The Status of Puerto Rico's Forests, 2003

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Front cover: top left, the best preserved examples of tabonuco forest in Puerto Rico are found in the El Yunque National Forest; top right, the relatively undeveloped coastline near Humacao, PR; bottom, forest area has been estimated from aerial photographs in this and previous forest inventories. Back cover: top right, tabonuco forest; top left, in some places of the Cordillera Central of Puerto Rico, forest land is being cleared for sun coffee cultivation; bottom, mango (*Mangifera indica* L.).

All photos by Thomas J. Brandeis unless otherwise noted.

The tiny coquí frog is the mascot of Puerto Rico. The name comes from its "ko-kee" call. (photo by Gerry Bauer, U.S. Forest Service)

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and Sonja N. Oswalt

Los Picachos, El Yunque National Forest. (photo by Gerry Bauer, U.S. Forest Service)

Welcome…


Edgardo Gonzalez


Ariel E. Lugo


Peter J. Roussopoulos

This Resource Bulletin contains the results of the third forest inventory for Puerto Rico conducted by the U.S. Department of Agriculture Forest Service. The International Institute of Tropical Forestry had the privilege of contributing to all three forest inventories and has reason to feel particularly pleased with this one for the number of important innovations it contains. This is the first time that the forest inventory includes all forest lands on the Island. Earlier forest inventories had focused on timberlands. This forest inventory also expands the scope of organisms inventoried so that it presents a clearer picture of the biodiversity of Puerto Rican forests.

As we enter a new era of rapid climatic and global change, resource inventories such as this one become increasingly important tools for informing policy and for advancing understanding on how organisms and ecosystems adapt to continuous change in environmental conditions. This is particularly important in the Caribbean where natural disturbances such as hurricanes, droughts, landslides, and earthquakes interact with high population densities and intensive human activity. The Caribbean is a harbinger for the future of continental land masses, and we are lucky to have in our land management and scientific tool kit the results of periodic forest inventories such as this one.

We at the Institute are pleased to collaborate with the Southern Research Station in this effort, which started with the 1980 forest inventory, and already look forward to the next forest inventory with the collaboration and participation of the Forest Bureau of the Department of Natural and Environmental Resources. The user of this Resource Bulletin will find the best information available on the continuing evolution of the Island forests. We trust users will be as pleased as we are to have available this information about our tropical forests.

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About Forest Inventory and Analysis Inventory Reports

The Southern Research Station's Forest Inventory and Analysis (FIA) Research Work Unit and cooperating State forestry agencies now conduct annual forest inventories of the 13 Southern States (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia), the Commonwealth of Puerto Rico, and the U.S. Virgin Islands.

The primary objective of these inventories is to develop the resource information needed to formulate sound forest policies and programs. This is done by gathering and analyzing data about forest resources including, but not limited to, forest area, forest ownership, forest type, stand structure, timber volume, growth, removals, and management activity. In addition, new assessments that address issues of ecosystem health have been added. These include information about ozone-induced injury, down woody material, soils, lichens, and tree crown condition. The information presented is applicable at the State and unit level; it furnishes the background for intensive studies of critical situations but is not designed to reflect conditions at very small scales.

More information about Forest Service resource inventories is available in "Forest Service Resource Inventories: An Overview" (U.S. Department of Agriculture Forest Service 1992). More detailed information about new sampling methodologies employed in annual FIA inventories can be found in "The Enhanced Forest Inventory and Analysis Program - National Sampling Design and Estimation Procedures" (Bechtold and Patterson 2005).

Data tables included in FIA reports are designed to provide a comprehensive array of forest resource estimates, but additional data can be obtained for those who require more specialized information. FIA data for all States in the United States can be accessed at: http://www.ncrs2.fs.fed.us/4801/FIADB/index.htm. Additional information about any aspect of this or other FIA surveys may be obtained from:

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Forest Land

- Puerto Rico's forest cover proportion continues to increase and now stands at 57 percent for mainland Puerto Rico, 85 percent for Vieques, and 88 percent for Culebra. Forest cover on mainland Puerto Rico has increased by 211 653 ha since the forest inventory of 1980.

- Subtropical dry forest occupies 50 346 ha, 6832 ha, 2591 ha, and 6217 ha in mainland Puerto Rico, Vieques, Culebra, and Mona, respectively. Subtropical moist forest occupies 258 861 ha in mainland Puerto Rico, more than any other forested life zone. Subtropical wet and rain forest occupies 161 503 ha, lower montane wet and rain forest covers 11 722 ha at the highest elevations, and mangrove forest occupies 7920 ha in coastal areas of mainland Puerto Rico.

- While the increase in overall forest land is encouraging, Puerto Rico does not yet receive the full benefits of its increasing forest cover because the vast majority of the forest is still very young, having for the most part naturally regenerated since the widespread abandonment of agricultural activities beginning in the 1950s.

Forest Structure and Succession

- Trees were recolonizing land that had been previously cleared of forest at 17.8 percent of the locations measured by field crews. Most of these reversions (57.1 percent) were in subtropical moist forest, 30.4 percent were in subtropical wet and rain forest, and 12.5 percent were in subtropical dry forest.

The Ruta Panoramica that runs along Puerto Rico's Cordillera Central opens to expansive views of the surrounding countryside.

- Most of Puerto Rico's forest is still in the early stages of development. Only 11.7 percent of the stands inventoried were categorized as mature secondary forest, while 65.7 percent of the forest was categorized as young secondary.

- Almost one-half (48.9 percent) of the forest consists of stands comprised of sapling-seedling trees, and 43.2 percent of the forest consists of stands of small-diameter trees. Only 7.6 percent of the forests were stands of medium-diameter trees, and 0.3 percent of the stands consisted of mature, large trees.

- All forests on Culebra were in the early sapling-seedling stage, while 80.8 percent of those on Vieques consisted of sapling-seedling stands and 19.2 percent of small-diameter stands.

- Puerto Rico's forests were found to have over 1.6 billion trees over 2.5 cm in diameter, 10.6 million m^2 of basal area, and 36.6 million Mg of sequestered carbon. There were 3,112 trees, 19.2 m^2 of basal area, 26.44 m^3 of merchantable growing-stock stem volume, and 80 Mg of aboveground biomass (AGB) on an average hectare of forest.

- The subtropical moist forest held most of the live trees, basal area, merchantable volume, and forest biomass in Puerto Rico, followed by the subtropical wet and rain forests, subtropical dry forest, and lower montane wet and rain forests.

- The subtropical moist and wet and rain secondary forests inventoried in 1990 are still young and increasing in average basal area, going from 13.2 m^2/ha in 1980, to 15.2 m^2/ha in 1990, to the current level of 20.9 m^2/ha.

Long-abandoned coffee shade slowly reverts to natural secondary forest near Florida, PR.

Species Composition

- The forest inventory encountered 305 tree species. Both native and introduced species are regenerating naturally in established, maturing forests and on recently abandoned agricultural land.

- African tuliptree (*Spathodea campanulata* Beauv.) had more basal area than any other tree species on the island, and it was the most frequently encountered tree.

- The native species American muskwood [*Guarea guidonia* (L.) Sleumer], cabbagebark tree [*Andira inermis* (W. Wright) Kunth ex DC.], and pumpwood (*Cecropia schreberiana* Miq.) were the next three most important species, indicating that native species are regenerating successfully and are being incorporated into secondary forest associations on a landscape that has been altered heavily by human activities.

- Gumbo limbo [*Bursera simaruba* (L.) Sarg.] was the most important species in the subtropical dry forest life zone and Sierra palm [*Prestoea montana* (Graham) Nichols] was the most important species in the lower montane wet and rain forests. White mangrove [*Laguncularia racemosa* (L.) Gaertn. f.] was the most important mangrove species.

Forest Health

- There was little indication of unhealthy, stressed trees or widespread pest and disease problems. Only 12.9 percent of live trees had some type of damage or disease. The most common disease was fungal infection (8.6 percent of live trees), as indicated by the presence of external fungal fruiting bodies or signs of advanced decay. Only 5.4 percent of trees showed indications of crown dieback, and when it did occur it was minor more often than not. More than one-half of the trees with crown dieback showed losses of 15 percent of the crown or less.

- Average per-hectare amounts of down woody material (DWM), forest floor duff, and forest floor litter were generally higher where the forest environment was more humid. Small-to-medium (10- to 100-hour) forest fire fuels predominated in subtropical dry forests, while quantities of medium-to-large (100- to 1,000-hour) fuels were greater in all of the more humid forest life zone.

- Most of the DWM found in the forests was smaller diameter (8 to 20 cm) pieces of wood. Puerto Rico's forests lack large pieces of DWM on the forest floor, probably because these forests are in an early successional stage and have few large trees.

New Inventory Design Successfully Implemented

- The third forest inventory of Puerto Rico was expanded to include all forests found on the islands. The new systematic sampling system used by FIA was successfully adapted to the forest inventory challenges found in highly diverse Caribbean island tropical forests.

- Future inventory work should include the installation of additional permanent plots in the islands' mangrove and lower montane forests to reduce the variability in our attribute estimates for these forest types. Also, more inventory plots should also be installed on Culebra, and we will need to continue adapting the sampling grid on Vieques to respond as more areas are made accessible. Expanding the forest inventory to include field work on Mona will complete the coverage of all the forested islands of Puerto Rico.

The relatively undeveloped coastline near Humacao, PR.

Palm growing in secondary forest.

Continued Relevance of Puerto Rico's Forest Inventories

A continuous forest inventory functions best when there is continuity from one survey to the next. However, inventories must change to meet changing information needs or they risk losing relevance. Since the design and implementation of the first survey in 1980, forest inventory work in Puerto Rico has evolved to meet new information needs. There has been gradual movement away from evaluating island forests primarily in terms of wood products and movement toward greater recognition of the valuable services that healthy forest ecosystems provide the human population. This change reflects the evolution of the Puerto Rican economy, which continues to move away from local production of agricultural and forestry products toward reliance on imported goods in these categories. Large-scale harvesting and forest-based industries that would use forest inventory data for sustainable management are nonexistent on the island. Only small-scale processing of locally grown woods for furniture and crafts production occurs (Kicliter 1997), so a forest inventory focused primarily on quantifying the potential for timber production would not provide much useful information to natural resource managers and decisionmakers.

Nevertheless, estimating the quantity of this forest commodity remains an important aspect of forest inventory reporting. Studies of forest resource sustainability and international assessments of forest resources, such as the Food and Agriculture Organization of the United Nations Forest Resource Assessments (FAO 2001) and the Montréal Process Working Group's Criteria and Indicators of Sustainable Forest Management, require the reporting of growing-stock volumes, even if they only represent potentially harvestable timber volumes.

Although reporting wood volume in Puerto Rico's forests remains an integral part of the forest inventory, there is also recognition

Fresh water remains one of the most valuable products of Puerto Rico's forests.

The Puerto Rican landscape consists of a mosaic of forest patches, grasslands, and developed areas.

Forests, and the water they provide, are valuable resources for the people of Puerto Rico.

that the economic value of these forests extends far beyond the direct monetary benefits coming from the harvest of forest products. A well-forested watershed will retain more freshwater, speeding aquifer recharge, which is a critical issue throughout the Caribbean. Forest cover stabilizes soils on the frequently steep, erodable slopes, keeping sediments from damaging coastal coral reefs and regulating freshwater runoff that affects estuarine and coastal marine ecosystems. Through these hydrological mechanisms, forests directly affect many island economic activities such as fishing and tourism that depend on healthy coastal marine ecosystems. Despite widespread, serious deforestation and other human impacts, Caribbean forests are recognized as global biodiversity hotspots due to their diversity and concentrations of endemic species (Helmer and others 2002, Myers and others 2000). Puerto Rico's public forests include relatively large examples of most of the major Caribbean forest types and constitute a locally and globally valuable ecological resource. They also provide recreational and ecotourism opportunities for an increasingly urbanized population and a growing international tourism sector.

Puerto Rico's human population now totals 3.9 million, and an average square kilometer houses 443 people and has 2.9 km of road (Central Intelligence Agency 2006). Population growth over the past two decades has put pressure on Puerto Rican forests. Despite their ecological significance and importance to the sustainable development of the islands, these forests are being cleared for urban development at increasing rates (Lopez and others 2001, Ramos-Gonzalez 2001, Ramos-Gonzalez and others 2003). Forest inventories must provide resource managers and decisionmakers with the timely, useful information they need to make informed decisions about management of their lands and resolve land use conflicts.

Puerto Rico's forest inventories have expanded understanding of the structure and functioning of Caribbean forest ecosystems. Inventory results supplement the findings from intensive, smaller scale studies of forest dynamics, stand structure, and species composition, putting them into a larger, landscape perspective (Chinea and Helmer 2003, Lugo and Brandeis 2005, Lugo and Helmer 2004). Inventory results have also advanced understanding of the secondary tropical forests that predominate in tropical landscapes worldwide (Brown and Lugo 1990, Corlett 1994, Guariguata and Ostertag 2001).

Across the coastal plain, forest was cleared for agriculture, which in turn has been replaced with urban development.

Previous Forest Inventories of Puerto Rico

Spanish colonial officials attempted to inventory public forests as early as 1870 (Domínguez-Cristóbal 1997). Birdsey and Weaver (1982) summarized historical forest cover estimates by drawing on sources as far back as the 1500s and up to a detailed land use map of the island prepared by the Puerto Rican Department of Natural Resources in 1972. The FIA Program's 1980 forest inventory provided the first systematic inventory of the forests on mainland Puerto Rico.

In 1980 a square sampling grid with lines spaced 3 km apart was established over mainland Puerto Rico (not including the outlying islands of Vieques, Culebra, Mona, and Desecheo). Intersections of lines that formed the grid were designated as sample points (Birdsey and Weaver 1987). The 978 sample points were located on black and white aerial photographs taken in the mid-1970s. Photointerpreters overlaid a smaller grid of 25 dots at each sample point location on the photo, and the dot-count method was used to estimate forest type and land use areas, which were ground-truthed by field visits by forest inventory crews (Birdsey and Weaver 1987).

Forest attributes were measured by field crews at sample points that fell in forests that were considered to have the potential for commercial wood production. Consequently, Puerto Rico was partitioned into areas based on productive capacity and land use. The field portion of the inventory excluded forests in some areas including the highest mountains due to excessive slope or rainfall, the subtropical dry forest region where rainfall is < 1000 mm/year, areas with unproductive soils, and areas with land uses that were not compatible with commercial wood production [see figure 5 on page 19 of Birdsey and Weaver (1982) for a map of the 1980 inventory area]. The commercially designated forest inventory area covered about 400 000 ha, 45 percent of the island, in the subtropical moist and wet forest life zones primarily in upland, nonurban areas between the valleys dedicated to agricultural production and in higher mountain areas.

The 1980 inventory provided baseline forest area figures for mainland Puerto Rico. Increasing forest area was documented for the first time when forest area estimates were updated in 1985 using aerial photographs taken in 1984 and field visits to a subsample of the inventory plots installed in 1980 (Birdsey and Weaver

Native wood is still used on a small scale for local crafts, furniture, and musical instruments.

1987). The 1985 inventory showed that forest area increased from 279 000 ha in 1980 to 299 900 ha in 1985, an increase of 4200 ha/year, mainly on abandoned agricultural land and pastures (Birdsey and Weaver 1987).

The forest inventory of 1990, which employed the same methods used in 1980 and 1985, documented the subsequent growth and development of Puerto Rico's forests. Forest area estimates were derived from aerial photographs of the island taken in 1988–89 and forest inventory plots were remeasured following the same protocols used in 1980 (Franco and others 1997). Although the 1990 results showed increases in forest area and stand development since 1980, the 1990 forest area estimate of 287 400 ha was less than that for 1985 (Franco and others 1997).

Summary of Previous Inventory Results and Observed Trends

Forest land was increasing—Past forest inventories have shown an overall forest land increase on mainland Puerto Rico due to natural regeneration on abandoned agricultural land. Most of the abandonment has been in rugged mountainous areas (60 percent of the stocked timberland in 1980 occurred in areas with slopes > 45 percent) where agriculture was difficult to sustain and where agricultural activities usually resulted in severe soil erosion (Birdsey and Weaver 1982). Franco and others (1997) attributed the increase in forest cover between the 1980 and 1990 inventories to continued reversion on abandoned cropland and pastures, which still exceeded losses of forest cover resulting from conversion to nonforest land uses. Coffee shade declined by about one-half as abandoned stands were reclassified as secondary forest or were converted to other agricultural uses such as full-sun coffee production (Franco and others 1997).

Young forests were maturing—Forest structure also reflected the young, recovering nature of Puerto Rico's forests. Overall, stands were characterized as understocked, with low basal areas and relatively little volume in commercially valuable trees with good form. Younger, smaller trees predominated in the many pole and sapling-size stands found on abandoned cropland and pasture that had recently (within the last 30 years) reverted to secondary forest. Larger, older trees of the kind that provide sawtimber were most frequently found in stands managed for coffee shade. These stands were categorized

Livestock pasturing and most other forms of agricultural activity have decreased, allowing forest reversion across Puerto Rico.

as understocked, and consisted of sapling-size natural regeneration beneath an overstory of relatively few large, open-grown, rough trees (Anderson and others 1982, Birdsey and Weaver 1982). The 1980 and 1990 inventories clearly illustrated the development and maturing of Puerto Rico's forests over that 10-year period. Franco and others (1997) highlight the substantial increases in basal areas, improved stocking, doubling of average volume per hectare, and decreased losses due to poor form as stands previously classified as poletimber size advanced to sawtimber size.

Species composition reflected past human influences—Puerto Rico's tree species richness stands out even when one considers that the previous forest inventories encountered only a portion of the total tree species native or introduced to the island [Little and others (1974) lists 750 tree species in Puerto Rico and the U.S. Virgin Islands]. The 1980 inventory tallied 189 species and the 1990 inventory 199 species. Despite the overall species richness of the forests, only 10 species accounted for about one-half of the basal area recorded in both 1980 and 1990 (Birdsey and Weaver 1982, Franco and others 1997). The vast majority of the tree species found by inventory crews were encountered infrequently.

Fast-growing, early successional species are common in young, regenerating forests.

The tree species mix found in Puerto Rico's secondary forests in the previous inventories clearly reflected past land uses and the relatively young age of those forests. Fast-growing species commonly found in the early stages of tropical forest succession, such as pumpwood, yuquilla [*Schefflera morototonii* (Aubl.) Maguire, Steyermark & Frodin], and loblolly sweetwood [*Ocotea leucoxylon* (Sw.) Mez.] were encountered frequently. The importance of species introduced for coffee shade, fruit production, or as ornamentals is demonstrated by the high frequency of occurrence and high basal areas of Malabar plum [*Syzygium jambos* (L.) Alston], African tuliptree, and mango (*Mangifera indica* L.). African tuliptree showed a notable increase in frequency and basal area between the 1980 and 1990 inventories (Franco and others 1997). The decreasing frequency and basal areas from 1980 to 1990 of shade coffee tree species, particularly river koko (*Inga vera* Willd.), sacky sac bean [*Inga laurina* (Sw.) Willd.], and coffee (*Coffea* spp.), reflected the abandonment of this agroforestry and senescence of older coffee shade trees.

The limited survey area of the previous forest inventories did not, however, allow for a truly island-wide view of tree species composition. The previous forest inventories did not provide us with insight into the species composition of subtropical dry forest, lower montane forests, mangroves, or any other forests not designated as commercially productive. Only those areas with the capacity to produce wood commercially—subtropical moist and wet forest areas with moderate slopes and productive soils—were inventoried. Because such areas include those suitable for shade coffee production, sampling was biased in favor of this land use and other similar agricultural activities. The overall view of Puerto Rico's forests may consequently have reflected mainly those trends observed in shade coffee stands. Where past land uses did not involve directly manipulating species composition, as in the forests on higher, steeper slopes, species composition and stand dynamics were not portrayed accurately.

Additions to the Current Forest Inventory

In contrast with the previous forest inventories that focused on areas with the commercial production potential, the current forest inventory has been expanded to include all forest types, management and reserve categories, and ownership classes. For the first time, the outlying islands of Vieques and Culebra have also been included in the forest inventory. Forest cover on Mona, Desecheo, and other small outlying islands has been included in forest area estimates, but because we do

Coffee production, while reduced from previous decades, still plays an important role in the Puerto Rican rural economy. Much of the shade coffee production has been abandoned or replaced with full-sun coffee plantations.

not yet collect field data on those islands, information about the characteristics of those forests will not appear in this report.

In addition to the kinds of information collected in past forest inventories, the FIA Program now collects data for forest health monitoring (FHM). Tree damage, pests, and diseases are described in detail when found. The health and condition of tree crowns are assessed also. Monitoring of tree crowns will help us understand how Puerto Rico's forest trees survive and recover from hurricanes. Also, we now measure amounts of DWM and collect samples of the forest floor and upper layers of soil. DWM is an essential component of forest ecosystems. Structurally, DWM serves as growth substrate for plants; habitat for essential decomposers like termites and beetles; habitat for birds, small mammals, and reptiles; and as a barrier to soil erosion and protection from rapid loss of soil moisture (Harmon and others 1986, Spetich and others 1998). Chemically, DWM influences soil formation, nutrient retention, and carbon sequestration on the tropical forest floor (Delaney and others 1998, Harmon and others 1986). Moreover, DWM contributes to forest fire potential and influences the dynamics of fire events in drier tropical forests or during dry seasons.

Forest area has been estimated from aerial photographs in this and previous forest inventories.

Study Area and Forest Associations

The Commonwealth of Puerto Rico consists of the islands of Puerto Rico, Vieques, Culebra, Mona, and a number of smaller islands centered on 18°15′ N. by 66°30′ W. (fig. 1). Previous forest inventories concentrated only on the mainland Puerto Rico, but the current inventory also provides forest area estimates for Vieques, Culebra, Mona, and other smaller islands. We did not, however, collect field data on Mona and the other smaller islands for this inventory.

Many researchers have pointed out relationships between the islands' rugged topography, climatic gradients, and forest vegetation. Forest vegetation reflects the marked environmental and climatic gradients resulting from the interaction between trade winds and abrupt elevation changes. Birdsey and Weaver (1982) and Ewel and Whitmore

Unique forests grow on the serpentine soils in southwestern Puerto Rico.

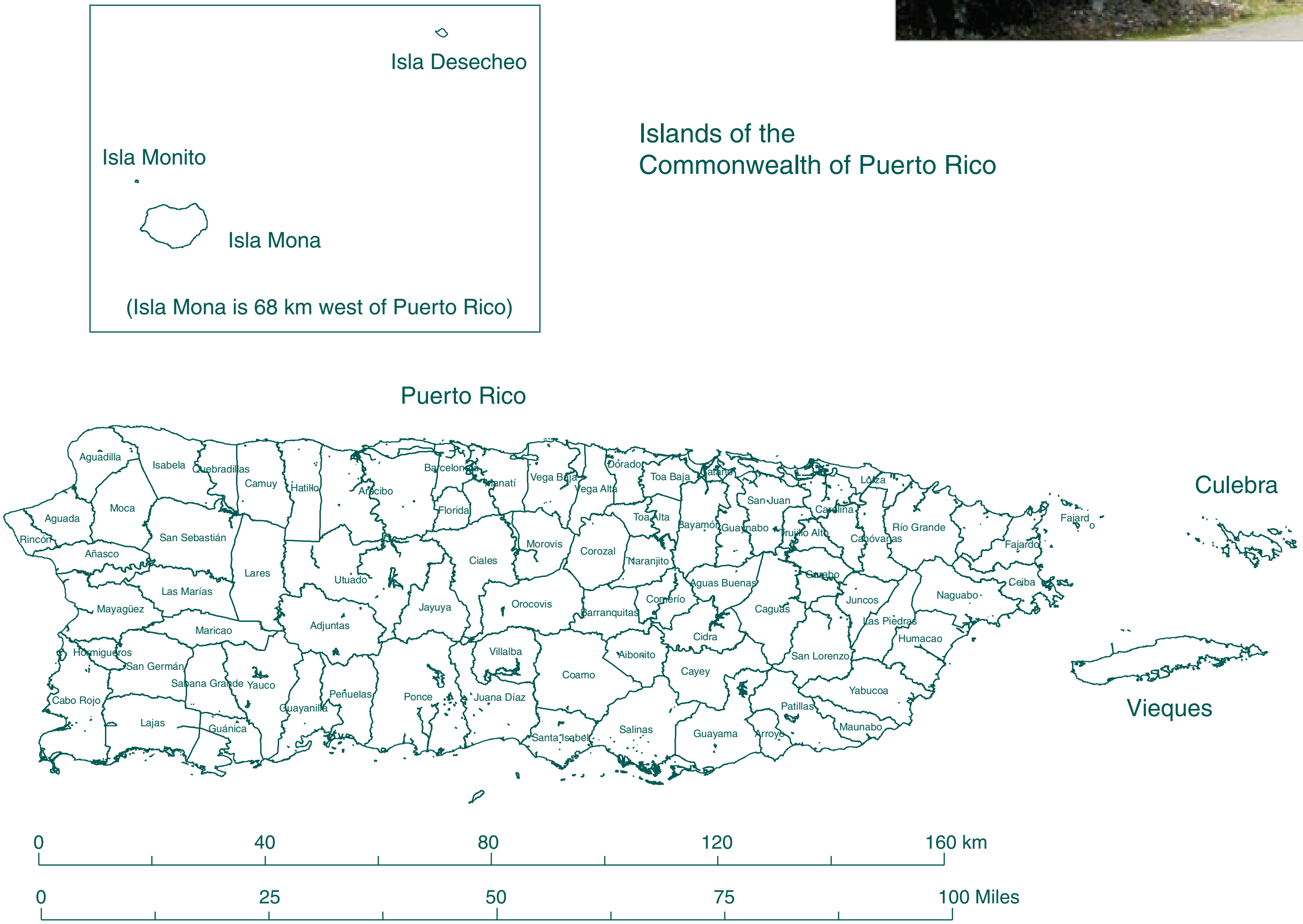

Figure 1—The islands of the Commonwealth of Puerto Rico.

(1973) give excellent descriptions of the forest associations found on Puerto Rico. Their descriptions follow the Holdridge life zone model, which defines ecological life zones on the basis of mean annual precipitation and mean annual biotemperature (Ewel and Whitmore 1973). Holdridge life zone associations are commonly used to describe vegetation in Puerto Rico and have been the basis for reporting forest categories in the previous forest inventories.

The forested life zones found on mainland Puerto Rico (fig. 2) are subtropical dry forest, subtropical moist forest, subtropical wet forest, subtropical rain forest, subtropical lower montane wet forest, and subtropical lower montane rain forest (Birdsey and Weaver 1982, Ewel and Whitmore 1973). Subtropical dry forest conditions predominate on the outlying islands of Vieques, Culebra, and Mona, and some subtropical moist forest occurs at higher elevations on Vieques.

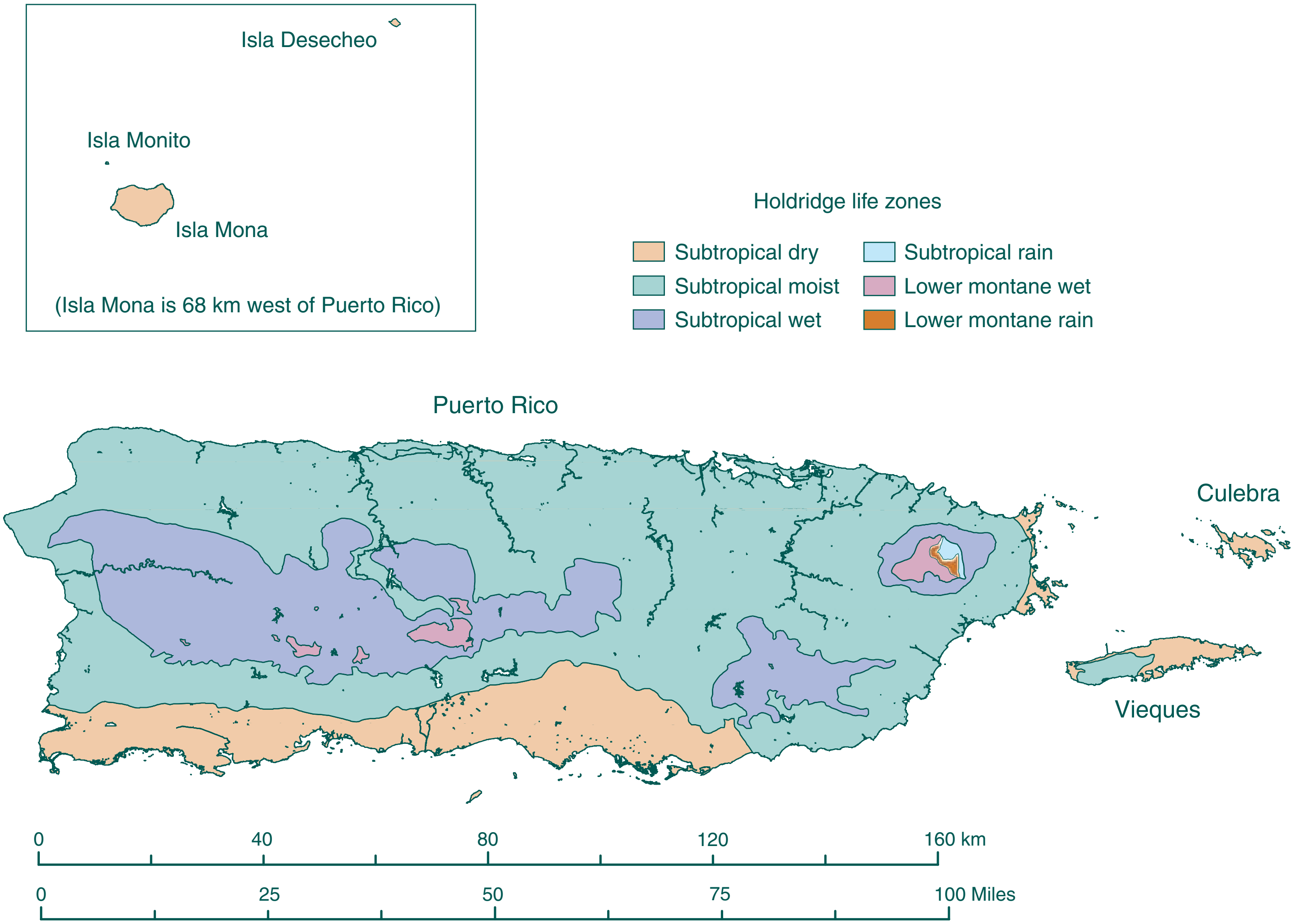

Figure 2—Holdridge life zones of the islands of the Commonwealth of Puerto Rico.

Subtropical wet forest in the Luquillo Mountains, Puerto Rico.

In this report we group subtropical wet forest and subtropical rain forest into one category (subtropical wet and rain), and lower montane wet forest and lower montane rain forest into one category (lower montane). We grouped these forested life zones in this way to make it easier to differentiate between them in the forest inventory data and because grouping resulted in increased sample sizes. Mangrove forests found on Puerto Rico, Vieques, and Culebra are included as a separate forest type because they occur in more than one forest life zone. The glossary of terms in this report contains a brief description of each forest life zone. The species composition described for each forest life zone is greatly simplified; only the most commonly found representative species are listed.

Forest Area Estimation

The FIA Program inventories forests using a three-phase system. The first phase is forest area estimation. The second phase is installation and measurement of permanent forest inventory and monitoring plots, and the third phase is the collection of additional data for FHM. All three forest inventory phases are based on a computer generated hexagonal grid that provides an unbiased, spatially systematic sampling framework [for details on the FIA sampling design, see Reams and others (2005)].

In the first phase of the inventory, forest area was estimated using essentially the same methods employed in the previous inventories. The sampling points that were classified as forest or nonforest by photointerpreters were generated by computer using a hexagonal sampling grid that gave a sampling point every 67 ha. This sampling grid produced 13,191 photointerpretation points over Puerto Rico, Vieques, Culebra, Mona, and other islands. Photointerpreters projected these points onto orthorectified color digital

Forest area has been estimated from aerial photographs in this and previous forest inventories.

aerial photos (digital orthophoto quarter quadrangles) that were taken in 2004. They then categorized the sampling points as forested or not forested according to the definition of forest land used by FIA in the Caribbean.

The FIA Program defines forest land as land that has at least 10 percent stocking of forest trees, or that had such tree cover previously and is not undergoing development for a nonforest use. Stocking refers to the degree of occupancy of land by trees, measured by basal area or the number of trees in a stand and spacing in the stand, compared with a minimum standard, depending on tree size, required to fully utilize the growth potential of the land. FIA considers that 10 percent stocking of mature trees occurs at 10 percent canopy coverage in the Caribbean. Stocking guidelines change with tree size, however, so an area is also considered forest if it has 10 percent stocking in tree seedlings, which is equivalent to 1,500 seedlings/ha. Because the FIA definition of forest takes all stages of forest development into account in this way, FIA classifies as forested some areas that might not be considered forest under definitions that are based only on canopy coverage of mature trees. An area must meet both minimum stocking and minimum area requirements to be classified as forest. The minimum area for classification as forest land is 0.4 ha. Roadside, streamside, and shelterbelt strips of trees must be at least 36 m wide to qualify as forest land. Grazed woodlands, reverting fields, and pastures that are not actively maintained are also included as forest land if the above size and stocking requirements are met.

Once photointerpreters classified sampling points as forested or not forested, each sampling point was assigned to a forest life zone using the map of Holdridge life zones for Puerto Rico produced by Ewel and Whitmore (1973) and digitized by the U.S. Geological Survey Caribbean Division and Southern Research Station's FIA Program (fig. 2). This allowed us to obtain forest area estimates for subtropical dry, subtropical moist, subtropical wet and rain, and lower montane forests. The area covered in mangrove forest could not be estimated accurately using the FIA forest area estimation methods, however, because too few of the systematically placed sampling points fell in the narrow bands of mangrove forest that fringe the coastlines. Area estimates for mangrove forest were based on a map of land cover and forest formations produced by Kennaway and Helmer (2006) for the year 2000. The map classified mangrove forests with an estimated accuracy of 82 percent. It

Mangrove forests protect Puerto Rico's coastlines.

was generated by using decision trees to classify a previously developed mosaic of Landsat Thematic Mapper (ETM+) imagery dated around the year 2000 (Helmer and Ruefenacht 2005).

Field Data Collection

On mainland Puerto Rico, field crews visited 1 out of every 36 of the photointerpretation points, or 1 point for every 2400 ha. The point visited in the field was at the center of the 36 photointerpretation points, and was visited regardless of whether it was forested, what type of forest might be there, or who owned the land. We increased our sampling for forest types that were not adequately sampled due to their smaller area, such as lower montane forest, by randomly selecting photointerpretation points that would not have otherwise been visited in the field [see McCollum (2001) and Brandeis (2003) for details on this procedure].

U.S. Forest Service personnel measure trees on permanent forest inventory and monitoring plots across Puerto Rico.

On Vieques and Culebra, one out of every six photointerpretation points was visited by field crews, producing one field sampling point every 400 ha. Although the U.S. Navy has terminated live-fire exercises on the island of Vieques, the possibility that unexploded ordnance was present meant that field crews could not safely access substantial portions of eastern Vieques. Consequently, during this survey cycle, additional inventory plots were installed in accessible areas in the eastern half of the island. Sampling points in the currently inaccessible western half of the island will be visited as they come accessible. As we have already noted, field plots are not yet being installed on Mona or any of the other smaller islands.

Forest inventory plots from the previous inventories were incorporated into the new sample wherever possible. Whenever an old forest inventory plot was located within the hexagon that contained the 36 photointerpretation points, the old plot was visited instead of the new sampling point. However, because the new sampling scheme uses a grid whose hexagonal cells are larger than the rectangles of the grid established in 1980 (900 ha/rectangle in 1980 versus 2400 ha/hexagon in 2001), about one-third of the sampling points from past inventories were not carried over into the new inventory. Field crews visited a total of 432 new and old sampling points spread across Puerto Rico, Vieques, and Culebra (table A.1).

Field crews visited all sampling points on mainland Puerto Rico in the months of January through July in 2001–03, and the sampling points on Vieques and Culebra were visited from February to June in 2004. Points were located using aerial photographs, maps, and Global Positioning System receivers. Sampling points falling in nonforest land were located and briefly described without any further data collection. Where the field crew found vegetation that met the FIA requirements for forest land, permanent plots were installed and measurements made regardless of ownership, intended use, or any restrictive management policy.

The permanent plots installed consisted of a four-subplot cluster (fig. 3). Each subplot in the cluster has a 7.3-m radius, so total sampled area is 0.067 ha/permanent plot [see Bechtold and Scott (2005) for further details on plot layout]. Field crews identified and measured all trees within the subplots with d.b.h. (measured at 1.37 m) ≥ 12.5 cm. Field crews also identified and measured all saplings with d.b.h. ≥ 2.5 cm within a 2.1-m radius microplot nested within each subplot. They also identified and counted all seedlings with height > 30 cm within the microplot.

Forest Health Monitoring

Field crews measured forest health indicators at one out of every seven sampling points they visited. The indicators measured included tree crown condition, forest floor litter, and DWM. Tree crown condition indicates tree vigor and stress. Monitoring of tree crown condition allows us to assess hurricane damage to trees and posthurricane tree recovery. Amount of DWM present affects forest fire risk. Data about DWM quantity is helpful to those who estimate how much carbon is sequestered in the forest, and DWM data can be combined with vegetation structure data to provide information about wildlife habitat.

Detailed information on plot location, installation, and monumentation, and site descriptions, tree measurement, tree damage description, and other data collected at each forested plot can be found in the FIA Southern Research Station field guide and field procedures for Puerto Rico and the Virgin Islands (U.S. Department of

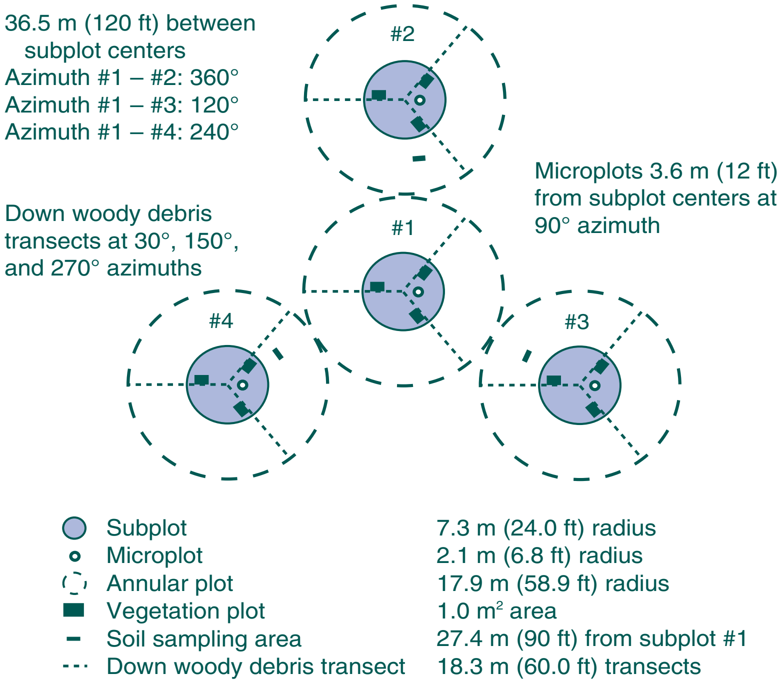

Figure 3—Forest inventory and health monitoring plot layout.

U.S. Forest Service personnel measure down woody materials in a mangrove forest.

Agriculture 2002). Descriptions of FHM by FIA can be found in Smith and Conkling (2005). The sampling protocols and analysis procedures for estimating amounts of DWM can be found in Woodall and Williams (2005).

Analytical and Statistical Techniques

Estimation of merchantable stem volume—In forest inventories of Puerto Rico conducted in 1980 (Birdsey and Weaver 1982) and 1990 (Franco and others 1997), researchers directly calculated merchantable stem volumes by applying a geometric formula to bole sections of those trees classified as growing stock. (For a tree to be considered growing stock, one-third or more of the gross volume in its saw-log section must meet grade, soundness, and size requirements for commercial logs, or the tree must have the potential to meet these requirements if it is poletimber size with 12.5 cm ≤ d.b.h. ≤ 27.5 cm. Rough-and-rotten trees were measured also, but their volume was not included in the final growing-stock volume estimates.) In the current inventory, species-specific volume equations developed by Brandeis and others (2005) were used to estimate individual tree stem volume for the following species and genus groupings: cabbagebark tree, pumpwood, *Cordia* spp., mountain immortelle [*Erythrina poeppigiana* (Walp.) O.F. Cook], American muskwood, sacky sac bean, river koko, mango, *Ocotea* spp., yuquilla, African tuliptree, Malabar plum, and white cedar [*Tabebuia heterophylla* (DC.) Britt.]. A general equation was used for all other species except palms and tree ferns, which were excluded from volume estimates (Brandeis and others 2005). All equations had the model form

$$V_{stem} = e^{b_0 + b_1(\ln D_{BH}) + b_2(\ln H_T) + b_3(D_{BH})}$$

where

V_{stem} = merchantable stem volume in cubic meters, and in which d.b.h. and total tree height are used as independent variables

Calculating the amount of available wood in the forest is a fundamental part of any forest inventory.

Additionally, volume equations developed by Brandeis and others (2006) were used to estimate merchantable stem volume for mixed species in Puerto Rican dry forest and for gregorywood (*Bucida buceras* L.) and gumbo limbo. These equations had the model form

$$V_{stem} = a + b^{*} D_{bh}^{2} H_{T}$$

where

V_{stem} = merchantable stem volume in cubic meters

The methods we use to measure trees and estimate merchantable stem volume have changed significantly since the 1990 forest inventory, so we have decided not to estimate change in growth and volume during the period between that inventory and the present one. True change can be estimated accurately and reported once trees have been remeasured using consistent methods.

Estimation of aboveground live tree biomass—Equations compiled from the scientific literature or developed by the FIA Program were used to calculate AGB for all living trees with d.b.h. ≥ 2.5 cm (table A.2). Locally developed biomass equations were used wherever possible, and equations developed from international datasets were used when equations based entirely on data from Puerto Rico could not be found. With few exceptions, species-specific AGB equations are not available for Puerto Rico. Rather, AGB equations have been developed for forest life zones. The digitized map of the island's Holdridge life zones was used to assign each inventory sampling point to one of the five life zones previously described; the assignment was then confirmed by field crews and examination of the data, and the appropriate AGB equation selected.

Note that all of the biomass equations estimate total tree AGB in kilograms (oven-dry basis) from ground level to the tip of the tree, including stem, branches, and

Trees are cut and weighed to develop equations for estimating tree biomass. (photo by James Bentley, U.S. Forest Service, Southern Research Station, FIA) foliage. Belowground biomass (BGB) (table A.2) was derived using an equation for estimating individual tree BGB for tropical forests (Cairns and others 1997). AGB and BGB estimates were summed for a total tree biomass estimate. Total tree biomass was multiplied by 0.5 for an estimate of carbon sequestered in each tree (Nabuurs and others 2003).

Per-hectare estimation—Once each individual tree's attributes were calculated, for example, each tree's merchantable stem volume, per-hectare values were derived for all the strata of interest using the "ratio of means" methodology described in Zarnoch and Bechtold (2000) and the SURVEYMEANS procedure in SAS (SAS 2003). Estimates of these parameters for the different d.b.h. classes were derived indirectly. This was done by first calculating the percentage of each parameter found in each d.b.h. class (for example, the percentage of total basal area found in trees in the 30-cm d.b.h. class) and multiplying that percentage by the total value for the parameter.

Total values for Puerto Rico's forests presented here are the product of mean per-hectare estimates derived from forest inventory plot data and the forest area estimates derived from photointerpretation, both of which have their own variance estimates. The standard error of this product was calculated using the formula for variance of the product of two independent variables,

$$SE_{XY} = \sqrt{\left(X^2\ Var_Y\right) + \left(Y^2\ Var_X\right)}$$

where

X and Y = mean values being multiplied together

Var_Y and Var_X = their respective variance estimates

Note that the per-hectare values used to estimate amounts of fine woody debris (FWD), coarse woody debris (CWD), and forest floor carbon for Culebra were derived from data collected on Vieques because there were no forested FHM plots on Culebra. Also, all values for mangrove forest on Vieques and Culebra were derived using per-hectare values from mangrove forest on mainland Puerto Rico because none of the systematically sampled points visited by field crews on both smaller islands fell in mangrove forest.

Species composition and relative importance value—Species nomenclature is based on the U.S. Department of Agriculture, Natural Resources Conservation Service Plants database (U.S. Department of Agriculture 2006), with supplemental reference to Little and Wadsworth (1989) and Little and others (1974). Molina and Alemañy (1997) was used as an additional reference to determine which tree species were native or introduced to Puerto Rico.

An importance value (IV) was calculated for each species so that the relative importance of species could be compared. The IV values were calculated as the average of relative dominance (each species' basal area divided by the total basal area), relative density (number of trees of each species divided by total number of trees per hectare), and relative frequency (number of plots where the species occurred divided by total number of plots) multiplied by 100 (Curtis and McIntosh 1951; McCune and Grace 2002, p. 15-16; Whittaker 1975, p. 87-88). Species IV was calculated for all stems with d.b.h. $\geq$12.5 cm.

Forest Land

A map of forest cover is presented in figure 4. Forest cover on mainland Puerto Rico increased from 32 percent in 1990 to 57 percent in 2004 (fig. 5) (tables A.3 and A.4). Subtropical dry forest occupies 50 346 ha, 6832 ha, 2591 ha, and 6217 ha on the island of Puerto Rico, Vieques, Culebra, and Mona, respectively (table A.4). Both Culebra (88 percent forest cover) and Vieques (85 percent forest cover) have relatively high percentages of young, recovering dry forest. On the island of Puerto Rico, however, the percentage of forest cover was lower for the subtropical

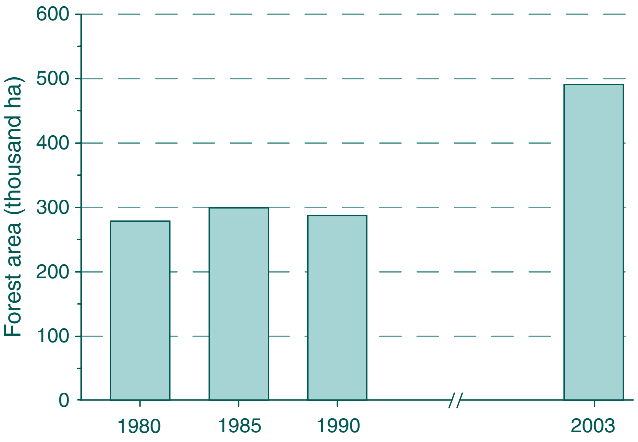

Figure 5—Forest area on mainland Puerto Rico as measured by the Forest Service's forest inventories of 1980, 1985, 1990, and 2003.

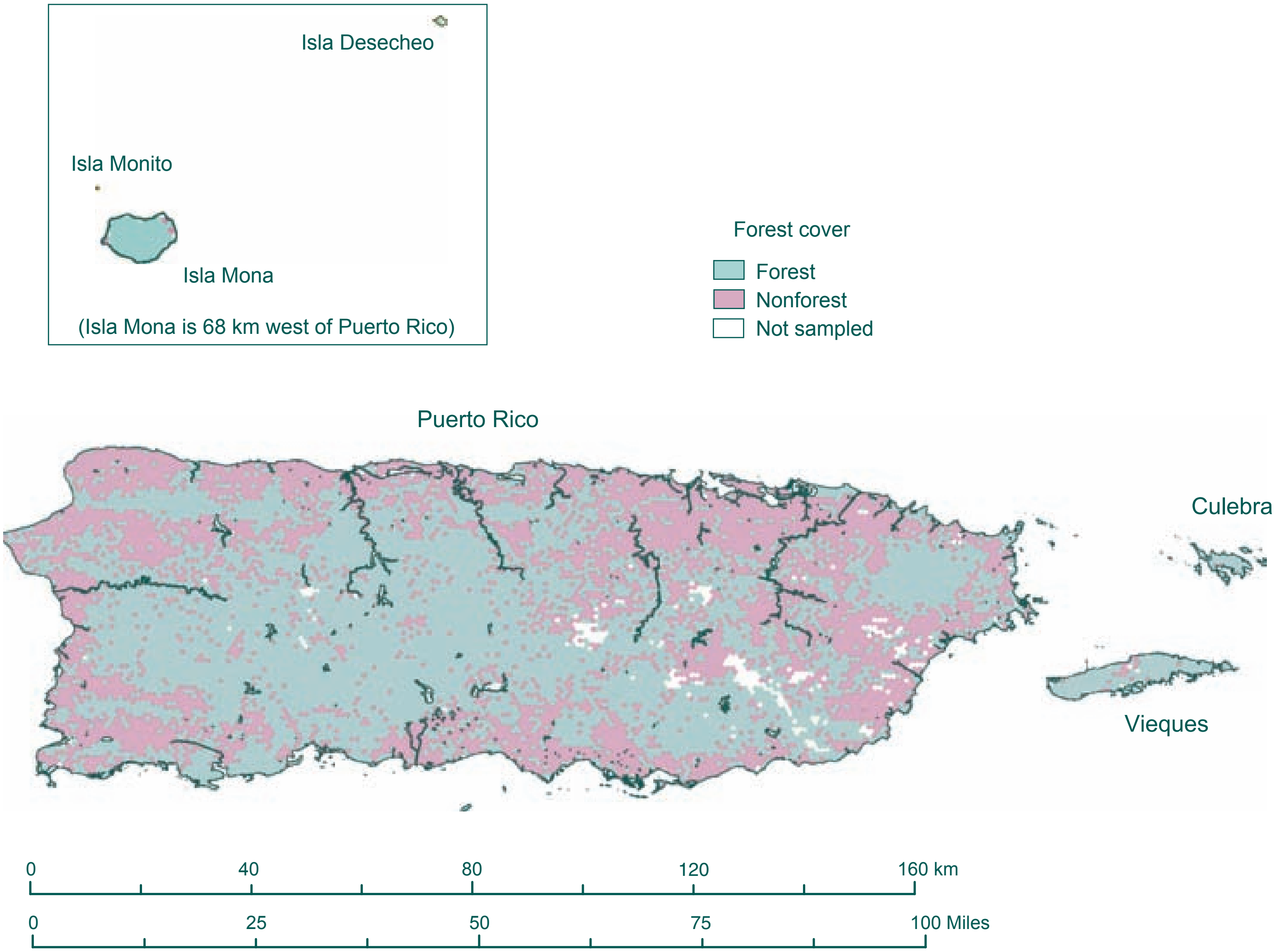

Figure 4—Forest cover on the islands of the Commonwealth of Puerto Rico.

Steep slopes and distinctive, conical "mogote" hills typify the landscape of the northwestern karst belt of Puerto Rico. This area of extensive recovering forest is under pressure from urban expansion and development.

dry forest life zone (45 percent) than for any other life zone. All of the life zones present on the islands are forested life zones, and the islands were probably nearly 100 percent forested in pre-Columbian times. On the island of Puerto Rico, the subtropical moist forest life zone, the largest life zone on that island, had 49 percent forest cover (258 861 ha of forest). The subtropical moist forest life zone occupies only 4101 ha on Vieques, but 89 percent of that area was in forest cover. Subtropical wet and rain forest occupied 161 503 ha, lower montane wet and rain forest covered 11 723 ha at the highest elevations, and mangrove forest occupied 7920 ha along the coast of mainland Puerto Rico. The subtropical wet and rain forest life zones had 80 percent forest cover, while the lower montane wet and rain forest life zones were almost entirely forested (99 percent).

Forest Structure and Succession

Forest was found at 317 of the 432 sampling points on Puerto Rico, Vieques, and Culebra (table A.1). Fifty-five plots were installed in subtropical dry forests, 157 in subtropical moist forests, 95 in subtropical wet and rain forests, 6 in lower montane wet and rain forests, and 4 in mangrove forests. Only 28 of the FHM sampling points fell on forested land, providing only 25 plots on mainland Puerto Rico and 3 plots on Vieques (table A.1). The single sample from Vieques was combined with those from Puerto Rico for all data summaries of FHM measurements. Plot attributes measured in the subtropical dry forest plots on Vieques were used to estimate values on Culebra. Summaries of FHM measurements are not available for lower montane forests because no FHM samples fell in forests in that climatic zone. We caution the reader to keep in mind that the FHM sample sizes were small, particularly for dry (four plots) and mangrove forests (two plots), when interpreting FHM results.

The percentages of live, growing-stock, sawtimber, and standing dead trees found by the 2003 forest inventory appear in figure 6. Almost 18 percent of the sites at which field crews made observations of forested condition were classified as natural forest reversions, areas that had recently

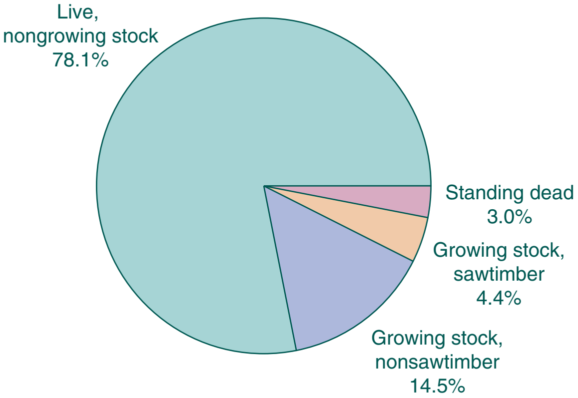

Figure 6—Percentages of live, nongrowing stock; growing stock, nonsawtimber; growing stock, sawtimber; and standing dead trees found by the 2003 Puerto Rico forest inventory.

been colonized by trees (fig. 7). Of these reverting areas, about one-half were in the process of reverting to forest during the last previous inventory, and the other one-half were not forested at that time. Most reversions (57.1 percent) were in subtropical moist forest, 30.4 percent were in subtropical wet and rain forest, and 12.5 percent were in subtropical dry forest (fig. 7).

There were other indications that most of the forest on Puerto Rico is still in the early stages of development. Field crews categorized 65.7 percent of the forest stands as young secondary and only 11.7 percent as mature secondary forest stands (fig. 7). Note that in figure 7 the percentages do not sum to 100 for some forest life zones because some stand types, such as coffee shade, were excluded. Although field assessments of forested condition are subjective, being based on

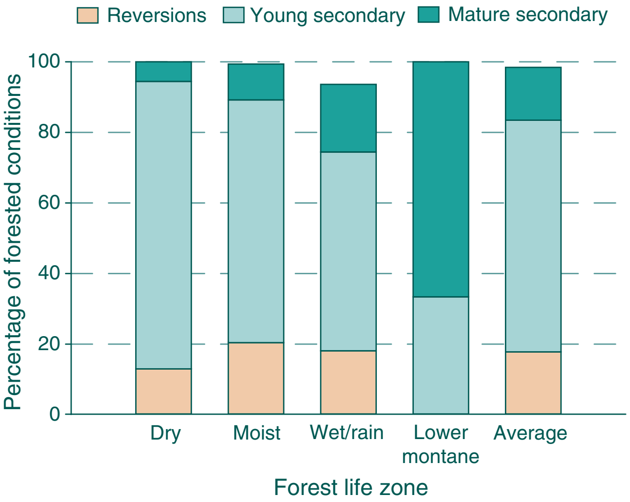

Figure 7—Percentage of forested conditions categorized by field crews as reversions, young secondary, and mature secondary stands, by forest life zone.

Traditional agroforestry activities such as crop cultivation and charcoal production continue to decline in Puerto Rico.

the crew's judgment and experience, they are consistent with measurements of stand structure. About 49 percent of stands were in the sapling-seedling stage (in which most trees have d.b.h. ≤12.5 cm), and about 43 percent of stands consisted mostly of small-diameter trees (trees with d.b.h. from 12.5 to 22.4 cm) (fig. 8). Only 7.6 percent of the forest stands visited by field crews consisted mostly of medium-diameter trees (trees with d.b.h. from 22.5 to 49.9 cm), and only 0.3 percent of the stands visited consisted mostly of trees with d.b.h. ≥ 50.0 cm (fig. 8). It is notable that 90.7 percent of the subtropical dry forest and all of the mangrove forest were in the sapling-seedling stage. Most of the mangrove forests, however, are mature, and much of the dry forest is more than 60 years old (Kennaway and Helmer 2006). Subtropical moist forest was almost evenly divided between sapling-seedling (48.4 percent) and small-diameter stands (45.9 percent). In the subtropical wet and rain forest life zone, more developed stands were somewhat more prevalent, with 59.6 percent of stands categorized as small diameter, 13.8 percent as medium diameter, and 1 percent as large diameter. Forests on Culebra were entirely in the early sapling-seedling stage, while those of Vieques were 80.8 percent sapling-seedling and 19.2 percent small diameter.

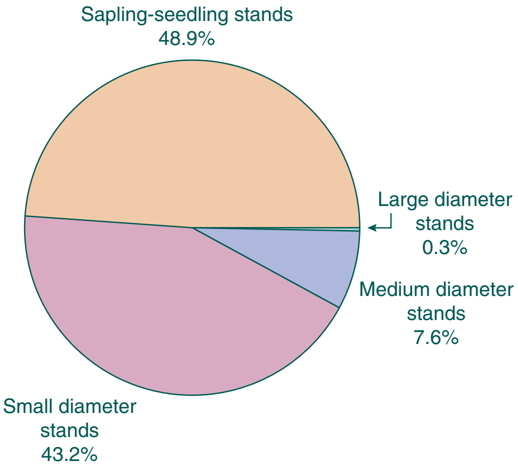

Figure 8—Stand-size class distribution for mainland Puerto Rico, Vieques, and Culebra.

There were more than 1.6 billion trees over 2.5 cm in diameter in Puerto Rico's forests (table A.5). The subtropical dry and subtropical moist forests had large numbers of trees in the 0- to 10-, 10-, and 20-cm d.b.h. classes (table A.6). There were 10.6 million m^2 of basal area (tables A.7 and A.8) and 38.2 million m^3 of merchantable stem volume (tables A.9 and A.10), predominantly in smaller diameter classes.

There were 3,112 trees and 19.2 m^2 of basal area in an average hectare of forest (figs. 9, 10, and 11, respectively). Number of live trees, basal area, merchantable volume, and forest biomass were greatest for the subtropical moist forest life zone and progressively smaller for the subtropical wet and rain forest, subtropical dry forest, and lower montane wet and rain forest life zones (tables A.7 to A.15). Average forest biomass was 80.07 Mg/ha, and ranged from a low of 34.09 Mg/ha in the subtropical dry forest to a high of 142.91 Mg/ha in the lower montane wet and rain forest (fig. 12) (tables A.11 to A.13).

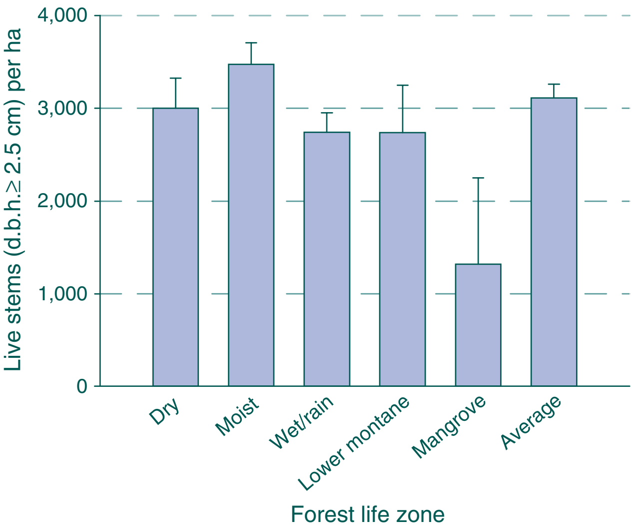

Figure 9—Mean per-hectare stem density with standard errors of the mean, by forest life zone.

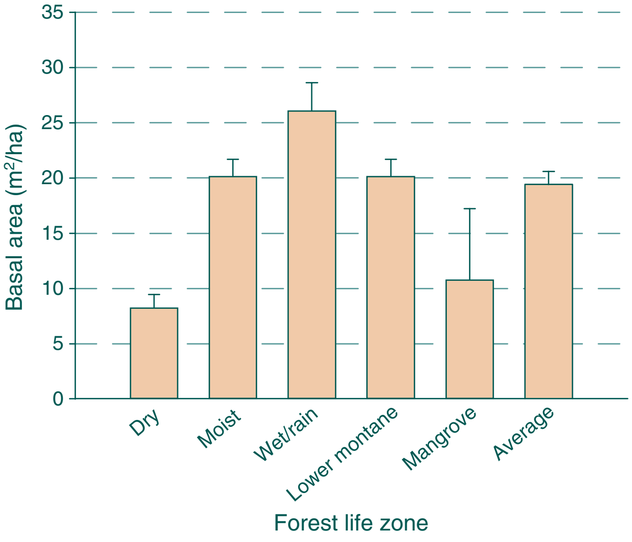

Figure 10—Mean basal area, with standard errors of the mean, by forest life zone.

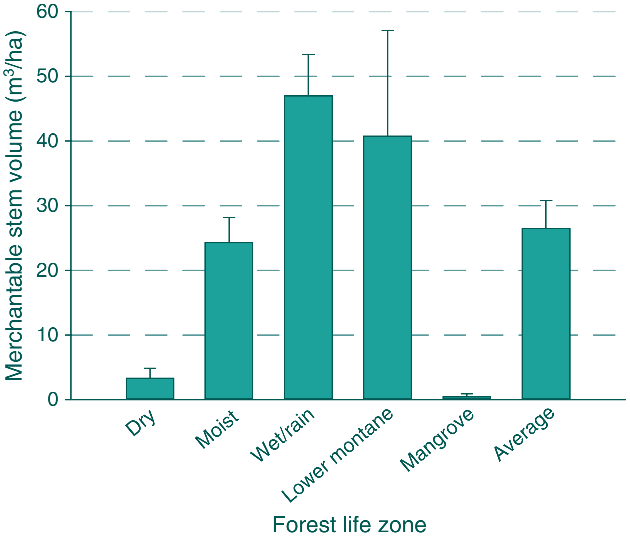

Figure 11—Mean growing stock inside bark merchantable stem volume, with standard errors of the mean, by forest life zone.

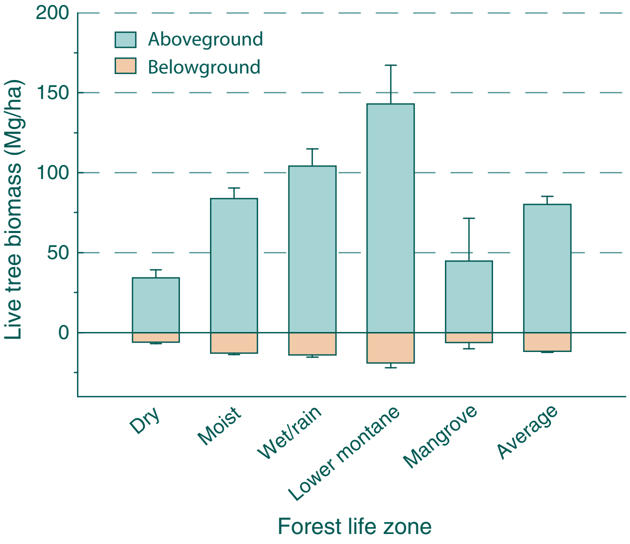

Figure 12—Mean per-hectare aboveground and belowground live tree biomass, with standard errors of the mean, by forest life zone.

We also calculated the number and volume of the subset of live trees classified as growing stock (see glossary for definition of growing stock), using the same forest life zone and diameter class categories (tables A.14 to A.17). There is only 15.0 million m^3 of merchantable stem volume in trees classified as growing stock (table A.16), an average of 26.44 m^3/ha, because there are few trees that meet growing-stock requirements (fig. 6).

Species Composition

Table A.18 lists the 20 species with the most volume in growing-stock trees. The introduced African tuliptree had at least four times as much volume in growing-stock trees as any other species. Table A.19 lists the 40 most important tree species with d.b.h. $\geq$12.5 cm. Tables A.20 to A.24 present the importance values of trees in the subtropical dry, subtropical moist, subtropical wet and rain, lower montane wet and rain, and mangrove forests, respectively. African tuliptree is the most important species Commonwealth-wide due to its strong presence in the subtropical moist and subtropical wet and rain forest life zone (tables A.21 and A.22). Gumbo limbo was the most important tree species in the subtropical dry forest life zone (table A.20) and Sierra palm was the most important species in the lower montane wet and rain forests (table A.23). White mangrove was the most important mangrove species (table A.24).

The African tuliptree (*Spathodea campanulata*) Beauv., an introduced species, is the most common tree in Puerto Rico's subtropical moist forest.

Forest Health Indicators and Carbon Sequestration

Frequency of tree damage and disease— Only 12.9 percent of live trees had some type of damage or disease. The most common disease was fungal infection (8.6 percent of live trees), as indicated by the presence of external fungal fruiting bodies or signs of advanced decay (fig. 13). Most of the fungal infections were located on tree stems (84.5 percent), with only 10.6 percent of infections on the roots and stumps, and only 4.9 percent on the branches and crown. The loss of apical dominance due to death or breakage of the tree's terminal leader was the second most frequently observed damage or disease, but it was uncommon, occurring in only 1.2 percent of all live trees. There were no indications that any one species was more prone to damage or disease than the others, or that the trees in any one forest life zone had a higher incidence of damage.

Tree crown condition—Tree crown condition did not indicate that unhealthy, stressed trees were numerous. Only 5.4 percent of trees showed indications of crown dieback, and more than one-half of the trees with crown dieback lost 15 percent or less of their crown. No one species had a higher incidence or severity of crown dieback. Compacted and uncompacted mean crown ratios, by crown class, appear in figure 14. Crown density, epiphyte and vine density, and crown transparency mean values appear in figure 15. Because these findings are products of FIA's first survey of tree crown condition in Puerto Rico, they will serve mainly as baseline information.

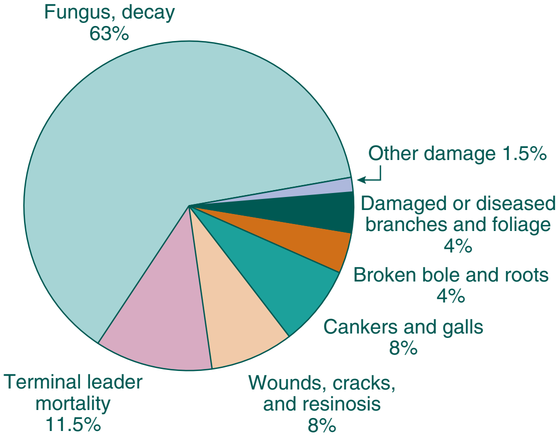

Figure 13—Occurrence of tree damage and disease.

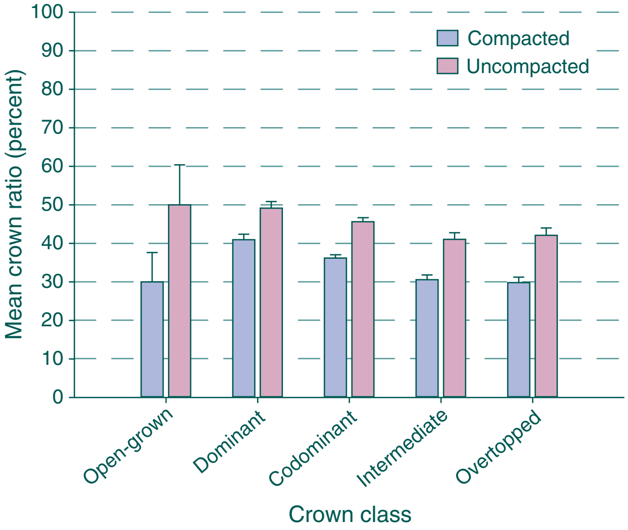

Figure 14—Mean compacted and uncompacted crown ratios with standard errors of the mean, by crown class.

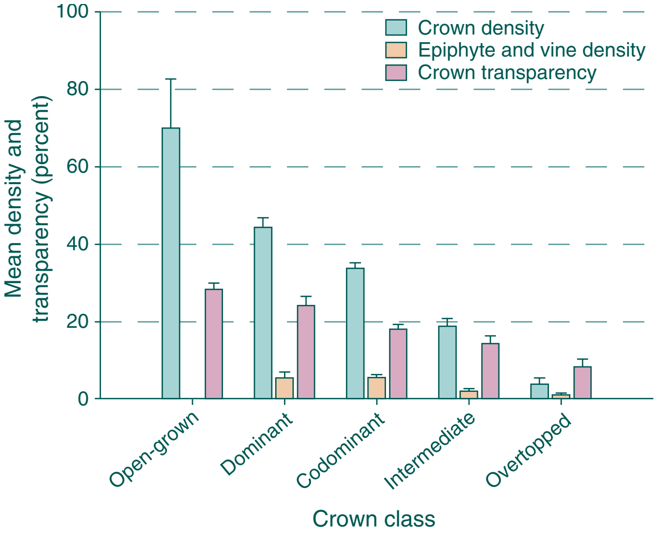

Figure 15—Mean crown density, epiphyte and vine density, and crown transparency with standard errors of the mean, by crown class.

Wildfires arrest forest succession and prevent further development of subtropical dry forest in Puerto Rico.

Down woody material, forest floor litter, and forest fire fuels— Although the small FHM sample sizes limit the conclusions that can be drawn from the data, the average per-hectare amounts of DWM, forest floor duff, and forest floor litter generally increased as the forest environment became more humid (tables A.25 and A.26) (fig. 16). Subtropical wet and rain forest had the greatest number of DWM pieces per hectare, but the larger (>35 cm) pieces were found only in moist forest (table A.25). Medium-to-large (10- to 100-hour) fuels predominated in subtropical dry forests, while quantities of large-

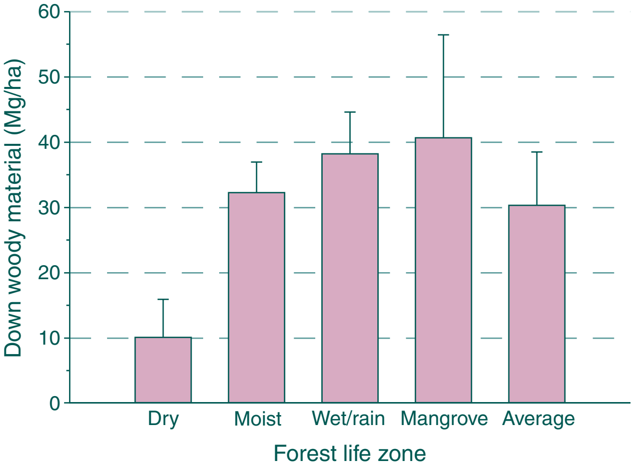

Figure 16—Mean quantities of all down woody material with standard errors of the mean, by forest life zone.

to-coarse (100- to 1,000-hour) fuels were greater in all of the more humid forest life zones (table A.26) (fig. 17). Accumulation rates in the mangrove forest life zone appear to be particularly high, but readers are again cautioned that only two samples were collected in mangrove forests and that there was a large variance between samples, so these results may not accurately reflect island-wide trends.

Carbon sequestered in trees, down woody material, and forest floor—We estimated mean carbon (megagrams per hectare) in DWM and forest floor by forest life zone for Puerto Rico and Vieques (table A.27) and mean organic carbon percentage for forest floor components by forest life zone (table A.28). Mean carbon accumulation appears to be higher in moist forests than in dry forests, and more carbon is retained in the litter and duff layer of the forest floor than in woody materials. On average, individual components of the forest floor contained between 30 and 56 percent organic carbon (table A.27). We estimated forest carbon storage by survey unit and forest life zone (table A.29) (fig. 18) on the basis of estimates of carbon sequestered in live and standing dead trees with d.b.h. ≥ 2.5 cm, FWD, CWD, and the forest floor. We estimate that Puerto Rico's forests hold 36.6 million Mg of sequestered carbon in the compartments measured by this forest inventory.

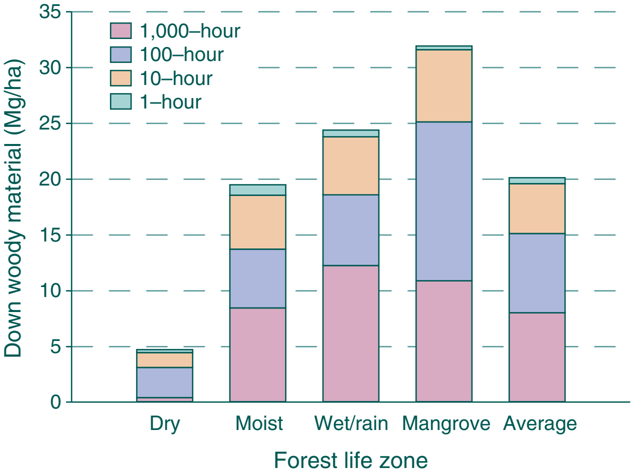

Figure 17—Mean quantity of down woody material, by fuel type and forest life zone.

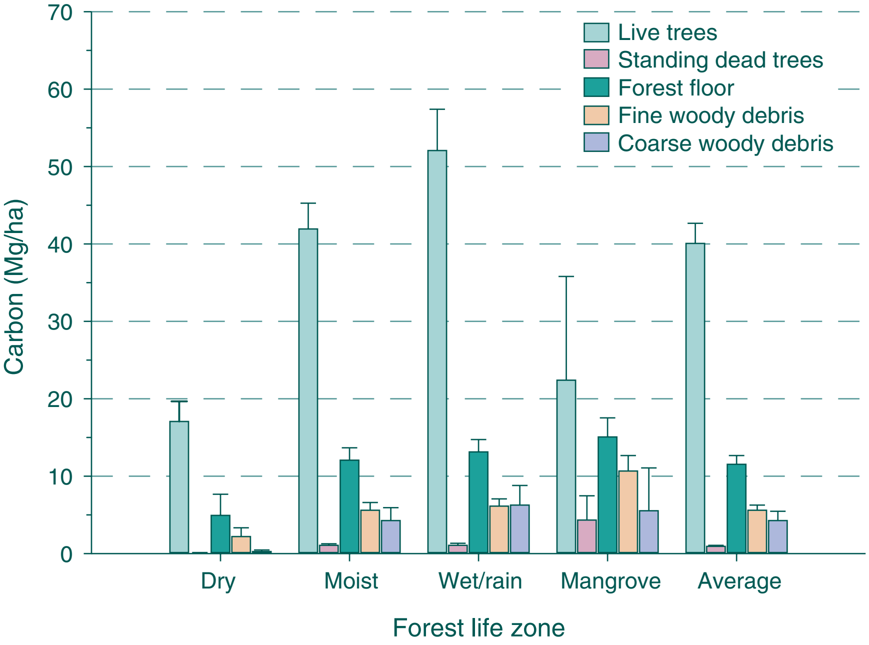

Figure 18—Mean carbon in live trees, standing dead trees, forest floor, fine woody debris, and coarse woody debris, with standard errors of the mean, by forest life zone.

Forest Land

Puerto Rico's forest land is increasing. This is notable; forest cover is either stable or decreasing in much of the world (Food and Agriculture Organization 2001, Rudel and others 2000). Puerto Rico has experienced extensive land development in recent decades, and some of this land development replaces forest with urban and built-up lands (Helmer 2004). The present inventory indicates, however, that Puerto Rico's forest cover continued to increase between 1989 and 2004. There are probably two main reasons why Puerto Rico's overall forest cover has not decreased despite rapid conversion of land to an urban or built-up condition. First, much of the land that undergoes development is agricultural or in pasture (Helmer 2004, Ramos-Gonzalez 2001). From 1978 to about 1992, for example, two-thirds of new land development in Puerto Rico replaced agricultural land or pasture and only about 28 percent of new land development replaced forest land (Helmer 2004). Secondly, according to a study of land cover change based on Landsat image classification (Kennaway and Helmer 2006), about four times as much pasture reverted to forest as forest underwent clearing for land development from around 1992 to

Landscapes consisting of a mixture of agriculture, pasture, and forest are common across Puerto Rico.

2000. Between 1978 and 1992, about 56 800 ha of pasture reverted to forest, and this was about six times the amount of forest that was cleared for land development (Helmer 2004).

Kennaway and Helmer (2006) estimate that forest land on the island of Puerto Rico increased by about 1 percent from around 1992 to 2000 and that the forest cover proportion was about 45 percent in 2000. We estimate that the forest cover proportion was 57 percent in 2004. One reason for the different estimates of forest land and forest land change is that the increase in forest land from the 1990 inventory to the present one is change that occurred over a longer time period of 14 years. The aerial photos used to estimate forest land in the 1990 inventory were from 1989, and the digital orthophotos that were used to estimate forest land for this inventory were collected in 2004. Consequently, with most of the recent Landsat image data in that classification dated close to the year 2000 (Helmer and Ruefenacht 2005), some of the difference likely stems from forest land increases between 2000 and 2004. The most important explanation for these differences, however, is that the FIA definition of forest includes lands with as little as 10 percent forest tree cover, but these Landsat image classifications defined forest as having a larger minimum cover of woody vegetation of 25 percent (including trees or trees plus shrubs). Together, these results suggest that most of the forest land increase measured by the inventory includes stands with between 10 and 25 percent forest tree cover that have only recently reverted to forest.

The reader should be cautious when comparing the FIA forest land estimate with estimates that are derived using different methods or based on different definitions of forest. For example, in 1990 the United Nations Food and Agriculture Organizations Forest Resource Assessment Program defined forest land as having "tree crown cover (stand density) of more than about 20 percent of the area" with "trees usually growing more than about 7 m in height and able to produce wood" (Food and Agriculture Organization 1995). While this definition also included "open forest formulations with continuous grass layer in which tree synusia cover at least 10 percent of the ground," a substantial amount of land reverting to forest, covered in sapling-seedling stands, and even small-diameter stands that are considered forest by FIA, would not meet this definition's requirements for forest. Because FIA uses stocking as a guideline for defining forest, FIA classifies as forested areas that might not be considered forest under definitions that are based on the current size, density, or canopy coverage of mature trees.

Also, the stand structure of Caribbean forests complicates estimation of forest land. The lower limits of tree cover and stocking required for vegetation to be classified as forest under many definitions,

Puerto Rico's subtropical dry forests are a valuable but threatened resource.

particularly the cutoff points between forest and shrubland, become especially important in the Caribbean. Island forests are often naturally short-statured, partly as a result of regular hurricane disturbance. Subtropical dry forests are prevalent on many of the islands, and these forests naturally tend to have more open canopies and more multistemmed trees (Ewel and Whitmore 1973). Many woody vegetation classification systems classify Caribbean dry forests as shrublands or scrublands (Lugo and others 2006). The long history of land clearance and recent agricultural abandonment has left the islands mostly with young, secondary stands that are still developing. In addition, repeated fires and grazing keep many areas in the subtropical dry forest life zone in a seral state.

Forest Structure and Succession

While the increase in overall forest cover bodes well for Puerto Rico, we must keep in mind that the vast majority of the forest is still very young, having regenerated naturally since widespread abandonment of agricultural activities began in the 1950s. These very young forests probably do not provide the same level of the valuable ecosystem services, such as improved aquifer recharging, protection from soil erosion, and habitat for forest flora and fauna that we expect from more developed, mature secondary forests. However, secondary forests of all ages provide valuable ecosystem services (Lugo and Helmer 2004). The continued lack of larger trees in mature forest stands across the islands can be taken as evidence that Puerto Rico does not yet receive the full benefits of its increasing forest cover.

Young, dense stands of small trees predominate in the subtropical dry forest on Vieques and other parts of Puerto Rico.

However, there are many indications that Puerto Rico's forests are following the generally expected, if somewhat unusual, successional course toward fuller development and maturity.

The maturing nature of Puerto Rico's forests is indicated by increases in average basal area for all live trees. Basal area in Puerto Rico's forests has increased from 13.2 m^2/ha in 1980, to 15.2 m^2/ha in 1990, to the current level of 20.9 m^2/ha. Previous forest inventories also documented structural development and maturation in Puerto Rico's forests based on indicators such as stands having a higher percentage of larger trees with more volume and better form. However, unlike the previous inventory report by Franco and others (1997), which focused mainly on increases in volume and basal area of growing-stock trees, the current inventory focuses more on all live trees. Franco and others (1997) report that the percentage of trees classified as growing stock increased from 50 percent in 1980 to 70 percent in 1990, and cite this increase in tree size and quality as an indication of maturing forests. In 2003 only 19 percent of the trees measured in the forest inventory were classified as growing stock (fig. 6). However, this must not be construed as an indication of a decrease in tree size or quality. Rather, this decrease in the average number of growing-stock trees probably reflects the expansion of the forest inventory into areas of forest that previously were not inventoried because they were not seen as having commercial wood production capacity. These newly included forests probably contain fewer, smaller, and lower quality trees, and this probably brings down the total percentage of growing-stock trees. The average merchantable stem volume in a hectare of forest may also have increased slightly, following the trend reported by Franco and others (1997) who found that volume increased from 44.0 m^3/ha in 1980 to 75.0 m^3/ha in 1990. Merchantable volume for all live trees had increased to 75.6 m^3/ha by 2003, but the significance of this apparent increase is not certain given the substantial changes in how merchantable stem volume is estimated by the forest inventory. True trends in volume cannot be determined until the next forest inventory is completed using the new methods applied in the current effort.

The lower montane wet and rain forest life zone had surprisingly high amounts of basal area and volume on a per-hectare basis, more than even the subtropical wet and rain forest. Plots categorized as lower montane wet and rain forest contained an unusual number of larger trees, particularly of the species achiotillo (*Alchomea latifolia* Sw.), star apple (*Chrysophyllum bicolor* Poir.), candletree (*Dacryodes excelsa* Vahl.), guayabota de sierra (*Eugenia borinquensis* Britt.), caimitillo verde (*Micropholis garciniifolia* Pierre), and bullwood (*Sloanea berteriana* Choisy ex DC.), and high densities of sierra palm. It is our opinion that the plots that were categorized as lower montane on the basis of their location on the life zone map may actually have been in the transition zone between lower montane and subtropical wet and rain forest, falling partially in the tabonuco and palo colorado forest types [see Ewel and Whitmore (1973) and Weaver and Gillespie (1992) for details on these forest types]. A reexamination of the life zone map's boundaries, or refinement of our understanding of these forest life zones, might be called for based on these results.

Species Composition

Inventory results show that many introduced species are fully naturalized in Puerto Rico's forests. Some exotics, such as African tuliptree, have shown surprising adaptability. African tuliptree accounted for 3 percent of live tree basal area in 1980 (Birdsey and Weaver 1982), 10 percent in 1990 (Franco and others 1997), and 19 percent in 2003. This increase in the importance of African tuliptree is probably due to continued forest reversion on abandoned agricultural land, mostly pasture, in the subtropical moist and subtropical wet forest life zones, which apparently is habitat favorable to African tuliptree regeneration (Aide and others 1996, Chinea and Helmer 2003). Kennaway and Helmer (2006) found that about two-thirds of the forests that regenerated between about 1992 and 2000 corresponded to forest types that occur in moist and wet forest life zones. Expansion of the forest inventory into areas previously not surveyed might also affect the relative rankings of species, limiting our present ability to detect with certainty some changes in the species composition. It is important to note that the next three most important species—American muskwood, cabbagebark tree, and pumpwood—are native to Puerto Rico, which indicates successful regeneration of native species and the incorporation of such species into secondary forest associations on a landscape that has been altered heavily by human activities. Both native and introduced species are found in recently reverted forest after successfully colonizing abandoned agricultural land. While some introduced species have shown they have the capacity to regenerate in closed canopy forest, many native tree saplings and seedlings are found beneath overstories dominated by fast-growing, introduced species that became

In some places of the Cordillera Central of Puerto Rico, forest land is being cleared for sun coffee cultivation.

established on deforested land. Future inventory remeasurement will allow us to track the course of species succession. This will provide insight into the dynamics between native and introduced species in the subtropical secondary forests of Puerto Rico, and perhaps the wider tropics.

There appear to be irregularities in our lists of species by relative IV in each forest life zone. For example, lathberry (*Eugenia sintenisii* Kiaersk.), a subtropical dry forest species, was found to be present in subtropical wet and rain forest, and gregorywood had relatively high importance in the subtropical wet and rain forest life zone. There are three possible reasons for these irregularities. Firstly, species may have been misidentified or miscoded in the field. Secondly, our understanding of which species are found in which forest life zones is not complete, so in some cases the data may be correct and our ideas about which species should be found where could be erroneous. Finally, the assignment of plots to forest life zones was based on a life zone map that may need refinement, particularly in the transition zones between forest life zones.

It is also useful to note the effect a single plot with large trees can have on the forest inventory data. Swamp mahogany (*Eucalyptus robusta* Sm.) ranks 11th in IV in the subtropical wet and rain forest because a single forest inventory sampling point fell in a eucalyptus plantation with many large, high basal area trees. Remeasurements in subsequent years will clarify these species' distributions.

Forest Health Indicators and Carbon Sequestration

Considering the recent history of severely damaging hurricanes (Hurricane Hugo in 1989 and Hurricane Georges in 1998), field crews observed surprisingly few instances of physical damage to trees. Apparently, the 5-year respite since the last large hurricane allowed most surviving trees to recover from their injuries to such an extent that broken branches and crowns were no longer immediately noticeable. However, we may be seeing long-term impacts of hurricanes on overall stand structure. The percentage of trees that met the size and form requirements for growing stock was very low, partly because most trees were small and partly because many trees were poorly formed. Trees may be considered to have poor form because they have broken tops, excessive branches, or crooked or leaning stems, and all of these defects can be caused by hurricane damage. Tracking individual tree changes in total height due to top breakage, broken branches, decreases in crown widths, increases in foliage transparency due to defoliation, and any other physical damage, before and after the inevitable hurricanes will help us better understand this important aspect of Caribbean forest stand dynamics.

Characteristics of DWM on the forest floor provide further insights into forest succession and hurricane effects. The present lack of large pieces of DWM on the forest floor is perhaps an additional indication that the forests are still developing, but we cannot be sure of this until remeasurements indicate trends.

Although size distributions are highly variable within forest life zones, smaller diameter (8 to 20 cm) wood makes up most of the CWM across the landscape. Our sampling of DWM did not detect CWM over 45 cm in diameter. These findings are consistent with findings for the central hardwood region of the continental United States, where the majority of CWM is in the smaller diameter classes in most forest types, and where few forest types contain material with diameter >45 cm (Woodall and others, 2007). Of the coarse wood detected in Puerto Rico, most was in the moderate decay class. The lack of larger DWM is understandable because it corresponds to the overall rarity of larger trees across the landscape. Nevertheless, the relative lack of larger DWM only 5 years after a severe hurricane is interesting. Whigham and others (1991) note that Hurricane Gilbert caused fairly low tree mortality in dry forests on the Yucatan Peninsula, and that most trees retained their largest branches. Thus, an accumulation of small-to-medium-sized materials is probably expected, while larger material may be distributed too sparsely to be detected by our sampling methods. We can assume that the smaller diameter DWM now present is of more recent origin and that DWM felled by Hurricane Georges has disintegrated completely. Continued monitoring of this resource will contribute to our understanding of how Puerto Rico's secondary forests develop and mature, are affected by hurricanes, and provide CWM as habitat for flora and fauna.

DWM and forest fire fuels increased with live tree basal area, which in turn increased with precipitation and the ability of areas to support tree growth, as previously observed by Lugo and Brown (1982). The exception to this trend occurred in mangrove forest, where there were very high amounts of DWM relative to stand basal area. We cannot interpret this result until we have a better sampling of DWM in mangrove forests. Further, the amount of DWM and forest fire fuels appears to be inversely related to the frequency and severity of forest fires in Puerto Rico. One cannot simply use the amount of potential forest fire fuels to assess the risk of forest fires without taking into account average temperatures, relative humidity, and the moisture content of those fuels. In fact, subtropical dry and moist forests, the two forest-type groups with the lowest amounts of forest fire fuels, have the highest frequency of forest fires in Puerto Rico.

The continued increase in forest cover means that Puerto Rico is still accumulating forest biomass and serving as a carbon sink, and the relative youth of the forests means that the islands have a much greater capacity for carbon sequestration. Almost 70 percent of the stored carbon measured by this forest inventory was in live trees. The remainder is sequestered in standing dead trees, DWM, or the forest floor, perhaps again indicating a rapid disintegration of dead plant material. Whether the carbon sequestered in this dead plant material is increasing the soil carbon pools or quickly being reincorporated into living plant biomass cannot be determined without soil carbon content analysis and continued remeasurements.

Forests of Vieques and Culebra

This first forest inventory of Vieques and Culebra provides valuable baseline data for assessing future trends. Forest cover was high on both Vieques and Culebra (85 and 88 percent, respectively). This inventory captures forest cover at a time of potentially important land use changes following the U.S. Navy's cessation of military exercises at Vieques and departure from that island. We were unable to access the western half of the island but expect to be able to do so in the future. Continued monitoring will enable us to determine whether Vieques and Culebra lose forest cover as tourism-oriented development continues. Recent studies have shown that the area of urban and built-up or bulldozed lands increased by 49 percent during the 1990s (Helmer and Ruefenacht 2005). The forests on these two islands differ markedly from those on mainland Puerto Rico. The subtropical dry forest of Culebra appears to be more open and have less basal area than the subtropical dry forest on mainland Puerto Rico and Vieques. On average, a hectare of subtropical moist forest on Vieques has 20 percent fewer trees than has a hectare of such forest on mainland Puerto Rico. It also has about one-half as much basal area as a hectare of such forest on mainland Puerto Rico. Future inventories will now be able to follow the development and maturation of the young, heavily impacted secondary forests on both islands.

Coastal area on the island of Vieques.

Future Forest Inventory and Monitoring Improvements

While the FIA Program has greatly expanded and strengthened its ability to inventory and monitor the forested ecosystems of Puerto Rico, there is still room for improvements. More forest inventory plots are needed in the islands' mangrove and lower montane forests to reduce the variability in our attribute estimates for these forest life zones. More inventory plots should also be installed on Culebra, and we will need to develop a flexible, adaptive sampling grid for Vieques so that we can take advantage of increasing access to areas that are now inaccessible. Expanding the forest inventory to include field work on Mona will complete the coverage of all the forested islands of Puerto Rico. Monitoring forest health on a greater proportion of the forest inventory plots in all forest types and on all islands can greatly reduce the current levels of uncertainty in FHM attribute estimates for Puerto Rico.

Forest cover on upper mountain slopes stabilizes soils and protects the agricultural and urban areas below.

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Basal area. The area in square meters of the cross section at breast height of a single tree or of all the trees in a stand, usually expressed in square meters per hectare.

Belowground biomass and carbon. Total oven-dry biomass in kilograms of all live belowground tree parts, as estimated using a regression equation that models the relationship between aboveground biomass and belowground biomass (Cairns and others 1997). Carbon is calculated by multiplying biomass by a factor of 0.5. Estimated for all trees with d.b.h. ≥2.5 cm.

Bole. That portion of a tree between a 30-cm high stump and a 10-cm top d.o.b. in trees 12.5 cm d.b.h. and larger.

Census water. Streams, sloughs, estuaries, canals, and other moving bodies of water 200 m wide and greater, and lakes, reservoirs, ponds, and other permanent bodies of water 1.8 ha in area and greater.

Coarse woody debris. Down pieces of wood with a minimum small-end diameter of at least 8 cm and a length of at least 0.9 m (excluding decay class 5). Coarse woody material pieces must be detached from a bole and/or not be self-supported by a root system, and must have a lean angle of more than 45 degrees from vertical. These pieces of down wood comprise the 1,000+ fuel-hour class, also.

Commercial species. Tree species currently or potentially suitable for industrial wood products.

Condition class. The combination of discrete landscape and forest attributes that identify, define, and stratify the area associated with a plot. Examples of such attributes include condition status, forest type, stand origin, stand size, owner group, reserve status, and stand density.

Crown class. Rating of tree crowns in relation to the sunlight received and proximity of neighboring trees.

Open grown. Trees with crowns that received full light from above and from all sides throughout most of their life, and especially during their early developmental period.

Dominant. Trees with crown extending above the general level of the crown cover and receiving full direct light from above and some from the sides. These trees are taller than the average trees in the stand and their crowns are well developed, but they can be somewhat crowded on the sides.

Codominant. Trees with crowns at the general level of the crown canopy. Crowns receive full light from above but little direct sunlight from their sides. Usually they have medium-sized crowns and are somewhat crowded on their sides. In stagnated stands, codominant trees have small-sized crowns and are crowded on the sides.

Intermediate. Trees that are shorter than dominants and codominants, but have a crown that extends into the canopy of codominant and dominant trees. They receive little direct light from above and none from the sides. As a result, intermediates usually have small crowns and are very crowded from the sides.

Overtopped. Trees with crowns entirely below the general level of the crown canopy that receive no direct sunlight either from above or the sides.

Crown density. The amount of crown stem, branches, twigs, shoots, buds, foliage, and reproductive structures that block light penetration through the visible crown. Dead branches and dead tops are part of the crown. Live and dead branches below the live crown base are excluded. Broken or missing tops are visually reconstructed when forming this crown outline by comparing this crown outline with those of adjacent healthy trees of the same species and d.b.h.

Crown dieback. This is recent mortality of branches with fine twigs, which begins at the terminal portion of a branch and proceeds toward the trunk. Dieback is only considered when it occurs in the upper and outer portions of the tree. When whole branches are dead in the upper crown, without obvious signs of damage such as breaks or animal injury, assume that the branches died from the terminal portion of the branch. Dead branches in the lower portion of the live crown are assumed to have died from competition and shading. Dead branches in the lower live crown are not considered as part of crown dieback, unless there is continuous dieback from the upper and outer crown down to those branches.

Crown ratio, compacted. Percentage determined by dividing the live crown length by the total live tree height, where live crown length is determined by field crew by ocularly transferring lower live branches to fill in large holes in the upper portion of the tree until a full, even crown is visualized.

Crown ratio, uncompacted. Percentage determined by dividing the live crown length by the total live tree height, where live crown length is the distance between live crown top and lowest live foliage.

D.b.h. (diameter at breast height). Tree diameter in centimeters (outside bark) at breast height (1.37 m aboveground).

Decay class. Rating of individual coarse woody material according to a 5-class decay scale defined by the texture, structural integrity, and appearance of pieces. Scale ranges from freshly fallen trees (decay class 1) to completely decomposed cubical rot heaps (decay class 5).

Diameter class. A classification of trees based on tree d.b.h. For example, the 20-cm class includes trees 15.0 through 24.9 cm d.b.h.

D.o.b. (diameter outside bark). Stem diameter including bark.

Down woody materials. Woody pieces of trees and shrubs that have been uprooted (roots no longer support growth) or severed from their root system, are not self-supporting, and are lying on the ground.

Duff. A soil layer dominated by organic material derived from the decomposition of plant and animal litter and deposited on either an organic or a mineral surface. This layer is distinguished from the litter layer in that the original organic material has undergone sufficient decomposition that the source of this material, e.g., individual plant parts, can no longer be identified.

Epiphyte and vine density. Additional crown density percentage comprised of epiphytic plants and vines in the tree crown.

Fine woody debris. Down pieces of wood with a diameter ≤8 cm, not including foliage or bark fragments. These pieces of down wood comprise the medium (0 to 0.6 cm diameter) and small fuel-hour classes (0.7 to 8 cm diameter), also.

Foliage transparency. The amount of skylight visible through microholes in the live portion of the crown, i.e., where you see foliage, normal or damaged, or remnants of its recent presence. Recently defoliated branches are included in foliage transparency measurements. Macroholes are excluded unless they are the result of recent defoliation. Dieback and dead branches are always excluded from the estimate. Foliage transparency is different from crown density because it emphasizes foliage and ignores stems, branches, fruits, and holes in the crown.

Forest fire fuels. Accumulated mass of coarse and fine down woody debris above the top of the duff layer (excluding live shrubs and herbs). Forest fire fuel-hour classes are further defined by the approximate amount of time it takes for moisture conditions to fluctuate. Larger coarse woody debris takes longer to dry out than smaller fine woody pieces.

Diameter	Down woody material class name	Fuel-hour class
cm		
0.0–0.6	Small-fine woody debris	1
0.7–2.4	Medium-fine woody debris	10
2.5–7.5	Large-fine woody debris	100
7.6+	Coarse woody debris	1,000+

Forest floor. The entire thickness of organic material overlying the mineral soil, consisting of the litter and the duff (humus).

Forest land. In the Caribbean, land where forest trees of any size provide at least 10 percent canopy coverage, or land formerly having such tree cover and not currently developed for a nonforest use. Only areas at least 0.4 ha in size may be classified as forest land. Roadside, streamside, and shelterbelt strips of trees must have a crown width of at least 36 m to qualify as forest land. Grazed woodlands, reverting fields, and pastures that are not actively maintained are also included as forest land if the above size requirements are met.

Forest life zone. A classification of timberland based on life zone and forest type.

Subtropical dry forest. Found in areas with 600 to 1100 mm of annual precipitation. *Bursera simaruba* (L.) Sarg., *Bucida buceras* L., *Cephalocereus royenii* (L.) Britton, and *Guaiacum officinale* L. are species typical of Puerto Rican dry forest. The more heavily disturbed dry forest areas have numerous, smaller stemmed *Leucaena leucocephala* (Lam.) deWit, *Prosopis juliflora* (Sw.) DC., *Acacia macracantha* Humb. & Bonpl., and *Acacia farnesiana* (L.) Willd. individuals.

Subtropical moist forest. Found in areas with 1000 to 2200 mm of annual precipitation. The subtropical moist life zone is the most extensive on Puerto Rico and covers a wide variety of soil parent materials, topographic classes, and land uses that give rise to highly diverse species mixtures that typically include *Tabebuia heterophylla* (DC.) Britton, *Spathodea campanulata* Beauv., *Guarea guidonia* (L.) Sleumer, *Andira inermis* (W. Wright) Kunth ex DC., *Roystonea borinquena* O.F. Cook, *Mangifera indica* L., *Cecropia peltata* L., *Schefflera morototoni* (Aubl.) Maguire, Steyermark & Frodin, and species of the *Nectandra*, *Ocotea*, and *Coccoloba* genera.

Subtropical wet and rain forest. Found in areas with 2000 to 4000 mm of annual precipitation. *Dacryodes excelsa* Vahl., *Sloanea berteriana* Choisy, and *Manilkara bidentata* (A.DC.) are species indicative of the tabonuco forest type. *Cecropia peltata* L., *Schefflera morototoni* (Aubl.) Maguire, Steyermark & Frodin, and *Ochroma lagopus* Sw. are also common in wet forest stands in early stages of succession or recovery from disturbance. Wet forest shade coffee plantations hold species such as *Guarea guidonia* (L.) Sleumer, *Inga laurina* (Sw.) Willd., *Inga vera* Willd., and *Erythrina poeppigiana* (Walp.) O.F. Cook. Palm forest characterized by *Prestoea montana* (Graham) (Nichols.) occupies higher elevations falling in the subtropical rain forest zone.

Lower montane wet and rain forest. Found in areas with elevations between 700 and 1000 m. Forest types and their typical species include the palo colorado forest type (*Cyrilla racemiflora* L., *Ocotea spathulata* Mez., *Micropholis chrysophylloides* Pierre, and *Micropholis garciniaefolia* Pierre), the elfin forest type (*Eugenia borinquensis* Britton, *Tabebuia rigida* Urban, *Weinmannia pinnata* L., and *Calycogonium squamulosum* Cogn.), and the palm brake forest type [*Prestoea montana* (Graham) Nichols.].

Mangrove forest. Mangrove forests comprised of *Rhizophora mangle* L., *Avicennia nitidia* Jacq., *Laguncularia racemosa* (L.) Gaertn. f., and *Conocarpus erectus* L. are found along the coastlines and estuaries.

Nonstocked stands. Stands < 10 percent stocked with live trees.

Forested tract size. The area of forest within the contiguous tract containing each FIA sample plot.

Fuel bed. Accumulated mass of all down woody material components above the top of the duff layer (excluding live shrubs and herbs).

Growing-stock trees. Living trees of commercial species classified as sawtimber, poletimber, saplings, and seedlings. For a tree to be considered growing stock, one-third or more of the gross volume in its saw-log section must meet grade, soundness, and size requirements for commercial logs, or the tree must have the potential to meet these requirements if it is poletimber size with 12.5 cm ≤ d.b.h. ≤ 27.5 cm.

Growing-stock volume. The cubic-meter volume of sound wood in growing-stock trees at least 12.5 cm d.b.h. from a 30-cm stump to a minimum 10-cm top d.o.b. of the central stem.

Land area. The area of dry land and land temporarily or partly covered by water, such as marshes, swamps, and river floodplains (omitting tidal flats below mean high tide), streams, sloughs, estuaries, and canals < 60 m wide, and lakes, reservoirs, and ponds < 1.8 ha in area.

Life zone. The Holdridge life zone model defines ecological life zones using mean annual precipitation and mean annual biotemperature. The forested life zones found on the U.S. Virgin Islands are subtropical dry forest, subtropical moist forest, subtropical wet forest, subtropical rain forest, subtropical lower montane wet forest, and subtropical lower montane rain forest.

Litter. Undecomposed or only partially decomposed organic material that can be readily identified, e.g., plant leaves, twigs, etc.

Live trees. All living trees. All size classes, all tree classes, and both commercial and noncommercial species are included.

Measurement quality objective (MQO). A data user's estimate of the precision, bias, and completeness of data necessary to satisfy a prescribed application, e.g., Resource Planning Act assessments by State foresters, forest planning, forest health analyses. A MQO describes the acceptable tolerance for each data element. MQOs consist of two parts: (1) a statement of the tolerance and (2) a percentage of time when the collected data are required to be within tolerance. MQOs can only be assigned where standard methods of sampling or field measurements exist, or where experience has established upper or lower bounds on precision or bias. MQOs can be set for measured data elements, observed data elements, and derived data elements.

Merchantable stem volume. The cubic-meter volume of sound wood in live trees at least 12.5 cm d.b.h. from a stump height of 30 cm to a minimum 10-cm top d.o.b. of the central stem, estimated by applying regression equations that use d.b.h. and total tree height to individual trees. Merchantable stem volume is not estimated for palms and tree ferns.

Mineral soil. A soil consisting predominantly of products derived from the weathering of rocks, e.g., sands, silts, and clays.

Noncommercial species. Tree species typically of small size, poor form, or inferior quality that normally do not develop into trees suitable for industrial wood products.

Nonforest land. Land that has never supported forests, and formerly forested land where timber production is precluded by development for other uses.

Nonstocked stands. Stands < 10 percent stocked with live trees.

Other forest land. Forest land other than timberland and productive reserved forest land. It includes available and reserved forest land which is incapable of producing annually 0.57 m^3/ha of industrial wood under natural conditions, because of adverse site conditions such as sterile soils, dry climate, poor drainage, high elevation, steepness, or rockiness.

Ownership. The property owned by one ownership unit, including all parcels of land in the United States.

National forest land. Federal land that has been legally designated as national forests or purchase units, and other land under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III land.

Forest industry land. Land owned by companies or individuals operating primary wood-using plants.

Nonindustrial private forest land. Privately owned land that is not forest industry land.

Corporate. Owned by corporations, including incorporated farm ownerships.

Individual. All lands owned by individuals, including farm operators.

Other public. An ownership class that includes all public lands except national forests.

Miscellaneous Federal land. Federal land other than national forests.

State, county, and municipal land. Land owned by States, counties, and local public agencies or municipalities or land leased to these governmental units for 50 years or more.

Phase 1 (P1). FIA activities related to remote sensing, the primary purpose of which is to label plots and obtain stratum weights for population estimates.

Phase 2 (P2). FIA activities conducted on the network of ground plots. The primary purpose is to obtain field data that enable classification and summarization of area, tree, and other attributes associated with forest land uses.

Phase 3 (P3). A subset of P2 plots where additional attributes related to forest health are measured.

Poletimber-size trees. Softwoods 12.5 to 22.6 cm d.b.h. and hardwoods 12.5 to 27.5 cm d.b.h.

Reversion. Land was in a nonforest condition and is in the process of reverting to forest land.

Rotten trees. Live trees of commercial species not containing at least one 3.7-m saw log, or two noncontiguous saw logs, each 2.4 m in length or longer, now or prospectively, primarily because of rot or missing sections, and with less than one-third of the gross board-foot tree volume in sound material.

Rough trees. Live trees of commercial species not containing at least one 3.7m saw log, or two noncontiguous saw logs, each 2.4 m in length or longer, now or prospectively, primarily because of roughness, poor form, splits and cracks, and with less than one-third of the gross cubic-meter tree volume in sound material; and live trees of noncommercial species.

Saplings. Live trees 2.5 to 12.4 cm d.b.h.

Saw log. A log meeting minimum standards of diameter, length, and defect, including logs at least 3.7 m long, sound and straight, with a minimum diameter inside bark of 15 cm for softwoods or 20 cm for hardwoods.

Saw-log portion. The part of the bole of sawtimber trees between a stump height of 30 cm and the saw-log top.

Seedlings. Hardwood trees < 2.5 cm d.b.h. and > 30 cm tall, and softwood trees < 2.5 cm d.b.h. and > 15 cm tall.

Standard error of the estimate. The standard error of the estimates presented here was calculated using the formula for variance of the product of two independent variables, where X and Y are the mean values being multiplied together, and Var_Y and Var_X are their respective variance estimates.

$$SE_{XY} = \sqrt{\left(X^2\, Var_Y\right) + \left(Y^2\, Var_X\right)}$$

Standard error of the mean. The standard error of the mean is as follows, where s is the sample standard deviation and N is the sample size.

$$SE_Y = {}^{s}\!/\!_{\sqrt{N}}$$

Stand-size class. A classification of forest land based on the diameter class distribution of live trees in the stand.

Nonstocked stands. Stands having < 10 percent stocking or < 10 percent canopy coverage with live trees.

Sapling-seedling stands. Stands that are at least 10 percent stocked with live trees with a d.b.h. ≤12.5 cm and in which saplings and seedlings account for more than one-half of total stocking.

Small diameter stands. Stands at least 10 percent stocked with live trees and in which trees with d.b.h. from 12.5 to 22.4 cm account for at least one-half of total stocking.

Medium diameter stands. Stands at least 10 percent stocked with live trees and in which trees with d.b.h. from 22.5 to 49.9 cm account for at least one-half of total stocking.

Large diameter stands. Stands at least 10 percent stocked with live trees and in which trees with d.b.h. ≥50 cm account for at least one-half of total stocking.

Stocking. The degree of occupancy of land by trees, measured by basal area or the number of trees in a stand and spacing in the stand, compared with a minimum standard, depending on tree size, required to fully utilize the growth potential of the land. FIA classifies land in the Caribbean as stocked if that land has at least 10 percent canopy coverage by forest trees of any size.

Density of trees and basal area per hectare required for full stocking

D.b.h. class (cm)	Trees per hectare	Basal area (m²) per hectare
Seedlings	1,500	—
5	1,400	—
10	1,150	—
15	850	15.0
20	600	18.8
25	400	19.6
30	300	21.2
35	250	21.6
40	200	22.6
45	150	23.8
50	130	25.5

— = not applicable.

Timberland. Forest land capable of producing at least 1.40 m^3 of industrial wood per hectare per year and not withdrawn from timber utilization.

Timber products. Roundwood products and byproducts.

Transect diameter. Diameter of coarse woody pieces at the point of intersection with sampling planes.

Tree. Woody plant having at maturity one erect perennial stem or trunk at least 7.6 cm d.b.h., a more or less definitely formed crown of foliage, and a height of at least 4 m.

Upper-stem portion. The part of the main stem or fork of sawtimber trees above the saw-log top to a minimum top diameter of 10 cm outside bark or to the point where the main stem or fork breaks into limbs.

Volume of live trees. The cubic-meter volume of sound wood in live trees at least 12.5 cm d.b.h. from a stump height of 30 cm to a minimum 10-cm top d.o.b. of the central stem.

Volume of saw-log portion of sawtimber trees. The cubic-meter volume of sound wood in the saw-log portion of sawtimber trees. Volume is the net result after deductions for rot, sweep, and other defects that affect use for lumber.

Mango (*Mangifera indica*).

Table A.1—Number of forest inventory and forest health monitoring sampling points[a] for mainland Puerto Rico, Vieques, and Culebra by forest life zone and forested status in 2003

Survey unit	Forest life zone[b]	Forest inventory		Forest health monitoring		Total
		Forested[c]	Nonforest	Forested	Nonforest	
		number				
Puerto Rico	Subtropical dry	30	19	2	5	56
	Subtropical moist	133	47	14	18	212
	Subtropical wet/rain	88	9	7	5	109
	Lower montane wet/rain	6	2	0	0	8
	Mangrove	2	0	2	0	4
	Unit subtotal	259	77	25	28	389
Vieques[d]	Subtropical dry	16	7	2	3	28
	Subtropical moist	9	0	1	0	10
	Unit subtotal	25	7	3	3	38
Culebra	Subtropical dry	5	0	0	2	7
	Unit subtotal	5	0	0	2	7
All units	All life zones	289	84	28	33	434

[a] FIA uses a systematic network of ground plots to collect field data on forest area, trees, and other attributes associated with forest land uses.

[b] Forest life zone is a classification of forest land based on Holdridge life zone and forest type.

[c] To be classified as forest land by FIA, land in the Caribbean must have at least 10 percent canopy coverage of forest trees of any size, or must be land that formerly had such tree cover and is not currently developed for a nonforest use. The minimum area for classification as forest land is 0.4 ha. Roadside, streamside, and shelterbelt strips of trees must have a crown width of at least 36 m to qualify as forest land. Grazed woodlands, reverting fields, and pastures that are not actively maintained are also included as forest land if the above size requirements are met.

[d] Vieques plots were concentrated entirely in currently accessible areas in the eastern half of the island.

Table A.2—Equations used to predict aboveground[a] and belowground[b] oven-dry biomass in Puerto Rico

Forest life zone or species	Equation	Source
Lower montane wet and rain forest	$AGB = 4.7962 + 0.0310 * D_{bh}{}^{2} H_T$	Weaver and Gillespie (1992)
Subtropical wet and rain forest	$AGB = e^{(0.950 * \ln D_{bh}^2 H_T - 3.282)}$	Scatena and others (1993)
Subtropical moist forest	$AGB = e^{(-1.71904 + 0.78214 * \ln D_{bh}^2 H_T)}$	Brandeis and others (2006)
Subtropical dry forest	$AGB = e^{(-1.94371 + 0.84134 * \ln D_{bh}^2)}$	Brandeis and others (2006)
Bucida buceras, all forest-type groups	$AGB = e^{(-1.76887 + 0.86389 * \ln D_{bh}^2)}$	Brandeis and others (2006)
Prestoea montana, all forest-type groups	$AGB = 10.0 + 6.4 * H_T$	Frangi and Lugo (1985), Brown (1997)
Rhizophora mangle, mangrove	$AGB = [125.957 * (D_{bh}^2 H_T{}^{0.8557})] / 1000$	Cintrón and Schaeffer-Novelli (1984)
Laguncularia racemosa, mangrove	$AGB = [70.0513 * (D_{bh}^2 H_T{}^{0.9084})] / 1000$	Cintrón and Schaeffer-Novelli (1984)
Avicennia germinans, mangrove	$AGB = 0.14 * (D_{bh}^{2.4})$	Fromard and others (1998)
Belowground biomass, all forest types	$BGB = e^{(-1.0587 + 0.8836 \ln AGB)}$	Cairns and others (1997)

AGB = oven-dry aboveground biomass in kilograms; D_{bh} = diameter in centimeters at 1.37 m; H_T = total tree height in meters; *BGB* = oven-dry belowground biomass in kilograms.

[a] Oven-dry biomass, of all live aboveground tree parts, including stem, stump, branches, bark, seeds, and foliage, as estimated from regression equations that predict aboveground biomass from individual tree d.b.h. and total height measurements.

[b] Oven-dry biomass, of all live belowground tree parts is estimated from a regression equation modeling the relationship between aboveground biomass and belowground biomass (Cairns and others 1997).

Table A.3—Total land area, by survey unit and forest life zone

		Forest life zone			
Survey unit	Total land area	Subtropical dry	Subtropical moist	Subtropical wet/rain	Lower montane wet/rain
	- - - - - - - - - - -	- - - - - - - - - - -	*ha*	- - - - - - - - - - -	- - - - - - - - - - -
Puerto Rico	864 360	119 929	532 693	199 947	11 791
Vieques	13 165	8 594	4 571	0	0
Culebra	3 009	3 009	0	0	0
Mona and others	6 462	6 462	0	0	0
All units	886 996	137 994	537 264	199 947	11 791

Table A.4—Area of forest[a] by survey unit and forest life zone, with standard error of the estimate

			Forest life zone									
	All life zones		Subtropical dry		Subtropical moist		Subtropical wet/rain		Lower montane wet/rain		Mangrove[b]	
Survey unit	Forest area	Standard error	Forest area	Standard error	Forest area	Standard error	Forest area	Standard error	Forest area	Standard error	Forest area	Standard error
	ha											
Puerto Rico	490 353	10 935	50 346	2 170	258 861	7 740	161 503	7 817	11 722	—	7 920	1 322
Vieques	10 932	316	6 832	717	4 101	151	NA	NA	NA	NA	285	37
Culebra	2 655	—	25 910	—	NA	NA	NA	NA	NA	NA	64	9
Mona and others	6 217	131	6 217	131	NA	NA	NA	NA	NA	NA	—	—
All units	510 157		89 305		262 962		161 503		11 722		8 269	

— = not estimated due to insufficient sample; NA = not applicable.

[a] To be classified as forest land by FIA, land in the Caribbean must have at least 10 percent canopy coverage of forest trees of any size, or must be land that formerly had such tree cover and is not currently developed for a nonforest use. The minimum area for classification as forest land is 0.4 ha. Roadside, streamside, and shelterbelt strips of trees must have a crown width of at least 36 m to qualify as forest land. Grazed woodlands, reverting fields, and pastures that are not actively maintained are also included as forest land if the above size requirements are met.

[b] Mangrove forest area was estimated using LandSat® satellite imagery, where all other forest areas were estimated from aerial photographs.

Table A.5—Number of live trees with d.b.h. ≥ 2.5 cm by forest life zone for mainland Puerto Rico, Vieques, and Culebra, with standard error of the estimate

			Forest life zone									
	All life zones		Subtropical dry		Subtropical moist		Subtropical wet/rain		Lower montane wet/rain		Mangrove	
Survey unit	Live trees	Standard error	Live trees	Standard error	Live trees	Standard error	Live trees	Standard error	Live trees	Standard error	Live trees	Standard error
	number											
Puerto Rico	1,558,053,059	85,936,855	159,938,446	24,553,288	912,882,804	69,554,525	442,664,397	40,303,354	32,097,620	5,975,977	10,469,792	7,555,014
Vieques	31,983,313	4,141,696	19,998,572	3,947,469	11,607,997	2,373,593	NA	NA	NA	NA	376,744	269,077
Culebra	12,804,060	943,181	12,719,061	920,339	NA	NA	NA	NA	NA	NA	84,999	60,786
All units	1,602,840,432	81,904,786	192,656,079	23,227,198	924,490,801	66,299,899	442,664,397	40,303,354	32,097,620	5,975,977	10,931,535	7,887,317

NA = not applicable.

Table A.6—Number of live trees with d.b.h. ≥ 2.5 cm by forest life zone and diameter class for the Commonwealth of Puerto Rico

		Diameter class (*cm at breast height*)						
Forest life zone	All classes	0–10	10	20	30	40	50	60+
	number							
Subtropical dry	192,656,079	106,392,163	56,550,789	21,086,735	6,134,323	1,150,186	766,790	575,093
Subtropical moist	924,490,801	293,225,817	276,205,362	241,733,554	72,390,797	22,191,226	9,695,196	9,048,850
Subtropical wet/rain	442,664,397	87,930,615	121,255,917	150,164,612	48,582,669	18,067,935	8,431,703	8,230,948
Lower montane wet/rain	32,097,620	4,766,973	9,533,947	13,347,525	2,542,386	635,596	741,529	529,664
Mangrove	10,931,535	2,001,549	2,309,479	4,157,063	2,309,479	153,965	0	0
All life zones	1,602,840,432	494,317,117	465,855,493	430,489,488	131,959,653	42,198,908	19,635,218	18,384,554

Table A.7—Basal area[a] of live trees with d.b.h. ≥ 2.5 cm by forest life zone for mainland Puerto Rico, Vieques, and Culebra, with standard error of the estimate

			Forest life zone									
	All life zones		Subtropical dry		Subtropical moist		Subtropical wet/rain		Lower montane wet/rain		Mangrove	
Survey unit	Basal area	Standard error	Basal area	Standard error	Basal area	Standard error	Basal area	Standard error	Basal area	Standard error	Basal area	Standard error
	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - - m^2 - - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -
Puerto Rico	10 474 797	667 816	418 372	82 547	5 417 971	456 811	4 208 776	459 459	344 536	52 870	85 142	53 331
Vieques	110 190	18 947	63 124	17 179	44 002	9 408	NA	NA	NA	NA	3 064	1 893
Culebra	26 616	3 080	25 924	3 005	NA	NA	NA	NA	NA	NA	691	428
All units	10 611 602	632 105	507 420	83 815	5 461 973	433 910	4 208 776	459 459	344 536	5 975 977	88 897	55 675

NA = not applicable.

[a] Basal area is the area in square meters of the cross section at breast height of a single tree or of all the trees in a stand, usually expressed in square meters per hectare.

Table A.8—Basal area[a] of live trees with d.b.h. ≥ 2.5 cm by forest life zone and diameter class for the Commonwealth of Puerto Rico

		Diameter class (*cm at breast height*)						
Forest life zone	All classes	0–10	10	20	30	40	50	60+
	- - - - - -	- - - - - -	- - - - - -	- - - - - - m^2	- - - - - -	- - - - - -	- - - - - -	- - - - - -
Subtropical dry	507 420	27 223	95 034	155 152	107 477	32 931	43 127	46 475
Subtropical moist	5 461 973	67 773	587 596	1 662 681	1 151 916	624 226	428 783	938 999
Subtropical wet/rain	4 208 776	21 246	303 519	1 077 945	812 921	535 379	405 741	1 052 025
Lower montane wet/rain	344 536	1 735	39 320	116 073	58 284	26 708	48 605	53 811
Mangrove	88 897	538	7 196	34 231	41 999	4 932	0	0
All life zones	10 611 602	118 516	1 032 666	3 046 081	2 172 596	1 224 178	926 256	2 091 310

[a] Basal area is the area in square meters of the cross section at breast height of a single tree or of all the trees in a stand, usually expressed in square meters per hectare.

Table A.9—Merchantable stem volume,[a] inside bark, of live trees with d.b.h. ≥ 12.5 cm by forest life zone for mainland Puerto Rico, Vieques, and Culebra, with standard error of the estimate

			Forest life zone									
	All life zones		Subtropical dry		Subtropical moist		Subtropical wet/rain		Lower montane wet/rain		Mangrove	
Survey unit	Stem volume	Standard error	Stem volume	Standard error	Stem volume	Standard error	Stem volume	Standard error	Stem volume	Standard error	Stem volume	Standard error
	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - - m^3 - - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -
Puerto Rico	38 171 092	2 769 306	806 033	263 094	18 146 190	1 871 688	17 855 805	1 990 126	1 085 540	216 405	277 524	165 497
Vieques	68 257	42 742	36 002	37 626	22 268	22 456	NA	NA	NA	NA	9 986	5 866
Culebra	11 330	3 876	9 077	3 783	NA	NA	NA	NA	NA	NA	2 253	1 326
All units	38 250 678	2 599 619	851 112	237 215	18 168 458	1 777 814	17 855 805	1 990 126	1 085 539	216 405	289 763	172 768

NA = not applicable.

[a] Volume of live trees is the cubic-meter volume of sound wood in live trees at least 12.5 cm d.b.h. from a 30-cm stump height to a minimum 10-cm top d.o.b. of the central stem.

Table A.10—Merchantable stem volume,[a] inside bark, of live trees with d.b.h. ≥ 12.5 cm by forest life zone and diameter class for the Commonwealth of Puerto Rico

Forest life zone	All classes	Diameter class (*cm at breast height*) 10[b]	20	30	40	50	60+
	m³						
Subtropical dry	851 112	97 684	292 752	205 014	56 665	84 757	114 241
Subtropical moist	18 168 458	932 748	4 850 027	4 449 144	2 477 008	2 091 007	3 368 525
Subtropical wet/rain	17 855 805	571 524	3 619 663	3 938 731	3 018 474	2 407 575	4 299 837
Lower montane wet/rain	1 085 539	29 437	243 075	206 360	122 295	230 255	254 118
Mangrove	289 763	15 768	106 306	145 588	22 101	0	0
All life zones	38 250 678	1 647 160	9 111 823	8 944 837	5 696 543	4 813 595	8 036 721

[a] Volume of live trees is the cubic-meter volume of sound wood in live trees at least 12.5 cm d.b.h. from a 30-cm stump height to a minimum 10-cm top d.o.b. of the central stem.

[b] Note that the 10-cm d.b.h. class is truncated at 12.5 cm.

Table A.11—Aboveground biomass[a] of live trees with d.b.h. ≥ 2.5 cm by forest life zone for mainland Puerto Rico, Vieques, and Culebra, with standard error of the estimate

			Forest life zone									
	All life zones		Subtropical dry		Subtropical moist		Subtropical wet/rain		Lower montane wet/rain		Mangrove	
Survey unit	Biomass	Standard error	Biomass	Standard error	Biomass	Standard error	Biomass	Standard error	Biomass	Standard error	Biomass	Standard error
	Mg											
Puerto Rico	43 326 880	2 955 055	1 771 159	363 545	22 715 096	1 952 111	16 810 879	1 907 130	1 675 318	285 452	354 429	220 355
Vieques	417 158	75 471	254 886	71 530	149 518	32 093	NA	NA	NA	NA	12 754	7 820
Culebra	98 120	13 727	95 242	13 395	NA	NA	NA	NA	NA	NA	2 877	1 767
All units	43 842 158	2 792 920	2 121 287	361 497	22 864 614	1 857 526	16 810 879	1 907 130	1 675 318	285 452	370 060	230 038

NA = not applicable.

[a] Oven-dry biomass of all live aboveground tree parts, including stem, stump, branches, bark, seeds, and foliage, as estimated from regression equations that predict aboveground biomass from individual tree d.b.h. and total height measurements.

Table A.12—Aboveground biomass[a] of live trees with d.b.h. ≥ 2.5 cm by forest life zone and diameter class for the Commonwealth of Puerto Rico

Forest life zone	All classes	Diameter class (*cm at breast height*) 0–10	10	20	30	40	50	60+
	Mg							
Subtropical dry	2 121 287	113 263	399 686	667 908	475 273	118 207	155 672	191 277
Subtropical moist	22 864 614	300 609	2 650 662	7 379 659	5 112 253	2 533 206	1 787 140	3 101 085
Subtropical wet/rain	16 810 879	34 303	871 375	3 716 471	3 352 628	2 466 610	1 954 953	4 414 538
Lower montane wet/rain	1 675 318	10 457	142 614	450 364	248 586	148 393	287 718	387 187
Mangrove	370 060	1 183	32 579	159 059	153 611	23 627	0	0
All life zones	43 842 158	459 815	4 096 916	12 373 461	9 342 352	5 290 044	4 185 482	8 094 086

[a] Oven-dry biomass of all live aboveground tree parts, including stem, stump, branches, bark, seeds, and foliage, as estimated from regression equations that predict aboveground biomass from individual tree d.b.h. and total height measurements.

Table A.13—Total biomass[a] of live trees with d.b.h. ≥ 2.5 cm by forest life zone for mainland Puerto Rico, Vieques, and Culebra, with standard error of the estimate

			Forest life zone									
	All life zones		Subtropical dry		Subtropical moist		Subtropical wet/rain		Lower montane wet/rain		Mangrove	
Survey unit	Biomass	Standard error	Biomass	Standard error	Biomass	Standard error	Biomass	Standard error	Biomass	Standard error	Biomass	Standard error
	Mg											
Puerto Rico	51 861 358	3 497 820	2 186 510	441 142	27 413 432	2 338 334	19 850 371	2 227 003	1 986 443	335 392	424 602	264 394
Vieques	515 588	92 317	315 687	87 667	184 622	39 344	NA	NA	NA	NA	15 279	9 383
Culebra	123 619	16 966	120 172	16 555	NA	NA	NA	NA	NA	NA	3 447	2 121
All units	52 500 565	3 311 505	2 622 369	440 756	27 598 053	2 222 696	19 850 371	2 227 003	1 986 443	335 392	443 328	276 013

NA = not applicable.

[a] Total biomass is the sum of aboveground biomass and belowground biomass. Oven-dry biomass of all live belowground tree parts is estimated from a regression equation modeling the relationship between aboveground biomass and belowground biomass (Cairns and others 1997).

Table A.14—Number of growing-stock[a] trees by forest life zone for mainland Puerto Rico, Vieques, and Culebra, with standard error of the estimate

			Forest life zone									
	All life zones		Subtropical dry		Subtropical moist		Subtropical wet/rain		Lower montane wet/rain		Mangrove	
Survey unit	Growing-stock trees	Standard error	Growing-stock trees	Standard error	Growing-stock trees	Standard error	Growing-stock trees	Standard error	Growing-stock trees	Standard error	Growing-stock trees	Standard error
	number											
Puerto Rico	126,953,738	14,689,312	2,825,396	2,038,107	86,723,776	13,474,502	35,873,113	6,653,521	1,495,020	901,490	36,433	35,064
Vieques	928,578	488,029	776,068	462,223	151,200	120,899	NA	NA	NA	NA	1,311	1,254
Culebra	296	—	0	—	NA	NA	NA	NA	NA	NA	296	283
All units	127,882,612	2,801,477	3,601,464	2,111,135	86,874,975	12,740,296	35,873,113	6,653,521	1,495,020	901,490	38,040	36,608

— = not estimated due to insufficient sample; NA = not applicable.

[a] Growing-stock trees are living trees of commercial species classified as sawtimber, poletimber, saplings, and seedlings. For a tree to be considered growing stock, one-third or more of the gross volume in its saw-log section must meet grade, soundness, and size requirements for commercial logs, or the tree must have the potential to meet these requirements if it is poletimber size with 12.5 cm ≤ d.b.h. ≤ 27.5 cm. Commercial species are tree species currently or potentially suitable for industrial wood products.

Table A.15—Number of growing-stock[a] trees by forest life zone and diameter class for the Commonwealth of Puerto Rico

		Diameter class (*cm at breast height*)						
Forest life zone	All classes	0–10	10	20	30	40	50	60+
	number							
Subtropical dry	3,601,464	442,285	1,200,488	1,390,039	442,285	0	126,367	0
Subtropical moist	86,874,975	6,015,311	21,169,268	37,595,695	14,806,920	4,511,483	1,850,865	925,432
Subtropical wet/rain	35,873,113	1,362,270	5,222,035	16,044,515	7,492,486	3,178,630	1,437,952	1,135,225
Lower montane wet/rain	1,495,020	37,375	336,379	672,759	186,877	37,375	74,751	149,502
Mangrove	38,040	0	0	38,040	0	0	0	0
All life zones	127,882,612	7,857,242	27,928,171	55,741,047	22,928,568	7,727,489	3,489,935	2,210,160

[a] Growing-stock trees are living trees of commercial species classified as sawtimber, poletimber, saplings, and seedlings. For a tree to be considered growing stock, one-third or more of the gross volume in its saw-log section must meet grade, soundness, and size requirements for commercial logs, or the tree must have the potential to meet these requirements if it is poletimber size with 12.5 cm ≤ d.b.h. ≤ 27.5 cm. Commercial species are tree species currently or potentially suitable for industrial wood products.

Table A.16—Merchantable stem volume,[a] inside bark, of growing stock by forest life zone for mainland Puerto Rico, Vieques, and Culebra, with standard error of the estimate

			Forest life zone									
	All life zones		Subtropical dry		Subtropical moist		Subtropical wet/rain		Lower montane wet/rain		Mangrove	
Survey unit	Stem volume	Standard error	Stem volume	Standard error	Stem volume	Standard error	Stem volume	Standard error	Stem volume	Standard error	Stem volume	Standard error
	m^3											
Puerto Rico	14 991 086	1 554 310	176 713	101 481	6 751 108	1 103 253	7 582 580	1 096 841	477 122	191 669	3 564	3 457
Vieques	37 202	23 420	26 165	22 304	10 908	6 410	NA	NA	NA	NA	128	124
Culebra	29	—	0	—	NA	NA	NA	NA	NA	NA	29	28
All units	15 028 317	2 237 192	202 878	103 442	6 762 016	1 043 693	7 582 580	1 096 841	477 122	191 669	3 721	3 610

— = not estimated due to insufficient sample; NA = not applicable.

[a] Volume of growing-stock trees is the volume of sound wood in live trees at least 12.5 cm d.b.h. from a 30-cm stump height to a minimum 10-cm top d.o.b. of the central stem.

Table A.17—Merchantable stem volume,[a] inside bark, of growing-stock trees by forest life zone and diameter class for the Commonwealth of Puerto Rico

		Diameter class (*cm at breast height*)					
Forest life zone	All classes	10	20	30	40	50	60+
	m^3						
Subtropical dry	202 878	22 201	81 517	54 757	0	44 404	0
Subtropical moist	6 762 016	245 549	1 739 440	2 056 074	1 167 580	855 594	697 779
Subtropical wet/rain	7 582 580	116 329	1 311 382	1 826 444	1 617 768	1 285 256	1 425 400
Lower montane wet/rain	477 122	14 304	69 535	57 129	34 243	81 905	220 005
Mangrove	3 721	0	3 721	0	0	0	0
All life zones	15 028 317	398 383	3 205 595	3 994 404	2 819 591	2 267 159	2 343 185

[a] Volume of growing-stock trees is the volume of sound wood in live trees at least 12.5 cm d.b.h. from a 30-cm stump height to a minimum 10-cm top d.o.b. of the central stem.

Table A.18—Growing-stock composition found by the 2003 forest inventory of the Commonwealth of Puerto Rico, ranked by mean volume

Rank	Species	Puerto Rico—common name	Plants—common name	Volume
				m^3/ha
1	*Spathodea campanulata* Beauv.	Tulipán africano	African tuliptree	8.12
2	*Cecropia schreberiana* Miq.	Yagrumbo hembra	Pumpwood	1.91
3	*Guarea guidonia* (L.) Sleumer	Guaraguao	American muskwood	1.88
4	*Dacryodes excelsa* Vahl.	Tabonuco	Candletree	1.19
5	*Calophyllum antillanum* Britt.	María	Antilles calophyllum	0.85
6	*Andira inermis* (W. Wright) Kunth ex DC.	Moca	Cabbagebark tree	0.83
7	*Eucalyptus robusta* Sm.	Eucalipto	Swampmahogany	0.80
8	*Bucida buceras* L.	Úcar	Gregorywood	0.70
9	*Erythrina poeppigiana* (Walp.) O.F. Cook	Bucayo gigante	Mountain immortelle	0.68
10	*Inga laurina* (Sw.) Willd.	Guamá	Sacky sac bean	0.66
11	*Schefflera morototoni* (Aubl.) Maguire, Steyermark & Frodin	Yagrumo macho	Yuquilla	0.52
12	*Terminalia catappa* L.	Almendra	Tropical almond	0.45
13	*Bursera simaruba* (L.) Sarg.	Almácigo	Gumbo limbo	0.44
14	*Zanthoxylum martinicense* (Lam.) DC.	Espino rubial	White pricklyash	0.44
15	*Tabebuia heterophylla* (DC.) Britt.	Roble blanco	White cedar	0.42
16	*Inga vera* Willd.	Guaba	River koko	0.37
17	*Mangifera indica* L.	Mango	Mango	0.34
18	*Alchornea latifolia* Sw.	Achiotillo	Achiotillo	0.34
19	*Swietenia macrophylla* King	Caoba hondureña	Honduras mahogany	0.29
20	*Cordia borinquensis* Urban	Muñeco	Muñeco	0.27
21–300	All others	—	—	5.23
	Total			26.73

Table A.19— Relative dominance, relative density, relative frequency, importance value,[a] and origin (whether native or introduced to the islands) of tree species with d.b.h. ≥ 12.5 cm found by the 2004 forest inventory of the Commonwealth of Puerto Rico

Rank	Species	Puerto Rico—common name	Plants—common name	Relative dominance	Relative density	Relative frequency	IV	Species origin
1	*Spathodea campanulata* Beauv.	Tulipán africano	African tuliptree	19.24	19.36	6.19	14.93	I
2	*Guarea guidonia* (L.) Sleumer	Guaraguao	American muskwood	8.23	7.81	5.99	7.34	N
3	*Andira inermis* (W. Wright) Kunth ex DC.	Moca	Cabbagebark tree	3.28	5.14	5.59	4.67	N
4	*Cecropia schreberiana* Miq.	Yagrumbo hembra	Pumpwood	4.14	4.63	4.70	4.49	N
5	*Mangifera indica* L.	Mango	Mango	7.97	2.06	2.00	4.01	I
6	*Syzygium jambos* (L.) Alston	Pomarrosa	Malabar plum	2.49	4.41	3.00	3.30	I
7	*Tabebuia heterophylla* (DC.) Britt.	Roble blanco	White cedar	1.85	3.01	3.10	2.65	N
8	*Inga laurina* (Sw.) Willd.	Guamá	Sacky sac bean	2.30	2.06	2.80	2.39	N
9	*Inga vera* Willd.	Guaba	River koko	1.81	2.25	3.00	2.35	N
10	*Prestoea montana* (Graham) Nichols.	Palma de sierra	Sierran palm	1.76	3.78	1.40	2.31	N
11	*Bursera simaruba* (L.) Sarg.	Almácigo	Gumbo limbo	1.76	1.84	2.10	1.90	N
12	*Zanthoxylum martinicense* (Lam.) DC.	Espino rubial	White pricklyash	1.15	1.59	2.40	1.71	N
13	*Schefflera morototoni* (Aubl.) Maguire, Steyermark & Frodin	Yagrumo macho	Yuquilla	1.33	1.94	1.80	1.69	N
14	*Dendropanax arboreus* (L.) Dcne. & Planch. ex Britt.	Pollo	Angelica tree	1.25	1.62	2.00	1.62	N
15	*Ocotea leucoxylon* (Sw.) De Laness.	Laurel geo	Loblolly sweetwood	0.71	1.24	2.30	1.42	N
16	*Roystonea borinquena* O.F. Cook	Palma real	Royal palm	1.17	0.95	1.70	1.27	N
17	*Eugenia biflora* (L.) DC.	Pitangueira	Blackrodwood	2.88	0.25	0.30	1.14	N
18	*Calophyllum antillanum* Britt.	María	Antilles calophyllum	1.69	0.73	1.00	1.14	I
19	*Erythrina poeppigiana* (Walp.) O.F. Cook	Bucayo gigante	Mountain immortelle	1.62	0.60	1.10	1.11	I
20	*Cordia sulcata* DC.	Moral	Mucilage manjack	0.70	0.92	1.60	1.07	N
21	*Citrus sinensis* (L.) Osbeck	China	Sweet orange	0.54	1.08	1.40	1.01	I
22	*Alchornea latifolia* Sw.	Achiotillo	Achiotillo	0.77	0.86	1.30	0.98	N
23	*Albizia procera* (Roxb.) Benth.	Albizia	Tall albizia	0.84	1.17	0.90	0.97	I
24	*Eucalyptus robusta* Sm.	Eucalipto	Swampmahogany	1.78	0.76	0.30	0.95	I
25	*Ficus citrifolia* P. Mill.	Jagüey blanco	Wild banyantree	1.72	0.29	0.80	0.93	N
26	*Buchenavia tetraphylla* (Aubl.) Howard	Granadillo	Fourleaf buchenavia	1.86	0.35	0.40	0.87	N
27	*Bucida buceras* L.	Úcar	Gregorywood	0.80	0.60	0.70	0.70	N
28	*Citharexylum fruticosum* L.	Péndula	Florida fiddlewood	0.39	0.60	1.10	0.70	N
29	*Artocarpus altilis* (Parkinson) Fosberg	Panapén	Breadfruit	0.62	0.76	0.70	0.69	I
30	*Laguncularia racemosa* (L.) Gaertn. f.	Mangle blanco	White mangrove	0.81	0.95	0.20	0.66	N
31	*Clusia rosea* Jacq.	Cupey	Scotch attorney	0.52	0.54	0.90	0.65	N
32	*Neolaugeria resinosa* (Vahl) Nicols.	Aquilón	Aquilón	0.49	0.79	0.60	0.63	N
33	*Hymenaea courbaril* L.	Algarrobo	Limestone snakevine	0.75	0.63	0.50	0.63	N
34	*Dacryodes excelsa* Vahl.	Tabonuco	Candletree	1.52	0.16	0.20	0.63	N
35	*Guazuma ulmifolia* Lam.	Guácima	Bastardcedar	0.48	0.60	0.70	0.60	N
36	*Coccoloba diversifolia* Jacq.	Uvilla	Tietongue	0.27	0.57	0.90	0.58	N
37	*Thouinia striata* Radlk.	Ceboruquillo	Ceboruquillo	0.24	0.54	0.90	0.56	N
38	*Micropholis garciniifolia* Pierre	Caimitillo verde	Caimitillo verde	0.60	0.67	0.30	0.52	N
39	*Albizia lebbeck* (L.) Benth.	Acacia amarilla	Woman's tongue	0.39	0.54	0.60	0.51	I
40	*Casearia arborea* (L.C. Rich.) Urban	Rabo ratón	Gia verde	0.18	0.44	0.90	0.51	N
41–210	All other species	—	—	17.07	20.88	31.67	23.21	—
	Total			100.00	100.00	100.00	100.00	

IV = importance value; I = species introduced to the islands; N = species native to the islands.

[a] Importance value for each species was calculated by taking the average of relative dominance (each species' basal area divided by the total basal area), relative density (each species' trees per hectare divided by total trees per hectare), and relative frequency (number of plots where the species occurred divided by total number of plots), multiplied by 100.

Table A.20—Relative dominance, relative density, relative frequency, importance value,[a] and origin (whether native or introduced to the islands) of tree species with d.b.h. ≥ 12.5 cm found by the 2004 forest inventory in the subtropical dry forest life zone of the Commonwealth of Puerto Rico

Rank	Species	Puerto Rico—common name	Plants—common name	Relative dominance	Relative density	Relative frequency	IV	Species origin
1	*Bursera simaruba* (L.) Sarg.	Almácigo	Gumbo limbo	18.85	16.77	13.33	16.32	N
2	*Prosopis pallida* (Humb. & Bonpl. ex Willd.) Kunth	Bayahonda	Kiawe	11.16	14.84	6.67	10.89	I
3	*Bucida buceras* L.	Úcar	Gregorywood	8.79	5.16	5.00	6.32	N
4	*Andira inermis* (W. Wright) Kunth ex DC.	Moca	Cabbagebark tree	12.83	2.58	1.67	5.69	N
5	*Guazuma ulmifolia* Lam.	Guácima	Bastardcedar	6.25	4.52	5.00	5.26	N
6	*Ziziphus mauritiana* Lam.	Aprín	Indian jujube	3.30	6.45	3.33	4.36	I
7	*Acacia farnesiana* (L.) Willd.	Aroma	Sweet acacia	4.36	3.87	3.33	3.86	I
8	*Pilosocereus royenii* (L.) Byles & Rowley	Sebucán	Royen’s tree cactus	2.28	4.52	3.33	3.38	N
9	*Guapira fragrans* (Dum.-Cours.) Little	Corcho	Black mampoo	1.78	2.58	5.00	3.12	N
10	*Zanthoxylum martinicense* (Lam.) DC.	Espino rubial	White pricklyash	1.06	2.58	5.00	2.88	N
11	*Symplocos martinicensis* Jacq.	Aceituna blanca	Martinique sweetleaf	2.91	3.87	1.67	2.82	N
12	*Eugenia sintenisii* Kiaersk.	Murta	Lathberry	2.13	4.52	1.67	2.77	N
13	*Pithecellobium arboreum* (L.) Urban	Cojoba	Wild tamarind	2.69	3.23	1.67	2.53	N
14	*Psidium guajava* L.	Guayaba	Guava	5.12	0.65	1.67	2.48	N
15	*Ocotea floribunda* (Sw.) Mez	Laurel espada	Laurel espada	2.79	2.58	1.67	2.34	N
16	*Guajacum officinale* L.	Guayacán	Lignum-vitae	1.38	1.29	3.33	2.00	N
17	*Ficus citrifolia* P. Mill.	Jagüey blanco	Wild banyantree	0.79	1.29	3.33	1.80	N
18	*Albizia lebbeck* (L.) Benth.	Acacia amarilla	Woman’s tongue	0.54	1.29	3.33	1.72	I
19	*Sapindus saponaria* L.	Jaboncillo	Wingleaf soapberry	1.19	1.94	1.67	1.60	N
20	*Samanea saman* (Jacq.) Merr.	Samán	Raintree	1.42	1.29	1.67	1.46	I
21	*Hymenaea courbaril* L.	Algarrobo	Stinkingtoe	1.42	1.29	1.67	1.46	N
22	*Urera caracasana* (Jacq.) Gaud. ex Griseb.	Ortiga colorada	Flameberry	1.02	1.29	1.67	1.33	N
23	*Pithecellobium dulce* (Roxb.) Benth.	Guamá americano	Monkeypod	0.96	1.29	1.67	1.30	I
24	*Adelia ricinella* L.	Cotorro	Wild lime	0.70	1.29	1.67	1.22	N
25	*Cordia alliodora* (Ruiz & Pavón) Oken	Capá prieto	Spanish elm	0.58	1.29	1.67	1.18	N
26	*Rondeletia pilosa* Sw.	Cordobancillo peludo	Cordobancillo peludo	0.42	1.29	1.67	1.13	N
27	*Tamarindus indica* L.	Tamarindo	Tamarind	0.73	0.65	1.67	1.01	I
28	*Trema micranthum* (L.) Blume	Guacimilla	Jamaican nettletree	0.35	0.65	1.67	0.89	N
29	*Spathodea campanulata* Beauv.	Tulipán africano	African tuliptree	0.33	0.65	1.67	0.88	I
30	*Zanthoxylum monophyllum* (Lam.) P. Wilson	Palo rubio	Yellow prickle	0.33	0.65	1.67	0.88	N
31	*Homalium racemosum* Jacq.	Caracolillo	White cogwood	0.30	0.65	1.67	0.87	N
32	*Turpinia occidentalis* (Sw.) G. Don	Sauco cimarrón	Muttonwood	0.28	0.65	1.67	0.86	N
33	*Pictetia aculeata* (Vahl) Urban	Tachuelo	Fustic	0.27	0.65	1.67	0.86	N
34	*Guettarda scabra* (L.) Vent.	Palo de cucubano	Wild guava	0.26	0.65	1.67	0.86	N
35	*Cassine xylocarpa* Vent. var. attenuata (A. Rich.) Kuntze	Aceituno, cipote	Marbletree	0.24	0.65	1.67	0.85	N
36	*Melicoccus bijugatus* Jacq.	Quenepa	Spanish lime	0.18	0.65	1.67	0.83	I
	Total			100.00	100.00	100.00	100.00	

IV = importance value; N = species native to the islands; I = species introduced to the islands.

[a] Importance value for each species was calculated by taking the average of relative dominance (each species’ basal area divided by the total basal area), relative density (each species’ trees per hectare divided by total trees per hectare), and relative frequency (number of plots where the species occurred divided by total number of plots), multiplied by 100.

Table A.21—Relative dominance, relative density, relative frequency, importance value,[a] and origin (whether native or introduced to the islands) of tree species with d.b.h. ≥ 12.5 cm found by the 2004 forest inventory in the subtropical moist forest life zone of the Commonwealth of Puerto Rico

Rank	Species	Puerto Rico—common name	Plants—common name	Relative dominance	Relative density	Relative frequency	IV	Species origin
1	*Spathodea campanulata* Beauv.	Tulipán africano	African tuliptree	25.22	25.89	7.84	19.65	I
2	*Andira inermis* (W. Wright) Kunth ex DC.	Moca	Cabbagebark tree	5.68	8.26	7.45	7.13	N
3	*Guarea guidonia* (L.) Sleumer	Guaraguao	American muskwood	5.79	5.75	5.10	5.55	N
4	*Mangifera indica* L.	Mango	Mango	7.94	2.44	2.16	4.18	I
5	*Tabebuia heterophylla* (DC.) Britt.	Roble blanco	White cedar	1.77	3.44	4.31	3.17	N
6	*Cecropia schreberiana* Miq.	Yagrumbo hembra	Pumpwood	2.68	3.25	2.94	2.96	N
7	*Bursera simaruba* (L.) Sarg.	Almácigo	Gumbo limbo	2.81	2.63	3.33	2.92	N
8	*Syzygium jambos* (L.) Alston	Pomarrosa	Malabar plum	2.23	4.19	1.96	2.79	I
9	*Zanthoxylum martinicense* (Lam.) DC.	Espino rubial	White pricklyash	1.51	2.06	3.14	2.24	N
10	*Inga laurina* (Sw.) Willd.	Guamá	Sacky sac bean	1.81	1.94	2.75	2.17	N
11	*Calophyllum antillanum* Britt.	María	Antilles calophyllum	3.21	1.06	1.37	1.88	I
12	*Roystonea borinquena* O.F. Cook	Palma real	Royal palm	1.82	1.13	2.35	1.77	N
13	*Albizia procera* (Roxb.) Benth.	Albizia	Tall albizia	1.59	2.06	1.37	1.67	I
14	*Ficus citrifolia* P. Mill.	Jagüey blanco	Wild banyantree	3.47	0.31	0.98	1.59	N
15	*Inga vera* Willd.	Guaba	River koko	0.82	1.31	1.96	1.36	N
16	*Dendropanax arboreus* (L.) Dcne. & Planch. ex Britt.	Pollo	Angelica tree	0.92	1.25	1.76	1.31	N
17	*Artocarpus altilis* (Parkinson) Fosberg	Panapén	Breadfruit	1.13	1.38	1.18	1.23	I
18	*Citharexylum fruticosum* L.	Péndula	Florida fiddlewood	0.69	0.94	1.76	1.13	N
19	*Hymenaea courbaril* L.	Algarrobo	Stinkingtoe	1.45	1.13	0.78	1.12	N
20	*Coccoloba diversifolia* Jacq.	Uvilla	Tietongue	0.53	1.06	1.57	1.05	N
21	*Guazuma ulmifolia* Lam.	Guácima	Bastardcedar	0.97	1.00	0.98	0.98	N
22	*Buchenavia tetraphylla* (Aubl.) Howard	Granadillo	Fourleaf buchenavia	1.95	0.38	0.39	0.91	N
23	*Thouinia striata* Radlk.	Ceboruquillo	Ceboruquillo	0.43	0.88	1.37	0.89	N
24	*Leucaena leucocephala* (Lam.) de Wit	Zarcilla	White leadtree	0.54	1.13	0.98	0.88	N
25	*Albizia lebbeck* (L.) Benth.	Acacia amarilla	Woman's tongue	0.79	0.94	0.78	0.84	I
26	*Schefflera morototoni* (Aubl.) Maguire, Steyermark & Frodin	Yagrumo macho	Yaquilla	0.63	0.88	0.98	0.83	N
27	*Thespesia grandiflora* DC.	Maga	Maga	0.73	0.50	0.98	0.74	N
28	*Neolaugeria resinosa* (Vahl) Nicols.	Aquilón	Aquilón	0.45	0.75	0.98	0.73	N
29	*Erythrina poeppigiana* (Walp.) O.F. Cook	Bucayo gigante	Mountain immortelle	1.08	0.31	0.78	0.73	I
30	*Terminalia catappa* L.	Almendra	Tropical almond	1.01	0.56	0.59	0.72	I
31	*Cinnamomum elongatum* (Vahl ex Nees) Kosterm.	Laurel avispillo	Laurel avispillo	0.50	0.50	0.98	0.66	N
32	*Clusia rosea* Jacq.	Cupey	Scotch attorney	0.32	0.63	0.98	0.64	N
33	*Ocotea leucoxylon* (Sw.) De Laness.	Laurel geo	Loblolly sweetwood	0.30	0.56	0.98	0.62	N
34	*Homalium racemosum* Jacq.	Caracolillo	White cogwood	0.49	0.56	0.78	0.61	N
35	*Cupania americana* L.	Guara	Wild ackee	0.22	0.38	1.18	0.59	N
36	*Guapira fragrans* (Dum.-Cours.) Little	Corcho	Black mampoo	0.20	0.38	1.18	0.58	N
37	*Citrus sinensis* (L.) Osbeck	China	Sweet orange	0.29	0.56	0.78	0.55	I
38	*Cordia alliodora* (Ruiz & Pavón) Oken	Capá prieto	Spanish elm	0.28	0.38	0.98	0.55	N
39	*Cedrela odorata* L.	Cedro hembra	Spanish cedar	0.95	0.25	0.39	0.53	N
40	*Mammea americana* L.	Mamey	Mammee apple	0.98	0.19	0.39	0.52	N
41–130	All others	—	—	13.82	16.82	26.47	19.04	—
	Total			100.00	100.00	100.00	100.00	

IV = importance value; I = species introduced to the islands; N = species native to the islands.

[a] Importance value for each species was calculated by taking the average of relative dominance (each species' basal area divided by the total basal area), relative density (each species' trees per hectare divided by total trees per hectare), and relative frequency (number of plots where the species occurred divided by total number of plots), multiplied by 100.

Table A.22—Relative dominance, relative density, relative frequency, importance value,[a] and origin (whether native or introduced to the islands) of tree species with d.b.h. ≥ 12.5 cm found by the 2004 forest inventory in the subtropical wet/rain forest life zone of the Commonwealth of Puerto Rico

Rank	Species	Puerto Rico—common name	Plants—common name	Relative dominance	Relative density	Relative frequency	IV	Species origin
1	*Spathodea campanulata* Beauv.	Tulipán africano	African tuliptree	14.73	14.25	4.86	11.28	I
2	*Guarea guidonia* (L.) Sleumer	Guaraguao	American muskwood	11.41	11.88	7.40	10.23	N
3	*Cecropia schreberiana* Miq.	Yagrumbo hembra	Pumpwood	6.00	6.05	6.98	6.34	N
4	*Syzygium jambos* (L.) Alston	Pomarrosa	Malabar plum	2.98	5.47	4.65	4.37	I
5	*Mangifera indica* L.	Mango	Mango	8.43	1.87	1.90	4.07	I
6	*Prestoea montana* (Graham) Nichols.	Palma de sierra	Sierran palm	2.65	5.69	2.96	3.77	N
7	*Inga vera* Willd.	Guaba	River koko	3.01	3.82	4.44	3.76	N
8	*Schefflera morototoni* (Aubl.) Maguire, Steyermark & Frodin	Yagrumo macho	Yaquilla	2.39	3.82	3.59	3.27	N
9	*Ocotea leucoxylon* (Sw.) De Laness.	Laurel geo	Loblolly sweetwood	1.43	2.95	4.86	3.08	N
10	*Inga laurina* (Sw.) Willd.	Guamá	Sacky sac bean	2.96	2.52	3.17	2.88	N
11	*Eucalyptus robusta* Sm.	Eucalipto	Swampmahogany	4.73	2.74	0.63	2.70	I
12	*Andira inermis* (W. Wright) Kunth ex DC.	Moca	Cabbagebark tree	1.24	2.23	4.02	2.50	N
13	*Tabebuia heterophylla* (DC.) Britt.	Roble blanco	White cedar	2.12	3.24	2.11	2.49	N
14	*Cordia sulcata* DC.	Moral	Mucilage manjack	1.50	2.30	3.59	2.47	N
15	*Dendropanax arboreus* (L.) Dcne. & Planch. ex Britt.	Pollo	Angelica tree	1.65	2.30	2.54	2.16	N
16	*Eugenia biflora* (L.) DC.	Pitangueira	Blackrodwood	5.63	0.22	0.21	2.02	N
17	*Micropholis chrysophylloides* Pierre	Caimitillo	Wild balata	2.18	2.16	1.06	1.80	N
18	*Alchornea latifolia* Sw.	Achiotillo	Achiotillo	1.37	1.58	2.33	1.76	N
19	*Citrus sinensis* (L.) Osbeck	China	Sweet orange	0.80	1.80	2.11	1.57	I
20	*Erythrina poeppigiana* (Walp.) O.F. Cook	Bucayo gigante	Mountain immortelle	2.22	1.01	1.48	1.57	I
21	*Dacryodes excelsa* Vahl.	Tabonuco	Candletree	3.03	0.65	0.85	1.51	N
22	*Casearia arborea* (L.C. Rich.) Urban	Rabo ratón	Gia verde	0.42	1.15	2.11	1.23	N
23	*Buchenavia tetraphylla* (Aubl.) Howard	Granadillo	Fourleaf buchenavia	2.48	0.43	0.63	1.18	N
24	*Zanthoxylum martinicense* (Lam.) DC.	Espino rubial	White pricklyash	0.81	1.01	1.27	1.03	N
25	*Ormosia krugii* Urban	Palo de matos	Peronia	0.64	1.37	0.85	0.95	N
26	*Roystonea borinquena* O.F. Cook	Palma real	Royal palm	0.61	0.86	1.06	0.84	N
27	*Trichilia pallida* Sw.	Gaeta	Gaita	0.43	0.86	0.85	0.71	N
28	*Cyathea arborea* (L.) Sm.	Helecho gigante	Alsophila	0.17	0.58	1.27	0.67	N
29	*Neolaugeria resinosa* (Vahl) Nicols.	Aquilón	Aquilón	0.57	1.01	0.42	0.67	N
30	*Pouteria multiflora* (A. DC.) Eyma	Jácana	Bullytree	0.83	0.29	0.42	0.51	N
31	*Senna siamea* (Lam.) Irwin & Barneby	Casia de siam	Siamese cassia	0.53	0.50	0.42	0.49	I
32	*Calophyllum antillanum* Britt.	María	Antilles calophyllum	0.34	0.43	0.63	0.47	I
33	*Bucida buceras* L.	Úcar	Gregorywood	0.39	0.36	0.63	0.46	N
34	*Casuarina cristata* Miq.	Casuarina	Belah	0.44	0.72	0.21	0.46	I
35	*Clusia rosea* Jacq.	Cupey	Scotch attorney	0.37	0.58	0.42	0.46	N
36	*Byrsonima spicata* (Cav.) Kunth	Maricao	Doncella	0.29	0.43	0.63	0.45	N
37	*Turpinia occidentalis* (Sw.) G. Don	Sauco cimarrón	Muttonwood	0.27	0.43	0.63	0.44	N
38	*Homalium racemosum* Jacq.	Caracolillo	White cogwood	0.32	0.22	0.63	0.39	N
39	*Myrcia splendens* (Sw.) DC.	Hoja menuda	Punchberry	0.16	0.36	0.63	0.38	N
40	*Cordia borinquensis* Urban	Muñeco	Muñeco	0.53	0.14	0.42	0.36	N
41–112	All others	—	—	6.94	9.72	20.08	12.25	—
	Total			100.00	100.00	100.00	100.00	

IV = importance value; I = species introduced to the islands; N = species native to the islands.

[a] Importance value for each species was calculated by taking the average of relative dominance (each species' basal area divided by the total basal area), relative density (each species' trees per hectare divided by total trees per hectare), and relative frequency (number of plots where the species occurred divided by total number of plots), multiplied by 100.

Table A.23—Relative dominance, relative density, relative frequency, importance value,[a] and origin (whether native or introduced to the islands) of tree species with d.b.h. ≥ 12.5 cm found by the 2004 forest inventory in the lower montane wet/rain forest life zone of the Commonwealth of Puerto Rico

Rank	Species	Puerto Rico—common name	Plants—common name	Relative dominance	Relative density	Relative frequency	IV	Species origin
1	*Prestoea montana* (Graham) Nichols.	Palma de sierra	Sierran palm	20.86	43.35	11.36	25.19	N
2	*Cecropia schreberiana* Miq.	Yagrumbo hembra	Pumpwood	16.77	14.59	9.09	13.48	N
3	*Micropholis garciniifolia* Pierre	Caimitillo verde	Caimitillo verde	10.28	9.44	9.09	9.60	N
4	*Clusia rosea* Jacq.	Cupey	Scotch attorney	4.91	1.72	6.82	4.48	N
5	*Micropholis chrysophylloides* Pierre	Caimitillo	Wild balata	4.96	5.58	2.27	4.27	N
6	*Henriettea squamulosum* (Cogn.) Judd	Jusillo	Jusillo	1.05	2.15	9.09	4.10	N
7	*Dacryodes excelsa* Vahl.	Tabonuco	Candletree	6.81	1.29	2.27	3.46	N
8	*Cyrilla racemiflora* L.	Palo colorado	Swamp titi	3.59	2.15	4.55	3.43	N
9	*Croton poecilanthus* Urban	Sabinón	Sabinón	2.60	3.00	4.55	3.38	N
10	*Alchornea latifolia* Sw.	Achiotillo	Achiotillo	3.50	1.72	4.55	3.25	N
11	*Sloanea berteriana* Choisy ex DC.	Motillo	Bullwood	3.85	0.86	4.55	3.08	N
12	*Chrysophyllum bicolor* Poir.	Caimitillo	Star apple	3.64	2.58	2.27	2.83	N
13	*Inga laurina* (Sw.) Willd.	Guamá	Sacky sac bean	3.65	1.29	2.27	2.40	N
14	*Byrsonima spicata* (Cav.) Kunth	Maricao	Doncella	2.57	2.15	2.27	2.33	N
15	*Inga vera* Willd.	Guaba	River koko	2.46	0.86	2.27	1.86	N
16	Unknown	—	—	2.77	0.86	2.27	1.97	Unk.
17	*Schefflera morototoni* (Aubl.) Maguire, Steyermark & Frodin	Yagrumo macho	Yaquilla	0.72	1.29	2.27	1.43	N
18	*Cordia sulcata* DC.	Moral	Mucilage manjack	1.03	0.86	2.27	1.39	N
19	*Eugenia borinquensis* Britt.	Guayabota de sierra	Guayabota de sierra	1.00	0.86	2.27	1.38	N
20	*Clusia clusioides* (Griseb.) D'Arcy	Cupeíllo	Cupeíllo	0.80	0.86	2.27	1.31	N
21	*Citrus sinensis* (L.) Osbeck	China	Sweet orange	0.98	0.43	2.27	1.23	I
22	*Henriettea macfadyenii* (Triana) Alain	Camasey	Macfadyen's camasey	0.45	0.86	2.27	1.19	N
23	*Syzygium jambos* (L.) Alston	Pomarrosa	Malabar plum	0.36	0.43	2.27	1.02	I
24	*Cordia borinquensis* Urban	Muñeco	Muñeco	0.20	0.43	2.27	0.97	N
25	*Ocotea leucoxylon* (Sw.) De Laness.	Laurel geo	Loblolly sweetwood	0.19	0.43	2.27	0.97	N
	Total			100.00	100.00	100.00	100.00	

IV = importance value; N = species native to the islands; Unk. = unknown; I = species introduced to the islands.

[a] Importance value for each species was calculated by taking the average of relative dominance (each species' basal area divided by the total basal area), relative density (each species' trees per hectare divided by total trees per hectare), and relative frequency (number of plots where the species occurred divided by total number of plots), multiplied by 100.

Table A.24—Relative dominance, relative density, relative frequency, importance value,[a] and origin (whether native or introduced to the islands) of tree species with d.b.h. ≥ 12.5 cm found by the 2004 forest inventory in the mangrove forest of the Commonwealth of Puerto Rico

Rank	Species	Puerto Rico—common name	Plants—common name	Relative dominance	Relative density	Relative frequency	IV	Species origin
1	*Laguncularia racemosa* (L.) Gaertn. f.	Mangle blanco	White mangrove	67.37	57.69	40.00	55.02	N
2	*Avicennia germinans* (L.) L.	Mangle prieto	Black mangrove	20.83	30.77	20.00	23.87	N
3	*Conocarpus erectus* L.	Mangle botón	Button mangrove	8.80	5.77	20.00	11.52	N
4	*Rhizophora mangle* L.	Mangle colorado	Red mangrove	2.99	5.77	20.00	9.59	N
	Total			100.00	100.00	100.00	100.00	

IV = importance value; N = species native to the islands.

[a] Importance value for each species was calculated by taking the average of relative dominance (each species' basal area divided by the total basal area), relative density (each species' trees per hectare divided by total trees per hectare), and relative frequency (number of plots where the species occurred divided by total number of plots), multiplied by 100.

Table A.25—Mean pieces of down woody material[a] by forest life zone, size class,[b] and decay class[c] for the Commonwealth of Puerto Rico

	Size class (*cm*)				Decay class				
Forest life zone	8–20	20–33	33–45	≥ 45	1	2	3	4	5
	- - - - - - - - - - - - - - - - - - *number/ha* - - - - - - - - - - - - - - - - -								
Subtropical dry	56	0	0	0	0	56	0	0	0
Subtropical moist	891	57	8	0	0	373	516	147	0
Subtropical wet/rain	1,247	631	0	0	0	543	1,097	238	0
Mangrove	1,176	0	0	0	0	376	666	135	0
Mean	843	172	2	0	0	337	570	130	0

[a] Down woody material is a term used to collectively describe attributes estimated by the down woody materials indicator. A majority of the indicator's components are down and dead forest materials, fine woody material, coarse woody material, duff, litter, slash, live and dead herb and shrubs, and fuel bed depths.

[b] Diameter (cm) where down woody material crossed the transect.

[c] Decay class is a rating of individual coarse woody material according to a 5-class decay scale defined by the texture, structural integrity, and appearance of pieces. Scale ranges from freshly fallen trees (decay class 1) to completely decomposed cubical rot heaps (decay class 5).

Table A.26—Mean forest fire fuels by forest life zone and fuel type[a] for the Commonwealth of Puerto Rico

Forest life zone	1-hour	10-hour	100-hour	1,000-hour	Duff	Litter	Total
	- *Mg/ha* -						
Subtropical dry	0.26	1.35	2.67	0.43	2.89	2.51	10.11
Subtropical moist	0.93	4.83	5.28	8.44	8.86	3.89	32.24
Subtropical wet/rain	0.59	5.19	6.33	12.26	8.45	5.36	38.18
Mangrove	0.34	6.45	14.24	10.89	0.55	8.22	40.68
Mean	0.53	4.46	7.13	8.01	5.19	5.00	30.30

[a] Fuel hour classes are defined by the amount of time it takes for moisture conditions to fluctuate. Larger coarse woody material takes longer to dry out than smaller fine woody pieces (small = 1-hour; medium = 10-hour; large = 100-hour; Coarse woody material = 1,000-hour).

Table A.27—Mean carbon[a] in down woody materials and forest floor by forest life zone for mainland Puerto Rico and Vieques, with standard error of the mean

		FWD[b]		CWD[c]		FF[d]		Total carbon	
Survey unit	Forest life zone	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error
		Mg/ha							
Puerto Rico	Subtropical dry	3.56	1.91	0.44	0.44	7.69	5.36	11.69	7.71
	Subtropical moist	5.86	0.99	4.55	1.76	12.55	1.62	22.96	2.96
	Subtropical wet/rain	6.13	0.88	6.20	2.54	13.12	1.61	25.45	3.98
	Mangrove forest	10.64	1.97	5.51	5.51	15.08	2.47	31.23	6.01
	All life zones	6.13	0.68	4.76	1.26	12.52	1.10	23.41	2.19
Vieques	Subtropical dry	0.77	0.77	0	0	2.11	0.40	2.88	1.16
	Subtropical moist	1.79	—	0.40	—	4.89	—	7.08	—
	All life zones	1.11	0.56	0.13	0.13	3.03	0.96	4.27	1.55
All units	All life zones	5.60	0.68	4.27	1.15	11.51	1.13	21.38	2.26

— = not estimated due to insufficient sample; FWD = fine woody debris; CWD = coarse woody debris; FF = forest floor.

[a] Carbon is calculated by multiplying biomass by a factor of 0.5. Estimated for all trees with d.b.h. ≥ 2.5 cm.

[b] Fine woody debris is down pieces of wood with a diameter ≤ 8.0 cm, not including foliage or bark fragments.

[c] Coarse woody debris is down pieces of wood with a minimum small-end diameter of at least 8 cm and a length of at least 0.9 m (excluding decay class 5). Coarse woody material pieces must be detached from a bole and/or not be self-supported by a root system, and must have a lean angle > 45 degrees from vertical.

[d] Forest floor is the layer of fallen leaves, needles, twigs, fruits, and dead herbaceous material, found on the ground. Forest floor includes the litter layer and the duff layer of decomposing organic material found just above mineral soil.

Table A.28—Mean percent organic carbon in forest floor components by forest life zone, with standard error of the mean

	Fruits and flowers		Leaves		Wood		Other	
Forest life zone[a]	Organic carbon	Standard error	Organic carbon	Standard error	Organic carbon	Standard error	Organic carbon	Standard error
	%		%		%		%	
Subtropical dry	47.72	0.29	39.82	8.51	53.11	1.10	31.88	11.78
Subtropical moist	52.90	0.57	48.46	1.06	53.41	0.47	48.80	0.92
Subtropical wet/rain	55.23	3.18	49.23	1.85	53.61	0.83	49.25	1.55
Mangrove forest	—	—	48.81	0.00	46.75	0.00	40.33	0
Mean	52.83	1.06	47.98	1.08	53.16	0.46	47.17	1.42

— = not estimated due to insufficient sample.

[a] No values given for lower montane wet/rain forest because there were no forest health monitoring plots in that zone.

Table A.29—Carbon in live trees with d.b.h. ≥ 2.5 cm, standing dead trees, fine woody debris, coarse woody debris, and forest floor by forest life zone for mainland Puerto Rico, Vieques, and Culebra, with standard error of the estimate

				Forest life zone									
		All life zones		Subtropical dry		Subtropical moist		Subtropical wet/rain		Lower montane wet/rain		Mangrove[a]	
Survey unit		Carbon	Standard error	Carbon	Standard error	Carbon	Standard error	Carbon	Standard error	Carbon	Standard error	Carbon	Standard error
		Mg											
Puerto Rico	Live	24 841 591	1 673 956	1 040 644	209 266	13 106 157	1 111 963	9 543 230	1 070 558	949 437	159 900	202 124	125 790
	Standing dead	515 862	1 563	1 007	1 008	289 925	52 493	174 424	41 249	16 529	7 503	33 978	25 817
	FWD	2 769 983	340 111	179 230	96 470	1 516 928	495 193	989 554	309 724	NS	—	84 271	21 009
	CWD	2 245 645	620 034	22 173	22 173	1 177 820	113 950	1 002 013	71 145	NS	—	43 640	43 640
	Forest floor	5 873 537	556 492	387 158	270 368	3 248 712	1 388 774	2 118 231	867 742	NS	—	119 437	27 934
	Unit subtotal	36 246 619		1 630 212		19 339 542		13 827 451		965 966		483 449	
Vieques	Live	247 496	43 620	149 885	41 494	89 973	18 616	NA	NA	NA	NA	7 638	4 691
	Standing dead	2 316	877	683	484	410	700	NA	NA	NA	NA	1 223	920
	FWD	15 633	6 132	5 260	5 260	7 341	—	NA	NA	NA	NA	3 032	688
	CWD	3 211	1 422	0	—	1 640	—	NA	NA	NA	NA	1 570	1 570
	Forest floor	38 766	10 539	14 415	3 124	20 053	—	NA	NA	NA	NA	4 298	903
	Unit subtotal	307 422		170 243		119 418		NA		NA		17 761	
Culebra[b]	Live	25 688	13 169	23 965	7 902	NA	NA	NA	NA	NA	NA	1 723	1 060
	Standing dead	924	690	648	674	NA	NA	NA	NA	NA	NA	276	208
	FWD	2 679	1 487	1 995	1 995	NA	NA	NA	NA	NA	NA	684	157
	CWD	354	345	0	—	NA	NA	NA	NA	NA	NA	354	354
	Forest floor	6 436	2 549	5 467	1 036	NA	NA	NA	NA	NA	NA	970	207
	Unit subtotal	36 082		32 074		NA		NA		NA		4 007	
All units	Total	36 590 123		1 832 529		19 458 959		13 827 451		965 966		505 217	

— = not estimated due to insufficient sample; FWD = fine woody debris; CWD = coarse woody debris; NS = not sampled because there were no forest health monitoring plots in lower montane wet/rain forest; NA = not applicable.

[a] Per-hectare values for mangrove forest on Culebra and Vieques come from plots on mainland Puerto Rico because there were no field plots in that forest type on either island.

[b] Per-hectare values for FWD, CWD, and forest floor carbon used for Culebra subtropical dry forest come from plots on Vieques because there were no forest health monitoring plots on Culebra.

Appendix B—Species List

List of all tree^{a} species found in the 2004 forest inventory of the Commonwealth of Puerto Rico, with number of individuals recorded, family, and origin [whether native (N) or introduced (I) to the islands]

Survey unit	Scientific name	Puerto Rico— common name	Plants— common name	No.	Family	Origin
Culebra	*Acacia farnesiana* (L.) Willd.	Aroma	Sweet acacia	6	Fabaceae	I
	Bucida buceras L.	Úcar	Gregorywood	6	Combretaceae	N
	Bursera simaruba (L.) Sarg.	Almacigo	Gumbo limbo	2	Burseraceae	N
	Cassine xylocarpa Vent. var. attenuata (A. Rich.) Kuntze	Aceituno, cipote	Marbletree	8	Celastraceae	N
	Croton astroites Ait.	Wild marrow	Wild marrow	2	Euphorbiaceae	N
	Guapira fragrans (Dum.-Cours.) Little	Corcho	Black mampoo	5	Nyctaginaceae	N
	Piscidia carthagenensis Jacq.	Venture	Stinkwood	1	Fabaceae	N
	Plumeria alba L.	Alelí	Nosegaytree	3	Apocynaceae	N
	Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	Bayahonda	Kiawe	19	Fabaceae	I
Puerto Rico	*Acacia farnesiana* (L.) Willd.	Aroma	Sweet acacia	40	Fabaceae	I
	A. muricata (L.) Willd.	Acacia nudosa	Spineless wattle	6	Fabaceae	N
	Acrocarpus fraxinifolius Wight ex Arn.	Pink cedar	Pink cedar	1	Fabaceae	I
	Acrocomia media O.F. Cook	Corozo	Grugru palm	2	Arecaceae	N
	Adenanthera pavonina L.	Peronías	Red beadtree	36	Fabaceae	I
	Albizia lebbeck (L.) Benth.	Albizia	Woman's tongue	24	Fabaceae	I
	A. procera (Roxb.) Benth.	Albizia	Tall albizia	60	Fabaceae	I
	Alchornea latifolia Sw.	Achiotillo	Achiotillo	54	Euphorbiaceae	N
	Alchorneopsis floribunda (Benth.) Muell.-Arg.	Palo de gallina	Palo de gallina	1	Euphorbiaceae	N
	Amyris balsamifera L.	Teílla	Balsam torchwood	5	Rutaceae	N
	A. elemifera L.	Tea	Sea torchwood	24	Rutaceae	N
	Anacardium excelsum (Bert. & Barb.) Skeels (Espavel)	Espave	Espave	1	Anacardiaceae	I
	Andira inermis (W. Wright) Kunth ex DC.	Moca	Cabbagebark tree	261	Fabaceae	N
	Annona muricata L.	Guanábana	Soursop	8	Annonaceae	N
	A. squamosa L.	Corazón	Sugar apple	2	Annonaceae	N
	Antirhea obtusifolia Urban	Quina roja	Quina roja	1	Rubiaceae	N
	Ardisia obovata Desv. ex Hamilton	Mameyuelo	Guadeloupe marlberry	46	Myrsinaceae	N
	Ardisia solanacea Roxb.	Mameyuelo	China-shrub	18	Myrsinaceae	I
	Artocarpus altilis (Parkinson) Fosberg	Panapén	Breadfruit	24	Moraceae	I
	A. integrifolius auct.	Jaca	Jackfruit	1	Moraceae	I
	Avicennia germinans (L.) L.	Mangle prieto	Black mangrove	28	Verbenaceae	N
	Badiera penaea Britt.	Crevajosa	Crevajosa	1	Polygalaceae	N
	Banara portoricensis Krug & Urban	Palo de ramon	Palo de ramon	1	Flacourtiaceae	N
	Bocconia frutescens L.	Pan cimarrón	Parrotweed	1	Papaveraceae	N
	Bourreria succulenta Jacq.	Palo de vaca	Bodywood	19	Boraginaceae	N
	B. virgata (Sw.) G. Don	Roble de guayo	Roble de guayo	4	Boraginaceae	N
	Brassaia actinophylla Endl.	Scheflera	Octopus tree	1	Araliaceae	I
	Brunfelsia densifolia Krug & Urban	Vega blanca	Serpentine Hill raintree	1	Solanaceae	N
	Buchenavia tetraphylla (Aubl.) Howard	Granadillo	Fourleaf buchenavia	15	Combretaceae	N
	Bucida buceras L.	Úcar	Gregorywood	83	Combretaceae	N
	Bursera simaruba (L.) Sarg.	Almacigo	Gumbo limbo	143	Burseraceae	N
	Byrsonima lucida (P. Mill.) DC.	Palo de doncella	Long Key locustberry	14	Malpighiaceae	N
	B. spicata (Cav.) Kunth	Maricao	Doncella	15	Malpighiaceae	N
	B. wadsworthii Little	Almendrillo	Almendrillo	3	Malpighiaceae	N
	Calophyllum antillanum Britt.	María	Antilles calophyllum	55	Clusiaceae	I
	Canella winteriana (L.) Gaertn.	Barbasco	Wild cinnamon	5	Canellaceae	N
	Capparis baducca L.	Sapo	Caper	3	Capparaceae	N
	Carapa guianensis Aubl. (Andiroba)	Crabwood	Crabwood	11	Meliaceae	I

continued

List of all tree[a] species found in the 2004 forest inventory of the Commonwealth of Puerto Rico, with number of individuals recorded, family, and origin [whether native (N) or introduced (I) to the islands] (continued)

Survey unit	Scientific name	Puerto Rico—common name	Plants—common name	No.	Family	Origin
Puerto Rico	*Casearia arborea* (L.C. Rich.) Urban	Rabo ratón	Gia verde	39	Flacourtiaceae	N
	C. decandra Jacq.	Tostado	Wild honeytree	20	Flacourtiaceae	N
	C. guianensis (Aubl.) Urban	Palo blanco	Guyanese wild coffee	184	Flacourtiaceae	N
	C. sylvestris Sw.	Cafeíllo	Crackopen	156	Flacourtiaceae	N
	Cassia glauca Lam.	Smooth senna	Smooth senna	1	Fabaceae	I
	Cassine xylocarpa Vent. var. attenuata (A. Rich.) Kuntze	Aceituno, cipote	Marbletree	6	Celastraceae	N
	Casuarina cristata Miq.	Casurina	Belah	11	Casuarinaceae	I
	Cecropia schreberiana Miq.	Yagrumbo hembra	Pumpwood	213	Cecropiaceae	N
	Cedrela odorata L.	Cedro hembra	Spanish cedar	5	Meliaceae	N
	Cestrum Laurifolim L'Hér.	Galen del monte	Galen del monte	5	Solanaceae	N
	Chionanthus domingensis Lam.	Caracolillo, huesillo	White rosewood	2	Oleaceae	N
	Chrysobalanus icaco L.	Hicaco	Icaco coco plum	2	Chrysobalanaceae	N
	Chrysophyllum bicolor Poir.	Caimitillo	Star apple	7	Sapotaceae	N
	C. cainito L.	Caimito	Star apple	2	Sapotaceae	N
	C. oliviforme L.	Caimitillo de perro	Satinleaf	4	Sapotaceae	N
	C. pauciflorum Lam.	Caimitillo de perro	Camito de perro	2	Sapotaceae	N
	Cinnamomum camphora (L.) J. Presl	Alcanfor	Camphortree	1	Lauraceae	I
	C. elongatum (Vahl ex Nees) Kosterm.	Laurel avispillo	Laurel avispillo	33	Lauraceae	N
	C. montanum (Sw.) Bercht. & J. Presl	Avispillo	Avispillo	5	Lauraceae	N
	Citharexylum fruticosum L.	Péndula	Florida fiddlewood	68	Verbenaceae	N
	Citrus aurantifolia (Christm.) Swingle	Limón agrio	Lime	1	Rutaceae	I
	C. paradisi	Toronja	Grapefruit	1	Rutaceae	I
	C. sinensis (L.) Osbeck	China	Sweet orange	42	Rutaceae	I
	Clusia clusioides (Griseb.) D'Arcy	Cupeíllo	Cupeillo	10	Clusiaceae	N
	C. rosea Jacq.	Cupey	Scotch attorney	48	Clusiaceae	N
	Coccoloba diversifolia Jacq.	Uvilla	Tietongue	65	Polygonaceae	N
	C. krugii Lindau	Ortegón	Whitewood	16	Polygonaceae	N
	C. microstachya Willd.	Uverillo	Puckhout	15	Polygonaceae	N
	C. pubescens L.	Moralón	Grandleaf seagrape	15	Polygonaceae	N
	C. sintenisii Urban ex Lindau	Uvero de monte	Uvero de monte	1	Polygonaceae	N
	C. swartzii Meisn.	Ortegón	Swartz's pigeonplum	1	Polygonaceae	N
	Coccothrinax alta (O.F. Cook) Becc.	Palma de abanico	Puerto Rico silver palm	2	Arecaceae	N
	Cocos nucifera L.	Palma de coco	Coconut palm	6	Arecaceae	I
	Coffea arabica L.	Café	Arabian coffee	34	Rubiaceae	I
	C. dewevrei Wildm. & T. Dur.	Café excelsa	Liberian coffee	9	Rubiaceae	I
	Colubrina arborescens (P. Mill.) Sarg.	Abeyuelo	Greenheart	5	Rhamnaceae	N
	Comocladia dodonaea (L.) Urban	Chicharrón	Poison ash	2	Anacardiaceae	N
	C. glabra (J.A. Schultes) Spreng.	Carrasco	Carrasco	6	Anacardiaceae	N
	Conocarpus erectus L.	Mangle botón	Button mangrove	5	Combretaceae	N
	Cordia alliodora (Ruiz & Pavón) Oken	Capá prieto	Spanish elm	19	Boraginaceae	N
	C. borinquensis Urban	Muñeco	Muneco	17	Boraginaceae	N
	C. laevigata Lam.	Capá colorado, cerezo del país	Smooth manjack	8	Boraginaceae	N
	C. rickseckeri Millsp.	San bartolomé	San Bartolome	2	Boraginaceae	N
	C. sulcata DC.	Moral	Mucilage manjack	43	Boraginaceae	N
	Cornutia pyramidata L.	Azulejo	Azulejo	1	Verbenaceae	N
	Crescentia cujete L.	Higuero	Common calabash tree	5	Bignoniaceae	N
	Crossopetalum rhacoma Crantz	Coral, manto	Maidenberry	11	Celastraceae	I
	Croton astroites Ait.	Marán	Wild marrow	6	Euphorbiaceae	N
	C. poecilanthus Urban	Sabinón	Sabinon	10	Euphorbiaceae	N

continued

List of all tree[a] species found in the 2004 forest inventory of the Commonwealth of Puerto Rico, with number of individuals recorded, family, and origin [whether native (N) or introduced (I) to the islands] (continued)

Survey unit	Scientific name	Puerto Rico—common name	Plants—common name	No.	Family	Origin
Puerto Rico	*C. rigidus* (Muell.-Arg.) Britt.	Adormidera	Yellow balsam	5	Euphorbiaceae	N
	Cupania americana L.	Guara	Wild ackee	27	Sapindaceae	N
	Cyathea arborea (L.) Sm.	Helecho gigante	West Indian treefern	16	Cyatheaceae	N
	C. portoricensis Spreng. ex Kuhn	Helecho gigante	Alsophila	2	Cyatheaceae	N
	Cyrilla racemiflora L.	Palo colorado	Swamp titi	5	Cyrillaceae	N
	Dacryodes excelsa Vahl	Tabonuco	Candletree	13	Burseraceae	N
	Dalbergia sissoo Roxb. ex DC.	Sisu	Indian rosewood	1	Fabaceae	I
	Daphnopsis americana (P. Mill.) J.R. Johnston	Majagua de sierra	Burn nose	1	Thymelaeaceae	N
	D. philippiana Krug & Urban	Majagau brava	Emajagua de sierra	1	Thymelaeaceae	N
	Delonix regia (Bojer ex Hook.) Raf.	Flamboyán	Royal poinciana	10	Fabaceae	I
	Dendropanax arboreus (L.) Dcne. & Planch. ex Britt.	Pollo	Angelica tree	99	Araliaceae	N
	Ditta myricoides Griseb.	Jaboncillo	Jaboncillo	2	Euphorbiaceae	N
	Dracaena fragrans (L.) Ker-Gawl.	Dracena	Fragrant dracaena	1	Liliaceae	I
	Drypetes alba Poit.	Hueso	Cafeillo	14	Euphorbiaceae	N
	D. glauca Vahl	Varital	Varital	5	Euphorbiaceae	N
	D. lateriflora (Sw.) Krug & Urban	Cueriduro	Guiana plum	3	Euphorbiaceae	N
	Erithalis fruticosa L.	Jayajabio	Blacktorch	4	Rubiaceae	N
	Erythrina berteriana Urban	Bucare enano	Machete	14	Fabaceae	I
	E. poeppigiana (Walp.) O.F. Cook	Bucayo gigante	Mountain immortelle	24	Fabaceae	I
	Erythroxylum rotundifolium Lunan	Ratón	Ratwood	4	Erythroxylaceae	N
	E. rufum Cav.	Rufous false cocaine	Rufous false cocaine	1	Erythroxylaceae	N
	E. urbanii O.E. Schulz	Urban's false cocaine	Urban's false cocaine	1	Erythroxylaceae	N
	Eucalyptus deglupta Blume	Eucalipto	Indonesian gum	1	Myrtaceae	I
	E. robusta Sm.	Eucalipto	Swampmahogany	46	Myrtaceae	I
	Eugenia biflora (L.) DC.	Pitanguera	Blackrodwood	39	Myrtaceae	N
	E. borinquensis Britt.	Guayabota de sierra	Guayabota de sierra	8	Myrtaceae	N
	E. confusa DC.	Cieneguillo	Redberry stopper	2	Myrtaceae	N
	E. cordata (Sw.) DC.	Murta	Lathberry	2	Myrtaceae	N
	E. monticola (Sw.) DC.	Birijí	Birdcherry	48	Myrtaceae	N
	E. pseudopsidium Jacq.	Quiebrahacha	Christmas cherry	2	Myrtaceae	N
	E. rhombea Krug & Urban	Hoja menuda	Red stopper	16	Myrtaceae	N
	E. sintenisii Kiaersk.	Murta	Lathberry	11	Myrtaceae	N
	Eupatorium portoricense Urban	Guerrero	Thoroughwort	1	Asteraceae	N
	Exostema caribaeum (Jacq.) J.A. Schultes	Albarillo	Caribbean princewood	38	Rubiaceae	N
	Exothea paniculata (Juss.) Radlk.	Gaita, guacarán	Butterbough	4	Sapindaceae	N
	Faramea occidentalis (L.) A. Rich.	Caféillo	False coffee	7	Rubiaceae	N
	Ficus americana Aubl.	Jaguey colorado	Jamaican cherry fig	1	Moraceae	N
	F. citrifolia P. Mill.	Jaguey blanco	Wild banyantree	27	Moraceae	N
	F. trigonata L.	Jaguey	Jaguey blanco	1	Moraceae	N
	Genipa americana L.	Jagua	Jagua	7	Rubiaceae	N
	Gesneria pedunculosa (DC.) Fritsch	Árbol de navidad	Arbol de Navidad	6	Gesneriaceae	N
	Gomidesia lindeniana Berg	Cieneguillo	Grand merisier	2	Myrtaceae	N
	Guaiacum officinale L.	Guayacán	Lignum-vitae	4	Zygophyllaceae	N
	Guapira fragrans (Dum.-Cours.) Little	Corcho bobo	Black mampoo	24	Nyctaginaceae	N
	Guarea glabra Vahl	Alligatorwood	Alligatorwood	9	Meliaceae	N
	G. guidonia (L.) Sleumer	Guaraguao	American muskwood	496	Meliaceae	N
	Guazuma ulmifolia Lam.	Guácima	Bastardcedar	27	Sterculiaceae	N
	Guettarda elliptica Sw.	Cucubano liso	Hammock velvetseed	1	Rubiaceae	N
	G. scabra (L.) Vent.	Cucbano	Wild guave	83	Rubiaceae	N

continued

List of all tree[a] species found in the 2004 forest inventory of the Commonwealth of Puerto Rico, with number of individuals recorded, family, and origin [whether native (N) or introduced (I) to the islands] (continued)

Survey unit	Scientific name	Puerto Rico—common name	Plants—common name	No.	Family	Origin
Puerto Rico	*Gymnanthes lucida* Sw.	Yaití	Oysterwood	40	Euphorbiaceae	N
	Henriettea fascicularis (Sw.) G. Maza	Camasey peludo	Camasey peludo	1	Melastomataceae	N
	H. macfadyenii (Triana) Alain	Camasey	Macfadyen's camasey	11	Melastomataceae	N
	H. squamulosum (Cogn.) Judd	Jusillo	Jusillo	13	Melastomataceae	N
	Hibiscus elatus Sw.	Majó	Mahoe	6	Malvaceae	I
	Hirtella rugosa Thuill. ex Pers.	Teta de burra cimarron	Teta de burra cinarron	2	Chrysobalanaceae	N
	H. triandra Sw.	Teta de burra	Pigeonberry	2	Chrysobalanaceae	N
	Homalium racemosum Jacq.	Caracolillo	White cogwood	28	Flacourtiaceae	N
	Hura crepitans L.	Molinillo	Sandbox tree	2	Euphorbiaceae	N
	Hyeronima clusioides (Tul.) Muell.-Arg.	Cedro macho	Cedro macho	1	Euphorbiaceae	N
	Hymenaea courbaril L.	Algarrobo	Stinkingtoe	27	Fabaceae	N
	Hyperbaena laurifolia (Poir.) Urban	Limestone snakevine	Limestone snakevine	3	Menispermaceae	I
	Ilex macfadyenii (Walp.) Rehd.	Acebo de sierra	Caribbean holly	2	Aquifoliaceae	N
	I. nitida (Vahl) Maxim.	Aceituno	Puerto Rico holly	2	Aquifoliaceae	N
	Inga laurina (Sw.) Willd.	Guamá	Sacky sac bean	96	Fabaceae	N
	I. quaternata Poepp. & Endl.	Guamá venezolano	Guamá venezolano	7	Fabaceae	I
	I. vera Willd.	Guaba	River koko	130	Fabaceae	N
	Ixora ferrea (Jacq.) Benth.	Palo de hierro	Palo de hierro	5	Rubiaceae	I
	Jacquinia armillaris Jacq.	Az úcares, barbasco, bizcocho	Braceletwood	2	Theophrastaceae	N
	Krugiodendron ferreum (Vahl) Urban	Bariacao	Leadwood	4	Rhamnaceae	N
	Laetia procera (Poepp.) Eichl.	Talantrón, cuero de rana	Cuero de rana	2	Flacourtiaceae	N
	Laguncularia racemosa (L.) Gaertn. f.	Mangle blanco	White mangrove	49	Combretaceae	N
	Leucaena leucocephala (Lam.) de Wit	Zarcilla	White leadtree	194	Fabaceae	N
	Licaria parvifolia (Lam.) Kosterm.	Canelilla	Puerto Rico cinnamon	19	Lauraceae	N
	L. triandra (Sw.) Kosterm.	Palo de misanteco	Pepperleaf sweetwood	3	Lauraceae	N
	Lonchocarpus domingensis (Turp. ex Pers.) DC.	Geno geno	Geno geno	2	Fabaceae	N
	L. glaucifolius Urban	Geno	Geno	6	Fabaceae	N
	Lyonia rubiginosa (Pers.) G. Don	St. Thomas staggerbush	St. Thomas staggerbush	2	Ericaceae	N
	Magnolia portoricensis Bello	Jaguilla	Puerto Rico magnolia	2	Magnoliaceae	N
	Mammea americana L.	Mamey	Mammee apple	5	Clusiaceae	N
	Mangifera indica L.	Mango	Mango	71	Anacardiaceae	I
	Manilkara bidentata (A. DC.) Chev.	Ausubo	Bulletwood	1	Sapotaceae	N
	Margaritaria nobilis L. f.	Millo	Bastard hogberry	5	Euphorbiaceae	N
	Matayba domingensis (DC.) Radlk.	Negra lora	Negra lora	5	Sapindaceae	N
	Melicoccus bijugatus Jacq.	Quenepa	Spanish lime	11	Sapindaceae	I
	Meliosma herbertii Rolfe	Aguacatillo	Aguacatillo	7	Sabiaceae	N
	Miconia impetiolaris (Sw.) D. Don ex DC.	Camasey de costilla	Camasey de costilla	5	Melastomataceae	N
	M. laevigata (L.) D. Don	Camasey de paloma	Smooth johnnyberry	11	Melastomataceae	N
	M. pachyphylla Cogn.	Camasey racimoso	Camasey racimoso	1	Melastomataceae	N
	M. prasina (Sw.) DC.	Granadillo bobo	Granadillo bobo	26	Melastomataceae	N
	M. pycnoneura Urban	Camasey	Ridge johnnyberry	1	Melastomataceae	N
	M. serrulata (DC.) Naud.	Jau jau	Jau jau	2	Melastomataceae	N
	M. tetrandra (Sw.) D. Don	Rajador	Rajador	2	Melastomataceae	N
	Micropholis chrysophylloides Pierre	Caimitillo	Wild balata	57	Sapotaceae	N
	M. garciniifolia Pierre	Caimitillo verde	Caimitillo verde	33	Sapotaceae	N
	Morus nigra L.	Mora	Black mulberry	1	Moraceae	I
	Mouriri helleri Britt.	Mameyuelo	Mameyuelo	1	Melastomataceae	N
	Myrcia citrifolia (Aubl.) Urban	Limoncillo del monte	Red rodwood	9	Myrtaceae	N
	M. deflexa (Poir.) DC.	Cieneguillo	Cieneguillo	3	Myrtaceae	N

continued

List of all tree[a] species found in the 2004 forest inventory of the Commonwealth of Puerto Rico, with number of individuals recorded, family, and origin [whether native (N) or introduced (I) to the islands] (continued)

Survey unit	Scientific name	Puerto Rico— common name	Plants— common name	No.	Family	Origin
Puerto Rico	*M. fallax* (L.C. Rich.) DC.	Curame	Curame	2	Myrtaceae	N
	M. splendens (Sw.) DC.	Hoja menuda	Punchberry	84	Myrtaceae	N
	M. cerifera L.	Mimbre, sauce	Wax myrtle	4	Myricaceae	N
	Myrsine coriacea (Sw.) R. Br. ex Roemer & J.A. Schultes	Mantequero	Leathery colicwood	33	Myrsinaceae	N
	M. guianensis auct. non (Aubl.) Kuntze	Bádula	Guianese colicwood	2	Myrsinaceae	N
	Neea buxifolia (Hook. f.) Heimerl	Teta de burra cimarron	Saltwood	1	Nyctaginaceae	N
	Neolaugeria resinosa (Vahl) Nicols.	Aquilon	Aquilon	64	Rubiaceae	N
	Ochroma lagopus Sw.	Guano	West Indian balsa	2	Bombacaceae	N
	Ocotea coriacea (Sw.) Britt.	Laurel avispillo	Lancewood	17	Lauraceae	N
	O. floribunda (Sw.) Mez	Laurel espada	Laurel espada	9	Lauraceae	N
	O. krugii (Mez) Howard	Laurel canelón	Krug's sweetwood	1	Lauraceae	N
	O. leucoxylon (Sw.) De Laness.	Laurel geo	Loblolly sweetwood	114	Lauraceae	N
	O. sintenisii (Mez) Alain	Laurel amarillo	Laurel amarillo	12	Lauraceae	N
	O. wrightii (Meisn.) Mez	Laurel canelón	Wright's laurel canelon	1	Lauraceae	N
	Ormosia krugii Urban	Palo de matos	Peronia	21	Fabaceae	N
	Ouratea striata (v. Tiegh.) Urban	Guanabanilla	Guanabanilla	1	Ochnaceae	N
	Oxandra lanceolata (Sw.) Baill.	Haya prieta	Blacklancewood	4	Annonaceae	N
	Palicourea crocea var. crocea	Cachimbo	Red cappel	2	Rubiaceae	N
	P. crocea var. riparia	Cachimbo	Yellow-cedar	3	Rubiaceae	N
	P. domingensis (Jacq.) DC.	Taburete	Cheakyberry	1	Rubiaceae	N
	Parathesis crenulata (Vent.) Hook. f.	Rascagarganto	Scratchthroat	1	Myrsinaceae	N
	Persea americana P. Mill.	Aguacate	Avocado	17	Lauraceae	I
	P. urbaniana Mez	Aguacatillo	Aquacatillo	1	Lauraceae	N
	Petitia domingensis Jacq.	Cupá blanco	Bastard stopper	21	Verbenaceae	N
	Picramnia pentandra Sw.	Guarema	Florida bitterbush	6	Simaroubaceae	N
	Pictetia aculeata (Vahl) Urban	Tachuelo	Fustic	37	Fabaceae	N
	Pilosocereus royenii (L.) Byles & Rowley	Aceitillo	Royen's tree cactus	21	Cactaceae	N
	Pimenta dioica (L.) Merr.	Pimienta	Allspice	1	Myrtaceae	I
	P. racemosa var. racemosa	Malgueta	Bayrumtree	26	Myrtaceae	N
	Pinus caribaea var bahamensis	Pino caribeño	Caribbean pine	5	Pinaceae	I
	Piper aduncum L.	Higuillo de hoja menuda	Higuillo de hoja menuda	6	Piperaceae	N
	P. amalago L.	Higuillo de limón	Higuillo de limon	18	Piperaceae	N
	Piscidia carthagenensis Jacq.	Venture	Stinkwood	1	Fabaceae	N
	Pisonia albida (Heimerl) Britt. ex Standl.	Corcho bobo	Corcho bobo	13	Nyctaginaceae	N
	Pithecellobium arboreum (L.) Urban	Cojoba	Wild tamarind	8	Fabaceae	N
	P. dulce (Roxb.) Benth.	Guamá americano	Monkeypod	12	Fabaceae	I
	Plumeria obtusa L.	Alelí cimarrón	Singapore graveyard flower	4	Apocynaceae	N
	P. rubra L.	Frangipani	Templetree	2	Apocynaceae	I
	Podocarpus coriaceus L.C. Rich.	Caobilla	Yucca plum pine	1	Podocarpaceae	N
	Pouteria multiflora (A. DC.) Eyma	Jácana	Bullytree	11	Sapotaceae	N
	P. sapota (Jacq.) H.E. Moore & Stearn	Mamey sapote	Naseberry	2	Sapotaceae	N
	Prestoea montana (Graham) Nichols.	Palma de sierra	Sierran palm	187	Arecaceae	N
	Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	Bayahonda	Kiawe	17	Fabaceae	I
	Prunus myrtifolia (L.) Urban	Almendrito	West Indian cherry	1	Rosaceae	N
	Pseudolmedia spuria (Sw.) Griseb.	Negra lora	False breadnut	6	Moraceae	N
	Psidium guajava L.	Guayaba	Guava	23	Myrtaceae	N
	P. insulanum Alain	Vieques island guava	Vieques Island guava	1	Myrtaceae	N
	Psychotria berteriana DC.	Cachimbo com ún	Cachimbo común	20	Rubiaceae	N

continued

List of all tree[a] species found in the 2004 forest inventory of the Commonwealth of Puerto Rico, with number of individuals recorded, family, and origin [whether native (N) or introduced (I) to the islands] (continued)

Survey unit	Scientific name	Puerto Rico—common name	Plants—common name	No.	Family	Origin
Puerto Rico	*P. brachiata* Sw.	Palo de cachimbo	Palo de cachimbo	3	Rubiaceae	N
	P. maricaensis Urban	Cachimbo de maricao	Cachimbo de maricao	1	Rubiaceae	N
	Pterocarpus marsupium Roxb.	Padauk	Indian kino tree	3	Fabaceae	I
	Quararibea turbinata (Sw.) Poir.	Garrocho	Swizzlestick tree	15	Bombacaceae	N
	Randia aculeata L.	Tintillo	White indigoberry	14	Rubiaceae	N
	Rauvolfia nitida Jacq.	Palo amargo	Palo amargo	1	Apocynaceae	N
	Rhizophora mangle L.	Mangle colorado	Red mangrove	7	Rhizophoraceae	N
	Ricinus communis L.	Higü erito	Castorbean	1	Euphorbiaceae	I
	Rondeletia inermis (Spreng.) Krug & Urban	Cordobancillo	Cordobancillo	3	Rubiaceae	N
	R. pilosa Sw.	Cordobancillo peludo	Cordobancillo peludo	2	Rubiaceae	N
	Roystonea borinquena O.F. Cook	Palma real	Royal palm	36	Arecaceae	N
	Sabinea florida (Vahl) DC.	Retama	Wattapama	2	Fabaceae	N
	Samanea saman (Jacq.) Merr.	Saman	Raintree	2	Fabaceae	I
	Samyda dodecandra Jacq.	Guayabilla	Guayabilla	1	Meliaceae	N
	Sapindus saponaria L.	Jaboncillo	Wingleaf soapberry	8	Sapindaceae	N
	Sapium laurocerasus Desf.	Tabaiba	Wingleaf soapberry	15	Euphorbiaceae	N
	Savia sessiliflora (Sw.) Willd.	Amansa guapo	Milktree	10	Euphorbiaceae	N
	Schaefferia frutescens Jacq.	Jíba	Amansa guapo	1	Celastraceae	N
	Schefflera gleasonii (Britt. & Wilson) Alain	Yuquilla	Florida boxwood	1	Araliaceae	N
	S. morototonii (Aubl.) Maguire, Steyermark & Frodin	Yagrumo macho	Yuquilla	84	Araliaceae	N
	Schoepfia obovata C. Wright	Araña	Matchwood	1	Olacaceae	N
	Securinega acidoton (L.) Fawcett & Rendle	White beefwood	White beefwood	2	Euphorbiaceae	N
	Senna siamea (Lam.) Irwin & Barneby	Casia de siam	Siamese cassia	44	Fabaceae	I
	Sideroxylon cubense (Griseb.) T.D. Pennington	Espejuelo	Espejuelo	3	Sapotaceae	N
	S. foetidissimum Jacq.	Tortugo amarillo	False mastic	5	Sapotaceae	N
	S. obovatum Lam.	Alquitrán	Breakbill	1	Sapotaceae	N
	S. portoricense Urban	Tabloncillo	Puerto Rico bully	1	Sapotaceae	N
	S. salicifolium (L.) Lam.	Almendrón, sabina	White bully	6	Sapotaceae	N
	Sloanea berteriana Choisy ex DC.	Motillo	Bullwood	14	Elaeocarpaceae	N
	Solanum erianthum D. Don	Berenjena de paloma	Potatotree	1	Solanaceae	N
	S. rugosum Dunal	Tabacón	Tabacon aspero	7	Solanaceae	N
	Spathodea campanulata Beauv.	Tulipán africano	African tuliptree	1,024	Bignoniaceae	I
	Spondias mombin L.	Jobo	Yellow mombin	10	Anacardiaceae	N
	S. purpurea L.	Ciruela de país	Purple mombin	1	Anacardiaceae	I
	Sterculia apetala (Jacq.) Karst.	Anacaguita	Panama tree	2	Sterculiaceae	I
	Swietenia macrophylla King	Caoba hondureña	Honduras mahogany	4	Meliaceae	I
	S. mahagoni (L.) Jacq.	Caoba dominicana	West Indian mahogany	17	Meliaceae	I
	Symplocos martinicensis Jacq.	Aceituna blanca	Martinique sweetleaf	10	Symplocaceae	N
	Syzygium jambos (L.) Alston	Pomarrosa	Malabar plum	262	Myrtaceae	I
	Tabebuia haemantha (Bertol. ex Spreng.) DC.	Roble cimarrón	Roble cimarron	38	Bignoniaceae	N
	T. heterophylla (DC.) Britt.	Roble blanco	White cedar	233	Bignoniaceae	N
	Tabernaemontana citrifolia L.	Palo lechoso	Milkwood	1	Apocynaceae	N
	Tamarindus indica L.	Tamarindo	Tamarind	4	Fabaceae	I
	Tecoma stans (L.) Juss. ex Kunth	Roble amarillo	Yellow trumpetbush	1	Bignoniaceae	N
	Terminalia catappa L.	Almendra	Troipical almond	13	Combretaceae	I
	Tetragastris balsamifera (Sw.) Oken	Masa	Masa	2	Burseraceae	N
	Tetrazygia elaeagnoides (Sw.) DC.	Verdiseco	Krekre	44	Melastomataceae	N
	T. urbanii Cogn.	Cenizo	Cenizo	1	Melastomataceae	N
	Thespesia grandiflora DC.	Maga	Maga	13	Malvaceae	N

continued

List of all tree[a] species found in the 2004 forest inventory of the Commonwealth of Puerto Rico, with number of individuals recorded, family, and origin [whether native (N) or introduced (I) to the islands] (continued)

Survey unit	Scientific name	Puerto Rico—common name	Plants—common name	No.	Family	Origin
Puerto Rico	*T. populnea* (L.) Soland. ex Correa	Emajaguilla	Portia tree	1	Malvaceae	I
	Thouinia striata Radlk.	Ceboruquillo	Ceboruquillo	89	Sapindaceae	N
	T. striata var. portoricensis	Serrasuela	Serrasuela	9	Sapindaceae	
	Trema lamarckianum (J.A. Schultes) Blume	Palo de cabrilla	Lamarck's trema	2	Ulmaceae	N
	T. micranthum (L.) Blume	Guacimilla	Jamaican nettletree	3	Ulmaceae	N
	Trichilia hirta L.	Tinacio	Broomstick	5	Meliaceae	N
	T. pallida Sw.	Gaeta	Gaita	49	Meliaceae	N
	Triplaris cumingiana Fisch. & C.A. Mey ex C.A. Mey	Triplaria	Long John	1	Polygonaceae	I
	Turpinia occidentalis (Sw.) G. Don	Sauco cimarrón	Muttonwood	7	Staphyleaceae	N
	Urera baccifera (L.) Gaud.	Ortiga brava	Scratchbush	14	Urticaceae	N
	U. caracasana (Jacq.) Gaud. ex Griseb.	Ortiga colorada	Flameberry	2	Urticaceae	N
	Vitex divaricata Sw.	Higuerillo	Higuerillo	4	Verbenaceae	N
	Xylosma pachyphylla (Krug & Urban) Urban	Spiny logwood	Spiny logwood	3	Flacourtiaceae	N
	X. schwaneckeana (Krug & Urban) Urban	Palo de candela	Schwaneck's logwood	3	Flacourtiaceae	N
	Zanthoxylum martinicense (Lam.) DC.	Espino rubial	White pricklyash	77	Rutaceae	N
	Z. monophyllum (Lam.) P. Wilson	Palo rubio	Yellow prickle	11	Rutaceae	N
Vieques	*Acacia farnesiana* (L.) Willd.	Aroma	Sweet acacia	30	Fabaceae	I
	A. macracantha Humb. & Bonpl. ex Willd.	Tamarindo silvestre	Porknut	29	Fabaceae	I
	Adelia ricinella L.	Cotorro	Wild lime	4	Euphorbiaceae	N
	Albizia lebbeck (L.) Benth.	Albizia	Woman's tongue	1	Fabaceae	I
	Andira inermis (W. Wright) Kunth ex DC.	Moca	Cabbagebark tree	9	Fabaceae	N
	Bourreria succulenta Jacq.	Palo de vaca	Bodywood	2	Boraginaceae	N
	Bucida buceras L.	Úcar	Gregorywood	16	Combretaceae	N
	Bursera simaruba (L.) Sarg.	Almacigo	Gumbo limbo	43	Burseraceae	N
	Capparis baducca L.	Sapo	Caper	9	Capparaceae	N
	Casearia decandra Jacq.	Tostado	Wild honeytree	2	Flacourtiaceae	N
	C. guianensis (Aubl.) Urban	Palo blanco	Guyanese wild coffee	18	Flacourtiaceae	N
	C. sylvestris Sw.	Cafeíllo	Crackopen	2	Flacourtiaceae	N
	Chrysophyllum pauciflorum Lam.	Caimitillo de perro	Camito de perro	2	Sapotaceae	N
	Citharexylum fruticosum L. var. fruticosum	Péndula	Florida fiddlewood	17	Verbenaceae	N
	Coccothrinax alta (O.F. Cook) Becc.	Palma de abanico	Puerto Rico silver palm	1	Arecaceae	N
	Comocladia dodonaea (L.) Urban	Poison ash	Poison ash	1	Anacardiaceae	N
	Cordia alliodora (Ruiz & Pavón) Oken	Capá prieto	Spanish elm	8	Boraginaceae	N
	C. laevigata Lam.	Capá colorado, cerezo del país	Smooth manjack	2	Boraginaceae	N
	Croton astroites Ait.	Wild marrow	Wild marrow	6	Euphorbiaceae	N
	Delonix regia (Bojer ex Hook.) Raf.	Flamboyán	Royal poinciana	2	Fabaceae	I
	Eugenia axillaris (Sw.) Willd.	Grajo	White stopper	3	Myrtaceae	N
	E. biflora (L.) DC.	Pitanguera	Blackrodwood	1	Myrtaceae	N
	E. monticola (Sw.) DC. var. latifolia Krug & Urban	Birijí	Birdcherry	14	Myrtaceae	N
	E. rhombea Krug & Urban	Hoja menuda	Red stopper	6	Myrtaceae	N
	E. stahlii (Kiaersk.) Krug & Urban	Guayabota	Stahl's stopper	2	Myrtaceae	N
	Ficus citrifolia P. Mill.	Jaguey blanco	Wild banyantree	3	Moraceae	N
	Guapira fragrans (Dum.-Cours.) Little	Corcho	Black mampoo	29	Nyctaginaceae	N
	Guazuma ulmifolia Lam.	Guácima	Bastardcedar	1	Sterculiaceae	N
	Guettarda elliptica Sw.	Cucubano liso	Hammock velvetseed	1	Rubiaceae	N
	Homalium racemosum Jacq.	Caracolillo	White cogwood	1	Flacourtiaceae	N
	Inga laurina (Sw.) Willd.	Guamá	Sacky sac bean	1	Fabaceae	N

continued

List of all tree[a] species found in the 2004 forest inventory of the Commonwealth of Puerto Rico, with number of individuals recorded, family, and origin [whether native (N) or introduced (I) to the islands] (continued)

Survey unit	Scientific name	Puerto Rico—common name	Plants—common name	No.	Family	Origin
Vieques	*Krugiodendron ferreum* (Vahl) Urban	Bariacao	Leadwood	1	Rhamnaceae	N
	Leucaena leucocephala (Lam.) de Wit	Zarcilla	White leadtree	97	Fabaceae	N
	Mangifera indica L.	Mango	Mango	2	Anacardiaceae	I
	Melicoccus bijugatus Jacq.	Quenepa	Spanish lime	1	Sapindaceae	I
	Piscidia carthagenensis Jacq.	Venture	Stinkwood	1	Fabaceae	N
	Pithecellobium unguis-cati (L.) Benth.	Uña de gato, rollón	Catclaw blackbead	1	Fabaceae	N
	Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	Bayahonda	Kiawe	64	Fabaceae	I
	Randia aculeata L. var. mitis (L.) Griseb.	Tachuelo	White indigoberry	11	Rubiaceae	N
	Samanea saman (Jacq.) Merr.	Saman	Raintree	7	Fabaceae	I
	Savia sessiliflora (Sw.) Willd.	Amansa guapo	Amansa guapo	7	Euphorbiaceae	N
	Terminalia catappa L.	Almendra	Tropical almond	7	Combretaceae	I
	Tetrazygia elaeagnoides (Sw.) DC.	Verdiseco	Krekre	1	Melastomataceae	N
	Trema micranthum (L.) Blume	Guacimilla	Jamaican nettletree	2	Ulmaceae	N
	Trichilia hirta L.	Tinacio	Broomstick	12	Meliaceae	N
	Zanthoxylum martinicense (Lam.) DC.	Espino rubial	White pricklyash	4	Rutaceae	N
	Z. monophyllum (Lam.) P. Wilson	Palo rubio	Yellow prickle	23	Rutaceae	N
	Ziziphus mauritiana Lam.	Aprín	Indian jujube	36	Rhamnaceae	I

[a] A tree is defined by FIA as a woody plant having one erect perennial stem or trunk at least 7.6 cm d.b.h., a more or less definitely formed crown of foliage, and a height of at least 4 m (at maturity). This species list includes all trees, saplings, and seedlings found.

Brandeis, Thomas J.; Helmer, Eileen H.; Oswalt, Sonja N. 2007. The status of Puerto Rico's forests, 2003. Resour. Bull. SRS–119. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 72 p.

Puerto Rico's forest cover continues to increase and is now 57 percent for mainland Puerto Rico, 85 percent for Vieques, and 88 percent for Culebra. Subtropical dry forest occupies 50 346 ha, 6832 ha, 2591 ha, and 6217 ha on the islands of Puerto Rico, Vieques, Culebra, and Mona, respectively. Subtropical moist forest, the most prevalent forested life zone on mainland Puerto Rico, had 49 percent forest cover or 258 861 ha of forest. Subtropical wet and rain forest occupies 161 503 ha, lower montane wet and rain forest occupies 11 723 ha at the highest elevations, and mangrove forest occupies 7920 ha in coastal areas. Puerto Rico's forests were found to have over 1,602,378,689 trees over 2.5 cm in diameter and 10 607 847 m^2 of basal area, and to hold 36.6 million Mg of sequestered carbon. There were 3,112 trees, 19.2 m^2 of basal area, 68.25 m^3 of merchantable stem volume, and 80 Mg of aboveground biomass in an average hectare of forest. The subtropical moist and wet and rain secondary forests inventoried in 1990 are still young and increasing in average basal area, which rose from 13.2 m^2/ha in 1980, to 15.2 m^2/ha in 1990, to the current level of 20.9 m^2/ha.

The most important tree species were the African tuliptree [*Spathodea campanulata*] Beauv., American muskwood [*Guarea guidonia*] (L.) Sleumer, cabbagebark tree [*Andira inermis*] (W. Wright) Kunth ex DC., and pumpwood [*Cecropia schreberiana*] Miq. Few unhealthy, stressed trees were noted and widespread pest and disease problems were not observed. Only 12.9 percent of live trees had some type of damage or disease. Average per-hectare amounts of down woody material, forest floor duff, and forest floor litter generally increased as the forest environment became more humid. Small-to-medium forest fire fuels were most common in subtropical dry forests, while medium-to-large fuels were most common in more humid forest life zones.

Keywords: Caribbean, FIA, forest inventory, Puerto Rico, tropical forest, secondary forest.

September 2007

Southern Research Station
200 W.T. Weaver Blvd.
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Puerto Rico Commonwealth Facts

Puerto Rico: The Isle of Enchantment; Founded in 1508 by Juan Ponce de León

Capital City: San Juan

Location: Latitude 18.15 N; Longitude 66.30 W

Population: 3,944,259

Geology: Mostly mountains with coastal plain belt in north; mountains precipitous to sea on west coast; sandy beaches along coast in most areas

Highest Point: Cerro Punta, 1,338 m (4,389 feet)

Largest City: San Juan (U.S. Bureau of the Census est. 1997 population: 436,334)

Lowest Point: Sea level, Caribbean Sea 0 m

Borders: Puerto Rico is under the U.S. customs jurisdiction. Borders are open between Puerto Rico and the United States, allowing for free movement of people and merchandise.

Coastline: 501 km (311 miles)

Maritime Claims:
- Continental shelf: 200 nautical miles (depth)
- Exclusive economic zone: 200 nautical miles
- Territorial sea: 12 nautical miles

Constitution: Ratified March 3, 1952, approved by U.S. Congress July 3, 1952, effective July 25, 1952 (territory of the U.S. with commonwealth status)

Bird: Stripe-headed tanager (Reina mora) (*Spyndalis zena*)

Industry: Includes pharmaceuticals, electronics, apparel, food products, and tourism.

Agriculture: Includes sugarcane, coffee, pineapples, plantains, bananas, livestock products, and chickens. In addition, tropical woods and hardwoods supply a very small furniture industry on the island. From an environmentalist standpoint, deforestation rates are almost nonexistent. Game fishing exists in the coastal regions, but most of the island's fish come from the U.S. fishing industry in waters closer to Africa. These U.S. fleets bring their catch to Puerto Rico to be processed and exported.

Natural Resources: Some stone, fish, copper, and nickel; potential for onshore and offshore oil

Flag: Five equal horizontal bands of red (top and bottom) alternating with white; a blue isosceles triangle based on the hoist side bears a large white five-pointed star in the center; the design of the Puerto Rican flag was not based on the United States flag, but rather on the Cuban flag. It was designed in the 1890's by the Puerto Rican Section of the Cuban Revolutionary Party in solidarity with their cause. The colors were inverted to preserve national identity.

Tree: Silk-cotton tree (*Ceiba pentandra*)

Song: The Borinquen Anthem (La Borinqueña)

Flower: Puerto Rican hibiscus (flor de maga) (*Montezuma speciosissima*)

Mascot: The tiny coquí frog is the mascot of Puerto Rico. The name comes from its "ko-kee" call.

Motto: "John is his name" (Juan es su nombre {sp}) (Iohannes est nomen eius)

Information courtesy of The World Factbook, www.cia.gov/library/publications/the-world-factbook

The Status of Puerto Rico's Forests, 2003

September 2007