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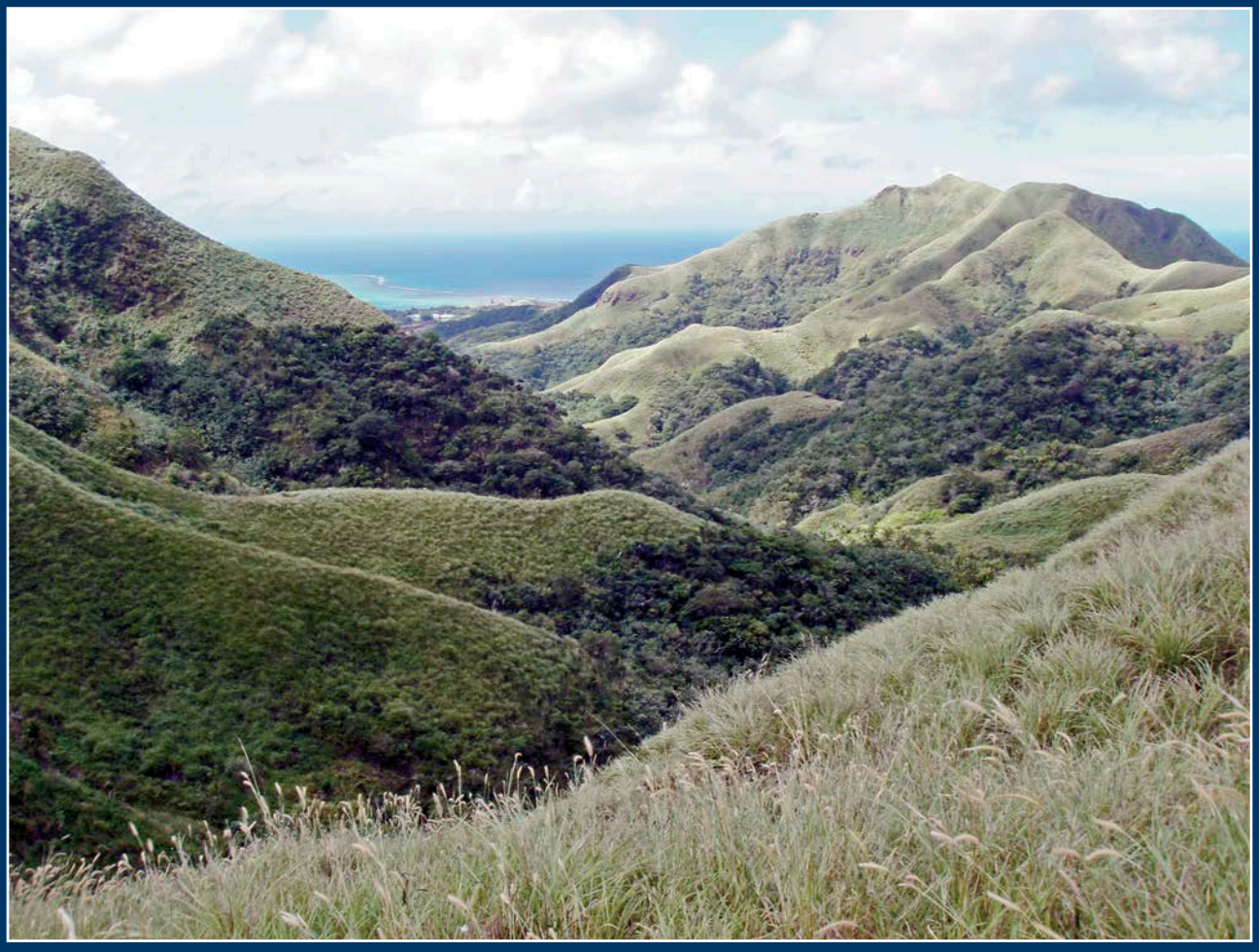
Guam's Forest Resources: Forest Inventory and Analysis, 2013

Michelle Lazaro, Olaf Kuegler, Sharon Stanton, Ashley Lehman, Joseph Mafnas, and Mikhail Yatskov



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Cover: Forest and savannah mosaic on volcanic soils, southern Guam. Photo by Seth Ayotte.

Abstract

Lazaro, Michelle; Kuegler, Olaf; Stanton, Sharon; Lehman, Ashley; Mafnas, Joseph; Yatskov, Mikhail. 2020. Guam's forest resources: Forest Inventory and Analysis, 2013. Resour. Bull. PNW-RB-270. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 43 p.

This report highlights key findings from 2013 data collected by the U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis program across all forested land on Guam, updating findings from data collected in 2002 that were published in Resource Bulletin PNW-RB-243. We summarize and interpret basic resource information such as estimates of forest area, stem volume, biomass, number of trees, damages to trees, and tree size distribution, as well as overstory and understory vegetation cover and information on invasive plant species presence and cover. Detailed tables and graphical highlights are included to help inform resource managers and policymakers, as well as to educate the public regarding the status and trends of their local natural resources. The appendixes provide details on inventory methods and design and include summary tables of data, with statistical errors, for the wide variety of forest characteristics inventoried.

Keywords: Guam, biomass, carbon, damage, forest land, inventory, vegetation, invasive plants.

Highlights

- Tallest measured tree: *Vitex parviflora,* 66 ft in height
- Estimated total forest area: 69,900 ac (table 1, p. 5)
- Estimated total number of live trees (≥1 inch diameter at breast height): 73.1 million (table A2-1, p. 30)
- Total number of tree species recorded: 55 species ("Scientific and Common Names of Plants Found During Inventory", p. 18)
- Estimated total net live tree volume: 52.0 million ft^3 (table A2-5, p. 35)
- Estimated total live tree aboveground biomass: 2.267 million dry tons (table A2-6, p. 36)
- Estimated total live tree aboveground carbon: 1.134 million dry tons (table A2-6, p. 36)

Contents

Guide to Forest Inventory and Analysis

Overview of the Purpose of This Report

This report presents a summary of Guam's forest resources from the most recent data collected by the U.S. Department of Agriculture (USDA) Forest Service Forest Inventory and Analysis (FIA) program in 2013 across all ownerships and forest types. It updates previously published findings from data collected in 2002 (Donnegan et al. 2004). We summarize and interpret basic resource information, including forest area, ownership, land use change, biomass, biodiversity, standing dead wood, and forest health indicators. The Pacific Northwest Research Station Forest Inventory and Analysis (PNW-FIA) program implemented a sampling strategy on Guam that measures forest and nonforest vegetated plots, within a single year, on an intended 10-year cycle. PNW-FIA partners with Guam's researchers and forest managers to use the inventory data to help answer local and national questions about the status and trends in tropical forests. These data update those published in the earlier report; however, not all the values presented here can be directly compared to previous reports or datasets to assess change in Guam's forest resources over the past decade. Consistent sampling and field protocols standardized across different ownerships and forest management regimes allow for comparisons of change over time only for certain attributes. This report covers all forested and vegetated nonforest lands on Guam, with estimates representing averaged values computed from all inventory plots visited by field crews in 2013.

Description of the Forest Inventory and Analysis Program

The FIA program was established in 1928 to conduct unbiased assessments of the nation's forested lands for use in economic and forest management planning. The program was charged with collecting forest data on a series of permanent field plots, compiling and making these data publicly available, and providing research and interpretations from the data. Four FIA units are responsible for inventories of all forested lands in the United States, including the insular areas and territories of Puerto Rico, Guam, American Samoa, Commonwealth of the Northern Mariana Islands, U.S. Virgin Islands, and freely associated Pacific Island nations of the Federated States of Micronesia, Republic of the Marshall Islands, and Republic of Palau. Historically, each of the four regional FIA units responsible for forest inventories in the United States implemented inventory methods to best fit its respective regional forest conditions and client needs, resulting in inconsistent national reporting (USDA FS 2006). After passage of the 1998 Farm Bill, the FIA program implemented an annualized inventory that was designed to be nationally consistent as well as spatially and temporally unbiased with respect

to forest types and land ownership groups (Bechtold and Patterson 2005). All FIA units use a common plot design, common set of measurement protocols, and standard database design for compilation and distribution of data. Under this unified approach, FIA is able to provide unbiased estimates of a wide variety of forest conditions over all forested lands in the United States in a consistent and timely manner.

The national design was adapted for the Guam inventory to include additional branching and rooting forms and additional tree crown measurements, as well as special interest species ranging from invasive plants to pathogens to invasive insects and animals. With significant project support from the Government of Guam's Forestry Division and the University of Guam, 48 plots were spaced uniformly at 1.9-mi intervals using a hexagonal grid, resulting in a threefold intensification of the spacing used in the mainland U.S. inventory plot grid. Forest inventory plots included four 24-ft fixed-radius subplots, where a variety of information was collected at the plot, subplot, and tree levels (USDA FS 2012). Primary variables collected include plot location, slope, aspect, elevation, subplot slope position and slope shape, tree species, diameters, heights, damages, branching and rooting forms, decay, and epiphytic loadings. Additional information about annual inventories is available in appendix 1 of this report and at http://fia.fs.fed.us/.

Common FIA Terminology

What is a tree?—

The U.S. Forest Service defines a tree as a woody perennial plant, usually with a single well-defined stem carrying a crown, with a minimum height of 15 ft at maturity (USDA FS 2006).

What is a forest? —

Forests come in many shapes and sizes, varying from complex and species diverse to monoculture plantations. The FIA program defines forest land as an area currently or formerly (within 30 years) having at least 10 percent crown cover by trees of any size and not currently developed for nonforest use (USDA FS 2006). Forest land must be at least 1 ac in size with a minimum continuous width of 120 ft.

Forest Resources on Guam

The island of Guam (fig. 1) is the largest and farthest south in the north-sweeping Marianas archipelago (fig. 2). The highest point on the island is Mount Lamlam at 1,332 ft elevation. Guam is an unincorporated territory of the United States and has the highest human population of any island in Micronesia. The climate is tropical marine with little annual variation in temperature, but with a pronounced dry season from January to May (Manner 1993) (fig. 3).

Forest Area

About half of Guam is forested (53 percent) (fig. 4). The island's total land area is about 132,230 ac, with 69,851 forested ac (table 1). A significant area of land is occupied by the U.S. military; on a portion of this area, a system of refuges and wildlife reserves has been designated. For example, Ritidian Point, about 22,500 ac in size at the northern tip of Guam, is administered by the U.S. Fish and Wildlife Service as a national wildlife refuge. The northern half of the island is generally a flat limestone plateau that can be strongly weathered into rugged karst topography. The limestone soils in the north are covered with forest in areas that are not cultivated or urbanized. The southern side of the island features a terrain composed of deeply weathered volcanic soils primarily covered by grassland, with some ravine forest in sheltered and leeward sites.

Ashley Lehman

Figure 1—Merizo, Guam, near ferry terminal to Cocos Island. .

Figure 2—Guam is an unincorporated territory of the United States in the North Pacific Ocean, about 1,600 mi east of Manila, Philippines, and 3,500 mi north of Melbourne, Australia.

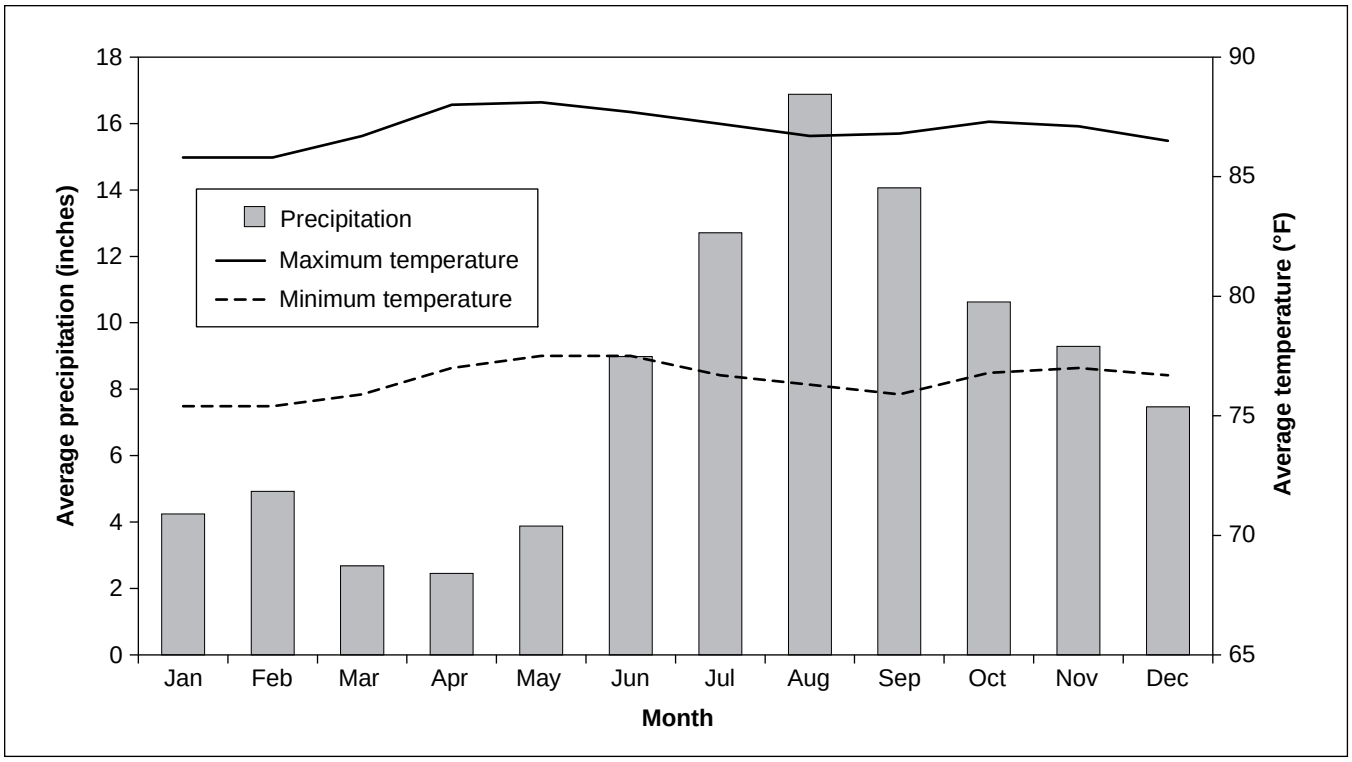

Figure 3—Average maximum and minimum temperatures, and total monthly precipitation for Guam. Note the pronounced seasonality in precipitation (Western Regional Climate Center, https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?pi4226).

Table 1—Estimated land area by status, 2013

Land status	Total
	Acres
Accessible forest land:	
Unreserved forest land	49,190
Reserved forest land (Bird Island Wildlife Conservation Area and Guam National Wildlife Refuge)	20,661
All accessible forest land	69,851
Nonforest and other areas:	
Nonforest urban	36,659
Nonforest vegetation	25,720
Barren lands	—
Water	—
All nonforest and other	62,379
Total area	132,230

QuickBird satellite imagery from Digital Globe, Inc. (Longmont, Colorado) was used to develop the vegetation mapping layers (Liu 2014). Note: the use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

— = none.

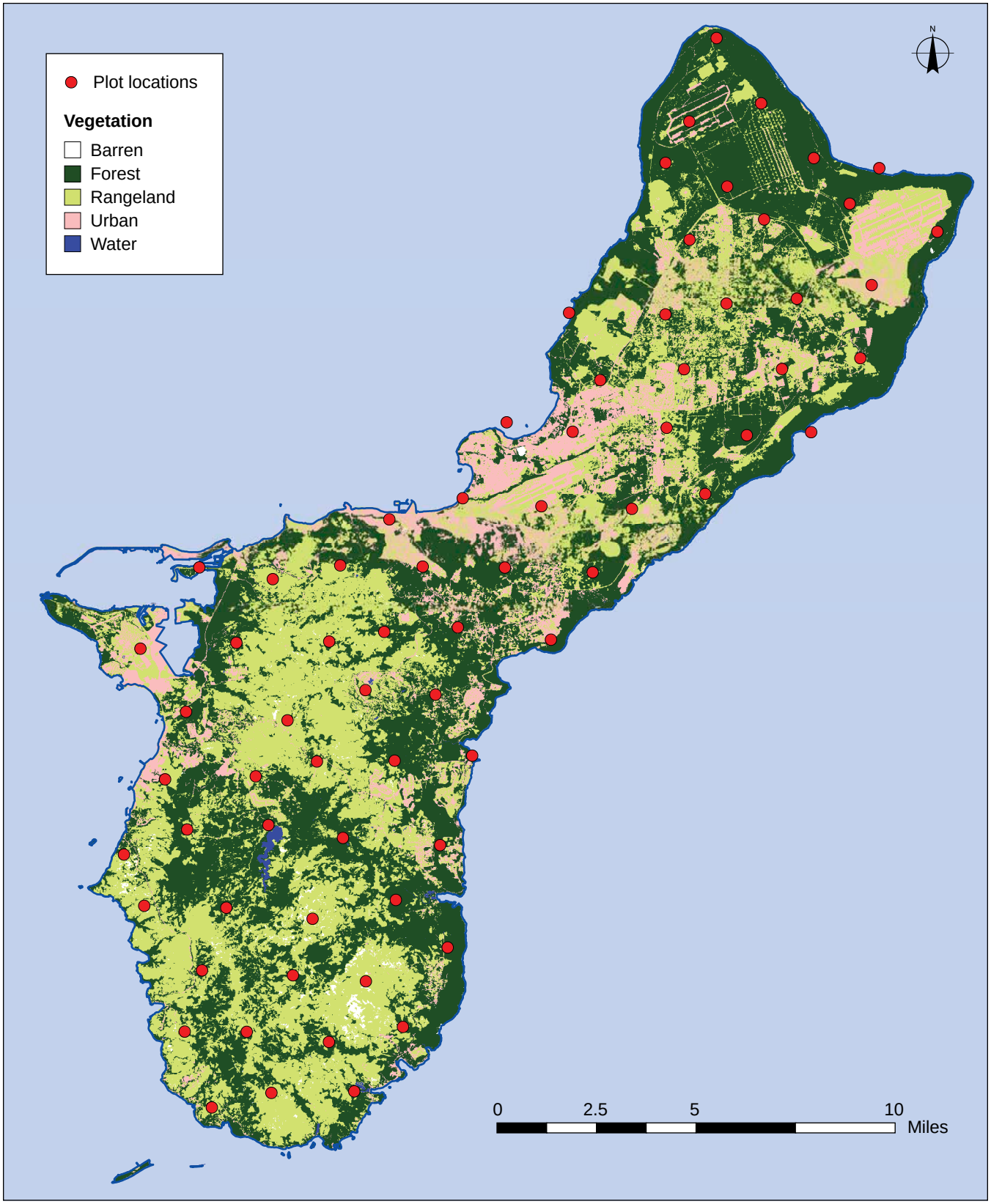

Figure 4—Forested plots measured in 2013 used to provide the data published in this report. Locations of 48 forested plots were measured, and locations are approximate (forest/nonforest geographic information system layer: Liu et al. 2014).

Forest Composition

FIA crews identified 55 tree species on FIA plots in Guam (see "Scientific and Common Names of Plants Found During Inventory"). The most common tree species were *Leucaena leucocephala*, *Guamia mariannae*, and *Hibiscus tiliaceus* (table 2). The estimated total number of trees during this 2013 inventory was about 74 million. FIA plots on Guam each contained from 1 to 11 different tree species (fig. 5). Forest stands tended to be dominated by smaller size trees that are less than 5 inches in diameter (fig. 6). The diameter distribution for trees follows a reverse-J pattern on Guam (fig. 7). Frequent typhoon disturbance and the abundance of numerous species of small-diameter, short-lived trees (such as *Leucaena leucocephala*) contribute to this pattern, which is persistent through time in many stands.

Table 2—Estimated number of trees on Guam, by species

		Number of trees	
Scientific name	**Common name**	**Total**	**Sampling error**
		Thousands	
Leucaena leucocephala	tangan tangan	9,341	2,983
Guamia mariannae	paipai	9,207	3,996
Hibiscus tiliaceus	sea-hibiscus, pago	9,049	2,452
Triphasia trifolia	lemondichina	8,526	6,470
Vitex parviflora	smallflower chastetree	4,584	1,661
Aglaia mariannensis	mapunyao	4,532	3,241
Morinda citrifolia	lada,	3,396	1,268
Premna obtusifolia	ahgao	2,571	1,055
Heterospathe elata	palma brava	2,182	1,408
Neisosperma oppositifolia	fagot	1,973	1,304
Averrhoa bilimbi	bilimbi, pickle tree	1,935	1,422
Areca catechu	Pugua, betel nut	1,722	1,193
Casuarina equisetifolia	gagu, ironwood	1,671	1,113
Ochrosia mariannensis	langiti	1,603	1,547
Cocos nucifera	niyok, coconut palm	1,464	528
Maytenus thompsonii	luluhut	1,247	1,203
Pandanus tectorius	kafu	1,131	352
Cananga odorata	ilang-ilang	961	955
Adenanthera pavonina	kulalis	834	826
Eugenia reinwardtiana	a'abang	712	687
Cycas circinalis	fandang, federico	624	242
Annona muricata	laguaná, kasoy, soursop	623	437
Bauhinia monandra	orchid tree, mariposa	481	484

Table 2—Estimated number of trees on Guam, by species (continued)

Scientific name	Common name	Number of trees	
		Total	Sampling error
		Thousands	
Calophyllum inophyllum	da'ok	471	301
Ficus tinctoria	hoda, tagete	357	306
Mangifera indica	mångga, mango	208	196
Annona reticulata	annonas, custard apple	200	126
Macaranga thompsonii	pengua	186	129
Eugenia thompsonii	atoto	178	172
Mammea odorata	chopak	176	178
Melanolepis multiglandulosa	alom	164	165
Chrysophyllum cainito	star apple	152	153
Tarenna sambucina	sumac-lada	152	153
Ficus prolixa	nunu	150	81
Spathodea campanulata	African tulip tree	124	82
Pisonia grandis	umumu	85	86
Tristiropsis obtusangula	faia, faniok	75	63
Artocarpus altilis	lemmai, breadfruit	73	51
Intsia bijuga	ifit	65	41
Artocarpus mariannensis	dugdug, seeded breadfruit	37	20
Barringtonia asiatica	puting, fish kill	37	37
Leucaena insularum	native tangan tangan	35	36
tree unknown	other or unknown live tree	27	18
Pandanus dubius	pahong	25	18
Eugenia palumbis	agatelang	14	14
Glochidion marianum	*Glochidion marianum*	14	14
Barringtonia racemosa	langasat	12	12
Hernandia sonora	nonak	12	12
Tabebuia pallida	pink tabebuia	12	12

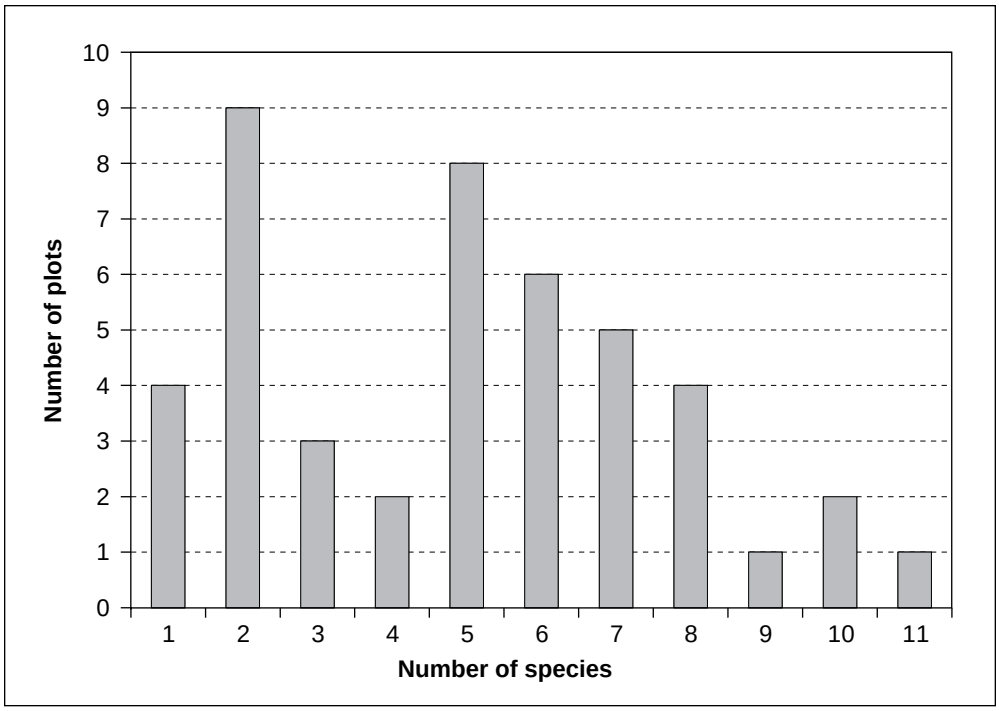

Figure 5—Number of tree species found on Forest Inventory and Analysis sampled plots. The average number of tree species per field-visited plot was 5 and ranged from 1 to 11 species per plot based on the 45 plots with inventoried trees.

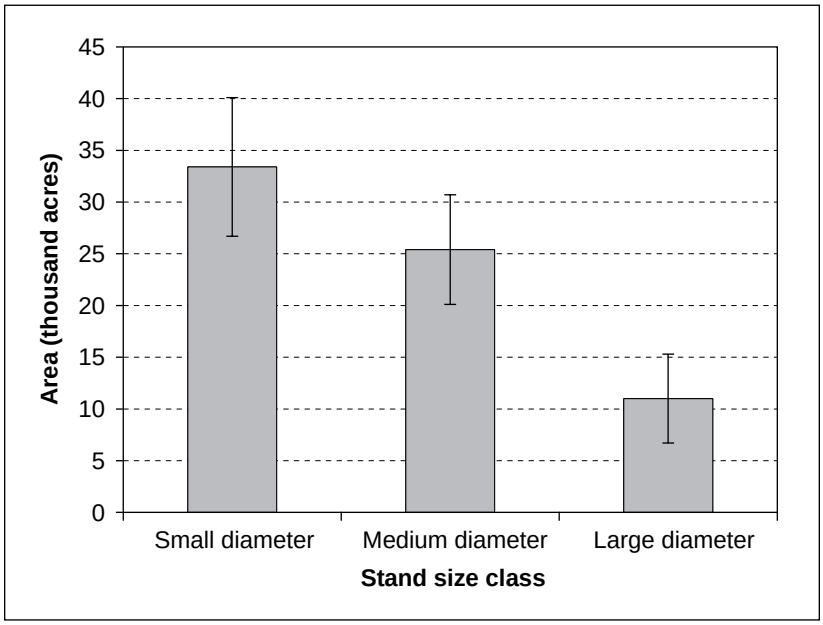

Figure 6—Forest area by stand-size class. Forests in the large-diameter stand-size class are defined as having a majority of trees ≥11.0 inches in diameter at breast height (d.b.h.). Forests in the medium-diameter stand-size class are defined as having a majority of trees between 5.0 and 11.0 inches d.b.h. Forests in the small-diameter stand-size class have a majority of trees with d.b.h. <5.0 inches.

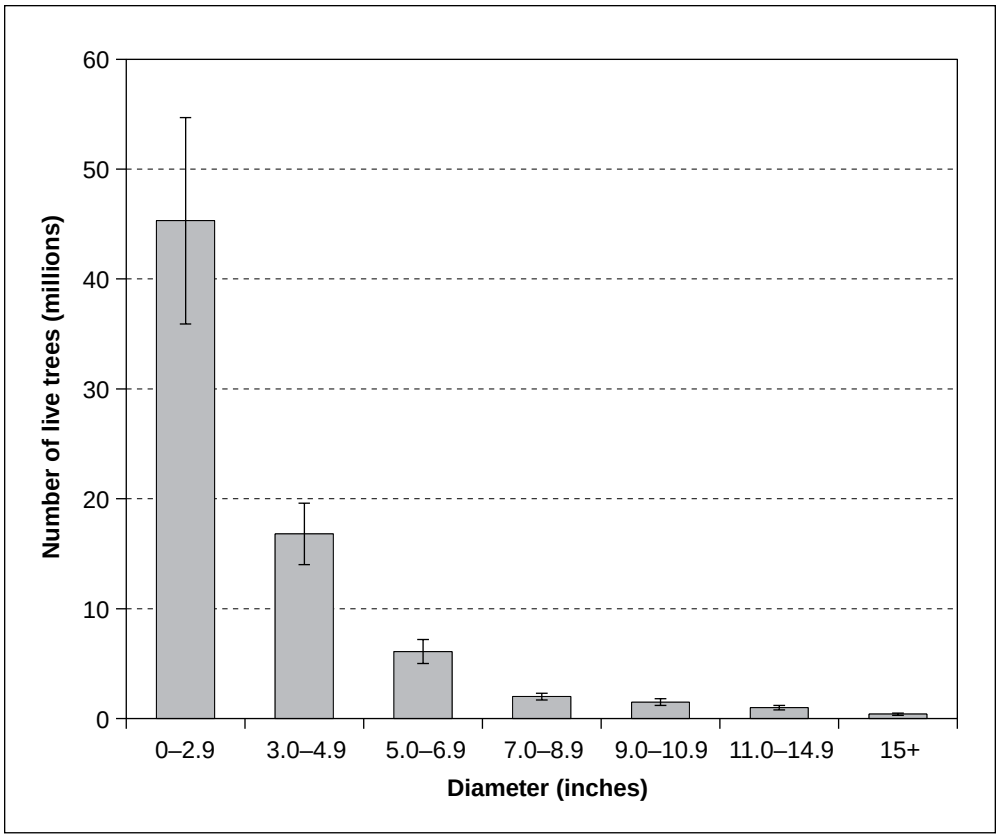

Figure 7—Estimated number of live trees by diameter class in 2013. Smaller trees are the most numerous across all size classes, indicating that regeneration is abundant.

Volume, Biomass, and Carbon

Stem volume (wood) is a metric by which forest productivity, vigor, and structure can be assessed and modeled to examine current forest conditions and project future forest status. Field-derived tree length and diameter measurements are used to produce single-tree volume estimates, which are then expanded to assess volume for entire forested stands. Volume estimates can then be used in additional models to study forest biomass and carbon dynamics. Biomass and carbon distribution by diameter class follows closely the pattern seen in volume by diameter-class distribution (tables A2-5 and A2-6), in which biomass was concentrated in the small to medium stand-size classes. Trees 5.0 to 9.9 inches in diameter represented the highest overall pool of aboveground biomass (fig. 8).

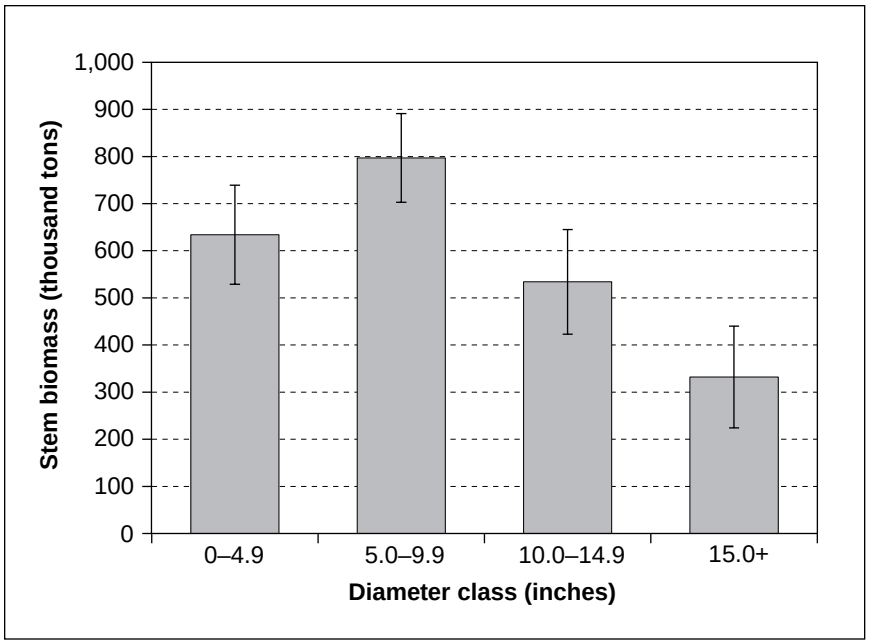

Figure 8—Stem biomass (thousand tons) by diameter class. On Guam, stem biomass is generally present in the small to medium stand-size classes.

Understory Vegetation

Understory vegetation is an important structural component in all forest ecosystems. The life form type and density of cover could affect forest structure and function, as well as influence wildlife habitat, spread of disease, soil stability, and competition between native and nonnative plants. FIA field crews sample understory vegetation in plots on forest and vegetated nonforest land. To reflect forest structure, the percentage of canopy cover by four structural layers and the percentage of total canopy cover to 1 percent are estimated for tree seedlings (trees <1.0 inch in diameter at breast height [d.b.h.]) and saplings (trees 1.0 to 4.9 inches d.b.h.); shrubs (woody, multiple-stem plants of any size, including woody vines); forbs (herbaceous, broadleaf plants, including nonwoody vines and ferns); and graminoids (grasses and grass-like plants, including rushes and sedges). To reflect species composition, the percentages of total canopy cover and main canopy layer are estimated for the four most abundant (≥3 percent canopy cover) life forms: seedlings and saplings, shrubs, forbs, and graminoid species. Graminoids were the most common understory vegetation found on all FIA plots, followed by seedlings and saplings, shrubs, and woody vines (fig. 9).

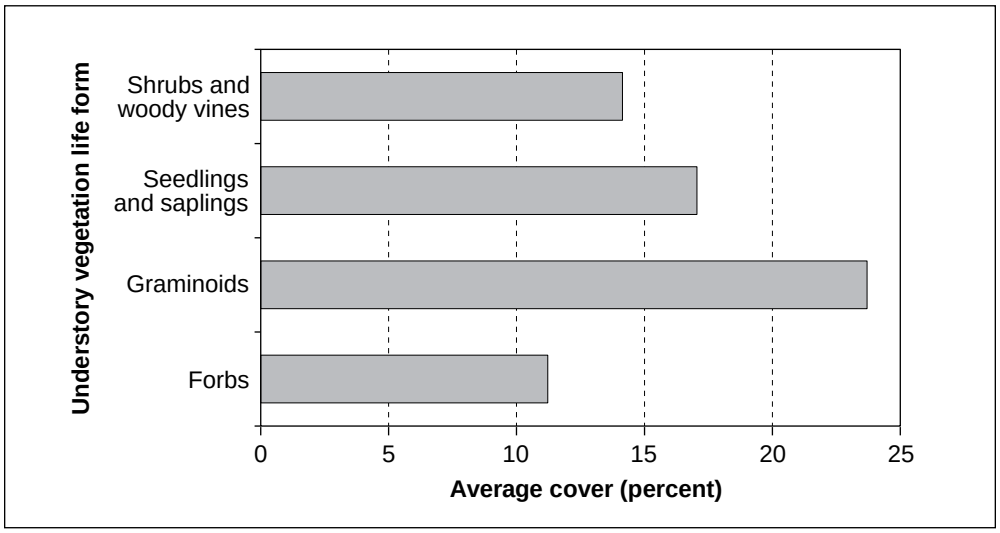

Figure 9—Average understory vegetation canopy cover percentage by life form in Guam's forests.

Extent of Standing Dead Wood

Standing dead trees (snags) represent an important component of forest structure and wildlife habitat. FIA plot measurements are well suited to estimating standing dead wood throughout all forest types and ownerships across the island. Dead trees fill many ecologically important roles in forests. Dead wood in a forest provides habitat for wildlife, insects, and fungi (both native and invasive); improves soil fertility through nutrient cycling and moisture retention; adds to fuel loads; and is a key structural element in mature forests. Large-scale disturbances caused by weather events and insects can substantially increase input into the dead wood pool, leading to a notable effect on the total dead wood stores present. Dead wood resources are complex, and FIA provides estimates of the amount of standing dead trees (snags). There are approximately 30,251 tons of dead wood on Guam: 21,331 tons in the 5.0- to 9.9-inch diameter class and 8,920 tons in the >10-inch diameter class (fig. 10; table A2-6).

Nontimber Forest Products

Nontimber forest products are those not traditionally included as timber in economic reporting. These products contribute in important ways to the livelihoods and welfare of people living in and near forests. They provide construction materials, fencing, furniture, foods, medicines, fibers, floral products, plant oils, dyes, food wrapping, fuels, and livestock feed, and represent other important cultural values (Dawson et al. 2014). In Guam's FIA plots, *Cocos nucifera* and *Pandanus tectorius* had the highest number of trees of these species of interest (fig. 11) and are used as a food crop and for handicrafts.

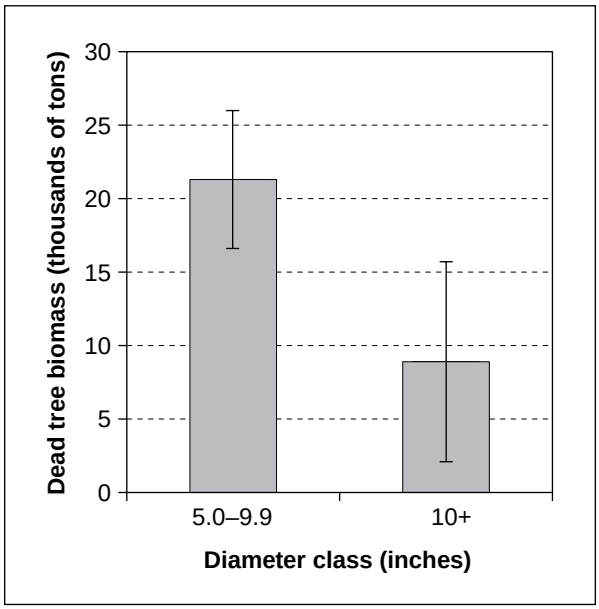

Figure 10—Aboveground standing dead tree biomass for trees with a diameter greater than 5 inches.

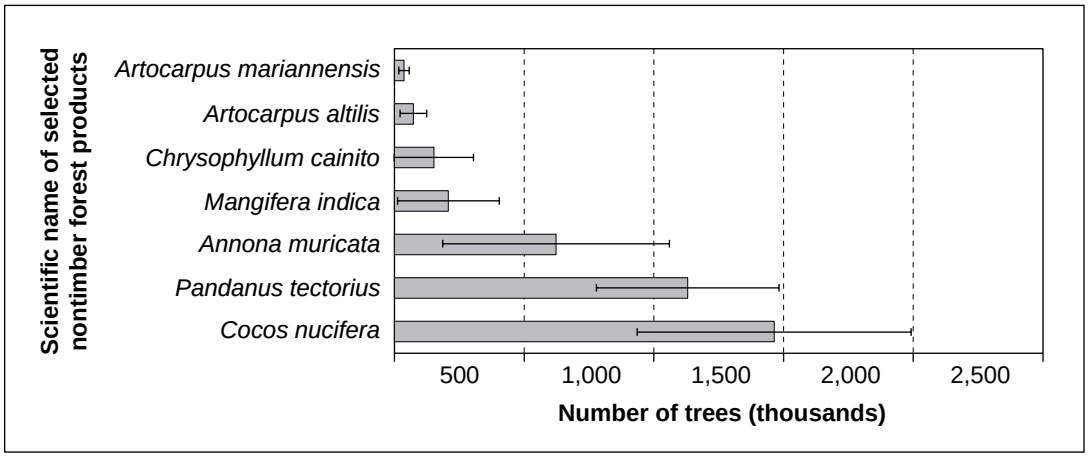

Figure 11—Number of trees in the thousands of selected nontimber forest product species. *Cocos nucifera* and *Pandanus tectorius* had the highest number of trees of the nontimber forest products sampled.

Forest Health

Forests are complex ecosystems composed of plants, animals, fungi, and bacteria that interact with each other and with nonbiotic elements. Trees dominate forested landscapes, but less obvious components such as fungi and soil microbes are also important (Molina 1994), with each piece of the system playing a role in creating a balanced and healthy environment. Forests can sequester carbon from the atmosphere, serve as long-term carbon storage (Harmon et al. 1990), protect soil from erosion, and remove pollutants to improve air quality (Nowak et al. 2014). On Guam, forests comprise nearly 53 percent of the land area, and the health of these forests affects their ability to maintain forest species composition and function and protect surrounding environments.

Forest Disturbances and Their Extent

The forests on Guam have been affected by typhoons, droughts, urbanization, wildfires, and invasions of introduced insects, plants, and ungulate species. Introduced ungulates such as the Philippine deer (*Rusa marianna)* and feral pigs (*Sus scrofa)* consume seeds, fruits, and foliage, and trample and uproot regenerating plants, inhibiting forest regeneration (Morton et al. 2000). In the mid-1940s, the unintentional introduction of the brown tree snake (*Boiga irregularis*) led to the functional extirpation of native seed dispersing birds from the forests (Rogers et al. 2017). Declines and losses of native species as a result of these disturbances have been especially severe on Guam, prompting the U.S. Fish and Wildlife Service, in 2015, to add 23 species to the federal list of endangered and threatened wildlife and plants on Guam (50 C.F.R. § 17 2015). Guam is located in "Typhoon Alley," where interactions between frequent tropical storms and anthropogenic disturbances, which expose soil and fragment ecosystems, have greatly altered natural communities (Mafnas 2010). Guam is also anticipating an increase in its human population because of the expansion of U.S. military installations, where proposed housing development and other activities are expected to eliminate about 9 percent of Guam's forest area (Mafnas 2010). Disturbances on forest and nonforest land on Guam were generally caused by fire, animals and insects (fig. 12). The presence of conks, other fungi fruiting bodies, and signs of advanced decay, i.e., rot in sapwood/heartwood of trees, represented the majority of tree damage (57 percent) observed in inventory plots (fig. 13).

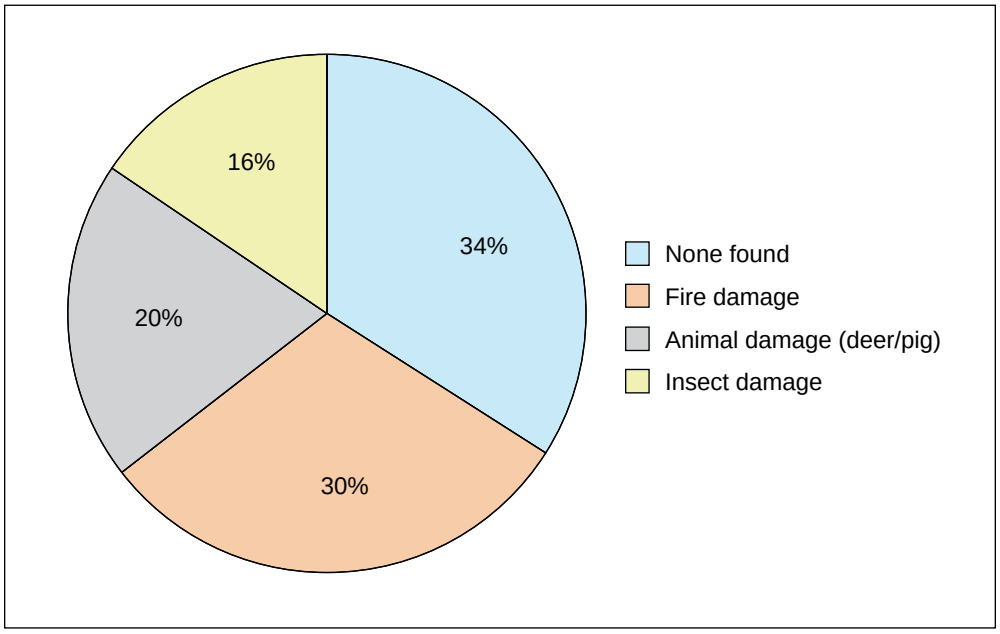

Figure 12—Area affected by type of disturbance on Guam.

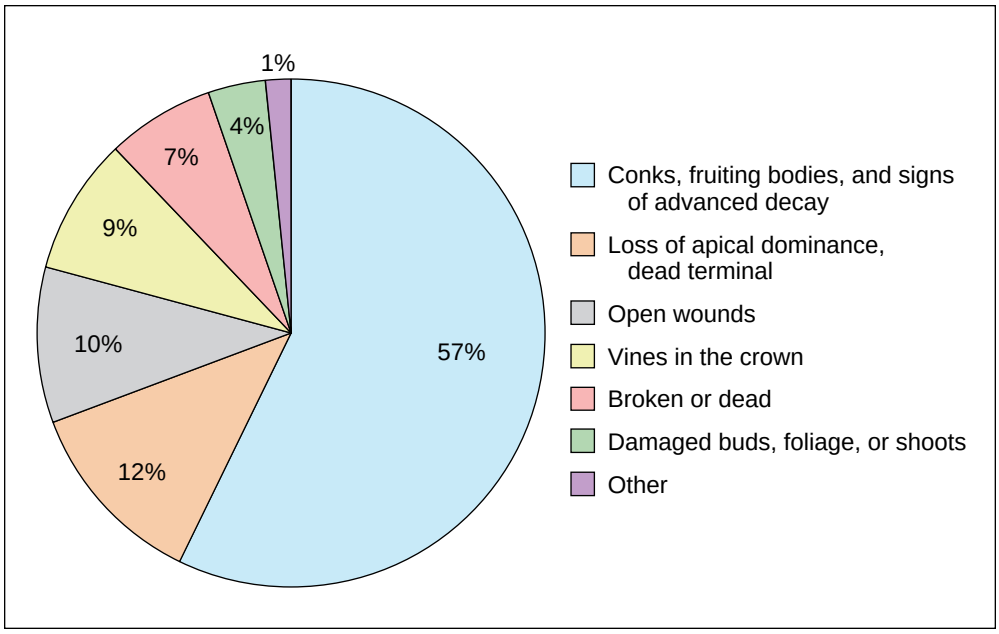

Figure 13—Tree damage types occurring on live trees in Forest Inventory and Analysis plots. The majority of damages to saplings and trees were conks, fruiting bodies, and signs of advanced decay.

Insects

In 2003, an unintentional introduction of cycad scale (*Aulacaspis yasumatsui*) on Guam resulted in a steep decline in the population of native cycad species (*Cycas circinalis)*, raising many concerns about the subsequent ecosystem response (Marler and Lawrence 2012). Rhinoceros beetle (*Oryctes rhinoceros)* was found on Guam in 2007 and has the potential to cause significant damage to Guam's forest ecosystems and economy (Mankin and Moore 2010). During the 2013 inventory, 93 percent of *Cycas circinalis* showed signs of damage as a result of cycad scale, and 15 percent of *Cocos nucifera* showed signs of damage from the rhinoceros beetle (fig. 14).

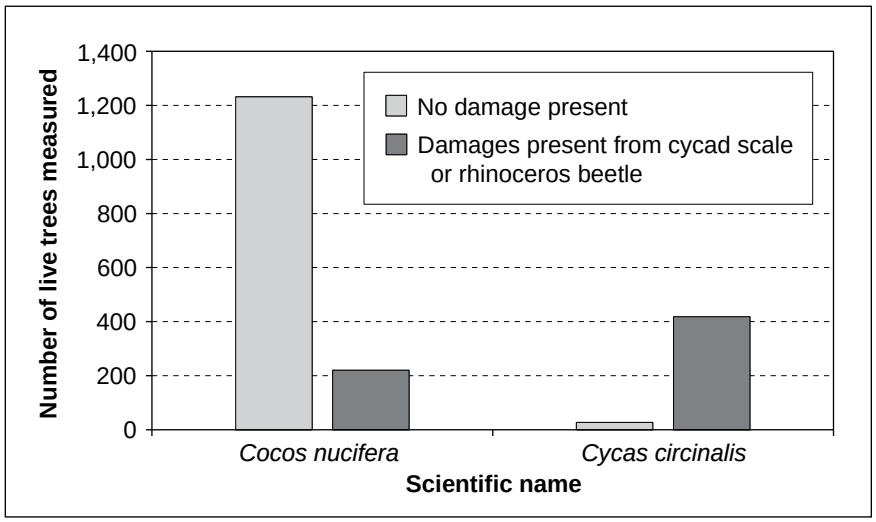

Figure 14—Severity of damage from Cycad scale in *Cycas circinalis* and rhinoceros beetle in *Cocos nucifera.*

Invasive Vegetation

Invasive plants can significantly alter forest structure and composition and can diminish ecosystem resilience to other disturbance processes. Accidental or intentional introductions of forbs, shrubs, vines, and trees have profoundly affected the environment on Guam (fig. 15). Invasive plants tend to proliferate owing to an absence of natural enemies and the inability of native plant species to compete with invasive species (Muniappan et al. 2002). During World War II, large areas of vegetation were cleared, leading to an increase in nonnative woody species such as Leucaena leucocephala (Fosberg 1960, Savidge 1987*).* Small oceanic islands are exceptionally vulnerable to damages caused by intentional and unintentional introduction of alien species that, once established, are difficult or even impossible to eradicate (Marler and Lawrence 2012, Van Driesche et al. 2010). Nineteen invasive species out of a list of 38 species identified by local land managers were found during the 2013 inventory (table 3). *Vitex parviflora* and *Leucaena leucocephala* were the most dominant invasive plant species present in 2013 (fig. 16).

Ashley Lehman

Figure 15—Invasive species, such as *Mikania micrantha* shown here, can outcompete and take over a landscape on Guam.

Table 3—Presence or absence of listed Guam invasive species

Scientific name	Presence/absence	Scientific name	Presence/absence
Achyranthes aspera	—	*Imperata cylindrica*	—
Adenanthera pavonina	✓	*Lantana camara*	—
Amaranthus spinosus	—	*Leucaena leucocephala*	✓
Antigonon leptopus	✓	*Lemna minor*	—
Arundina graminifolia	✓	*Lonicera japonica*	—
Averrhoa bilimbi	✓	*Mimosa diplotricha (M. invisia)*	—
Bidens alba	✓	*Mikania micrantha*	✓
Chromolaena odorata	✓	*Mucuna pruriens*	✓
Cinnamomum verum	—	*Nymphaea* sp.	—
Clerodendrum chinense	—	*Pennisetum polystachion*	✓
Clerodendrum sp.	—	*Piper auritum*	—
Coccinia grandis	—	*Pistia stratiotes*	—
Egeria densa	—	*Spathodea campanulata*	✓
Eichhornia crassipes	—	*Stachytarpheta jamaicensis*	✓
Epipremnum pinnatum	✓	*Syngonium podophyllum*	✓
Euphorbia cyathophora	✓	*Tinospora* sp.	—
Falcataria moluccana	—	*Tradescantia spathacea*	✓
Heterospathe elata	✓	*Panicum maximum (Urochloa maxima)*	✓
Hydrilla verticillata	—	*Vitex parviflora*	✓

Note: 38 species were searched for; 19 species were found on plots.
✓ = species was found during Forest Inventory and Analysis (FIA) inventory.
— = species was not found during FIA inventory.

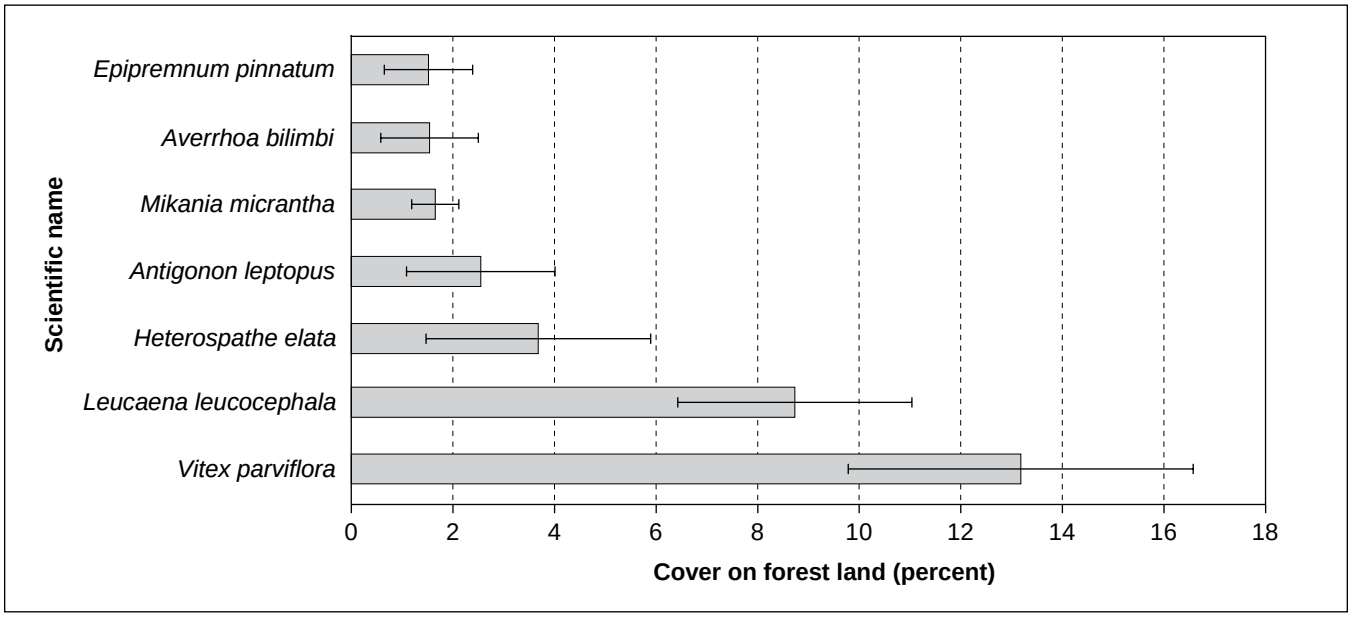

Figure 16—Total percentage of cover of invasive species present in the vegetation in Guam's forested lands. *Vitex parviflora* and *Leucaena leucocephala* were the most dominant invasive vegetation species present during the 2013 inventory.

Conclusions

This report presents an updated overview of Guam's forest resources, highlighting information that is new as well as confirming previously known information. Some readers may want to see more indepth research and analysis on selected topics to fully understand the current state and changes taking place in Guam's forests. Note, however, that not all the results published in this report can be directly compared to those in the previous report (Donnegan et al. 2004) for the purpose of assessing changes in forest resources over the past decade. Use of the same sampling protocols and plot design in the future will support meaningful assessment of change in each 10-year interval between field visits. Long-term forest monitoring in FIA plots is expected to provide information on the impacts of disturbances such as invasive species on tree growth and survival. Armed with these data, we can begin quantifying trends in Guam's forest, from the growth and survival of understory seedlings to large, landscape-level shifts in forests from such challenges associated with a growing population and a changing climate.

Scientific and Common Names of Plants Found During Inventory

Life form	Scientific name	Common name
Trees:	*Adenanthera pavonina* L.	kulalis
	Aglaia mariannensis sensu Kaneh., non Merr.	mapunyao
	Annona muricata L.	laguaná, kasoy, soursop
	Annona reticulata L.	annonas, custard apple
	Areca catechu L.	puguá, betel nut
	Artocarpus altilis (Parkinson) Fosberg	lemmai, breadfruit
	Artocarpus mariannensis Trécul	dugdug, seeded breadfruit
	Averrhoa bilimbi L.	bilimbi, pickle tree
	Barringtonia asiatica (L.) Kurz	puting, fish kill, sea putat
	Barringtonia racemosa Roxb.	langaasag
	Bauhinia monandra Kurz	orchid tree, mariposa
	Calophyllum inophyllum L.	da'ok
	Cananga odorata (Lam.) Hook. f. & Thomson	ilang-ilang
	Carica papaya L.	papaya
	Casuarina equisetifolia L.	gagu, ironwood
	Cerbera dilatata Markgr.	chiute
	Chrysophyllum cainito L.	star apple
	Cocos nucifera L.	niyok, coconut palm
	Cyathea lunulata (G. Forst.) Copel.	tsatsa, Pacific tree fern
	Cycas circinalis L.	fandang, federico
	Eugenia palumbis Merr.	agatelang
	Eugenia reinwardtiana (Blume) DC.	a'abang
	Eugenia thompsonii (Merr.) N.Snow	atoto

Scientific and Common Names of Plants Found During Inventory (continued)

Life form	Scientific name	Common name
	Ficus prolixa G. Forst.	Nunu, fig
	Ficus tinctoria G. Forst.	hoda, tagete, fig
	Glochidion marianum Müll. Arg.	*Glochidion marianum*
	Guamia mariannae (Saff.) Merr.	paipai
	Hernandia ovigera L.	oschal
	Hernandia sonora L.	nonak, mago
	Heterospathe elata Scheff.	palma brava
	Hibiscus tiliaceus L.	sea hibiscus, pago
	Inocarpus fagifer (Parkinson) F.R. Fosberg	budo buoy, Tahitian chestnut
	Intsia bijuga (Colebr.) Kuntze	ifit
	Kleinhovia hospita L.	guest tree
	Leucaena insularum (Guill.) Daniker	native tangan tangan
	Leucaena leucocephala (Lam.) de Wit	tangan tangan
	Macaranga thompsonii Merr.	pengua
	Mammea odorata (Raf.) Kosterm.	chopak
	Mangifera indica L.	mångga, mango
	Maytenus thompsonii (Merr.) Fosberg	luluhut
	Melanolepis multiglandulosa (Reinw. ex Blume) Rchb. f. & Zoll.	alom
	Morinda citrifolia L.	lada
	Neisosperma oppositifolia (Lam.) Fosberg & Sachet	fagot
	Ochrosia mariannensis A. DC.	langiti
	Pandanus dubius Spreng.	pahong
	Pandanus tectorius Parkinson ex Zucc.	kafu, kaffo, Tahitian screwpine
	Pisonia grandis R. Br.	amumo
	Polyscias grandifolia Volkens	pepega
	Premna obtusifolia R. Br.	ahgao, premna
	Spathodea campanulata P. Beauv.	African tulip tree
	Tabebuia pallida (Lindl.) Miers	pink tabebuia
	Tarenna sambucina (G. Forst.) Durand	sumac-lada
	Triphasia trifolia (Burm. f.) P. Wilson	lemondichina
	Tristiropsis obtusangula Radlk.	faia, faniok
	Vitex parviflora Juss.	smallflower chastetree
Forbs:	*Abelmoschus moschatus Medik.*	musk okra
	Alocasia cucullata (Lour.) G. Don	Chinese taro
	Alocasia macrorrhizos (L.) G. Don	giant taro
	Antigonon leptopus Hook. & Arn.	coral vine, chain of love
	Arundina graminifolia (D. Don) Hochr.	bamboo orchid
	Asplenium nidus L.	Hawaii birdnest fern
	Bidens alba (L.) DC.	romerillo
	Chromolaena odorata (L.) R.M. King & H. Rob.	Siam weed, kesengesil, masigsig
	Curcuma longa L.	common turmeric

Scientific and Common Names of Plants Found During Inventory (continued)

Life form	Scientific name	Common name
	Dicranopteris linearis (Burm.) Underw.	Old World forkedfern
	Epipremnum pinnatum (L.) Engl.	pothos, centipede tongavine
	Gleichenia linearis (Burm. f.) C.B. Clarke	
	Hyptis capitata Jacq.	false ironwort
	Hyptis rhomboidea Martius & Galeott	
	Ipomoea pes-caprae (L.) R. Br.	bayhops
	Ipomoea pes-caprae (L.) R. Br. ssp. *brasiliensis* (L.) van Ooststr.	Brazilian bayhops
	Lycopodiella cernua (L.) Pic. Serm. var. *cernua*	staghorn clubmoss
	Lygodium microphyllum (Cav.) R. Br.	small-leaf climbing fern
	Lygodium scandens	
	Malvastrum coromandelianum (L.) Garcke	threelobe false mallow
	Microlepia speluncae (L.) T. Moore	limpleaf fern
	Mikania micrantha Kunth	bittervine, mile-a-minute vine
	Mimosa pudica L.	shameplant, sleeping grass
	Mucuna pruriens (L.) DC.	cowitch, velvet bean, akangkang dangkulo
	Musa L.	banana
	Nephrolepis biserrata (Sw.) Schott	giant swordfern
	Nephrolepis hirsutula (J.R. Forst.) C. Presl	scaly swordfern
	Passiflora foetida L.	fetid passionflower
	Passiflora suberosa L.	corkystem passionflower, devils pumpkin
	Phymatosorus scolopendria (Burm. f.) Pic. Serm.	monarch fern
	Polypodium punctatum Thunb. ex Murray	elkhorn fern
	Pteris tripartita Sw.	giant brake
	Pyrrosia lanceolata (L.) Farw.	Lanceleaf tongue fern
	Senna tora (L.) Roxb.	sickle senna
	Sida rhombifolia L.	Cuban jute
	Spathoglottis plicata Blume	Philippine ground orchid
	Sphagneticola trilobata (L.) Pruski	Bay Biscayne creeping-oxeye
	Stachytarpheta jamaicensis (L.) Vahl	light-blue snakeweed
	Stictocardia tiliifolia (Desr.) Hallier f.	spottedheart
	Stylosanthes guianensis (Aubl.) Sw.	
	Syngonium podophyllum Schott	American evergreen
	Teramnus labialis (L. f.) Spreng.	blue wiss
	Thelypteris maemonensis (W.H. Wagner & Grether) B.C. Stone	Maemon Valley maiden fern
	Thelypteris opulenta (Kaulf.) Fosberg	jeweled maiden fern
	Thelypteris parasitica (L.) Fosberg	parasitic maiden fern
	Thelypteris pennata (Poir.) Morton	graceful maiden fern
	Thelypteris unita (L.) Morton	
	Tradescantia spathacea Sw.	boatlily, moses-in-the-cradle
	Vigna adenantha (G. Mey.) Marechal, Mascherpa & Stanier	wild pea
	Waltheria indica L.	uhaloa
	Wedelia Jacq.	creepingoxeye

Scientific and Common Names of Plants Found During Inventory (continued)

Life form	Scientific name	Common name
Graminoids:	*Bothriochloa bladhii* (Retz.) S.T. Blake	Caucasian bluestem
	Centotheca latifolia (L.) Desv.	
	Cynodon dactylon (L.) Pers.	bermudagrass
	Dimeria chloridiformis sensu Ohwi 1941, non (Gaudich.) K. Schum. & Lauterb.	
	Eleusine indica (L.) Gaertn.	Indian goosegrass
	Fimbristylis dichotoma (L.) Vahl	forked fimbry
	Fimbristylis tristachya R. Br.	fimbry
	Imperata conferta (J. Presl) Ohwi	
	Miscanthus floridulus (Labill.) Warb. ex K. Schum. & Lauterb.	swordgrass
	Oplismenus compositus (L.) P. Beauv	running mountaingrass
	Oplismenus hirtellus (L.) P. Beauv	basketgrass
	Paspalum paniculatum L.	arrocillo
	Pennisetum polystachion (L.) Schult.	mission grass
	Pennisetum polystachion (L.) Schult. ssp. *Setosum* (Sw.) Brunken	mission grass
	Phragmites karka (Retz.) Trin. ex Steud. [excluded]	tall reed
	Rhynchospora rubra Domin	rhynchospora
	Saccharum spontaneum L.	wild sugarcane
	Scleria polycarpa Boeckeler	nutrush
	Sorghum halepense (L.) Pers.	Johnsongrass
	Urochloa maxima (Jacq.) R. Webster	guineagrass
Shrubs and woody vines:	*Abrus precatorius* L.	rosarypea
	Cestrum diurnum L.	day jessamine
	Colubrina asiatica (L.) Brongn.	Asian nakedwood
	Discocalyx megacarpa Merr.	
	Entada pursaetha DC.	
	Flagellaria indica L.	
	Flemingia strobilifera (L.) W.T. Aiton	wildhops
	Freycinetia reineckei Warb. iul (Palau)	
	Ixora triantha Volkens	
	Jasminum marianum DC.	
	Medinilla medinilliana (Gaudich.) Fosberg & Sachet	
	Melastoma malabathricum L.	Malabar melastome
	Melastoma malabathricum var. *mariannum*	
	Miconia punctata (Desr.) D. Don ex DC.	auquey
	Myrtella bennigseniana (Volkens) Diels	
	Scaevola sericea Vahl	beach naupaka
	Scaevola sericea Vahl var. *taccada* (Gaertn.) Thieret & B. Lipscomb	nanaso, beach naupaka
	Telosma Coville	telosma
	Wikstroemia elliptica Merr.	gapit atayaki

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Metric Equivalents

When you know:	Multiply by:	To find:
Inches	2.54	Centimeters
Feet (ft)	0.3048	Meters
Acres (ac)	0.405	Hectares
Cubic feet (ft^3)	0.0283	Cubic meters
Tons (ton)	0.907	Tonnes or megagrams

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Appendix 1: Inventory Design and Methods

Field Design and Sampling Method

The Forest Inventory and Analysis (FIA) program conducts a systematic, sample-based field inventory across all ownerships on a periodic basis, remeasuring the same plots approximately every 10 years. All FIA units use a common plot design, common set of measurement protocols, and a standard database design for compilation and distribution of data. Adaptations were made to the national design for the Guam inventory to include additional branching and rooting forms and additional tree crown measurements, as well as special interest species ranging from invasive plants to pathogens to invasive insects and animals.

With active assistance from our partners at the University of Guam, 48 plots were spaced uniformly at 1.9-mi intervals using a hexagonal grid, at a threefold intensification of the spacing used in the mainland United States inventory plot grid. Forest inventory plots included four 24-ft, fixed-radius subplots in which a variety of information is collected at the plot, subplot, and tree levels (USDA FS 2012). Primary variables collected include plot location, slope, aspect, elevation, subplot slope position and slope shape, tree species, diameters, heights, damages, branching and rooting forms, decay, and epiphytic loadings.

All plots classified by aerial photography as possibly being forested are established in the field without regard to land use or land cover. Field crews delineate areas within the plot that are comparatively less heterogeneous than the plot as a whole with regard to reserved status, owner group, forest type, stand-size class, and tree density; these areas are described as condition classes. The process of delineating these condition classes on a fixed-radius subplot is called mapping. All measured trees are assigned to the mapped condition class in which they are located.

On plots, crews assess physical characteristics such as slope, aspect, and elevation; stand characteristics such as age, size class, forest type, disturbance, site productivity, and regeneration status; and tree characteristics such as tree species, diameter, height, damages, decay, and vertical crown dimensions. They also collect general descriptive information such as proximity to water and roads and the geographic position of the plot in the larger landscape.

Estimates of tree volume and other forest attributes were derived from tree measurements and classifications made at each plot. A number of other variables are unique to the Pacific Northwest Research Station's FIA program. These are "regional" variables and include such items as insect and disease damage, a record of previous disturbance on the plot. The Pacific Islands standardized plot installed at each forested location is a cluster of four subplots spaced 120 ft apart (fig. A1-1). Subplot 1 is in the center, with subplots 2 through 4 distributed radically around it.

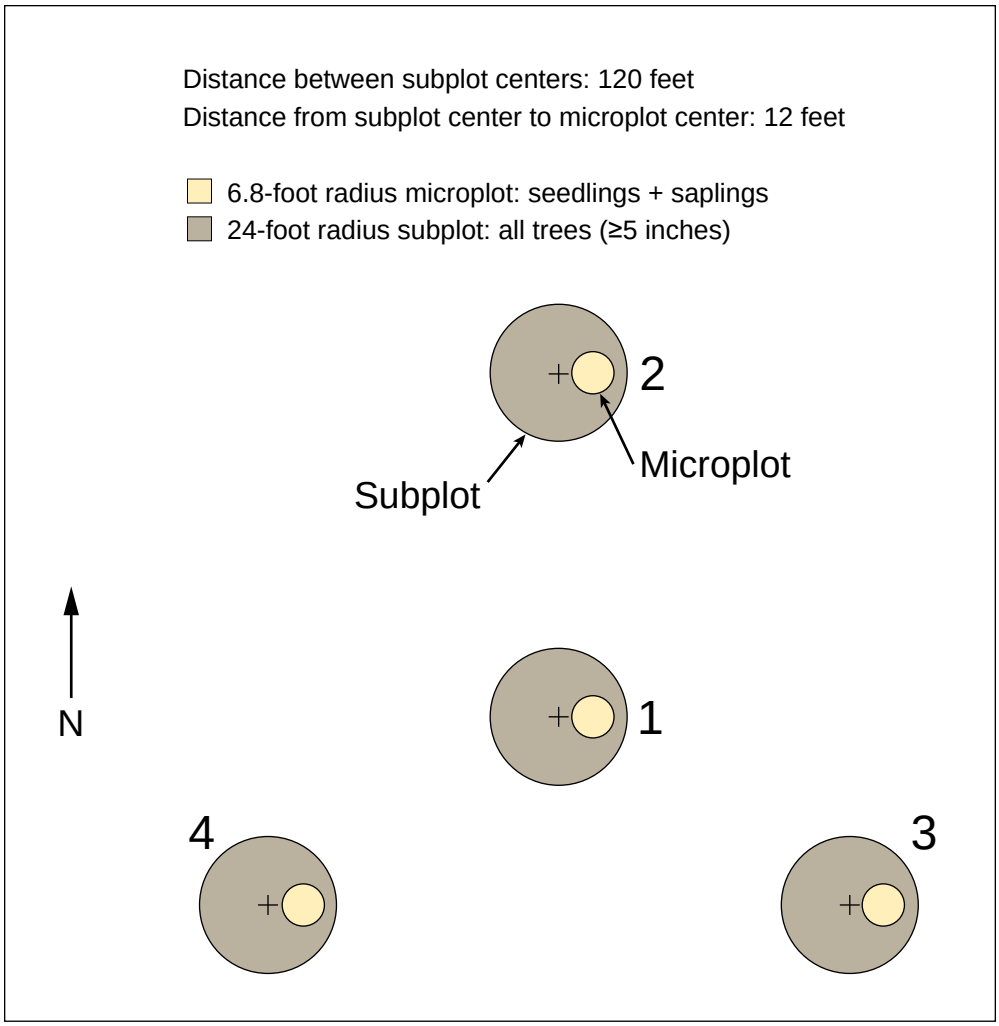

Figure A1-1—The Forest Inventory and Analysis plot design used on Guam.

Each point serves as the center of a 1/24-ac circular subplot used to sample all trees at least 5.0 inches in diameter at breast height (d.b.h.). A 1/300-ac microplot, with its center located 12 ft east of each subplot center, is used to sample trees 1.0 to 4.9 inches d.b.h., as well as seedlings (trees less than 1.0 inch d.b.h.).

Data Processing

The data used for this report are stored in the FIA National Information Management System (NIMS), which provides a means to input, edit, process, manage, and distribute FIA data. It includes a process for data loading, a national set of edit checks to ensure data consistency, an error correction process, approved equations and algorithms, code to compile and calculate attributes, a table report generator, and routines to populate the presentation database. The NIMS applies numerous algorithms and equations to calculate such variables as stand size, volume, and

biomass. It also generates estimates and associated statistics based on county areas and stratum weights developed outside of NIMS. Additional FIA statistical design and estimation techniques are further reviewed in Bechtold and Patterson (2005).

Statistical Estimates

Throughout this report, we have published standard errors (SE) for most of our estimates. These SEs account for the fact that we measured only a small sample of the forest (thereby producing a sample-based estimate) and not the entire forest (which is the population parameter of interest). Because of small sample sizes or high variability within the population, some estimates can be very imprecise. The reader is encouraged to take the SE into account when drawing any inference. One way to consider this type of uncertainty is to construct confidence intervals. Customarily, 66- or 95-percent confidence intervals are used. A 95-percent confidence interval means that one can be 95 percent confident that the interval contains the true population parameter of interest. For more details about confidence intervals, please consult Moore and McCabe (1989) or other statistical literature.

Access Denied, Hazardous, or Inaccessible Plots

Although every effort was made to visit all field plots that were entirely or partially forested, some were not sampled for a variety of reasons. Field crews may have been unable to obtain permission from the landowner to access the plot, and some plots were impossible for crews to safely reach or access. Some private landowners deny access to their land, but privately owned plots usually are not as hazardous or inaccessible as plots on public land. Although permission to visit public land is almost always granted, some public land lies in higher elevation areas that can be very dangerous or impossible to reach.

This kind of missing data can introduce bias into the estimates if the nonsampled plots tend to be different from the entire population. Plots that are obviously nonforested (based on aerial photos) are rarely visited, and therefore the proportion of denied-access, hazardous, or inaccessible plots is significantly smaller than it is for forested plots. The poststratification approach outlined in Bechtold and Patterson (2005) removes nonsampled plots from the sample. Estimates are adjusted for plots that are partially nonsampled by increasing the estimates by the nonsampled proportion within each stratum.

Appendix 2: Summary Data Tables

The following tables contain basic information about the forest resources of Guam as they relate to the discussion of current forest issues and basic forest resource information presented in this report. Data are also available for download in nonsummarized form at https://www.fia.fs.fed.us.

Number of Live Trees

Table A2-1—Number of live trees on forest land by diameter class
Table A2-2—Percentage of live trees on forest land by species
Table A2-3—Number of live trees on forest land by species and diameter class

Tree Volume

Table A2-4—Estimated net volume of live trees on forest land by species and diameter class
Table A2-5—Estimated volume of all live trees on forest land by diameter class

Biomass and Carbon

Table A2-6—Aboveground biomass and carbon of live and dead trees on forest land
Table A2-7—Aboveground biomass of live trees on forest land by species and diameter class

Understory Vegetation

Table A2-8—Average understory vegetation cover and number of Forest Inventory and Analysis plots where the species occurred

Table A2-1—Number of live trees[a] on forest land by diameter class

	Estimated number of live trees	
Diameter class	**Total**	**SE**
Inches	*Millions*	
0–2.9	45.3	9.4
3.0–4.9	16.8	2.8
5.0–6.9	6.1	1.1
7.0–8.9	2.0	0.3
9.0–10.9	1.5	0.3
11.0–14.9	1.0	0.2
15+	0.4	0.1

Note: Totals may be off because of rounding; estimates are subject to sampling error.
SE = sampling error.
[a] Includes all live trees ≥1 inches in diameter at breast height.

Table A2-2—Percentage of live trees[a] on forest land by species

Scientific name	Common name	Percentage of all trees
Leucaena leucocephala	Tangan tangan	12.72
Guamia mariannae	paipai	12.54
Hibiscus tiliaceus	sea-hibiscus, pago	12.33
Triphasia trifolia	lemondichina	11.61
Vitex parviflora	smallflower chastetree	6.24
Aglaia mariannensis	mapunyao	6.17
Morinda citrifolia	lada	4.63
Premna obtusifolia	ahgao	3.50
Heterospathe elata	palma brava	2.97
Neisosperma oppositifolia	fagot	2.69
Averrhoa bilimbi	bilimbi, pickle tree	2.64
Areca catechu	Puguá, betel nut	2.35
Casuarina equisetifolia	gagu, ironwood	2.28
Ochrosia mariannensis	langiti	2.18
Cocos nucifera	niyok, coconut palm	1.99
Maytenus thompsonii	luluhut	1.70
Pandanus tectorius	Kafu, kaffo	1.54
Cananga odorata	ilang-ilang	1.31
Adenanthera pavonina	kulalis	1.14
Eugenia reinwardtiana	a’abang	0.97
Cycas circinalis	fandang, federico	0.85
Annona muricata	laguaná, kasoy, soursop	0.85
Bauhinia monandra	orchid tree, mariposa	0.66

Table A2-2—Percentage of live trees[a] on forest land by species (continued)

Scientific name	Common name	Percentage of all trees
Calophyllum inophyllum	daok	0.64
Ficus tinctoria	hoda, tagete	0.49
Mangifera indica	mango	0.28
Annona reticulata	annonas, custard apple	0.27
Macaranga thompsonii	pengua	0.25
Eugenia thompsonii	atoto	0.24
Mammea odorata	chopak	0.24
Melanolepis multiglandulosa	alom	0.22
Chrysophyllum cainito	star apple	0.21
Tarenna sambucina	sumac-lada	0.21
Ficus prolixa	nunu	0.20
Spathodea campanulata	African tulip tree	0.17
Pisonia grandis	amumo	0.12
Tristiropsis obtusangula	fai'a	0.10
Artocarpus altilis	lemmai, breadfruit	0.10
Intsia bijuga	ifit	0.09
Artocarpus mariannensis	dugdug, seeded breadfruit	0.05
Barringtonia asiatica	putting, fish kill	0.05
Leucaena insularum	strand tangan tangan	0.05
tree unknown	other or unknown live tree	0.04
Pandanus dubius	pahong	0.03
Eugenia palumbis	agatelang	0.02
Glochidion marianum	*Glochidion marianum*	0.02
Barringtonia racemosa	langaasag	0.02
Hernandia sonora	nonak	0.02
Tabebuia pallida	pink tabebuia	0.02

[a] Includes all live trees ≥1 inches diameter at breast height.

Table A2-3—Number of live trees[a] on forest land by species and diameter class

	Diameter class (inches)									
	0–4.9		5.0–9.9		10.0–14.9		15.0+		All classes	
Scientific name	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Number of trees (thousands)									
Leucaena leucocephala	8,607	2,866	734	320	—	—	—	—	9,341	2,983
Guamia mariannae	9,126	3,955	82	45	—	—	—	—	9,207	3,996
Hibiscus tiliaceus	7,765	2,278	1,255	424	29	28	—	—	9,049	2,452
Triphasia trifolia	8,526	6,470	—	—	—	—	—	—	8,526	6,470
Vitex parviflora	2,855	1,433	1,206	340	421	164	102	42	4,584	1,661
Aglaia mariannensis	4,274	3,199	257	93	—	—	—	—	4,532	3,241
Morinda citrifolia	3,322	1,246	75	42	—	—	—	—	3,396	1,268
Premna obtusifolia	1,938	949	578	205	41	30	14	14	2,571	1,055
Heterospathe elata	1,060	687	1,122	868	—	—	—	—	2,182	1,408
Neisosperma oppositifolia	1,673	1,247	286	214	14	14	—	—	1,973	1,304
Averrhoa bilimbi	1,825	1,341	110	81	—	—	—	—	1,935	1,422
Areca catechu	1,561	1,190	161	82	—	—	—	—	1,722	1,193
Casuarina equisetifolia	1,472	1,066	155	92	43	41	—	—	1,671	1,113
Ochrosia mariannensis	1,603	1,547	—	—	—	—	—	—	1,603	1,547
Cocos nucifera	—	—	705	281	745	290	14	14	1,464	528
Maytenus thompsonii	1,247	1,203	—	—	—	—	—	—	1,247	1,203
Pandanus tectorius	330	230	801	229	—	—	—	—	1,131	352
Cananga odorata	912	918	37	37	—	—	12	12	961	955
Adenanthera pavonina	760	765	49	49	12	12	12	12	834	826
Eugenia reinwardtiana	712	687	—	—	—	—	—	—	712	687
Cycas circinalis	—	—	610	242	14	14	—	—	624	242
Annona muricata	599	429	24	17	—	—	—	—	623	437
Bauhinia monandra	456	459	24	25	—	—	—	—	481	484
Calophyllum inophyllum	356	227	114	76	—	—	—	—	471	301
Ficus tinctoria	304	306	53	31	—	—	—	—	357	306
Mangifera indica	—	—	37	37	49	38	122	123	208	196
Annona reticulata	—	—	186	114	14	14	—	—	200	126
Macaranga thompsonii	—	—	86	69	86	59	14	14	186	129
Eugenia thompsonii	178	172	—	—	—	—	—	—	178	172
Mammea odorata	152	153	24	25	—	—	—	—	176	178
Melanolepis multiglandulosa	152	153	12	12	—	—	—	—	164	165
Chrysophyllum cainito	152	153	—	—	—	—	—	—	152	153
Tarenna sambucina	152	153	—	—	—	—	—	—	152	153
Ficus prolixa	—	—	98	60	24	24	29	28	150	81

Table A2-3—Number of live trees[a] on forest land by species and diameter class (continued)

	Diameter class (inches)									
	0–4.9		5.0–9.9		10.0–14.9		15.0+		All classes	
Scientific name	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Number of trees (thousands)									
Spathodea campanulata	—	—	49	38	51	30	24	25	124	82
Pisonia grandis	—	—	61	61	24	25	—	—	85	86
Tristiropsis obtusangula	—	—	75	63	—	—	—	—	75	63
Artocarpus altilis	—	—	37	20	37	37	—	—	73	51
Intsia bijuga	—	—	39	28	27	18	—	—	65	41
Artocarpus mariannensis	—	—	24	17	12	12	—	—	37	20
Barringtonia asiatica	—	—	24	25	—	—	12	12	37	37
Leucaena insularum	—	—	35	36	—	—	—	—	35	36
Tree unknown	—	—	27	18	—	—	—	—	27	18
Pandanus dubius	—	—	25	18	—	—	—	—	25	18
Eugenia palumbis	—	—	14	14	—	—	—	—	14	14
Glochidion marianum	—	—	14	14	—	—	—	—	14	14
Barringtonia racemosa	—	—	—	—	12	12	—	—	12	12
Hernandia sonora	—	—	—	—	12	12	—	—	12	12
Tabebuia pallida	—	—	12	12	—	—	—	—	12	12

Note: Totals may be off because of rounding; estimates are subject to sampling error.
SE = sampling error.
[a] Includes all live trees ≥1 inches in diameter at breast height.

Table A2-4—Estimated net volume of live trees[a] on forest land by species group and diameter class

	Diameter class (inches)									
	5.0–9.9		10.0–14.9		15.0–19.9		20+		All classes	
Scientific name	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand cubic feet									
Cocos nucifera	4,444.1	1,612.6	7,457.6	2,807.1	313.7	302.7	—	—	12,215.4	4,235.1
Vitex parviflora	3,912.8	1,254.0	4,446.2	1,738.7	739.7	394.6	842.2	721.5	9,940.8	3,425.0
Mangifera indica	83.5	84.1	836.4	622.1	1,784.3	1,795.8	419.7	422.4	3,123.9	2,877.0
Hibiscus tiliaceus	2,881.5	1,105.1	135.3	130.6	—	—	—	—	3,016.8	1,171.3
Heterospathe elata	2,782.9	2,216.5	—	—	—	—	—	—	2,782.9	2,216.5
Pandanus tectorius	2,273.3	720.1	—	—	—	—	—	—	2,273.3	720.1
Ficus prolixa	435.9	299.8	78.5	80.0	365.1	352.3	1,346.7	1,299.5	2,226.2	1,736.4
Premna obtusifolia	1,163.1	478.0	231.8	173.7	—	—	679.3	655.5	2,074.1	1,086.5
Macaranga thompsonii	478.3	346.3	996.3	637.7	162.8	157.1	—	—	1,637.5	1,045.1
Spathodea campanulata	263.8	202.2	813.6	467.9	122.4	123.2	415.3	418.0	1,615.1	1,057.7
Leucaena leucocephala	1,346.4	616.3	—	—	—	—	—	—	1,346.4	616.3
Casuarina equisetifolia	589.8	409.6	538.5	519.6	—	—	—	—	1,128.3	912.7
Cycas circinalis	1,070.8	458.7	32.5	31.4	—	—	—	—	1,103.3	458.9
Neisosperma oppositifolia	1,001.7	742.4	1.3	1.2	—	—	—	—	1,003.0	742.6
Annona reticulata	546.5	415.5	166.7	160.8	—	—	—	—	713.1	573.7
Artocarpus altilis	86.6	58.0	625.8	629.9	—	—	—	—	712.4	652.0
Aglaia mariannensis	600.3	262.3	—	—	—	—	—	—	600.3	262.3
Pisonia grandis	273.8	275.6	319.4	321.5	—	—	—	—	593.3	597.1
Intsia bijuga	198.6	138.3	388.1	278.2	—	—	—	—	586.7	342.8
Adenanthera pavonina	146.9	147.9	20.1	20.2	—	—	380.8	383.2	547.8	410.7
Cananga odorata	39.2	39.4	—	—	385.8	388.3	—	—	425.0	388.3
Barringtonia asiatica	144.0	145.0	—	—	—	—	267.9	269.7	412.0	414.6
Tristiropsis obtusangula	276.8	266.9	—	—	—	—	—	—	276.8	266.9
Calophyllum inophyllum	244.7	161.6	—	—	—	—	—	—	244.7	161.6
Artocarpus mariannensis	112.9	113.0	128.7	129.5	—	—	—	—	241.5	167.5
Morinda citrifolia	184.0	92.8	—	—	—	—	—	—	184.0	92.8
Areca catechu	179.5	91.6	—	—	—	—	—	—	179.5	91.6
Ficus tinctoria	139.4	88.5	—	—	—	—	—	—	139.4	88.5
Guamia mariannae	138.9	76.9	—	—	—	—	—	—	138.9	76.9
Hernandia sonora	—	—	129.1	131.6	—	—	—	—	129.1	131.6
Bauhinia monandra	77.2	77.7	—	—	—	—	—	—	77.2	77.7
Averrhoa bilimbi	74.9	63.0	—	—	—	—	—	—	74.9	63.0
Glochidion marianum	56.3	54.3	—	—	—	—	—	—	56.3	54.3
Pandanus dubius	54.9	40.0	—	—	—	—	—	—	54.9	40.0

Table A2-4—Estimated net volume of live trees[a] on forest land by species group and diameter class (continued)

	Diameter class (inches)									
	5.0–9.9		10.0–14.9		15.0–19.9		20+		All classes	
Scientific name	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand cubic feet									
Annona muricata	31.9	24.8	—	—	—	—	—	—	31.9	24.8
Mammea odorata	28.5	28.7	—	—	—	—	—	—	28.5	28.7
Leucaena insularum	16.7	17.0	—	—	—	—	—	—	16.7	17.0
Melanolepis multiglandulosa	16.7	16.8	—	—	—	—	—	—	16.7	16.8
Barringtonia racemosa	—	—	16.4	16.7	—	—	—	—	16.4	16.7
Eugenia palumbis	12.2	11.8	—	—	—	—	—	—	12.2	11.8
Tree unknown	10.2	9.0	—	—	—	—	—	—	10.2	9.0
Tabebuia pallida	4.2	4.3	—	—	—	—	—	—	4.2	4.3

Note: Totals may be off because of rounding; estimates are subject to sampling error.
SE = sampling error.
[a] Includes all live trees ≥5 inches in diameter at breast height.

Table A2-5—Estimated volume of all live trees[a] on forest land by diameter class

	Diameter class (inches)									
	5.0–9.9		10.0–14.9		15.0–19.9		20.0+		All sizes	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand cubic feet									
Net volume	26,423.7	3,287.6	17,362.2	3617.0	3,873.7	1,890.4	4,351.8	1,597.3	52,011.4	6,353.0

Note: Totals may be off because of rounding; estimates are subject to sampling error.
SE = sampling error.
[a] Includes all live trees ≥5 inches in diameter at breast height.

Table A2-6—Aboveground biomass and carbon of live [a] and dead trees[b] on forest land by diameter class

	Diameter class (inches)									
	5.0–9.9		10.0–14.9		15.0–19.9		20+		All classes	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousands of tons									
Live tree biomass	776.0	92.6	524.6	111.3	174.7	81.2	157.7	50.1	2,267.0	233.3
Dead tree biomass	21.3	4.7	8.9	6.8	—	—	—	—	30.3	8.8
Live tree carbon	388.0	46.3	262.3	55.7	87.4	40.6	78.9	25.1	1,133.5	116.7
Dead tree carbon	10.7	2.4	4.5	3.4	—	—	—	—	15.2	4.4

Note: Totals may be off because of rounding; estimates are subject to sampling error.
SE = sampling error;
[a] Includes all live trees ≥1 inches in diameter at breast height (d.b.h.); biomass of live trees 1 to 4.9 inches in diameter are not shown here.
[b] Includes all dead trees ≥5 inches d.b.h.; smaller dead trees were not measured in this inventory.

Table A2-7—Aboveground biomass of live trees[a] on forest land by species and diameter class

	Diameter class (inches)									
	0–4.9		5.0–9.9		10.0–14.9		15+		All classes	
Scientific name	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousands of tons									
Vitex parviflora	30.9	16.7	138.4	41.5	164.7	70.4	104.2	46.1	438.2	141.0
Cocos nucifera	—	—	104.8	39.2	198.8	78.8	7.1	6.9	310.7	111.8
Hibiscus tiliaceus	129.9	35.7	114.2	38.8	8.1	7.8	—	—	252.2	65.2
Leucaena leucocephala	103.1	34.6	57.5	25.6	—	—	—	—	160.6	52.7
Mangifera indica	—	—	3.3	3.3	26.1	21.3	90.1	90.7	119.5	114.8
Premna obtusifolia	16.9	11.4	56.6	21.1	9.2	6.6	25.4	24.5	108.2	50.1
Heterospathe elata	22.8	14.2	75.1	58.9	—	—	—	—	97.9	69.0
Aglaia mariannensis	57.9	49.1	20.0	8.3	—	—	—	—	77.8	51.2
Casuarina equisetifolia	26.2	20.6	16.8	10.5	20.5	19.8	—	—	63.5	36.3
Spathodea campanulata	—	—	7.3	5.5	26.2	15.6	24.0	24.2	57.5	38.3
Guamia mariannae	51.6	26.5	5.0	2.8	—	—	—	—	56.6	29.0
Neisosperma oppositifolia	14.0	9.4	28.9	21.5	4.2	4.1	—	—	47.1	29.1
Cananga odorata	26.5	26.6	2.1	2.2	—	—	15.1	15.2	43.8	31.9
Morinda citrifolia	38.4	17.5	5.3	2.8	—	—	—	—	43.7	18.4
Pandanus tectorius	3.7	2.6	34.2	10.3	—	—	—	—	37.9	11.2
Ficus prolixa	—	—	6.0	3.8	6.1	6.3	24.9	24.1	37.1	26.2
Adenanthera pavonina	2.6	2.6	4.2	4.2	2.9	2.9	23.8	24.0	33.5	25.4
Macaranga thompsonii	—	—	7.8	5.7	16.6	10.7	3.7	3.6	28.1	18.0
Averrhoa bilimbi	19.1	14.1	6.2	4.7	—	—	—	—	25.3	18.8
Cycas circinalis	—	—	23.1	9.9	2.0	1.9	—	—	25.1	10.1
Triphasia trifolia	24.9	20.9	—	—	—	—	—	—	24.9	20.9
Intsia bijuga	—	—	7.7	5.4	16.0	11.3	—	—	23.7	14.1

Table A2-7—Aboveground biomass of live trees[a] on forest land by species and diameter class (continued)

	Diameter class (inches)									
	0–4.9		5.0–9.9		10.0–14.9		15+		All classes	
Scientific name	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousands of tons									
Areca catechu	15.3	11.2	6.3	3.3	—	—	—	—	21.6	11.7
Annona reticulata	—	—	17.6	11.6	3.7	3.6	—	—	21.3	15.0
Artocarpus altilis	—	—	4.5	2.8	14.2	14.3	—	—	18.8	15.4
Barringtonia asiatica	—	—	3.5	3.5	—	—	13.9	14.0	17.4	17.5
Bauhinia monandra	13.7	13.8	1.9	1.9	—	—	—	—	15.6	15.7
Tristiropsis obtusangula	—	—	11.6	9.8	—	—	—	—	11.6	9.8
Ochrosia mariannensis	10.3	10.0	—	—	—	—	—	—	10.3	10.0
Calophyllum inophyllum	1.5	1.0	7.6	5.0	—	—	—	—	9.1	5.9
Pisonia grandis	—	—	4.1	4.2	4.4	4.4	—	—	8.5	8.5
Mammea odorata	5.2	5.3	1.5	1.5	—	—	—	—	6.8	6.8
Eugenia reinwardtiana	6.5	6.3	—	—	—	—	—	—	6.5	6.3
Maytenus thompsonii	5.8	5.6	—	—	—	—	—	—	5.8	5.6
Artocarpus mariannensis	—	—	2.0	1.4	3.4	3.5	—	—	5.5	3.7
Annona muricata	3.1	2.2	1.2	0.8	—	—	—	—	4.2	2.8
Hernandia sonora	—	—	—	—	3.9	4.0	—	—	3.9	4.0
Ficus tinctoria	0.8	0.8	3.0	1.6	—	—	—	—	3.8	1.8
Leucaena insularum	—	—	2.8	2.8	—	—	—	—	2.8	2.8
Barringtonia racemosa	—	—	—	—	2.4	2.5	—	—	2.4	2.5
Eugenia thompsonii	2.4	2.3	—	—	—	—	—	—	2.4	2.3
Tree unknown	—	—	1.4	1.0	—	—	—	—	1.4	1.0
Glochidion marianum	—	—	1.2	1.1	—	—	—	—	1.2	1.1
Tabebuia pallida	—	—	0.8	0.8	—	—	—	—	0.8	0.8
Eugenia palumbis	—	—	0.7	0.6	—	—	—	—	0.7	0.6
Melanolepis multiglandulosa	0.3	0.3	0.4	0.4	—	—	—	—	0.7	0.7
Pandanus dubius	—	—	0.7	0.5	—	—	—	—	0.7	0.5
Chrysophyllum cainito	0.5	0.5	—	—	—	—	—	—	0.5	0.5
Tarenna sambucina	0.2	0.2	—	—	—	—	—	—	0.2	0.2

Note: Totals may be off because of rounding; estimates are subject to sampling error.
SE = sampling error.
[a] Includes all live trees ≥1 inches in diameter at breast height.

Table A2-8—Average understory vegetation cover and number of Forest Inventory and Analysis subplots where the species occurred

Scientific name	Average cover	Number of subplots
	Percent	
Saccharum spontaneum	41.8	13
Epipremnum pinnatum	41.0	5
Bauhinia monandra	40.0	1
Antigonon leptopus	39.1	9
Miscanthus floridulus	37.5	48
Urochloa maxima	35.5	11
Musa	31.0	2
Bambusa vulgaris	30.0	2
Telosma	30.0	1
Tradescantia spathacea	30.0	1
Bothriochloa bladhii	29.4	23
Heterospathe elata	25.8	12
Casuarina equisetifolia	25.6	5
Gleichenia linearis	25.0	1
Hibiscus tiliaceus	23.1	59
Guamia mariannae	23.0	29
Triphasia trifolia	22.6	19
Aglaia mariannensis	22.3	14
Tarenna sambucina	21.5	2
Leucaena leucocephala	21.2	49
Tabebuia heterophylla	20.5	2
Dicranopteris linearis	20.3	15
Colubrina asiatica	20.3	12
Freycinetia reineckei	20.2	9
Neisosperma oppositifolia	20.0	4
Ochrosia mariannensis	20.0	4
Sorghum halepense	20.0	1
Teramnus labialis	20.0	2
Averrhoa bilimbi	19.4	8
Cocos nucifera	18.4	20
Flagellaria indica	18.0	27
Nephrolepis hirsutula	18.0	41
Curcuma longa	17.2	5
Syngonium podophyllum	16.3	3
Ochrosia oppositifolia	16.3	10
Pennisetum polystachion	16.1	24
Annona reticulata	15.9	7
Abelmoschus moschatus	15.0	1
Vitex parviflora	14.5	33
Nephrolepis biserrata	14.1	19
Pandanus dubius	14.0	2
Medinilla medinilliana	13.3	7
Scleria polycarpa	13.3	8
Annona squamosa	13.0	1
Flemingia strobilifera	13.0	9
Jasminum marianum	13.0	3
Morinda citrifolia	13.0	37
Areca catechu	12.5	13
Adenanthera pavonina	12.5	2
Pandanus tectorius	12.3	35
Rhynchospora rubra	12.3	11
Phymatosorus scolopendria	12.1	22
Phragmites karka	12.0	4
Cananga odorata	11.0	1
Thelypteris pennata	11.0	1
Premna obtusifolia	10.9	17
Maytenus thompsonii	10.3	3
Annona muricata	10.0	7
Citrus × *limon*	10.0	1
Cynodon dactylon	10.0	1
Melanolepis multiglandulosa	10.0	1
Melochia villosissima var. *compacta*	10.0	1
Microlepia speluncae	10.0	1
Thelypteris opulenta	10.0	1
Wikstroemia elliptica	9.7	3
Oplismenus hirtellus	9.5	6
Bidens alba	9.1	8
Eugenia thompsonii	9.0	2
Mikania micrantha	9.0	21
Spathodea campanulata	9.0	2
Calophyllum inophyllum	8.8	5
Cestrum diurnum	8.5	4
Oplismenus compositus	8.4	8

Table A2-8—Average understory vegetation cover and number of Forest Inventory and Analysis subplots where the species occurred (continued)

Scientific name	Average cover	Number of subplots
	Percent	
Barringtonia racemosa	8.0	2
Dimeria chloridiformis	8.0	11
Plumeria obtusa var. *obtusa*	8.0	1
Fimbristylis tristachya	7.7	9
Stylosanthes guianensis	7.7	3
Ficus microcarpa	7.5	2
Lycopodiella cernua var. *cernua*	7.5	6
Scaevola sericea	7.5	2
Thelypteris parasitica	7.5	2
Lygodium scandens	7.4	10
Cycas circinalis	7.0	2
Ipomoea pes-caprae ssp. *brasiliensis*	7.0	1
Entada pursaetha	6.8	9
Mucuna pruriens	6.8	4
Stictocardia tiliifolia	6.4	8
Sphagneticola trilobata	6.2	5
Acacia confusa	6.0	1
Alocasia macrorrhizos	6.0	1
Artocarpus altilis	6.0	1
Eugenia reinwardtiana	6.0	2
Ficus tinctoria	6.0	4
Melastoma malabathricum var. *mariannum*	6.0	1
Scaevola sericea var. *taccada*	6.0	1
Chromolaena odorata	5.9	14
Centotheca latifolia	5.0	1
Ipomoea pes-caprae	5.0	1
Ixora triantha	5.0	3
Senna tora	5.0	1
Sida rhombifolia	5.0	1
Hyptis capitata	5.0	26
Carica papaya	4.8	5
Fimbristylis dichotoma	4.8	4
Glochidion marianum	4.3	6
Polypodium punctatum	4.2	20
Waltheria indica	4.2	5
Averrhoa carambola	4.0	1
Hyptis rhomboidea	4.0	3
Mangifera indica	4.0	1
Miconia punctata	4.0	1
Passiflora foetida	4.0	4
Tecoma stans	4.0	1
Vigna adenantha	4.0	1
Pyrrosia lanceolata	3.8	6
Melastoma malabathricum	3.5	2
Passiflora suberosa	3.3	3
Arundina graminifolia	3.3	12
Abrus precatorius	3.0	1
Acacia mangium	3.0	1
Alocasia cucullata	3.0	1
Asplenium nidus	3.0	1
Cerbera dilatata	3.0	1
Discocalyx megacarpa	3.0	1
Eleusine indica	3.0	1
Imperata conferta	3.0	1
Lygodium microphyllum	3.0	3
Malvastrum coromandelianum	3.0	1
Mimosa pudica	3.0	2
Myrtella bennigseniana	3.0	1
Paspalum paniculatum	3.0	1
Pennisetum polystachion ssp. *setosum*	3.0	1
Psidium guajava	3.0	1
Pteris tripartita	3.0	2
Samanea saman	3.0	1
Spathoglottis plicata	3.0	1
Stachytarpheta jamaicensis	3.0	2
Thelypteris maemonensis	3.0	1
Thelypteris unita	3.0	2
Tristiropsis obtusangula	3.0	2
Wedelia	3.0	1

Glossary

abiotic—Pertaining to nonliving factors such as temperature, moisture, and wind.

aerial photography—Imagery acquired from an aerial platform (typically aircraft or helicopter) by means of a specialized large-format camera with well-defined optical characteristics. The geometry of the aircraft orientation at the time of image acquisition is also recorded. The resultant photograph will be of known scale, positional accuracy, and precision. Aerial photography for natural resource use is usually either natural color or color-infrared, and is film-based or acquired using digital electronic sensors.

aspect—Compass direction that a slope faces.

biodiversity—Variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequencies. https://www.epa.gov/enviroatlas/enviroatlas-benefit-category-biodiversity-conservation. (27 October 2019).

biomass—The aboveground weight of wood and bark in live trees 1.0 inch in diameter at breast height (d.b.h.) and larger from the ground to the tip of the tree, excluding all foliage. The weight of wood and bark in lateral limbs, secondary limbs, and twigs under 0.5 inch in diameter at the point of occurrence on sapling-size trees is included in the measure, but is excluded on poletimber- and sawtimber-size trees. Biomass is typically expressed as green oven-dry weight in tons (USDA FS 2006).

bole—Trunk or main stem of a tree.

damage—Damage to trees caused by biotic agents such as insects, diseases, and animals or abiotic agents such as weather, fire, or mechanical equipment.

diameter at breast height (d.b.h.)—The diameter of a tree stem, located 4.5 ft above the ground (breast height) on the uphill side of a tree. The point of diameter measurement may vary on abnormally formed trees (USDA FS 2006).

disturbance—Any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment (Helms 1998).

down woody material (DWM)—Dead material on the ground in various stages of decay. It includes coarse and fine wood material. Previously named down woody debris (DWD). https://www.nrs.fs.fed.us/fia/data-tools/state-reports/glossary/default.asp (27 October 2019).

ecosystem—A spatially explicit, relatively homogeneous unit of the Earth that includes all interacting organisms and components of the abiotic environment within its boundaries. An ecosystem can be of any size: a log, a pond, a field, a forest, or the Earth's biosphere (Helms 1998).

elevation—Height above a fixed reference point, often the mean sea level.

erosion—The wearing away of the land surface by running water, wind, ice, or other geological agents.

fixed-radius plot—A circular sampled area with a specified radius in which all trees of a given size, shrubs, and other items are tallied (USDA FS 2006).

forb—A broad-leaved herbaceous plant, as distinguished from grasses, shrubs, and trees (USDA FS 2006).

forest land—Land that is at least 10 percent tree cover by forest trees of any size, or land formerly having such tree cover, and not currently developed for a nonforest use (USDA FS 2006).

forest type—A classification of forest land based on and named for the tree species that forms the plurality of live-tree cover that are not overtopped (USDA FS 2006). These forest types are also called forest communities and are delineated by the classification guide outlined in Mueller-Dombois and Fosberg (1998).

forest type group—A combination of forest types that share closely associated species or site requirements (USDA FS 2006).

graminoid—Grasses (family Gramineae or Poaceae) and grass-like plants such as sedges (family Cyperaceae) and rushes (family Juncaceae).

grassland—Land on which the vegetation is dominated by grasses, grass-like plants, or forbs.

invasive plant—A plant that is not native to the ecosystem under consideration and that causes or is likely to cause economic or environmental harm or harm to human, animal, or plant health. http://www.invasivespeciesinfo.gov/docs/council/isacdef.pdf. (5 January 2015).

live trees—All living trees, including all size classes, all tree classes, and both commercial and noncommercial species listed in the Forest Inventory and Analysis (FIA) field manual (USDA FS 2006).

mortality—The death of trees from natural causes, or subsequent to incidents such as storms, wildfire, or insect and disease epidemics (Helms 1998).

native species—Plant species that were native to an American region prior to Euro-American settlement. For vascular plants, they are the species that are not present on the USDA Natural Resources Conservation Service list of nonnative species (see **nonnative species**) (USDA NRCS 2000).

nonforest land—Land that has never supported forests or formerly was forested and currently is developed for nonforest uses. Included are lands used for agricultural crops, residential areas, and constructed roads. The area must be at least 1.0 ac and 120.0 ft wide.

nonnative species—Plant species that were introduced to America subsequent to Euro-American settlement. Nonnative vascular plants are present on the USDA Natural Resources Conservation Service list of nonnative species (USDA NRCS 2000).

nontimber forest products (NTFP)—Species harvested from forests for reasons other than production of timber commodities.

ownership—A legal entity having an ownership interest in land, regardless of the number of people involved. An ownership may be an individual; a combination of persons; a legal entity such as corporation, partnership, club, or trust; or a public agency. An ownership has control of a parcel or group of parcels of land (USDA FS 2006).

pathogen—An organism or virus directly capable of causing disease or mortality.

regeneration—The established progeny from a parent plant, seedlings or saplings existing in a stand, or the act of renewing tree cover by establishing young trees naturally or artificially. May be artificial (direct seeding or planting) or natural (natural seeding, coppice, or root suckers) (adapted from Helms 1998).

remote sensing—Capture of information about the Earth from a distant vantage point. The term is often associated with satellite imagery but also applies to aerial photography, airborne digital sensors, ground-based detectors, and other devices.

reserved forest land—Land permanently reserved from wood products utilization through statute or administrative designation. Examples include national forest wilderness areas and national parks and monuments (USDA FS 2006).

sampling error—Difference between a population value and a sample estimate that is attributable to the sample, as distinct from errors due to bias in estimation, errors in observation, etc. Sampling error is measured as the standard error of the sample estimate (Helms 1998).

sapling—A live tree 1.0 to 4.9 inches in diameter (USDA FS 2006).

seedlings—Live trees <1.0 inch d.b.h. and at least 6 inches in height (softwoods) or 12 inches in height (hardwoods) (USDA FS 2006).

shrub—Perennial, multistem woody plant, usually less than 13 to 16 ft in height, although under certain environmental conditions shrubs may be single-stem or taller than 16 ft. Includes succulents (e.g., cacti) (USDA FS 2006).

slope—Measure of change in surface value over distance, expressed in degrees or as a percentage (Helms 1998).

snag—Standing dead tree ≥5 inches d.b.h. and ≥4.5 ft in length, with a lean of <45 degrees. Dead trees leaning more than 45 degrees are considered to be down woody material. Standing dead material shorter than 4.5 ft are considered stumps (USDA FS 2006).

species group—A collection of species used for reporting purposes (USDA FS 2006).

stand-size class—A classification of stands based on tree size. Large-diameter stands have the majority of trees at least 11.0 inches d.b.h. for hardwoods and 9.0 inches d.b.h. for softwoods; medium-diameter stands have the majority of trees at least 5.0 inches d.b.h. but not as large as large-diameter trees; and small-diameter stands have the majority of trees less than 5.0 inches d.b.h.

stratification—A statistical tool used to reduce the variance of the attributes of interest by partitioning the population into homogenous strata (Bechtold and Patterson 2005).

succession—The gradual supplanting of one community of plants by another (Helms 1998).

terrestrial—Of or relating to the Earth or its inhabitants; of or relating to land as distinct from air or water. http://www. merriam-webster.com/dictionary/terrestrial. (5 January 2015).

tree—A woody perennial plant, typically large, with a single well-defined stem carrying a more or less definite crown; sometimes defined as attaining a minimum diameter of 3 inches and a minimum height of 15 ft at maturity. For FIA, any plant on the tree list in the current field manual is measured as a tree (USDA FS 2006).

understory—All forest vegetation growing under an overstory (Helms 1998).

unreserved forest land—Forest land that is not withdrawn from harvest by statute or administrative regulation. Includes forest lands that are not capable of producing in excess of 20 ft^3/ac per year of industrial wood in natural stands (Smith et al. 2004).

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