Estudios Técnicos Inc.

Investigación | Estrategias | Soluciones

# National Priorities Section
# Puerto Rico Forest Action Plan

November 19, 2015

Submitted to:

COMMONWEALTH OF PUERTO RICO
DNER
DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES

# CONTENTS

**INTRODUCTION** ..... 7

**1. CONSERVING WORKING FOREST LANDSCAPES** ..... 8

1. Continue land acquisition programs of key private forested land by available mechanisms ..... 8
2. Promote conservation easements on private forested land ..... 9
3. Provide adequate conservation management for private forests through Forest Stewardship plans ..... 11
4. Develop forest and wildlife interpretation trainings ..... 12
5. Develop management information on agroforestry practices suitable for the Río Loco Watershed at Guánica Bay Watershed ..... 13
6. Increase capacity of community to manage trees ..... 16
7. Increase tree canopy cover and condition ..... 19
8. Acquire community open spaces to protect key forested areas ..... 19
9. Hazard tree mitigation ..... 20
10. Increase use of native plant material (native tree propagation and use) ..... 20
11. Develop nursery quality standards (work with nursery growers to provide quality nursery stock) ..... 21
12. Develop educational programs and activities (i.e. demonstration of forests projects) ..... 22
13. Introduction of agroforestry concepts ..... 25
14. Promote arboriculture in universities curricula ..... 26

**2. PROTECT FORESTS FROM HARM** ..... 28

A - Fire ..... 28

1. Create a database to collect information on fire occurrences recording: (1) location, (2) type of vegetation, (3) number of acres affected, (4) resources used, and (5) resources needed ..... 28
2. Develop and implement a Fire Danger Rating System for the areas with high wild land fires occurrences ..... 29
3. Offer fire prevention education to the communities within the areas with high wildland fire occurrences (Increase efforts on the wildland urban interface) ..... 30
4. Develop Community Wildfire Protection Plans and educational programs ..... 31
5. Wildland fire suppression ..... 32
6. Use prescribed burning as a resource to control fire occurrences in areas with high fire incidence ..... 32
7. Tree planting and resource restoration in areas affected by fires ..... 33
8. Acquire, maintain, and pre-position essential equipment and supplies for wildland fire suppression ..... 34
9. Develop an effective communication strategy between partners involved in the suppression of wildland fires ..... 34

B - Insect pests and disease ..... 35

1. Establish a Forest Health Monitoring Program at the DNER Forest Service Bureau ..... 35
2. Encourage early detection and rapid response from DNER Forest Managers ..... 35
3. Provide professional training to DNER Forest Managers ..... 36

4. Promote public education about possible detrimental effects on forest floristic components.....36
5. Maintain adequate urban tree inventories and management practices .....36
6. Promote Integrated Pest Management.....36
C - Development; urban sprawl; fragmentation .....37
1. Protect developed large contiguous forest areas and corridors to ensure connectivity by: land acquisition, conservation easements, adequate land use zoning, voluntary protection .....37
2. Encourage planting trees to increase tree canopy cover and green corridors.....38
3. Promote proper land-use planning and accurate zoning on forested areas.....39
4. Promote professional training for assessing the forest cover and its benefits on agencies involved in determining present and future land use.....39
5. Increase programs availabilities for the East side of the Islands by: (1) Increasing outreach, (2) Increasing Water Conservation (3) Enhancing Forest Diversity, (4) Enhancing all restored riparian habitats .....40
D - Climate Change.....42
1. Create and conserve corridors for tree mitigation .....42
2. Increase carbon storage through increases in tree canopy cover .....42
3. Conduct urban forests inventories.....42
4. Encourage development of management plans.....42
5. Perform hazard tree mitigation .....44
6. Provide professional training.....44
E - Hurricane/storms .....45
1. Conduct urban forests inventories.....45
2. Develop management plans.....45
3. Perform hazard trees mitigation.....45
4. Promote adequate tree selection .....45
F - Flooding.....45
1. Promote forested wetland protection.....45
2. Promote riparian buffer installations .....47
3. Maintain and increase forest cover in catchment and groundwater recharge areas.....47
4. Conduct urban trees inventories and perform hazard mitigation .....48
G - Invasive plants and animals.....48
1. Provide professional and public education.....48
2. Promote usage of native and other suitable species.....48
3. Apply eradication practices.....49
4. Adequate law enforcement against introduction of exotics .....49
5. Promote early detection of invasive species .....49

**3. ENHANCE PUBLIC BENEFITS ASSOCIATED WITH TREES AND FORESTS.....50**

1. Continue encouraging reforestation.....50
2. Maintain and manage existing forests .....51
3. Private forested land acquisition by several means including Forest Legacy Program.....54
4. Encourage conservation easements.....54
5. Promote voluntary private land conservation management.....54

6. Continue land acquisition programs to conserve private mature forests .....55
7. Promote and encourage agroforestry practices (sun coffee plantations to shade grown coffee) .....55
8. Establish Maricao Commonwealth Forest and a 5 mile buffer (it includes Susúa Commonwealth Forest) .....55
9. Provision of proper management of public forested lands .....56
10. Plant biodiversity .....58
11. Retain forest cover .....58
12. Carbon sequestration .....58
13. Manage for forest health and growth .....58
14. Forest products benefits to incentivize protecting and enhancing forest cover .....59

**REFERENCES ..... 63**

## Figures

Figure 1. Acres of Auxiliary Forest Agreements 2010 – 2015 ..... 10
Figure 2. Forest Cover ..... 19
Figure 3. Trees propagated and distributed at the Cambalache nursery ..... 21
Figure 4. Location of schools in relation to areas with higher wildfire incidences ..... 30
Figure 5. Karst Special Planning Area ..... 37
Figure 6. Extension of the Puerto Rico Model Forest ..... 38
Figure 7. Collaborative agreements with community organizations for the management of State Forests and other Natural protected areas with important forest resources ..... 53
Figure 8. Community-based economic development projects related to DNER natural protected areas 61

## Tables

Table 1. Acquisitions made by DNER, IITF, Para La Naturaleza and Ciudadanos del Karso: 2010-2015 ..... 9
Table 2. Forest Stewardship Program Plans 2010-2015 ..... 11
Table 3. UCFP funded initiatives aimed at increasing the capacity of communities to manage trees ..... 16
Table 4. Educational initiatives implemented by the DNER 2010-2015 ..... 23
Table 5. Management Plans developed by the DNER 2010-2015 ..... 42

# ACRONYMS

| | |
|---|---|
| ARRA | American Recovery and Reinvestment Act |
| CADA | Consejo Asesor para el Desarrollo Agroforestal (Advisory Council for Agroforestry Development) |
| CATIE | Centro Agronómico Tropical de Investigación y Enseñanza (Tropical Agricultural Research and Higher Education) |
| CCP | Centro para la Conservación del Paisaje (Center for Landscape Conservation) |
| CDK | Ciudadanos del Karso (Citizens of the Karst) |
| CEDES | Centro de Estudios para el Desarrollo Sustentable (Center for Sustainable Development Studies) |
| CICA | Cuerpo de Intérpretes Científicos Auxiliares (Auxiliary Corps of Scientific Interpreters) |
| DNER | Department of Natural and Environmental Resources |
| DTOP | Department of Transportation and Public Works |
| ENUAM | Escuela Ecológica Niños Uniendo al Mundo, Caguas |
| GAEI | Grupo Antillano de Especies Invasoras (Antillean Group for Invasive Species) |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| IITF | International Institute of Tropical Forestry |
| INECOH | Iniciativa Ecoturística Humacao (Humacao Ecotourism Initiative) |
| MOU | Memorandum of Understanding |
| NAI | National Association for Interpretation |
| NEON | National Ecological Observatory Network |
| NGO | Non-Governmental Organization |
| NOAA | National Oceanic and Atmospheric Association |
| NRCS | Natural Resource Conservation Service |

| | |
|---|---|
| NSF | National Science Foundation |
| NWS | National Weather Service |
| PECES | Programa de Educación Comunal de Entrega y Servicio, Inc. (Service and Delivery Community Education Program) |
| PLN | Para La Naturaleza |
| PLT | Project Learning Tree |
| PRASA | Puerto Rico Aqueduct and Sewer Authority |
| PRCCC | Puerto Rico Climate Change Council |
| PRFC | Puerto Rico Firefighters Corps |
| RPTM | Response Protocol Tree Management |
| SMART | Stewardship Mapping and Accomplishment Reporting Tool |
| SPA | Special Planning Area |
| UCFP | Urban and Community Forestry Program |
| UMET | Universidad Metropolitana (Metropolitan University) |
| UNEP | United Nations Environment Program |
| UPR | University of Puerto Rico |
| UPRM | University of Puerto Rico Mayagüez Campus |
| USDA | Unites States Department of Agriculture |
| USFS | United States Forest Service |
| USFWS | United States Fish and Wildlife Service |
| USVI | United States Virgin Islands |

# INTRODUCTION

This report presents the National Priorities Section of the Puerto Rico Forest Action Plan. The Department of Natural and Environmental Resources (DNER) developed the Puerto Rico Forest Action Plan in 2010, according to the 2008 Farm Bill. It required that each state develop a long-term, state-wide assessment and strategies for forest resources focused on the following three National Priorities:

1. Conserve and Manage Working Forest Landscapes for Multiple Values and Uses,
2. Protect Forests from Threats, and
3. Enhance Public Benefits from Trees and Forests.

The Puerto Rico Forest Action Plan identified six priority issues and seven priority landscapes. To address these issues and priorities, the plan includes 69 strategies.

Recently, it was required that all Forest Action Plans must contain a new section titled "National Priorities", describing actions and success stories contributing to each national priority. The purpose is to demonstrate how federal investments leverage other resources and produce measurable outcomes that address national priorities.

This National Priorities section serves as a record of activities taken by all Commonwealth stakeholders to address strategic goals. It includes efforts and achievements of the DNER as well as other federal and Commonwealth agencies, and NGOs working in forest protection. The information was gathered through interviews, data provided by government officials and the revision of secondary data.

## Puerto Rico

### Issues

- Fragmentation of forest systems
- Water resources and watershed conservation strategies
- Information needs related to ecosystem services and other benefits from public and private forest land.
- Disturbances affecting forests (hurricanes, floods, fires, pests, etc.)
- Concern over invasive species
- Economic opportunities and alternative market development

### Priority Landscapes

- Interface Landscapes
- Critical Wildlife Areas
- Areas of Hydrological Importance
- Fire Prone Landscapes
- Urban Forests
- Riparian Corridors
- Joint Priority Landscapes

# 1 CONSERVING WORKING FOREST LANDSCAPES

## National Objectives:

*1.1. Identify and conserve high-priority forest ecosystems and landscapes in Puerto Rico*

*1.2. Actively and sustainably manage forests*

***Issues addressed:***

- ✓ *Fragmentation of forest systems*
- ✓ *Water resources and watershed conservation strategies*
- ✓ *Information needs related to ecosystem services and other benefits from public and private forest land.*
- ✓ *Economic opportunities and alternative market development*

## Puerto Rico Strategies:

### 1. Continue land acquisition programs of key private forested land by available mechanisms (e.g. Forest Legacy)

During 2010-2015 more than 7,814.23 acres of forested lands where protected through acquisitions by the DNER, the International Institute of Tropical Forestry (IITF), and two local NGOs: the Conservation Trust of Puerto Rico, and its unit Para La Naturaleza (PLN), and Ciudadanos del Karso (Citizens of the Karst or CDK, by its Spanish acronym).[1]

Of these, 774.32 acres were acquired to expand the following State Forests: Toro Negro, Cambalache, Río Abajo, De Vega and Carite. The following table presents acquisitions carried out during the past five years by different mechanisms such as purchase, donations and mitigations.

[1] Source: Data extracted from the: Caribbean Landscape Conservation Cooperative. 2015. Puerto Rico Protected Areas Database [version of September, 2015]. GIS data. San Juan, PR.

**Table 1. Acquisitions made by DNER, IITF, PLN and CDK: 2010-2015**

| | *Property Name* | *Management* | *Area (acres)* | *Mechanism* |
|---|---|---|---|---|
| 1 | Guayama Experimental Forest | FS-IITF | 329.7 | Purchase |
| 2 | Manatí Experimental Forest | FS-IITF | 89.6 | Purchase |
| 3 | Finca José Santiago | CDK | 31.4 | Purchase |
| 4 | Área Natural Protegida Sendra | PLN | 13 | Purchase |
| 5 | Área Natural Protegida Culebras | PLN | 25 | Purchase |
| 6 | Área Natural Protegida El Conuco | PLN | 35.8 | Purchase |
| 7 | Área Natural Protegida La Robleda | PLN | 249.7 | Purchase |
| 8 | Área Natural Protegida Marín Alto | PLN | 128.2 | Purchase |
| 9 | Área Natural Protegida San Juan Park | PLN | 26.2 | Purchase |
| 10 | Área Natural Protegida Ulpiano Casal | PLN | 340.5 | Purchase |
| 11 | Finca Colón | PLN | 15.5 | Purchase |
| 12 | Área Natural Protegida Finca Jájome | PLN | 356.5 | Purchase |
| 13 | Área Natural Protegida Luz Martínez de Benítez | PLN | 126.1 | Purchase |
| 14 | Área Natural Protegida Pedro Marrero | PLN | 107.8 | Purchase |
| 15 | Área Natural Protegida Punta Cabullones | PLN | 530.8 | Purchase |
| 16 | Área Natural Protegida Ojo de Agua | PLN | 1305.8 | Purchase |
| 17 | Área Natural Protegida Punta Pozuelo | PLN | 124.6 | Purchase |
| 18 | Finca Nolla | DNER | 110.2 | Purchase |
| 19 | Reserva Natural Corredor Ecológico del Noreste | DNER | 2,932.20 | Purchase |
| 20 | Cañón Las Bocas | DNER | 70.3 | Purchase |
| 21 | Canóvanas (Bo. Cambalache) | DNER | 4.8 | Donation |
| 22 | Ciales (Bo. Toro Negro Arriba) | DNER | 53.4 | Donation |
| 23 | Gurabo (Bo. Jaguas) | DNER | 0.6 | Purchase |
| 24 | San Juan | DNER | 8.3 | Purchase |
| 25 | Reserva Natural Centro Geográfico de Puerto Rico | DNER | 11.01 | Expropriation |
| 26 | Villalba (Bo. Vacas) (Near Toro Negro State Forest) | DNER | 71.02 | Purchase |
| 27 | Jayuya (near Toro Negro State Forest) | DNER | 87.00 | Purchase |
| 28 | Vega Alta (De Vega State Forest) | DNER | 384.48 | Donation |
| 29 | Finca San Salvador Caguas (Carite State Forest) | DNER | 24.32 | Purchase |
| 30 | Finca ACT (Rio Abajo State Forest) | DNER | 163.27 | Mitigation |
| 31 | Finca ACT (Cambalache State Forest) | DNER | 44.23 | Mitigation |
| 32 | Finca ACT (Boquerón Wildlife Refuge) | DNER | 13.6 | Mitigation |

*Sources:* Caribbean Landscape Conservation Cooperative. 2015. Puerto Rico Protected Areas Database [version of September, 2015]. GIS data. San Juan, PR.; DNER- 2014 Achievements Report presented to La Fortaleza; 2012 Transition Report: Assistant Secretary of Comprehensive Planning. Data on acquisitions provided by Coralys Ortiz, DNER.

## 2. Promote conservation easements on private forested land

The Conservation Easement Act of 2001 (Act No. 183 of December 27, 2001), allows the DNER and other organizations to establish conservation agreements with owners of lands of high ecological or agricultural value. In Puerto Rico, the DNER and PLN are

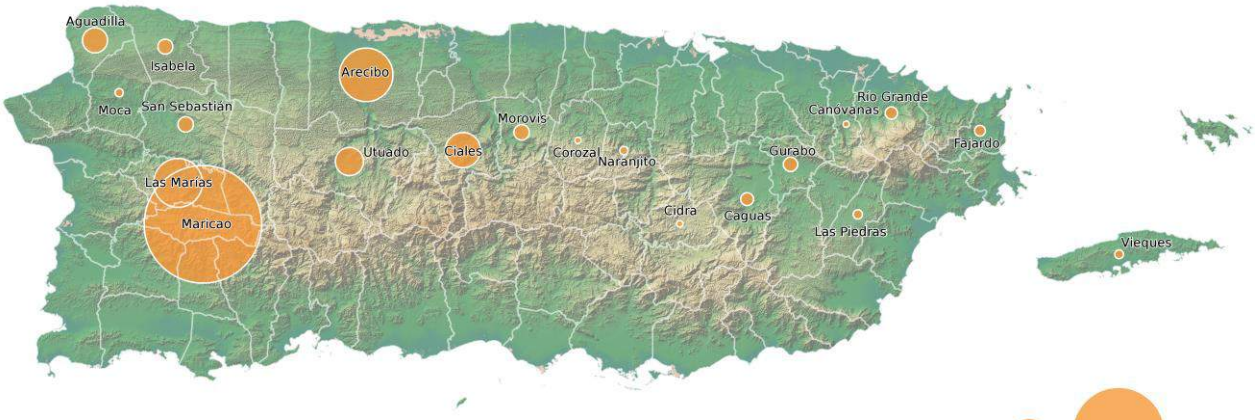
the two organizations that are actively establishing conservation agreements for the protection of private lands of high ecological value.

Between 2010-2015, approximately 1,187.5 acres of land were protected through conservation easements by PLN and the DNER. Some of these protect important tree species such as *Pterocarpus officinalis and Coccoloba rugosa*. Others, such as Finca Gulín, are located in the periphery of El Yunque National Forest.

In addition, The Puerto Rico Forest Act (Act No. 113 of July 1, 1975) grants the DRNA the authority to designate Auxiliary Forests under a protection covenant with landowners.[2]

Between 2010-2015, the DNER's Forest Service Bureau signed 42 Auxiliary Forest agreements, bringing more than 2,865 acres into the program.

**Figure 1. Acres of Auxiliary Forest Agreements 2010 – 2015**




| Municipality | Acres | Municipality | Acres | Municipality | Acres | Municipality | Acres | Municipality | Acres |
|---|---|---|---|---|---|---|---|---|---|
| Maricao | 1,681 | Utuado | 97 | Isabela | 27 | Fajardo | 15 | Naranjito | 9 |
| Arecibo | 350 | Aguadilla | 76 | Gurabo | 25 | Las Piedras | 11 | Corozal | 5 |
| Las Marias | 292 | San Sebastián | 30 | Caguas | 20 | Vieques | 10 | Canóvanas | 5 |
| Ciales | 152 | Morovis | 29 | Rio Grande | 20 | Moca | 9 | Cidra | 5 |

Source: Department of Natural and Environmental Resources, Forest Service Bureau, Conservation and Reforestation Section

[2] These forest landscapes are required to be more than 4.85 acres and not be part of agricultural activities. Under an Auxiliary Forest Agreement the landowners receive property tax and income tax exemption for income derived from the sales of forest products. Under conservation easement agreements private individuals receive a tax credit for 50% the market value of the protected lands.

## 3. Provide adequate conservation management for private forests through Forest Stewardship plans

Between 2010-2015, the Forest Stewardship Program has completed 64 management plans (5,956.29 acres), 28 of which are renewed plans (903.5 acres). Combined, the current management plans comprise a total area of 6,859.79 acres.

**Table 2. Forest Stewardship Program Plans 2010-2015**

| Municipality | Barrio (Ward) | Acres |
|---|---|---|
| **2010-2012** | | |
| Ponce | Real and Anón | 1,756.90 |
| Patillas | Muñoz Rivera, Mulas and Marín | 905.11 |
| Vieques | Florida | 12.91 |
| Patillas | Cacao Bajo | 134.95 |
| Villalba | Hato Puerco Arriba | 174.60 |
| Cabo Rojo | Monte Grande | 9.28 |
| Arecibo | Dominguito | 339.22 |
| Moca | Pueblo | 9.22 |
| Aibonito | Cuyón 2 | 92.30 |
| Ciales | Frontón | 23.00 |
| **Total** | | 3,457.49 |
| **2013-2014** | | |
| Yauco | Rubias | 346.02 |
| Maricao | Montoso | 10.00 |
| Maricao | Montoso | 10.30 |
| Maricao | Montoso | 58.06 |
| Maricao | Indiera | 270.58 |
| Salinas | Quebrada Yeguas | 132.30 |
| **Total** | | 827.26 |
| **2014-2015** | | |
| Aguada | Cruces | 19.90 |
| San Sebastián | Culebrinas | 12.90 |
| San Germán | Minillas | 21.36 |
| Isabela | Planas | 8.83 |
| Isabela | Guayabos | 24.61 |
| Ciales | Cialitos | 181.55 |
| Aguas Buenas | Juan Ascencio | 16.50 |
| Orocovis | Gato | 48.54 |
| Río Grande | Guzmán Abajo | 16.14 |
| Naguabo | Pueblo, | 9.71 |
| Ceiba | Daguao | 6.80 |
| Coamo | Cuyón | 492.23 |
| Salinas | Quebrada Yeguas | 5.00 |
| Arecibo | Dominguito | 31.17 |
| Las Marías | Alto Sano | 21.36 |
| Lajas | Lajas Arriba | 14.64 |
| Maricao | Bucarabones | 316.50 |
| Maricao | Indiera Baja | 242.72 |
| Maricao | Indiera Fría | 176.70 |
| Maricao | Montoso | 5.34 |
| **Total** | | 1,672.50 |
| **Total 2010-2015** | | **5956.29** |

Forest Technicians participated in a Workshop provided by the USFS-IITF on the use of the Stewardship Mapping and Accomplishment Reporting Tool (SMART). This is an

application that assists with the creation of Forest Stewardship Plans and tracking on-the-ground spatial accomplishments.

## 4. Develop forest and wildlife interpretation trainings

In 2013, the DNER created the Auxiliary Corps of Scientific Interpreters (CICA, by its Spanish acronym). CICA integrates teachers and students from colleges and schools in gathering technical and scientific information for environmental research in Puerto Rico.

This effort aims to open Natural Protected Areas to research activities, in coordination with the DNER personnel. For example, the Isla de Mona Nature Reserve will host internships for students in environmental interpretation. In addition, the Río Abajo State Forest will provide interns with experience in management and monitoring of the Puerto Rican parrot (*Amazona vittata vittata*), which is a Commonwealth and Federal protected species.

**Auxiliary Corps of Scientific Interpreters (CICA, by its Spanish acronym)**

In February 2015, the National Association for Interpretation (NAI) Southeast Region chapter celebrated its Annual Workshop in Humacao, Puerto Rico. The workshop allowed continued development of interpretation skills for communities, environmental organizations, concessionaires and DNER staff. During the proceeding, the NAI recognized Puerto Rico as one of the jurisdictions with the highest number of certified interpreters.

**NAI Southeast Region Chapter Annual Workshop in Humacao, Puerto Rico**

Source: DNER

The DNER, through the Urban and Community Forestry Program (UCFP) provided funds to the Inter American University Metro Campus to develop the project "More Forests for Our City". Twelve undergraduate students were trained as environmental volunteers and nine were certified as environmental interpreters accredited by NAI. The volunteer students helped produce a digital herbarium with a tree guide, and also established three forest interpretative stations inside the campus.

## 5. Develop management information on agroforestry practices suitable for the Río Loco Watershed at Guánica Bay Watershed

The DNER has worked continuously with other local and Federal agencies, farmers, community groups and environmental organizations in the Río Loco/Guánica Bay Watershed Initiative. This is part of the Guánica/Maricao Joint Landcape. Several initiatives have been implemented or are underway, including more sustainable agricultural practices.

In 2011, the USFWS, NRCS, the DNER and Envirosurvey Inc. delivered 6,600 native trees to 16 farmers in order to restore and conserve habitat for wildlife. Trees were planted within 291 acres of multicrop farms of coffee, oranges and banana plantations in the mountains of Yauco and Maricao. These farms needed the shade-producing trees to protect their crops from wind damage and minimize soil erosion. By agreeing to maintain the native trees planted for at least 10 years, the farmers committed to long term conservation (USFWS, 2011).

**Ramón Rivera, PRDNER and Magaly Figueroa, USFS delivering trees to farmers.**

April 25, 2011- Maricao, Puerto Rico.

Photo by Lilibeth Serrano, USFWS.

Particularly in the coffee growing sector, more than 690 acres of native shade trees have been planted by the NRCS and FWS throughout Maricao, Sabana Grande and Yauco.

Another effort is the "Shaded Coffee Roundtable" in which the DNER is one of the collaborating agencies. Established in 2011, the "Roundtable" brings together farmers, communities, government and nongovernmental organizations. Through the initiative, educational and technical assistance is provided to promote shaded coffee agro-ecological practices, including: contour planting, runoff management, shade management, cultural practices and the proper use of agrochemical products.

Other outstanding educational and capacity building projects in this priority landscape have been the Trees and Corals (Árboles & Corales) project and CAFEiCANTO. Both were led by Cafiesencia, one of the local NGOs participating in the "Shaded Coffee Roundtable".

Funded by the NRCS, Árboles & Corales aimed to empower women through trainings and education in sustainable agricultural business, agricultural entrepreneurship, watershed ecosystems, and computer and Internet literacy workshops. Additionally, the project developed a community-based radio broadcast titled "Life in the Watershed" (Vida en la Cuenca) which served as a forum for residents and other stakeholders.

- CAFEiCANTO is funded by the USFS through the project called "Shade Grown Coffee Farmers as Bird Custodians: Multiplying social, environmental and economic opportunities for farming communities in Puerto Rico through Agroforestry practices". It is a groundbreaking project in Puerto Rico, which combines education and capacity building to farming communities in six municipalities near the Maricao, Susúa and Guilarte State Forests. The project focuses on sustainable shade-grown coffee agroforestry, with bird monitoring and eco-agritourism opportunities.3 The NGO, Puerto Rican Ornithological Society and the Puerto Rico Tourism Company are also collaborators in this effort.

- Recently, the DNER contracted Cafiesencia to develop management plans for private properties in the Guánica/Maricao Joint Landscape.

**Trees and Corals and CAFEiCANTO agroforestry projects**

Source: http://www.cafipr.org/projects/current

[3] Retrieved from: [http://www.cafipr.org/projects/current/].

## 6. Increase capacity of community to manage trees

### Projects developed through the Urban and Community Forestry Program

Through the UCFP, the DRNA has funded several community initiatives on topics such as reforestation, greening of public schools and university campuses, composting and solid waste reduction, ecotourism and environmental education. From 2010-2015 through the sub grants provided by the DNER, communities in more than 11 municipalities have been impacted, accounting for more than 3,300 volunteer hours. Projects are described in the following table.

**Table 3. UCFP funded initiatives aimed at increasing the capacity of communities to manage trees**

| Project | Sub grantee | Project Description |
|---|---|---|
| **Community based organizations/ Local NGO** | | |
| Establishing demonstrative projects of community reforestation as a tool for the conservation of natural resources and the development of ecotourism activities | Comité Caborrojeños Pro Salud y Ambiente, Inc. | •Demonstration projects of reforestation with native trees<br>•Workshops<br>•Development of a protocol<br><br>(The project is described in Strategy 12) |
| Humacao Ecotourism Initiative | Programa de Educación Comunal de Entrega y Servicio Inc. (PECES) | •Signage of trails and development of educational material<br>•Web page<br>(The project is described in Strategy 12) |
| Greening Schools, Parks And Urban Forests: Conservation Practices In An Ecological Infrastructure | Luis Munoz Marín Foundation | •Through the project, practical and theoretical trainings were offered on conservation practices and management of green areas in schools, parks and urban forests. The project was aimed at school and municipal staff, and communities. It included the development of fact sheets on conservation practices in the management of green areas; the evaluation of green infrastructure at selected schools (with the participation of students); an intensive training in techniques for cutting, trimming and tree climbing; and a planting activity with volunteers at a coastal urban park (El Escambrón). |
| Parque De La Juventud | Corporación para el Desarrollo del Oeste, Inc. Mayagüez | •The Project included planting of 40 "flamboyán" trees in two acres of land, a specialist in gardening was hired for the maintenance of the Park and the planting and care of the trees that we planted, and the purchase of equipment for the park's maintenance. |

| Project | Sub grantee | Project Description |
|---|---|---|
| **Universities/Schools** | | |
| Protocol to determine the quality of compost and the development of marketing guidelines | University of Puerto Rico, Ponce Campus | •The project studied the appropriate balance of nutrients in compost or organic soil. The material was used in an area at the university's campus where endemic and native trees were going to be planted. Two workshops about organic material and its uses where held, which had 44 participants. |
| Urban Forestry and its benefits to the community (TV programs) | Sistema TV Canal Universitario Ana G. Méndez | •The project consisted in developing two television programs of thirty (30) minutes each. The purpose was to inform the community about the management of urban forest resources and to promote and establish sustainable ecosystems.<br>•First Program: Urban Forestry – presents the history of forestry in Puerto Rico; explains the problems of deforestation and loss of primary forest; natural reforestation and natural areas resiliency.<br>•Second Program: Urban and Community Forestry: presents the urban forests and their function as a dynamic ecosystem.<br>•An interview with the Secretary of the DNER, Carmen R. Guerrero was conducted on August 22 and 23, 2013. The interview and the programs were published on Sistema TV's digital platforms (Web, Social Media and Video Channel).<br>•Links:http:www.youtube.com/watch?v=i4HlkHOe5M&list=Uuh06G7bTyUMwBA http://www.youtube.com/watch?v=eGAm7qY4SkI&feature=c4-overview&list=UUhO6G7N-SG0H67bTyUiMwBA |
| Compost and its benefits on sowing | Escuela Especializa-da en Agroecología, Laura Mercado, San Germán | •Students were taught on how to make compost. Ninety (90) students from the regular program and the special education program were impacted. |
| Jardín Del Cielo/ Sky Garden | Escuela Ecológica Niños Uniendo al Mundo (ENUAM), Caguas | •The Project seeks to create an ecological laboratory/ interactive environment, where nature is a learning tool and an essential part of the human experience. The aim of the project was to educate the students to be defenders of wildlife and develop sensory, motor, and social skills through playing, conserving and managing the natural resources on the school property. The project included planting native species and the transfer of technical knowledge: seed germination, planting and tree maintenance. |
| Más Bosques para Nuestra Ciudad/ More Forests for Our City | InterAmerican University – Metro Campus | •Environmental interpretation training for ten students' volunteers and the installation of three forest interpretation stations.<br>•Development of a digital herbarium<br>•Environmental education outreach activities<br>•The project aims to provide a model for similar projects in schools and other university campuses. |
| **Municipalities** | | |
| Preparation of a protocol for the management of trees | Municipality of Caguas | •Inventory of trees<br>•Preparing the document "Response Protocol Tree Management".<br>•This project is described in Goal 1, Strategy 9. |
| Public Education and Outreach | Municipality of San Juan | •Workshops on the importance of green spaces for the management of flood risks in the Río Piedras watershed.<br>•Community training on the importance of green spaces to maximize water catchment.<br>•Two conferences were held and a Webpage was designed as part of the outreach efforts: http://www.lacuencadelriopiedras.com |
| Community composting project | Municipality of Trujillo Alto | •The project aims to decrease the generation of municipal vegetative waste by producing compost. Municipal staff were trained on how to make compost from Christmas trees and water hyacinths. Ten conferences and ten workshops on composting were given to Municipal employees, communities and schools. |

*Source: List of Projects completed under the Urban and Community Forestry Program. Information obtained from project's progress reports submitted to the USFS. List on September 18, 2015 by Mariana Quiñones Rosado, Independent Consultant to the DNER.*

- In 2010, the Puerto Rico Urban and Community Council organized, together with the USDA-IITF and the DNER, the 13th Caribbean Urban and Community Forestry Conference. The theme was Green Economy, Laws, Communities and Capacity Building. The conference was attended by communities, municipalities, arborists and other professionals and firefighters.

- In 2015, the Urban and Community Forestry Councils from Puerto Rico and USVI developed a strategic plan together, to address common issues affecting the US Caribbean landscape. This document will facilitate exchange of information, ideas, and needs among government agencies, private landowners, non-profit organizations and the general public.

- The Municipality of Caguas continued participating in the Arbor Day Foundation's Tree City USA program. Caguas is the only municipality in Puerto Rico that has been recognized as a Tree City USA. It has had that honor since 2009 and was recertified in 2014. The program recognizes those towns and cities that have organized tree care programs contributing to healthier and safer urban forests. For the past seven years, the City of Caguas has invested $4,206,607 on urban forestry management actions, an average of $29.42 per citizen.

- In November 2014, the Inter American University of Puerto Rico - Metropolitan Campus was certified as a Tree Campus USA by the Arbor Day Foundation. The program recognizes universities that effectively manage their campus trees, develop connectivity with the community beyond campus borders, and strive to engage their students utilizing service learning opportunities centered on campus, and community forestry efforts.[4]

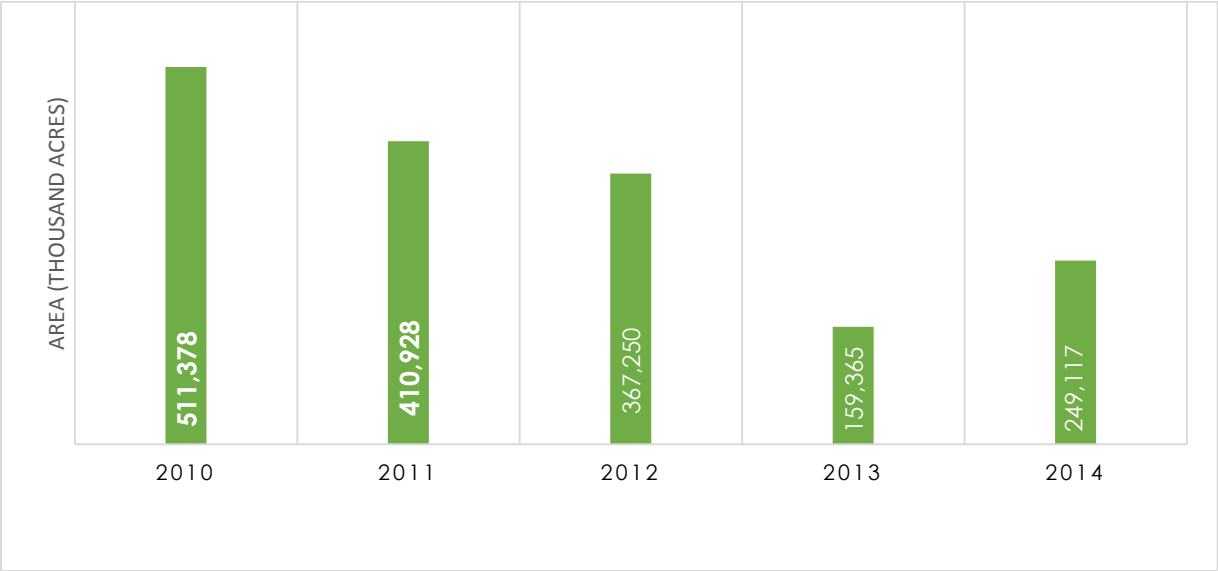
**The Inter Metro Campus is the first educational institution to be admitted into the Tree Campus USA Program in Puerto Rico.**

[4] http://www.arborday.org/programs/treecampususa/learn.cfm

## 7. Increase tree canopy cover and condition

In 2013, together with the DNER, the USFS-IITF published *Puerto Rico's Forests 2009,* a review of data generated by the Forest Inventory and Analysis Program.[5] Between 2003 and 2009 mainland Puerto Rico's forest cover experienced an increase in its total area from 1,127,416 acres in 2003 to 1,168,291 acres in 2009 (Figure 2). This increase represents a 1.9 percent rise in forested lands between the two periods.

**Figure 2. Forest Cover**




Data source: Puerto Rico Statewide Assessment and Strategies for Forest Resources 2010 and Brandeis 2013.

Forest conditions reflected minor damage due to fungus and vines. Tree canopy also reflected conditions of normal healthy trees. The authors highlight the fact that Puerto Rico hasn't suffered from a major hurricane since the 2001 report.

## 8. Acquire community open spaces to protect key forested areas

In May 2015 the Municipality of Mayagüez was the recipient of a grant under the Community Forestry and Open Space Program. This grant will be used to protect 67.9 acres of land in the Río Hondo sector. These lands contain the only contiguous forest left in the area, which is densely populated. The grant provides for the acquisition of these lands and for the development of a management plan, in coordination with the

[5] Data from the previous 2007 publication was highlighted in the Puerto Rico Statewide Assessment and Strategies for Forest Resources.

community. The Municipality of Mayagüez will enter into an agreement with the local NGO, "Estampas Agro-EcoTurísticas de Puerto Rico" to manage the area.

## 9. Hazard tree mitigation

- In 2010, the USFS State and Private Forestry Unit administered a $1,167,000 grant under the American Recovery and Reinvestment Act (ARRA) funds for the Puerto Rico Department of Transportation and Public Works (DTOP, by its Spanish acronym). This investment supported the implementation of the Puerto Rico Hurricane and Hazardous Fuel Mitigation Project, impacting more than 323.7 kilometers of roadway segments where pruning, removal of hazardous trees and tree planting were carried out. The initiative also provided for new environmental entrepreneurship with the participation of "Cooperativa Vías Lindas", an initiative integrated by former DTOP workers. Funds were used to provide comprehensive training to the members of the Cooperativa Vías Lindas and the DTOP staff, to reduce the risks from hurricanes and fire to roads and people. In 2012, the Ponce brigade of the Cooperative took an additional round of courses to increase skills and train new employees in safety and technical topics, such as roadside safety, chainsaw operation, tree pruning, tree identification and inventory, and business management (IITF, 2012).
- Another initiative has been the "Response Protocol Tree Management" developed by the Municipality of Caguas through a grant from the UCFP. The purpose was to develop and establish procedures to prepare the staff for handling emergency situations in the following stages: preparation / prevention, mitigation, response and recovery. The project included an inventory of trees in Caguas traditional downtown, and a comparison of the data collected in the inventory with existing data, in order to understand the current and potential impact of urban trees on the municipality's gray infrastructure. The project benefited the Municipality of Caguas, which has a population of about 150,000 inhabitants and residents of Gurabo, Cayey, Juncos and Aguas Buenas.

## 10. Increase use of native plant material (native tree propagation and use)

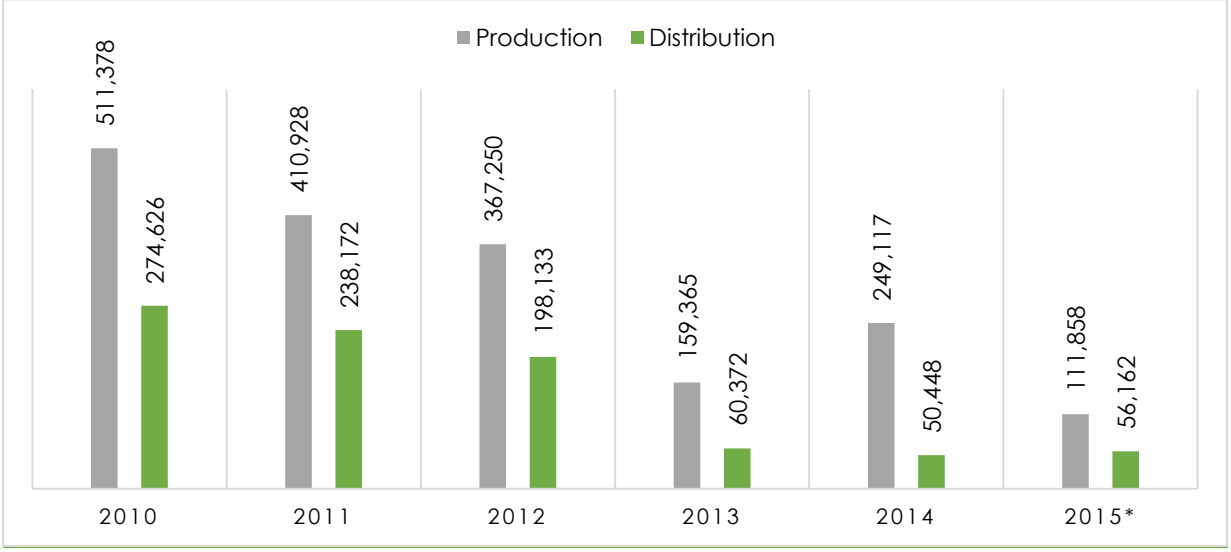
- Propagation

The DNER, through the" Puerto Rico Verde" campaign (2008-2012), focused on the propagation of native tree species between four and six feet tall. Plantings were concentrated in urban and coastal areas. The goal of the initiative was to plant a million

trees, of which, in 2013 it was estimated that there was an 85% survival rate. Among these, over 5,000 mangrove trees were planted.[6]

During the past five years, at the Cambalache nursery alone, the DNER has propagated 1,809,896 trees, from which 877,913 have been distributed.[7]

**Figure 3. Trees propagated and distributed at the Cambalache nursery**




Use

The DNER Forest Service Bureau will use forest thinning as a management technique at the Río Abajo State Forest. In order to provide a beneficial use and generate revenues for the DNER, native tree species such as teak, mahogany and mahoe are to be removed and sold.

## 11. Develop nursery quality standards (work with nursery growers to provide quality nursery stock)

The DNER signed an agreement with in UPR's Mayagüez Campus on July 2015 to complete the project known as "Development of Phytosanitary Protocols for the Management of Plant Material at DNER Nurseries". This project is funded by a grant from the Forest Health Program. Specific tasks include:

[6] http://www.elnuevodia.com/noticias/locales/nota/reforestacionenlavitrina-1495082/
[7] Information provided by the Agronomist Rubén Ubiñas from the Cambalache nursery.

- Improve practices in nurseries by creating a phytosanitary protocol and a checklist. In addition, the development of an assessment or report on the current phytosanitary conditions at the Cambalache nursery and six regional nurseries administered by the DNER. The report must include recommendations to improve current management practices.
- Provide trainings and workshops to the Forest Health Project Leader, supervisor, agronomists and workers of the DNER's nurseries. Topics include: early detection, monitoring, and management of diseases and pests that affect plants. The first series of workshops titled "Entomology workshop for nurseries' managers", was held on October 22, 2015. These were aimed at leaders, nursery agronomist, and its nursery workers.
- Promote public education on forest health, through public meetings, conferences and workshops.

## 12. Develop educational programs and activities (i.e. demonstration of forests projects)

### Educational programs

The Puerto Rico Legislature approved the Green Contact Program Act (Law No. 36 of March 2015). The Program, to be administered by the Puerto Rico Department of Education, will be developed in coordination with the DNER. The purpose is to ensure the participation of students in workshops and visits to areas of ecological value in order promote contact with nature.

**Through this Act, students can visit DNER forests and other natural protected areas**

Source: https://es-la.facebook.com/drnapr

The DNER has collaborated with the Department of Education in designing the agency's Circular Letter to implement this Law. The DNER identified Commonwealth and federal agencies, NGO and private entities to create a Green Contact Network.

### Educational activities

Since 2013, the DNER has been very active developing educational activities that help connect people to forests and involve them in management activities.

**Table 4. Educational initiatives implemented by the DNER 2010-2015**

| | |
|---|---|
| **Programs** | |
| • The Forest at Night Program (Programa Bosque Nocturno) | A program of tours in the woods at night to enjoy the night biodiversity |
| • CICA Students Internship Program (Programa de internados para Estudiantes CICA) | Discussed in Strategy 4 |
| **Workshops** | |
| • The Puerto Rican parrot and the Maricao State Forest, its new home<br>• Climate Change<br>• From the tops to the reefs<br>• Conservation of wetlands and the west Indian whistling duck<br>• Environmental interpretation techniques on natural protected areas | |
| **Special activities** | |
| • Forests Day (March)<br>• Wetlands Day (February)<br>• Water Day (March)<br>• Earth Day (April)<br>• Biodiversity Day (May)<br>• National Trails Day (June)<br>• Annual Research Symposium (November) | Each activity is held every year in a different natural protected area. These activities provide an opportunity for families to participate in thematic experiences and to visit different natural areas throughout the year. Some of these activities provide conferences and guided/interpretative tours. |

*Source: Information provided by Eliezer Nieves, DRNA.*

Other workshops provided to educators are:

- WILD Project- Terrestrial (Proyecto WILD Terrestre). This is a 3-6 hour workshop, where several activities on ecology of terrestrial ecosystems are discussed. All WILD workshops combine theory with games and activities included in the handbooks that are provided to teachers at the end of the session. The Project is sponsored by the Council for Environmental Education.
- Project Learning Tree (PLT)- In 2014, the IITF partnered with the DNER to sponsor the PLT program in Puerto Rico. The same year, PLT staff traveled to Puerto Rico to organize the first workshop for PLT advisors. Participants included IITF staff, the Society for Natural History of Puerto Rico, Santa Ana Environmental Center; Cabo Rojo National Wildlife Refuge staff; the Center for Landscape

Conservation; the Interamerican University of Puerto Rico- Fajardo Campus, and the Department of Geography of the University of Puerto Rico. These entities are now empowered to train their teachers with PLT materials.

**First Group of Facilitators Project Learning Tree Puerto Rico**

Logo: http://www.fs.usda.gov/

Photo: https://es-la.facebook.com/drnapr

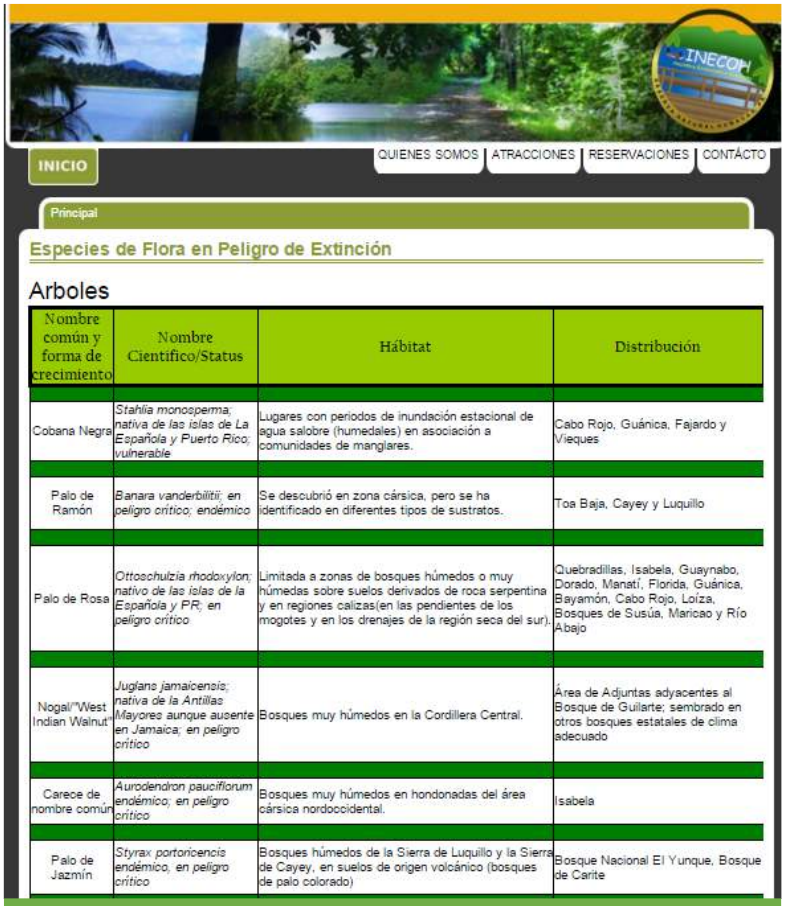
A first workshop for teachers in schools from the Eastern region, near El Yunque, was provided in collaboration with the USFS, as part of the revision process of El Yunque Management Plan. In addition, K-8-PLT books and *Forest of the World* books were purchased with IITF funding, to provide additional workshops as part of Green Contact Program.

### Demonstrative projects

Through the UCFP, the DNER funded the Project "Establishing demonstrative projects of community reforestation as a tool for the conservation of natural resources and the development of ecotourism activities". The project was developed by the NGO, "Comité Caborrojeños Pro Salud y Ambiente, Inc." and consisted of demonstration projects of reforestation with native trees in communities of Mayagüez, San Germán and Cabo Rojo. The project included workshops, a protocol for the handling and caring for reforested areas in the Southwestern region of Puerto Rico, and theoretical and practical activities on eco-tourism. It was estimated that the project had a direct impact on 400 families; children between the ages of 8-12 in seven schools; youth between 14-17 years, and adults with an average age of 40 years.

Another project funded through the UCFP was the "Humacao Ecotourism Initiative" that had two main components: an educational component and a socioeconomic development component. Through the project, signs were installed along trails in the Humacao Nature Reserve to identify its flora and fauna; a Web page was design [Ecotourism Initiative Project Humacao, (INECOH) www.inecoh.com] to provide information on existing resources in the Reserve; several open houses where carried out in the Reserve, and a scale model contest with students from the surrounding communities was held, where they made a representation of an eco-friendly house built with recycled materials.

Through the project, the sub grantee envisioned and created an outdoor study room- without walls- using the Reserve as a lab/study space to practice ecotourism.




| Nombre común y forma de crecimiento | Nombre Científico/Status | Hábitat | Distribución |
|---|---|---|---|
| Cobana Negra | *Stahlia monosperma; nativa de las islas de La Española y Puerto Rico; vulnerable* | Lugares con periodos de inundación estacional de agua salobre (humedales) en asociación a comunidades de manglares. | Cabo Rojo, Guánica, Fajardo y Vieques |
| Palo de Ramón | *Banara vanderbiltii; en peligro crítico; endémico* | Se descubrió en zona cársica, pero se ha identificado en diferentes tipos de sustratos. | Toa Baja, Cayey y Luquillo |
| Palo de Rosa | *Ottoschulzia rhodoxylon; nativo de las islas de la Española y PR; en peligro crítico* | Limitada a zonas de bosques húmedos o muy húmedas sobre suelos derivados de roca serpentina y en regiones calizas(en las pendientes de los mogotes y en los drenajes de la región seca del sur). | Quebradillas, Isabela, Guaynabo, Dorado, Manatí, Florida, Guánica, Bayamón, Cabo Rojo, Loíza, Bosques de Susúa, Maricao y Río Abajo |
| Nogal/"West Indian Walnut" | *Juglans jamaicensis; nativa de la Antillas Mayores aunque ausente en Jamaica; en peligro crítico* | Bosques muy húmedos en la Cordillera Central. | Área de Adjuntas adyacentes al Bosque de Guilarte; sembrado en otros bosques estatales de clima adecuado |
| Carece de nombre común | *Aurodendron paucifiorum endémico; en peligro crítico* | Bosques muy húmedos en hondonadas del área cársica nordocidental. | Isabela |
| Palo de Jazmín | *Styrax portoricencis endémico, en peligro crítico* | Bosques húmedos de la Sierra de Luquillo y la Sierra de Cayey, en suelos de origen volcánico (bosques de palo colorado) | Bosque Nacional El Yunque, Bosque de Carite |

**Webpage created as part of the 'Humacao Ecotourism Initiative" showing a list of tree species present in the Reserve.**

http://www.inecoh.com/flora

## 13. Introduction of agroforestry concepts

- In 2011, Tropic Ventures Education & Research Foundation, received a grant from the USDA Economic Action Program. The purpose was to carry out an inventory of forestry products in Puerto Rico, including wood and non-wood products. This was a baseline study to understand the actual uses that are being given to forest resources in Puerto Rico.
- On May 2013, a group of individuals, businesses, universities, organizations, and state and federal agencies organized the Advisory Council for Agroforestry Development in Puerto Rico (CADA, by its Spanish acronym). The DNER participates in this effort,

which aims to promote the sustainable use of Puerto Rico's forest products, through education and sustainable practices.

## 14. Promote arboriculture in universities curricula

On April 2015, the Center for Sustainable Development Studies (CEDES, by its Spanish acronym) from the Metropolitan University (UMET, by its Spanish acronym), launched a continuing education program to provide a certificate in Urban and Community Forestry.

The 132-hour professional certification covered topics on tree biology, soils, tree

management, and diagnosis and management of pests and diseases. The project was funded by a USFS grant, with the endorsement and collaboration of the DNER.

The program will also offer formal education in business development for communities. Related topics include: businesses plans, best practices in marketing, accounting and management of community based initiatives.

In addition, and also with a USDA grant, CEDES has developed two educational videos on: green infrastructure, trees suitable for urban areas and proper maintenance of urban trees. These videos provide basic information on tree pruning and management practices, narrated by certified arborist.[8]

[8] http://www.suagm.edu/umet/cedes/

# 2 PROTECT FORESTS FROM THREATS

## National Objectives:

*2.1. Restore fire-adapted lands and reduce risk of wildfire impacts*

*2.2. Identify, manage, and reduce threats to forest and ecosystem health*

***Issues addressed:***

- ✓ *Fragmentation of forest systems*
- ✓ *Water resources and watershed conservation strategies*
- ✓ *Disturbances affecting forests (hurricanes, floods, fires, pests, etc.)*
- ✓ *Concern over invasive species*

## Puerto Rico Strategies:

### A - Fire

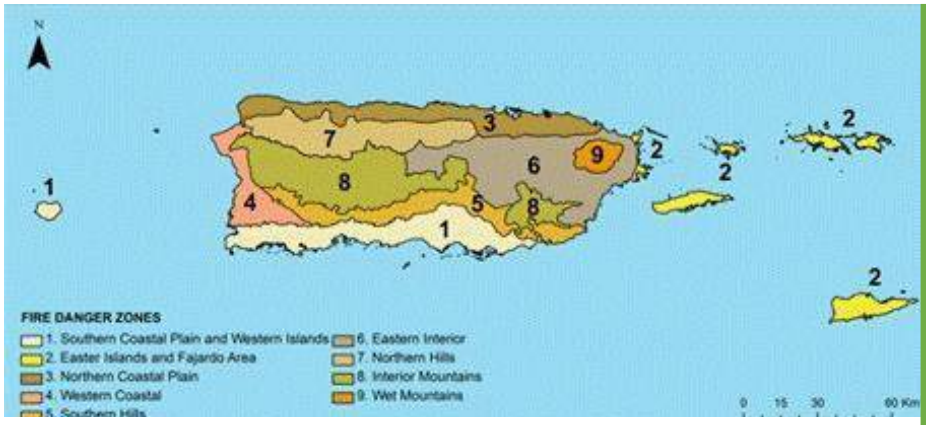
**1. Create a database to collect information on fire occurrences recording: (1) location, (2) type of vegetation, (3) number of acres affected, (4) resources used, and (5) resources needed**

The USDA-IITF is currently developing a database of fire occurrences in Puerto Rico. In addition, the relationships of occurrence, fuels, land use, and climate are analyzed in order to better predict the risk of fire in current and future climate scenarios.[9]

[9] http://www.fs.fed.us/research/highlights/highlights_display.php?in_high_id=456

## 2. Develop and implement a Fire Danger Rating System for the areas with high wild land fires occurrences

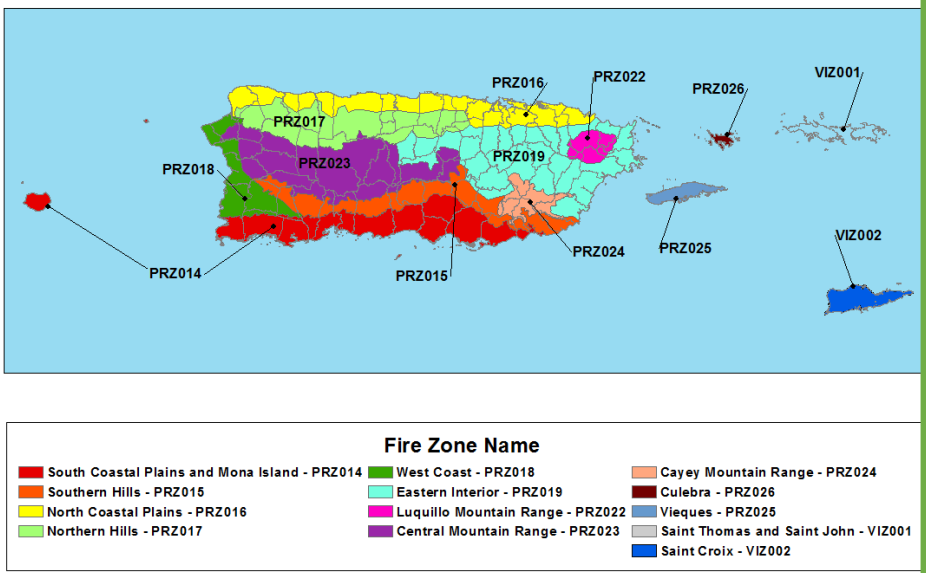
In 2013, the USDA-IITF developed and initiated, in collaboration with the National Weather Service San Juan Office (NWS), a Fire Danger Rating System and Fire Weather Zones for Puerto Rico and U.S. Virgin Islands. Effective Thursday August 6, 2015, the fire weather zones are now being used by the NWS in daily public announcements during fire season and are used on the NWS San Juan web site.[10]




**Fire weather zones for Puerto Rico and the U.S. Virgin Islands. William Gould, USDA Forest Service**

Source: http://www.fs.fed.us/research/highlights/highlights_display.php?in_high_id=456

# Fire Weather Zones




**WFO San Juan Fire Wather Zones**
**Effective August 6, 2015**

Source: http://www.srh.noaa.gov/sju/?n=firezonechanges

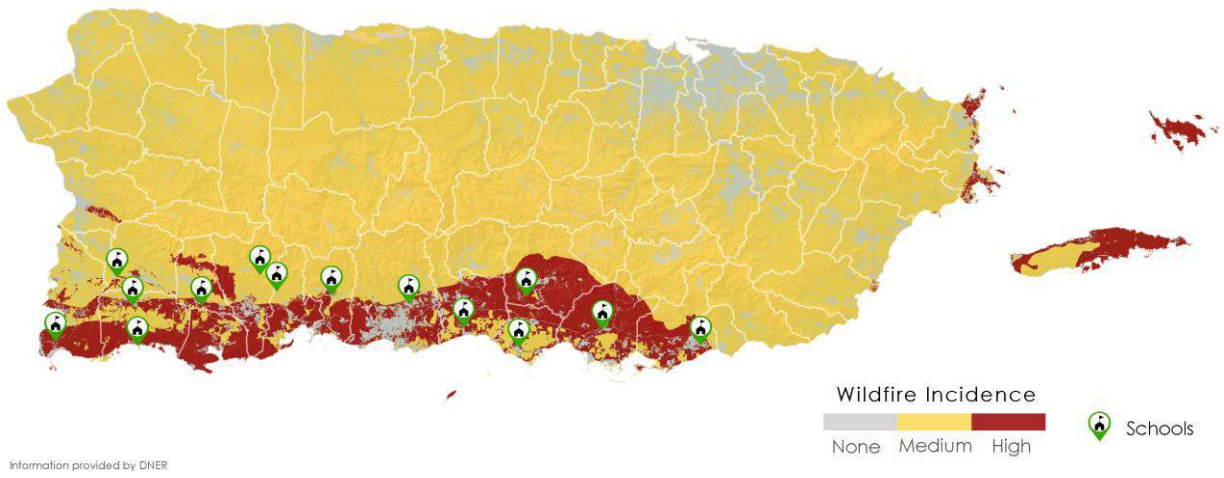
[10] http://www.fs.fed.us/research/highlights/highlights_display.php?in_high_id=456
http://www.srh.noaa.gov/sju/?n=firezonechanges

## 3. Offer fire prevention education to the communities within the areas with high wildland fire occurrences (Increase efforts on the wildland urban interface)

The Puerto Rico Firefighters Corps (PRFC) in coordination with the NRCS, the DNER, UPR Extension Service, 911 and many other agencies and organizations, launched the educational campaign "Puerto Rico Frente Al Fuego". The project aims to impact all communities at risk around the entire island, starting from the South region.

It was launched on February 2, 2015, and impacted 14 schools in the Southern region of the Island, which has the highest incidence of wildland fires.

**Figure 4. Location of schools in relation to areas with higher wildfire incidences**




| Municipality, Neighborhood | School |
|---|---|
| Coamo, Barrio Los Llanos | Escuela Herminio W. Santaella |
| Lajas, Barrio La Parguera | Escuela Alejandro Tapia Y Rivera |
| Guayama, Urb. Costa Sur, Calle 9 | Escuela Francisco García Boyrie |
| Santa Isabel, Barrio Paso Seco | Escuela Esther Rivera |
| Juana Diaz, Barrio La Plena | Escuela Intermedia Máximo Donoso Sánchez |
| San German, Barrio Sabana Eneas | Escuela Galo Rosado |
| Cabo Rojo, Barrio Corozo (Boqueron) | Escuela Sebastián Colon Alves |
| Salinas, Barrio El Coco | Escuela Elemental Felix Garay |
| Ponce, Urb. Glenview | Escuela Jardines De Ponce |
| Guayanilla, Barrio Consejo Alto | Escuela Consejo - Trabajo De Mitigación En La Finca Del Señor Elizardo Martinez |
| Peñuelas, Barrio Encarnacion | Escuela Jorge Lucas Valdivieso |
| Guanica, Barrio Ensenada | Escuela José Rodriguez Soto |
| Sabana Grande, Barrio Marginas | Escuela Antorgeorge |
| Yauco, Barrio Duey | Escuela Unidad Jaime Castañer |

*Source: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/pr/home/?cid=NRCSEPRD328877*

As part of the "Puerto Rico Frente al Fuego" educational campaign, a web page was developed for the general public, but specially aimed to target a younger audience. The web page includes music, a video and a comic to educate about forest fire prevention.

**Activities and Web page related to the Puerto Rico Frente al Fuego Educational Campaign**

http://prfrentealfuego.com

In 2012, agronomists, biologists and managers from the DNER Forest Bureau attended a GIS workshop with the purpose of developing spatial data (GIS Shapefile) for wildland-urban interface areas for priority landscapes in Ceiba, Fajardo, Guánica, Maricao and Naguabo. The workshop was led by specialist from the UPR School of Public Health's Environmental Health Department (IITF, 2012).

## 4. Develop Community Wildfire Protection Plans and educational programs

The Puerto Rico Firefighters Corps has been very active in developing educational activities and in the use of original approaches. Indeed, the Puerto Rico's Fire Chief Angel Crespo won the 2013 Silver Smokey Bear Award for its innovative strategies.

**Ángel Crespo Puerto Rico Firefighters Corps; Winner Silver Category Smokey Bear Award**

Photo credits: Puerto Rico Fire Fighters Corps Press office and http://www.smokeybear.com/awards-profile.asp?id=72

The most outstanding is the use of music to spread a preventive message. Known as the "Bombero Rapero" the Fire Chief has established an internet presence through his music video for "Fuego Forestal" (Forest Fire). He has partnered with the DNER in an effort to inform the public about the role humans play in starting wildfires.

## 5. Wildland fire suppression

- During the 2015 fire season (January–May) the DNER's volunteer fire brigades continued efforts of fire prevention and suppression. The 44 firefighter northern and southern brigades participated in 20 suppression efforts which impacted approximately 388 acres. Year-round readiness activities for fire suppression include an evaluation of fire prone areas, clearing of trails, and preparing fire control lines. During 2015, firefighters participated in controlled burning exercises, safety orientations and physical aptitude tests.
- During 2015, the Commonwealth of Puerto Rico invested $1,098,000 to create the Firefighters Academy which will support the efforts to suppress fires. This center will provide workshops on combating multiple types of fire occurrences, including wildland fires.

## 6. Use prescribed burning as a resource to control fire occurrences in areas with high fire incidence

On August 2015, the Puerto Rico Firefighters Corps, the USFWS, the DNER and the Municipalities of Lajas and Cabo Rojo conducted a training on prescribed burning techniques. The training took place at the Laguna Cartagena National Wildlife Refuge. The prescribed burning is expected to result in a significant decrease of invasive plants

in the lagoon, which in turn should result in an increase in its water storage capacity. This increased capacity could help alleviate flooding of surrounding communities. The burn-off of 205 acres of land opens more area for the use of aquatic birds species like the west Indian whistling duck, masked duck, ruddy duck, white-cheeked pintail and the glossy ibis (Palmer, 2014).

## 7. Tree planting and resource restoration in areas affected by fires

- In May 2014, the DNER implemented a pilot program to stabilize areas damaged by fire in the Boquerón State Forest, which occurred in February of the same year. The DNER, in collaboration with volunteers, stabilized the soils using a technique known as hydroseeding, before planting native trees. Initially, planting took place in 1.9 acres, with a cost of $10,000 that was possible due to the collaboration of NGO and an interested citizen. Subsequently, the plan will be implemented in the rest of the affected area.[11]
- In March 2014, the "Bosque del Pueblo" (People's Forest) between Adjuntas and Jayuya was impacted by a fire that destroyed almost 15% of its vegetation. A month later, the NGO Casa Pueblo together with the DNER, led a reforestation activity named "Bosque del Pueblo Reverdece: Brigada Nacional de Restauración". A total of 1,000 endemic and fruit trees were planted by volunteers. A year later it was estimated that 98% of these survived. Subsequently, small plantings have been carried out in parts of the Bosque Modelo (Model Forest) in Adjuntas (Estrada, 2014).

[11]http://www.elnuevodia.com/noticias/locales/nota/restauranelareaafectadaporfuegoenelfarodecaborojo-1776934/

## 8. Acquire, maintain, and pre-position essential equipment and supplies for wildland fire suppression

During 2011, the Puerto Rico Firefighters Corps received a $2,064,000 two-year grant from the USFS State and Private Forest unit for the employment, training and equipment of new wildland firefighting crews. This represented the first effort in developing a specialized crew for wildland firefighting, prevention and mitigation. Training covered topics of incident command, safety, fire behavior, and basic and intermediate firefighting techniques.

In 2013, the following equipment was acquired for the firefighter's staff: 100 bunker suits, seven vans Ford Econoline 2013, which were distributed in the six areas of the Puerto Rico Firefighters Corps, in order to guarantee them adequate transportation for trainings, and emergencies (Puerto Rico Firefighters Corps, 2013).

## 9. Develop an effective communication strategy between partners involved in the suppression of wildland fires

The DNER is one of the participating agencies of the Caribbean Cohesive Wildland Fire Management Strategy. This is a joint effort led by the IITF State and Private Forestry in coordination with partners agencies from Puerto Rico and the USVI, including the DNER. At present, and for the first time, participating entities are drafting a five-year Caribbean-wide implementation strategy consistent with the national goals. The

document includes management options and implementation planning guidance. The strategy is to be completed in 2016.[12]

### B - Insect pests and disease

#### 1. Establish a Forest Health Monitoring Program at the DNER Forest Service Bureau

The DNER Forest Service Bureau has appointed a Forest Health Coordinator to administer funds from the USFS to attend forest health issues. The Coordinator is currently managing several grants related to forest health, including forest health monitoring and nursery practices.

Among forest monitoring projects undertaken is the *Survey of abiotic damage, pest and diseases affecting endangered plant species in the karst region of Puerto Rico*, described in Strategy 3 in this topic.

#### 2. Encourage early detection and rapid response from DNER Forest Managers

During the 2010-2015 period the DNER Forest Service Bureau has established forest health monitoring projects at the Caja de Muertos Island Nature Reserve and in other four State forests: Toro Negro, Boquerón, Piñones and Guajataca.

- At Caja De Muertos Island the monitoring program aims to maintain the health of tropical dry forest ecosystems at risk from damaging agents by: detecting, delimiting, and monitoring existing outbreaks of *Harrisia* cactus mealybug; assess and respond to newly detected infestations; and share information with resource managers and cooperators to manage future outbreaks in other areas. Observations will be made in a two year period, and a final report with recommendations will be drafted.
- At the four State Forests, the project aims to: provide long-term monitoring of forest ecosystems at risk from damaging insects, diseases and animals; assess and report the impacts of these damaging agents on forest health, and share collected information with cooperators. A general monitoring for damaging insects and diseases will be carried out in a two year period. Also a report will be generated to provide management recommendations. The idea is to start with these four State Forests and provide management recommendations to forest managers, in addition to starting a database detailing the status of forests in PR.

[12] http://www.fs.usda.gov/main/iitf/spforestry

### 3. Provide professional training to DNER Forest Managers

- In 2015, researchers from the University of Puerto Rico were contracted by the DNER through a grant funded by IITF Forest Health Monitoring Program to conduct the *Survey of abiotic damage, pest and diseases affecting endangered plant species in the karst region of Puerto Rico*. This project surveyed the condition of ten endangered plant species of the karst region of Puerto Rico. As part of this project, DNER personnel participated in workshops on Forest Pathology and Arthropod collection, which were held in April 2013 and September 2012, respectively.
- Forest Health Project leader attended the 2014 Forest Health Monitoring Workgroup Meeting, in Jacksonville, Florida, and the Caribbean Food Crop Society and Phytopathological Society Conference, in St. Thomas, USVI.

### 4. Promote public education about possible detrimental effects on forest floristic components

In December 2012 a training-workshop known as "Palm Management in the Landscape", was provided by the University of Puerto Rico Agricultural Extension Service, in collaboration with the Puerto Rico Urban and Community Forestry Council. The workshop was provided by Monica Elliot and Timothy Broschat, known for their expertise in care, nutrition and palms' diseases.

### 5. Maintain adequate urban tree inventories and management practices

During September 2011 the NGO Center for Landscape Conservation provided municipal and DNER employees with iTree software training. iTree was developed by the USFS to provide analysis in urban tree benefits and assessment. With two training sessions held in Cabo Rojo and Caguas, the participants received information on: how to access and use the software and how to conduct tree inventories that could be later integrated to the tool.

### 6. Promote Integrated Pest Management

Through a collaborative agreement, the IITF worked with the UPRM Plant Diseases and Pests Diagnostic Clinic to develop fact sheets of important forest pests and diseases, and to provide training to the UPRM Agricultural Extension Service agents. An Integrated Management of Forest Pests and Diseases Website (http://sea.uprm.edu/forest/index.html) was developed as part of this project. The Website contains information on major forest pests/diseases and those of potential introduction, pest management, and basic identification in Puerto Rico (IITF, 2012).

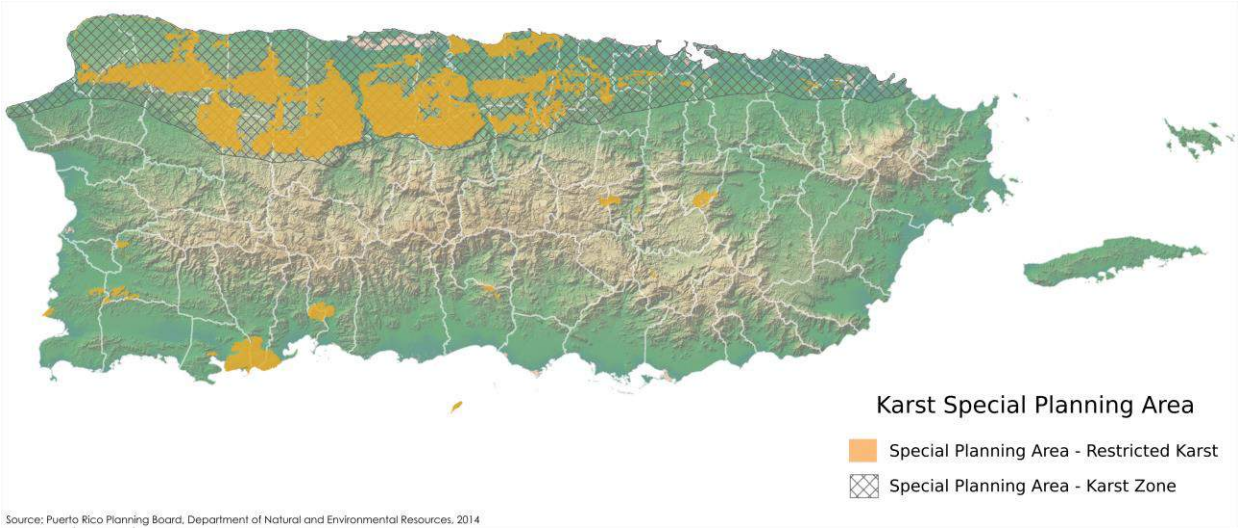
## C - Development; urban sprawl; fragmentation

### 1. Protect developed large contiguous forest areas and corridors to ensure connectivity by: land acquisition, conservation easements, adequate land use zoning, voluntary protection

| Adequate land use zoning

In June 2014, the Plan and Regulation for the Karst Special Planning Area (SPA) was approved. This plan and regulation was prepared by the DNER and the Puerto Rico Planning Board in compliance with the "Act for the Protection and Conservation of Puerto Rico's Karst Physiography (Law 292-1999). This SPA covers 236,138 acres where proper land use practices are promoted with the aim of protecting forest and water resources in the region. This SPA includes the northern limestone region, which contains Puerto Rico's most extensive freshwater aquifer, largest continuous expanse of mature forest, and largest coastal wetland, estuary, and underground cave systems.

**Figure 5. Karst Special Planning Area**




| Voluntary Protection

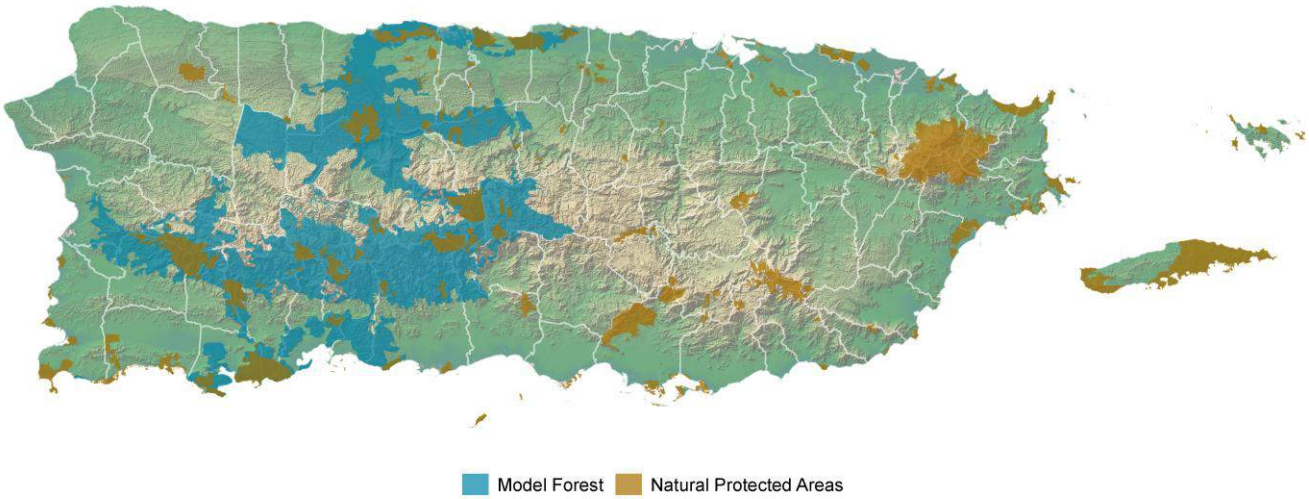
In November 2014, the Puerto Rico Model Forest Act was approved (Law No. 182 of 2014). The Puerto Rico Model Forest covers 378,639 acres of forested lands, across 17 municipalities, accounting for 17% of the Commonwealth's territory. It connects 26 natural protected areas.

Through this Act, the area was identified as a priority for planning and sustainable development, and the role of citizens in landscape conservation was recognized.

Voluntary conservation practices and the sustainable use of the landscape are to be promoted, such as sustainable tourism, education and agriculture.

To implement this initiative, an office was established in the UPR Utuado Campus, an Executive Director was appointed, a Board of Directors was constituted and its bylaws drafted and adopted, and an allocation of $500,000 was made by the Commonwealth of Puerto Rico for its operations. A "Multisectoral Table" as provided by the Law, was convened with representation from NGOs, local and federal governments, the academia and the community at large to form a broad based collaboration. Their input was used in the development of the Strategic Plan for the Model Forest.

**Figure 6. Extension of the Puerto Rico Model Forest**




Information provided by DNER

In March 2015, the DNER participated, along with several members of the Ibero-American Model Forest Network, and other strategic partners in the workshop "Restoring territorial scale developments and opportunities in Forest Model". It was held in La Habana, Cuba. The purpose of the workshop was to share best practices and opportunities to increase Model Forests impacts on territorial scale restoration in Latin America.

## 2. Encourage planting trees to increase tree canopy cover and green corridors

In April 2015, the DNER presented the Puerto Rico Watershed Reforestation Plan. This plan focuses on reforestation efforts in the watersheds of the Commonwealth's major reservoirs. As part of the plan, the DNER will conduct 14 monthly planting activities, two

on each of its operational regions. The agency's biologists will evaluate the soils along streams, rivers and reservoirs to decide the amount of trees and which species are required. The plan includes the creation of a reforestation committee, periodic reports to evaluate the program, and a GPS system will be used to collect geo-referenced data on plantings. This information will be used to create a database that will be available to other agencies and the public. Also the progress of the plantings will be monitored periodically.[13]

### 3. Promote proper land-use planning and accurate zoning on forested areas

- In November 2015, the Governor of Puerto Rico signed the Island wide Land Use Plan developed by the Puerto Rico Planning Board (PRPB). The plan includes additional mechanism for the protection of areas of ecological importance, including private and public forests. Through land-use classification or broad general zoning areas, the plan provides for the protection of regions of ecological value. The classification is known as "Specially Protected Rustic Lands of Ecological Value".
- As part of the development of the Comprehensive Water Plan for Puerto Rico the DNER outlined regions of high hydrological importance. These were considered in the land use classifications of the Island wide Land Use Plan. The classification is known as "Specially Protected Rustic Lands of Hydrological Value". These are mostly present in large tracks of forested lands.

### 4. Promote professional training for assessing the forest cover and its benefits on agencies involved in determining present and future land use

- In September 2015, the DNER conducted a workshop on green infrastructure, facilitated by architect Fernando Abruña, which is a local expert in this subject. The workshop was attended by the managers of State Forests and other natural areas administered by the DNER.

[13] http://www.fortaleza.pr.gov/content/se-viabiliza-protecci-n-del-bosque-urbano-los-filtros-y-se-presenta-plan-de-reforestaci-n

**Managers participating in the Green Infrastructure Workshop**

Source: Luz Medina, Arecibo region/ Rosamaria Quiles

- On the other hand, the iTree software training, described in Goal 1 B-5, provided representatives of municipalities and participating employees from the DNER, an additional professional training to assess forest cover and its benefits.

### 5. Increase programs availabilities for the East side of the Islands by: (1) Increasing outreach, (2) Increasing Water Conservation (3) Enhancing Forest Diversity, (4) Enhancing all restored riparian habitats

Federal and Commonwealth agencies are developing various initiatives in the East side of the island.

- The USFS- El Yunque National Forest began the revision of the 1997 Forest Land and Management Plan. Based on the "All Lands Policy" a Citizens Collaboration Committee has been established and an outreach campaign has been launched known as "Mi Yunque, Mi Plan" (My Yunque, My Plan). This is being carried out by The Center for Landscape Conservation (CCP, by its Spanish acronym), a consultant for El Yunque. The purpose is not only to inform the public, but also to educate and engage citizens in the process.

- Between 2010-2011, the CCP completed a Reforestation Project for the Río Espíritu Santo in Río Grande, for the USFS. The project promoted resident's participation in conservation strategies at areas important for the environmental and social services provided for the surrounding communities.

- In 2015, the CCP also completed the Río Fajardo Watershed Management Plan Project, prepared for the DNER, the USFS and NOAA. The purpose of the plan was to recommend best practices and parameters to maintain and improve the benefits

provided by the Fajardo River. In addition, the plan addresses stressors that impact coastal and marine communities in its outlet. The development of the plan included participatory mapping, interviews and other consultations.

The DNER is collaborating with the USFS, the Interamerican University, Fajardo Campus the CCP and the NGO, Coalición Pro Corredor Ecológico del Noreste in the program known as "Community Environmental Leadership Program". This program involves high school students and focuses on the interaction between society and the environment from a watershed perspective. It focuses on the cultural and ecological connections between natural protected areas on the East side of the island, including El Yunque National Forest, and the Northeast Ecological Corridor Nature Reserve and the Arrecifes La Cordillera Nature Reserve.

**Community Environmental Leadership Program**

Source: http://www.ccpaisaje.org/node/26

In June 2015, the DNER's Division of Community Affairs coordinated a workshop on Watersheds of the Northeast Ecological Corridor. The purpose of this workshop was to educate residents, teachers and the general public on the activities that impact these ecosystems and what community strategies can be develop to protect and restore this resource.

## D - Climate Change

### 1. Create and conserve corridors for tree mitigation

Initiatives described in Goal 2, Strategies D-1 and 2, provides for the creation of green corridors for tree mitigation associated with climate change.

### 2. Increase carbon storage through increases in tree canopy cover

Planting initiatives, such as the DNER's Watershed Reforestation Plan discussed in Goal 2, Strategy C-2, will increase tree canopy cover and in turn promote carbon storage.

Moreover, shaded coffee plantations also contribute to carbon sequestration. Consequently, the initiatives and plantings in the Río Loco Watershed at Guánica Bay Watershed discussed in Goal 1, Strategy 5 will transform agricultural practices and will increase carbon sequestration.

### 3. Conduct urban forests inventories

- In 2014, the "San Juan Bay Estuary Watershed Urban Forest Inventory" was published by scientists from the USDA-IITF. It presents information on the urban forests and land uses within the San Juan Bay Estuary watershed, based on urban forest inventories undertaken in 2001 and 2011 (Brandeis T., Escobedo, F. Staudhammer, C., Nowak, D., Zipperer, W. 2014).
- Another initiative is the project conducted by the Municipality of Caguas to prepare a protocol for the management of trees during hurricanes, described in Goal 1 Strategy 9.

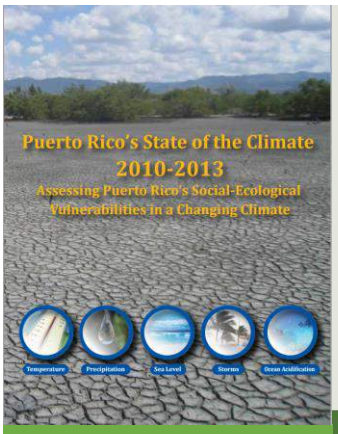
### 4. Encourage development of management plans

- As described in Goal 1, Strategy 3, between 2010-2015, a total of 64 management plans for private forests were completed. In addition, the DNER has developed management plans for six natural protected areas under its jurisdiction, which contain mangrove forests, secondary forests and other species of importance.

**Table 5. Management Plans developed by the DNER 2010-2015**

| Management Plan or Reserve Designation | DNER completion |
|---|---|
| Mona and Monito Islands Nature Reserve Management Plan | June 2010 |
| Caño Tiburones Nature Reserve Management Plan | December 2010 |
| Caja de Muerto Island Nature Reserve Management Plan | March 2011 |
| Desecheo Island Natural Reserve Management Plan | June 2011 |
| Punta Viento Nature Reserve Management Plan | March 2013 |
| Vieques Bioluminescent Bay Nature Reserve Management Plan | April 2013 |

The development of relevant information on the effects of climate change in the islands of Puerto Rico will support the drafting of future management strategies that effectively tackle challenges in its local context. Towards this effort the DNER, along with a broad coalition of partners including Federal and local government agencies, NGOs, institutions of higher education and the local private sector, collaborated in drafting the Puerto Rico Climate Change Council's Puerto Rico's State of the Climate 2010-2013 report. The report includes analysis of the potential effects of climate change on the natural resources and biodiversity of Puerto Rico. For Coastal Lowlands Moist Forest, Dry, Karst and Montane forest in Puerto Rico potential stressors are identified.




**Assessment of potential climate change impacts on Puerto Rico's forests**

**Working Group 2 Report: Ecology and Biodiversity**

Source: http://pr-ccc.org/download/PR%20State%20of%20the%20Climate-FINAL_ENE2015.pdf

144

Working Group 2 Report: Ecology and Biodiversity

## Outcomes and Consequences of Climate Change on Puerto Rico's Forests

### COASTAL AND MOIST LOWLAND FORESTS – including freshwater Pterocarpus swamps and other lowland moist forests and woodlands

Elevational and hydrologic gradients control the occurrence of natural vegetation and also favor certain human activities in the coastal zone. Among them are topographic and associated salinity gradients at or very near sea level that influence the distribution of mangrove species (Lugo and Snedaker 1974); the growth of secondary littoral woodlands under the influence of wind and salt spray along shorelines; the regeneration of secondary semi-evergreen seasonal forest on abandoned pastures and hills up to 100 m; and the development of coconut plantations on relatively level terrain. The northeastern sea coasts were originally occupied by littoral woodland and mangroves (Wadsworth 1950), freshwater swamp forests, and different types of subtropical dry forests. *Pterocarpus* formed extensive stands in freshwater swamps and extended to higher elevations along riparian corridors. Species associated with drier conditions include *Bursera simaruba* and *Guaiacum officinale*, which were likely prevalent on less protected coastal slopes and hilltops, and Bucida buceras which also grows in coastal basins and along streams (Gill 1931, Little and Wadsworth 1964). In protected locations, species associated with moist forests such as *Calophyllum calaba*, *Manilkara bidentata*, *Tabebuia heterophylla*, and *Mastichodendron foetidissimum* were likely common.

### PTEROCARPUS FORESTS

In the Caribbean, swamps formed by *Pterocarpus officinalis* trees (hereby Pterocarpus forests) occur in topographical depressions influenced by freshwater inputs, particularly in low-lying coastal areas (Bacon 1990). Adapted to flooded ecosystems, Pterocarpus forests occur in river floodplains, coastal basins and subtropical rain forests in Puerto Rico (Alvarez-Lopez 1990). Early assessments of the Puerto Rico flora described *Pterocarpus officinalis* as an abundant species covering most of the mountainous region of the island (Bates 1929, Alvarez-Lopez 1990). However, during the early 1900's, Puerto Rico lost most of its *Pterocarpus* cover to deforestation driven by agricultural practices. By 1980, the total area of *Pterocarpus* forests in Puerto Rico was estimated to cover only 238 ha in 15 locations (Cintrón 1983), while the most recent estimate calculates their extent to 261 hectares based on 2000 Landsat imagery analysis and classification (Gould 2008a). This increase in wetland cover can be attributed to the abandonment of agricultural practices in coastal plains and the associated reestablishment of natural hydrological cycles (Martinuzzi et al. 2009). Nevertheless, *Pterocarpus* forests now occur in genetically isolated populations typically restricted to the coast, abutting mangrove ecosystems (Eusse and Aide 1999, Rivera-Ocasio et al. 2007), an important factor when considering the amount of biodiversity implied in a particular forest. The remaining stands of *Pterocarpus* forests in Puerto Rico are highly diverse, including basin and riverine forests in coastal and mountainous areas. In the Humedal Punta Viento Natural Ecological Reserve, located in the town of Patillas, a groundwater-fed spring provides a small *Pterocarpus* stand enough freshwater to survive in spite of being encroached on by mangroves in a coastal basin site that receives less rainfall than the Guánica Dry Forest (Alvarez-Lopez 1990, Van Bloem et al. 2007). Over the next decades, these remaining stands of *Pterocarpus* forests face a new set of threats, mainly because of environmental changes driven by sea level rise.

### Stressors and consequences to Pterocarpus forests

The importance of hydrology in wetland ecosystems is well known (Mitsch and Gosselink 2007). The pulsating nature of the wetland's flooding and drying periods transfers energy and materials through the system driving many aspects of the ecosystem structure and function in the process (Odum et al. 1995). It is precisely this close relation between hydrology and the ability

The DNER's Guánica Dry Forest was selected as a site for National Science Foundation (NSF) National Ecological Observatory Network (NEON). The NSF funded this $434

million construction of the observatory, starting in 2011.[14] Participation in this groundbreaking project will allow local and international scientists to study changes at a regional level, focusing on changes in climate and land uses, water use and invasive species.[15] Data gathered at the Guánica Dry Forest will focus on long term climatology, atmosphere-forest gas exchange, soils, flora and fauna taxonomy, biodiversity and forest health indicators. As of November 17, 2015 the site was under construction. Required infrastructure consists of a 70 ft. tower that will house instruments for data collection.[16]

### 5. Perform hazard tree mitigation

Discussed in Goal 1, Strategy 9 - Hazard tree mitigation.

### 6. Provide professional training

- Funds provided in 2012 under the American Recovery and Reinvestment Act (ARRA), administered by the USFS State and Private Forestry Unit for the Puerto Rico Hurricane and Hazardous Fuel Mitigation Project contributed to reducing the risk of fire and hurricane debris damage in state roads. (Discussed in Goal 1, Strategy 9-Hazard Tree Mitigation).
- In November 2013, a member of the DNER Forest Service Bureau staff, through a grant from the USFS, attended a course provided by the Tropical Agricultural Research and Higher Education of Costa Rica (CATIE), whose theme was "Economic Foundations for the Assessment and Management of Environmental Services". Its objective was to contribute to the understanding of the causes and effects of environmental degradation in Latin America and the Caribbean region, in an increasingly demanding context of variability and climate change. It provided tools to participants in topics such as: methods for valuing the environment from an economic perspective and consideration of results in decision making processes; analysis of the communities' role in managing local ecosystems; determining economic costs of climate change adaptation programs, among other.

---

[14] http://www.neoninc.org/updates-events/update/neon-receives-construction-funding-national-science-foundation-slated-begin#sthash.SknWKkCO.dpuf
[15] National Ecological Observatory Network (NEON) http://nsf.gov/funding/pgm_summ.jsp?pims_id=13440
[16] Bosque Seco de Guánica será un centro de monitoreo internacional de cambios climáticos http://www.fortaleza.pr.gov/content/bosque-seco-de-gu-nica-ser-un-centro-de-monitoreo-internacional-de-cambios-clim-ticos

- The forest manager of the Toro Negro State Forest, through a grant from the USFS, also participated in a training provided by CATIE. The theme of the training was management of tropical forest in the face of climate change.
- Toro Negro State Forest Manager, Gerardo Hernández attended a three week intensive training course titled "Diversified Management of Natural Tropical Forests: Management at the cusp of challenges Climate Change" that took place in Turrialba, Costa Rica from October 5, 2015 to October 30, 2015. The course was given by our partners at CATIE.

### 6. E - Hurricane/storms

#### 1. Conduct urban forests inventories

The protocol for the management of trees for the Municipality of Caguas included an inventory of trees in Caguas' traditional downtown, and a comparison of the data collected in the inventory with existing data, in order to understand the current and potential impact of urban trees on the municipality's gray infrastructure. This project is described in Goal 1, Strategy 9.

#### 2. Develop management plans

As discussed in the previous Strategy, the Municipality of Caguas developed a plan for the management of trees in preparation for hurricane seasons.

#### 3. Perform hazard trees mitigation

Discussed in Goal 1, Strategy 9 - Hazard tree mitigation.

#### 4. Promote adequate tree selection

The Puerto Rico Hurricane and Hazardous Fuel Mitigation Project, discussed in Goal 1, Strategy 9 - Hazard tree mitigation, involves species selection to meet specific site's objectives.

### F - Flooding

#### 1. Promote forested wetland protection

- Acquisitions and management

  In 2010, the Puerto Rico Conservation Trust and Palmas Homeowners Association (PHA) signed a conservation easement on 101 acres of lands that include a *Pterocarpus* forest in the Municipality of Humacao.

In addition, in recent years the DNER has made acquisitions to protect coastal forested lands and wetlands. An important achievement was the purchase of Finca Nolla in Camuy, in 2012. This is part of the Peñón Brusi Conservation Priority Area. Finca Nolla has wetland forested areas, and forest vegetation associated to the back-dune. Through a grant from the UCFP the Municipality of Camuy hired three environmental interpreters as part of an ecotourism project in this natural area.

**Finca Nolla**
Source: DNER

In 2013, the DNER, in collaboration with the NGO, The Trust for Public Land, purchased coastal lands composed of secondary forests, mangroves and other coastal wetlands in the Municipality of Fajardo. These lands are part of the Northeast Ecological Corridor Nature Reserve.

### Education

Through a sub-grant from the UCFP, the Municipality of San Juan carried out workshops and conferences on the importance of green spaces for the management of flood risks in the Río Piedras watershed. Through this project the Municipality of San Juan developed a Community Training Program about the importance of green spaces to maximize water catchment. Two conferences were held and a webpage was designed to provide information.

The website link is: http://www.lacuencadelriopiedras.com.

**Webpage created as part of the "Workshops and talks on the importance of green spaces for the management of flood risks in the Río Piedras watershed**

## 2. Promote riparian buffer installations

In 2013 the DNER, together with the municipality of Barceloneta, carried out a reforestation project at the Río Grande de Barceloneta. A total of 100 trees were planted by students in what would become the Río Grande de Barceloneta Forest.[17] The purpose is to expand green areas near the urban center and to include an interpretative trail within the forest that will be developed by the Municipality.

## 3. Maintain and increase forest cover in catchment and groundwater recharge areas

In April 2014, the Municipality of Vega Baja and the DNER announced the creation of the first urban forest in 4.9 acres at the Municipality of Vega Baja urban center. The forest will help to mitigate flooding, improve the landscape and serve as a recreational space for residents and visitors.

Initially, 500 native trees were planted by participants of a Courts Administration diversion program that includes psychosocial treatment to those who have been

[17]http://www.drna.gobierno.pr/oficinas/oficina-de-prensa-y-comunicaciones/comunicados-de-prensa/comunicados-de-prensa-2013/departamento-de-recursos-naturales-y-ambientales-y-el-municipio-de-barceloneta-se-unen-en-proyecto-de-reforestacion/

accused of using controlled substances. A trail for birdwatching will be developed, along with gardens, an area with a variety of fruit trees, and an area planted with native and endemic trees from the karst region.

### 4. Conduct urban trees inventories and perform hazard mitigation

Discussed in Goal 1, Strategy 9 - Hazard tree mitigation.

## G - Invasive plants and animals

### 1. Provide professional and public education

During 2011, the Agricultural Experimental Station at the UPRM established the "*Grupo Antillano de Especies Invasoras* (GAEI). This group combines and integrates academic and operational units to conduct and coordinate research and education on invasive species.

GAEI developed the Puerto Rico Invasive Species Atlas, a web map platform that displays occurrences of 13 invasive plants and 6 invasive insect species. The webpage also provides information on the biology and control practices for each species.

**Atlas of Puerto Rico's Invasive Species**

Source: http://atlas.eea.uprm.edu/%20distribucion

### 2. Promote usage of native and other suitable species

Discussed in Goal 1, Strategy 10, Increase the use of native plant material (native tree propagation and use).

### 3. Apply eradication practices

In collaboration with the USDA, the DNER completed a project to eradicate and control the invasive plant *Melaleuca quinquenervia*. The project, led by Dr. Paul D. Pratt and Tony Pernas, consisted in the removal of the main stand of trees and seedlings in the "Ciénaga Cabo Caribe" at the northeast of the Laguna Tortuguero Nature Reserve. A total of 3,874 adult trees were treated and germinated seeds were removed (DNER, 2012).

### 4. Adequate law enforcement against introduction of exotics

Puerto Rico Law 223 of 2014 amended the Wildlife Act of 1999 to broaden enforcement powers by defining violations related to the introduction of exotic species. The amendment included treating such violations as criminal offences, as well as listing environmentally prejudicial and venomous species.

### 5. Promote early detection of invasive species

Discussed in Goal 1, Strategy 11 - Develop nursery quality standards.

# 3 ENHANCE PUBLIC BENEFITS ASSOCIATED WITH TREES AND FORESTS

*3.1. Protect and enhance water quality and quantity*

*3.2. Improve air quality and conserve energy*

*3.3. Assist communities in planning for and reducing forest health risks*

*3.4. Maintain and enhance economics benefits and values of trees*

*3.5. Protect, conserve and enhance wildlife and fish habitat*

*3.6. Connect people to trees and forests, and engage them in environmental stewardship activities*

*3.7. Manage trees and forests to mitigate and adapt to global climate change*

***Issues addressed:***

- ✓ *Fragmentation of forest systems*
- ✓ *Water resources and watershed conservation strategies*
- ✓ *Information needs related to ecosystem services and other benefits from public and private forest land.*
- ✓ *Disturbances affecting forests (hurricanes, floods, fires, pests, etc.)*
- ✓ *Economic opportunities and alternative market development*

## Puerto Rico Strategies:

### 1. Continue encouraging reforestation

The DNER has been very active in the development of reforestation activities. Other initiatives, besides those described above include:

- The DNER, the Puerto Rico Department of Education and the Puerto Rico Power Authority participated in the international initiative known as "Green Wave", a project from the UNEP. As part of the initiative, fifty public schools (seven per each Educational Region) planted a tree simultaneously at 10:00 am, as a symbol of commitment to the development and promotion of environmental awareness among students and to celebrate the International Day for Biological Diversity.

Locally, the initiative has been promoted by the NGO Puerto Rico Garden Club since 2011. In 2012, the Commonwealth was the top ranked territory worldwide with the largest number of trees planted.

In 2014, the DNER, the UPR and the organization "Movement for Achieving Independent Living" (Movimiento para el Alcance Vida Independiente) celebrated a planting activity known as "Planting without Excuses". More than 75 people with physical disabilities had their first experience planting a tree.

**Participants from the activity "Planting without Excuses"**

Source: https://www.facebook.com/media/set

Together with more than a 100 AmeriCorps volunteers, the DNER replanted native trees in the La Plata Reservoir Protected Area during September 2015.

## 2. Maintain and manage existing forests

The DNER, through its Forest Service Bureau, Division of Forest Management, provides continuous management and maintenance to State Forests in Puerto Rico. In addition, training managers in different subjects has been an important component. For example, in August 2014 the DNER, through a grant from the USFS, hired technical advisors from CATIE for a 5-day course on Diversified Management of Tropical Forests. This training was held in Adjuntas, and was attended by 24 members of DNER staff, including Forest Technicians. It focused on topics such as: agroforestry, forest

products, non-timber forest products, certifications, forestry, community management models, and Model Forest concepts.

**Participants and professors of the course offered by CATIE to DNER staff on Diversified Management of Tropical Forests**

Photo: Andrés Rua González

In addition, given the Commonwealth's difficult fiscal situation, the DNER has established various agreements with NGOs for the management of forests and other natural protected areas. The following map and table depicts those natural protected areas where the DNER shares various management responsibilities with community organizations.

**Figure 7. Collaborative agreements with community organizations for the management of State Forests and other natural protected areas with important forest resources**

| Id | Entity | Natural Area |
|---|---|---|
| 1 | Taller de Arte y Cultura | Bosque del Pueblo y Bosque La Olimpia, Adjuntas |
| 2 | Coalición Pro Corredor Ecológico del Noreste (CPCEN) | Reserva Natural Corredor Ecológico del Noreste (CEN) |
| 3 | ALAPÁS (Alianza Laura Aponte por la Paz Social) | Bosque Estatal del Nuevo Milenio |
| 4 | Iniciativa de Eco-Desarrollo de Bahía de Jobos (IDEBAJO) | Reserva de Investigación Estuarina de Bahía de Jobos (JOBANERR) |
| 5 | Sociedad Ornitológica de Puerto Rico (SOPI) | Bosque Estatal de Cambalache |
| 6 | Protectores de Cuencas | Bosque Seco de Guánica |
| 7 | Arrecifes Pro Ciudad | Reserva Marina Arrecifes de Isla Verde |
| 8 | Fideicomiso de Conservación e Historia de Vieques | Reserva Natural Bahía Bioluminiscente de Vieques |
| 9 | Programa de Educación Comunal de Entrega y Servicio (PECES) | Reserva Natural de Humacao |
| 10 | Comunidades Unidas contra la Contaminación (CUCCo) | Reserva Natural Ciénaga Las Cucharillas, Cataño |
| 11 | Comité Pro Desarrollo de Maunabo | Reserva Natural Humedal Punta Tuna, Maunabo |
| 12 | Frente Ambiental Amigos de la Naturaleza Patillas | Reserva Natural Punta Viento |
| 13 | Defensores del Ambiente y la Cacería de Isla de Mona (DACIM) | Reserva Natural Isla de Mona |
| 14 | Amigos de Amoná | Reserva Natural Isla de Mona |
| 15 | Leaders of the World, Inc. | Recursos Costeros de Península de Cantera, Islote de la Guachinanga |
| 16 | Club Cívico Recreativo y Cultural de Palos Blancos | Bosque Monte Choca |
| 17 | COPI (Corporación Piñones se Integra) | Bosque Estatal de Piñones |
| 18 | Ciudadanos Pro Bosque San Patricio | Bosque San Patricio |

### 3. Private forested land acquisition by several means including Forest Legacy Program

Goal 1, Strategies 1,2 and 8, and Goal 2, Strategy F-1 discuss different mechanisms that have been used for the past years, for the acquisition of forested lands in Puerto Rico.

### 4. Encourage conservation easements

- At present, the DNER is improving internal processes to promote the conservation easement program. The DNER is developing protocols to manage the procedures to establish conservation easement within the agency. This effort will allow the agency to promote and establish additional easements. The agency is also reviewing information regarding all its easement agreements, including geospatial information of the location and boundaries of each property which are currently under review.
- During 2013, Puerto Rico House of Representatives Bill 1149 was presented as an amendment to the Puerto Rico Conservation Easement Act of 2001. The bill provides for an increase in the amount of tax credits available to private owners of lands of environmental or cultural importance who enter into an easement agreement with a governmental agency or a non-profit organization dedicated to conservation. The proposal raises the incentive from 15 million to 100 million per tax year, in order to promote greater land conservation and environmental-based tourism activities in Puerto Rico. The Bill is under the consideration of the Transportation, Infrastructure, Recreation and Sports Commission.[18]

### 5. Promote voluntary private land conservation management

Between 2010-2015, the Forest Stewardship Program has focused its efforts in six main strategies to strengthen the protection of private forested land in Puerto Rico. These strategies are:

- Renew expired 10 year management plans;
- Contract specialists for plan development within specific priority areas;
- Establish partnerships with other Commonwealth and Federal organizations in order to identify potential program participants;
- Offer management plan development to landowners participating in DNER Auxiliary Forest Program;

[18] Retrieved on October 9, 2015 from the Oficina de Servicios Legislativos. Sistema de Información del Trámite Legislativo: http://www.oslpr.org/buscar/].

- Develop and publish a Technical Guide for Forest Management Best Practices; and
- Develop supportive positions within the Program, such as an Administrative Assistant or Assistant Biologist to help with administrative tasks and to aid technical personnel in the program.

### 6. Continue land acquisition programs to conserve private mature forests

Discussed in Goal 1, Strategy 1.

### 7. Promote and encourage agroforestry practices (sun coffee plantations to shade grown coffee)

As discussed in Goal 1, Strategy 5, various agencies and NGO have developed several projects to transform agricultural practices, specifically in the coffee growing sector, to promote shade grown coffee.

In October, 2015, the DNER, NRCS and the USFWS signed a memorandum of understanding (MOU) to promote shade-grown crops as a measure to protect Puerto Rico's waterbodies. The purpose of this MOU is to coordinate efforts towards providing assistance to property owners so that they can improve the productivity, diversity and health of crops, forests and pastures. The DNER will facilitate the participation of farm owners in forest planting programs and help them access financial assistance from the USFWS. In addition, the DNER will propagate species typical of the areas where they are going to be planted. To be distributed, the species should be 1.5 feet tall.

### 8. Establish Maricao Commonwealth Forest and a 5 mile buffer (it includes Susúa Commonwealth Forest)

Through the Guánica/Maricao joint landscape, federal, Commonwealth and private efforts are being leveraged. Watersheds, wildlife species, coral reefs, as well as residents and farmers are benefiting from the several initiatives that are being carried out in this area. It lies along the mountain corridor that connects two major State forests: Maricao and Guilarte.

The USFWS, in addition, identified private lands within the Las Marías and Maricao municipalities, adjacent to the Maricao State Forest, to participate in the Partners for Fish and Wildlife Program Candidate Species Conservation Pilot Initiative. Selected lands were the ones where elfin-wood warbler (*Dendroica angelae*), a candidate species under the *Endangered Species Act* and a Commonwealth vulnerable species has been documented nesting in shade coffee plantations.

In addition, the DNER and other Commonwealth and federal agencies are working towards the restoration of this joint landscape for the reintroduction of the Puerto Rican parrot. In August 2015, 25 parrots were taken to the Maricao State Forest and placed on "flight cages" where they are going to be trained prior to their release.

**Transfer of the Puerto Rican parrots to the Maricao State Forest**

Photos: DNER

Moreover this initiative aims to improve watershed conditions that directly impact the Guánica Bay, by promoting and implementing soil practices that reduce erosion. Other initiatives include those previously described, such as the planting and conversion to shade grown coffee as a measure to reduce disease, improve product quality and soil condition.

## 9. Provision of proper management of public forested lands

Goal 3, Strategy 2 describes actions that have been implemented by the DNER for the proper management of natural protected areas, including forested lands. For example in the Guánica State forest, the DNER signed an agreement with the NGO Protectores de Cuencas. This organization will be responsible for: promoting public participation, improving recreational areas, implementing educational campaigns and identifying sources of income for the management of the forest, among other responsibilities.

**DNER Secretary signing the agreement with representatives of the NGO Protectores Cuenca**

Source: https://www.facebook.com/media/set

Other public forested lands have been protected through agreements with community organizations, such as the Bosque Urbano Los Filtros in Guaynabo. In April 2015, the DNER, the Puerto Rico Aqueduct and Sewer Authority (PRASA) (owner of these lands), and the community organization Comité Cívico Los Filtros signed an agreement for the protection of 6.1 acres of secondary forest. In this case, the DNER received the land from PRASA by an usufruct agreement and, in turn, signed an agreement with the NGO for the management of the area.

## 10. Plant biodiversity

The DNER's Watershed Reforestation Plan discussed in Goal 1, Strategy C-2 and the MOU signed by the DNER, NRCS and the USFWS, described in Goal 3, Strategy 7 are measures that will foster plant biodiversity.

## 11. Retain forest cover

Several actions have been implemented or are carried out continuously to achieve this strategy. These include education and community involvement efforts Goal 1, Strategy 12; reforestation efforts in particular the DNER's Watershed Reforestation Plan discussed in Goal 2, Strategy C-2; as well as the Model Forest Act and the Plan and Regulation for the Karst Special Planning Area, both described in Goal 2 Strategy C-1b.

## 12. Carbon sequestration

Discussed in Goal 2, Strategy d-2.

## 13. Manage for forest health and growth

Discussed in Goal 2, Strategies B 1 to 6.

## 14. Forest products benefits to incentivize protecting and enhancing forest cover

Goal 1 Strategy 13, discusses CADA and its efforts to promote agroforestry practices. In addition, the DNER, federal agencies and NGOs promoted a symposium on forest products. The first symposium theme was the wood and other forest products of Puerto Rico. It had the participation of local wood artists, furniture makers and private land owners. This symposium was held in April 2012. The second symposium theme was the sustainable management and use of forest resources in Puerto Rico. It was held in December 2014.

**Native woods and forest products symposiums: 2012 and 2014**

In 2012, through a grant from the USDA-IITF, the NGO CDK organized a conference and a workshop on "El Yunque National Forest and its Periphery". The purpose was to discuss opportunities available for sustainable tourism, conservation, and economic development in the communities surrounding this National Forest. Both events benefited from the participation of Dr. Hitesh Mehta, a renowned architect in the

ecotourism field. The workshop focused on Eco lodges planning, design and operations.

- In May 2015, the DNER, the Puerto Rico Tourism Company, the Puerto Rico Trade and Export Company and the "Comunidades Especiales" Office launched the "Program for Sustainable Community-Based Tourism". This program seeks to promote the economic development of the communities neighboring DNER's natural protected areas, through initiatives such as ecotourism. The program includes education and counseling, assessment and management of financing, training and accompaniment in the creation of community-based business. Participating communities are identified in the following map and table.

**Figure 8. Community-based economic development projects related to DNER natural protected areas**

| | Natural Protected Area | Organization | Municipality | Potential business |
|---|---|---|---|---|
| 1 | **Guánica State Forest** | Protectores de Cuencas | Guánica | Guided tours |
| 2 | **Barrio Rio Hondos Community Forest** | Estampas Agro-Eco Turísticas del Barrio Rio Hondo | Mayagüez | Guided tours of trails<br>Sofrito production small business |
| 3 | **Punta Tuna Natural Reserve** | Comité Pro Desarrollo de Maunabo | Maunabo | Guided tours<br>Small Business |
| 4 | **Rio Abajo State Forest** | Eco-hospedería "El Cantar del Bosque Rio Abajo" | Arecibo, Utuado | Environmental interpretation tours |
| 5 | **Aguirre State Forest, Bahía de Jobos Estuary Research Reserve** | Iniciativa de Eco-Desarrollo de Bahía de Jobos – IDEBAJO | Guayama, Salinas | Environmental interpretation tours |
| 6 | **Ceiba State Forest – Roosevelt Roads** | Alianza Pro-Desarrollo Económico de Ceiba - APRODEC | Ceiba, Naguabo | Environmental interpretation tours |
| 7 | **Piñones State Forest** | Corporación Piñones se Integra - COPI | Loíza | Environmental interpretation tours<br>Immersion experiences<br>Forest products |
| 8 | **El Yunque National Forest** | Comité Consultor para la Participación Pública - CCPP | Río Grande | Interpretative guided tours<br>Educational workshops |
| 9 | **Northeast Ecological Corridor** | Coalición Pro Corredor Ecológico del Noreste - CEN | Luquilllo, Rio Grande, Fajardo | Educational activities<br>Hiking trails<br>Tinglar Festival<br>Sumer Camps |
| 10 | **Caño Tiburones, Cueva del Indio Natural Reserve** | Comunitaria Caño Tiburones - COCOCATI | Barceloneta | Bird Watching<br>Environmental interpretation tours<br>Trekking |
| 11 | **San Juan Bay Estuary** | Proyecto de la Península de Cantera | San Juan | Environmental interpretation tours<br>Educational activities |
| 12 | **Lucchetti Wildlife Refuge** | Centro de Microempresas y Tecnologías Agrícolas Sustentables Yauco, Inc. (CMTAS) | Yauco | Agricultural activities small business<br>Restaurant<br>Guided tours |

*Source: DNER. Planner Héctor M. Cortés Ramírez, Community Economic Development.*

# COLLABORATORS

### Department of Natural and Environmental Resources

| | |
|---|---|
| Carmen R. Guerrero Pérez | Secretary |
| Cristina Cabrera Barros | Special Assistant, Office of the Secretary and State Forester |
| Carlos Juan Cruz | Biologist and Forest Legacy Coordinator |
| Darién López | Director, Forest Management Division |
| Eliezer Pérez | Special Assistant, Office of the Secretary |
| Enrique Santiago | Forest Stewardship Coordinator |
| Héctor M. Cortes | Community Economic Development Planner |
| Juan Casanova | Forest Manager, Boquerón State Forest |
| Laura Arroyo | Executive Special Assistant, Office of the Secretary |
| Luz E. Medina | Biologist, Arecibo Regional Office |
| Rosa M. Quiles | Urban and Community Forestry Program Planner |
| Rubén Ubiñas | Cambalache Nursery Agronomist |
| Vicente Quevedo Bonilla | Assistant Secretary, Comprehensive Planning Area |
| Mariana Quiñones | Forest Health Projects (Consultant) |
| Sandra Soto Bayó | GIS (Consultant) |

### Model Forest Office (Oficina del Bosque Modelo)

| | |
|---|---|
| Norma Peña | Executive Director |

### USDA International Institute of Tropical Forestry

| | |
|---|---|
| Magaly Figueroa | Natural Resources Specialist |
| Maya Quiñones | Cartographic Technician |
| Humfredo Marcano | Research Biologist |

### Puerto Rico Firefighters Corps

| | |
|---|---|
| Joel R. Figueroa | Federal Affairs Director |

### Para La Naturaleza

| | |
|---|---|
| María Soledad Gaztambide | Policy and Government Relations Coordinator |

# REFERENCES


Arbor Day Foundation. (2015). *Learn About Tree Campus USA*. Retrieved Nov. 2, 2015 from: [http://www.arborday.org/programs/treecampususa/learn.cfm]

Brandeis, Thomas J.; Escobedo, Francisco J.; Staudhammer, Christina L.; Nowak, David J.; Zipperer, Wayne C. 2014. San Juan Bay Estuary watershed urban forest inventory. Gen. Tech. Rep. SRS-GTR-190. Asheville, NC: USDA-Forest Service, Southern Research Station. 44 p. Retrieved October 13, 2015, online from: [http://www.treesearch.fs.fed.us/pubs/45759.]

Caribbean Landscape Conservation Cooperative. (2015). Puerto Rico Protected Areas Database [version of September, 2015]. GIS data. San Juan, PR.

Commonwealth of Puerto Rico. (2013). Puerto Rico Law 18 of 2013. Law to create the Northeast Ecological Corridor.

Commonwealth of Puerto Rico. (2014). Puerto Rico Law 182 of 2014. Law to create The Puerto Rico Model Forest.

Del Valle, S. (2014*). Listas varias agencias para enfrentar los fuegos forestales.* Primera Hora. Retrieved October 30, 2015, from: [http://www.primerahora.com/noticias/policia-tribunales/nota/listasvariasagenciasparaenfrentarlosfuegosforestales-984959/]

Department of Natural and Environmental Resources. (2012). Transition Report: Assistant Secretary of Comprehensive Planning.

Department of Natural and Environmental Resources. (2012). Transition Report: Division of Coasts, Natural Reserves and Wildlife Refuges.

Department of Natural and Environmental Resources. (2012). Transition Report: Forest Service Bureau.

Department of Natural and Environmental Resources. (2013). Crean cuerpo de científicos e intérpretes voluntarios para trabajar por los recursos naturales de Puerto Rico. Retrieved October 5, 2015, from: [http://drna.gobierno.pr/crean-cuerpo-de-cientificos-e-interpretes-voluntarios-para-trabajar-por-los-recursos-naturales-de-puerto-rico/]

Department of Natural and Environmental Resources. Oficina De Prensa y Comunicaciones. (2013). Departamento De Recursos Naturales Y Ambientales y el Municipio De Barceloneta Se Unen En Proyecto De Reforestación. Retrieved October 5, 2015 from: [http://www.drna.gobierno.pr/oficinas/oficina-de-prensa-y-comunicaciones/comunicados-de-prensa/comunicados-de-prensa-2013/departamento-de-recursos-naturales-y-ambientales-y-el-municipio-de-barceloneta-se-unen-en-proyecto-de-reforestacion/]

Department of Natural and Environmental Resources. (2013). Departamento de Recursos Naturales y Ambientales Emprende Trabajos Sobre el Bosque Modelo. Retrieved October 5, 2015, from: [http://www.drna.gobierno.pr/historico/oficinas/oficina-de-prensa-y-comunicaciones/comunicados-de-prensa/comunicados-de-prensa-2013/departamento-de-recursos-naturales-y-ambientales-emprende-trabajos-sobre-el-bosque-modelo]

Department of Natural and Environmental Resources. (2013). DRNA adquiere terrenos en el Corredor Ecológico del Noreste. Retrieved October, 5, 2015, from: [http://drna.gobierno.pr/drna-adquiere-terrenos-en-el-corredor-ecologico-del-noreste/]

Department of Natural and Environmental Resources. (2014). Informe de Logros Año 2014. Submitted to La Fortaleza.

Department of Natural and Environmental Resources. (2014). Recommendations for the Urban and Community Forestry Program Review. May 2013.

Department of Natural and Environmental Resources. 2014. Auxiliary Forests Report. Guayama Region.

Department of Natural and Environmental Resources. 2014. Auxiliary Forests Report. Humacao Region.

Department of Natural and Environmental Resources. 2014. Auxiliary Forests Report. Ponce Region.

Department of Natural and Environmental Resources. 2014. Auxiliary Forests Report. San Juan Region.

Department of Natural and Environmental Resources. (2015). Personal del DRNA capacitará a intérpretes ambientales en el exterior tras el reconocimiento de la organización que certifica a esos profesionales. Retrieved October 4, 2015, from: [http://drna.gobierno.pr/historico/ oficinas/ oficina-de-prensa-y-comunicaciones/comunicados-de-prensa/comunicados-2015/personal-del-drna-capacitara-a-interpretes-ambientales-en-el-exterior-tras-el-reconocimiento-de-la-organizacion-que-certifica-a-esos-profesionales/]

Department of Natural and Environmental Resources. (2015). *Survey of abiotic damage, pest and diseases affecting endangered plant species in the karst region of Puerto Rico*.

Department of Natural and Environmental Resources. (2015). Progress reports submitted to USFS. *Urban and Community Forestry Program.* Prepared by Mariana Quiñones Rosado on September 18, 2015.

El Nuevo Día. (2013, April 21). Reforestación en la vitrina. Retrieved November 2, 2015, from [http://www.elnuevodia.com/noticias/locales/nota/reforestacionenlavitrina-1495082/]

El Nuevo Día. (2014, May 21). Restauran el área afectada por fuego en el Faro de Cabo Rojo. Retrieved September 5, 2015, from: http://www.elnuevodia.com/noticias/locales/nota/restauranelarea afectadaporfuegoenelfarodecaborojo-1776934/

Estrada M. (April, 2014). Se recupera el Bosque del Pueblo a un año de voraz incendio. Primera Hora. http://www.primerahora.com/noticias/puerto-rico/nota/serecuperaelbosquedelpuebloaun anodevorazincendio-1074432/

International Institute of Tropical Forestry. (2012). 2011 Accomplishment Report: Retrieved October 30, 2015, from: [http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3798441.pdf]

International Institute of Tropical Forestry. (2013). 2012 Accomplishments Report. Retrieved online from: [http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3798091.pdf]

Internews Services. (2015). Primera dama lidera plan de reforestación de las cuencas hidrográficas. Periódico Metro. Retrieved from: [http://www.metro.pr/noticias/primera-dama-lidera-plan-de-reforestacion-de-las-cuencas-hidrograficas/pGXoim!DZSaoBL7YOoQ/]

La Fortaleza. Oficina Del Gobernador. (2015). *Bosque Seco De Guánica Será un Centro De Monitoreo Internacional De Cambios Climáticos.* Retrieved October 22, 2015 from: [http://www.fortaleza.pr.gov/content/bosque-seco-de-gu-nica-ser-un-centro-de-monitoreo-internacional-de-cambios-clim-ticos]

La Fortaleza. Oficina Del Gobernador. (2015). *Se Viabiliza Protección Del Bosque Urbano Los Filtros Y Se Presenta Plan De Reforestación.* Retrieved October 5, 2015 from: [http://www.fortaleza.pr.gov/content/se-viabiliza-protecci-n-del-bosque-urbano-los-filtros-y-se-presenta-plan-de-reforestaci-n]

National Association of State Foresters and the USDA Forest Service. 2012. State and Private Forestry (S&PF) Annual Report: FY2011 State Fact Sheets.

National Association of State Foresters and the USDA Forest Service. 2013. State and Private Forestry (S&PF) Annual Report: FY2012 State Fact Sheets.

National Association of State Foresters and the USDA Forest Service. 2015. State and Private Forestry (S&PF) Annual Report: FY2014 State Fact Sheets.

National Oceanic and Atmospheric Administration. National Weather Service Weather Forecast Office. (2015). *Fire Weather Zones*. Retrieved October 4, 2015 from [http://www.srh.noaa.gov/sju/?n=firezonechanges]

National Science Foundation. National Ecological Observatory Network (NEON). (2014). *Stimulating Research Using NEON Data Awards*. Retrieved October 27, 2015 from: [http://nsf.gov/funding/pgm_summ.jsp?pims_id=13440]

Natural Resources Conservation Service – Caribbean Area. 2015. Guánica/Río Loco Update 2nd Qtr FY15.

Palmer, Cass. (June 2014). *Prescribed Burn Helps Restore Historic Lagoon in Puerto Rico.* U.S. Fish and Wildlife Service: National Wildlife Refuge System. Retrieved October 25, 2015, from:[http://www.fws.gov/refuges/RefugeUpdate/MayJun_2014%20HTML/prescribed_burn.html]

Primera Hora. (2012). La DRNA adquiere 100 cuerdas de terreno para su conservación en Camuy. Retrieved November 5, 2015, from:[http://www.primerahora.com/noticias/puerto-rico/nota/ladrnaadquiere100cuerdasdeterrenoparasuconservacionencamuy-623541/]

Puerto Rico Climate Change Council (PRCCC). 2013. *Puerto Rico's State of the Climate 2010-2013: Assessing Puerto Rico's Social-Ecological Vulnerabilities in a Changing Climate.* Puerto Rico Coastal Zone Management Program, Department of Natural and Environmental Resources, NOAA Office of Ocean and Coastal Resource Management. San Juan, PR.

Puerto Rico Firefighters Corps. (2013). Recognition of values of the year and provision of vehicles and equipment on the firefighter's week. Caguas, May 3, 2013. Press release.

Puerto Rico Planning Board. (2014). Plan y Reglamento del Área de Planificación Especial del Carso.

Treesearch. (2015). United States Forest Service. Retrieved October 27, 2015, from [http://www.treesearch.fs.fed.us/pubs/45759]

U.S. Fish and Wildlife Service: Ecological Services in the Caribbean. (2011, May 3). Shade Coffee for Wildlife. Retrieved October 5, 2015 from [http://www.fws.gov/caribbean/ES/Shadecoffee.html]

United States Department of Agriculture. (2013). *Research Highlights: Scientist Develops Fire Danger Rating System and Fire Weather Zones for Puerto Rico and U.S. Virgin Islands.* US Department of Agriculture: Forest Service: Research & Development. Gould, William A. Retrieved October 3. 2015 from [http://www.fs.fed.us/research/highlights/highlights_display.php?in_high_id=456]

United States Department of Agriculture. International Institute of Tropical Forestry. Ed. Grizelle González. (2012). IITF 2012 Accomplishments Report. Retrieved October 25 2015 from: [http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3798091.pdf]

United States Department of Agriculture: Forest Service. (2015). El Yunque National Rainforest: Collaboration, Communication, and Conversation. Retrieved from: [http://www.fs.usda.gov/detail/elyunque/home/?cid=STELPRDB5411382]

United States Department of Agriculture: Forest Service. (2015). El Yunque National Rainforest: Planning. Retrieved from: [http://www.fs.usda.gov/detail/elyunque/home/?cid=STELPRDB5411382]

United States Department of Agriculture: Forest Service: International Institute of Tropical Forestry. (2012). State and Private Forestry. Retrieved 5 Nov. 2015 online from: [http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3798091.pdf]

Valentín, J. and Más, E. (2015). *Puerto Rico Wildfire Prevention Initiative*. United States Department of Agriculture. Natural Resources Conservation Service: Caribbean Area. Retrieved from: [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/pr/home/?cid=NRCSEPRD328877]

Victoria 840. (2013, August 11). Quema controlada en el Refugio Nacional de Vida Silvestre de Laguna Cartagena. Retrieved from:[ http://www.victoria840.com/quema-controlada-en-el-refugio-nacional-de-vida-silvestre-de-laguna-cartagena/]

## Web pages

| | |
|---|---|
| Cafiesencia | http://www.cafipr.org/cafiesencia/ |
| Centro de Estudios para el Desarrollo Sustentable | http://www.suagm.edu/umet/cedes/ |
| Centro para la Conservación del Paisaje | http://www.ccpaisaje.org/ |
| Department of Natural and Environmental Resources | http://drna.gobierno.pr/ |
| International Institute of Tropical Forestry | http://www.fs.usda.gov/iitf/ |
| La Perla del Sur | https://twitter.com/LaPerlaPR |
| Las Casas de la Selva | http://eyeontherainforest.org |
| Municipality of San Juan | http://www.lacuencadelriopiedras.com |
| Natural Resources Conservation Service | http://content.govdelivery.com/ accounts/ USDANRCS/bulletins |
| Oficina de Servicios Legislativos | http://www.oslpr.org/buscar |
| Puerto Rico Frente Al Fuego | http://prfrentealfuego.com |
| US Department of Agriculture | http://www.fs.fed.us/research |
| US Fish and Wildlife Service | http://www.fws.gov/caribbean |