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Incidence of Damage and Cull in Puerto Rico's Timber Resource, 1980

Robert L. Anderson, Richard A. Birdsey, and Patrick J. Barry

FQREWORD

This bulletin reports survey data on agents damaging trees in Puerto Rico's secondary forests. Data were collected in 1980 by the Renewable Resources Evaluation Work Unit of the Southern Forest Experiment Station.

This effort was part of a comprehensive inventory of Puerto Rico's potential commercial forest land. The variety of information collected makes possible the publication of reports on forest resources other than timber, such as this specialized report on timber damage.

The Southern Forest Experiment Station in New Orleans, La. periodically inventories and evaluates forest resources in Tenn., La., Miss., Ala., Tex., Okla., Ark., and Puerto Rico. The Southeastern Area, State and Private Forestry, Forest Pest Management headquarters, in Atlanta, Ga. provides training and field support, and helps evaluate the data on forest insects, diseases, and other damaging agents.

While damage is described here, appropriate measures for preventing damage are not described. Residents of Puerto Rico needing technical assistance on damaging agents should contact: Commonwealth of Puerto Rico, San Juan, PR Department of Natural Resources.

UNIT CONVERSION FACTORS
Metric to English and English to Metric Conversions

1 cm. = 0.3937 in.	1 in. = 2.54 cm.
1 m. = 3.281 ft.	1 ft. = .3048 in.
1 km. = .6214 mi.	1 mi. = 1.6093 km.
1 sq. m. = 10.7639 sq. ft.	1 sq. ft. = 0.0929 sq. m.
1 ha. = 2.471 ac.	1 ac. = 0.4047 ha.
1 cu. m. = 35.3145 cu. ft.	1 cu. ft. = 0.0283 cu. m.
1 sq. m. per ha. = 4.356 sq. ft./ac.	1 sq. ft./ac. = 0.2296 sq. m./ha.
1 cu. m. per ha. = 14.29 cu. ft./ac.	1 cu. ft./ac. = 0.07 cu. m./ha.

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INTRODUCTION

During the inventory of Puerto Rico's secondary forests in 1980, damage to trees on sample plots in timberland was noted. Where possible, the principle type of damage was specified. This bulletin reports and interprets those observations.

Since plots are visited only once and at any time of year, it is only possible to keep records on damage types that remain identifiable in all seasons. On the basis of these "durable" symptoms and signs, the damages defined on pages 11 and 12 were recognized.

Prior to the field survey, people from the Southeastern Area, State and Private Forestry, Forest Pest Management, developed a handbook for identifying damage types. It should be recognized that the data reported here were not gathered by people with expertise in entomology or tree pathology. Rather, crew members are trained and experienced in forest inventory. They received training, pictures of each damage type, specimen kits, and forms to help them identify types of damage.

Signs, symptoms, and damage types selected for the survey were required to be; (1) easily identifiable, (2) present year-round, and (3) present on trees at least 2.5 centimeters in diameter at breast height. Therefore, small trees with problems, such as shoot insects, and trees of all sizes with damage such as defoliation, are not accounted for in this report.

Many damage types, such as form and cankers, are easy to identify; others, such as root rot and hardwood borers, are sometimes difficult to recognize. Consequently, the estimates for easily recognizable and persistent damage types are more reliable than the estimates for damage types that are difficult to recognize.

SAMPLING PROCEDURE

The data in this report were obtained by a sampling method involving a forest-nonforest classification on aerial photographs and on-the-ground measurements of trees at sample locations. The sample locations were at the intersections of a grid of lines spaced three kilometers apart. In Puerto Rico, 10,925 photographic classifications were made, and 437 ground sample locations were visited. The initial estimates of forest area obtained from the aerial photographs were adjusted on the basis of the ground check.

A cluster of 3 variable-radius plots was installed at each ground sample location. Each sample tree on the variable-radius plots represented 2.5 square meters of basal area per hectare. Trees less than 12.5 centimeters in diameter were tallied on fixed-radius plots around the plot centers. Together, these samples provided most of the information for the damage incidence and cull.

This sampling procedure was designed to provide reliable forest area and volume estimates for the whole island. Accordingly, the errors associated with uncommon species exceed those for frequently tallied species.

Only the most significant damage type was recorded for each sample tree. The damage type chosen was that which would cause the death of the tree, the most degrade, or the most growth loss. Damaging agents which are common, but do not seriously affect the tree may be underestimated with this procedure.

COMPUTATIONS

1. All field data were edited, compiled, and tabulated in New Orleans as part of the regular survey data processing. Data concerning damage incidence were summarized and sent to Asheville for further tabulation and analysis.
2. The percent basal area with some type of damage was calculated by taking the basal area of the damaged trees and dividing it by the total basal area for the species.
3. The pereent of saplings, poletimber, and sawtimber damaged by tree species was calculated by totaling the number of damaged trees and dividing it by the total number of trees in that size class and species.
4. The percent incidence for damage types by size class and species was calculated by taking the total number of damaged trees and dividing them by the total number of damaged and undamaged trees.
5. The volume of cull associated with each species was measured in the field and tabulated in the office.

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INCIDENCE OF DAMAGE

Detailed tables in this report show numbers of damaged trees by tree species. Tables 1 and 2 provide some basic inventory estimates of land area and forest area in various forest classes and stand-size classes.

Table 3 shows the percent of trees and basal area damaged by species and tree size class. Overall, about 50 percent of the basal area of trees in Puerto Rico had some type of damage, with the lowest occurrence in *Roystonea borinquena* (10%), and highest in *Ficus citrifolia* (100%). Most of the damaged trees were sawtimber size, with poletimber size trees affected to a lesser degree and saplings the least affected. However, each species should be examined individually, since some trees, like *Miconia prasina,* have damage-free sawtimber, with the only recorded damage showing up in the saplings. This size class distribution of the damage is expected since form damage was the most common damage type, and the older the tree the longer it would be susceptible to damage.

Table 4 presents the incidence of damage by tree species and size class. Form was the most common damage type, significantly affecting most of the species. In most cases, the sawtimber-size trees had more damage than the smaller size classes. Form damage can be caused by a variety of factors, such as wind, insects, cankers, and vines and parasitic plants. The actual cause of form damage was unidentifiable because of the time lapse between the damage and the survey date. Because Puerto Rico is subjected to frequent storms, the high occurrence of form damage is not surprising. Other diseases, basal defects, top breakage, vines, and cankers are significantly less common than form damage, but make up the bulk of the remaining damage occurrence. Many of these damage types, such as top breakage and cankers, may result in form damage as the tree reponds with crook or sweep. Therefore, in future surveys many of these trees will become form-damaged, and a new group of recently damaged trees will take their places.

Sound and unsound cull are presented by species in table 5. Seventy-two percent of the cull was sound cull. This fits with the high occurrence of form damage, which usually causes deformity, but little unsound cull. The unsound cull (28% of the cull) is normally associated with damage types such as basal defects, branch stubs, and top breakage. An example of this relationship would be *Inga vera,* which has a high occurrence of form damage (57%) and a relatively high occurrence of branch stubs and other diseases. The sound and unsound cull for this species is high. However, *Prestoea montana,* a common palm, has a low occurrence of form damage and other defects, except for vines in the sawtimber. The sound and unsound cull volume are also low for this species. The reader may find it helpful to compare tables 4 and 5 by species to determine further relationships and their implication for management.

Table *1.-Area by land classes, Puerto Rico, 1980*

Land class	Area
	---hectares---
Forest	
Commercial survey region:	
Public	8,200
Private	122,300
Total	130,500
Noncommercial survey region:	
Subtropical Dry Forest Zone	30,000
Critical watersheds	74,400
Other[1]	43,800
Total	148,200
Total Forest	278,700
Nonforest	
Commercial survey region:	
Cropland	41,500
Pasture	187,700
Other[2]	76,900
Total	306,100
Noncommercial survey region	305,500
Total Nonforest	611,600
All land	890,300

[1] Unproductive soils, alluvial and metropolitan regions, mangroves and swamps, non-contiguous land areas.

[2] Idle farmland, water, roads and rights of way, urban and industrial areas.

Table *2.-Area of timberland by stand-size class and forest class, Puerto Rico, 1980*

Stand-size class	All forest classes	Secondary forest	Abandoned coffee shade	Active coffee shade	Nonstocked areas
	hectares				
Sawtimber	40,900	15,300	17,800	7,800	. . . . .
Poletimber	44,700	18,700	16,500	9,500	. . .
Sapling and seedling	33,200	25,200	3,900	4,100	. . . . .
Nonstocked areas	11,700	. . . . .	. . . . .	. . . .	11,700
All classes	130,500	59,200	38,200	21,400	11,700

48 spp + other

Table *3.-Tree damage by specks and tree size class, Puerto Rico timberland, 1980'*

Species	Total basal area damage	Total no. live trees	Trees damaged		
			Saplings	Poletimber	Sawtimber
	percent	*thousand*		*percent*	
Znga vera Willd.	72	7,385	20	75	83
Guarea guidonia (L.) Sleumer	57	12,938	16	49	77
Cecropia peltata L.	31	3,731	11	29	13
Andira inermis (W. Wright) H.B.K.	41	8,506	17	26	50
Znga fagifolia (L.) Willd.	54	3,645	25	11	62
Eugenia jumbos L.	65	9,605	21	86	94
Tabebuia heterophylla (DC.) Britton	32	9,746	11	4	81
Spathodea campanulata Beauv.	37	6,693	5	61	42
Mangifera indica L.	90	1,057	0	54	93
Citrus sinensis Osbeck	65	4,479	27	83	....
Erythrina poeppigiana (Walp.) O.F. Cook	69	607	50	95	70
Dendropanax arboreus (L.) Decne. & Planch.	69	3,039	27	53	100
Didymopanax morototoni (Aubl.) Decne & Planch.	22	2,407	12	20	40
Coffea arabica L.	27	25,425	16	....	....
Ocotea ***leucoxylon*** (Sw.) Mez	56	3,963	12	67	100
Prestoea montana (R. Grah.) Nichols	6	946	...	3	100
Calophyllum calaba L.	14	3,411	2	10	29
Roystonea borinquena O.F. Cook	12	241		0	10
Alchornea latifolia Sw.	5	1,571	'25	62	44
Thouinia striata Radlk.	49	3,903	24	75	....
Casearia guianensis (Aubl.) Urban	18	12,224	22	....	....
Cyathea arborea (L.) J.E. Smith	17	1,695	15	23	....
Myrcia splendens (Sw.) DC.	29	5,231	17	86	...
Ficus citrifolia Mill.	100	566	67	100	100
Cordia sulcata DC.	45	2,213	30	48	53
Clusia rosea Jacq.	76	797	0	92	100
Citharexylum fruticosum L.	53	1,968	5	100	90
Terebraria resinosa (Vahl) Sprague	46	2,908	15	100	100
Miconia sp.	25	2,144	23	9	42
Casearia sylvestris Sw.	30	8,815	32	....	....
Psidium guajava L.	20	7,656	23	99	....
Unidentified species	53	2,281	18	2	100
Tetrazygia elaeagnoides (Sw.) DC.	27	3,861	17	100	....
Cordia alliodora (Ruiz & Pav.) Oken	19	1,542	9	25	16
Lonchocarpus pentaphyllus (Poir.) DC.	44	1,227	0	81	86
Petitia domingensis Jacq.	63	1,111	31	65	100
Nectandra sintenisii Mez.	22	2,030	21	9	73
Dipholis salicifolia (L.) A.DC.	40	1,044	0	58	....
Cedrela odorata L.	61	445	100	30	79
Guettarda scabra (L.) Vent.	12	8,637	5	....	....
Spondias mombin L.	61	449	14	....	87
Micropholis chrysophylloides Pierre	53	847	25	79	48
Zanthoxylum martinicense (Lam.) DC.	67	987	8	90	66
Byrsonima coriacea (Sw.) DC.	55	355	0	56	65
Artocarpus altilis (Parkinson) Fosberg	73	167	0	75	73
Miconia prasina (Sw.) DC.	16	4,686	18	....	0
Pouteria multiflora (A.DC.) Eyma	54	227	0	32	77
Montezuma speciossima Sesse & Moc.	85	340	0	70	100
Other Species (142)	38	68,566	18	59	82
All Species	48	258,747	21	53	69

[1] Totals may not add due to rounding.

Table *4.-Damage incidence by tree species, size class, and damaging agent, Puerto Rico timberland, 1980*

Host/damage	Tree size class		
	Saplings	Poletimber	Sawtimber
	percent		
Inga vera Willd.			
Other insects	*1*	*0*	*0*
Cankers	*0*	2	1
Branchstubs	*0*	8	2
Other diseases	5	10	14
Root rots	1	0	0
Other basal defects	0	2	1
Top breakage	0	3	1
Form(damaging)	9	44	57
Suppression & stagnation	3	0	1
Vines and parasitic plants	0	2	2
People	0	1	1
Other damage	1	3	3
Damage free	80	25	17
Guarea guidonia (L.) Sleumer			
Cankers	*0*	3	2
Branchstubs	*0*	0	1
Other diseases	1	1	3
Other basal defects	0	0	1
Top breakage	2	0	1
Form(damaging)	10	37	63
Suppression & stagnation	1	6	0
Vines and parasitic plants	1	0	1
Weather	0	2	2
People	1	0	2
Other damage	0	0	1
Damage free	84	51	23
Cecropia peltata L.			
Cankers	*0*	5	2
Other diseases	*0*	5	0
Other basal defects	*0*	0	3
Top breakage	*0*	3	1
Form(damaging)	11	19	4
Vines and parasitic plants	0	0	1
Weather	0	7	1
Other damage	0	0	1
Damage free	89	61	a7
Andira inermis H.B.K. (W. Wright)			
Other diseases	2	0	6
Other basal defects	*0*	0	10
Top breakage	2	3	12
Form(damaging)	7	24	13
Suppression & stagnation	3	0	0
Vines and parasitic plants	1	4	0
Weather	0	3	6
People	2	2	3
Damage free	83	64	50
Znga ***fagifolia*** (L.) Willd.			
Cankers	*0*	2	12
Other diseases	*0*	2	7
Top breakage	3	4	0
Form(damaging)	19	0	35
Suppression & stagnation	0	2	0
Vines and parasitic plants	3	0	4
Weather	0	0	4
People	0	1	0
Damage free	75	89	38

Table 4.-Damage incidence by tree species, size class, and damaging agent, Puerto Rico timberland, 1980—Continued

Host/damage	Tree size class		
	Saplings	Poletimber	Sawtimber
	percent		
Eugenia jambos L.			
Cankers	0	4	0
Other diseases	1	2	9
Form(damaging)	19	77	86
Suppression & stagnation	1	0	0
Weather	0	5	0
Damage free	79	14	6
Tabebuia heterophylla (D.C.) Britton			
Cankers	1	0	10
Other diseases	1	0	15
Form(damaging)	7	1	56
Vines and parasitic plants	0	1	0
People	2	0	0
Other damage	0	2	0
Damage free	89	96	19
Spathodea campanulata Beauv.			
Cankers	0	16	2
Branch stubs	0	3	0
Other diseases	0	0	11
Other basal defects	0	11	0
Top breakage	0	0	7
Form(damaging)	3	27	15
Vines and parasitic plants	0	7	0
Weather	0	0	2
People	2	0	0
Other damage	0	0	5
Damage free	95	39	58
Mangifera indica L.			
Other diseases	0	0	8
Other basal defects	0	0	1
Form(damaging)	0	64	83
People	0	0	1
Damage free	100	36	7
Citrus sinensis Oebek.			
Other diseases	2	11	....
Other basal defects	0	3	....
Top breakage	0	4	....
Form(damaging)	13	65	....
Suppression & stagnation	2	0	....
People	20	0	....
Damage free	63	17	....
Erythrina poeppigiana (Walp.) O.F. Cook			
Other diseases	0	0	12
Top breakage	0	0	2
Form(damaging)	50	67	39
Vines and parasitic plants	0	5	8
Weather	0	15	0
People	0	0	2
Other damage	0	8	7
Damage free	50	5	30
Dendropanax arboreus (L.) Decne. & Planch.			
Other diseases	0	0	11
Other basal defects	0	0	5
Top breakage	0	0	13
Form(damaging)	27	50	66
People	0	0	5
Other damage	0	3	0
Damage free	73	47	0

Table 4.—*Damage incidence by tree species, size class, and damaging agent, Puerto Rico timberland, 1980—Continued*

Host/damage	Tree size class		
	Saplings	Poletimber	Sawtimber
	percent		
Didymopanax morototoni (Aubl.) Decne & Planch.			
Other diseases	0	0	23
Other basal defects	0	6	0
Form (damaging)	12	11	17
Vines and parasitic plants	0	3	0
Damage free	88	80	60
Coffea arabica L.			
Other diseases	1	....	....
Top breakage	1	....	....
Form (damaging)	23	....	....
Weather	1	....	....
Damage free	74	....	....
Ocotea leucoxylon (Sw.) Mez.			
Cankers	0	6	0
Other diseases	0	4	37
Form (damaging)	5	52	63
Suppression & stagnation	4	0	0
Weather	0	5	0
People	1	0	0
Other damage	2	0	0
Damage free	88	33	0
Prestoea montana (R. Grah.) Nichols			
Vines and parasitic plants	....	0	100
Weather	....	3	0
Damage free	....	97	0
Calophyllum calaba L.			
Other diseases	0	0	11
Other basal defects	0	0	14
Form (damaging)	2	10	4
Damage free	98	90	71
Roystonea borinquena O.F. Cook			
Other diseases	...	0	6
Form (damaging)	....	0	4
Damage free	....	100	90
Alchornea latifolia SW			
Branch stubs	0	12	0
Other diseases	0	6	7
Other basal defects	0	11	0
Top breakage	0	0	0
Form (damaging)	17	21	15
Vines and parasitic plants	0	0	22
Other damage	8	12	0
Damage free	75	38	56
Thouinia striata Radlk.			
Other diseases	1	0	....
Form (damaging)	21	75	....
Suppression & stagnation	2	0	...
Damage free	76	25	....
Casearia guianensis (Aubl.) Urban			
Top breakage	3	....	....
Form (damaging)	12	...	....
Suppression & stagnation	4	....	....
Vines and parasitic plants	3	....	....
Damage free	78	....	....

Table 4.-Damage incidence by tree specks, size class, and damaging agent, Puerto Rico timberland, 1980—Continued

Host/damage	Tree size class		
	Saplings	Poletimber	Sawtimber
	percent		
Cyathea arborea (L.) J.E. Smith			
Form (damaging)	15	23	
Damage free	85	77	....
Myrcia spkndens (Sw.) D.C.			
Other diseases	0	21	....
Top breakage	1	0	....
Form (damaging)	14	65	....
People	1	0	....
Other damage	1	0	....
Damage free	83	14	....
Ficus citrifolia Mill.			
Form (damaging)	67	100	82
People	0	0	18
Damage free	33	0	0
Cordia sukata D.C.			
Cankers	5	0	0
Other diseases	8	0	0
Other basal defects	0	13	0
Top breakage	0	0	0
Form (damaging)	17	31	28
Weather	0	0	26
People	0	4	0
Damage free	70	52	47
Clusia *rosea* Jacq.			
Branchstubs	0	10	0
Form (damaging)	0	72	100
Other damage	0	10	0
Damage free	100	8	0
Citharexylum fiuticosum L.			
Branch stubs	0	5	0
Other diseases	1	0	0
Form (damaging)	4	90	90
Other damage	0	5	0
Damage free	95	0	10
Terebraria resinosa (Vahl.) Sprague			
Other diseases	4	0	0
Other basal defects	0	19	0
Form (damaging)	11	81	100
Damage free	85	0	0
Miconia sp.			
Other diseases	0	0	19
Form (damaging)	13	9	23
Suppression & stagnation	10	0	0
Damage free	77	91	58
Casearia sylvestris Sw.			
Other diseases	5	....	....
Top breakage	1	....	....
Form (damaging)	25	....	....
Suppression & stagnation	1	....	....
Damage free	68	....	....
Psidium guajava L.			
Other insects	1	0	....
Top breakage	1	0	....
Form (damaging)	20	99	....
Other damage	1	0	....
Damage free	77	1	

Table 4.-Damage incidence by tree species, size claw, and damaging agent, Puerto Rico timberland, 1980—Continued

Host/damage	Tree size class		
	Saplings	Poletimber	Sawtimber
	percent		
Unidentified species			
Other diseases	10	2	0
Branchstubs	0	0	8
Top breakage	4	0	0
Form(damaging)	4	0	55
People	0	0	29
Other damage	0	0	8
Damage free	82	98	0
Tetrazygia elaegnoides (Sw.) DC.			
Form(damaging)	14	100	....
Suppression & stagnation	3	0	....
Damage free	83	0	....
Cordia alliodora (Ruiz & Pav.) Oken			
Other diseases	0	16	0
Top breakage	0	0	15
Form(damaging)	9	9	0
Damage free	91	75	85
Lonchocarpus pentaphyllus (Poir.) DC.			
Branchstubs	0	0	43
Form(damaging)	0	73	0
People	0	8	0
Other damage	0	0	43
Damage free	100	19	14
Petitia domingensis Jacq.			
Other diseases	0	0	95
Form(damaging)	25	65	5
Suppression & stagnation	6	0	0
Damage free	69	35	0
Nectandra sintenisii Mez.			
Other insects	6	0	0
Other diseases	0	9	39
Other basal defects	0	0	35
Form(damaging)	9	0	0
Other damage	6	0	0
Damage free	79	91	26
Dipholis salicifolia (L.) A.DC.			
Form(damaging)	0	58	....
Damage free	100	42	....
Cedrela odorata L.			
Form(damaging)	100	30	69
Damage free	0	70	21
Guettarda scabra (L.) Vent.			
Other diseases	3	. . .	....
Top breakage	1	....	. . .
Form(damaging)	1	....	....
Damage free	95	....	....
Spondias mombin L.			
Other diseases	0	. .	30
Other basal defects	0	....	4
Top breakage	0	....	18
Form(damaging)	14	. . .	4
Vines and parasitic plants	0	....	9
People	0	....	22
Damage free	86	....	13

Table 4.—*Damage incidence by tree species, size class, and damaging agent, Puerto Rico timberland, 1980—Continued*

Host/damage	Tree size class		
	Saplings	Poletimber	Sawtimber
	percent		
Micropholis chrysophylloides Pierre.			
Other diseases	0	0	22
Branchstubs	0	11	0
Form(damaging)	25	35	26
Other damage	0	33	0
Damage free	75	21	52
Zanthoxylum martinincense (Lam.) DC.			
Other diseases	0	6	66
Branchstubs	0	8	0
Top breakage	0	17	0
Form(damaging)	8	51	0
Other damage	0	8	0
Damage free	92	10	34
Byrsonima coriacea (Sw.) DC.			
Form(damaging)	0	56	65
Damage free	100	44	45
Artocarpus altilis (Parkinson) Fosberg			
Other basal defects	0	0	9
Branchstubs	0	0	14
Form(damaging)	0	75	36
Other damage	0	0	14
Damage free	100	26	27
Miconia prasina (Sw.) DC.			
Cankers	1	....	0
Other diseases	2	....	0
Form(damaging)	12	....	0
Vines and parasitic plants	3	....	0
Damage free	82	....	100
Pouteria multiflora (A.DC.) Eyma			
Other diseases	0	0	34
Other basal defects	0	32	0
Top breakage	0	0	2
Form(damaging)	0	0	41
Damage free	100	68	23
Montezuma speciossima Sesse & Moe.			
Cankers	0	42	0
Other diseases	0	0	24
Top breakage	0	0	30
Form(damaging)	0	28	37
Other damage	0	0	9
Damage free	100	30	0
Other species			
Cankers	0	0	2
Branchstubs	0	3	2
Other diseases	1	3	7
Other basal defects	0	3	5
Top breakage	1	1	2
Form(damaging)	12	38	27
Suppression & stagnation	2	0	0
Vines and parasitic plants	1	3	0
Weather	0	2	1
People	0	1	29
Other damage	1	6	7
Damage free	82	41	18

Table 5.-Timber volume and sound and unsound cull volume by species for damaged trees, Puerto Rico timberland, 1980

Species	Timber volume	Sound[1] cull	Unsound cull
	Thousand cubic meters		
Inga vera Willd.	532.3	108.3	55.7
Guarea guidonia (L.) Sleumer	385.2	74.1	10.0
Cecropia peltata L.	131.6	5.9	16.9
Andira inermis (W. Wright) H.B.K.	114.7	20.8	3.1
Znga fagifolia (L.) Willd.	155.3	16.0	12.6
Eugenia jambos L.	104.5	31.4	4.5
Tabebuia heterophylla (DC.) Britton	45.2	4.2	4.2
Spathodea campanulata Beauv.	69.3	12.3	7.2
Mangifera indica L.	160.0	46.6	13.6
Citrus *sinensis* Osbeck	50.3	9.3	6.5
Erythrina poeppigiana (Walp.) O.F. Cook	117.5	19.7	5.4
Dendropanox arboreus (L.) Decne. & Planch.	88.7	16.4	8.4
Didymopanax morototoni (Aubl.) Decne. & Planch.	24.5	4.0	2.1
Coffea arabica L.	0.0	0.0	0.0
Ocotea leucoxylon (Sw.)Mez	43.8	6.6	3.9
Prestoea montana (R. Grah.) Nichols	11.5	0.4	0.0
Calophyllum calaba L.	20.3	5.6	0.6
Roystonea borinquena O.F. Cook	16.4	0.6	2.5
Alchornea latifolia Sw.	32.5	5.6	4.6
Thouinia striata Radlk.	5.4	0.3	0.0
Casearia guianensis (Aubl.) Urban	0.0	0.0	0.0
Cyathea arborea (L.) J.E. Smith	3.6	0.0	0.0
Myrcia splendens (Sw.) DC.	8.4	0.9	0.5
Ficus citrifolia Mill.	46.4	12.5	6.4
Cordia sukata DC.	26.1	3.8	0.9
Clusia rosea Jacq.	52.9	10.7	1.9
Citharexylum fruticosum L.	21.4	4.6	0.3
Terebraria resinosa (Vahl) Sprague	11.8	1.4	0.7
Miconia sp.	21.0	1.2	0.6
Casearia sylvestris Sw.	0.0	0.0	0.0
Psidium guajava L.	1.2	1.2	0.0
Unidentified species	35.1	4.1	3.3
Tetrazygia elaeagnoides (Sw.) DC.	2.4	0.5	0.0
Cordia alliodora (Ruiz & Pav.) Oken	8.8	1.3	0.9
Lonchocarpus pentaphyllus (Poir.) DC.	21.6	5.2	0.0
Petitia domingensis Jacq.	22.7	4.0	2.9
Nectandra sintenisii Mez.	11.6	0.9	3.0
Dipholis salicifolia (L.) A.DC.	18.5	1.0	0.4
Cedrela odorata L.	30.7	3.5	0.6
Guettarda scabra (L.) Vent.	0.0	0.0	0.0
Spondias mombin L.	28.3	4.6	2.4
Micropholis chrysophylloides Pierre	15.3	2.4	1.3
Zanthoxylum martinicense (Lam.) DC.	26.3	11.3	1.8
Byrsonima coriacea (Sw.) DC.	31.9	7.3	0.0
Artocarpus altilis (Parkinson) Fosberg	34.0	2.3	2.7
Miconiu prasina (Sw.) DC.	0.0	0.0	0.0
Pouteria multiflora (A.DC.) Eyma	27.3	3.0	2.5
Montezuma speciossima Sesse & Moc.	27.5	5.1	3.5
Other Species (142)	333.0	69.4	19.1
All Species	2975.7	549.9	215.2

[1] Sound cull is included in timber volume.

Damaging Agents and Their Symptoms

Hardwood Borers.-The initial symptom is a dark sap spot on the bark surface (often mixed with frass). Eventually, the coarse boring particles appear in bark cracks and crevices beneath the point of attack. Old damage appears as knobby overgrowths or scars on the bark surface.

Bark Beetles.-If the infestation is well established and some trees still retain their foliage, tunnels or egg galleries are evident on the inner bark surface and on the surface of the sapwood. Streaks caused by blue stain fungi are often also evident on sapwood. Foliage gradually yellows, then reddens.

Terminal Shoot and Stem Borers.-Fresh attacks will show boring dust and frass at the entrance holes located most often at the base of leaf petioles and buds. White to pinkish globs of resin may appear at point of attack. Older attacks are seen as terminal and/or branch dieback, due to larval tunnels within the terminal and/or branch. Shoots will show yellow, then red, and finally brown needle color.

Other Insects.-All damage caused by insects not identified are in separate categories. This includes hardwood defoliators (e.g., variable oak leaf caterpillars and forest tent caterpillars) and pine defoliators (e.g., redheaded pine sawfly and pine weevils).

Other Diseases.-All damage caused by diseases not identified are in separate categories; e.g., red heart of pine, brown spot, and leaf diseases. Trees showing disease-caused degrade not identified elsewhere should be coded here.

Root Rots.-Look for groups of dead or windthrown trees with tufted, thin crowns, which may be yellowing. Conks (fruiting bodies) of various fungi may be present on or near base of diseased trees. Disease is more frequent in trees of reduced vigor, thinned stands, and in trees with butt or root injury. Bark beetles often follow.

Cankers.-Affected trees have dead, sunken areas on the stem, frequently with annual callus ridges around the dead areas.

Branch Stubs.-Branch holes or stubs greater than 10 centimeters in diameter on the stem (trees 12.5 cm dbh and larger). Branch holes or stubs greater than 2.5 centimeters in diameter appear on stem (trees 2.5 to 12.5 cm dbh).

Basal Defects.-Butt swelling, burls, and low branch stubs below dbh are symptoms of basal defect. Conks of decay fungi are often associated with defect.

Fire.-Fire scars are usually at base of stem. Widespread occurrence in stands is usually on uphill side on slopes. Signs of charring are generally present on the stem.

Example of a canker on a young hardwood, Puerto Rico.

Animal.-Branches clipped off or broken, the bark removed, holes in the stem, tears, and tooth marks in the wood are all common symptoms of animal activity.

Weather.-Windthrow, broken tops, broken branches, and marginal leaf burn are the common symptoms.

Top Breakage.-Broken stem is greater than four inches in diameter.

Suppression and Stagnation.-Suppressed and stagnated trees are characterized by their vigor and small crown. Suppressed trees are overtopped and receive indirect sunlight. Stagnated trees have thin foliage and receive some direct sunlight. Stagnation is usually associated with poor growing sites or overstocked stands.

People.-Initials in bark, nails in tree, lantern burn, bark stripped, calloused roots, wire around stem, and ax marks are symptoms of people damage.

Logging and Related.-Logging scars on stem will have callus ridges within 1 to 2 years after wounding. They are scattered in stands and show no charring. Limb breakage and/or stem scar near crown will

occur from the felling of other trees. Look for skid trails, stumps, etc.

Form (damaging).-All trees with enough crook or sweep to result in total tree cull or total loss of sawtimber value.

Dieback.-Tips of the branches die back. Just a few branches are affected at first, with whole branches dying in advanced stages. Tree mortality may result. Dieback is frequently associated with stress caused by unfavorable environment.

Sucking Insects.-Yellowing, sooty mold and curling of the foliage are the common results of attack by sucking insects. There should normally be a scale aphid, and/or the evidence that the insect had been there on the affected leaves.

Vines and Parasitic Plants.-The vines or parasitic plants should be present in such a quantity that the tree is damaged or will soon be damaged if the problem is not corrected.

Other Damage.-This would be any type of damage that could not be classified in one of the above categories.

Severe damage due to a landslide after a period of *heavy rain, Puerto Rico.*

FOREST SURVEY TERMS

Forest Land Class

Forest Land.-Land at least 10 percent stocked' by forest trees of any size, or formerly having such tree cover and not currently developed for nonforest use. The minimum area for classification of forest land is one-half hectare, and the minimum width for forest strips is 35 meters. Unimproved roads and trails, streams, and clearings in forest areas are classed as forest if less than 35 meters in width.

Timberland.—Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization. Forest lands with higher priority uses, yet not specifically withdrawn from timber utilization, are excluded from this class of forest land. Coffee shade is included.

Noncommercial Forest Land.-Forest land incapable of yielding crops of industrial wood because of adverse site conditions, forest land withdrawn from timber utilization through statute or administrative regulation, or forest land considered to have higher priority use (except coffee shade).

Nonstocked Land.-Commercial forest land less than 10 percent stocked[1] with growing-stock trees. This includes areas covered by inhibiting vegetation (brush, vines, ferns, etc.) classed as forest land.

Secondary Forest Land.-Forest land resulting from the abandonment of cropland or pasture, and forest resulting from the regeneration of previously cutover or disturbed forest land. Abandoned coffee shade is excluded from this class.

Coffee Shade.-A multi-stored, multi-crop system used principally for the production of coffee. An upper story of shade trees is characteristic.

Abandoned Coffee Shade.-Secondary forest land resulting from the abandonment of coffee production under shade trees.

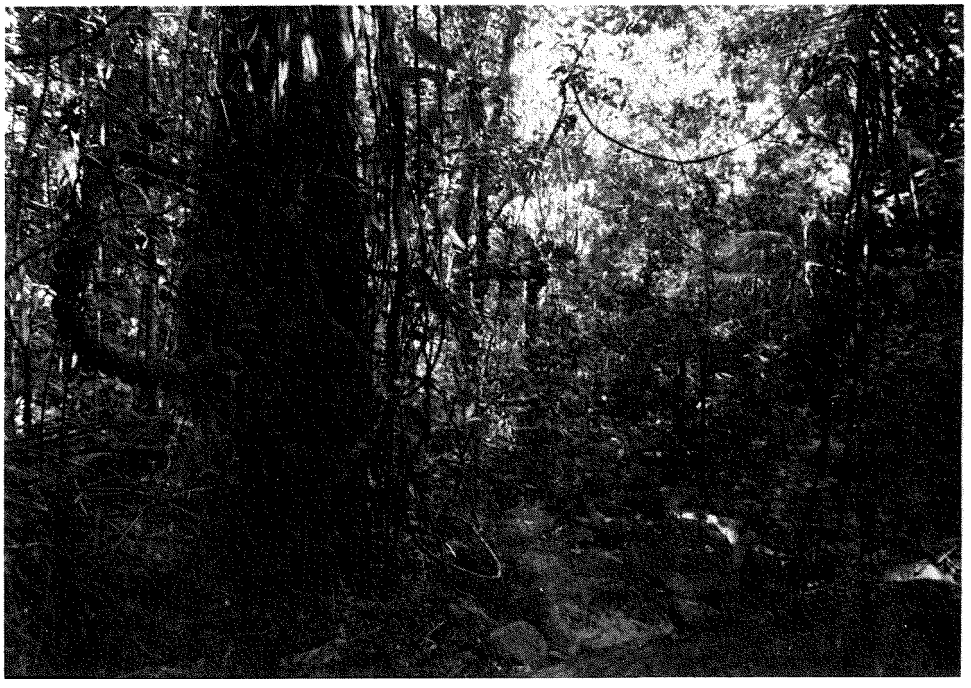
Noncommercial Survey Region

Subtropical Dry Forest.—An ecological Life Zone delineated by a mean annual rainfall of between 600 millimeters and 1,000 or 1,100 millimeters, and a mean annual biotemperature between about 18 ° and 24 ° C (Holdridge 1967).

Critical Watersheds.—Upland areas with an average slope greater than 60 Percent or rainfall greater than 2,500 millimeters Per year. These areas require a continuous protective forest cover. Some timber removal would be feasible; however, much of the area is not highly productive.

Unproductive Soils.—Soils incapablie of yielding crops of industrial wood.

[1] Ten percent of "full" stocking as defined for the Midsouth forest survey.



Vines *cover the bole of this large hardwood, Puerto Rico.*

Alluvial Regions.-River-flood plains with priority agricultural land use.

Metropolitan Regions.-Regions with primarily urban or residential use.

Mangrove and Swamp.--Coastal wetlands with unique characteristics and values requiring special management considerations.

Noncontiguous Regions.-Islands and other land bodies separated from mainland Puerto Rico.

Class of Timber

Sawtimber-Size Trees.—Trees 22.5 centimeters and larger in dbh for softwoods and 27.5 centimeters and larger for hardwoods.

Poletimber-Size Trees.-Trees 12.5 to 22.5 centimeters in dbh for softwoods and 12.5 to 27.5 centimeters for hardwoods.

Saplings.—Trees 2.5 to 12.5 centimeters in dbh.

Stand-Size Class

Sawtimber Stands.—Stands with at least 5 square meters per hectare of basal area in sawtimber-or poletimber-size trees, and with sawtimber basal area at least equal to poletimber basal area.

Pqletimber Stands.-Stands with at least 5 square meters per hectare of basal area in sawtimber-or poletimber-size trees, and with poletimber basal area exceeding that of sawtimber basal area.

Sapling-Seedling Stands.-Stands with at least 5 square meters per hectare of basal area, with more than half of this basal area in saplings or seedlings, or stands with less than 5 square meters per hectare of basal area.

Volume

Volume of Timber.-Volume of all sound wood (including sound cull) in the bole and branches of all live trees 12.5 centimeters and larger in dbh, from stump to a minimum 10 centimeter diameter outside bark. The minimum length of any section included is one meter.

Miscellaneous Definitions

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, expressed as square meters per hectare.

Dbh (diameter at breast height).—Tree diameter in centimeters, outside bark, measured at 1.3 meters above ground.

ANDERSON, ROBERT L., RICHARD A. BIRDSEY, and PATRICK J. BARRY.

1982. Incidence of damage and cull in Puerto Rico's timber resource, 1980, U.S. Dep. Agric. For. Serv. Resour. Bull. SO-88, 13 p. South. For. Exp. Stn., New Orleans, La.

Presents the incidence of tree damage and cull recorded during a forest inventory of Puerto Rico. Form damage was most common.

Additional keywords: forest inventory, tropical forest resources, insects, disease.