

Puerto Rico Forests 2019

This resource update provides an overview of the status of forest resources in the Archipelago of Puerto Rico (Mainland, Culebra, and Vieques) based on the sixth forest inventory funded and conducted by the U.S. Department of Agriculture Forest Service, Forest Inventory and Analysis (FIA) program of the Southern Research Station and the International Institute of Tropical Forestry. Data estimates are based on field data collected using the FIA annualized sample design for the measurement years 2016–2019 with comparisons made to data collected in 2011–2014, 2006–2009 and 2001–2004. The sample plot population presented here for Puerto Rico consists of 526 plots, collected across a period of 4 years (about 132 plots, or about 25 percent of the data per year). The data used in this publication were accessed from the FIA Database at <https://apps.fs.usda.gov/fiadb-api/evaluator> on March 2023. Timberland statistics in table 1 refer to forest land that is capable of producing crops of industrial wood and excludes

reserved forest lands. For the methods used for forest area estimation and field data collection see Brandeis and others (2007) and Brandeis and Turner (2013).

OVERVIEW

It is estimated that forest cover on Puerto Rico (PR) decreased by 64.4 thousand acres (5.3 percent) between 2014 and 2019 (table 1). In parallel, the number of live trees with diameter at breast height (d.b.h.) ≥ 1.0 inch on forest land decreased by around 113.4 million trees (8 percent) during the same period. On the other hand, net volume and aboveground biomass of live trees with d.b.h. ≥ 5.0 inches remained steady because their respective changes of 2.9 percent and 2.6 percent were encompassed within the estimated sampling errors (table 1).

Average annual net growth of trees in forest land decreased to 19.9 million cubic feet per year, and average annual removals and average annual

Table 1—Puerto Rico forest statistics and change between 2014 and 2019.

Forest statistics	2014 Estimate	2014 Sampling error percent	2019 Estimate	2019 Sampling error percent	Change 2014 to 2019
<i>Area (thousand acres)</i>	1,206.3	3.34	1,141.9	3.55	-64.4
<i>Number of live trees >1 inch d.b.h. (million trees)</i>	1,421.5	5.62	1,308.1	6.61	-113.4
<i>Net volume live trees >5 inches d.b.h. (million cubic feet)</i>	1,390.3	6.95	1,349.5	7.34	-40.8
Forest land¹					
<i>Live trees aboveground biomass (thousand oven-dry tons)</i>	42,339.1	5.78	41,258.7	6.42	-1,080.4
<i>Net growth live trees >5 inches d.b.h. (million cubic feet per year)</i>	43.2	15.80	19.9	31.25	-23.3
<i>Annual removals of live trees >5 inches d.b.h. (million cubic feet per year)</i>	4.5	58.40	10.8	28.42	6.3
<i>Annual mortality of live trees >5 inches d.b.h. (million cubic feet per year)</i>	32.7	18.61	39.3	14.63	6.6
<i>Area (thousand acres)</i>	881.8	5.0	752.6	5.90	-129.2
<i>Number of live trees >1 inch d.b.h. (million trees)</i>	961.1	7.1	696.0	8.14	-265.1
<i>Net volume live trees >5 inches d.b.h. (million cubic feet)</i>	1,128.0	8.0	1,127.8	8.72	-0.2
Timberland²					
<i>Live trees aboveground biomass (thousand oven-dry tons)</i>	33,593.4	7.1	32,894.7	8.29	-698.7
<i>Net growth live trees >5 inches d.b.h. (million cubic feet per year)</i>	33.6	19.1	15.6	39.36	-18.0
<i>Annual removals of live trees >5 inches d.b.h. (million cubic feet per year)</i>	1.8	74.9	2.7	31.25	0.9
<i>Annual mortality of live trees >5 inches d.b.h. (million cubic feet per year)</i>	29.0	20.5	36.1	15.85	7.1

d.b.h. = diameter at breast height

¹ Forest land is land at least 1 acre in size where trees of any size provide at least 10 percent canopy coverage.

² Timberland is forest land capable of producing at least 20 cubic feet of industrial wood per acre per year.

mortality increased to 10.8 million cubic feet and 39.3 million cubic feet, respectively (table 1). These estimates reveal a negative growth-to-mortality and removals ratio, with a net total loss of 151 million cubic feet of volume over the entire 5-year period that FIA data is regularly analyzed.

FOREST AREA

During 1980 to 2004, mainland PR experienced a high rate of forest area increase from a total cover of 31.3 percent to 52.8 percent. Then the island transitioned to a phase of forest cover steadiness from 2004 to 2019, where the area of natural forest regeneration paralleled that of deforestation activities (Marcano-Vega 2019). But according to estimates of the last forest inventory, the total forested land for mainland PR has decreased from 1,172,439 acres in 2004 to 1,108,002 acres in 2019 (fig. 1). This indicates that the percent forest cover on mainland PR slightly fell from 54.8 to 51.8 percent during that period (fig. 2).

On the island of Culebra, total forest cover was estimated at 94.6 percent in 2004, 90.2 percent in

2009, 91.1 percent in 2014, and 86.6 percent in 2019, and on the island of Vieques it was estimated at 77.1 percent in 2004, 74.4 percent in 2009, 79.1 percent in 2014, and 80.5 percent in 2019 (fig. 2). Although these fluctuations would seem to illustrate a pattern of slight decrease in Culebra and a slight increase in Vieques, it is more appropriate to state that total forest cover on both islands has remained relatively stable since 2004, because the differences in forest cover were encompassed within sampling errors.

The forests of the archipelago of PR are typically described using the Holdridge life zone classification system (fig. 3). Nevertheless, mangroves have been considered as a separate forest type for reporting FIA data because they occur in more than one life zone.

The dynamics observed in forest area by forest-type group exemplify the small changes that suggest the slight reduction in total forest cover experienced in the Archipelago of PR from 2004 to 2019 (fig. 4).

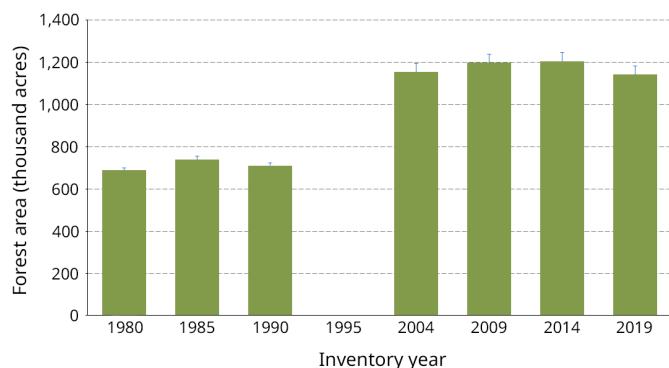


Figure 1—Forest area with sampling errors for mainland Puerto Rico, 1980–2019.

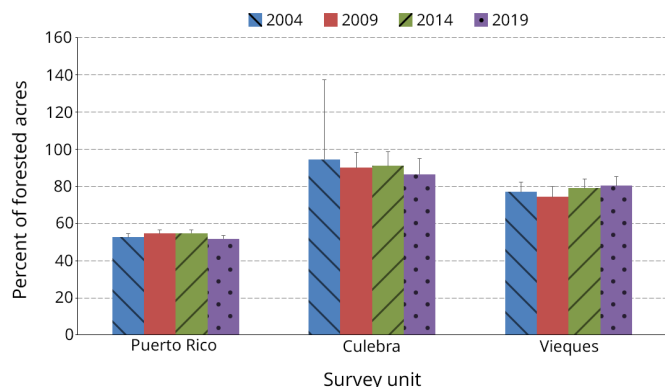


Figure 2—Percent of forested acres with sampling errors by survey unit, Puerto Rico, 2004–2019.

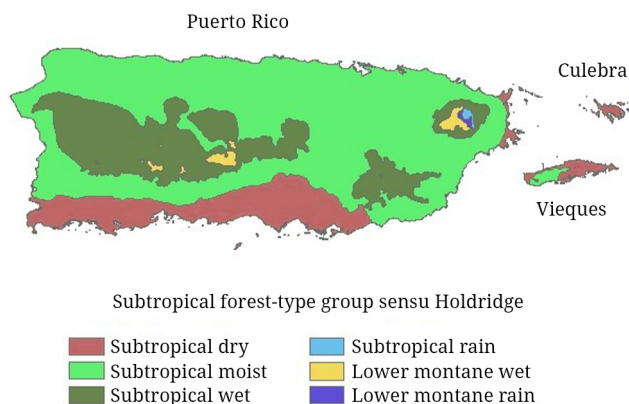


Figure 3—Forest survey units by forest-type group in Puerto Rico.

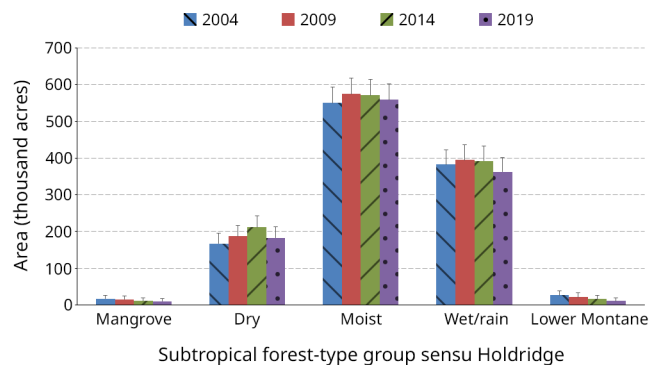


Figure 4—Forest area with sampling errors by forest-type group sensu Holdridge, including mangrove as a separate group, Puerto Rico, 2004–2019.

VOLUME, BIOMASS, AND TRENDS

Values of net volume (i.e., gross volume minus deductions for rotten, missing and broken-top cull) by forest-type group in 2019 show 5.8 million cubic feet of wood in mangrove forest, 78.5 million in dry forest, 635.9 million in moist forest, 608.8 million in wet/rain forest, and 20.3 million in lower montane forest (fig. 5). Values of aboveground biomass in 2019 show 0.2 million tons stored in mangrove forest, 3.1 million tons in dry forest, 20.1 million tons in moist forest, 17.3 million tons in wet/rain forest, and 0.6 million tons in lower montane forest (fig. 6). The patterns of total net volume and aboveground biomass in live trees suggest a general trend of increase within the dominant forest types of PR between the years 2004 and 2019 (figs. 5, 6). The dry, moist and wet/rain forest types cover around 98 percent of the study area, reflecting the prevailing dynamics of natural forest regeneration in the landscape of PR since 2004.

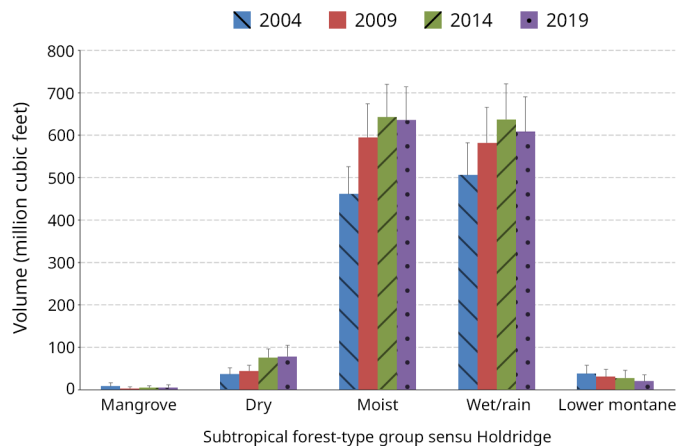


Figure 5—Net volume of live stems ≥5 inches d.b.h., with sampling errors, on forest land by forest-type group sensu Holdridge, including mangrove as a separate group, Puerto Rico, 2004–2019.

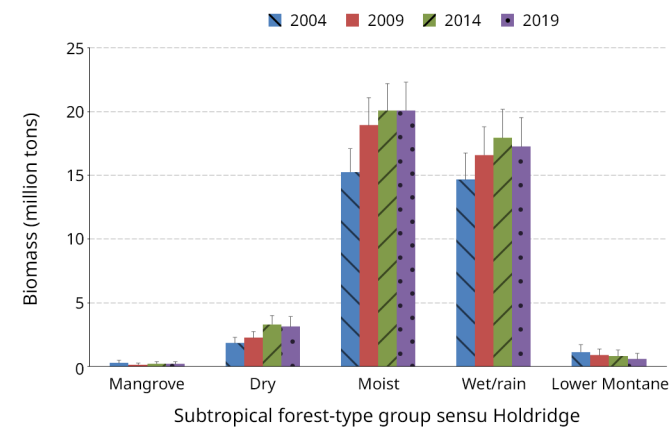


Figure 6—Aboveground biomass of live stems ≥1 inch d.b.h., with sampling errors, by forest-type group sensu Holdridge, including mangrove as a separate group, Puerto Rico, 2004–2019.

Table 2—Number of stems and aboveground biomass of live trees ≥1.0 inch d.b.h. of the top 10 species for biomass on forest land, Puerto Rico, 2019

Scientific name	Number of stems	Aboveground biomass
	million trees	thousand tons
<i>Spathodea campanulata</i> [†]	61.3	7,402.1
<i>Guarea guidonia</i>	87.1	3,953.1
<i>Cecropia schreberiana</i>	10.7	2,345.7
<i>Mangifera indica</i> [†]	3.7	1,832.2
<i>Tabebuia heterophylla</i>	51.0	1,230.5
<i>Inga vera</i>	10.3	1,032.4
<i>Andira inermis</i>	20.1	1,010.1
<i>Eucalyptus robusta</i> [†]	1.4	889.0
<i>Schefflera morototoni</i>	4.2	708.3
<i>Bursera simaruba</i>	10.7	705.3

d.b.h. = diameter at breast height

[†] introduced species

A total of 289 species of trees (d.d.h ≥ 1.0 inch) were recorded on the plots sampled between 2016 and 2019. Like previously found (Marcano-Vega 2019), native and introduced tree species cohabit in the forests of PR. The native *Guarea guidonia* stands out as the species with the highest number of trees, showing a reduction of 7.1 million stems between 2014 and 2019 in contrast to the introduced *Spathodea campanulata*, which showed a reduction of 28.7 million stems during the same period. *S. campanulata*, *G. guidonia*, and *Cecropia schreberiana* account for the highest biomass storage (table 2), representing 17.9, 9.6, and 5.7 percent of the total aboveground biomass, respectively.

Mean annual mortality represented 66 percent of the changes in tree volume per area of forested land between 2014 and 2019, while mean growth

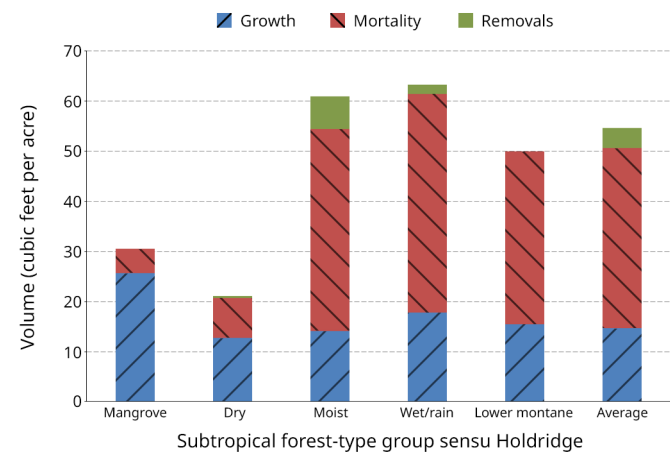


Figure 7—Annual growth, mortality, and removals of live stems ≥5 inches d.b.h by forested-type group, Puerto Rico, 2016–2019.

and removals represented 27 and 7 percent of the changes, respectively (fig. 7). Chiefly, mortality drove most of the changes in volume and biomass, and part of this mortality was tightly linked to the effects of Hurricane María.

EFFECTS OF HURRICANES IRMA AND MARÍA

In September 2017, Hurricanes Irma and María made landfall in PR. One of the major effects of these events was the loss of tree tops. While 9 percent of the saplings (d.b.h. 1–4.9 inches) displayed a broken top, a contrasting 31 percent of larger trees, which are more exposed to winds due to their greater height, displayed a broken top. Figure 8 shows the frequency of forest health indicators, highlighting the increase in broken tops after the storms. A mean of 42.8 percent of total prehurricane stem length was lost from the trees found with a broken top. Posthurricane data suggests a gradient effect according to prehurricane stand structure, forest type, and elevation. While the mortality accounted for 3.9 percent of trees in the dry forest, which is characterized by the dominance of seedling and sapling-size stems at low elevation, mortality in the moist forest was 11.9 percent and 15.5 percent in the wet/rain forest, which are characterized by larger trees at higher elevations (fig. 9). Overall, the mean tree mortality was 10.4 percent in these forest types, but in mangroves a higher mean mortality (22 percent) was reported by Branoff

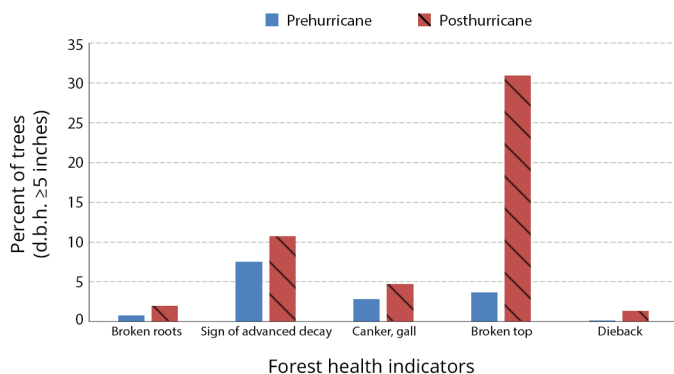


Figure 8—Frequency of prehurricane and posthurricane forest health indicators on trees with d.b.h. ≥ 5 inches, Puerto Rico.

(2019). As a result of the large amounts of down wood biomass from the 2017 hurricane season, an overall increase in the density of carbon from woody debris was found in the forests of PR in 2018 (fig. 10).

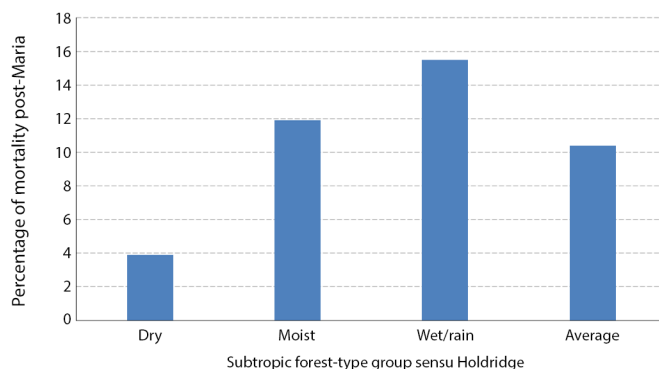


Figure 9—Frequency of posthurricane María (October 2017–2019) mortality by forest-type group sensu Holdridge on trees with d.b.h. ≥ 1 inch, Puerto Rico.

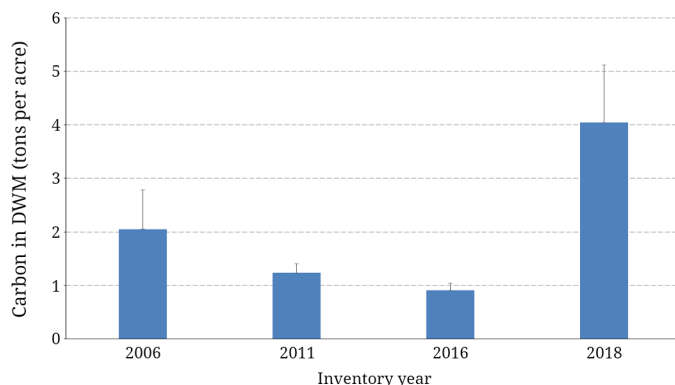


Figure 10—Mean carbon in down woody materials (DWM) by inventory year, Puerto Rico.

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CONTACT INFORMATION

Humfredo Marcano-Vega, Research Biologist
Forest Inventory and Analysis
Southern Research Station, USDA Forest Service
Jardín Botánico Sur, 1201 Calle Ceiba
San Juan, PR 00926
Phone: 787-766-5335
Email: humfredo.marcano@usda.gov

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