



United States
Department of
Agriculture
Forest Service



International Institute of Tropical Forestry

2012 Accomplishment Report



Cover image: views of the headquarters of the International Institute of Tropical Forestry. Top photo by G. Bauer.

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Editor's Message

Fiscal year (FY) 2012 was marked by the inaugurations of the renovated facilities at the Institute's Headquarters in Río Piedras and the Sabana Field Research Station in Luquillo, PR. Amidst the moving and celebrations, much was accomplished this fiscal year within each of the Institute's programs. I hope you enjoy learning what we accomplished in Research and Development, State and Private Forestry, and International Cooperation during FY 2012. Thanks to the Institute's program managers, employees and partners for their text and photo contributions to this report. Special thanks to Marinelis Talavera for help editing this second annual report within the new framework, which includes all of the Institute's units. Happy reading!



Grizelle González
Project Leader,
Research Unit



G. Bauer



John Cohrs



G. Bauer

Ariel E. Lugo

A Message from the Director

Fiscal year 2012 was historic for the Institute because we completed the restoration of the Institute Headquarters building and opened new facilities at the Sabana Field Research Station. We dedicated these facilities through well-attended public ceremonies with the presence of Chief of the Forest Service Tom Tidwell. We had a blast—a grand time showing off our brand new facilities to the public. Our employees were particularly happy because we finally abandoned the temporary trailer facilities and other locations where they had spent the past 5 years under crowded and sub-optimal conditions.

Our new facilities are spacious, safe, and accessible. They also conserve water and electricity, and help mitigate the city heat island effect and flooding problems. In our next accomplishment report we will explain and document how we accomplished these conservation feats, because in FY 2012 we were not completely done with the construction of all the facilities at the Institute. 1

Another historic moment in FY 2012 was the acquisition of lands for conservation under the Forest Legacy Program by our partners in the U.S. Virgin Islands. This was the first time that Forest Legacy funds have been used for land acquisition in the U.S. Virgin Islands, and the purchase by the Virgin Islands Department of Agriculture focused attention on a beautiful 76-acre property in St. Croix

that will be part of a new territorial park system where none existed before.

Each year, as I read the accomplishments of the Institute, I marvel at how much we do and how many people and institutions we touch with our work. These accomplishment reports include only the highlights of our work and provide only a hint about the broad scope of what we do every year. We are engaged internationally with many countries between Argentina and the Caribbean, including substantial work in Brazil, Perú, Venezuela, the Dominican Republic, and many other Caribbean islands. Our involvement in Puerto Rico covers the whole island, and we have presence in the mainland United States and even in Alaska. The scientific productivity of the Institute is also very rewarding and we are now engaged in interpreting our work for the benefit of non-scientists and other users of research information. This year, the new program in social-ecology began to bear fruit, and the reader might be interested in the network of technical information flow for Puerto Rico highlighted in this report.

As I do every year, I ask for your feedback and ask you to help us be more responsive to the needs of our society as we engage social-ecological systems in the never-ending task of coping with environmental change. Enjoy our report!

Ariel E. Lugo
Institute Director



J. Vicens

Vision and Mission

We are a center for excellence where creativity and accomplishments result in timely products and services that anticipate the needs of society as it mitigates and adapts to environmental change.

Our mission is to develop and disseminate scientifically based knowledge that contributes to the conservation of forests, wildlife, and watersheds of the American tropics in the context of environmental change.

A Working Vision for Safety

We actively care for the safety of ourselves, one another, and the public. Success is safely achieving our mission — with all of us returning home every day!



The Institute

The International Institute of Tropical Forestry (the Institute) is a tropical forestry research and technology transfer institute. Located in Río Piedras, Puerto Rico, it has a long and productive history. Created in 1939 as the Tropical Forest Experiment Station in cooperation with the University of Puerto Rico, the Institute has been in operation continuously for 73 years. The Institute serves as a focal point for bringing external research and educational resources to bear on issues affecting tropical forests and grasslands.



Because of the high diversity of tropical landscapes and the multicultural and multilingual user base, Institute employees must have specialized knowledge and skills in many fields. Our assets include an exceptional cadre of bilingual and trilingual scientists, natural resources managers, professionals, and technicians; state-of-the-art facilities, including laboratories, experimental research forests, and an excellent tropical forestry library; a long tradition of collaborations; and constituents who are highly supportive of our mission and programs.

Institute Headquarters—Historic and Sustainable

Inaugurated July 18, 2012

For more than 70 years, the Institute's Headquarters building has been an icon for tropical forestry research. Originally, the grounds where the Headquarters building was erected were part of an experimental station owned by the Sugar Producers Association. The property included 200 acres of land, 50 of them dedicated to experimental sugar cane crops and the remaining acreage to other crops. In 1911, the association transferred ownership to the People of Puerto Rico, with control and administration

entrusted to the newly created Agriculture Commission Board. In August 1933, the property was transferred to the University of Puerto Rico.

In 1941 the U.S. Department of Agriculture, represented by Mr. Arthur Bevan, director of the Tropical Forest Experiment Station, signed the first lease agreement with the University of Puerto Rico for the use of lands where the building was erected, and in 1942 construction began on what is today the Institute's Headquarters building.



In 2008, construction/renovation was initiated, and the building has now been restored with the distinctive architectural characteristics of the Spanish Revival style popular at the time it was built in the early 1940s. After an evaluation of the building by the State Preservation Office, it was concluded that the headquarters building is eligible for inclusion in the National Register for Historic Places.

Using sustainable design concepts, the renovation project was designed to meet the Silver Certification

Level of the United States Green Building Council. Leadership in Energy and Environmental Design (LEED) elements were incorporated into the renovation, which included a fresh-air system, lighting, and thermal insulation. This project showcases that historic buildings can be made highly energy-efficient while maintaining their historical value and providing for contemporary use.



On July 18, 2012, with the assistance of U.S. Forest Service Chief Tom Tidwell and University of Puerto Rico President Dr. Miguel Muñoz-Muñoz, we inaugurated the newly renovated Headquarters. The Inauguration of the International Institute of Tropical Forestry's Headquarters Building was the first event of many we have been conducting in anticipation of our 75th Anniversary in 2014.

Description of the Institute's Facilities

Headquarters

The Institute Headquarters has 50,000 square feet of modern, state-of-the-art facilities that are secure, functional, accessible, and that service the scientific community of the Institute and its collaborators. The Headquarters complex is located in Río Piedras, Puerto Rico, and houses:

- 1 The Institute's Headquarters building—a historical building fully restored and modernized into a high-performance sustainable building (see the previous page).
- 1 A recently remodeled Forest Service National Library, containing major publications in English and Spanish on forestry, ecology, management, and utilization of tropical forests as well as other documents and materials related to tropical forests around the world.
- 1 A Chemistry Laboratory focusing on analytical chemistry of plant tissues, water, soils, and air. In a typical year, more than 50,000 analyses on samples collected from tropical ecosystems around the world are completed by laboratory personnel.
- 1 A GIS and Remote Sensing Laboratory to study landscape ecology using geographic information systems (GIS), remote sensing, and field studies. This laboratory develops information, methods, and products using spatial data and analyses at multiple scales, which are made available through maps, publications, and training.
- 1 A technology transfer conference center with capabilities for multiple use combinations for meetings, trainings, and conferences. This facility has a food serving area and accessible restrooms.
- 1 A multipurpose building that houses a dormitory, a gym, general storage area, office space, and lunch area.
- 1 An area for sample preparation and long-term storage of samples.
- 1 Three back-up generators to ensure that electrical power is available for continuous operation during power blackouts, and a 3,400-gallon potable water tank that can provide drinking water during water shortages.



M. Rivera



M. Rivera



L. Muñoz



G. González

GIS and remote sensing staff.

Sabana Field Research Station

On July 16, 2012, with the help of Chief Tidwell, we celebrated the inauguration ceremony of the newly remodeled Sabana Field Research Station.

The Sabana Field Research Station has a rich history; it was originally established by the Forest Service in 1938 with the objective of maintaining security and surveillance of all surrounding forest areas. Later, between the 1970s and the 1980s, the station was a saw mill, and finally, after 1989, the station was fully dedicated to research activities.

The Sabana Field Research Station has all the amenities to accommodate individuals and groups interested in completing scientific work in the surrounding or nearby areas located within the Luquillo Experimental Forest, like the Sabana River and Bisley (experimental watersheds).

The station is located on PR Road 988 km 6.5 in the Sabana neighborhood in the town of Luquillo and offers multiple facilities:

- 1Dormitory building with restrooms, showers, and kitchen; and
- 1A multipurpose building with a mycology laboratory, oven room, sample preparation room, laundry room, and storage areas.



G. Bauer

A Visit From the Chief

With State and Private Forestry Partners at El Tallonal

Strong partnerships are the foundation of State and Private Forestry programs. U.S. Forest Service Chief Tom Tidwell spent a day with the Institute's director, State and Private Forestry staff and, several partners at El Tallonal, a biological reserve in Arecibo administered by the Citizens for the Karst (CDK).

Each person had an opportunity to talk with the Chief and with the other guests, to share the goals and accomplishments of their respective programs and ongoing projects. The day's activities provided the Chief with a sample of the great diversity of State and Private Forestry programs and projects ranging from fire to forest production, urban forestry, community gardens, outdoor classrooms, and forest health.

Partners represented at Tallonal included the following.

- Tropic Ventures (Thrity "3t" Vakil and Andrés Rúa).
- Puerto Rico Fire Department (Sgt. Joel Figueroa).
- 1University of Puerto Rico–Mayagüez Agricultural Extension Service (Dr. Hipólito O'Farril).



G. Bauer

USFS Chief Tidwell, Institute's Director Ariel Lugo and CDK Abel Vale view the tropical forest canopy at Tallonal Nature Reserve.

- 1University of Puerto Rico–Río Piedras, Center for Urban, Community, and Business Action (Germán Ramos).
- 1Juan Ponce de León High School in Florida (Elliot López).
- 1San Patricio Urban Forest (FSB) (Víctor Hernández).
- 1Puerto Rico Conservation Trust (Juan Rodríguez).
- 1Citizens for the Karst, Inc. (Abel Vale).

Support and Administration

Administrative Specialist: Adolfo Menéndez, amenendez@fs.fed.us

Our Business Operations staff continues to provide critical support to the Institute’s Research, International Cooperation, and State and Private programs. Our staff engages in providing technical and administrative support in the areas of Budget, Engineering and Facilities Maintenance, Contracting and Procurement, Facilities and Property Management, Mail Services, Grants and Agreements, and Reception.

Finances and Workforce

The budget allocation for the Institute supports the workforce, business operations, and programs. Because of budget reductions, in FY 2012 we saw a decrease in the number of our temporary and part time work force—from last year’s 25 temporary/part time employees to today’s 12, a reduction of more than 50 percent.

The numbers that follow (illustrated in Figs. 1 and 2) are for FY 2012 (October 1, 2011, through September 30, 2012).

Incoming Funding*

- 1Research appropriations: \$ 2.98 million
- 1State and Private : \$1.86 million
- 1International cooperation: \$550,000
- 1Construction and related funds: \$192,869
- 1Administration: \$1.47 million
- 1TOTAL FUNDING: \$7.06 million

Distribution of Funds*

- 1Employee salaries: \$3.986 million 1 (56 percent) 1
- 1Support and operations: \$0.445 million (6 percent)
- 1Distributed to cooperators: \$1.25 million (18 percent)

Workforce Statistics

- 1Total Institute workforce: 56
- 1Permanent workforce: 44
- 1Of the permanent workforce, 10 employees (23 percent) are scientists.
- 1Temporary workforce: 12

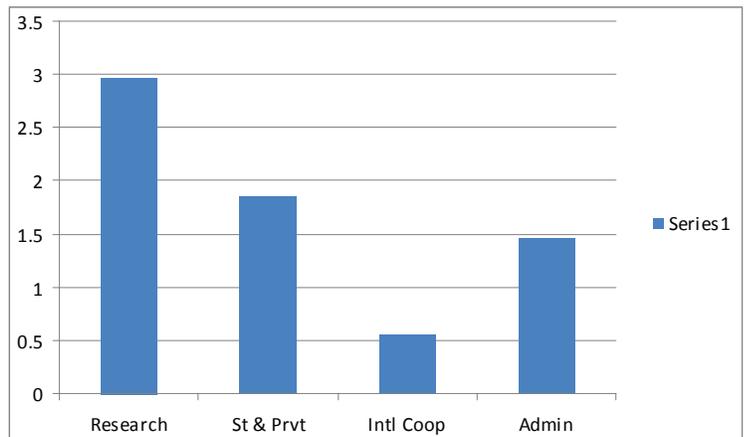


Figure 1. FY2012 Institute Funding.

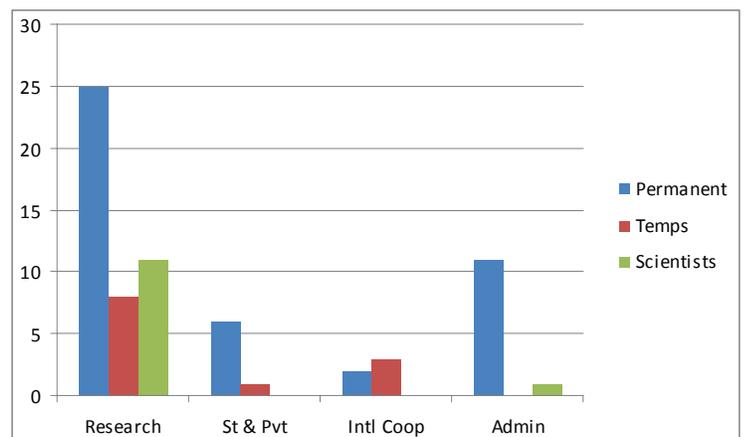


Figure 2. International Institute of Tropical Forestry employees by status.

*Does not include American Recovery and Reinvestment Act (ARRA) funds.

Funding Partners for FY12

Cooperators Who Received Funding from the Institute

Non-Governmental Organizations

- 1Area de Desarrollo y Conservación de Recursos El Atlántico, Inc.
- 1Centro Para La Conservación del Paisaje
- 1Consejo Asesor para la Forestación Urbana y de Comunidades de Puerto Rico, Inc.
- 1Ciudadanos del Karso
- 1Fundación Puertorriqueña de Conservación
- 1International Society of Tropical Foresters
- 1Natural History Society of Puerto Rico
- 1Paso Pacífico
- 1Puerto Rico Conservation Trust Foundation
- 1Southern Group of State Foresters
- 1St. Croix Environmental Association
- 1University of Georgia Research Foundation Inc.
- 1*Virgin Islands Resource Conservation and Development Council, Inc.

Private Industry and Individuals

- 1The Greenleaf Group, Inc.
- 1Dr. James Grogan

Universities

- 1Colorado State University
- 1Oregon State University
- 1Universidad Metropolitana
- 1University of California–Berkeley
- 1University of Indiana
- 1University of Missouri
- 1University of New Hampshire
- 1University of Pennsylvania
- 1University of Puerto Rico–Agricultural Extension Service
- 1University of Puerto Rico–Research Division
- 1University of Rhode Island

State Government

- 1Puerto Rico Fire Department
- 1Puerto Rico Department of Natural and Environmental Resources
- 1*Puerto Rico Department of Transportation and Public Works
- 1U.S. Virgin Islands Department of Agriculture
- 1U.S. Virgin Islands Fire Department

Cooperators Who Provided Funds to the Institute

- 1Puerto Rico Department of Natural and Environmental Resources
- 1U.S. Fish and Wildlife Service
- 1U.S. Geological Survey

*These partners received American Recovery and Reinvestment Act (ARRA) funds.

Institute Social Media (Twitter)

In 2012 in a concerted outreach effort, the Institute joined Twitter, providing a daily outlet for the latest news and activities at the Institute and about tropical forestry. The Institute account was also joined on Twitter by the Caribbean Landscape Conservation Cooperative (CLCC) account.



Tana Wood collects soil samples in El Yunque for an ongoing drought experiment.

Institute Twitter Account - @USFS_IITF

In 2012 the @USFS_INSTITUTE Twitter account, run by Dr. Tana Wood, has continued to grow with now more than 250 followers. With tweets about current activities and research in the Institute, a focus on international tropical forestry news, tropical forest ecology, and the impacts of climate change on tropical forests, it is an excellent source for scientists, students, and the general public. Part of the @USFS_INSTITUTE account is the #ScienceInAction theme, where everyone can see Institute scientists, employees, students, and volunteers working on a wide range of projects and activities.

Institute Contact: Tana Wood, wood.tana@gmail.com

Caribbean Landscape Conservation Cooperative Twitter Account - @Caribbean_LCC

Like the @USFS_INSTITUTE Twitter feed, in 2012 the @Caribbean_LCC account—run by Kasey Jacobs, Gary Potts, and Dr. William Gould—has grown to more than 150 followers. With tweets related to conservation priorities in the Caribbean, information about CLCC activities such as workshops and meetings, and news from around the Caribbean related to a wide range of topics including sea level rise, climate change, coral reefs, land cover and land use change, agriculture, and mangrove conservation, this feed provides a great opportunity to keep on top of the latest happenings in the Caribbean, Puerto Rico, and the U.S. Virgin Islands.

Institute Contact: William Gould and Gary Potts, wgould@fs.fed.us and garyspotts@fs.fed.us



Research and Development

Project Leader: Grizelle González, ggonzalez@fs.fed.us

Research has been the cornerstone of the Institute's program since its inception. Early research focused on reforestation, plantation forestry, tropical species identification, forest inventory methods, endangered species, and carbon sequestration. Currently, the Institute's research programs are focused on forest ecology, disturbance ecology, ecosystem functions and services, urban ecology, watershed dynamics, migratory species, climate change, and policy science to better understand the effects of natural and human-induced pressures on tropical forests and the landscapes in which they are found.

Research will continue to focus on the Luquillo Experimental Forest and its Bisley Experimental Watershed Long-Term Ecological Research (LTER) work, the San Juan Urban Long-Term Research Area, the Guánica Biosphere Reserve, various novel secondary forests, and other ecosystems in Puerto Rico; the Estate Thomas Experimental Forest in St. Croix, U.S. Virgin Islands; the Brazilian Amazon; and throughout the Western Hemisphere in collaboration with partners in the region.

The Institute has one work unit: IITF-4151. Its mission is to develop and disseminate scientifically based knowledge that contributes to the conservation of forests, wildlife, and watersheds of the American tropics in the context of environmental change. The work unit envisions that creativity and accomplishments result in timely products and services that anticipate the needs of society as it mitigates and adapts to environmental change. The Institute accomplishes its mission by developing and disseminating knowledge of scientifically sound practices that contribute to sustainable management of forest resources including water and wildlife, the conservation of primary forests, and the rehabilitation of degraded lands

Research FY 2012 Key Accomplishments

The Institute had a successful year in producing high-quality research and outreach related to environmental change, watershed management, wildlife management, protection of endangered species, forest ecology, and urban ecosystems.

Information Technology Highlights of 2012

With the assistance of the Chief Information Office, the Institute served as proof-of-concept for three projects that will benefit other R&D facilities with similar needs.

- **Network Attached Storage** is a dedicated data storage technology that can be connected directly to a computer network to provide centralized data access and storage to heterogeneous network clients. The Institute was able to successfully implement this robust information technology corporate solution that facilitates and enhances research operation, addresses the research and development (R&D) data management needs and storage issues, enables a fast and continuous local access and management of large data files, and provides an efficient and secure backup procedure during the hurricane season.
- **Internet2 Network** is the foremost advanced networking consortium in the United States. Led by the research and education community since 1996, Internet2 promotes leading-edge network capabilities and unique partnership opportunities that facilitate the development, deployment, and use of revolutionary internet technologies. The Forest Service's Chief Information Office and Research and Development (R&D) Program have committed Forest Service R&D to a pilot exploration of Internet2 capability and efficacy. Two sites were selected for the pilot—the Rocky Mountain Research Station's Fire Sciences Lab in Missoula, MT, and the Institute in Puerto Rico. Implementation at the Institute was done in partnership with the University of Puerto Rico.
- This year the Institute FS Guest Wireless was installed at the Institute Headquarters and Sabana Field Research Station.

Research Highlights of 2012

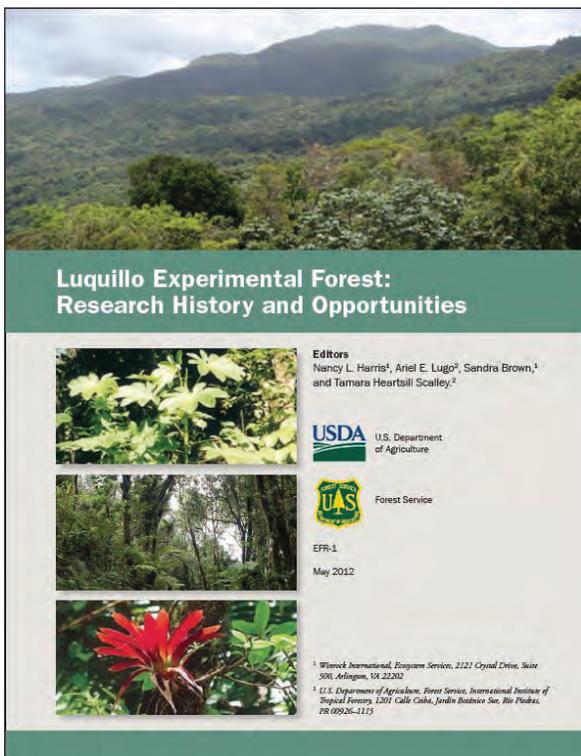
- Forest Service R&D and International Programs collaborated to establish the Sustainable Landscapes Program in Brazil with support from USAID and the the U.S. Department of State. An Institute scientist leads the program from Brazil, where he is a visiting scientist with our sister agency, the Brazilian Agricultural Research Corporation. The program has developed partnerships with Brazilian government agencies and non-governmental organizations to improve forest carbon accounting in Brazil at local and national levels using advanced technologies such as airborne lidar (light detection and ranging) remote sensing.
- The Institute has again shown that it is at the forefront of mapping tropical forests by producing the first-ever country-wide map of tropical forest tree communities. An Institute scientist led the use of multi-season satellite imagery to complete the most detailed map in existence of the forests and land cover of the Republic of Trinidad and Tobago, which funded the work, and new 1:25,000 topographic maps.
- The Institute is leading the Caribbean Landscape Conservation Cooperative (CLCC)—a multi-organization partnership to develop and put to use climate and conservation science to sustain and restore natural and cultural resources for the future. The CLCC is one of 22 landscape conservation cooperatives that geographically cover the 50 States and include partners in Mexico, Canada, and the Caribbean. In addition to Institute leadership of the CLCC, R&D personnel are involved in the landscape conservation cooperative effort nationwide by serving on steering committees, advisory boards, and as science providers.
- The Institute long-term avian community research in Puerto Rican dry and wet forest over the past 40 years continues to reveal population declines in several resident bird populations, and an alarming population collapse in nearctic-neotropical migratory species over-wintering (for as many as 9 months) in dry forest. Research is underway to elucidate the cause-and-effect components in relation to our changing climate, among other factors.
- Analyses of Kirtland's Warbler data gathered over eight winters in the Bahamas continues. Results of analyses recently presented at an international conference show that rainfall in the Bahamas affects the endangered warbler's body condition, which carries over to its Michigan breeding grounds. Analyses led by the Institute indicate that March droughts result in reduced body mass, which also corresponds with our cooperators' findings that after these March droughts male Kirtland's warblers arrive later on the breeding grounds, where late arrival results in reduced reproductive success. Therefore, wintering ground habitats that retain moisture during droughts are especially important for conservation of the Kirtland's Warbler.



- An Institute team is researching the tropical forest response to climate change. These efforts have resulted in the development of multi-agency collaborations to begin improving tropical forest representation in models and the development of a future ecosystem-scale climate manipulation experiment. Specifically: (1) participation in a Department of Energy workshop to discuss the Next Generation of Ecosystem Scale Experiments in the Tropics, which involved significant contribution to the resulting report; (2) a highly competitive USGS

Powell Center Award to improve representation of tropical forests and their response to warming in earth systems models; and (3) four scientific publications in prestigious journals.

- 1 The Forest Service's Experimental Forests and Ranges (EFR) book series was published and its first book was made available online. Edited by Institute scientists and collaborators, the Luquillo Experimental Forest: Research History and Opportunities summarizes and illustrates more than 30 years of research at the site, including chapters on vegetation, ecosystem dynamics, soils, fungi, fauna, key findings, and, of course, emerging research opportunities. The book is a reflection of the intense research agenda and collaborations at the site. <http://www.treearch.fs.fed.us/pubs/41159>.



- 1 The Institute is leading the Luquillo Long-Term Ecological Research Program (LUQ-LTER). The goal of LUQ-LTER is to understand how forest and stream ecosystems, and the services that they support, are changing in Puerto Rico, thereby providing guidance for management at a time of change in the tropics.
- 1 The Institute is a member of the core interdisciplinary team of the El Yunque National Forest Land Management Plan Revision Process. The El Yunque National Forest is one of the first national forests to begin its planning efforts under the new Forest Service planning rule. This year, Institute scientists have been directly involved in the development of the assessment report.
- 1 Institute scientists worked with the National Weather Service (NWS) in support of fire suppression activities. The Puerto Rico and U.S. Virgin Islands Fire Departments, a Multi-agency coordination group involved in regional emergency response planning, and Forest Service State and Private Forestry and National Forest System personnel collaborated to develop and implement a Fire Danger Rating System for Puerto Rico and the U.S. Virgin Islands. The NWS has adopted a set of fire danger zones developed by Institute researchers to reflect ecological variation associated with fuels and fire likelihood, replacing previous fire weather zones used by the NWS that had less ecologically meaningful boundaries.



Cabo Rojo, Puerto Rico.

Scientist Profiles



Ecosystem Ecology

ARIEL E. LUGO

Director

Research interests:

Assembly and functioning of novel ecosystems vulnerability, and functioning of urban ecosystems; response of tropical forests to environmental change.



Soil Ecology

GRIZELLE GONZÁLEZ

Project Leader

Research interests:

Soil ecology and biology, ecosystem ecology, tropical ecology, earthworm ecology.



Social Science

KATHLEEN MCGINLEY

Research Social Scientist

Research interests:

Natural resource and forest policies, institutions, and governance approaches, primarily in Latin America and the Caribbean, to determine their effects on tropical landscapes, forests and other natural resources, and associated human dimensions.

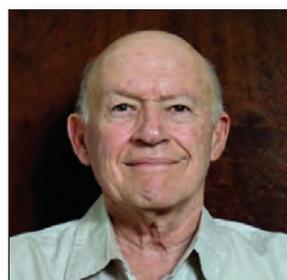


TISCHA A. MUÑOZ-ERICKSON

Research Social Scientist

Research interests:

Institutional arrangements, processes, and tools for facilitating more productive interactions among diverse research and policy stakeholders; and improving the ability of decision-makers, managers, and citizens to achieve more sustainable and just outcomes.



Plant Physiology

ERNESTO MEDINA

Adjunct Scientist

Research interests:

Physiological ecology of plants in stressful environments (wetlands, calcareous substrates) with emphasis on carbon balance, water stress, and nutrient relations.



Wildlife Ecology

WAYNE J. ARENDT

Wildlife Biologist

Research interests:

Disturbance ecology, climate change, conservation and management of neotropical resident and migratory bird communities and invasive species, with an emphasis on distribution, population dynamics, avian ectoparasites and life-history strategies.



JOSEPH M. WUNDERLE JR.

Wildlife Biologist

Research interests:

Conservation biology of birds, especially neotropical-nearctic migrants and their response to human and natural disturbances with objective of devising management practices to ameliorate adverse effects.



Silviculture

FRANK H. WADSWORTH

Emeritus Scientist

Research interests:

Scientific and technical basis for the management and sustainable use of forests and fiber-based products—silviculture and production.



Biogeochemistry

TANA E. WOOD

Adjunct Scientist

Research interests:

Effects of climate and land-use change on soil and ecosystem-level processes, with an approach ranging from field studies that evaluate landscape-scale responses, to variability in climate to laboratory experiments that elucidate linkages between microbes and the soil environment.



MICHAEL KELLER

Research Physical Scientist

Research interests:

Ecology and biogeochemistry of tropical forests, tropical deforestation and forest degradation, and the effects of changing tropical land uses on regional and global atmospheric composition. His studies have used a wide variety of tools including remote sensing, forest inventory, biogeochemical experimental manipulations, and ecosystem modeling.



Watersheds

TAMARA HEARTSILL-SCALLEY

Research Ecologist

Research interests:

Ecosystem services of riparian zones and streams; riparian vegetation and stream dynamics in headwater catchments; ecosystem responses to disturbance; long-term plots in Caribbean forests; knowledge and perceptions of riparian zones and wetlands by adjacent communities and stakeholders.



Landscape Ecology

EILEEN HELMER

Research Ecologist

Research interests:

Relationships between tropical forest disturbance and dynamics from stand to landscape scales; monitoring forest disturbance, species composition, structure and phenology with satellite imagery; socioeconomic controls on tropical forest disturbance and recovery.



WILLIAM A. GOULD

Research Ecologist

Research interests:

Conservation science, biodiversity, ecology, land cover mapping, modeling future scenarios for conservation planning, and field education and outreach.



SEBASTIÁN MARTINUZZI

Adjunct Scientist

Research interests:

Remote sensing, biodiversity conservation and environmental change.



AZAD HENAREH

Postdoctoral Scientist

Research interests:

Global effects of climate change, large-scale vegetation and ecosystem change, disturbances and their interactions on landscape structure and ecosystem functions at large scales, and changes in their dynamics through time.

Research Highlights By Scientist

I. Water, Air, And Soil

1. Rainfall chemistry along elevation gradient

We studied spatial and temporal patterns of inorganic ion composition rainfall in northeastern Puerto Rico, for the years 2010–2011.

Rainfall amount and ion concentrations vary along altitudinal gradients, in a process associated with exposure of mountain slopes to predominant winds. Rainfall was collected fortnightly from 20 stations (Fig. 3) located in coastal and interior lowlands at 0 to 100 meters; in lower montane sites at 200 to 500 meters; and in upper montane sites at the cloud formation level of 650 to 800 meters, and at the upper cloud formation level of 900 to 1,000 meters. Ion concentration in rainfall was measured once a month.

Total rainfall increased consistently and by a similar magnitude in all stations from 2009 to 2010, and decreased by a smaller magnitude in 2011 for all stations except the southeastern stations Humacao and Palmas del Mar (Fig. 4). The data for Río Grande and Toro reveal a decrease in rainfall in spite of their elevation. The pattern of increasing rainfall with elevation in Puerto Rico is valid only for the stations located in areas facing the northeast trade winds.

Average volume-weighted concentrations showed consistent variations with altitude during the period 2010–2011. The ion/sodium ratios used as indicators of the influence of marine aerosols were fairly similar for all stations in the case of chloride and magnesium; those of sulfate/sodium were about twice as high, whereas those of potassium/sodium and calcium/sodium ratios were considerable higher than the reference sea water values. The variability of those

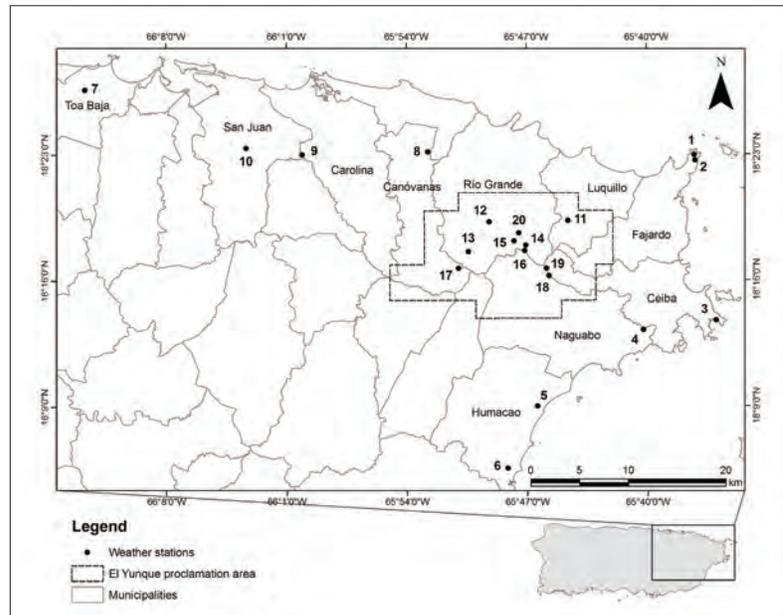


Figure 3. Weather station locations.

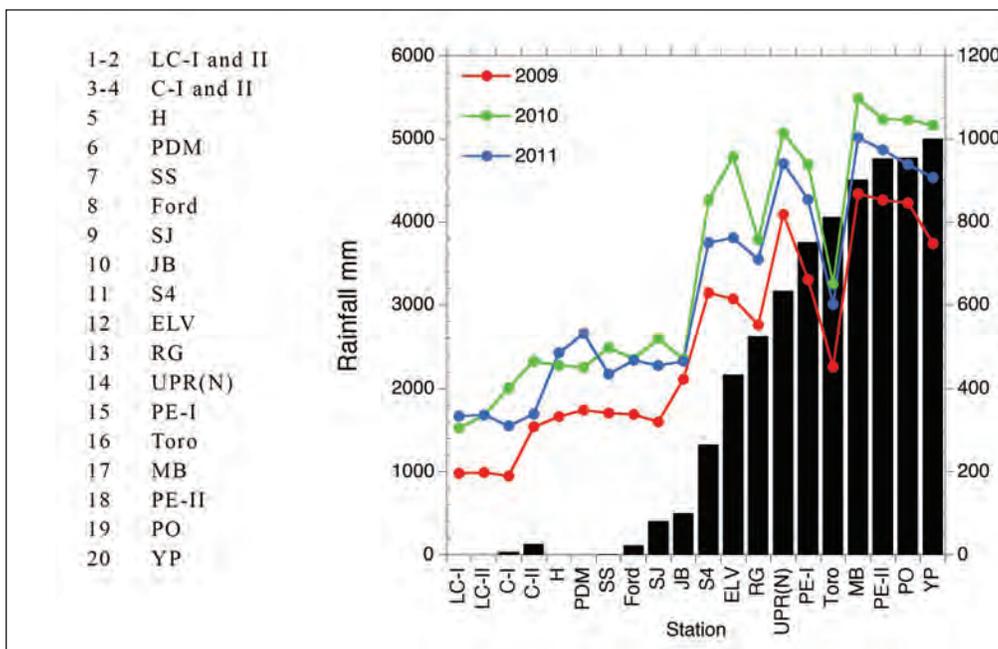


Figure 4. Total rainfall 2009-2011 stations distributed according to altitude above sea level.

ratios was large, in part due to the unusually large values for potassium and calcium in the Sabana Seca station.

Lowland coastal and interior stations showed higher volume-weighted concentrations of chloride, sodium, and magnesium in agreement with measurements in 2009 (Fig. 5). Concentrations of sulfate were lower for 2010–2011 compared to the values reported for 2009, but again ion concentrations measured at cloud formation level and upper cloud

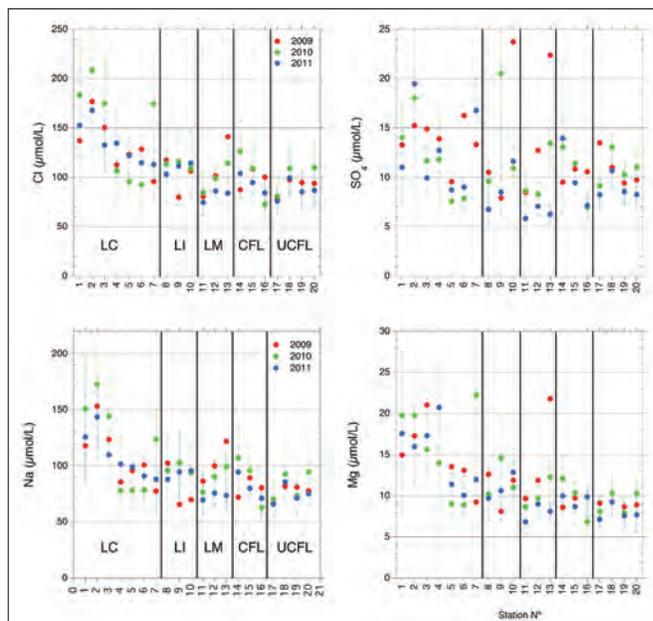


Figure 5. Average volume - weighted concentrations main ions in rainfall for the period 2009-2011 (n=20-22). Bars (2010-2011) indicate standard error of the volume-weighted mean.

formation level stations showed a clear tendency to lower values. Concentrations of potassium and sodium were consistently lower for cloud formation and upper cloud formation levels.

The calculated values of annual inputs of ions showed a pattern revealing that total rainfall was more important than ion concentration in determining the amount of ions deposited in rainfall. Input of chloride was at or above 142 kilograms per hectare per year in upper montane stations and below 69 kilograms per hectare per year in the lowland stations. The same pattern was observed in the case of sulfate—around 16 kilograms per hectare per year in the upper montane stations compared to 6 kilograms per hectare per year in the lowland coastal stations.

The sodium and magnesium cations showed an altitudinal pattern similar to that of chloride and sulfate. Sodium averaged about 92 kilograms per hectare per year in the upper montane stations and 45 kilograms sodium per hectare per year in the lowland stations. For magnesium the input was around 10 kilograms per hectare per year in the upper montane stations and 7 kilograms per hectare per year in the lowland stations. Potassium and sodium did not show a clear altitudinal pattern. 1

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2. Assessing the carbon balance of a novel forest stand in the karst region of Puerto Rico

Tropical forests play a major role in the global carbon cycle, and their soils represent the largest natural source of carbon dioxide (CO₂) to the atmosphere. As such, research that quantifies the natural variability of soil CO₂ efflux in these ecosystems and identifies potential climatic controls could improve our ability to predict the response of this large carbon flux to future climate change. As part of an overarching goal to estimate the net carbon balance of a novel subtropical forest stand dominated by the introduced species, *Castilla elastica*, we installed an automated soil respiration system in March 2011 in the privately owned El Tallonal Reserve. Since installation, we have consistently measured hourly CO₂ efflux from six permanently placed chambers. We have additionally collected meteorological data from two towers installed at the site. Mean daily soil CO₂ efflux varied significantly over the first year of data collection. This seasonal variation was significantly positively related to air temperature ($R^2=0.58$, $p=0.0001$). In addition to significant seasonal variation, soil CO₂ efflux also varied on a diel time scale, demonstrating a bi-modal pattern with a depression occurring at midday. Results from the first year of soil respiration data were presented by Omar Gutiérrez del Arroyo, an undergraduate student at the University of Puerto Rico, at the 2012 Annual Luquillo Long-Term Ecological Research Meeting in Puerto Rico and at the 97th Annual Ecological Society of America (ESA) meeting in Portland, OR. Omar was awarded best undergraduate poster presentation at the ESA meeting. He was also awarded a prestigious Sigma Xi Grants-in-Aid of Research Award to purchase soil moisture and temperature probes for the El Tallonal research. In collaboration with the Institute, Omar will continue researching controls on soil respiration at El Tallonal as a Masters degree student at the University of Puerto Rico.

Collaborating Institutions: Citizens for the Karst; Fundación Puertorriqueña de Conservación; and University of Puerto Rico-Río Piedras

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3. Millipedes and litter decay: direct and indirect effects on litter of varying lignin content

Millipedes constitute an essential part of tropical ecosystems for their role in decomposition and nutrient cycling. Diplopods can influence decomposition directly by fragmenting leaf litter and indirectly by impacting microbial biomass. We investigated both the direct and indirect effects of millipedes on decomposition in a subtropical wet forest in Puerto Rico using microcosms.



C. Murphy

The microcosms consisted of clear plastic containers, with mesh tops to keep millipedes within.

We studied the influence of the substrate, by using three leaf species with varying lignin/nitrogen ratios, and the effect of millipede density on the above-mentioned direct and indirect effects. We found that the remaining leaf mass and leaf area were lowest in the leaf species with the lowest L/N ratio (*Dacryodes excelsa*). There was significantly less leaf mass remaining from microcosms with the highest density of millipedes. Soil microbial biomass was significantly higher under *D. excelsa* leaves than for the other litter species, but microbial biomass did not significantly differ among the different millipede densities. We found that the effect of millipedes differed depending on the lignin content of the litter species when the



C. Murphy

Millipedes used in the microcosms were all from the Order Stemmiulida, Family Stemmiulidae.

litter species were looked at separately, with the highest lignin-content leaf species (*Rourea surinamensis*) having significantly less leaf mass remaining with millipedes than without at the last collection. Soil pH was significantly affected by the litter species and the density of millipedes. Our results show that millipedes had direct effects on decomposition by fragmenting litter, and this effect depended on litter quality; they also suggest that millipedes had little or no indirect effects in terms of influencing microbial biomass.

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4. Effects of drought on tropical soil biogeochemistry and greenhouse gas emissions

Although considerable uncertainty remains, many climate models predict large areas of the tropics will experience significant declines in precipitation in the coming decades. Projected changes in tropical forest water availability could significantly alter the net balance of greenhouse gases that contribute to climate change. Tropical soils release large amounts of carbon dioxide (CO₂) as a by-product of organic matter decomposition as well as several other soil microbial processes that are known to be influenced by water availability. These biological processes also control the emission and consumption of key greenhouse gases, such as nitrous oxide (N₂O) and methane (CH₄). In collaboration with the NOAA Climate and Global Change Postdoctoral Fellowship Program and the University of California-Berkeley, the Institute supported the establishment of a throughfall exclusion experiment in the Bisley Experimental Watershed. (Throughfall is rainfall in a forest area that is not intercepted by the crown canopy and reaches the forest floor.) This experiment simulated the effects of a prolonged dry season by preventing throughfall from reaching the forest floor for a 3-month period using clear plastic panels. Greenhouse-gas emissions from soil were measured before, during, and after the experiment. The short-term simulated “drought” resulted in significant reductions in CO₂ emissions and an increase in both N₂O and CH₄ consumption. However, topographic position significantly influenced the direction and magnitude of the effect of drought on greenhouse gas emissions, which challenges our ability to accurately represent tropical forest responses to drought in earth system models. As a follow up to the aforementioned study, a second simulated drought was imposed in the same system. Results from this experiment showed that pre-exposure to drought increases the resistance of soil bacterial communities to extended drought. This work was published in *Global Biogeochemical Cycles* and a review of the publication appeared in the journal *Nature*. Results from the microbial work are currently in press with

the *International Society of Microbial Ecology Journal*. In addition to publications in scientific journals, Institute scientists contributed significantly to a chapter on drought effects in the tropics as part of a summary report on a 2012 DOE workshop on the Critical Research Needs for Tropical Ecosystems

Collaborating Institutions: University of California-Berkeley, NOAA Climate and Global Change Postdoctoral Fellowship Program, Lawrence Berkeley National Laboratory, and Luquillo Long-Term Ecological Research

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5. Seasonality and forest succession in tropical watersheds affect stream exports

Continuous export of organic matter from montane streams depends on forested headwaters contributing leaf litter of varied quantity and quality year round. Independently of the level of hillslope or stream runoff, the state of watershed vegetation development limits how much material can be exported during a storm. The synergy between hurricane intensity and frequency, and level of vegetation maturity, defines the long-term pattern of high leaf litter export events in forested watersheds. Headwaters under non-forested land cover conditions may not be able to retain and process a large percentage of leaf litter inputs, which in turn affects water quality and resource availability for aquatic ecosystems downstream.

In the Bisley Experimental Watershed, stream leaf litter exports varied in terms of quality (nutrient content) between the dry and wet season during a 15-year study. Variation in the quantity and quality of exported material depended on traits of particular events (storms, hurricanes), season, and the successional



status of the forest. The quality (chemical composition) of exports varies temporally, with proportion of carbon to nitrogen being highest in the driest months (low quality for consumers) and lowest during rainy months (high quality for consumers).

The differences in export quality signal that more attention should be given to changes in rainfall seasonality in the tropics, because these changes could not only affect stream discharge and timing of new leaf and flower production, but also increase the seasonal range in quality of organic matter exports to reach streams.

The export and retention of leaf litter greatly influences the water quality, food webs, and habitat structure of forested headwater streams. With this in mind, watershed and aquatic wildlife managers need to consider that changes in the quality of organic matter resources in streams can potentially alter ecosystem processes and aquatic food webs that depend on them.

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6. New study shows reduced-impact logging maintains tropical rain forest's critical role in carbon and water cycling

For decades scientists and foresters have debated how best to reap economic benefits from tropical rainforests while still maintaining their high biodiversity and critical roles in the global carbon, energy, and water cycles. In an unprecedented comparison of a logged tropical forest with an intact forest ecosystem, a new scientific study, "Reduced Impact Logging Minimally Alters Tropical Rainforest Carbon and Energy Exchange," conclusively demonstrates that with reduced-impact logging, Amazon rainforests can generate profits while emitting only 4 percent of the carbon emissions that come with total forest clearing.

In reduced-impact logging, loggers cut the heavy vines that connect trees and direct where the trees that have been selected for harvest will fall. Far fewer surrounding trees are damaged or killed when the target logs fall than in conventional selective logging.

The study, led by Dr. Scott D. Miller of the State University of New York at Albany, was co-authored by Dr. Michael Keller of the Institute, who envisioned and initiated the study in 1997. Miller and Keller are joined by co-authors from several American and Brazilian universities. The study measured the exchanges of carbon dioxide and water between forests and the

atmosphere, comparing an old-growth forest in Central Amazonia with one nearby that was logged commercially using reduced-impact methods. The scientists monitored the air exchanges from a 65-meter (213-foot) tall tower that extended above the forest canopy. Detailed measurements of the carbon exchange and the carbon stocks in live and dead trees showed that the logged forest lost carbon during the first year after logging but thereafter the forest carbon balance turned positive. Similarly, forest transpiration declined

briefly but the water budget of the logged forest returned to pre-logging levels within a year.

Logging is a profitable land use in the Brazilian Amazon, and frequently it is considered as nothing more than a process that accelerates deforestation. This study shows to the contrary that by using reduced-impact methods, logging can be ecologically benign while being economically beneficial.

A copy of the study can be obtained at www.pnas.org.

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II. Wildlife

1. Duration and rate of spring migration in the endangered Kirtland's Warbler

For most migrant birds, mortality during the annual cycle is believed to be highest during migration, at least relative to the more sedentary breeding and wintering periods. However, for most birds little is known about their ecology and behavior during migration, and hence, we are mostly ignorant of the various factors that may contribute to mortality during migration. This lack of knowledge pertaining to migration also applies to the duration of migration or the number of days it takes an individual bird to fly from its wintering grounds to its breeding grounds.

Prior to our study little was known about the endangered Kirtland's Warbler migratory behavior. Because of the warbler's limited breeding range (Michigan and small colonies recently established in Wisconsin and Ontario) and wintering grounds restricted to the Bahamas Archipelago, Wunderle and his collaborators were able to estimate the duration of spring migration for five male Kirtland's Warblers (Ewert et al. 2012). This was accomplished by capturing Kirtland's Warblers and providing each individual with a unique combination of color-bands enabling recognition of individuals by observation with binoculars in the field. Wintering warblers were banded on Eleuthera, Bahamas, where our field crew regularly observed individuals in April and noted the dates when they disappeared from their winter territory. Once a banded male disappeared, cooperators in Michigan were notified to search for the specified banded individuals as they returned to their breeding territories. Each of the banded male warblers had been observed in Michigan in the previous breeding season, so the Michigan observers knew where to search for specific individuals as they arrived on their

breeding territories. Therefore, by observing uniquely color-banded males at or near both the beginning and end of spring migration we were able to estimate the average duration of spring migration. The actual times of migration could be less than the durations that we reported because an individual may not have departed immediately following its last observation on Eleuthera. Also, individuals may not have been observed on the day of their arrival on their Michigan breeding territory.

Based on field observations we estimated that the average duration of spring migration for these five individuals to have been no more than 15.8 days (range 13–23 days) to cover approximately 2,200 kilometers (1,367 miles) from Eleuthera to Michigan (Fig. 6). On average, these five males were moving at a rate of 144.5 kilometers per day (96.1–169.1 kilometers per day) or 89.8 miles per day during their spring migration. This migratory rate of male Kirtland's Warblers was comparable to individual migratory rates that have been studied in other song bird species.

These observations indicate that male song birds migrate relatively quickly during spring migration and likely do not linger for long in their stopover sites as they make their way north. Our understanding of the various ecological, meteorological, and physiological factors that affect duration and rate of migration will be better understood as advancing technology provides sophisticated monitoring techniques (e.g., light-sensing geolocators) to permit researchers to follow larger numbers of individual birds during migration. These new techniques will help us determine when and where along the migratory route Kirtland's Warblers are most vulnerable, and allow us to develop a comprehensive conservation program for the species.

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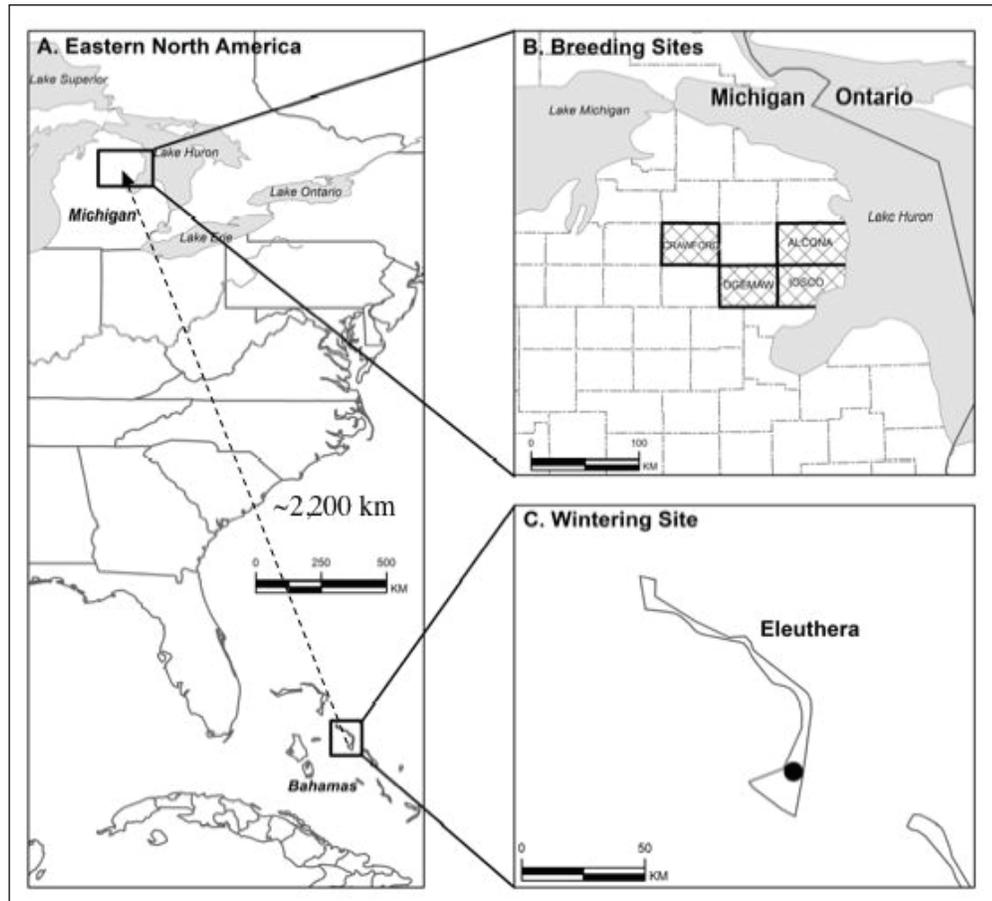


Figure 6. Approximate breeding and wintering locations (A) of color-banded male Kirtland's Warblers for which durations and rates of spring migration were determined. Dashed line with arrow indicating the Michigan breeding grounds shows the approximate 2200 km direct route from Eleuthera, The Bahamas. The breeding sites (B) for the color-banded males are shown by county in the Lower Peninsula of Michigan. The wintering sites where the color-banded males were observed are shown (C) for southern Eleuthera, The Bahamas. This figure was reproduced from Ewert et al. (2012) published in the *Wilson Journal of Ornithology*.

2. Differences in knowledge between rural and urban residents in their knowledge about birds and their conservation in Puerto Rico

As part of his doctoral dissertation, Edgar Vázquez-Plass quantified people's knowledge and opinions about Puerto Rican birds and compared their responses in rural and urban communities in northeastern Puerto Rico (Vázquez-Plass and Wunderle 2010). Data were gathered through interviews using a standardized questionnaire presented to 131 people in rural and urban areas in the vicinity of the Luquillo Experimental Forest. The sampled urban residents had significantly higher levels of education than the rural residents and were more knowledgeable about the bird species in their neighborhoods than were the rural residents. Rural and urban residents did not differ in their knowledge of exotic bird species in their

communities and both identified psittacids (parrots and parakeets) and finches as the most common exotics in their neighborhoods. Approximately half the respondents failed to identify exotic bird species in their communities (rural 56 percent, urban 47 percent) and only 5.7 percent of rural and 6.3 percent of urban residents had exotic birds as pets.

However, the two groups of respondents did differ in what they considered important threats to birds in their neighborhoods. For example, urban residents cited urban sprawl (48 percent) deforestation (44 percent), and hunting (5 percent) in contrast to rural residents who mentioned deforestation (44 percent), urban sprawl (31 percent), and hunting (25 percent) as important threats affecting birds. The respondents also differed significantly in their perception of the effectiveness of conservation laws and regulations. Although 58 percent of the rural respondents believed that current conservation laws are adequate, only 45

percent of urban respondents believed these laws are adequate. Overall, both rural and urban residents had little knowledge of birds in their communities although the two groups differed in their opinions and attitudes regarding conservation issues facing bird populations.

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3. Photographic key to determine age and gender in two *Thryothorus* wrens from Nicaragua's Pacific slope: a visual and metric aid to determining age and gender in tropical wrens

We used meristics, plumage, and molt characteristics to derive an innovative photographic key to be used by neotropical bird biologists to determine age and gender in two species of neotropical wrens (*Thryothorus rufalbus* and *T. modestus*). Our results and key are useful in age and gender determination within the family, a daunting task throughout the species' range, but especially in the tropics, where few studies have been done.

Knowing a bird's age is an essential component of long-term avian banding programs designed to track changes in the demographics of nearctic-neotropical migrants and permanent residents, while monitoring their population trends. Plumage characteristics can be used to determine the gender and (much less often) the age of sexually dichromatic species. Avian sexual dichromatism is prominent in species with

wide geographical ranges, and especially in those that undergo long-distance migration, whereas it is much less common in species with limited distribution and restricted movements. Neotropical wrens, which are members of the mostly new-world family Troglodytidae (only 1 of 80 species is found in Eurasia), generally tend to be sexually monochromatic (although seasonal sexual dichromatism occurs in some species). Consequently, wrens pose a serious challenge for aging and sexing.

To investigate the best techniques to confidently age and sex two permanent-resident wrens, we captured 153 individuals of both species: 92 total (36 captures, 56 recaptures.) rufous-and-white wrens (*Thryothorus rufalbus*), and 61 total (45, 16) plain wrens (*T. modestus*). We discovered that the gradation in the hues of the eumelanin (black) pigment in the feather barbs of both species (lighter in young birds) can be used with confidence in aging but should be used in combination with molt limits in the flight feathers (primaries, secondaries, and rectrices). Wing chord length, in combination with plumage characters and brood patch, are reliable criteria for determining the sex of rufous-and-white wrens. Knowledge of the demographics of disturbance-sensitive species, including several neotropical wrens, is essential in habitat conservation and management.

Collaborating Institutions: Universidad Centroamericana, Managua; Paso Pacífico; and Biodiversity Research Institute, Maine

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Wildlife Researcher demonstrating banding techniques for wren photographic key.

III. Resource Management and Use

1. Assessing litterfall trap bias: are traps preferentially representing certain kinds of leaf litter?

Several factors may cause bias while sampling litterfall, which can lead to over- or under-representation of the species present in the surrounding vegetation. For example, trees standing precisely above litterfall traps, or vegetation having big and wide crowns and/or with high leaf fall rate, may be over-represented in litterfall samples. Additionally, trees or shrubs standing upslope or in the windward side of litterfall traps may be more likely to have their litter collected in litterfall traps. Conversely, species with big and/or heavy leaves or fronds may be under-represented in litterfall traps. However, the few studies dealing with patterns of litterfall dispersal and collection have found contradictory results. In this study, we examine the correspondence between litterfall samples and standing vegetation in the Luquillo Experimental Forest, Puerto Rico.

We compared litterfall and standing vegetation in a subtropical wet forest in Puerto Rico at three spatial scales (forest, 106 m²; sampling blocks, 4x104 m²; and plots, 4x102 m²) to: (1) determine the effect of tree height, crown area, leaf size, and distance to traps on litterfall species composition; (2) determine if

representativeness of litterfall samples was affected by litter traps' central or lateral location relative to vegetation plots; and (3) gain insights on scaling up data of litterfall from sampling plots into forest stand scale (Fig. 7).

Higher height and a wider crown were more important than a closer location to litter traps with respect to determining relative abundance of species in litterfall samples. Central and lateral traps provided equally representative samples at the forest scale. However, correlations between litterfall and plant species relative abundances at the plot scale showed that central traps better represented the surrounding vegetation than lateral traps. When comparing vegetation community with litterfall across scales, similarity decreased from the scale of forest to that of plots. Leaf size had a slight effect on litterfall composition, suggesting that big and heavy leaves could be under-represented in litterfall samples. Because of the wide range of horizontal mobility of leaf litter, traps were not necessarily collecting leaf litter from the near vicinity. Therefore, care should be taken when scaling up from small to intermediate sampling units, owing to the high variation of leaf litter dispersal at scales lower than 102 m².

Collaborating Institution: University of Puerto Rico

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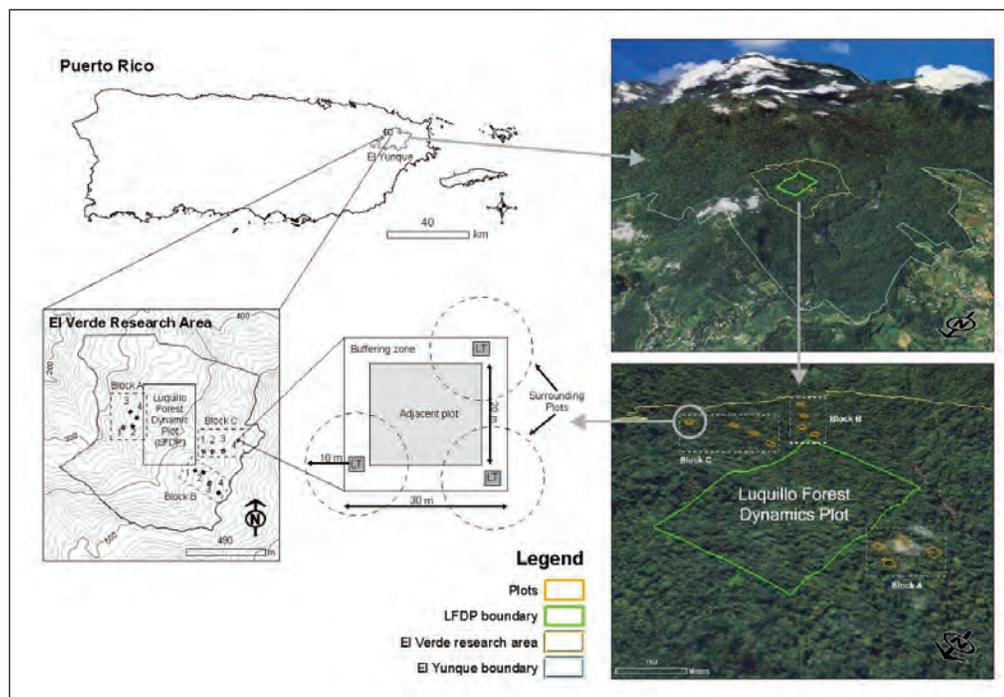


Figure 7. Location of blocks, adjacent plots (square plots, numbered 1-4 within each block), surrounding plots (circular plots), and litter traps (LT) in El Verde research area. Inferred area covered by each block is 40,000 m² (broken lines). The complete study area covers around 106 m².

2. Knowledge-action systems analysis for urban governance and sustainability

A recent issue of *Scientific American* poses the idea that as engines of culture, innovation, and economic activity, cities play a pivotal role in the ability of society to develop in a better, more innovative and sustainable manner. It behooves us to understand, evaluate, and design knowledge and anticipatory capacities that help city managers and residents formulate positive, plausible visions for transformative relationships of society and ecosystems. Yet, frameworks to evaluate and design novel and adaptive capacities in urban systems are virtually non-existent. This research examined how knowledge-action systems—the networks of actors involved in the production, sharing, and use of policy-relevant knowledge—work in order to determine

what capacities are necessary to effectively attain sustainable outcomes. I developed and applied a novel interdisciplinary framework—the knowledge-action system analysis (KASA) framework (Fig. 8)—and implemented it in the contested context of land use and green area governance in San

Juan in order to evaluate institutional capacities to address and implement sustainable strategies in the city. The application of KASA involved five steps and quantitative and qualitative tools from social science research methods:

- a. Knowledge mapping with surveys and social network analysis (Fig. 9);
- b. Identifying central actors and examining knowledge-power relations in the network using social network analysis (Fig. 10);
- c. Analyzing dominant and marginal visions for the future of the city using ethnographic methods such as interviews, media, and official document analysis;
- d. Exploring influences of epistemic cultures on vision divergence (same methods as above); and

e. Understanding dynamics and politics of expertise using participant observation methods, interviews, and document analysis.

Results from the analysis revealed a diverse network of actors contributing different types of knowledge, suggesting a potential for creativity and innovation in governance. These capacities, however,

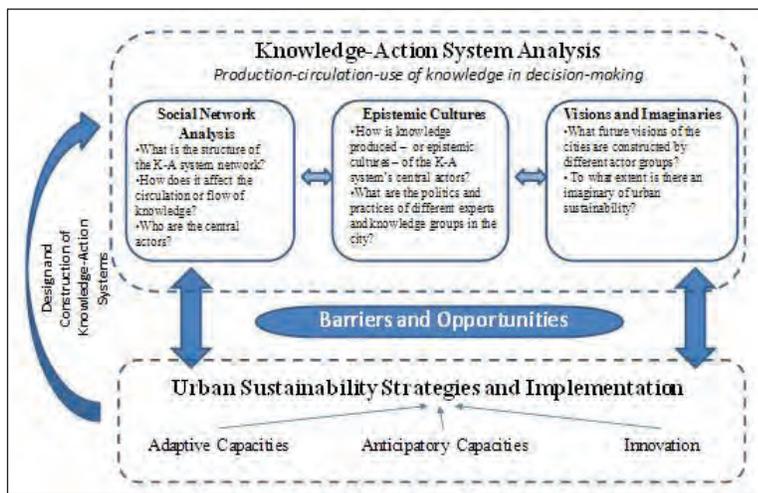


Figure 9. Conceptual Model of the Knowledge-Action System Analysis (KASA) Framework

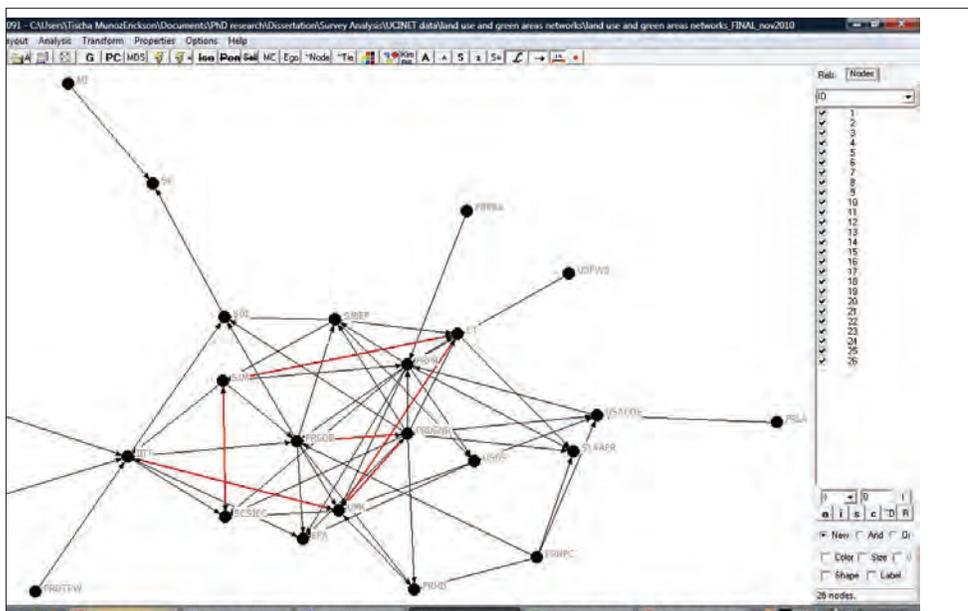


Figure 9. Knowledge network ‘maps’ to characterize the diversity and the structure of the network’s central actors.

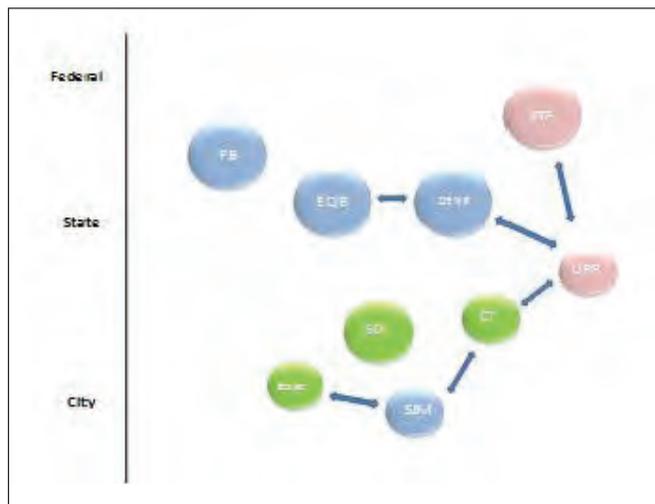


Figure 10. Knowledge-action system analysis in San Juan.

are hindered by various political and cultural factors, such as: (1) actors who dominate knowledge about land use are the same ones who hold power over the resource; (2) a knowledge hierarchy exists in which conventional expertise and planning procedures dominate over other alternative ways of knowing; (3) multiple visions and possible pathways for the city exist that have not been deliberated or tested; and (4) boundary spanning opportunities are limited by assumptions that knowledge and action should be done in distinct policy spheres of city planning.

This study shows that developing adaptive and innovative capacities necessary to transition to sustainability in cities like San Juan is not solely a matter of harnessing more science or technology, but about managing the politics of knowledge and visions of the city that emerge from complex governance systems.

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3. Forest regulations are rigorous throughout much of the Americas, but implementation remains a challenge in Latin America

While forestry rules and regulations for private land are often stricter and more comprehensive in Central and South America compared to the United States, poor implementation in many cases mostly makes them ineffective and underscores the need for better enforcement and incentives.

Since the first Earth Summit in 1991, most countries in the Americas have significantly revised their forest laws and regulations in order to better achieve sustainable forest management. U.S. Forest Service scientists wanted to know more about the intended and actual effects of these laws on forest sustainability and how they compare among countries—information that has not been studied much but is crucial to the

effective design and implementation of good forest governance. With a group of forest policy scientists from throughout the Americas, the Forest Service led a study that examined key components of natural forest management and how they are addressed through legislation and other policy directives in Argentina, Brazil, Chile, Costa Rica, Guatemala, Nicaragua, Paraguay, Uruguay, and the United States. They found that, on paper, Latin America is not an unregulated frontier, as occasionally claimed by some critics. In fact, much of Latin America has more rigorous and comprehensive forestry rules (i.e., stricter thresholds on more environmental, economic, and social aspects) for private land than much of the United States. Overall, the protection of at-risk species and riparian buffers are required in all countries and include specific prescriptions in most; forest management planning and secure legal land title or tenancy are commonly required; and mandatory processes to protect soil and water quality are customary. Less common requirements include forest monitoring and social and economic aspects, and, when in place, they are usually voluntary.

However, while there was a significant degree of rigor and comprehensiveness in the forestry rules from Latin America, significant gaps persist between rules on paper and rules in use. On the whole, despite significant efforts to improve governmental forest regulation and to increase the transparency and legality of timber production and commerce in the tropics in particular, competing land uses, unclear tenure, and limited institutional capacity for effective implementation and enforcement of forest legislation continue to be significant challenges for advancing the sustainability of forest management in many Latin American countries. Ultimately, the researchers stress that it is not the number, rigor, or comprehensiveness of rules and regulations related to forest sustainability that matter as much as the implementation and



Reviewing Compliance of Harvest in the Consorcio Forestal Amazónico, Ucayali, Perú.

application of sound practices on the ground, which ultimately depend on the appropriate mix and balance of mandatory requirements for sustainable forest management, voluntary guidelines, information and education, and laissez faire.

Collaborating Institutions: Universidad de la República, Uruguay; North Carolina State University;

Instituto Nacional de Tecnología Agropecuaria, Argentina; Universidad Austral de Chile; Universidade Federal de Viçosa, Brasil; Universidad Nacional de Asunción, Paraguay

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IV. Climate Change

1. Tundra vegetation and climate change: results from long-term global observation and experimentation

Information from studies around the circumpolar biome was analyzed to look for trends over time in the relative cover of various tundra vegetation growth forms—and to measure the relationship of these trends with climate change. Long-term observations generally match experimental warming findings; the response of vegetation to warming varied depending on initial climate and the suite of species present. The greatest increases in shrub cover are in the warmer parts of the Arctic.

Long-Term Observations. Temperature is increasing at unprecedented rates across most of the tundra biome. Remote-sensing data indicate that contemporary climate warming has already resulted in increased productivity over much of the Arctic, but plot-based evidence for vegetation transformation is not widespread. We analyzed change in tundra vegetation surveyed between 1980 and 2010 in 158 plant communities spread across 46 locations (Fig. 11). We found biome-wide trends of increased height of the plant canopy and maximum observed plant height for most vascular growth forms, increased abundance of litter, increased abundance of evergreen, low-growing, and tall shrubs, and decreased abundance of bare ground. Inter-site comparisons indicated an association between the degree of summer warming and change in vascular plant abundance, with shrubs, forbs, and rushes increasing with warming. However, the association was dependent on the climate zone, the moisture regime, and the presence of permafrost. Our data provide plot-scale evidence linking changes in vascular plant abundance to local summer warming in widely dispersed tundra locations across the globe.

Global Experimental Results. Understanding the sensitivity of tundra vegetation to climate warming is critical to forecasting future biodiversity and vegetation feedbacks to climate. In-situ warming experiments accelerate climate change on a small scale to forecast responses of local plant communities. Limitations of this approach include the apparent site-specificity of results and uncertainty about the power of short-term studies to anticipate longer term change. We address

these issues with a synthesis of 61 experimental warming studies, of up to 20 years duration, in tundra sites worldwide (Fig. 12). The response of plant groups to warming often differed with ambient summer temperature, soil moisture, and experimental duration. Shrubs increased with warming only where ambient temperature was high, whereas graminoids increased

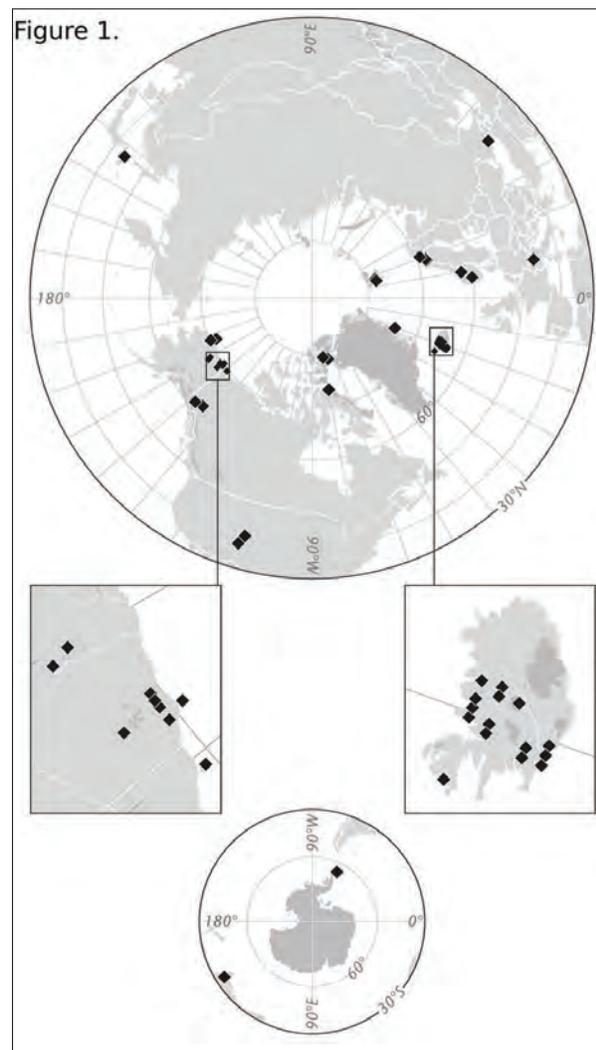


Figure 11. Study sites spread across the tundra biome in the Arctic, alpine and Antarctic regions. Black symbols represent the grid-cell centers of the 46 locations into which the 158 studies were grouped for the analysis (from Elmendorf et al. 2012: <http://treearch/pubs/41558>).

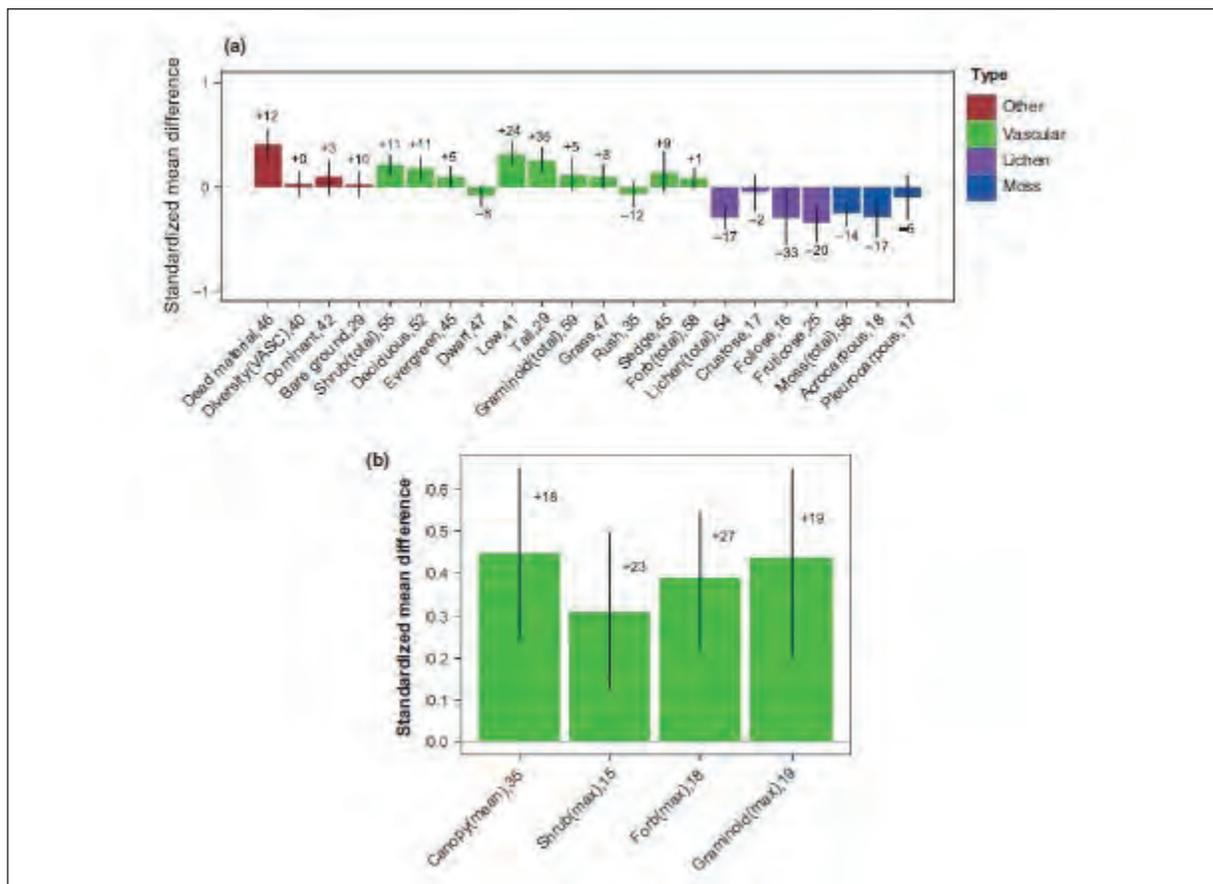


Figure 12. Average effects of warming on community attributes and growth form abundance (a) and vegetation height (b). Bars show the weighted mean effect size (standardized mean difference) based on intercept-only weighted linear mixed models of all studies and sampling years. Error bars show 95% credible intervals. Median per cent change recorded over all studies and years is inset above or below the corresponding bar. The x-axis labels show response variable and number of studies included in the analysis (from Elmendorf et al. 2012: <http://treesearch/pubs/40535>).

primarily in the coldest study sites. Linear increases in effect size over time were frequently observed. There was little indication of saturating or accelerating effects, as would be predicted if negative or positive vegetation feedbacks were common. These results indicate that tundra vegetation exhibits strong regional variation in response to warming, and that in vulnerable regions, cumulative effects of long-term warming on tundra vegetation—and associated ecosystem consequences—have the potential to be much greater than we have observed to date.

Collaborating Institutions: University of British Columbia; Grand Valley State University; University of Gothenburg; Université du Québec à Trois-Rivières; University of Tromsø; VU University Amsterdam; Arizona State University; Umeå University; Moscow State Lomonosov University; Environment Canada; University of California at Berkeley; University of Alberta; Norwegian Institute for Nature Research; University of Texas; University of Saskatchewan; University of Iceland; U.S. Fish and Wildlife Service; Norwegian University of Life Sciences; Colorado State University; Hokkaido University; Icelandic Institute

of Natural History; University of Copenhagen; Florida International University; Institute for Snow and Avalanche Research, Aarhus University; Marine Biological Laboratory, University of California at Davis; Forest Research Institute, University of Oulu; La Trobe University; Michigan State University; and University of Alaska Anchorage.

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2. Global warming and the potential effects on the tropical forest carbon balance

Global models project a significant and permanent increase in temperature in tropical regions over the next 2 decades. Given the importance of tropical forests to the global carbon budget, understanding the potential for these forests to adapt to an unprecedented temperature regime is critical to our ability to accurately predict feedbacks to future climate. In response to a recognized need to understand the tropical forest response to increased temperatures, the Institute is leading a collaborative effort to develop a full-scale forest warming experiment in Puerto Rico.

This experiment would be the first to integrate both canopy and soil warming in a forested ecosystem and will enable us to determine the resilience and adaptability of these valuable ecosystems to increasing temperatures.

Over the past year, the Institute's scientists and collaborators have laid the groundwork for a multi-institution collaboration on understanding the tropical forest response to increased temperature; the collaboration includes the Department of Energy (DOE), the U.S. Geological Survey (USGS), the U.S. Forest Service, the University of Puerto Rico-Río Piedras (UPR), and the Institute. Specific activities included: (1) participation in a DOE workshop on the Next Generation of Ecosystem Scale Experiments in the Tropics, which resulted in significant contribution to the temperature chapter in the resulting report; (2) a highly competitive USGS Powell Center Award

to improve representation of tropical forests and their response to warming in earth system models; (3) significant investment by the Forest Service in infrastructure for the proposed experiment; and (4) informal agreement with UPR for use of the Jardín Botánico for the prototype of the full-scale warming experiment. Working with Dr. Bruce Kimball (Greenleaf Group) we have made significant advances in full-scale prototype design. Finally, this work has resulted in three publications in highly prestigious journals: *Biological Reviews*, *New Phytologist*, and *Theoretical and Applied Climatology*.

Collaborating Institutions: Michigan Technological University; U.S. Geological Survey; and Fundación Puertorriqueña de Conservación

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V. Inventory and Monitoring

1. Characterization of lichen communities along an elevational gradient in Puerto Rico

Lichens are important components of biodiversity worldwide. They remain poorly characterized in the tropics, even though they perform important ecological functions. Their diversity reaches a maximum in tropical forests, and they are truly eye-catching organisms! We have been studying lichen communities in a series of plots representing different terrestrial ecosystems along an elevational gradient in order to increase our knowledge about these organisms and their ecological role in Puerto Rican forests. Our results are already starting to reveal important ecological patterns for lichens, particularly in the four main upper elevation ecosystems present at the Luquillo Experimental Forest: tabonuco (*Cyrilla racemiflora*), sierra palm (*Prestoea montana*), palo colorado (*Dacryodes*

excelsa), and elfin woodland. We have found that corticolous (bark-inhabiting) lichens are more diverse in tabonuco and palo colorado forests (Fig. 13). Palm forests have the lowest number of species but harbor the highest number of foliose cyanobacterial lichens. Squamulose and fruticose growth forms, such as species within the genera *Cladonia* and *Cladia*, are occasionally found in elfin forests, which are in turn richer in species than palm forests. Additional ecological information of lichens in these and other ecosystems will be included in the upcoming Institute report, "Lichens in Puerto Rico: An Ecosystem Approach," and the lichen monitoring manual, "Lichens As Indicators of Forest Health in Puerto Rico."

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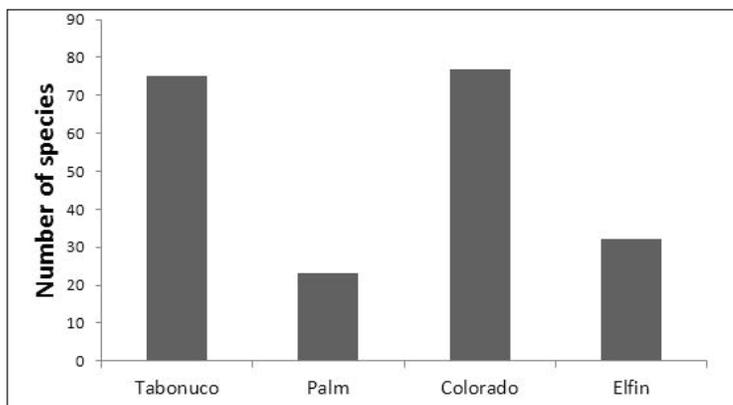


Figure 13. Number of lichen species inhabiting the bark of trees present in different ecosystems in El Yunque National Forest, Puerto Rico.



Thalli of fruticose lichen species *Cladia aggregata* growing in an Elfin forest in El Yunque National Forest, Puerto Rico

2. U.S. Virgin Islands Gap highlights

The U.S. Virgin Islands (USVI) Gap Analysis Project has mapped the predicted habitat distribution of 154 vertebrate species and assessed their conservation status (Fig. 14). This project is part of the National Gap Analysis Program, whose mission is to keep common species common. Our results are based on a remarkable occurrence records gathering endeavor—gathering more than 30,000 records from many sources, including: expert collaborators input and review, the development of a new landcover for the USVI, the assessment of the islands' protected areas, and integration and analyses with other geospatial datasets. We indicate how much of each species' habitat is under protection within the currently protected lands (Fig. 15). We identified 69 protected areas, which include more than 13 percent of the USVI territory. The largest protected area is the Virgin Islands National Park located on St. John. As part of the final product the USVI Gap Analysis Project provides a final report, more than 300 maps in various formats, a database of the species' natural history and habitat associations, along with GIS datasets and ancillary data that resulted from our analyses. These products will represent valuable tools not only for land managers, conservationists, and environmentalists, but also for educators and wildlife enthusiasts. The Institute and the USVI Gap Analysis Project owe a great deal to the collaboration and support of the USVI local and Federal government

agencies, including the U.S. Virgin Islands Division of Fish and Wildlife, the University of the Virgin Islands, non-government organizations such as the St. Croix Environmental Association, non-affiliated individuals, and the private sector GIS community.

Collaborating Institutions: University of the Virgin Islands; and St. Croix Environmental Association

Institute Contacts: Mariano Solorzano and William A. Gould, mcsolorzano@fs.fed.us and wgould@fs.fed.us

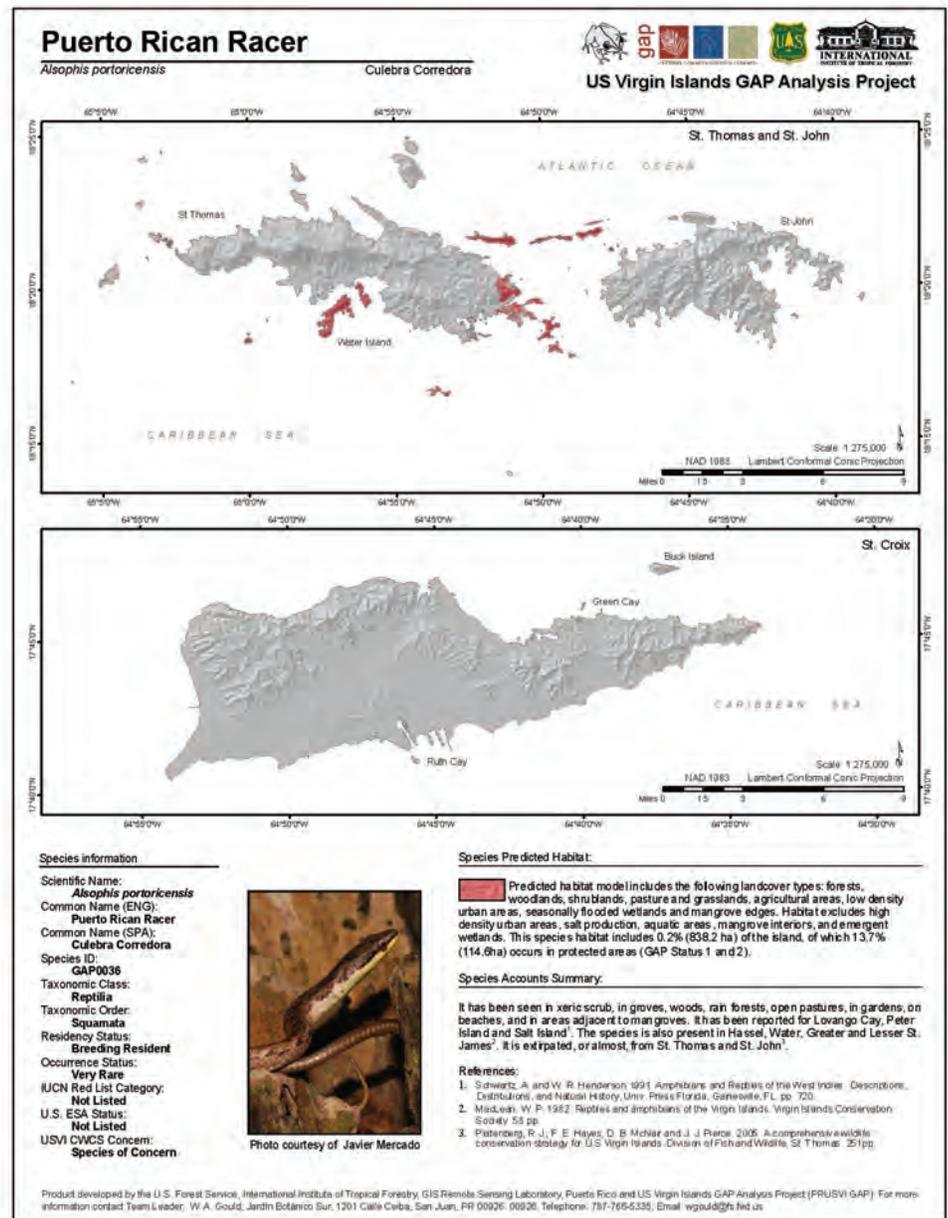


Figure 14. Predicted habitat map for the Puerto Rican racer (*Alsophis portoricensis*).

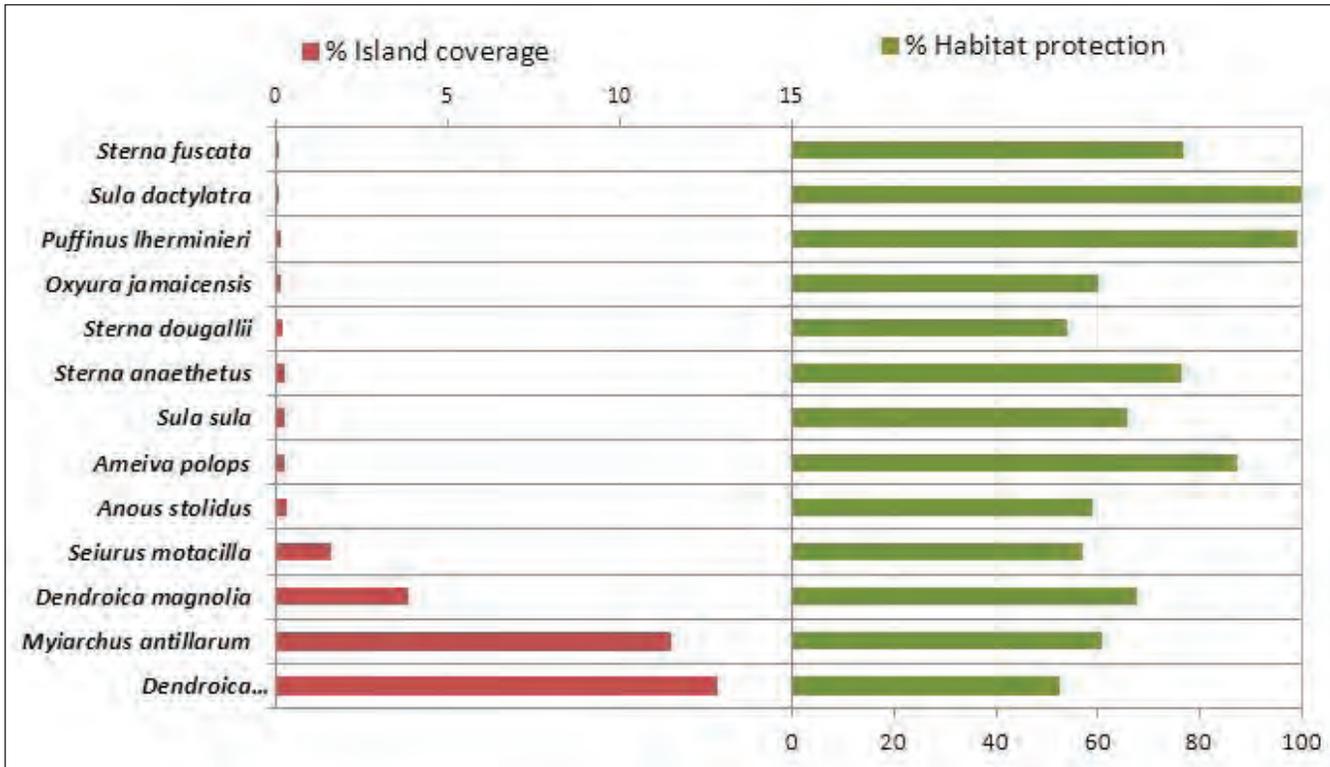


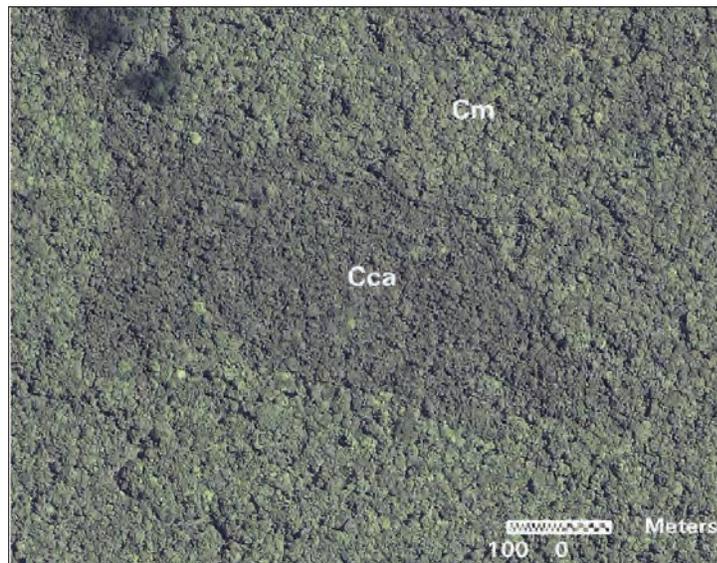
Figure 15. Percent of species habitat island coverage versus percent of species habitat that is under protection. This graph represents a subset of the findings.

3. New study leads the way to detailed mapping of tropical rain forest types

A new study shows that widely available satellite imagery can be used to map tropical rain forests with much more detail than was previously thought possible. Although satellite imagery is commonly used to map tropical forests over large areas, only a few forest types are usually identified. This study, however, showed that if many dates of imagery are available, as

in newly available satellite image archives, then clues to distinguishing among forest patches containing different groups of tree species can be found.

Tropical countries need to produce detailed forest maps for REDD+, which is a mechanism that gives countries financial incentives for reducing carbon emissions from deforestation and degradation and for managing forests to sustain biodiversity and enhance carbon stocks. Detailed maps of forest types, including



Some tropical tree communities are readily recognizable by canopy structure in high resolution imagery.

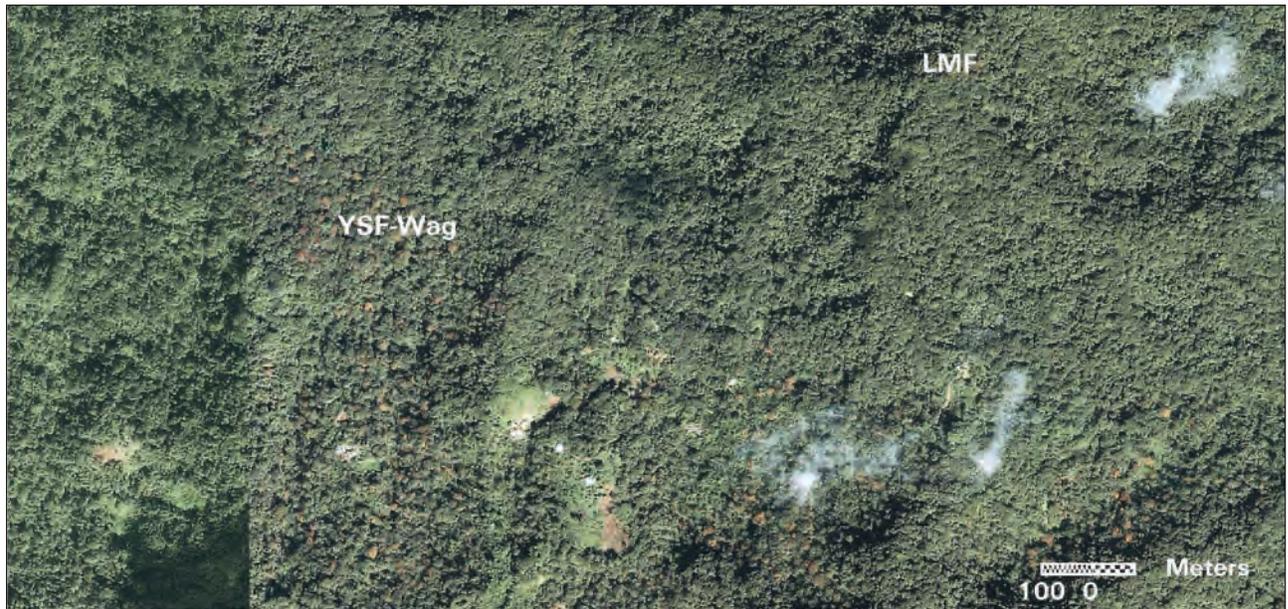
maps that distinguish among groups of tree species, are essential, but until now scientists have assumed that tropical forest tree communities are too similar to each other in most satellite imagery to be mapped.

Working in the Republic of Trinidad and Tobago, the study authors searched through the recently opened archives of Landsat satellite imagery (<http://www.sciencemag.org/content/320/5879/1011.1.full>) and through the very-high-resolution satellite images viewable with Google Earth™. They discovered that the spatial distributions of many tree communities thought to be indistinguishable in satellite imagery can in fact be revealed, but only in imagery from unique times, such as that collected during periods of severe

drought, or when a particular tree species is flowering. Other forest types were distinct in very-high-resolution imagery because of unique canopy structure. These are the first maps for an entire tropical country that show the distributions of communities of tropical forest tree species. The study also produced a new set of topographic maps for the country at two scales that depict reserve areas, town, roads, rivers, and other landscape features in addition to forest type.

Collaborating Institutions: Colorado State University; and the Forestry Division of the Republic of Trinidad and Tobago

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Tropical tree communities may be recognizable by flowering if high resolution imagery is available from the right season.

Cooperative Research Agreements

Ecological Effects of Nutrient Enrichment on a Coastal Fringe Mangrove System in Jobos Bay, Puerto Rico

Over the past year, we have successfully developed and initiated a long-term nutrient enrichment experiment within fringe mangroves at Jobos Bay, PR. While the overall research objectives and methods are consistent with the proposed study, some design changes were determined to be necessary as we gained a better understanding of the research site characteristics and logistics. The most significant change is the nutrient application method and experimental plot design, which is described below. The timing of the nutrient enrichment was delayed approximately 4 months to allow for more baseline data collection and site characterization.

In brief, the past year of research was highlighted by:

- 1 Cooperation with other State agencies and academic and non-profit organizations; 1
- 1 Selection of the research site and experimental plot-set-up;
- 1 Baseline measurements and site characterization in all plots;
- 1 Selection and training of student research assistants and boat operators;
- 1 Research method development for field and laboratory use; and
- 1 Acquiring appropriate nutrients and modification of application dosage and procedure.

It was also decided that the experimental plots for this study work would be moved off the keys along the nearby coastline to avoid potential cross-fertilization and other issues. This location was evaluated by Drs. Ariel Lugo and Ernesto Medina before the experimental plots were established.

We have successfully established partnerships with other organizations through funding opportunities or assistance. These partnerships include Puerto

Rico and Rhode Island Sea Grants, the University of Puerto Rico, the Nature Conservancy, and the Coastal Institute at the University of Rhode Island (URI).

This project has provided a platform for undergraduate's student involvement. Jessica Foley, a recent URI graduate, accompanied Brita J. Jessen to the field for 2 weeks, followed by sediment and leaf sample processing at Graduate School of Oceanography and the Environmental Protection Agency (EPA) throughout summer. Ryann Rossi, an undergraduate at URI, was engaged through the Coastal Fellows program to work at the Jobos Bay field site to examine shredder behavior and decomposition rates of mangrove litter in connection with this project.

The re-design of the nutrient enrichment procedure depends on routine data collection and nutrient input. Two undergraduate students from the University of Puerto Rico at Humacao have been hired and trained to accomplish these tasks. Ishamari Colon and Sandra Schleier collect litter samples, which they process at the Institute, and apply nutrients. Each student has expressed interest in conducting independent research projects related to this research, and they have been communicating with Dr. Jessen on their research questions and design.

In August, Dr. Jessen gave a presentation of the proposed work to staff at the Jobos Bay National Estuarine Research Reserve, followed by a discussion with the staff about the ways this research interacts with the goals of the reserve. In October, she designed a poster of research objectives that was displayed at the annual National Estuarine Research Reserve (NERR) conference on Ponte Verda, FL. This poster was presented by Angel Dieppa, the research coordinator for the Jobos Bay NERR.

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Sustainable Management of Big-Leaf Mahogany in the Brazilian Amazon

The Mahogany Project seeks to understand what makes big-leaf mahogany "tick" in natural forests across southern Brazilian Amazonia by monitoring vital rates for all stages of its life cycle, from seeds to senescent adults, across temporal and spatial scales relevant to each life phase. With steady support from the Institute since 1995, the Mahogany Project has addressed a long list of basic and applied research questions, as demonstrated by more than 30 mahogany-related scientific articles and book chapters

published to date. Several manuscripts and technical papers were advanced during 2012; three papers are currently in review or in press at scientific journals, while at least three more will be submitted before the end of 2013. As importantly, project researchers have contributed directly to Brazilian national forest policy through participation in working groups and seminars revising and improving industry harvest practices.

Based on 18 years (1995–2012) of annual censuses of more than 600 trees and many thousands of seedlings

and saplings scattered across nearly 5,000 hectares of forest at five long-term research sites, project researchers have developed demographic models that simulate both short- and long-term population responses to forest management practices such as minimum diameter felling limits, commercial tree retention rates, and vine cutting. One of these, the Big-Leaf Mahogany Growth and Yield Model, is a highly interactive and user-friendly computer application that can be operated online (<http://www.swietking.org/model-applet.html>) or downloaded onto office or home computers with complete instructions for use. In 2012, the Growth and Yield Model user interface and

user manual were translated into Spanish to make the model more widely available to forest managers and regulators in Central and South America. In 2013, we will offer training workshops on use of the model and how to modify it to suit local populations and growing conditions.

Finally, the project website, Big-Leaf Mahogany in Brazil and South America (<http://www.swietking.org/>), was expanded and improved in 2012, with additional topics, text, and interactive features planned for 2013.

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Institute Contact: Grizelle González, ggonzalez@fs.fed.us

Big-Leaf Mahogany in Brazil & South America

A one-stop location for information on big-leaf mahogany (*Swietenia macrophylla*, Meliaceae)

Home History Ecology Management Model More Acknowledgements About Us Contact

HOME

Welcome to **SwietKing.org**, a resource library dedicated to educating the public about big-leaf mahogany, or *Swietenia macrophylla* King. These web pages, photographs, interactive management tools, and links to related internet resources are designed to answer questions and satisfy curiosity about the ecology, management, and conservation of mahogany in natural forests.

We hope to stimulate visitors to consider tropical timber species as not so very different from the trees inhabiting forests near their own communities. The New World mahoganies produce the most 'branded' luxury timber in the world. They inhabit lowland tropical forests from Mexico to Bolivia, and are increasingly rare in the wild after 500 years of commercial exploitation. Yet in broad outline their ecology – their life history strategies for surviving and reproducing within intensely competitive tropical forest environments – resembles that of many trees around the world, including, perhaps, some growing near you. This means that anyone interested can understand the issues and challenges associated with managing and conserving natural mahogany populations that survive in the wild today.

The assumption that underlies our research program in Brazil is that better ecological information about mahogany can improve forest management practices. In our view, improving forest management practices offers the best possibility of conserving natural populations for their own sakes, as well as for their appreciation and use by future generations of us.

These pages describe what we and other researchers have learned about mahogany from field research during the past two decades. The emphasis here is on mahogany in Brazil, mainly in southeast Amazonia where our principal **Field Sites** are located, but also in southwest Amazonia in the western Brazilian state of Acre. For information about mahogany in other regions where researchers have studied it, see references under **Readings & Links**, especially those about mahogany in Mexico, Central America, and Bolivia.

History
This section describes mahogany's natural range and provides a brief overview of humankind's commercial relationship with mahogany since early colonial times.

Ecology
This section provides descriptive information about mahogany the tree, seed, and seedling; its distribution, population structure, and demographic rates.

Management
This section describes how mahogany has historically been harvested from forests and how recent changes in regulations are improving management practices.

Model
The section offers visitors an interactive tool for investigating outcomes from harvesting mahogany populations. The model is also available for download.

More
This section provides maps of our field sites, images of mahogany in natural forests, and a list of mahogany publications and related resources for reference.

Acknowledgements
This section gives us an opportunity to thank the funders and supporters we have depended on since 1995. Thank you for your support.

About Us
This section provides a brief biography for each of the members of our research team.

Contact
This section provides details on how to contact us with questions and comments. Thank you for visiting!

Home | History | Ecology | Management | Model | More | Acknowledgements | About Us | Contact

State and Private Forestry

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The Institute has a long tradition of information exchange with government agencies, universities, and local communities in Central and South America and the Caribbean. Through the State and Private Forestry Program (S&PF), the Institute provides professional, technical, and financial assistance to local communities and private landowners in Puerto Rico and the U.S. Virgin Islands (St. Thomas, St. Croix, and St. John). Through focused technical and financial assistance and conservation education, Federal resources are leveraged to protect and support sustainable management of the islands' forests and ecosystems to produce goods and services that are important to many communities. This assistance is focused on cooperative forestry, cooperative fire protection, forest health, urban and community forestry, and landowner and legacy assistance programs. Key issues addressed by this program include: rapid urbanization and residential development and its sprawl into natural areas, ecological restoration of natural and built-up areas, water quality (including storm water runoff and restoration of natural areas), soil protection and watershed management, sustainable urban forestry programs at the local level, damage of reefs and over-fishing of key species, and sustainable tourism development in small communities.



Staff members in the State and Private Forestry program.

The Urban and Community Forestry Program

The Urban and Community Forestry Program (UCF) promotes the conservation of our urban forests. This program engages more local citizens in Puerto Rico and the U.S. Virgin Islands than any other Institute program by supporting educational initiatives that help the public understand the benefits they derive from our urban forests, and by providing technical assistance with the development of urban forest management plans and tree planting to create new urban forests. Each year the program provides technical and financial assistance to communities, non-profit organizations, educational institutions, and State governments. This year the Institute hired Kelcie Troutman, an intern from the University of Virgin Islands St. Thomas, to help in the preplanning of an Urban and Community Forestry Conference on St. Thomas. Troutman worked with Marilyn Chakroff, Virgin Islands Department of Agriculture forester, and the Virgin Islands Urban and Community Forestry Council.

The program is a Federal, State, and local partnership established in law. The Puerto Rico Department of Natural and Environmental Resources (DNER) Forest Service Bureau and the Virgin Islands Department of Agriculture are State-level partners that administer the program in their respective jurisdictions and work closely with local urban and community forestry

councils to plan education and outreach initiatives that lead to the conservation of green spaces that preserve the benefits of urban forests. By implementing the UCF program we promote beautiful urban forests and a healthy environment for urban residents. The councils assist in the promotion and selection of local community and urban forestry projects to be funded through a portion of the State's program funds. During FY 2012, nine community projects were selected in Puerto Rico and a total of \$161,335 were distributed, with the recipient community groups providing in-kind services equivalent to \$196,221. In the U.S. Virgin Islands, four projects received funding representing the categories of tree planting demonstration, inventory and assessment, and tree maintenance. A total of \$60,767 was distributed, with the community groups providing in-kind services equivalent to \$78,696.

The U.S. Virgin Islands Urban and Community Forestry Council recently joined the Puerto Rico Council in gaining certification of its non-profit status. This allows the organizations to seek funding of high-quality projects from a wider variety of agencies and private and public philanthropic organizations in addition to the U.S. Forest Service.

Tables 1, 2, and 3 provide details of UCF projects in Puerto Rico and the U.S. Virgin Islands for FY 2012.



Amalia Marín School students planting native trees in the San Juan Ecological Corridor

Table 1. Urban and community forestry statistics for Puerto Rico and the U.S. Virgin Islands for FY 2012.

Performance Measures	Puerto Rico	U.S. Virgin Islands
Total population	3,725,789	106,405
People living in communities participating in educational, technical, or financial assistance	1,227,308	31,133
Percentage of population living in communities participating in educational, technical, or financial assistance	33	29
Number of people living in communities developing urban and community forestry programs and activities	523,013	31,133
Percentage of population living in communities developing urban and community forestry programs and activities	18	29
Number of persons living on communities managing urban and community forestry programs and activities	704,295	--
Percentage of population living in communities managing urban and community forestry programs and activities	25	--
Number of communities with active urban and community forestry management plans	225	--
Number of communities with urban and community forestry local/advisory organizations	26	9
Hours of volunteer service	420,934	1,433

Table 2. List of local Urban and Community Forestry Program projects funded in Puerto Rico in FY 2012.

Community Group	Project
Escuela Ecológica Niños Uniendo al Mundo	Jardín del Cielo Demonstration Project
Municipio Autónomo de Caguas	Preparación de Protocolo Manejo de Arboles Municipio de Caguas (Urban Forest Management Plan)
Programa de Educación Comunal de Entrega y Servicio Inc. (PECES)	Iniciativa Eco-turística de Humacao (Ecotourism)
Municipio Autónomo de Trujillo Alto	Proyecto de Composta Comunitaria (Composting Demonstration Project)
Sistema TV. Canal Universitario Ana G. Méndez	Forestación Urbana y sus Beneficios para las Comunidades Programas de Televisión (Urban Forestry Television Programs)
Escuela Especializada en Agroecología Laura Mercado, San Germán	La Composta y sus Beneficios en la Siembra (Composting Demonstration Project)
Universidad de Puerto Rico en Ponce	Protocolo para Determinar la Calidad de la Composta y Desarrollo de Guías para su Mercadeo (Composting Demonstration Project)
Universidad Interamericana–Metro	Más Bosque para Nuestra Ciudad (Urban and Community Forestry Demonstration Project)
Comité Caborrojeño Pro Salud y Ambiente, Inc.	Establecimiento de proyectos demostrativos de reforestación comunitaria (Urban and Community Forestry Demonstration Project)

Table 3. List of local Urban and Community Forestry Program projects funded in the U.S. Virgin Islands in FY 2012.

Community Group	Project
St. Croix Environmental Association	Tree Planting Demonstration Project
St. John Community Foundation, Inc.	Urban Forestry Inventory and Assessment
St. Paul's Episcopal Church	Urban Trees Management
St. Thomas Historical Trust, Inc.	Tree Planting Demonstration Project

Green Infrastructure and Our Parks

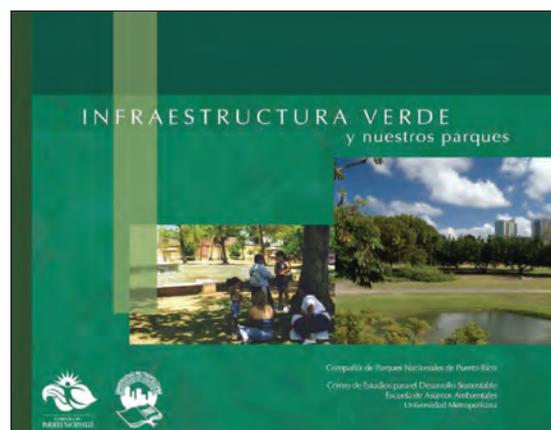
The Center for Sustainable Development Studies (CSDS) of the Metropolitan University, School of Environmental Studies, prepared a second edition of the popular publication *Green Infrastructure and Our Parks*. The technical information in the book was updated and a chapter was added with examples and illustrations on how to design a community green infrastructure plan. The book, co-sponsored by the Puerto Rico Architect Foundation, the Puerto Rico National Parks Company, and the Institute, made it possible to produce a full color edition.

All Puerto Rican mayors, senators, and House representatives received copies to use as a resource that outlines the importance and benefits of urban green areas and the relevance of urban green space projects to urban planning and development efforts. CSDS also distributed the publication to employees of the Department of Natural and Environmental Resources, the Puerto Rico Planning Board, the Puerto Rico National Parks Company, and all the libraries of the Puerto Rico Department of Education.

A limited number of books are for sale to benefit the Huerto, Bosque y Vivero Comunitario Capetillo, a community initiative led by the Centro de Acción Urbana, Comunitaria y Empresarial (CAUCE), an organization of the University of Puerto Rico's Chancellor's Office. The Capetillo project is restoring

forests on a 1.45-acre parcel that was vacated owing to flooding and other safety issues. The neighbors in Capetillo work in coordination with CAUCE planting trees, improving the forest, and managing a nursery. Today a forest has regenerated and the nursery produces vegetables and trees that are sold to visitors to help support the project and provide services in the community. The University of Puerto Rico is engaged by bringing students and volunteers to tutor neighborhood children. For more information on this initiative please visit their Web site at: <http://huertocapetillo.wordpress.com/>.

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Caguas Arbor Day Celebration

During the Caguas Arbor Day Celebration April 27, 2012, community leaders planted a native tree for each of the 11 communities that make up the Autonomous Municipality of Caguas. The Puerto Rico Interamerican University and the municipality hosted the event at the William Miranda Marín Botanical and Cultural Garden. In related activities, agronomists from the Caguas Urban Forestry and Beautification Department distributed 1,000 trees and provided advice on tree planting and tree care. During that day the Caguas Mayor Hon. William Miranda Torres, recognized Omarf Ortega, director of the Caguas Urban Forestry and Beautification, for his leadership and success directing the department. Also, Myraida Anderson, graduate student of the Interamerican University Metro Campus, received an award for her initiative,

Arbol Familiar (Family Tree), which promotes respect for nature, society, and family values. More than 1.2 million trees were planted over a 2-year period. The President of the Puerto Rico Interamerican University, Manuel J. Fernós, a strong supporter of that initiative, was recognized as well. For more information visit the Arbol Familiar Web site at <http://www.arbolfamiliar.org/>.

Caguas is the only municipality in Puerto Rico that has been recognized as a Tree City USA. It has had that honor since 2009. The program, managed by the Arbor Day Foundation, recognizes those towns and cities that have organized tree care programs contributing to healthier and safer urban forests.

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Caguas Tree City USA Arbor Day Celebration Recognition: Omarf Ortega, Director of Caguas Urban Forestry and Beautification Department; Myraida Anderson, Arbol Familiar Project, Interamerican University Metro Campus; Hon. William Miranda Torres, Mayor of Autonomous Municipality of Caguas; and Dr. Rafael Cabrera, Interamerican University Vice President of Academic Affairs in representation of Manuel L. Fernoz, President of the Interamerican University.

St. Croix Historic Trees

The U.S. Virgin Islands consists of the major islands of St. Thomas, St. Croix, and St. John, and several smaller islands and cays. In addition to its majestic landscapes, these islands are home to many species of flora and fauna that are linked to the history and culture of the islands but often were brought from afar.

The Virgin Islands Urban and Community Forestry Program has sponsored several projects in St. Croix that highlight the importance of this linkage to the communities. Good Hope School students prepared a “Talking Tree Tour” to entice people to explore Fredriksted and learn local tree lore and a bit of history. For example, each knot in the trunk of the tamarind tree (*Tamarindus indica*) is thought to represent the spirit of a lost one buried nearby. The sound from a wind breaker tree (*Casuarina equisetifolia*) is said to cure insomnia. World War II parachutes were made from silk of the jumbie tree (*Ceiba pentandra*).

There is a large variety of tree species on the island and many have multiple common names related to historical subsistence and medicinal uses. Some individual trees also have historical significance. The UCF Council worked with the St. Croix Historic Preservation Committee to protect a 250-year old baobab tree (*Adansonia digitata*) that recalls the fate of some of the women who were burned alive for joining “Queen” Mary Thomas in the 1878 Fireburn labor revolt on St. Croix. The council worked with the State Historic Preservation Office to preserve a kapok tree (*Ceiba pentandra*) and the historical wall that it was undermining over centuries of growth in Fredriksted.

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Local resident Veronica Gordon tells students about the many uses of the Baobab tree and the legend of the voyage of a scared young boy that held the Baobab seed in his scared mouth to remind him of home as he traveled in the hold of a slave ship from West Africa.



Tree roots and branches were pruned to the specifications of a Certified Arborist. The new wall has a metal fence above it to protect the tree from vandalism. The community has installed a brass plaque that contains information about the tree and its history. This project is one of several historic tree preservation projects on the Island.

Forest Legacy Program

The Forest Legacy Program (FLP) is a partnership between States and the U.S. Forest Service to identify and help conserve environmentally important forest areas that are threatened by conversion to non-forest uses. To date 2,857 acres (1156ha 1868.9m²) have been entered into the program in Puerto Rico and 98 (39ha 6591.9m²) acres in the U.S. Virgin Islands. Land can be purchased outright under the program or a landowner can enter into a conservation easement that identifies attributes and functions of the land that are to be protected from development and other uses.

The land is acquired only from willing sellers within high priorities areas called Forest Legacy Areas, which are identified following an assessment of long-term conservation needs. Funding is awarded through a national competitive process and the State must provide a match of 25 percent of the cost of any project submitted. The match may come from cash, State land purchase, or donations of land or land rights to the State.

Virgin Islands Acquires First Forest Legacy Properties

The Virgin Islands Department of Agriculture acquired two tracts of land totaling 76 (30ha 7561.1m²) acres in St. Croix in a project called Annaly Bay/Hermitage Valley. The purchases were matched with a donation of approximately 22 acres (8ha 9030.8m²) of land in St. John. The donation, secured by The Nature Conservancy, will be held in perpetuity by the Virgin Islands Trust for Public Land. The Forest Legacy Program in the U.S. Virgin Islands will contribute to the development of a territorial park system where none exists today. The project is designed to preserve outstanding scenic, cultural, and ecological values important to the terrestrial and marine life, and to secure public land for hiking. In St. Croix the vision of the territorial park includes conservation of Maroon Ridge in order to memorialize the brave souls who escaped slavery during the plantation era. The Annaly Bay/Hermitage Valley Project is scheduled for completion in 2014.

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Landscape view from Estate Spring Garden legacy tract.

The Cooperative Fire Program

The Cooperative Fire Program provides assistance to the Puerto Rico and the U.S. Virgin Islands Fire Departments as they build capacity in fire prevention, preparedness, and suppression in rural areas and in the wildland-urban interface. Firefighters in the islands are responsible for wildland and structural fire suppression and various other emergency response activities. Each island within these jurisdictions must be fairly self-sufficient in terms of equipment and manpower, because sharing of resources among islands is expensive and time consuming. This year the program was able to assist in providing new brush trucks in the Puerto Rico municipalities of Castañer and Vieques, and a wildland-urban interface truck in the U.S. Virgin Islands that will be deployed to the Cotton Valley Fire Station. In a new initiative, the Puerto Rico Fire Department graduated 105 municipal employees who can now safely assist with suppression of wildland fires. Interagency cooperation is highly beneficial. A multi-agency coordination group meets



The firefighting rapper Angel Crespo (el Bombero Rapero) teams up with Smokey the Bear and a crew of wildland firefighters (bomberos forestales) to spread the fire prevention message.

regularly to coordinate wildfire training, suppression, dispatch, and prevention activities; this year the Puerto Rico Fire Department, U.S. Forest Service, U.S. Fish and Wildlife Service, and National Park Service signed an agreement for mutual fire aid.



Virgin Islands Fire Fighters hosted the Cooperative Fire Review Team in St. Croix.

Incident Qualifications System (IQS)

The Puerto Rico Fire Department recently acquired Incident Qualification System (IQS) software. This is a computer program that tracks the training, fire line experiences, safety record, and fitness levels of individuals against national standards, which are then used to determine the jobs and responsibilities a firefighter can safely and competently execute during a wildfire incident. In February 2012, Keith Smith of the National Association of State Foresters visited Puerto Rico and with assistance from Bruce Drapeau helped to install the program, demonstrate data entry protocols, and provide technical assistance as training officers entered existing records for their personnel.

The Department now has the ability to easily manage its wildland fire resources and to analyze and schedule training based upon their internal needs. The program has records of all responders, and the roles in which they are qualified. Managers can plan out the number of responders they would want qualified at certain positions, and IQS will list the training courses required to meet those goals. From this output, managers have the information they need to prepare, logistically and financially, for their upcoming training needs. For example, a crew consisting of three squads of five to six firefighters each will encompass training in basic firefighting and fire behavior; training in leadership and administrative processes necessary for squad bosses and crew bosses; and training in special skills needed to operate, pumps, trucks, saws, etc. A benefit of IQS is that not only is it suitable for wildland fire preparedness, it but can also be used to manage qualifications for all risk incidents including hurricanes, urban search-and-rescue operations, and even the qualifications for certified dog handlers. Prior to adopting IQS, Puerto Rico Fire Department wildland qualifications were managed by the fire dispatcher at the El Yunque National Forest.

Another benefit to the Department is that dispatchers can identify personnel who are qualified for deployment outside Puerto Rico. By linking to the National Interagency Resource Ordering and Status System (ROSS), they can connect with nearly 400 interagency dispatch and coordination offices throughout the United States. This helps the Nation respond to national emergencies but also allows the Puerto Rico Fire Department to seek opportunities for its own personnel to meet experience requirements that are part of the National Interagency Incident Management System's Wildland Fire Qualification System Guide.

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A fire fighter must take courses in basic fire behavior, learn the incident command system, and participate in fire line construction as a member of a team.

Dry Hydrant Demonstration Project

El Atlantico Resource Conservation and Development Council (RC&D), Inc., received a grant through the U.S. Forest Service State and the Private Forestry Cooperative Fire Assistance Program to demonstrate and promote the use of dry hydrants in rural areas. Dry hydrants are non-pressurized pipe fixtures placed next to natural or artificial water bodies; fire trucks equipped with pumps then use the pipes to draw water into the tank, greatly increasing the efficiency of fire stations in suppressing fire emergencies in rural or remote areas. The first demonstration area is located on the grounds of Escuela Vocacional Agrícola Soller, Agro. Hector M. Cordero Rivera, Carretera 453, Camuy, Puerto Rico. On February 3, 2012, members of El Atlantico RC&D invited students from the agriculture machinery course, teachers and administrators from the school, the Department of Education, the Natural

Resource Conservation Service, and the U.S. Forest Service to a field demonstration of the hydrant by El Cibao and Bayaney Fire Stations.

The area surrounding the demonstration site is typical of those that would benefit from a dry hydrant: it is an area of mostly hilly fields and farms with limited public water utilities and no natural lakes or readily accessible streams. Narrow winding roads can slow the time to initial attack of reported fires, and the lack of fire hydrants and natural water bodies means empty tank trucks must travel a long distance to refill amidst serious fire incidents. This dry hydrant adjoins with the towns of Camuy, Lares, and San Sebastián, and will serve the communities of Pileta, Lares, Cibao, Camuy, Quebradas, Aibonito, Hatillo; and Cibao, San Sebastián.

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A. Mojica

Students at the school were involved in many aspects of the project, including helping survey and construct the road to the dry hydrant site, installation of the pipe, and even landscaping of road banks after the project ended.

Sgt. José Jesús González, Bayaney Fire Station, Hatillo, Puerto Rico, explains the value of this dry hydrant to their operations.



A. Mojica

American Recovery and Reinvestment Act

The islands in Puerto Rico and the U.S. Virgin Islands are subject to hurricanes, tropical storms, and wildfires. Fallen trees and broken branches along roadways can down power lines, cause flooding in storm sewers and streams, and pose a variety of physical safety hazards. The State and Private Forestry unit is administering three projects under the American Recovery and

Reinvestment Act of 2009 to mitigate these impacts. The funding is authorized through the Cooperative Forestry Assistance Act. One project in St. Croix closed in March 2012 and two projects in Puerto Rico remained open.

St. Croix Roadside Tree Inventory and Management Strategies

The St. Croix Hurricane and Hazardous Fuel Mitigation Project was completed following the development of a tree management plan and installation of a roadside tree demonstration planting. This project provided three full-time jobs and training for around 80 people. Training included various aspects of tree care, pruning, and removal; and safety training. On-the-job training was provided in GPS, and tree identification training was provided for tree inventory crews.

A report, St. Croix Roadside Tree Inventory and Management Strategies (RTIMS), presents an analysis of the results of a GIS-based comprehensive roadside right-of-way inventory and tree health and hazard tree assessments developed for this project. It also includes a review of existing roadside tree management practices and the development of tree management strategies that not only would improve the island's response to tree failures during catastrophic events, but also would prevent them through proactive management. The tree planting demonstration sites can be viewed on roadways near Southgate Coastal Reserve, Henry Rohlsen Airport, and Estate Bethlehem.

The assessments and report were produced by Geographic Consulting, LLC, for the Virgin Islands Resource Conservation and Development Council, which received the Recovery Act grant. St. Croix is approximately 83 square miles (214.97km²), with more than 1,300 miles of paved and unpaved roads. GPS-armed inventory crews collected inventory data on almost 10,000 trees covering 11 percent of the road miles on the entire island. That translates to the equivalent of 870 acres of right-of-way along both sides of 143.5 miles of the major roadways in St. Croix. Trees were included in the inventory if they were within 25 feet of the road. Roughly 81 percent of the trees were within the public right-of-way; the remainder occurred on private land, which in some cases made those trees inaccessible for the forest health and hazard tree assessments that followed.

St. Croix has a rich diversity of trees; 108 species were identified in the course of the survey, but the major roads were overwhelmingly dominated by three species: genip (*Melicoccus bijugatus*), West Indian mahogany (*Swietenia mahogany*), and tibit or mother-in-law's tongue (*Albizia lebbek*). The largest and oldest trees are generally planted mahogany, while the smaller trees sprang from voluntary seedings of genip. Twenty-seven percent of public trees were in direct conflict with utility lines or pavement and 93 percent of trees had crown damage. Unfortunately, all major St. Croix roadways have trees located too close to the road, and in many cases the wrong species are growing under or adjacent to power lines and utilities. Tree limbs were considered a hazard if they could fall on roads, power lines, buildings, parking areas, sidewalks, transformers, utility lines, and utility poles.

Recommendations to mitigate the risks of damage from trees following hurricanes or fire include the following: (1) immediately begin removing the 200 most hazardous trees; (2) establish a roadside tree planting program to ensure a diversity of trees with characteristics that pose no physical risk to the public, eliminate utility conflicts, cost less to maintain, and increase the islands' scenic qualities; (3) conduct proactive, coordinated, and regular tree maintenance that ensures storm preparedness; and (4) establish a legally binding document that assigns responsibilities to appropriate agencies, permits certain actions such as tree removal and utility pruning of public and private trees, and prescribes best management practices for comprehensive management. The project has identified the locations of hazard trees and made recommendations for mitigating the problems and has identified suitable planting locations (Fig. 16). The report can be downloaded at www.geographicconsulting.com.

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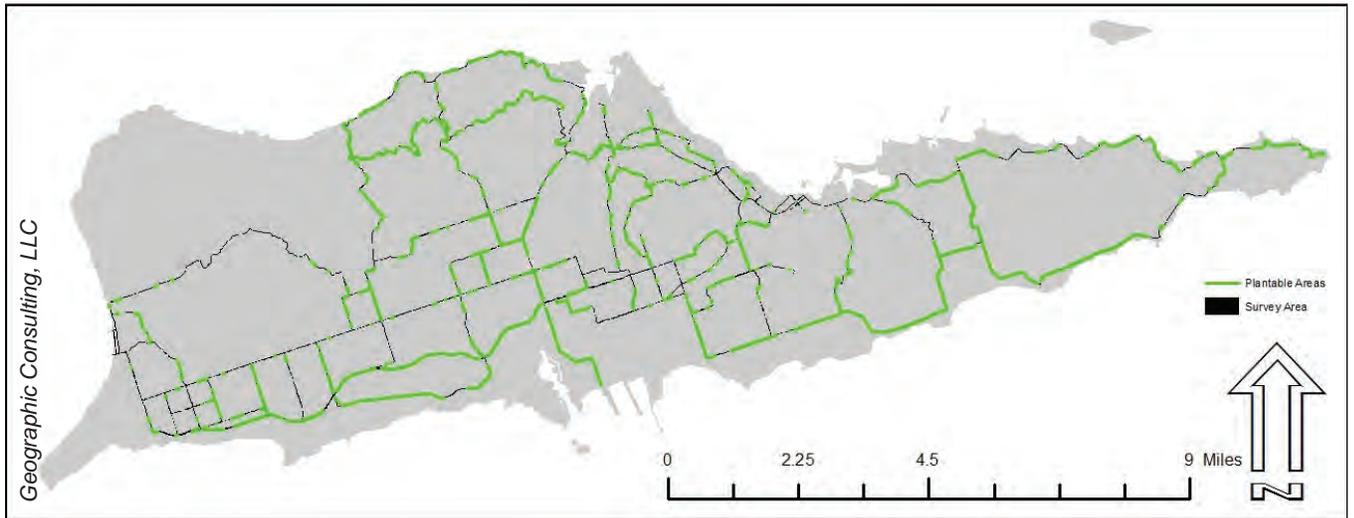


Figure 16. The St. Croix Roadside tree planting assessment identified major roadways that would benefit from planting trees of suitable species.

A comprehensive street tree management program would solve utility conflicts without leaving unsightly injured trees.



Seventy seven people participated in workshops on topics such as maintaining tree health, pruning and roadside safety.

Puerto Rico Hurricane and Hazardous Fuels Mitigation Project Update

The State and Private Forestry unit is administering a grant of \$1,167,000 to the Puerto Rico Department of Transportation and Public Works (DTOP) for the implementation of the Puerto Rico Hurricane and Hazardous Fuel Mitigation Project. The project involves training, roadside tree inventory, tree management, planning, and plan implementation. The management plan addresses existing risks, retention of structurally sound trees, and species selection to meet site objectives.

Implementation activities include pruning to improve tree health and structural conditions, removal of hazard trees, and tree planting.

The DTOP has addressed hazard trees on nearly on 323.7 kilometers of the roadways targeted in the Hurricane and Hazardous Fuels Mitigation Project (Table 4). As part of the project, three-to-five-member crews from Cooperativa Vías Lindas worked on roadside tree inventory and management. The Cooperative was an entrepreneurial endeavor by former DTOP employees following widespread government downsizing. The crews work out of the San Juan, Mayagüez, and Ponce DTOP regional offices.

American Recovery and Reinvestment Act funds were used to provide comprehensive training to the members of the Cooperativa Vías Lindas and the DTOP to reduce the risks to roads and

people from hurricanes and fire. The cooperative has been successful in contracting additional projects in the private sector, and this fiscal year the Ponce brigade initiated a new round of courses to increase skills and train new employees. Skill development covers safety topics such as roadside safety, chainsaw operation, and tree pruning, and technical topics such as tree identification and inventory, and business management.

Table 4. Roads where hazard trees were addressed by Vias Lindas crews, 2012.

Vias Lindas Crew	Municipality	Road Number	Kilometers
Ponce	Guayama	PR-15	20.0
	Guayama	PR-53	8.0
	Ponce-Guayama	PR-2	35.4
	Ponce	PR-511	1.0
	Ponce	PR-132	5.0
	Patillas	PR-184	18.0
	Patillas	PR-181	16.0
Mayagüez	Aguadilla	PR-111	3.0
	Aguadilla	PR-462	4.6
	Hatillo	PR-119	4.0
	Isabela-Añasco	PR-2	61.6
	Mayagüez	PR-342	5.1
	Rincón	PR-429	8.0
	Sabana Grande	PR-2	14.0
	San Sebastián	PR-125	2.0
	Utua	PR-10	22.0
San Juan	Caguas	PR-30	1.0
	Canóvanas	PR-185-PR-3	5.0
	Carolina (Piñones)	PR-187	3.0
	Cataño	PR-165	20.0
	Cayey	PR-184	17.0
	Cayey	PR-1	11.7
	Luquillo-Fajardo	PR-3	4.0
	San Juan	Muñoz Rivera Ave.	6.0
	San Juan (Cupey)	PR-176	7.0
	San Juan	Baldorioty Ave.	5.0
	San Juan	Roosevelt Ave.	2.0
	San Juan	Barbosa Ave.	4.0
	San Juan	Iturregui Ave.	3.0
	San Juan	PR-199	2.0
	San Juan	PR-35	5.3
Total kilometers			323.7



Pruning this Saman tree in Cayey, Puerto Rico will eliminate the conflict with the utility line before there are problems.

The crews, with the assistance of the DTOP agronomists, determine the structural soundness of roadside trees. The management actions are incorporated into a plan. In the event that a tree must be removed, the project provides for planting trees suitable to the different growing conditions following

the rule of “the right tree for the right place.” DTOP purchased the plant material needed for the mitigation phase from several local nursery growers, which helped revamp the local economy.

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Mitigating Fire Hazards in Puerto Rico

Throughout FY 2012 the Puerto Rico Fire Service provided jobs and training for 34 wildland fire fighters. The crews continued to work to mitigate fire hazards. Communities have benefitted from the rapid initial attack of wildfire, thanks to the presence of these crews as well as to increased attention to wildland fire prevention and reduction of high fuel loads before they are ignited. This results in a reduction in the amount of land burned and the need for emergency funds to suppress fires. Other benefits are the reduced impacts to agricultural land and less effort dedicated to restoration of natural and protected areas damaged by fire.

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Firefighter conducts “mop up” operations. After a fire moves through an area, sources of sparks that could reignite a fire are sought out and extinguished.



The Forest Stewardship Program

The U.S. Forest Service Forest Stewardship Program was established in 1991 to encourage forest landowners to actively manage their forests. The Institute partners with the Puerto Rico Department of Natural and Environmental Resources (DNER), Forest Service Bureau and the U.S. Virgin Islands Department of Agriculture on program implementation. Program activities include providing educational activities and technical assistance to landowners and the development of forest stewardship management plans.

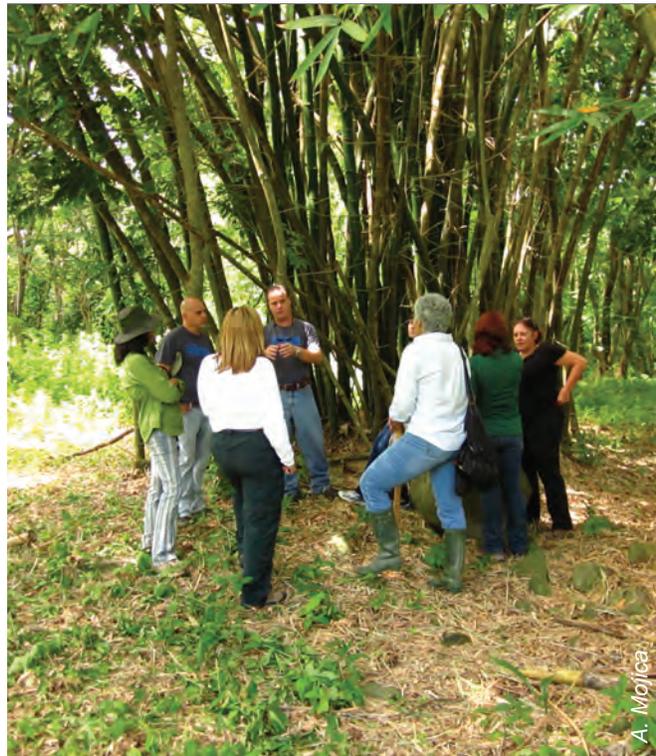


Forests in St. Croix, U.S. Virgin Islands, protect important watersheds.

Enrique Santiago, a biologist with the DNER Forest Service Bureau, was appointed as the Puerto Rico Forest Stewardship Program Coordinator in June 2012. He oversees the program and works with field staff located in the DNER regional offices. Each office has at least one biologist who works with private landowners to develop forest stewardship management plans. Marilyn Chakroff continued in her sixth year as the coordinator for the U.S. Virgin Islands Department of Agriculture. She is solely in charge of the forestry programs at the agency. A program review of the Puerto Rico Forest Stewardship Program was conducted in August 2012.

Forest Stewardship Plan Development

Forest stewardship management plans must meet national standards set by the program, meet landowner objectives, and be approved by the State forester. Once the management plan is delivered, the landowner becomes eligible for other Federal programs that can help pay to implement recommended practices, and could be eligible for State tax abatement programs. Landowners and foresters need to develop the plans together. Landowners set the goals and objectives for their land; these may include goals related to water, range, aesthetics, recreation, timber, fisheries, wildlife, cultural or historic sites, wetlands, and threatened



Patillas, Puerto Rico Forest Stewardship participants discuss plan implementation on the Graciela Basora/Lucio García Moliner property.

Forest Stewardship Program activities are guided by State action plans prepared roughly every 5 years. The Puerto Rico and U.S. Virgin Islands' State Action Plans identified critical resource needs and the areas that are targeted for additional education, awareness, and program outreach activities during this period. In Puerto Rico, 703,967 forested acres occur in "important forest resource areas." The U.S. Virgin Islands State Action Plan identified 42,628 forested acres as important forest resource areas. In the Virgin Islands these areas include forests in riparian and wildlife-urban interface areas, habitat of native and endangered species, and important landscapes. In addition to these resources needs, Puerto Rico important forest resource areas also include uplands that protect drinking water reservoirs, biodiversity, and fire-prone landscapes.

or endangered species. The forest professionals help the landowner recognize the opportunities and limitations unique to their property. The final product will identify the actions needed and a timetable for any planned harvests; a plan can also be designed to meet the objectives of a variety of programs offered by the Natural Resources Conservation Service, Fish and Wildlife Service, and other Federal and State initiatives. Forest Stewardship Program accomplishments for FY 2012 are presented in Table 5.

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Table 5. Forest Stewardship Program (FSP) accomplishments in Puerto Rico and the U.S. Virgin Islands, FY 2012

Performance Measures	Puerto Rico	U.S. Virgin Islands
Non-industrial private forests in important forest resource areas (acres)	703,967	42,628
New forest stewardship management plans (number of plans) (FY 2012)	6	7
Acres in new FSP management plans (FY 2012)	686	71
Acres in important forest resource areas (FY 2012)	686	63
Acres covered by FSP management plans (cumulative)	9,333	1,090
Acres in important forest resource areas covered by FSP management plan (cumulative)	7,469	974
Acres of important forest resource areas being managed sustainably (cumulative)	2,963	974
New Environmental Quality Incentives Program (EQIP) management plans (number of plans) (FY 2012)	11	--
Acres in EQIP management plans (FY 2012)	165	--



Hilda Colon of Villalba, Puerto Rico (center) discusses her experience implementing her Forest Stewardship Plan.



Hilda Colón property in Villalba, Puerto Rico. Moralón (*Coccoloba pubescens*) plantation.

Let's Get SMART

Modern technology can help in the preparation of stewardship management plans. The Forest Service has worked with States across the country to develop a Stewardship Mapping and Reporting Tool (SMART). This is a national Web-based data entry and report writing tool designed to support field-going personnel. Landowners' goals for their land are entered into the planning tool. The forest professional then enters information on forest composition, landscape characteristics, conservation needs, maps, and other important information that describes the property. The technician identifies management and conservation practices that meet the landowners' needs and goals. The end result is a forest stewardship management plan that can guide the landowner's management for conservation and forest products over time.

SMART is also useful for program record-keeping and can help track a plan's achievements. The Puerto Rico Department of Natural and Environmental Resources will be piloting its implementation of SMART in the Guánica/Maricao and the Humacao Joint Priority Landscapes. SMART output now is delivered in

English but a Spanish version for use nationally is on the drawing board.

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Forest Stewardship property in Rio Limon Ward, Utuado, Puerto Rico.

Landscape Conservation

The Puerto Rico State Action Plan identified several areas where Federal and State agencies and non-governmental organizations were independently establishing conservation priorities and could leverage resources for mutual benefit. To capture the benefits of cooperation, they identified two joint priority landscapes for concerted effort: the Guánica-Maricao Landscape and Landscape and the Humacao Landscape.

The Guánica-Maricao Landscape is in the southwestern corner of mainland Puerto Rico. The areas of collaboration include the restoration of habitat for the reintroduction of the Puerto Rican parrot in the Maricao State Forest, improvement of habitat for endemic birds, and the implementation of soil erosion control and other practices for improved stream and marine water quality. The Humacao Landscape is located in eastern part of Puerto Rico. The area's forests may be lost or degraded by activities associated with urban sprawl. In both cases the majority of the land is in private ownership. No conservation effort will succeed in these areas without the support of landowners and communities.

Department of Natural and Environmental Resources technicians are familiar with the people and resources of the joint priority landscapes. They will be working with several private contractors to expand the number

of people receiving technical assistance, and to increase the number of stewardship plans that can be produced. Filigrana, CSP, will be working in the Guánica-Maricao Landscape and the Cooperativa de Servicios Profesionales (COSPRO) will work in the Humacao Landscape. Both entities specialize in environmental projects.

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Guánica-Maricao Joint Priority Landscape links conservation of freshwater and marine ecosystems with upland forests and farmland.

Knowing and Celebrating the Río Piedras

During FY 2012, the Forest Stewardship Program continued supporting the San Juan Urban Long-Term Research Area (San Juan ULTRA). Our active participation and funding ensured that communities within the study area have the opportunity to see first-hand the research initiatives that are taking place and how the research will translate into actions that will improve their quality of life.

On June 2, 2012, the Puerto Rico Conservation Foundation, Puerto Rico Conservation Trust, Allied Interdisciplinary Environmental Group (GAIA), San Juan Bay Estuary Program, the Institute, and San Juan ULTRA hosted an environmental fair Registering My Watershed: Knowing and Celebrating the Río Piedras. The fair offered workshops and activities that provided

information on the history of management of the area, as well as social and ecological information of the Río Piedras watershed. The people who participated that day had the opportunity to visit exhibition booths prepared by the various agencies and organizations that are partners in the project. Children participated in art workshops that were prepared especially for them. More than 350 people attended the event. During that day ULTRA presented a documentary where elders and residents of the basin related stories about activities in the area and the historical changes that happened over the years. The activity is only one of several outreach and educational activities planned for the communities within the Río Piedras Watershed.

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Champion Trees Registry

Somewhere out in a forest, a field, a back yard, or a road you may see a very large tree and be awed by its sheer size, the majesty of its crown, or the history it has survived. It seems only natural that people around the world have measured and marked the size and location of the biggest trees they have ever seen. And it is no surprise that this has led to a friendly competition to find the biggest tree of every kind. Since 1940 the National Arbor Day Foundation has held a competition of big trees and registered the “national champions” by genus and species across the United States. Many jurisdictions have their own competitions for champions, and Puerto Rico is no exception. The Institute has kept the Registry of Puerto Rico’s

Champion Trees since 1989 and recently entered into a partnership with the Conservation Trust of Puerto Rico to revitalize the island-wide competition and to re-measure the existing champions, which is required every 10 years.

This year the Conservation Trust began to locate and assess the condition of the 140 champion trees on the Institute registry. They organized into four regions, established GPS locations for 42 trees, and created a new database for the registry that incorporated existing records from Institute. They also held staff training at their nature reserves and nursery facilities, and trained 35 volunteers in tree identification and forest mensuration. Of 37 trees visited, 2 had died and



Measuring champion trees such as this Panama Canoe Tree (*Cananillesia platanifolia*) takes teamwork.



Champion trees can occur in many locations even in urban areas as the one where this Haiti Catalpa Tree (*Catalpa longissima*) is found. This tree is also known as *Roble dominicano*.

5 were lost to development. This means there is an opportunity to designate new champions for *Spathodea campanulata*, *Thrinax morrisii*, *Cassia javanica*, *Ficus sintenissi*, *Samanea saman*, *Albizia lebbek*, and *Cordia collococca*. Already two new species of trees have tree nominations pending, a sea grape (*Coccoloba uvifera*) and groucho (*Quarariba turbinata*).

Several activities have been held to promote the program. The Conservation Trust provided information and hosted a tree-measuring exercise at their Annual Conservation and Reforestation Fair held at Parque Luis Muñoz Rivera in April. More than 3

dozen fairgoers took the tree-measuring challenge. A presentation to the college environmental association Capítulo Estudiantil Sociedad Ambiente Marino at the University of Puerto Rico yielded a number of volunteers who helped locate and measure trees in the Metro Central Región. Over time we hope more communities will choose to participate and people will nominate trees from their own neighborhoods and local forests.

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Communities, Conservation, and Public Land

The organization Ciudadanos de Karso (Citizens of the Karst) received a grant from the Forest Stewardship Program to host a series of activities to share information about sustainable tourism, conservation initiatives, and economic development opportunities. The first of two workshops—held on May 17, 2012 and titled El Yunque and its Periphery: Uses and Preservation of Land in the Northeast Region of Puerto Rico—targeted architects, engineers, and planners in Puerto Rico. The workshop provided an overview of the development impacts and conservation initiatives in northeastern Puerto Rico and the Northeastern Ecological Corridor. Hitesh Mehta, an international expert on sustainable tourism, ecotourism, and eco-hotel design, offered a lecture and described the different alternatives that are suitable for the area. An interdisciplinary panel of renowned experts discussed the integration of conservation and development of the northeastern region of Puerto Rico. The workshop was co-sponsored by the College of Architects and Landscape Architects of Puerto Rico, Puerto Rico Conservation Trust, Puerto Rico Society of Planning, Interamerican University, Puerto Rico Conservation Foundation, and El Yunque National Forest. The event was also supported by private entities such as El Nuevo Día, one of the major newspapers in Puerto Rico, and Yaucono, a local coffee-producing company.

Ciudadanos del Karso (CDK) hosted a second workshop titled Eco-hotels Planning and Management on May 18, 2012. The workshop was co-sponsored by

the College of Architects and Landscape Architects of Puerto Rico, Puerto Rico Conservation Trust, Puerto Rico Society of Planning, and El Yunque National Forest. This workshop also was led by Hitesh Mehta, author of *Authentic Ecolodges*, a reference book on the subject of eco-hotel planning, design, and operation. Dr. Mehta shared various experiences he has had over the course of his career and shared key considerations in the development of successful eco-hotels and the elements that must be taken into consideration during operations. A closing presentation took attendees on a virtual tour to the most successful projects Dr. Mehta has developed throughout the world.

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Forest Products in Puerto Rico?

Tropic Ventures, a Patillas, PR, non-profit entity and landowner participant of the Forest Stewardship Program, teamed with the Department of Natural and Environmental Resources and the Institute to develop a forest products assessment for Puerto Rico. The assessment, coordinated by Adrés Rúa from Tropic Ventures, provides information on markets and types of wood use Puerto Rico. This includes information

on timber supply sources, types of wood used, buyers, and the source of demand for forest products.

Rúa developed a list of sawmills that are operating in Puerto Rico (Table 6) and created a register of those facilities for artisans and local wood consumers. He visited sawmills and spoke with wood dealers and forest landowners to gather information of the kinds of services and the types of wood that are typical in

Puerto Rico. He also interviewed local artisans to identify their needs in terms of types of forest products they work with, the size specifications of wood, and the type of non-timber forest products, such as seeds, that were being sold.

On April 11, 2012, Tropic Venture and the Department of Natural and Environmental Resources hosted a symposium, La Madera y Otros Productos Forestales de Puerto Rico (Wood and Other Forest Products in Puerto Rico). The targeted audience was the general public, landowners, artisans, woodworkers, government agencies, students, and non-profit organizations. More than 80 people attended the event, which featured presentations on topics that exemplify all aspects related to wood and non-timber forest products in Puerto Rico, including a description of the types of wood that are available in Puerto Rico, where they are available, and their uses. As an alternative to those who are interested in developing businesses related to non-timber forest products, there was a presentation on ethnobotany. The forum also provided information to landowners on the potential of tree plantations in Puerto Rico, the potential for a sustainable small-scale industry, and the opportunities available for support through Federal and State programs.

Thrity ("3t") Vakil shared Tropic Ventures' experiences in land management and gave an overview of the Sustainable Forestry and Rainforest Enrichment Project that was established in 1983. The University of Puerto Rico presented a proposal for the establishment of a forestry curriculum to prepare the forestry professionals of the future and provide educational opportunities to our partners. At the end of the symposium Tropic Ventures presented a report of the partial results of the assessment. The assessment

will be available to our partners on the Web site, Las Maderas de Puerto Rico (<http://www.nuestramadera.org/>).

The group that attended the symposium was highly motivated and expressed interest in getting more information on the wood harvesting and processing processes. By popular demand, on August 8, Tropic Ventures hosted a workshop that included demonstrations on how to use the chainsaw, safety equipment, safe working practices, tree removal, and sawmill operation. The symposium was dedicated to Peter Weaver, a retired Institute Scientist, and Carlos Domínguez, also retired from the Institute. A demonstration of tree harvest and milling operations was held at Tropic Ventures in Patillas, PR.

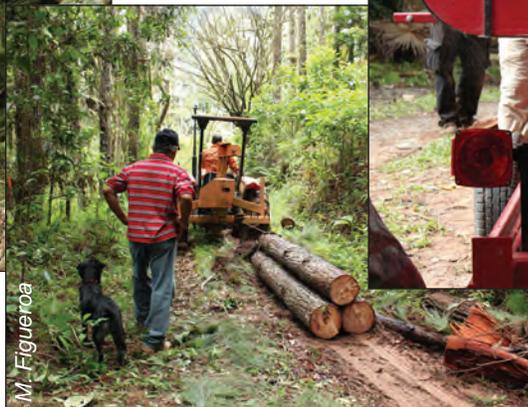
Institute Contact: Magaly Figueroa, mafigueroa@fs.fed.us

Table 6. Active sawmills in Puerto Rico (visited by April 2012).

Name	Location
Aserradero Nando Otero	Ciales
La Cialeña	Ciales
Taller Zayas	Naranjito
Aserradero Bayaney	Hatillo
Taller Alvarado	Orocovis
Taller Miraflores	Patillas
Aserradero Toño Rivera	Morovis
Vicente Valentín	Vega Baja
Aserradero Luis Hidalgo	Camuy
Aserradero Casa Vieja	Lares



Bucking tree limbs.



Skidding logs out of the woods.



Sawmill demonstration

Transparency and Accountability

Monitoring is an important part of public service and one aspect of technical assistance that is seldom mentioned. There is a nationwide push to justify Federal programs and to increase transparency and accountability, so this year additional training has been provided by the Forest Service to State agencies and other partners. Partners attended trainings and

reevaluated internal processes. Several participated in mandatory program reviews that looked at the alignment of the program with legislated goals and objectives, program development and delivery, safety, grant administration, records management, and civil rights.

Forest Health Protection Program

The U.S. Forest Service Forest Health Protection Program at the Institute focuses on providing technical, professional, and financial assistance to stakeholders monitoring forest pests, diseases, and other biotic and

abiotic factors that may cause detrimental changes to the health of Puerto Rican and U.S. Virgin Islands' forests.

Puerto Rico and Virgin Islands Plant Conservation

A workshop on plant conservation in Puerto Rico and the Virgin Islands (PR-VI) was held at the University of Puerto Rico, Mayagüez Campus, June 25–29, 2012.

The dual purpose was building capacity on plant conservation initiatives, including training in the International Union of Conservation of Nature (IUCN) Red Listing, and establishing a regional task force to analyze plant conservation issues and support conservation within the PR-VI biogeographic region. The workshop was a collaboration of the Fundación Puertorriqueña de Conservación, the

U.S. Forest Service Forest Health Protection Program at the Institute, the Biology Department of the University of Puerto Rico at Mayagüez (UPR Mayagüez), and the United Kingdom Overseas Territories Programme of the Royal Botanical Gardens, Kew (Kew). Sara Bárríos, Martin Hamilton, and Dr. Colin Clubbe from Kew conducted a full-day Red Listing training and energized the discussions during the workshop. Red Listing assessments were undertaken for *Erythrina eggersii*, *Zanthoxylum thomasianum*, and *Eugenia fajardensis*, by using expert collective knowledge, herbarium data, and the Geospatial Conservation Assessment Tool (GeoCAT; <http://geocat.kew.org>), a newly developed tool to streamline geospatial analysis (Bachman et al. 2011). Another major outcome of this workshop was the

establishment of the PR-VI Plant Conservation Task Force. The task force's overall goal is to "Protect and sustain the native plant diversity of Puerto Rico and the

Virgin Islands." A Web site (<http://herbaria.plants.ox.ac.uk/bol/prvi>) and Google group were developed with information about the workshop, including presentations and relevant literature. Presently a PR-VI Plant Conservation Strategy is being drafted that aims to collaboratively enable in-situ conservation and restoration, increase ex-situ conservation through partnerships, facilitate communication and outreach, and develop a plan for regional Red Listing of plants.



Endangered *Banara vanderbiltii* (Palo de Ramón) growing ex situ at the USFWS



Field trip participants looking at the *Harrisia* cactus mealybug impacts on *Pilosocereus royerii* in the Guánica UNESCO Biosphere Reserve.

IITF 2012 Accomplishments Report

Presentations covered ongoing local, regional, and global conservation efforts and policies (e.g., the history of plant listings in PR-VI, West Indian plant diversity, the PR Endangered Plant Initiative, the Convention of Biological Diversity's Global Strategy for Plant Conservation, the Global Partnership for Plant Conservation, and the IUCN Red List). Dr. Mike Maunder (Florida International University), the plenary speaker, provided a global overview of plant conservation, looking at the major threats to plant diversity and the tools available for conservationists. The workshop was dedicated to Dr. Miguel A. "Papo" Vives Heyliger, who was recently awarded a Doctor honoris causa by UPR/Mayagüez for his botanical accomplishments and service as an inspiration to the university community. His knowledgeable contributions to the workshop were greatly appreciated by participants.

Dr. Duane Kolterman and Jeanine Vélez (UPR Mayagüez) led a tour of the MAPR Herbarium facilities. Visits to the Guánica UNESCO Biosphere Reserve and to the Cabo Rojo National Wildlife Refuge highlighted the endangered plants and dry forest ecosystems, especially cacti species threatened by the *Harrisia cactus mealybug* (*Hypogeococcus pungens*).

The workshop drew speakers and participants from 40 organizations, among them 17 academic departments in nine universities; various Federal, State, national, and local agencies; scientific and other non-governmental organizations; private consultants; and other experts as well as students. Participants attended from nine countries—Puerto Rico, U.S. Virgin Islands, British Virgin Islands, Antigua and Barbuda, Cuba, Jamaica, Mexico, the United Kingdom, and the United States.

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Citizen Efforts for Monitoring Invasive Species in Puerto Rico

Puerto Rico experienced severe deforestation at the beginning of the 20th century. As a consequence, many introduced species were brought in for agriculture, reforestation, soil stabilization, and ornamental purposes. Additional species were inadvertently brought in shipments, and others such as fire ants have hitchhiked with imported potted plants or wood materials. As a result our ecosystems are currently coexisting with introduced and native species, yet some introduced species are becoming invasive because of their high abundance and harmful impacts on our economy and environment. In Puerto Rico, other introduced invasive species are capable of providing valuable ecosystem services. For example, the African tulip promotes favorable conditions for the establishment of understory species in abandoned pastures (Lugo 2004), and the European honeybees effectively pollinate the endangered tree *Goetzea elegans* (Caraballo-Ortiz and Santiago-Valentín 2011). The Invasive Species Executive Order 13112 of February 3, 1999, directs Federal agencies, among other things, to monitor populations of such species and to promote public education about them. For effective monitoring and detection of incipient invasive species it is important to raise public awareness among citizens.

Public education and citizen awareness of invasive species are two important approaches that would facilitate early detection of newly introduced and established invasives according to Prof. Sally González, landscape architect and urban forester, and Dr. Wilfredo Robles, weed scientist with the College of Agricultural Sciences at the UPR Mayagüez.

Nowadays, public awareness and systematic citizen monitoring is considered one way to counteract the spread of unwanted invasive species. In 2010, the State and Private Forestry Forest Health Protection program supported a pilot citizen monitoring effort. The Grupo Antillano de Especies Invasoras (GAEI or Antillean Group for Invasive Species)—an interdisciplinary group of scientists, an extension specialist, and technicians from the College of Agricultural Sciences at the UPR Mayagüez—was established as part of this project. They developed 13 factsheets and a field guide in Spanish, and they trained citizens to identify and monitor invasive plants and insects. Volunteers were asked to attend a one-day training workshop that covered topics related to invasive plant and insect species, field identification, and the use of global positioning systems and databases to store data. Currently, more than 200 volunteers ranging from 12 to 70 years of age have attended and are still involved with this program. Moreover, GAEI's website (Atlas de Especies Invasoras de Puerto Rico; www.atlas.eea.uprm.edu) developed for this program has been consulted 70,743 times since its launch in April 2011. The water hyacinth factsheet (Fig. 17) is the most frequently consulted, with 1,794 hits to date. The main achievement since this monitoring program started is that attendees have gained knowledge about the worldwide problem of invasive species and about how they may prevent new introductions and further spread of invasive species. The GAEI Web site and Facebook page currently inform the general public on local relevant invasive species issues, and serve as a reporting database and a repository of the factsheets.

Furthermore, in 2012, the emphasis of this project expanded to include becoming bilingual (Spanish and English), to be implemented on the U.S. Virgin Islands of St. Croix, St. Thomas, and St. John. Additional partners and expertise (PR Department of Agriculture and the UPR Río Piedras and Humacao Campuses)

were integrated, new invasive organisms will be included, and monitoring has advanced to now occur using a smartphone application that is currently being developed by GAEI.

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Figure 17. Water hyacinth (*Eichhornia crassipes*) factsheet with distribution map in Spanish.



Dr. Rosa A. Franqui describing insect mounting techniques during a workshop offered in Vieques Island.

International Cooperation

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International Cooperation (IC) had a very active year working mostly in Central America and the Caribbean regions. Our primary areas of focus again this year were the Dominican Republic and Nicaragua, although we supported CAFTA-DR and other USAID activities throughout the region and the Mesoamerican Society for Biology and Conservation (SMBC).



Hispanola parrot feeding in tree.

G. Bauer

Global Activities

- Provided a grant to the International Society for Tropical Forestry (www.istf-bethesda.org) (ISTF) for production and worldwide distribution of a newsletter.

Regional Activities

- Participated in the Mesoamerican Society for Biology and Conservation (SMBC) at their annual conference held in Panama City, Panama.
 - Sponsored an environmental communications pre-conference, 2-day workshop titled "Conservation Photography for Biologists." Participation by 30 members from six countries.
 - Sponsored a SMBC member Conservation Photography Contest. Participation by 31 members from eight countries.
 - Produced 5-minute multimedia show on "Biodiversity in Panama." National Geographic photographer Christian Ziegler cooperated with the Institute in the production of this multimedia show.
 - Co-sponsored, with Institute NGO partner Paso Pacífico and the SMBC, the VIII Mesoamerican Seminar on Psittaciformes. A total of 12 presentations were given by scientists from six countries (Costa Rica, Cuba, Honduras, México, Nicaragua, and USA). These included:
 - White, Thomas, Jr. Estado y conservación de los psitácidos nativos del Caribe.
 - Canizares, Maikel. Resultados de 15 años de manejo de los psitácidos en Cuba.
 - Renton, Katherine. Estado de conocimiento sobre los psitácidos en México. 1
 - Lainez, Said; and Héctor Orlanod Portillo. Conocimiento del estado de conservación de los psitácidos en Honduras.
 - Lezama-Lopez, Martín. Aproximación al estado de conservación de loro (Psittacidae) en Nicaragua. 1

- Monge, Guissella; Oliver Chassot; Yolando Matamoros; and Randall Arguedas. Estado de conservación de los psitácidos en Costa Rica.
 - Arriaga-Weiss, Stefan Louis; Lilia María Gama-Campillo; Juan Ramón Hernández-Ugalde; Juan Manuel Koller-González; and Juana Lourdes Trejo Pérez. Datos preliminares estatus de conservación de psitácidos en la Sierra Teapa-Tacataipa, Tabasco, Mexico.
 - Reyes-Mercado, Gladys; Ricardo Ramírez-Julian; Raúl Rivera-García; Laura Paciano Leyva; Antonio de Jesús Núñez Cebrero; and Remedios Martínez García. Actualización del estado de conocimiento del perico corona Blanca (*Pionus senilis*) en Oaxaca, México.
 - White, Thomas, Jr. Restricción y conservación del nicho ecológico de un psitácido neotropical: el caso del loro portorriqueño.
 - Ornelas Carrillo, Roberto; Claudia C. Cinta Magallon; and Carlos R. Bonilla Ruz. Uso de hábitat interanual de *Ara militaris* en un manglar del Occidente de México.
 - Mondragón Hung, María Eugenia; and Héctor Orlando Portillo Reyes. Inicio de un plan de acción para la conservación de psitácidos en la Moskitia hondureña.
 - Cruz Maldonado Nereyda Nathalie; Sonia Gabriela Ortíz Maciel; Javier Cruz Nieto; and Fabrice De Clerck. Estado y conservación de la cotorra serrana occidental (*Rhynchopsitta pachyrhyncha*), Costa Rica.
 - Lezma-López, Martín. Abundancia de la lora nuca amarilla en el Paso del Istmo, Rivas, Nicaragua; una revisión sobre los esfuerzos de su conservación.
- Sponsored a technical presentation at general sessions, including:
- Ulate-Gómez, Katherine; Zaida Piedra Cerdas; Guissella Monge-Arias; Oliver Chassot; and Roberto Salom-Pérez. La Carta de la Tierra y Kamishibai como herramientas para la conservación de animales amenazados.
 - Torrez, Marvin; Wayne Arendt; and Marlón Sotelo. Comunidad de aves del sureste de Nicaragua y taza indicadoras.

Nicaragua Activities

In coordination with Institute Wildlife Unit, we continued with our technical assistance and technology transfer to Nicaragua with support to long-term biomonitoring, sustainable tourism development, and sampling for mercury and other persistent toxic substances (PTS) in shade coffee and cloud forest within the Mombacho Volcano Natural Reserve (Granada, Nicaragua). Our primary partners in Nicaragua were the Ministry of Environment and the NGOs Paso Pacífico and Fundación Cocibolca. Long-term plots were measured in agroforestry systems under five land uses (secondary and riparian forest, forest fallow, coffee plantations, and 'open lands,' e.g., grass- and pasturelands with scattered trees) in the northern highlands and the same agroforestry systems, with the exception of coffee plantations, in southern coastal areas within the Paso del Istmo biological corridor:

- 1 Bird surveys using distance-point-count methodology in the Paso del Istmo Biological Corridor and central mountain region: 300 point counts.
- 1 Entomological survey as part of long-term monitoring in the Paso del Istmo Biological Corridor: 854 individuals of 37 species; contribution to global database.

- 1 Use of the MORPHO platform for data management in long-term biodiversity monitoring.
- Publication: Arendt, W.J.; Tórrez, M.; Vílchez, S. 2012. Diversidad de aves en agropaisajes cafetaleros en la región norte de Nicaragua. [Avian diversity in agroscares in Nicaragua's north highlands] *Ornitología Neotropical* 23: 113–131.

In addition, several presentations and posters on the Nicaragua work were made during the year:

- 1 Presentation: Arendt, W.J.; Tórrez, M.A.; Chavarría, L.; Duriaux, G.; Jovel Amaya, N.; and Gutiérrez Ramírez, M. 2011. Use of residual body condition to determine habitat suitability and use of cloud forest and shade coffee by resident and migratory birds in Nicaragua (Presentation at the IX Neotropical Ornithological Congress, Cusco, Perú (8–14 November).
- 1 Poster: Lane, O.; Arendt, W.J.; Tórrez, M.A.; and Evers, D. 2012. Heavy metal exposure in resident birds and neotropical migrants in selected sites in Central America. 5th North American Ornithological Conference, Vancouver, British

Columbia, Canada, 14–18 August (Category: Ecotoxicology and pollution).

Other significant accomplishments in Nicaragua from IC and our international partners included:

- NGO Paso Pacífico was invited for the third consecutive year to participate in the Clinton Global Initiative.
- IIC provided technical assistance to local partners to establish eco-consulting businesses to serve conservation NGOs and development projects in protected area buffers zones that would provide benefits to economically disadvantaged Hispanic community members.
- IIC developed a working relationship with the Universidad de Centro América in Managua and assisted with training biology students at the Santa Mauro Field Research Station.
- Undergraduate student training—Provided technical support for two students at La Universidad Nacional Autónoma de Nicaragua, Managua (UNAN).
- Graduate student training—Provided technical support for one student at La Universidad Nacional Autónoma de Nicaragua, Managua (UNAN) in the Biology Department in cooperation with Fundación Cocibolca, and one student at Universidad de Managua in Environmental Communications, in cooperation with Deutsche Welle Akademie.
- ICo-sponsored the Sociedad Mesoamericana para la Biología y Conservación, Nicaragua Chapter,

annual meeting and V Simposio Nacional de Medio Ambiente y Biología de la Conservación, August 29–30, 2012. More than 50 participants discussed natural resource management issues in Nicaragua.

- I Presented film nights on parrot conservation and sustainable tourism, presenting two films produced through support of the Institute in 2008–2009. Films were presented at seven ‘cine-foros,’ four targeting youth, and three community-wide events. More than 200 viewers participated across communities.
- I Offered two bird-watching field trips to mangrove estuaries and dry tropical forests for more than 50 youth from rural villages of the San Juan del Sur municipality, March–May 2012.
- I Social Media—Used social media to share conservation and environmental messages to Nicaraguan and U.S. publics. On the Institute’s non-governmental organization partner Paso Pacífico Twitter account (@pasopacifico), 950 followers shared in more than 1,000 tweets.
- I Conducted beach clean-up events in the San Juan del Sur municipality, including 12 events between October 2011 and September 2012, involving 617 volunteers and collecting 3,035 pounds of garbage from Pacific and Atlantic beaches.
- I Assisted with organizing and conducting five “FAM” (familiarization) tours or trips for journalist to cover conservation activities in Nicaragua. A total of 27 journalists participated in these events.

Dominican Republic Activities

IC began a new agreement to continue to provide leadership, mentorship, and technology transfer to Dominican Republic partners in biodiversity conservation and sustainable tourism activities in local, underserved, and disadvantaged Hispanic communities and tourism clusters in coordination with the Dominican Consortium for Tourism Development (Consortio Dominicano de Competitividad Turística, CDCT) and eight tourism clusters in Barahona, La Altagracia, La Romana-Bayahibe, Jarabacoa, Perdernales, Puerto Plata, Samana, and Santo Domingo.

The primary focus was to assist Dominican Republic tourism clusters with biodiversity conservation and sustainable tourism development through on-the-ground technical assistance and training programs by:

1. Conducting biological assessments for project activities;
2. Providing technical training for communities to develop ecotourism activities;

3. 1 Providing promotion and marketing assistance;
4. 1 Providing information to support environmental education; and
5. 1 Providing technical support to the Ministry of Environment in support of protected area management.

The following major activities were undertaken:

- I Provided technical assistance to underserved, disadvantaged Hispanic local communities and NGOs to foster economic benefits by helping to establish eco-businesses in protected areas and their buffer zones in Laguna Bavaro Wildlife Refuge, Laguna Limón Wildlife Refuge, and local communities in Jarabaco (Sonido de Yaque) and Constanza (Salto Aguas Blancas).
- I Promoted International Migratory Bird Day with a rd watch in the Santo Domingo Colonial Zone and a public presentation on “Biodiversity, Birds and and Cultural Integration.”

- Participated in local television programs (six times) in Santo Domingo and Puerto Plata to promote biodiversity conservation and ecotourism; these programs reached an audience in Dominican Republic and the United States of about 50,000 persons.
- Developed interpretive signs for critical important protected areas such as Reserva Biológica Charco Loma Azul and Monumento Natural Loma Isabel de Torres, Refugio de Vida Silvestre, and Laguna Bavaro.
- Provided ecotourism and community development training to U.S. Peace Corps volunteers and their local counterparts.
- Invited presentation: Arendt, WJ. 2011. Status of the white-crowned pigeon in the Dominican Republic in the 1970s. Joint U.S. Fish and Wildlife Service/Society for the Conservation and Study of Caribbean Birds: White-crowned Pigeon Conservation Project. Reunión y Taller de Capacitación de la Paloma Coronita, Punta Cana, República Dominicana (13–18 de noviembre de 2011).
- Completed seven technical reports to help provide for conservation of biodiversity in protected areas and buffer zones, these included:
 - 1) Evaluación rápida y recomendaciones para el Desarrollo Ecoturístico de Sereno de La Montaña, Espaillat, República Dominicana.
 - 2) Evaluación rápida de sitio arqueológico Piedras Letreadas, Constanza, República Dominicana.
 - 3) Rapid assessment of ecotourism potential in La Refugio de Vida Silvestre Manglar, La Gina, Miches, Dominican Republic.
 - 4) Rapid assessment for ecotourism development at Laguna Limon, Los Guineos, Dominican Republic.
 - 5) Mejoramiento del Sendero Aguas Blancas, Parque Nacional Valle Nuevo, Constanza, República Dominicana.
 - 6) Estado de avances acciones pendientes Sendero Padre Nuestro, Parque Nacional del este, Bayahibe, República Dominicana.
 - 7) Ideas para la producción de miel orgánica Sendero Padre Nuestro, Parque Nacional del Este, Bayahibe, República Dominicana.
 - 8) Taller sobre diseño, construcción y mantenimiento de senderos, proyecto ecoturístico Sereno de La Montaña, Espaillat, República Dominicana.
 - 9) Taller sobre diseño, construcción y mantenimiento de senderos, Monumento Natural Loma Isabel de Torres, Puerto Plata, República Dominicana.
 - 10) Análisis de sitio y recomendaciones para el desarrollo del sendero ecoturístico Loma Isabel de Torres, Monumento Natural Loma Isabel de Torres, Puerto Plata, República Dominicana (Fig. 18).



Figure 18. Map for Sendero Ecoturístico Loma Isabel de Torres

Publications—Fiscal Year 2012

For electronic versions of Institute publications, please go to Treeseearch at www.treeseearch.fs.fed.us. For hardcopy versions, please contact greyes@fs.fed.us, or write to:

U.S. Forest Service - International Institute of Tropical Forestry
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 1201 Ceiba Street
 Jardín Botánico Sur
 San Juan, Puerto Rico 00926.

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