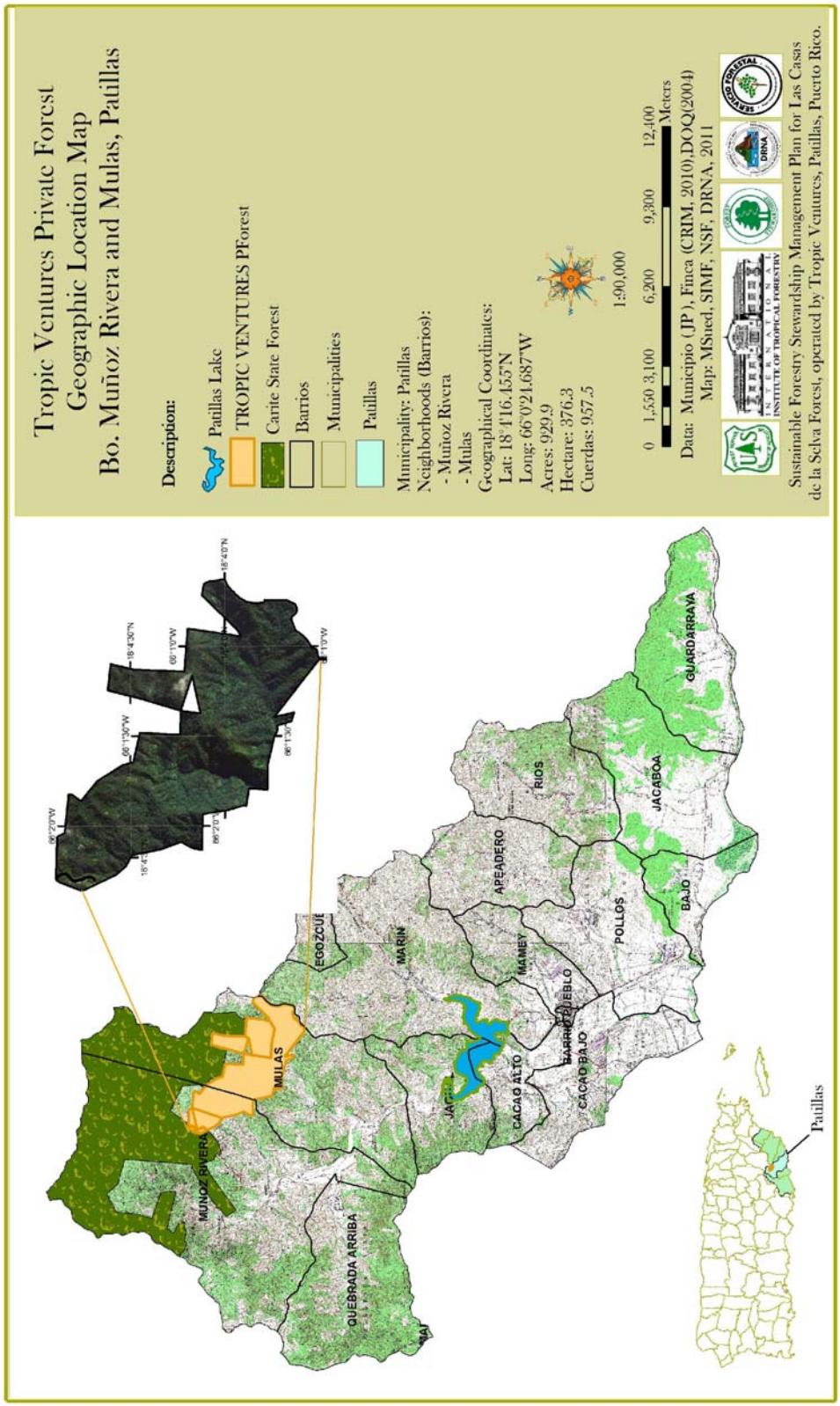
According to Cooperative Weather Station # 66-6904 (Patillas Dam), the annual temperatures average is 78.0°F (25.55°C), while mean annual precipitation ranges from 75 to 85 inches. The newly installed weather station located at Las Casas de la Selva has recorded 102 inches of precipitation during May 2009-May 2010. (See the Precipitation Table below).

Table 3: Estimate of Precipitation Frequency (in inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.33	0.45	0.58	0.92	1.37	1.72	2.13	2.63	3.21	3.79	5.08	5.89	7.00	7.89	10.63	13.27	16.66	20.18
2	0.46	0.62	0.80	1.28	1.91	2.48	2.77	3.46	4.25	5.03	6.76	7.81	9.22	10.29	13.64	16.86	21.07	25.40
5	0.56	0.77	0.99	1.58	2.35	3.20	3.65	4.74	5.92	7.14	9.63	11.05	12.80	13.89	17.53	21.14	25.93	30.67
10	0.65	0.89	1.14	1.82	2.70	3.76	4.34	5.77	7.30	8.94	12.06	13.79	15.83	16.88	20.73	24.60	29.85	34.86
25	0.76	1.04	1.33	2.13	3.16	4.52	5.30	7.21	9.27	11.57	15.65	17.82	20.25	21.17	25.22	29.39	35.19	40.46
50	0.84	1.16	1.48	2.37	3.52	5.11	6.08	8.39	10.91	13.80	18.68	21.23	23.96	24.70	28.85	33.21	39.40	44.81
100	0.93	1.27	1.64	2.62	3.88	5.72	6.88	9.64	12.65	16.21	21.93	24.90	27.95	28.47	32.63	37.11	43.68	49.15
200	1.02	1.40	1.79	2.87	4.26	6.37	7.74	10.98	14.55	18.85	25.50	28.92	32.30	32.54	36.67	41.21	48.13	53.61
500	1.15	1.57	2.01	3.22	4.78	7.25	8.92	12.87	17.25	22.66	30.64	34.71	38.56	38.78	42.31	46.92	54.22	59.62
1000	1.24	1.70	2.18	3.49	5.18	7.95	9.87	14.40	19.45	25.83	34.89	39.49	43.71	43.90	46.83	51.44	59.03	64.27

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval. Please refer to NOAA Atlas 14 Document for more information.

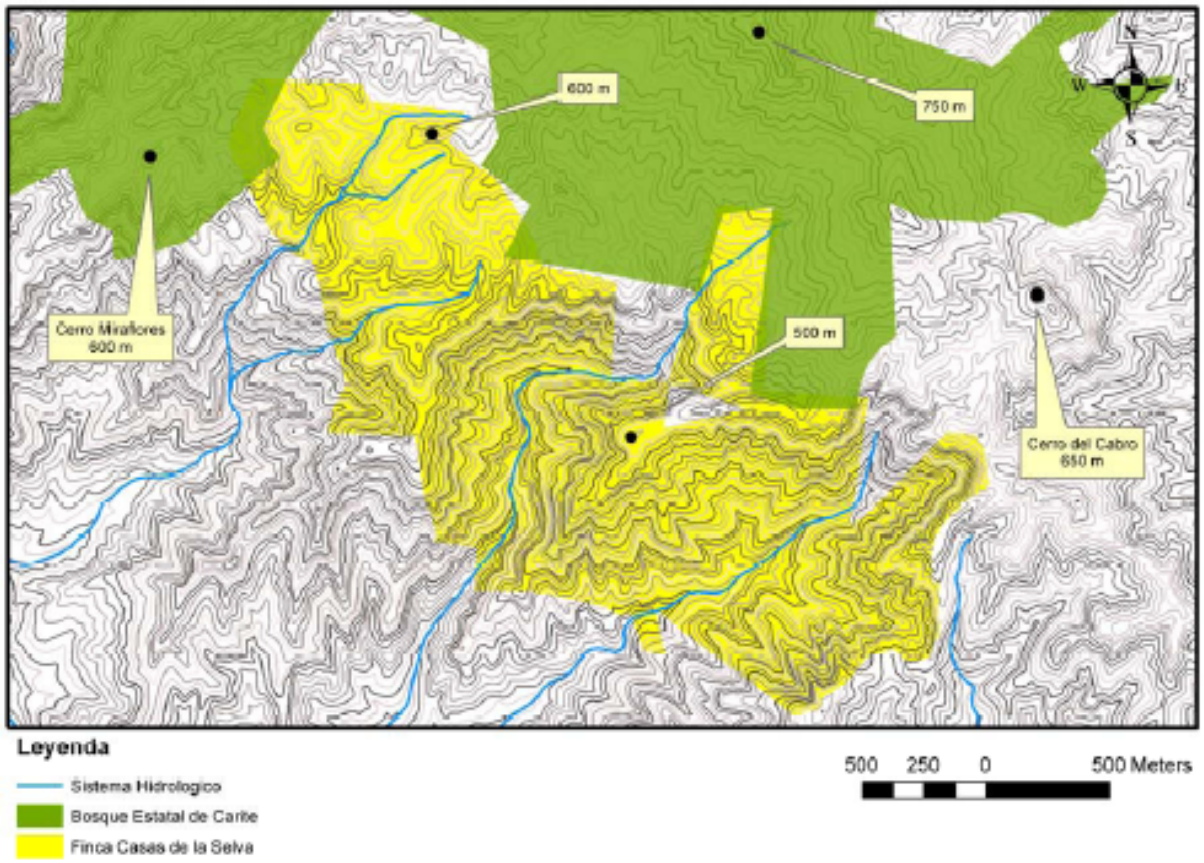
Figure 1: Geographic Location Map



3.5.4 **Description of Topography**

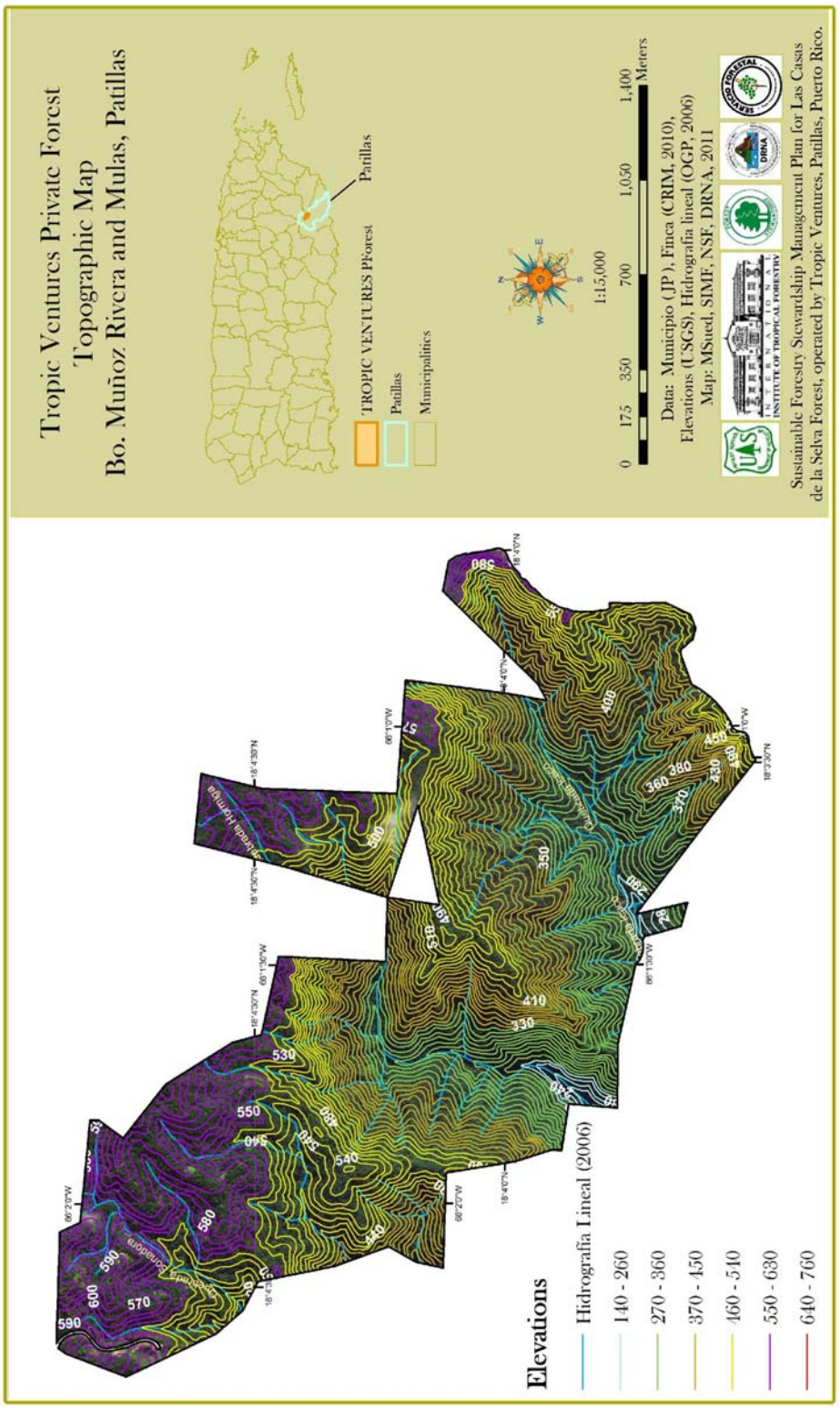
The lands under consideration are part of the mountains south of Cordillera de Cayey. The landscape is mountainous, with elevations such as Cerro Miraflores (600 m, 1,970 ft) located northwest of the property, and Cerro Del Cabro (650 m), (2,132 ft) between Barrio Muñoz Rivera and Barrio Mulas.

Figure 2: Elevation Point and Topography Map



Map 3 shows the property's topography. The elevation ranges from 200 to 620 meters high. The vast majority of lands on the south side are steep, with slopes of 40 to 60 degrees. On this side of the Tropic Ventures project flow tributaries and creeks that feed the Río Grande de Patillas. It is a spectacular site with steep thickly-forested slopes, and beautiful streams and waterfalls.

Figure 3: Topographic Map



3.5.5 Hydrology

The property is located within Humacao-Río Seco Basin at Río Grande de Patillas watershed, and at least five intermittent tributaries and streams run through or from this property.

- **Humacao to Río Seco Basin;**

  The Humacao–Río Seco watershed has an area of 591.0 square kilometers. It is subdivided in 25 watersheds belonging to the municipalities of Guayama, Arroyo, Patillas, Maunabo, Yabucoa, and Humacao. The focus of the Tropic Ventures plan is in the Río Grande de Patillas watershed.

- **Río Grande de Patillas Watershed**:

  The Tropic Ventures Proyect is located in the Río Grande de Patillas watershed in the southeast region of Puerto Rico, in the municipality of Patillas, with some of its land areas in the municipality of Arroyo. The watershed catchment area is 29.1 mi^2, including part of the southeast slopes of the Carite State Forest and the alluvial valley formed by the Río Grande de Patillas. This area is characterized by hills up to 2,988 feet inelevation, with steep slopes and dense forests. The Río Grande de Patillas flows from the Carite State Forest peaks to the southeast, from the Muñoz Rivera ward in Patillas, to the Jagual and Marín wards where the slope decreases and the alluvial valley of the river widens. The Patillas reservoir provides water to the region for home consumption and agricultural irrigation, and is part of the Irrigation District of the South Coast built and operated by the Puerto Rico Electric Power Authority (PREPA) is located in this area (DRNA, 2004).

- **Patillas Lake**:

  The Río Grande de Patillas and the Río Marín feed the Lake Patillas reservoir, 18.5 million cubic meters (15,000 acres-feet). Lake Patillas supplies drinking and irrigation water to the area. In this lake are shrimps and fish species like guabinas, chopas, dajaos, lobinas, and tilapia. The dam that forms the reserve was built between 1910 and 1914 by the Puerto Rico Irrigation Service, today known as the Puerto Rico Electric Power Authority.

- **Water Resources in the Tropic Ventures Forest:**

  The hydrological system forming these lands includes five creeks born and/or that run through and from the property. They add up to 42.42 km (26 miles), taking in consideration a buffer zone of 10 meters (5m on each side) that represents 203 acres (82 hectares, 209 cuerdas). Several creeks flow towards the Río Grande de Patillas. This river is the biggest tributary that supplying the Patillas Dam Reserve. Fortunately, the integrity of forest and land cover keeps the land in healthy condition and protects these water bodies. The adjacent banks of these tributaries have not been exposed to adverse impacts, so they still function as good buffers that maintain the water quality.

  The following table describes some characteristics of the watersheds and sub-watersheds, streams and tributaries that are born inside the forest, soils series, rainfall data, and population data affecting the entire basin as a single hydrologic unit. This information needs to be taken into consideration in planning all local and regional level actions.

Table 4: **Description of the Humacao to the Rio Seco Basin and the sub-basin that surrounds the Tropic Ventures Private Forest**

Names	Area (M^2)	Acres	Km^2
BASIN			
Basin Humacao- Río Seco	591,036,786.3	146,048.4	591.0
WATERSHEDS			
Río Grande de Patillas at Patillas Dam	55,112,023.6	13,618.5	55.1
Río Marín	11,538,390.9	2,851.2	11.5
PRINCIPAL RIVERS AND STREAMS			
Watershed Bodies:	Río Grande de Patillas and Río Marin Rivers		
Tropic Ventures Principal Streams:	Sonadora, Hormigas, Icaco and other important streams.		
WATERSHED SOILS (Series)			
Aceituna, Caguabo, Cayagua, Cobbly, Guayabota, Lirios, Los Guineos, Múcara, Naranjito, Pandura, Parcelas, Patillas, Rock land, SNS, Toa.			
PRECIPITATION			
The average annual rainfall in the catchment area of Río Grande de Patillas to its outlet to the Caribbean Sea is 81 inches, varying from 105 inches in Carite Forest area up to 56 inches on the coast. In years of severe drought, the annual rainfall in the basin can be reduced to 57 inches (DRNA, 2004).			
POPULATION			
The population of the Río Grande Basin from Patillas to its outlet to the Caribbean Sea in 2004, mostly rural, was approximately 7,240 people. Projected population by 2010, according to Planning Board (2006) is of 20, 620 inhabitants.			
Data: Water Management Plan (DNER 2004), Planning Board (2006), Analysis of Watersheds and subwatersheds in GIS, MSued (NSF, DNER, 2011).			

Figure 4: Basin and Watershed Regional Map

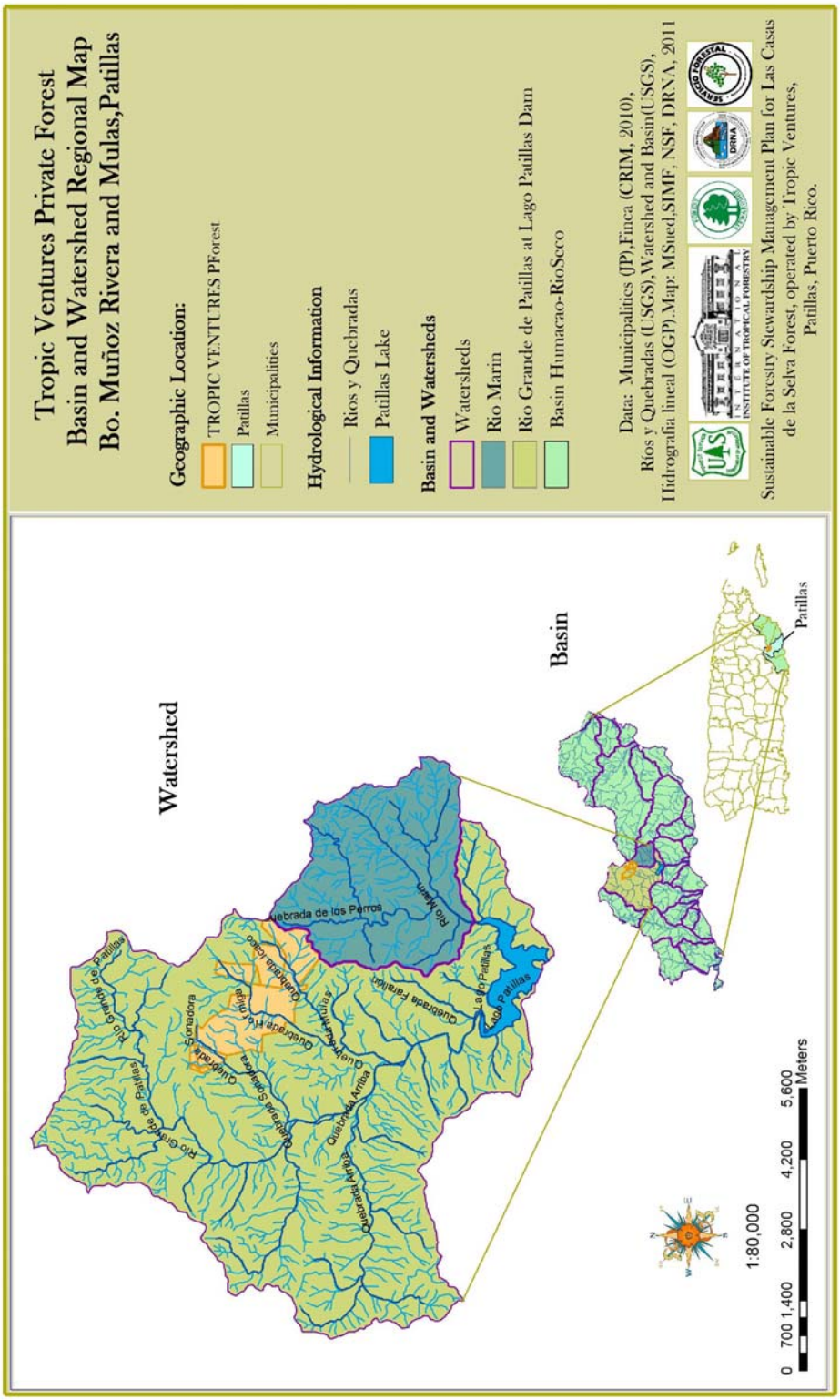
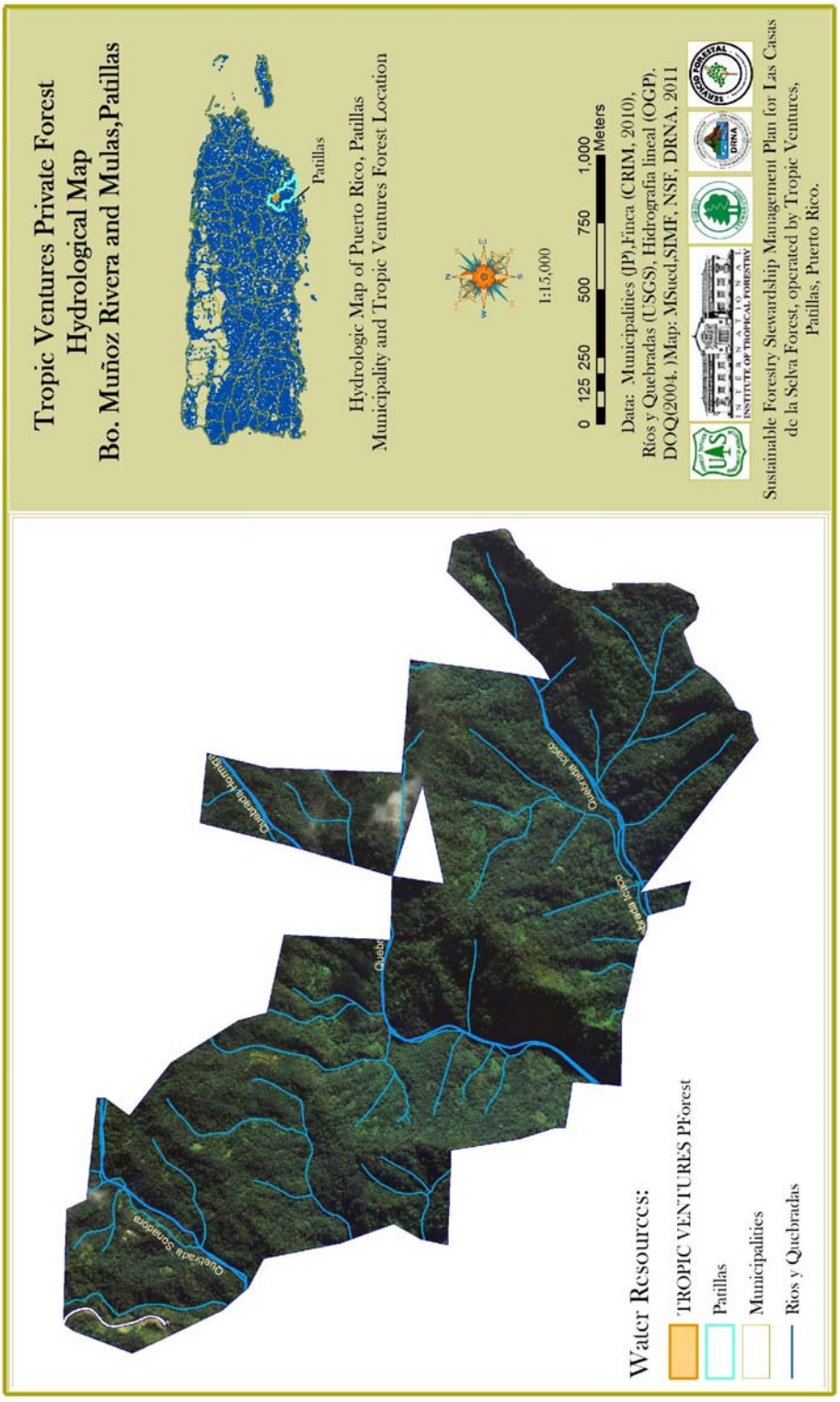


Figure 5: Hydrological Map



3.5.6 Type and Uses of Soils

Type of Soils

This soil area, described as humid, is classified as an association known as Pandura Rocosa Tierra Patillas. According to the General Soil Map in the "Soil Survey of Humacao Area of Eastern Puerto Rico", they range from shallow, moderate cliffs to big cliffs with good drainage and elevated plutonic lands. (See Figure 6: Soil Types Map.)

There are 3 types of associated soils within these lands:

1. CbF2- Caguabo arcilloso lómico, from 20 to 60% slope with erosion potential.
2. LsF2- Los Guineos limoso arcilloso lómico, from 40 to 60% slope with erosion potential.
3. PaF2- Pandura lómico, from 40 to 60% slope with erosion potential.

3.5.7 Earlier Land Use and Recent Activities in the Farm.

Before Tropic Ventures acquired this land, it was utilized for traditional growing of coffee and other minor crops, and forest was cleared for grazing of cattle. In 1983, Tropic Ventures bought these lands and started the experimental enrichment and sustainable forestry project. Since its beginnings, this project has had as its main focus, the management and production of valuable hardwood as a source of generating income sustainably.

Between 1984 and 1990, line planting of around 40,000 seedlings of a variety of valuable native and introduced broadleaf timber trees, including mahogany (Swietenia macrophylla x S. mahagoni) and blue mahoe (*Talipariti elatum*, previously *Hibiscus elatus*), was carried out on 230 acres (93 hectares) of this land at an average elevation between 350-600 m.

Present Use and Recent Activities:

The present use of the soil was divided according to management zones established and described in the next section. (For details see Figure: #7: Management Zones):

Zone I: This is historically the most disturbed zone of the property which has largely remained without human impact at least since the 1960s, when these lands were abandoned. These forest zones maintain continuity with Carite State Forest since they adjoin, maintaining structural connectivity within their ecological context. Most of the land is very steep.

Zone II and IIa: An area of approximately 300 acres (121 hectares, 308 cuerdas) of the property has been earmarked for silvicultural management practices. Approximately 230 acres (93 hectares, 236 cuerdas) have been enriched by tree planting to date.

Trees planted between 1983 and 1988.

- Mahogany (*Swietenia macrophylla* x S. *mahagoni*): 22,400 on approx 155 acres (63 hectares, 159 cuerdas)·
- Blue mahoe (*Talipariti elatum*, previously *Hibiscus elatus*): 3,600 on approx 23 acres (9 hectares, 23.70 cuerdas)
- Pine (*Pinus caribaea*): 5,000 on approx 10 acres (4 hectares, 10.29 cuerdas)

On approximately 40 acres (41 cuerdas, 16 hectares):

- Algarrobo (*Hymenaea coubaril*)
- Ausubo (*Manilkara bidentata*)
- Cacao (*Theobroma cacao*)
- Capa Blanco (*Petitia domingensis*)
- Capa Prieto (*Cordia alliodora*)
- Cedro (*Cedrela odorata*)
- Granadillo (*Buchenavia capitata*)·
- Eucalyptus (*Eucalyptus robusta*)
- Maga (Thespesia grandiflora)
- Moca (*Andira inermis*)
- Nogal (*Juglans jamaicensis*)
- Roble Blanco (*Tabebuia heterophylla*)
- Teak (*Tectona grandis*)

The plantations were established between 1984 and 1990 considering topographic outlines, east-west orientation to maximize sun exposure and following criteria for erosion control. The line planting was at approximately 3 m (10 ft) spacing within the lines and 10 m (32.5 ft) spacing from line to line under a canopy of secondary forest. The initial planting density for mahogany was approximately 370 trees/ha (148 trees/ac) and for mahoe 415 trees/ha

(166 tree/ac). During planting, large native trees of valuable timber species were left untouched with gaps in planting lines around them.

Since 2,000 tree surveys have been underway to determine the survival and growth rate of the mahogany and mahoe.

The Las Casas de la Selva enrichment was designed to test the efficacy of line-planting enrichment in the wet forest life zone as a dual means of providing both economic return and protection of natural biological resources. Nelson et al. found that vegetation and amphibian biodiversity were similar in areas of line-plantings and unplanted secondary forest at Las Casas de la Selva 20 years after line planting. If valuable economic returns are achieved from line-planting efforts, Las Casas de la Selva will provide a model for future sustainable forestry initiatives in secondary forest management.

As part of an ongoing study of the impact of line-planting of tropical hardwoods in a secondary subtropical wet forest area of Puerto Rico, eight plots were randomly selected for study of diversity and dominance patterns in the planted areas and in the undisturbed forest. The plots were each 10m x 10m and chosen to examine comparable aspects and elevation. In addition, the composition and abundance of amphibian species, an important component of Puerto Rican ecosystems, were studied over two seasons in transects located in the line-planted and undisturbed forest at similar elevations. This study has shown that no statistically significant changes have occurred in either amphibian diversity or in tree species as measured by richness, evenness, and diversity indices, showing that line-planting of valuable timber species in secondary wet subtropical forest may indeed be a viable ecological alternative for productive long-term use of this kind of forest.

In unmanaged secondary forest, trees tend to grow rapidly initially, but come to a point where overcrowding retards tree productivity significantly (usually at a density of around 25 m2/ha), thus lengthening the time before a commercial harvest can be made (Wadsworth et al. 2008). Counteracting this eventual slow growth is a concern if formerly harvested forest land is to continue to be productive and economically beneficial (de Graaf et al. 1999, Wadsworth et al. 2008). In the case of the Las Casas wet subtropical forest, such management can be of benefit to both unplanted secondary forest and the line-planted areas.

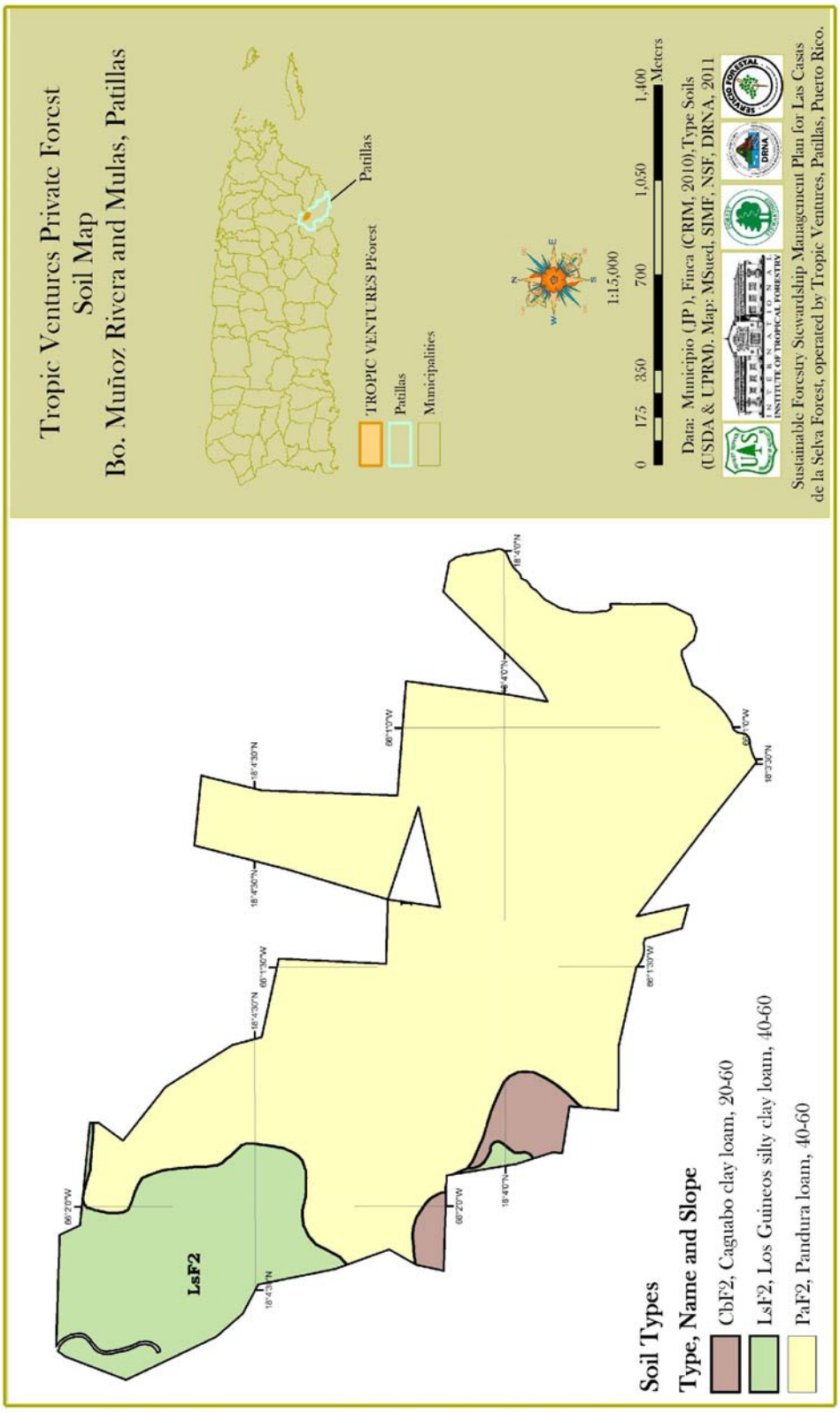
Parts of the line-planted plantation that have poorly developed mahogany or mahoe trees contain many other marketable timber species, such as Ausubo (*Manilkara bidentata*), Guamá (*Inga laurina*), Caracolillo (*Homalium racemosum*), Granadillo (*Buchenavia tetraphylla*) and Motillo (*Sloanea berteriana*). Larger individuals of these species were left untouched when line-planting was carried out and many young seedlings have grown up since.

In early 2009, 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 are accessible by the forest road. All five plots have similar tree density and species composition. Three plots, named Wadsworth, Weaver and Gonzalez, were selected to have the liberation treatment applied to them. Each has a 10 meter isolation strip on each side of the plot. Trees within the isolation strip were eligible for felling if they crowded crop trees within the liberation plots. The additional two plots are control plots, one located adjacent to the Wadsworth plot and the other adjacent to the Weaver plot.

It is expected that increases in growth rates will persist for several years. However, de *Graaf et al.* (1999) and Kammersheidt et al. (2003) both reported that positive effects on growth rate of liberation thinning decreased significantly after 10 years. Should such a slowing in growth rate occur in our experimental plots, the possibility of re-applying the liberation thinning treatment will need to be assessed.

Another consideration is determining a sustainable cutting cycle for the land once the crop trees have been harvested. How much time should pass before liberation thinning is applied again and trees are harvested, needs to be determined if the operation is to be truly sustainable, and to ensure adequate timber crop yields over the long term.

Figure 6: Soil Map



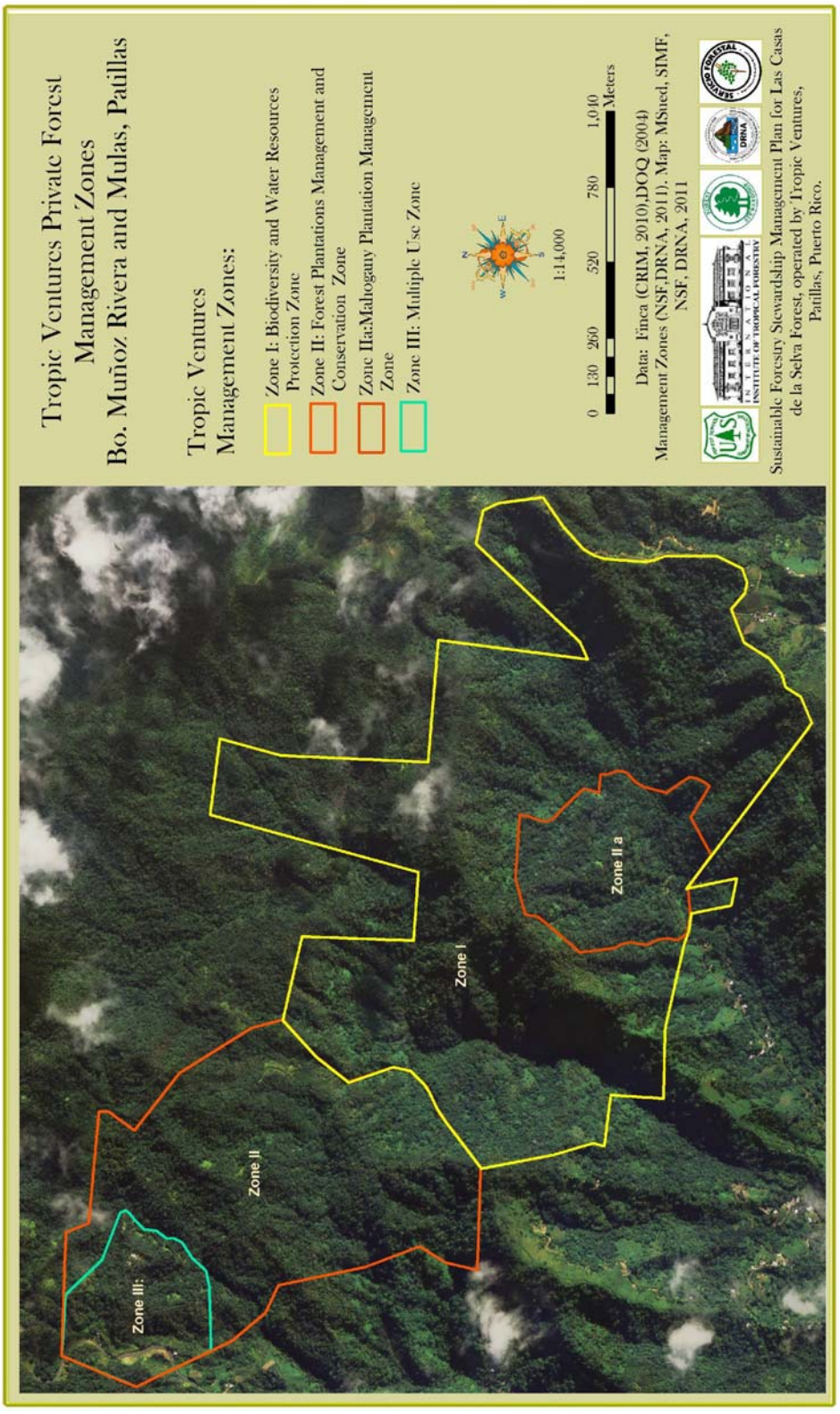
IV. THE CONSERVATION AND MANAGEMENT ZONES

To establish the management zones the farm was divided in four (4) management units (See Figure 7: Management Zone Map). This provides the owners a more effective and sustainable way to use the land ecologically and economically.

The areas were divided accordingly to the owner's objectives but in harmony with the goals and objectives of the federal programs contemplated in this document.

Each management zone that is described below contains a reference map, the description of the zone, the particular objectives of each zone, and the norms or regulations discussed with the owners. The norms are the activities (allowed or not allowed) that the owners established for each unit management units.

Figure 7: Management Zone Map



4.1 Description of the Management Zones:

Zone I: Biodiversity and Water Resources Protection Zone.

Purpose: Hydrologic area of protection of ecosystems and resources with access limited to projects of artistic or scientific research.

Objective: To protect and conserve forest and hydrologic resources.

Description: Forest area in the very humid mountain interior also described as secondary succession forest in a mature stage as a result of abandoned traditional system of planted coffee under shade.

Extension Area: This zone covers 591.77 acres (239.48 hectares, 601.44 cuerdas) of terrain with the greatest proportion covered with native arboreal species.

Permitted: Scientific research, education, exploration, limited adventure ecotourism, camping and recreation.

Not permitted: Hunting, gas or diesel powered vehicles, minerals extraction, paved roads, large infrastructure, altering the course (or damming) of rivers. Littering or dumping any kind of trash.

Figure 8: Zone I: Biodiversity and Water Resources Protection Zone

Zone II: Forest Plantation Management and Conservation Zone.

Purpose: conservation and management of biodiversity, mahoe, mahogany and other plantations, soil and water resources.

Objective: In the context of global increases in deforestation, demonstrating long-term methods for economic utilization of previously disturbed secondary forests is valuable for giving alternatives to forest clear-cutting or conversion of land to grazing or agriculture, helping reduce pressure on the economic exploitation of pristine rainforest areas globally. To encourage the protection and sustainable management of secondary tropical forests. Soil protection and erosion control.

Description: Between Zone II and IIa approximately 230 acres (93 hectares, 236 cuerdas) have been enriched by tree planting to date (See Page 19). Wood extraction will be carried out using Oxen (Bueyes). (See Apendix 4).

Extension Area: This zone covers 221.3 acres (89.5 hectares, 227.9 cuerdas) of terrain

Permitted: Scientific research, education, exploration, limited camping and recreation, sampling, fruit extraction, seedling extraction for propagation. Wood extraction: selective thinning practices, Timber Stand Improvement practices. Sawmill activities, and all necessary sustainable forestry management activities. Educative projects, hikes (eg: ethnobotanical trail), livestock use.

Not permitted: hunting.

Figure 9: Zone II: Forest Plantation Management and Conservation Zone

Zone IIa: Mahogany Plantation Management Zone

Purpose: Forest plantations for timber purposes. Experimental Management, Tree selection, and Timber Stand Improvement (TSI)

Objective: To pioneer experiments in sustainable rainforest ecology, through line-planting and selective harvesting of valuable timber trees.

Description: Area of forest plantations Mahogany, Teak, Pine.

Extension Area: This zone covers 76 acres (30.8 hectares, 78.3 cuerdas) of terrain

Permitted: Scientific research, education, exploration, limited camping and recreation, sampling, fruit extraction, seedling extraction for propagation. Wood extraction: selective thinning practices, Timber Stand Improvement practices. Sawmill activities, and all necessary sustainable forestry management activities. Livestock use.

Not permitted: Hunting.

Figure 10: Zone IIa: Mahogany Plantation Management Zone

Zone III: Multiple Use Zone

Purpose: Zone with all infrastructure, service facilities and road access necessary to carry out activities in manufacture, sale and marketing and trade in lumber and forest products by Tropic Ventures.

Objective: To demonstrate on a small scale, in Puerto Rico, that secondary forest can be ecologically and economically suitable for sustainable timber production.

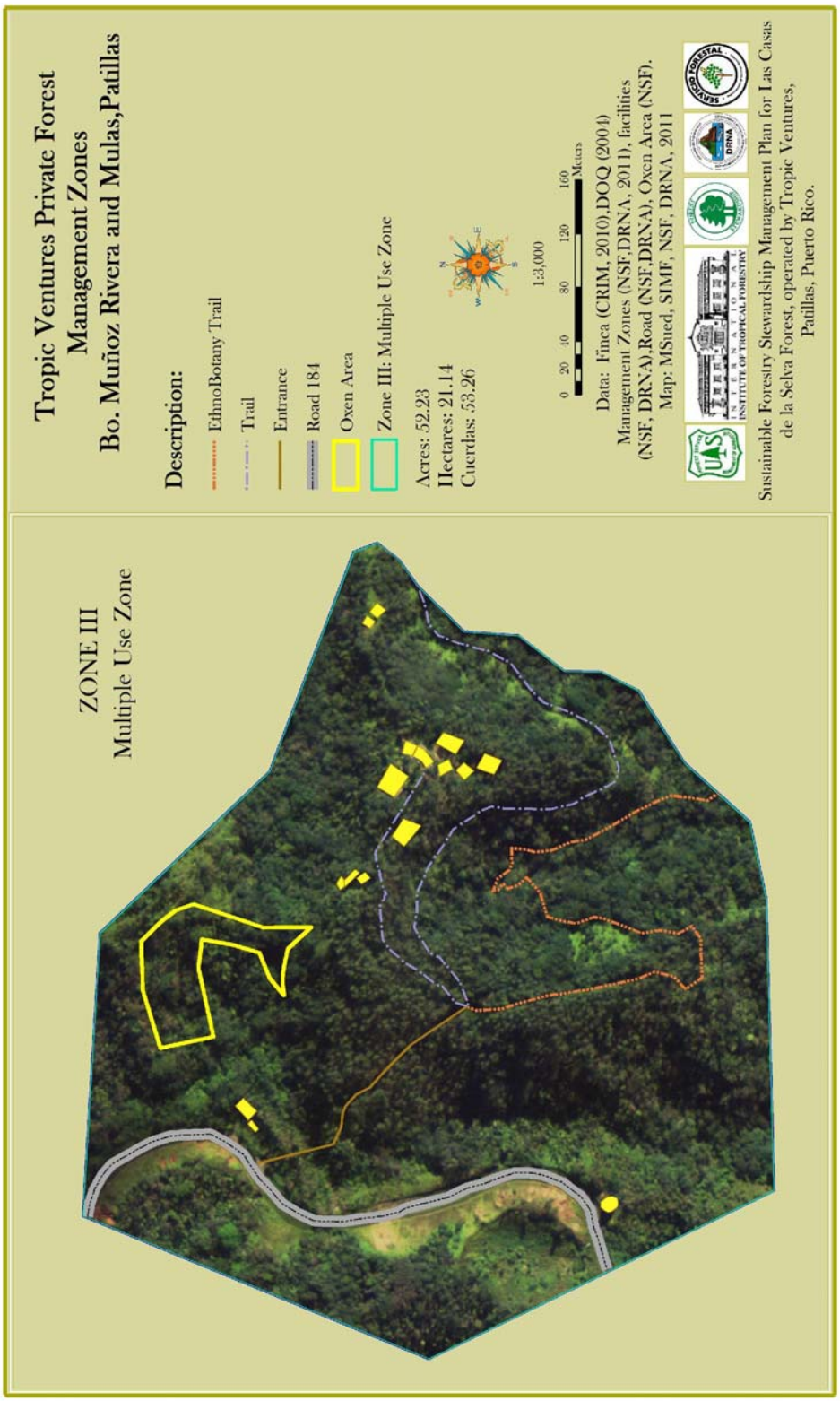
Description: Approximately 16 acres consist of the living spaces, the wood workshop and timber drying shed and storage areas. Around these structures there are agricultural vegetable gardens, propagation nurseries and fruit orchards for domestic use and a Wastewater Garden for sewage treatment and water reuse. An ethnobotanical trail is being developed for educational purposes. There are camping areas for tent use. The Route 184 runs through the northwest border of the property, and a municipal watertank is located in this area as well. In May 2011, two oxen were brought to the land and their living area will be located in this zone. (See Apendix 4).

Extension Area: This zone covers 52.23 acres (21.14 hectares, 53.80 cuerdas) of terrain

Permitted: Shelter maintenance and building, paved roads vehicles, parking, crafts, woodworking, milling, environmental education: arts, theater, music and painting. Eco-touristic enterprises. Workshops, retreats, camping, public tours. Library for research, study, recreation. Organic gardening. Handling and maintenance of green areas contiguous with Rte 184. Experimental silvicultural work and selective thinnings. Agroforestry and small scale livestock.

Not permitted: Hunting

Figure 11: Zone III: Multiple Use Zone



V. **MANAGEMENT STRATEGIES**

Table 5: Management Strategies for the Management Zones

Management Strategies for the Tropic Ventures Management Zones		
Goals and Objetives		**Strategies Actions**
Goals	**Objectives**	**Addrees to the Conservation and Sustainable Management**
1. Conserve high priority forest ecosystems and landscapes	1. Identify sustainable management strategies for the conservation and uses of the private forest. 2. Protect, conserve and enhance wildlife.	**Site:** ZONE:I ,II, IIa, III **Action:** Management and conservation of habitat. To maintain as a natural rainforest reserve, approximately 675 acres, (273 hectares, 695 cuerdas) of secondary growth forest land at Tropic Ventures "Las Casas de la Selva " project site. **Management**: The remaining 230 acres (93 hectares, 236 cuerdas) to be used to experiment with species enrichment and restoration of damaged areas as well as raising of hardwoods.
2. Protect forests from harm	1. Identify, manage and reduce threats to forested ecosystems health; 2. Reduce risks of wildfire impacts. 3. Protect and enhance water quality and quantity; 4. Improve air quality and conserve energy; 5. Assists communities in planning for and reducing forest health risks; 6. Manage trees and forests to mitigate and adapt to global climate change.	**Site:** Zone III: Rte 184, trails, facilities (eg: living spaces house, workshop, storage places for chemicals (eg: medicines, paints, detergents, gasoline, oil, etc.), places of storage or deposit of solid wastes and liquid, Borders of the forest. **Action**: Pollution prevention, proper handling and disposal of solid and liquid wastes. **Site:** Zone II, IIa: Erosion control. **Management:** Erosion control strategies,. To continue to promote at the project, and in the surrounding farms, the non-use of synthetic fertilizers and toxic pesticides, and vigorously promote the use of compost, and composted manure as valuable fertilizers. A demonstration Wastewater Garden takes care of the household black and gray water.
3. Enhance benefits from trees, forests and the integration of communities	1. To carry out research and educational projects in the ecological use of rainforest resources to promote rainforest preservation and sustainable forestry practices	**Site:** Zone II,IIa, III. **Action:** Sustainable use of rainforest resources for economic benefit; Connect people in ours activities and introduce new alternative for wood extraction and transportation of logs. **Management**: Processing and marketing valuable hardwoods as part of a total systems approach to rainforest management that emphasizes sound ecological practice and economic sustainability. Scientific research on trees and biodiversity. Encourage voluntary participation of local school and university students, in trailwork, planting, research etc. Provide employment for communities and instigate educational, artistic and theatrical programs, and public outreach. Investigate alternative modes of transport through the forest to minimize erosion, eg: use of oxen for hauling, wood extraction, and touristic activities.
	2. Identify economic alternatives and viability of rainforest communities, and sustainable use of rainforest resources.	
	3. Maintain and enhance economics benefits and values of trees.	
	4. Connect people to trees and forests, and engage them in environmental and educative activities	

Data: Management Strategies are analyzed according to the goals and objectives of federal programs and objectives of the land owners . Table: MSued,NSF, DRNA and 3T and Rua of the Tropic Venture, April-May, 2011.

VI. **RECOMMENDATIONS FOR THE MANAGEMENT ZONE:**

Zone I (Forest area): The following management guides are recommended for the existing forest zones of the land:

- To further develop a favorable forest structure for native arboreal species and wildlife; a thorough inventory must identify trees with outstanding characteristics or species that present special attributes useful for eco-tourism. Liberation of these individuals or other native species using the TSI (Timber stand Improvement) method can assist in the development of a better overall forest structure.

- To define the structure of the existing forest stands in areas associated with disturbances such as landslides and wind/hurricane damage. Establishing a protective canopy is recommended for regenerative purposes.

- Improving arboreal vegetation composition should give priority to native species. The liberation process must be selective so as to keep the recommended irregular structure.

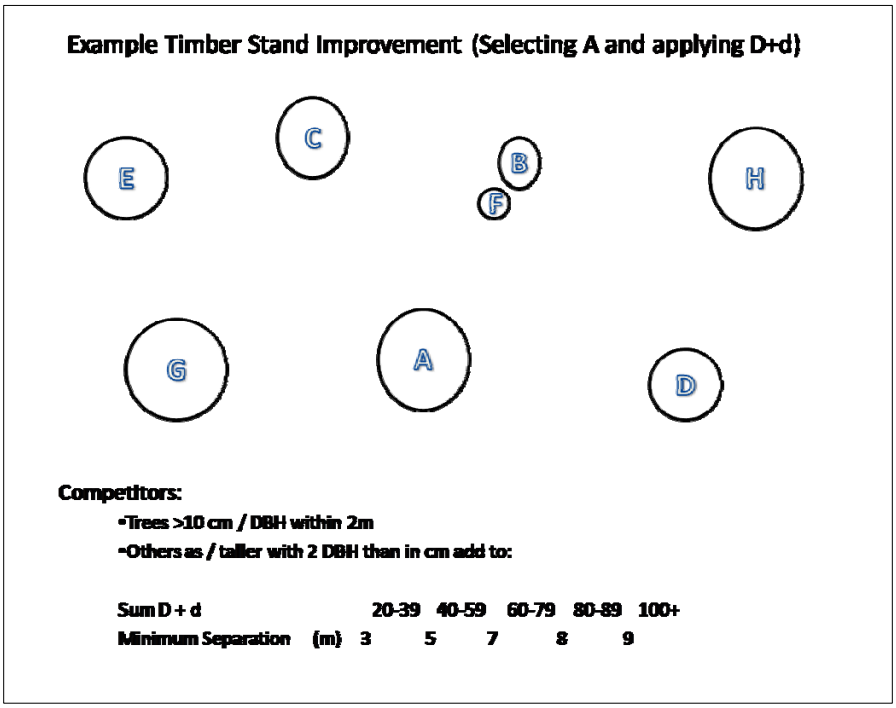
- To continue with long-term study of flora and fauna of this zone.

Zone II, IIa and III:

In the long term, the established plantations in these zones will be the object of training and management for timber purposes. Thinning methods and selective harvesting will be implemented as needed. Scientific studies will gather data on flora and fauna.

Implementation of the Timber Stand Improvement Method (TSI) to liberate individual trees. Trees can also be selected for elimination applying Wadsworth's Guide (2000) for the spacing and liberation of trees for future harvest in Puerto Rico. D method+d, where D=diameter at breast height of a tree of future harvesting. And d= diameter of each one of the non manipulated neighbors. The following diagram can be used as an example:

Table 6: Diagram of Liberation scheme by Frank Wadsworth



Tree	DBH	Distance	Decision
A	30	0	Keep
B	8	3	Keep
C	28	6	Keep
D	31	8	Keep
E	32	8	Keep
F	16	1.5	Remove
G	41	8	Keep
H	47	8	Keep

Standard Thinning Classification that is applied:

Thinning class	Trees removed
A. Light	Moribund, diseased, and suppressed
B. Moderate	Class A trees plus defective subdominants, whips, and branchy advance growth
C. Heavy	ClassB trees plus all subdominants and defective codominants that's can be removed without leaving a permanent gap in the canopy
D. Very Heavy	Class C trees plus any dominant and codominants that can be removed, yet also retaining a well-spaced, evenly distributed stand of trees with good boles and crowns.
Reference: Forest Production for Tropical America, Frank H. Wadsworth, 1997.	

a. **Erosion areas**

The objective is to implement practices which promote soil retention and improvement, and to minimize erosion. Landslide areas have been planted with bamboo in the past, and this successful practice should continue. Vetiver (*Chrysopogon zizanioides*) is currently being experimented with to enhance soil stability. The use of biodegradable material (branches/slash) to create protective barriers from materials made available by forest improvement activities, or from thinning as part of management in timber plantation zones, can assist in road drainage maintenance.

b. **Harvesting Areas**

The objective is to practice selective harvesting, and train in methods of directional felling that minimize damage to surrounding vegetation. Hauling methods will be studied and use of vehicles kept to a minimum in harvest areas. Pruning of lower branches and vines in advance, will aid in this process. Areas will be assessed for erosion vulnerability after harvesting, and all slash will be placed strategically as erosion control on slopes.

c. **Creek or river areas**

The different river zones, Quebrada Hormigas and other Río Grande de Patillas' tributaries, must be protected. On the creek banks, planting must be kept at a distance of 10 meters, and 30 meters from each side of the river. To achieve the conservation objectives in this plan, restoring these segments with forest fringe buffers is considered a priority. These strips must be established with trees and bushes in adjacent areas to the rivers or creeks. Well-defined strips can be developed to create three strips. For example:

- **Strip 1**- formed by water-tolerant trees and bushes, can be established adjacent to streams and rivers. This will provide a habitat for wildlife, organic matter for aquatic organisms, and provide shade to keep favorable temperature and humidity for the hydrological system.
- **Strip 2** - formed with trees and bushes to retain sediment, nutrients, agro-chemicals and other contaminants.
- **Strip 3** – formed with trees and shrubs to create terraces that would be covered with herbs and grasses to function like a front-line to support the operations of Strip 1 and 2.

d. **Wild life**

Habitat and food for birds and other species of the area should be taken into consideration when selecting species for different forestry practices serving varied purposes and functions.

Table 7 : Arboreal and shrub species that serve as food or habitat for birds

Scientific Name	Common Name
Roystonea borinquena	**Palma real**
Guarea guidonea	**Guaraguao**
Citharexylum fruticosum	**Péndula**
Cestrum diurnum	**Dama de día**
Ocotea leucoxylon	**Laurel geo**
Cordia sulcata	**Moral**
Cecropia scheberiana	**Yagrumo hembra**
Schefflera morototonii	**Yagrumo macho**
Clusia rosea	**Cupey**
Ficus citrifolia	**Jaguey**
Guapira fragans	**Corcho bobo**
Hibiscus elatus	**Mahoe**
Thespesia grandiflora	**Maga**
Petitia domingensis	**Capá blanco**
Zanthoxylum martinicense	**Espino rubial**
Myrcia splendens	**Hoja menuda**
Trema micranthum	**Guacimilla**
Andira inermis	**Moca**
Bursera simaruba	**Almácigo**
Byrsonima spicata	**Maricao**
Solanum rugosum	**Tabacón**
Guajacum officinale	**Guayacán**
Buchenavia tetraphylla	**Granadillo**
Bourreria suculenta	**Palo de vaca**
Inga vera	**Guaba**
Miconia prasina	**Camasey**
Myrsine coriacea	**Mantequero**
Sideroxylon foetidissimum	**Tortugo amarillo**
Trichilia pallida	**Gaeta**

e. **Recreation and other recommendations**

A specific area of 0.76 acres (0.30 hectares, 0.78 cuerdas,) has been identified for recreational activities taking into consideration the project's objectives of sustainability and conservation of resources, and preserving scenic and cultural values. Educational activities such as walks, expeditions, and/or research according to participating groups' interests are encouraged.

Ecotourism (nature-based tourism), ecologically sustainable, non-damaging and non-degrading, provides a direct contribution to the continued protection and management of protected areas used, but needs an adequate and appropriate management regime.

This includes establishing interpretative trails to promote ecotourism and recreation. All eco-touristic activities at this property must consider an ecological reference frame and promote the use of natural and environmental resources. They will help develop a profitable eco-touristic model based on environmental conservation.

To promote ecological and educational tourism, interpretative trails can be integrated by areas, where visitors may appreciate the management practices in the forest. With the owner's assistance routes and areas will be identified as needed.

This forest zone can offer a route to the highest areas on the property, with valuable scenic points where the beauty of the mountainous landscape may be appreciated. This trail can maximize contemplation of the variety of trees, plants, wildlife and intermittent creeks. Labeling of outstanding features is recommended for orientation and the visitor's benefit. Planting endemic and fruit trees on both sides of the trails where other vegetation is lacking is recommended. This type of planting promotes knowledge of our flora, conserves threatened or endangered species, and benefits wild life. Identification of key species, including scientific, common names and additional features or uses of the species, will be carried out.

Parameters in route design must consider:

- Existing roads and trails
- Areas of clearing in the forest areas can be used as camping sites, observation posts etc.
- Conservation strips in areas surrounding natural drainage.

- Slopes and distance between points of possible trails for the integration of erosion control runoffs and turnouts as part of the design.
- Route's final design should not affect the land's natural drains and other important water bodies of the respective zones.

Bird watching will play an important role in the eco-tourism plan.

The owner might develop a complex of rustic ecological cottages avoiding negative effects upon the existing vegetation. This strategy must consider additional economical options for the owner. Intentions are: touristic enjoyment and promotion of non-impacting recreation, rest, meditation and total enjoyment of nature.

Recommended design parameters in ecotourism integration

- Consideration of open spaces in the forest for the installment of infrastructures associated to trails, camping areas, cabins and observation areas. Implement integration of designs that do not alter nor threaten existing vegetation, nor natural topography.

- Sustainable practices such as roof water collection and composting toilets should be part of the design.

- Boundary and identification of access areas for cooking and any other activity related to the cabins should be considered within the concept of adhering to the limits of acceptable change.

- Cooking areas must be provided with fire prevention systems.

- Technical and field expertise is required for the establishment and operation of recreation and interpretative trails.

Future plans in these zones include construction of an Eco-lodge and a visitor center for world-class conferences on forestry and ecology, an observation tower, and a zip-line for canopy observation and ecotourism.

Table 8: Agencies and Cooperative Programs Identified for the Management Activities in the Tropic Ventures Private Forest.

Agencies and Cooperative Programs Identified for the Management Activities in the Tropic Ventures Private Forest.

MANAGEMENT	ACTION	ZONE	TIMELINE	USDA/DRNA CO-OPERATIVE PROGRAMS
CONSERVATION DESIGN AND PLANNING	Design and planning for the protection of 929.9 acres (957.8 cuerdas) of forest.	I	2012-2022	FWS – " Program Partners for Wildlife"/ NRCS – "Wildlife Habitat Incentive Program"./ FS-IITF- Technical consultation for management activities specifically relating to "Forest Stewardship Program"./ DRNA- Auxiliary Forest Program techniques and regulations.
SILVICULTURE	1. No action, and/ or enrichment planting and/or various ecological thinning practices in secondary forest. Result: Influence health, growth, quality of secondary forest, biodiversity, wildlife habitat, ecotourism values.	I	2012-2022	USFS Forest Stewardship / FWS (Fish & Wildlife Service)/FS-IITF/DNER Forest Service Bureau/ NRCS (Natural Resources Conservation Service). Forest Legacy Program, Forest Health Management Program, Urban & Community Forestry Program,
	2. Experiment with combination of thinning practices and timber stand improvement strategies. Gain experience in directional tree felling, rope-work, tree-climbing, de-branching, safety, equipment and terrain. Result: Increase health quality, size and distribution of merchantable timber in plantations. Economic return on timber/product sales. Provide consultation on tree harvesting and extraction techniques. Planting and use of native and non-invasive exotic species.	II, III	2012 -2022	USFS Forest Stewardship/ FWS / FS-IITF/DNER Forest Service Bureau/USFS Forest Health Monitoring Program/ NRCS
	3. Management of plantings and/or plantations			FWS – "Program Partners for Wildlife"./ DRNA – Technical consultation
WOOD AND FOREST PRODUCTION	1. Wood and Forest products, manufacture, marketing and sales. RESULTS: demonstrate on a small scale in Puerto Rico, secondary forests can be ecologically and economically suitable for sustainable timber production.	III, II, IIa (future action)	2012-2022	USFS Forest Legacy Program -DNER PR Natural Heritage Program -DNER PR High Ecological Value Land Acquisition and Conservation Fund -USFS Forest Stewardship Program -NRCS Healthy Forest Reserve Program -USFWS State Wildlife Grant -PR Conservation Trust Land Acquisition Initiative -PRIDCO PR Arts and Crafts Development Program
AGROFORESTRY	Use secondary forest products for wood, food, medicine, crafts. Interplanting with shade crops such as cacao and coffee.	II,IIa,III	2012-2022	-USFS Forest Stewardship Program -NRCS Healthy Forest Reserve Program -USFWS State Wildlife Grant

Agencies and Cooperative Programs Identified for the Management Activities in the Tropic Ventures Private Forest.				
URBAN INTERFACE AREAS	1. Shade, aesthetics, climate control, mental health, wood products, mulch, wildlife, green infrastructure, Recreation, safety, energy conservation, air quality improvement	III	2012-2022	=E12-USFS U&CF Community Cost-share Grants -NGOs Education Programs -Tree City USA -PR Via Verde Program -DNER Reforestation Programs -USFS Community Forest and Open Space Conservation Program -International Society of Arboriculture -Municipalities -Universities -DNER -PR U&CF council -UPR Extension Service -PR Association of Professional Arborists -College of Architects and Landscape Architects. -PR Correctional and Rehabilitation Department
ROAD MAINTENANCE	1.Safety, usability, drainage, clearing overhanging branches. RESULTS: Safe, easy access to plantation trees, for pruning, harvesting, extraction. For use with bikes in dry weather, ecotourism benefits.	II,IIa, III	2012-2022	FWS/ NRCS/ DNER
BRIDGE BUILDING	1. Thirty year old culverts need replacing with bridges, necessary for vehicle movement in harvesting and forest activities.	II,IIa,III	2012	FWS/ NRCS/ DNER
EROSION CONTROL	1. Plant up landslides and vulnerable areas.RESULT: Protect roads from damage during rains, inhibit/prevent soil loss, minimize sedimentation of streams.	II,IIa,III	2012-2022	NRCS/ DNER Forest Service Bureau

Agencies and Cooperative Programs Identified for the Management Activities in the Tropic Ventures Private Forest.

WATERSHED-RIPARIAN ZONES	1. Protect streams and banks from sedimentation & erosion. Plant buffer strips. Address flooding issues. RESULT: Increase quantity and quality of clean water, diminish sedimentation of local reservoir, Lake Patillas.	I,II,IIa,III	2013	NRCS – 'Wildlife Habitat Incentive Program'/ DNER Forest Service Bureau. Forest Legacy Program, Forest Health Management Program.
WILDLIFE HABITAT PROTECTION	1. Protect, conserve and assist the spread and flow of all wildlife in this region. Large contiguous forests are vital for some species to maintain viable populations. RESULTS: Ecotourism benefits, public value forests more.	I,II,IIa,III	2012-2022	FWS – 'Partners For Wildlife Program'. Forest Health Management Program. -Forest Legacy Program -DNER PR Natural Heritage -Program -DNER PR High Ecological Value Land Acquisition and Conservation Fund -USFS Stewardship Program -NRCS WHIP, EQUIP, -US F&WS Partners for WL -Federal and State agencies management -NRCS Healthy Forest Reserve Program -NRCS Wildlife Habitat Incentive Program
FOREST MONITORING	1. Research and monitoring of plant, animal and fungal communities. 2. Inventory of Species and populations. RESULTS: Enhance knowledge of local flora and fauna, encourage sudents to participate in surveys, increase student interest in forests.	I,II,IIa,III	2012-2018	USFS Forest Stewardship, Urban & Community Forestry Program
BIRD-WATCHING	1. Identify species of the area, and migrants and encourage planting of trees and shrubs that attract birds.Result: Ecotourism benefits, public value forests more, increase interest in forests.	I,II,IIa,III	2012-2022	NRCS/FWS: Technical assistance
CONSTRUCTION OF FACILITIES	1. Drying shed for lumber, woodworking shed, living spaces, Eco-lodge for world class conferences, Observation Tower. RESULTS: Hurricane proof shelters, Ecotourism benefits, all aspects of Forestry & Ecology Education, attract experts and world class scientists and artists to stay and promote the benefits of forests to the wider public.	II,III	2012-2022	Look for possible funding from private banking (eg: loan)
RECREATION/ ECOTOURISM	1.Create walking trails, camping areas, identify and promote areas of scenic views & beauty, create facilities for enhanced outdoor experiences, river expeditions, picnics, zip-lines etc. RESULT: Greater involvement of public with nature, and understanding of sustainable practices and use of natural resources.	II,IIa,III	2012-2017	USFS Forest Legacy Program -DNER PR Natural Heritage Program -DNER PR High Ecological Value Land Acquisition and Conservation Fund -USFS Forest Stewardship Program -NRCS Healthy Forest Reserve Program -USFWS State Wildlife Grant -PR Conservation Trust Land Acquisition Initiative

Agencies and Cooperative Programs Identified for the Management Activities in the Tropic Ventures Private Forest.				
EDUCATION	1. Interpretive Trails, Ethnobotanical Trail, Scientific Investigations on flora, fauna, climate change issues. Results: Greater value of natural resources, historical & cultural understandings.	I,II,III	2012-2022	DNER/ NRCS USFS Forest Stewardship, Forest Legacy Program, Urban & Community Forestry Program
PUBLIC OUTREACH	1. Establish a program for public outreach. Promote forest protection and responsibility. Instigate Mountains to Mangroves awareness.	I,II,III	2013-2022	Forest Health Management Program, Urban & Community Forestry Program,
NURSERIES	1. Need reconstruction and development of nursery quality standards. RESULT: propagation of tree seedlings for enrichment or sale. Provide local people with native tree species.	III	2013-2015	DNER/ NRCS/ FWS, USFS Forest Stewardship, Forest Legacy Program, Urban & Community Forestry Program
GARDENS	1. Farming for food, flowers, medicinals. RESULT: Sustainable production of quality organic food, necessary for health. RESULT: Sustainable production of quality organic food for the project and visitors, promote organic gardens to visitors, encourage involvement and learning in growing food.	II,III	2012-2022	NRCS: Organic Farming.
COMPOSTS	1. Create areas: Recycle all garden weedings, prunings, kitchen waste. RESULT: Quality soil for sustainable food production, less waste production.	III	2012-2022	NRCS: Organic Farming.
WASTEWATER GARDEN	1. Continue to monitor water quality, promote the system to all visitors. RESULT: Ensuring clean water; encourage the implementation of wastewater gardens across the island.	III	2012-2022	Pending for future funding sources.

Agencies and Cooperative Programs Identified for the Management Activities in the Tropic Ventures Private Forest.

ANIMAL S	1. Small livestock in corrals. RESULT: Sustainable food production. 2. Bulls (bueyes) for hauling logs and rent to local farmers	II,III	2014-2022	Puerto Rico Department of Agriculture
FIRES	1. Education on tree planting & restoration of areas affected by wildfires. 2. Prevention & Management of borders near fire risk (Rte 184, Municipal water tank)	I,II,III	2012-2022	-PR Fire Department Fire Prevention Program -DNER Forest Service Bureau -US F&WS -USFS -USFS Cooperative Fire Program -USFS Volunteer Fire Program
INSECT PEST AND DISEASE	1. Entomological studies. 2. Promote integrated Pest Management for any agricultaral actvities.	I,II,IIa,III	2012-2022	USFS Forest Health Monitoring Program, UPR Extension Service Forest Health Clinic and Diagnostics Lab, DNER Forest Health Program, UPRP, USFS.
DEVELOPMENT,URBAN SPRAWL, FRAGMENTATION	1. Education in assessment of forest cover, forest zones. 2. Integrate voluntary land protection by local communty. 3. Participate in municipal meetings covering use of the municipal terrain and other issues related to urban sprawl and fragmentation of forestland, and impact on watersheds, and other environmental issues.	Interface Area or borderline	2012-2022	USFS Forest Legacy program, USFS Forest Stewardship Program, Professionals who evaluate.
HURRICANES/STORMS	1. Erosion control, develop internal management plan, forest tree inventory, identify adequate tree selection for different zones, eg near buildings, gardens etc. Prune tree branches off trees that pose a threat to humans in hurricanes or storms.	I,II,IIa,III	2012-2022	USFS U&CF Program, PR U&CF Council, International Society of Arboriculture, PR Association of Professional Arborists, Tree City USA, ITree (adapted to tropics), FEMA Programs, PR Conservation Trust.

Agencies and Cooperative Programs Identified for the Management Activities in the Tropic Ventures Private Forest.

CLIMATE CHANGES	Participate in, and conduct training and education in climate change, impact of humans on the forestland, conduct tree inventories, conserve forest canopy. Conserve resources	I,II,IIa,III	2012-2022	USFS U&CF Program, USFS Forest Stewardship Program, USFS Forest Legacy Program, USFS Community Forest and Open Space Conservation Program, International Society of Arboriculture, PR Association of Professional Arborists, Tree City USA, ITree (adapted to tropics), PR Conservation Trust, UPR Marine Science Department.
DROUGHT (See fire, see climate change)	Participate in, and conduct training and education in climate change and drought. Conserve resources.	I,II,IIa,III	2012-2022	
INVASIVE PLANTS	Promote use of native flora species. Monitoring program. Education in invasive species identification and inventory.	I,II,IIa,III	2012-2022	Nursery growers and buyers, DNER, Puerto Rico Forest Health Advisory Committee, USFS Forest Health Program, San Juan Bay Estuary Program, Puerto Rico Conservation Trust, PR Department of Agriculture.
INVASIVE ANIMALS	Promote use of native fauna species. Monitoring program. Education in invasive species identification and inventory.	I,II,IIa,III	2012-2022	DNER., San Juan Bay Estuary Program, Puerto Rico Conservation Trust, Lion Fish Control Program.

Agencies and Cooperative Programs Identified for the Management Activities in the Tropic Ventures Private Forest.

WATER QUALITY BENEFITS	Maintain forest canopy, minimise erosion, especially riparian areas: Protect and enhance water quality and quantity. Maintain and manage existing forest, and reforest as necessary eg: landslides.	I,II,IIa,III	2012-2022	DNER reforestation program -USFS Forest Stewardship Program -NRCS Healthy Forest Reserve Program -USFWS State Wildlife Grant -NRCS Wildlife Habitat Incentive Program
PLANT BIODIVERSITY	Scientific studies, identify, inventory, identify plant zones. Careful management of forest areas around trails and roads. Plant native species that are not represented but are from the area.	I,II,IIa,III	2012-2022	-USFS Forest Legacy Program -USFS Community Forest and Open Space Conservation Program -Conservation Easement Commonwealth Law -DNER Puerto Rico Natural Heritage Program -DNER High Ecological Value Land Acquisition and Conservation Fund -NRCS Wildlife Habitat Incentive Program -NRCS Healthy Forest Reserve Program -USFS Forest Stewardship Program -USFWS State Wildlife Grant -NRCS Wildlife Habitat Incentive Program
CARBON SEQUESTRATION	Maintain canopy cover, education in forest health, encourage optimal forest growth, create incentives to benefit forest health.	I,II,IIa,III	2012-2022	=E35-USFS Stewardship Program -USFS Forest Legacy Program -USFS Community Forest and Open Space Conservation Program -Conservation Easement Commonwealth Law -Forest Legacy Program -NRCS Healthy Forest Reserve Program

TROPIC VENTURES Sustainable Forestry & Rainforest Enrichment Project. Management Strategies, Management Zones, Timeline, USDA/DRNA Co-operative Programs. Table: Msued, ESantiago y 3T Vakil, 2011

VII. **FINAL CONSIDERATIONS**

Adaptive Management - This document represents a management guide to be updated as specific changes or adjustments in the contained recommendations arise that justify new practices or changes in the recommended systems, without jeopardizing or adversely affecting the natural resources present on the property. The 10 year plan must have space for adjustments in the strategies to be adopted in each unit of handling.

Reach of the Management Plan - This document does not exempt the owner of the property to fulfill the established processes of law and order; like requests of permissions to realize activities, constructions, or other activities that require such, according to the laws and regulations of Puerto Rico.

Auxiliary Forest program - The wooded area of this property turns out to be most extensive of all the zones outlined in the plan of proposed handling, and is, in essence, the fundamental matrix that makes this land especially important from the point of view of protection and conservation. Thus, the Auxiliary Forest Program is an opportunity for the owner to benefit from contributing by exemption to property tax.

Monitoring Program - The Management and Custody of Private Forests Program needs to measure effectiveness of what is proposed or recommended in the short and long term, in the adoption of this plan. The Forest Service Bureau of the DNER has designed monitoring strategies to measure the effectiveness of forest practices with bio-indicators, so that zones that have possibly been impacted by forest practices of conservation like those recommended in this document, could be measured with monitoring exercises, which would provide valuable fields of data with which these practices could be quantified and qualified.

VIII. APPENDIX

Appendix 1: Forest Species Composition:

NB: The following lists should be seen as ongoing identification work, and not complete surveys.

Table 9: Tree and Shrub Species

Common Name(s)	Botanical Name	Family	Specific Gravity	Wood description
Carrasco	*Comocladia glabra*	ANACARDIACEAE		
Mango	*Mangifera indica*	ANACARDIACEAE	0.62	hard, mod heavy
Jobo de la india	*Spondias dulcis*	ANACARDIACEAE		
Guanabana	*Annona muricata*	ANNONACEAE	0.4	soft, not durable
Ylang ylang	*Cananga odorata*	ANNONACEAE		soft, not durable
Haya blanca	*Guatteria caribaea*	ANNONACEAE	0.8	hard, heavy
Palo de murta	*Ilex nitida*	AQUIFOLIACEAE		lightweight, tough
Palo de pollo	*Dendropanax arboreus*	ARALIACEAE	0.5	soft, lightweight
Yagrumo macho	*Schefflera morotonii*	ARALIACEAE		
Norfolk Island Pine	*Araucaria heterophylla (excelsa)*	ARAUCARIACEAE		
African Tulip	*Spathodea campanulata*	BIGNONIACEAE		
Higuero, calabash	*Crescentia cujete*	BIGNONIACEAE	0.8	hard, heavy, strong, flexible
Candle tree	*Parmentiera cereifera*	BIGNONIACEAE		
Roble blanco, white cedar	*Tabebuia heterophylla*	BIGNONIACEAE	0.58	mod hard, mod heavy, strong
Roble colorado	*Tabebuia schumanniana*	BIGNONIACEAE	0.9	hard, heavy
Ceiba	*Ceiba pentandra*	BOMBACACEAE	0.23	soft, lightweight
Capa Prieto	*Cordia alliodora*	BORAGINACEAE	0.57	cabinetry, durable in the grd
Muñeco	*Cordia borinquensis*	BORAGINACEAE	0.7	
Moral	*Cordia sulcata*	BORAGINACEAE	0.6	soft, mod lightweight
Tabonuco	*Dacryodes excelsa*	BURSERACEAE	0.53	mod hard, mod heavy, strong
Papaya	*Carica papaya*	CARICACEAE		
Granadillo	*Buchenavia capitata*	COMBRETACEA	0.61	mod hard, mod heavy
Helecho gigante (tree fern)	*Cyathea arborea*	CYATHEACEAE		
Helecho gigante (tree fern)	*Cyathea brittoniana*	CYATHEACEAE		
Queen sago	*Cycas cirinalis*	CYCADACEAE		
Palo colorado	*Cyrilla racemiflora*	CYRILLACEAE	0.53	v hard, mod heavy
Motillo	*Sloanea berteriana*	ELAEOCARPACEAE	0.8	v hard, heavy
Achiotillo	*Alchornea latifolia*	EUPHORBIACEAE	0.39	soft, strong

Palo de Gallina	***Alchorneopsis floribunda***	**EUPHORBIACEAE**	**0.4-5**	**soft, lightweight**
Varital, Palo blanco	***Drypetes glauca***	**EUPHORBIACEAE**		
Taibaba	***Sapium laurocerasus***	**EUPHORBIACEAE**	**0.38**	**soft, lightweight**
Rabo raton	***Casearia arboria***	**FLACOURTIACEAE**		
Caracolillo	***Homalium racemosum***	**FLACOURTIACEAE**	**0.77**	**v hard, v heavy**
Talantrón	***Laetia procera***	**FLACOURTIACEAE**	**0.75**	**soft, mod heavy**
Maria	***Calophyllum brasiliense***	**GUTTIFERAE**	**0.55**	**hard, mod heavy**
Palo de cruz	***Garcinia portoricensis***	**GUTTIFERAE**	**0.9**	**v hard, heavy**
Laurel avispillo	***Nectandra coriacea***	**LAURACEAE**		
Laurel espada	***Ocotea floribunda***	**LAURACEAE**		**lightweight**
Laurel geo	***Ocotea leucoxylon***	**LAURACEAE**	**0.45**	
Nuez moscada	***Ocotea moschata***	**LAURACEAE**	**0.59**	**hard, heavy**
Nemóca	***Ocotea spathulata***	**LAURACEAE**	**0.62**	
Moca	***Andira inermis***	**LEGUMINOSAE**	**0.63**	**hard, fairly heavy**
Mariposa	***Bauhinia monandra***	**LEGUMINOSAE**		
Mata-ratón, mother of cocoa	***Gliricidia sepium***	**LEGUMINOSAE**		**hard, heavy, strong**
Algarrobo	***Hymenaea courbaril***	**LEGUMINOSAE**	**0.7**	**v hard, heavy, copal resin**
Guamá	***Inga laurina***	**LEGUMINOSAE**	**0.62**	**mod hard, mod heavy**
Guamá venezolano	***Inga quaternata***	**LEGUMINOSAE**		**hard**
Guaba	***Inga vera***	**LEGUMINOSAE**	**0.59**	**mod hard, mod heavy**
Zarcilla, tantan, lead tree	***Leucaena leucocephala***	**LEGUMINOSAE**	**0.7**	**hard, heavy**
Palo de Matos	***Ormosia krugii***	**LEGUMINOSAE**	**0.5**	
Pterocarpus, padauk	***Pterocarpus indicus***	**LEGUMINOSAE**		**valuable timber in Philipines**
Reina de las Flores	***Lagerstroemia speciosa***	**LYTHRACEAE**		
Jaguilla	***Magnolia portoricensis***	**MAGNOLIACEAE**	**0.7**	**hard, heavy, fine-texture**
Laurel sabino	***Magnolia splendens***	**MAGNOLIACEAE**	**0.59**	**hard, mod heavy, strong**
Maricao	***Byrsonima spicata***	**MALPIGHIACEAE**	**0.64**	**mod hard, heavy, strong, brittle**
Majó Azul	***Hibiscus elatus***	**MALVACEAE**	**0.50-0.60**	**hard, strong**
Emajagua	***Hibiscus tiliaceus***	**MALVACEAE**	**0.6**	**soft, porous, mod heavy**
Camasey	***Miconia serrulata***	**MELASTOMATACEA**		
Camasey blanco	***Miconia tetrandra***	**MELASTOMATACEA**		
Jusillo	***Calycogonium squamulosum***	**MELASTOMATACEAE**	**0.74**	**hard, heavy, strong**
Camasey	***Miconia mirabilis***	**MELASTOMATACEAE**		
Camasey blanco	***Miconia prasina***	**MELASTOMATACEAE**	**0.7**	**hard, heavy**

Camasey	***Miconia racemosa***	**MELASTOMATACEAE**		
Cedro hembra, Spanish cedar	***Cedrela odorata***	**MELIACEAE**	**0.45**	**lightweight, strong, resistant**
	Guarea glabra	**MELIACEAE**		
Guaraguao	***Guarea guidonia***	**MELIACEAE**	**0.51**	**hard, strong, tough**
Mahogany	***Swietenia macrophylla x S.mahagoni***	**MELIACEAE**	**0.7-8**	
Gaeta	***Trichilia pallida***	**MELIACEAE**	**0.7**	**hard, heavy**
Jackfruit	***Artocarpus heterophyllus***	**MORACEAE**		
Yagrumo hembra	***Cecropia peltata***	**MORACEAE**	**0.29**	
Jaguey blanco	***Ficus citrifolia***	**MORACEAE**	**0.4**	**soft, tough, strong**
Mameyuelo	***Ardisia obovata***	**MYRSINACEAE**		**hard, heavy**
Badúla	***Rapanea guianensis***	**MYRSINACEAE**		**strong, hard**
Mantequero	***Rapanea ferruginea***	**MYRSINACEAE**	**0.7**	**hard, heavy**
Eucalyptus	***Eucalyptus robusta***	**MYRTACEAE**	**0.51**	**hard, mod heavy, strong, brittle**
Guayabota de sierra	***Eugenia borinquensis***	**MYRTACEAE**		**hard, heavy, durable**
Guasábara	***Eugenia domingensis***	**MYRTACEAE**	**0.51**	**hard, heavy, strong**
Pomarrosa	***Syzyglum jambos***	**MYRTACEAE**	**0.7**	**hard, heavy**
Murta	***Eugenia cordata***	**MYRTACEAE**		
Guayabota	***Eugenia stahlii***	**MYRTACEAE**	**0.73**	**v hard, heavy**
Cieneguillo	***Myrcia deflexa***	**MYRTACEAE**	**0.8**	**hard, heavy, strong**
Hoja menuda	***Myrcia splendens***	**MYRTACEAE**		
Guayabacón	***Myrcia leptoclada***	**MYRTACEAE**	**0.8**	
Malagueta	***Pimenta racemosa***	**MYRTACEAE**	**0.9**	**v hard, v heavy**
Guayaba (guava)	***Psidium guajava***	**MYRTACEAE**	**0.8**	**hard, heavy, v. strong**
Hueso blanco	***Chionanthus domingensis***	**OLEACEAE**	**0.9**	**hard, heavy**
Corozo, Prickly Palm	***Acrocomia media***	**PALMAE**		**v hard outer wood**
Palma de coyer	***Aiphanes acanthophylla***	**PALMAE**		
Madagascar palm	***Chrysalidocarpus lutescens***	**PALMAE**		
Coconut Palm	***Cocos nucifera***	**PALMAE**		
Palma de Sierra	***Prestoea montana***	**PALMAE**		
Palma real, Royal palm	***Roystonea borinquena***	**PALMAE**		
Palma de Sombrero	***Sabal causiarum***	**PALMAE**		
Norfolk-Island Pine	***Araucaria heterophylla***	**PINACEAE**		**soft**
Pino hondureño	***Pinus caribaea***	**PINACEAE**	**0.61-0.66**	**soft, mod lightweight**
Higuillo	***Piper aduncum***	**PIPERACEAE**		

Uvilla	***Coccoloba diversifolia***	**POLYGONACEAE**	**0.8**	**heavy, strong, brittle**
Moralón	***Coccoloba pubescens***	**POLYGONACEAE**	**1**	**v hard, v heavy**
Uvera	***Coccoloba pyrifolia***	**POLYGONACEAE**		**hard**
Uvero de monte	***Coccoloba sintenisii***	**POLYGONACEAE**		**hard**
Ortegon	***Coccoloba swartzii***	**POLYGONACEAE**	**0.7**	**heavy, hard**
Uva de Playa	***Coccoloba uvifera***	**POLYGONACEAE**	**0.7**	**hard, mod heavy**
Palo de Gongolí	***Cassipourea guianensis***	**RHIZOPHORACEAE**		**mod hard, heavy, strong**
Icaquillo	***Hirtella rugosa***	**ROSACEAE**	**0.9**	**hard, heavy, strong**
Quina	***Anthirea obtusifolia***	**RUBIACEAE**		**hard, strong, heavy**
Coffee	***Coffea arabica***	**RUBIACEAE**		**hard, heavy, tough**
Jagua	***Genipa americana***	**RUBIACEAE**	**0.66**	**hard, heavy, strong**
Cafeillo	***Ixora ferrea***	**RUBIACEAE**		**hard, heavy, strong**
Cachimbo	***Psychotria berteriana***	**RUBIACEAE**		**hard**
Cenizo, Espino rubial	***Zanthoxylum martinicense***	**RUTACEAE**	**0.46**	**m. weight, hard**
China, sweet orange	***Citrus sinensis***	**RUTACEAE**		
Naranja agria, sour orange	***Citrus aurantium***	**RUTACEAE**		**hard, fine grain**
Tortugo prieto	***Ravenia urbanii***	**RUTACEAE**	**0.9**	**hard, heavy**
Aguacatillo	***Meliosma herbertii***	**SABIACEAE**	**0.42**	**mod heavy, firm, tough**
Guara	***Cupania americana***	**SAPINDACEAE**	**0.4**	**hard, medium weight**
Negra lora	***Matayba domingensis***	**SAPINDACEAE**	**0.7**	**v hard, heavy**
Ausubo	***Manilkara bidentata***	**SAPOTACEAE**	**0.82**	**hard, heavy, v. strong**
Caimitillo	***Micropholis guayanensis***	**SAPOTACEAE**	**0.68**	**hard, heavy, strong**
Caimitillo verde	***Micropholis garciniifolia***	**SAPOTACEAE**	**0.64**	**hard, mod heavy, strong**
Jacana	***Pouteria multiflora***	**SAPOTACEAE**	**0.74**	**hard, heavy, construction**
Aceitillo Falso	***Simarouba tulae***	**SIMAROUBACEAE**	**0.85**	**heavy, strong, durable**
Sauco cimarrón	***Turpinia occidentalis***	**STAPHYLEACEAE**		**hard**
Cacao	***Theobroma cacao***	**STERCULIACEAE**		
Travelers palm	***Ravenala madagascariensis***	**STRELITZIACEAE**		
Péndula (edible)	***Citharexylum fruticosum***	**VERBENACEAE**	**0.7**	**heavy, strong, musical instr**
Teak	***Tectona grandis***	**VERBENACEAE**	**0.55**	**mod hard, mod heavy, strong**

Appendix 2. Vegetation Assessment

Table 10: Vegetation.

Mosses, Liverworts & Lichens **ID by Amelia Merced & Silvia Galva**	**Orchids** **ID by Jon Every & Jim Ackerman**
Crossomitrum spp. **Dumortiera (marchantiiaceae)** ***Fissidens*** ***Hymenophilaceae*** ***Leucobryaceae(?)*** ***Lycopodiella cernum*** ***Lyeaneaceae*** ***Neceropsis undulate*** ***Ochtoblepharum*** **Pogohatum tortile** **Ramalina** ***Ricardia*** ***Scagathoglotis plicata(orchid?)*** ***Sellaginella (pteridophyte)*** ***Tricomanii* (Hymenphiaceae)** **Usnea spp.**	***Campylocentrum micranthum/johnensis*** ***Epidendrum borincarum*** ***Epidendrum nocturnum*** ***Oeceoclades maculata*** ***Polystachya concreta*** ***Polystachya foliosa*** ***Vanilla mexicana*** ***Vanilla planifolia***
Vines and Lianas **ID by Thrity Vakil, Pedro Acevedo & Patricia Boyko**	
Cayaponia racemosa ***Centrosema virginianum*** ***Cissampelos pareira*** ***Cissus erosa*** ***Cissus verticillata*** ***Clusia gundlachi*** ***Columnea tulae*** ***Comocladia glabra*** ***Dioscorea alata*** ***Dioscorea altissima*** ***Dioscorea bulbifera*** ***Dioscorea pilosiuscula*** ***Dioscorea polygonoides*** ***Forsteronia portoricensis*** ***Gonocalyx concolor*** ***Heteropterys laurifolia*** ***Hippocratea volubilis*** ***Ipomoea alba*** ***Ipomoea repanda*** ***Ipomoea setifera*** ***Ipomoea tiliacea*** ***Ipomoea violacea*** ***Lepidaploa borinquensis*** ***Marcgravia rectiflora*** ***Marcgravia sintenisii*** ***Matelea sintenisii*** ***Mikania fragilis*** ***Mikania micrantha***	***Microgramma heterophylla*** ***Microgramma piloselloides*** ***Mimosa ceratonia*** ***Momordica charantia*** ***Neorudolphia volubilis*** ***Odontosoria aculeata*** ***Olyra latifolia*** ***Passiflora tulae*** ***Paullinia pinnata*** ***Philodendron consanguineum*** ***Philodendron lingulatum*** ***Pinzona coriacea*** ***Piptocarpha tetrantha*** ***Pristimera caribaea*** ***Pueraria phaseoloides*** ***Schlegelia brachyantha*** ***Securidaca virgata*** ***Senna nitida*** ***Smilax coriacea*** ***Smilax domingensis*** ***Syngonium podophyllum*** ***Thunbergia grandiflora*** ***Turbina corymbosa*** ***Vanilla mexicana*** ***Vanilla planifolia*** ***Vigna hosei*** ***Vigna luteola***

Ferns **ID by Frank Axelrod & Joanne Sharpe**	**Ferns continued**
Adiantum latifolium ***Adiantun latifolium*** ***Arachniodes chaerophylloides*** ***Blechnum fragile*** ***Blechnum occidentale*** ***Camploneum*** ***Cyathea arborea (*tree fern) ***Cyathea borinquena*** ***Cnemidaria horrida(tree fern)*** ***Alsophila portoricensis*** ***Dicranopteris pectinata*** ***Gleicheniaceae*** ***Hypolepis repens*** ***Lomariopsis sorbifolia***	***Lonchitis hirsuta*** ***Lycopodiella cernua var.*** ***Nephrolepis brownie (hirsuta)*** ***Nephrolepis rivularis*** ***Microgramma lycopodioies*** ***Microgramma piloselloides*** ***Polybotrya cervina*** ***phlepodium aureum*** ***Phlepodium polypdioides*** ***Selaginella krugii*** ***Sticherus bifidus*** ***Sticherus owhyensis*** ***Thelypteris deltoidea*** ***Thelypteris reticulate***
Fungi & Slime Molds **Collected by Patricia Boyko & Thrity Vakil** **ID by Jean Lodge & Patricia Boyko**	**Grasses, rushes, Sedges** **ID by Jon Every**
Amauroderma sp. ***Amparoina spinosissima*** ***Armillaria sp.*** ***Auricularia auricula*** ***Auricularia delicata*** ***Auricularia mesenterica*** ***Auricularia polytricha*** ***Clavariaceae sp.*** ***Cookeina sulcipes*** ***Coprinellus disseminatus*** ***Cyathus sp.*** ***Cyptotrama asprata*** ***Dacryopinax spathularia*** ***Earliella scabrosa*** ***Entoloma sp.*** ***Exidia alba*** ***Exidia glandulosa*** ***Filoboletus gracilis*** ***Fuligo septica*** ***Ganoderma australe*** ***Gloeophyllum sp.*** ***Guepinia helvelloides*** ***Gymnopilus imperialis*** ***Gymnopilus sp.*** ***Gymnopus sp.***	*Panicum glutinosum* *Andropogon* *Fimbristylis dichtomu* *Rhyncohospia colorata*

Hemimycena sp. ***Hygrocybe chloochlora*** ***Hygrocybe nigrescens var. brevispora*** ***Laccaria bicolor*** ***Lentinus crinitus*** ***Lentinus strigosus*** ***Lentinus sp.*** ***Lepiota sp.*** ***Leptonia caeruleocapitata*** ***Leucoagaricus hortensis*** ***Leucocoprinus cretaceus*** ***Leucocoprinus sp.*** ***Lycogala epidendrum*** ***Lycoperdon sp.*** ***Marasmius sp.*** ***Mycena sp.*** ***Mycena holoporphyra*** ***Parasola sp.*** ***Phillipsia domingensis*** ***Pisolithus arrhizus*** ***Pleurotus djamor*** ***Polyporus tenuiculus*** ***Stemonitis splendens*** ***Trametes cubensis*** ***Trametes elegans*** ***Tremella fuciformis*** ***Xylaria sp.***	

Appendix 3. Wildlife Assesment:

Table 11: A. Birds
ID by Andrés Rúa & Dr.Thomas White

Common Name	Genus and species	Endemic	English Name
Carpintero de Puerto Rico	*Melanerpes portoricensis*	*E*	**Puerto Rican Woodpecker**
Pitirre	*Tyrannus dominicensis*		**Gray Kingbird**
Paloma Común	Columba livia		**Rock Pigeon**
Paloma Turca	*Patagioenas squamosa*		**Scaly-naped Pigeon**
Guaraguao Colirrojo	*Buteo jamaicensis*		**Red-tailed Hawk**
Guaraguao de Bosque	*Buteo platypterus*		**Broad-winged Hawk**
Comeñame de Puerto Rico	*Loxigilla portoricensis*	E	**Puerto Rican Bullfinch**
Zorzal Pardo	*Margarops fuscatus*		**Pearly-eyed Thrasher**
Múcaro Común	*Megascops nudipes*	E	**Puerto Rican Screech-Owl**
Zumbador Verde de Puerto Rico	*Anthracothorax viridis*	*E*	**Green Mango**
Zumbadorcito de Puerto Rico	*Chlorostilbon maugaeus*	E	**Puerto Rican Emerald**
San Pedrito	*Todus mexicanus*	E	**Puerto Rican Tody**
Reinita común	*Coereba flaveola*		**Bananaquit**
Candelita	*Setophaga ruticilla*		**American Redstart**
Ruisenor	*Mimus polyglottos*		**Northern Mockingbird**
Pájoro Bobo Mayor	*Coccyzus vieilloti*	E	**Puerto Rican Lizard-Cuckoo**
Tórtola Aliblanca	*Zenaida asiatica*		**White-winged Dove**
Julián Chiví	*Vireo altiloquus*		**Black-whiskered Vireo**
Bienteveo	*Vireo latimeri*	E	**Puerto Rican Vireo**
Clérigo	*Tyrannus caudifasciatus*		**Loggerhead Kingbird**
Zorzal de Patas Coloradas	Turdus plumbeus		**Red-Legged Thrush**
Tórtola cardosantera	Zenaida aurita		**Zenaida Dove**
Gorrión Negro	*Tiaris bicolor*		**Black-Faced Grassquit**
Golondrina bicolor	*Tachycineta bicolor*		**Tree Swallow**
Reinita Pechidorada	*Parula americana*		**Northern Parula**
Reinita Trepadora	*Mniotilta varia*		**Black and White Warbler**

Table 12: B. Reptiles, amphibians & invertebrates
ID by Norman Greenhawk, Ruslan Butovsky & Thrity Vakil

Common Name	Genus and species	Family	Order
REPTILIA (LIZARDS)			
Puerto Rican Crested Anole	*Anolis cristatellus cristatellus*	Polychrotidae (Iguanidae)	**Squamata**
Yellow Chinned Anole	*Anolis gundlachi*	Polychrotidae (Iguanidae)	**Squamata**
Emerald Anole	*Anolis evermanni*	Polychrotidae (Iguanidae)	**Squamata**
Grass Anole	*Anolis pulchellus*	Polychrotidae (Iguanidae)	**Squamata**
Olive Bush Anole	*Anolis krugi*	Polychrotidae (Iguanidae)	**Squamata**
St. Thomas Anole	*Anolis stratulus*	Polychrotidae (Iguanidae)	**Squamata**
REPTILIA (GECKOES)			
Puerto Rico Upland Gecko	*Sphaerodactylus klauberi*	Gekkonidae	**Squamata**
Big-scaled Least Gecko	*Spharodactylus macrolepis*	Gekkonidae	**Squamata**
Gaige's Dwarf Gecko	*Spharodactylus gaigae*	*Gekkonidae*	**Squamata**
REPTILIA GALLIWASPS			
Puerto Rican Galliwasp	*Diploglossus pleei*	Anguidae	**Squamata**
REPTILIA (SNAKES)			
Puerto Rican Whitetailed Blindsnake	*Typhlops platycephlaus*	Typhlopidae	**Squamata**
Puerto Rican Boa	*Epicrates inornatus*	Boidae	**Squamata**
Puerto Rican Racer	*Borikenophis portoricensis*	Dipsadidae	**Squamata**
AMPHIBIA (FROGS)			

Puerto Rican Grass Frog	*Eleutherodactylus brittoni*	*Eleutherodactylidae*	**Anura**
Common Coqui	*Eleutherodactylus coqui*	*Eleutherodactylidae*	**Anura**
Coqui De La Montaña	*Eleutherodactylus portoricensis*	*Eleutherodactylidae*	**Anura**
Coquí Melodioso	*Eleutherodactylus wightmanae*	*Eleutherodactylidae*	**Anura**
White-Lipped Frog	*Leptodactylus albilabris*	Leptodactylidae	**Anura**
Cane Toad	*Bufo marinus*	Bufonidae	**Anura**
ARTHROPODA			
Scorpions	*Tityus_obtusus*	Buthidae	**Scorpiones**
ARACHNIDA			
Puerto Rican Pink Toe Tarantula	*Avicularia laeta*	Theraphosidae	**Araneae**
Wolf Spider			
Wolf Spider	*Pardosa spp*	Lycosidae	**Araneae**
Spiny Orbweaver	*Lycosa spp.*	Lycosidae	**Araneae**
Daddy long-legs spider	*Micrathena militaris*	Araneidae	**Araneae**
Harvestmen		Pholcidae	**Araneae**
			Opiliones
Tailless Whip-scorpion	*Daemon variegatus*	Phrynichidae	**Amblypygid**
CHILOPODA (CENTIPEDES)			
Puerto Rican Giant Centepede	***Scolopendra spp***	Scolopendridae	**Scolopendromorpha**
Centipedes	*Lithobius spp.*	Lithobiidae	**Lithobiomorpha**
DIPLOPODA (Millipedes)			
Yellow-banded millipede	*Anadenobolus monilicornis*		
Velvet Worms	*Onychophorus spp.*	**Peripatidae**	**Euonychophora**

GASTROPODA (SNAILS)			
INSECTA			
Shield-backed bug	*Pachycoris spp.*	Scutellieridae	**Hemiptera**
Straight-snouted weevil		Brentidae	**Coleoptera**
Termites	*Nasutitermes costalis*	Termitidae	**Isoptera**
Cicada		Cicadidae	**Hemiptera**
Cucullo or Firefly		**Lampyridae**	**Coleoptera**
Katydid	*Tettigonia spp*	Tettigoniidae	**Orthoptera**
Brown Cockroach	*Periplaneta spp*	Blattidae	**Blattodea**
Green Cockroach	*Panchlora nivea*	Blaberidae	**Blattodea**
Bess Beetles		Passalidae	**Coleoptera**
Clown Beetles	*Histeridae spp*	Histeridae	**Coleoptera**
Pill Beetles		Burrhidae	**Coleoptera**
Cucubano or Click Beetle	***Pyrophorus luminosus***	Elateridae	**Coleoptera**
Meloid Beetle	*Cissites maculatus*	Meloidae	**Coleoptera**
Long-Horned beetle		Cerambycidae	**Coleoptera**
Beetles		Curculionidae	**Coleoptera**
Caballo de San Pedro – Walking stick	*Diapherodes acalus*	Phasmatodea	**Phasmoptera**
Butterflies		Satyridae, Pieridae	**Lepidoptera**
Wasps	*Polistes crinutus*	Polistes crinutus	**Hymenoptera**
Ants	*Formicidae spp.*	Formicidae	**Hymenoptera**
Bees	*Xylocopa mordax*	Anthophoridae	**Hymenoptera**
Dragonflies			**Odonata**

Appendix 4:
Proposal to Initiate and Use Two Bulls (Bueyes) for Wood Extraction and Transportation of Logs at Las Casas de la Selva.

INITIATE THE KEEPING & USE OF TWO BULLS (*E*) FOR WOOD EXTRACTION & TRANSPORTATION OF LOGS AT LAS CASAS DE LA SELVA

The initiative to use the white Criollo bulls arrived at the project in May 2011. They have been trained in hauling and ploughwork. A simple three-string barbed-wire fence is being set up. The fence will be made in phases, starting at the back of the tractor shed, which will be an entrance and exit.

Tropic Ventures will provide a home for the two bulls for an initial period of one year as an experiment in sustainable animal husbandry, for use as part of the timber project. The land in question covers the terrain behind the old sawmill area. It is mostly pine forest overgrown with fern and thick razor grass. There is an old road lying under eight-foot-high fern and grass (it once connected the old sawmill area with the homestead). The bulls will enrich the soil, and provide manure for our organic gardens and fruit trees.

Andrés & 3t will become the handlers of the bulls for log hauling, and trailer use. We anticipate interest from other people in learning this skill too.

PROPOSAL TO INITIATE THE KEEPING & USE TWO BULLS (*BUEYES*) FOR WOOD EXTRACTION & TRANSPORTATION OF LOGS AT LAS CASAS DE LA SELVA. April 2011.

For millennia, humans have relied on animals to accomplish tasks that without them would be impossible.

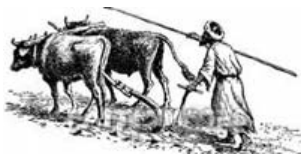
1) The pair of white Criollo bulls, above right, that we are looking to purchase, are trained to pull logs, trailers, and ploughs. We have met the bulls, aged 2.5 years, and their current owners who are bull-men from Rincon.

2) Andrés' father will purchase the bulls for $2,000, and the materials necessary for appropriate fencing over a three- acre patch of land. Simple three-string barbed-wire. A water set-up will use the overflow of the black water tank, with a long hose. The fence will be made in phases, starting at the back of the tractor shed, which will be an entrance and exit. The fence building would begin on receipt of approval for this proposal.

3) Tropic Ventures will <u>not</u> incur any $ cost. Andrés and his father will be the primary caretakers of the bulls, regarding extra food, vets fees etc. Andrés & 3t will become the handlers of the bulls for log hauling, and trailer use. We anticipate interest from other people in learning this skill too.

4) Tropic Ventures will provide a home for the two bulls for an initial period of one year as an experiment in sustainable animal husbandry, for use as part of the timber project.

5) The land in question covers the terrain behind the old sawmill area. It is mostly pine forest overgrown with fern and thick razor grass. There is an old road lying under eight-foot-high fern and grass (it once connected the old sawmill area with the homestead). The bulls will enrich the soil, and provide manure for our organic gardens and fruit trees.



Opportunities for Tropic Ventures:

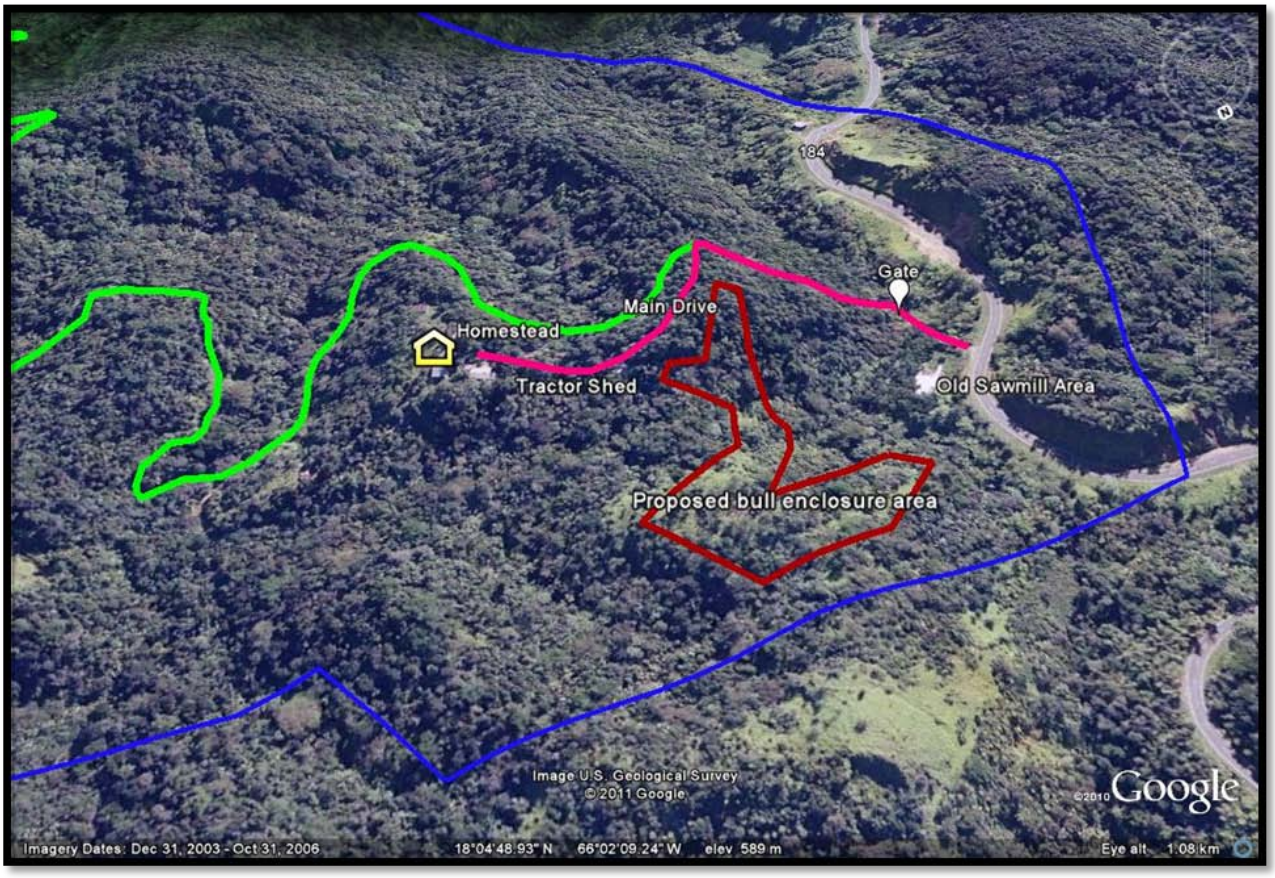
1) Experimenting with, and becoming proficient in a traditional method for log hauling and transportation.

2) Being able to access remote areas of tree plantations, otherwise inaccessible by vehicle to extract logs.

3) Local farmers can rent the bulls. There are economic incentives available from The Dept of Agriculture for the farmers that rent bulls for ploughing land. The current fee for renting bulls is is $100 per day (6 hrs).

4) Tourism benefits. There is a growing interest in the use of alternative transportation methods on mountain lands. People pay to visit areas where this kind of work is occuring. The bulls could be used for paid touristic rides off the property, from Las Casas to Charco Azul, for example.

5) Cultural/social benefits: Nelson Alvarez, advocate of organic agriculture in Puerto Rico, has featured the use of bulls quite prominently in his well acclaimed book, "*La Tierra Viva*", the organic agriculture manual for Puerto Rico. Many young people returning to the island are reclaiming family lands for agriculture, and/or tree-planting. Food growing is on all agendas in PR, and non-fossil fuel modes of transportation and working the land are being encouraged. The bulls are a significant symbol of Jibaro culture in Puerto Rico.



The Red line indicates the location of an old road that is severely over-grown with fern and razor grass. The entire area of nearly three acres is mostly pine-tree planted area with trees approx 30 feet tall with diameters of about 8-12 inches. The barbed-wire fence would follow the edges of this road, and include a plateau with pine trees. This would keep the bulls on relatively flat ground, and we would have easy access to them. The blue line is the NW border of the property. The green line is the forest road.

Note from Andrés: "My grandfather's life revolved around livestock. He owned 70 cows and he used bulls to transport materials and plough the land, inside and outside of his farm. The farm was as steep as the land of Las Casas de la Selva. My father continued this tradition, keeping 30 cows and bulls until I was fifteen years old, but the social and economic climate soon changed this lifestyle completely, and he sold all his animals, and went to work in the city.

For nearly a year, my father's interest in keeping bulls has been revived and I am keen to learn the art from him and keep two bulls. My father has offered to buy a pair of Puerto Rican bulls, and help me to manage them. These types of bulls (Criollo) have been used in the mountains of Puerto Rico for centuries by the jíbaros. Frank Wadsworth recommends bulls to extract wood from the mountain forests instead of heavy equipment like tractors or other vehicles. I want to train myself as a bull-handler to use them as part of the Timber Project. I can train them and myself here on the Las Casas land, where I want to use them. I feel that a one-year experiment would enable us to see how we can benefit enormously by using the bulls".

Addressing main concerns:

Erosion: Our main concern in the initial phase of this plan is erosion of the land under impact of these large animals. Where there is enough terrain for the animals and impact is spread over a wide area, erosion should be minimized. The old road will be compacted by the continuous use of the bulls. **This is a one year experiment, and if we cannot manage to steward the land beneficially, then we will stop.**

Heavy Rains: Before very heavy rains, the bulls will be moved to a designated area, to minimize erosion.

Shelter: Bulls do not need a shelter in the tropics.

Escape: Proper fencing is key to reducing the risk of escape.

Hurricanes: The bulls will be in an area with the least trees and will be left to fend for themselves.

Visitors: Proper orientation for visitors to minimize any contact with the bulls.

Andrés & 3t absent: Andrés father and Raul Rosado have agreed to be the caretakers of the bulls in our absence.

Aggressive bulls?: We have met the bulls (picture below), and they are very docile. They have been trained for more than a year already. They will be castrated in a year's time, as all oxen are.

IX. GLOSSARY

Agroforestry – where trees or shrubs are intentionally used within agricultural systems, or non-timber forest products are cultured in forest settings. Knowledge, careful selection of species and good management of trees and crops are needed to optimize the production and positive effects within the system and to minimize negative competitive effects.

Biological corridor – an area of habitat connecting wildlife populations separated by human activities (such as roads, development, or logging). This allows an exchange of individuals between populations, which may help prevent the negative effects of inbreeding and reduced genetic diversity (via genetic drift) that often occur within isolated populations. Corridors may also help facilitate the re-establishment of populations that have been reduced or eliminated due to random events (such as fire or disease). This may potentially moderate some of the worst effects of habitat fragmentation.

Birth or origin - the discharge of water from underground, such as a spring of a stream or river. Formed by volcanic activity, fissures, cracks or channels, or by the contact between rocky formations with different porosity. Some are perennial, some intermittent, and only activated in rains.

Canopy– the upper layer or habitat zone, formed by mature tree crowns and including other biological organisms (epiphytes, lianas, arboreal animals,) etc. Provides protection from strong winds and storms, whilst also intercepting sunlight and precipitation.

Contour planting – the preparation of land and planting areas following the curves or natural forms of the land, instead of straight lines, in order to help retain water and reduce soil erosion

Ecological succession - the gradual process of change in an ecosystem brought about by the progressive replacement of one community by another in a definite order until a stable community i.e. climax community is established over a period of time.

Ecosystem - consists of all the organisms living in a particular area, as well as all the nonliving, physical components of the environment with which the organisms interact, such as air, soil, water, and sunlight. It is all the organisms in a given area, along with the nonliving (abiotic) factors with which they interact; a biological community and its physical environment. The entire array of organisms inhabiting a particular ecosystem is called a community.

Ecotone - a transition area between two adjacent but different plant communities, such as forest and grassland. It may be narrow or wide, and it may be local (the zone between a field and forest) or regional (the transition

between forest and grassland). An ecotone may appear on the ground as a gradual blending of the two communities across a broad area, or it may manifest itself as a sharp boundary line.

Endangered species - a population of organisms at risk of becoming extinct because of low numbers or threatened by changing environmental or predation parameters.

Endemic species - a species which is only found in a given region or location and nowhere else in the world.

Exotic species - introduced, alien, exotic, non-indigenous, or non-native species, or simply an introduction, is a species living outside its native distributional range, which has arrived there by human activity, either deliberate or accidental.

Forest fragmentation - a form of habitat fragmentation, occurring when forests are cut down in a manner that leaves relatively small, isolated patches of forest known as *forest fragments* or *forest remnants*. The intervening matrix that separates the remaining woodland patches can be natural open areas, farmland, or developed areas.

Forest refinement - consists of the elimination of trees, undesirable vines and shrubs to stimulate the complete use of a selected place where a future harvest is planned.

Forest restoration - consists of improving and accelerating the natural processes of forest regeneration in order to restore the health of the ecosystem. The restoration is obtained when the composition of species, the structure of the forest mass, the biodiversity, the functions and the processes of the recovered forest are nearest to the original forest.

Functional connectivity - population and genetic flow of species through ecological or mosaic corridors that are structurally interconnected.

Geographic information system (GIS) - a system that captures, stores, analyzes, manages, and presents data that are linked to location. In the simplest terms, GIS is the merging of cartography and database technology. GIS systems are used in cartography, remote sensing, land surveying, utility management, geography, urban planning, emergency management, navigation used for scientific investigations, resource management, asset management, archaeology, environmental impact assessment, urban planning, cartography, geographic history, marketing, logistics, and other purposes.

Habitat - an ecological or environmental area that is inhabited by a particular species of animal, plant or other type of organism. It is the natural environment in which an organism lives, or the physical environment that surrounds (influences and is utilized by) a species population.

Landscape – land morphology and its canopy cover forming the distant visual scene. The cover of the land includes water, vegetation and different anthropic developments, including cities. It is the total of the characteristics that distinguish a certain area of the Earth surface from other areas; these characteristics are the result not only from natural agents but also from the occupation of humans and the use of the land.

Limits of Acceptable Change (LAC) - Tool of analysis and planning where methodology allows identification and monitoring of important environmental and social indicators in natural areas.

Management - the set of actions of organization, planning, administration and control, as well as the decisions associated to this, that maximize opportunities to reach the goals and objectives that are stipulated in some plan or program of specific management. This set of actions can be directed to lands, plantations, bodies of water, flora, fauna, facilities or public or private goods, in a particular zone or area, following a plan or general or specific guide for the resources contained it.

Matrix – the most common and dominant elements that manifest structural and functional connectivity in a certain landscape.

Mosaic –intermixed features on a landscape, creating a pattern or 'mosaic' of different features used by wildlife in daily, annual, or life cycles. These mosaics result from a multitude of variables, including differences in soils, topography, microclimate and disturbance.

Natural resource - any element of the environment that can be useful to humans.

Patches - relatively small and fragmented areas with borders or edges that can be distinguished in a matrix within a landscape on a certain scale.

Pattern – adjustment and composition of patches that make up the landscape.

Private forest - land under the jurisdiction of a proprietor or particular owner who owns forest vegetative cover of 4 acres (5 cuerdas) or more. It is the center of action of the Forest Stewardship Program.

Riparian zone buffer strips – areas of natural or man-made forest vegetation made up of adjacent strips of trees, shrubs and grasses. They reduce contamination of water by trapping sediment and pollutants in areas bordering cultivated land. They reduce erosion of riverbanks, improve the aquatic environment, increase habitat available for wildlife and have aesthetic value.

River - continuous flow of water that ends at another current, or the sea. Rivers are of perennial or intermittent form.

Secondary forest (or **second-growth forest**)- is a forest or woodland area which has re-grown after natural or human disturbance such as fire, insect infestation, timber harvest or agricultural activities, until a long enough period has passed so that the effects of the disturbance are no longer evident.

Sedimentation - Process by which soil materials are suspended in a water body. This material separates and settles out from the medium, where wind, water, or ice originally carried it. For fluvial sediments the ability of a river to carry sediment depends on particle size as well as the river discharge.

Soil erosion - the process of weathering and transport of solids (sediment, soil, rock, and other particles) in the natural environment by the action of wind and/or flow of water. This natural process can be accelerated by human elimination of vegetation.

Structural connectivity - continuity of mosaics formed by arboreal and/or bush vegetative communities.

Sustainable agriculture - the integration of interdependent agro-ecosystems, which conserve natural resources and are productive. It includes several disciplines and concepts like: agro-ecology, agro-forestry, integrated systems of cultivation and integrated pest management; practices that produce without destroying, conserve the environment, and restore and/or increase productivity.

Topography - The three-dimensional arrangement of physical attributes (such as shape, height, and depth) of a land surface in a place or region. Physical features that make up the topography of an area include mountains, valleys, plains, and bodies of water. Human-made features such as roads, railroads, and landfills are also often considered part of a region's topography.

Understory - the part of forest and bush located below the canopy formed by main tree species. It consists of young trees, shrubs and herbs.

Watershed – drainage or catchment areas where water meets mountains and runs down river to feed rivers and lakes before emptying into the sea.

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The rainforest defends itself by a beauty that makes us stop, and take an oath to protect her. www.eyeontherainforest.org

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