

**FOREST MANAGEMENT AND THE
RESTORATION OF HISTORIC SCENES
PETERSBURG NATIONAL BATTLEFIELD, VIRGINIA**

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Summary

Petersburg National Battlefield is a mosaic of fields and forest in the upper Coastal Plain and lower Piedmont of Virginia. The forests are generally healthy, and are represented by a mixture of pine, pine-hardwood, and hardwood cover types with loblolly pine, sweetgum, and oaks as the primary forest canopy species. Southern pine beetle has infested small portions of some of the pine stands, but the damage is minimal. The forest stands range in age from seedling to mature, but are generally in the intermediate age class.

A detailed forest description, forest cover type maps, and recommendations for forest management are provided. Fuel reduction strategies are proposed, with monitoring recommended as the stands change with natural succession. A long-term vegetation monitoring program has been initiated in order to document changes in the forest composition. Also, visual buffer zones need to be established, supplemented, and maintained along the perimeters and around maintenance sheds in order to enhance the historic scene at the park.

Recommendations for historic scene restoration at the Five Forks Unit should be considered carefully before being implemented to ensure the desired result. There is a tremendous opportunity for the development of the true historic scene, as the landscape has been minimally altered and there is adequate documentation of the vegetation present during the Civil War.

Introduction

Petersburg National Battlefield (PNB), located in Petersburg, Virginia, is one of many commemorative Civil War battlefields administered by the National Park Service (NPS).

Petersburg is situated in the Upper Coastal Plain geographic province, where the Appomattox River intersects the Fall Line (Frye 1986). PNB is the site of the longest siege during the Civil War. The campaign of Petersburg was a ten-month struggle beginning in the early summer of 1864 and ending just before the surrender at Appomattox in the spring of 1865.

PNB is maintained in a mixture of forests and fields, and is broken into two major units and six minor units. This report addresses the forest management objectives of the major, more heavily forested units: the Five Forks Unit and the Main (Headquarters) Unit.

The preservation of historic integrity and the maintenance of healthy forests are essential to fulfilling the park's mission. An assessment of the current forest resource conditions is crucial to the development of vegetation management recommendations. Specifically, this report addresses the following objectives for both units:

1. delineate and map the forest cover types;
2. describe and quantify forest structure and composition;
3. develop management recommendations for the maintenance of a vigorous forest ecosystem and for visual buffer zones;
4. provide management alternatives for historic scene restoration (Five Forks Unit only);
5. determine wildfire fuel models and an associated fuel reduction plan;
6. present Integrated Pest Management options for the southern pine bark beetle;
7. establish long-term monitoring of plots and procedures.

Five Forks Unit

The Five Forks Unit, located in Dinwiddie County west of Petersburg, was acquired by NPS in 1991. Five Forks was the final obstacle between the Union Army and the last operating supply railroad for the South, the South Side Railroad. Union forces arrived at Five Forks on the morning of April 1, 1865, and it was only three days later that General Lee evacuated both Petersburg and Richmond. Surrender at Appomattox occurred one week later.

The Five Forks Unit, approximately 451 ha, is about 91% forested, with the remaining land in row crop cultivation. In the years after the Civil War until NPS ownership, the Five Forks area was maintained in crop fields and managed pine forests and woodlots. According to historic documentation, this mosaic is very similar to what it was when the battle was fought, as there has been very little development in the surrounding area (Caulkins 1990).

Main (Headquarters) Unit

The Main Unit occupies 584 ha of land adjacent to the city of Petersburg, and preserves several batteries and fortifications associated with the ten-month siege of Petersburg. Prior to park establishment in 1926, the land was cultivated, with tobacco and cotton as the principal crops (Wallace 1983). Today, the Main Unit consists of a mosaic of forests and fields, with approximately 88% covered by pine and/or hardwood forests, and 12% in fields and open lands.

Forest Structure and Composition

Knowledge of current forest conditions and the natural processes that regulate the forest is key to the development of wise land management plans. In order to effectively describe the forest structure and composition at PNB, a complete vegetative inventory, including the overstory, understory, and ground strata for the Main and Five Forks Units, was completed. The same data collection procedures were followed for each unit.

Methods

Forest Cover Types

Forest cover types in the Main and Five Forks Units were mapped based on leaf-off, color infrared aerial photographs of the area (taken in March 1992, scale 1:3600). Overstory composition of the forest cover types was delineated based on the dominant overstory species following the PNB Vegetation Classification System as described below:

Pine Cover Types: >75% pine basal area.

Mixed (Pine-hardwood) Cover Type: deciduous and pine species present with the basal area of either group between 25% and 75%.

Hardwood Cover Types: >75% deciduous basal area.

Classification of forest cover types into stand types was based on origin and age class. Origin of a stand was either natural or planted. Age classes were defined as follows: Young, 0-20 years; Immature/Intermediate, 21-50 years; and Mature, 51+ years. Nonforested areas were classified as being open fields or non-forested wetland areas.

Sampling and Plot Location

Final forest cover type maps were digitized into a geographic information system (GIS) using PC ARC/INFO software, (ESRI, Inc., 1990). The stand type areas reported in this

document were based on the values generated by the GIS software. Field sample plots were randomly located along transects in each stand type using a random number table for the direction and distance to each plot. All sample plots were established at least 10 m away from roads, trails, boundaries, and other forest edges. Forest cover type maps were reconciled with the field survey observations for any misinterpretations that may have been made during original map development from the aerial photographs. A total of 115 sample plots were inventoried for both units, 63 in the Main Unit and 52 in the Five Forks Unit (Table 1).

Forest Vegetation Inventory

Sample plots were established to inventory the overstory, understory, and regeneration strata in each stand type. General site measurements, such as slope percent and aspect, and any observations of insect/disease damage, fire, highly erosive areas, and historic trees were recorded on each plot. A complete list of common and scientific names for all strata of the Main and Five Forks Units is located in Appendices 1-4.

The overstory was defined as trees over 5 m tall. Overstory trees were sampled in a 2.5 m BAF prism plot. All sample trees were recorded by species, diameter at breast height (dbh) in cm, and crown class. Two healthy, dominant trees in each plot were bored at breast height to determine age. Heights of these trees were measured using a clinometer.

The understory stratum consisted of all woody stems between 1.37 m and 5 m tall. Two circular 16 m² subplots (0.002 ha) were located 5.6 m north and south of the sample plot center. All stems were recorded by species, dbh, and total height.

The regeneration stratum included all woody and herbaceous vegetation less than 1.37 m in height. Four square 1 m² sub-subplots were located 7.26 m from the sample plot center in each cardinal direction in order to sample this stratum. All tree seedlings originating within the sub-subplots were identified by species and counted. Woody species, including shrub

Table 1. Distribution of sample plots by cover and stand type in the Five Forks and Main Units, PNB, Virginia.

Forest Cover Type	Stand Type	Five Forks Unit	Main Unit
		----- no. of plots -----	
Pine	Natural/young	12	3
	Planted/young	6	---
	Natural/intermediate	---	9
	Planted/intermediate	---	3
	Natural/mature	---	21
Pine-hardwood	Natural/young	9	---
	Planted/young	9	---
	Natural/intermediate	3	---
	Natural/mature	---	6
Hardwood	Natural/intermediate	8	---
	Natural/mature	5	22
Total		52	63

seedlings, and herbaceous ground cover were estimated based on the following percent cover classes: 1: 0%; 2: 1-15%; 3: 16-35%; 4: 36-65%; 5: 66-85%; 6: 85-99%; 7: 100%.

Vegetation Computations

Vegetation variables were compiled by plot to describe the stand types within each forest cover type. Basal area (m^2/ha), frequency, and density were calculated by species for the overstory stratum in each stand type. Importance values were calculated as the mean of relative basal area, relative density, and relative frequency. Mean height of the canopy and age of the overstory were also determined for each stand type. Average vegetation density by species in the understory and regeneration strata was calculated. Herbaceous and woody ground cover classes were also averaged for each stand type.

Results

Vegetation of the Five Forks Unit

The Five Forks Unit consists of 451 ha of forests and fields divided by five roads intersecting in the center of the unit (Figure 1). This area includes land in a conservation easement that is around the "Burnt Quarter" plantation, adjacent to the park (Caulkins 1990). Some of the fields are under cultivation, while others are slowly converting back to forest cover following agricultural abandonment. The forested areas include a mosaic of pine, pine-hardwood, and hardwood cover types. No intensive forestry practices have been conducted since the land was acquired by the NPS; however, some of the pine stands are plantations that were intensively managed prior to park acquisition. Several streams trace the rolling landscape, while a nonforested wetland area is located along the northern boundary of the unit. Total nonforested area covers approximately 41 ha, or 9% of the land area; the remaining 410 ha are forested.

National Park Service

Petersburg National Battlefield

Five Forks Unit

Forest Cover Types and Forest Stand Types

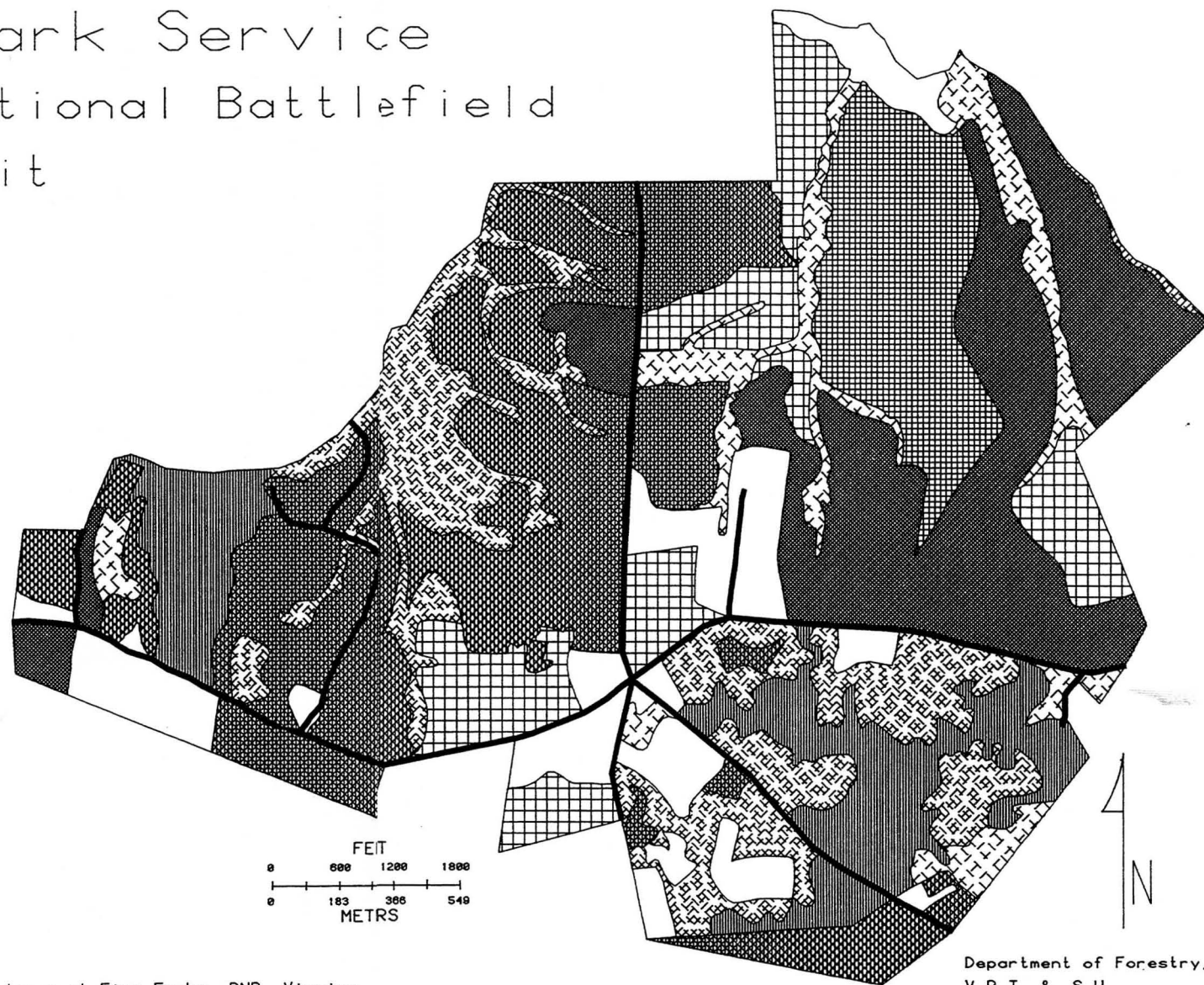
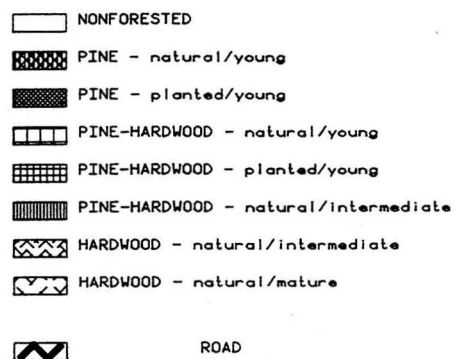


Figure 1. Forest cover and forest stand types at Five Forks, PNB, Virginia.

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Pine Cover Type: The pine cover type, which includes natural/young and planted/young stand types, is 196 ha, or 43% of the total land area, comprised of large patches in the unit (Figure 1). Trees in the cover type range in age from 7 to 24 years, with canopy heights averaging 16-17 m. Loblolly pine (*Pinus taeda* L.) is the only pine species found in this cover type, comprising an average of 73% of the total basal area (Table 2). Scarlet oak (*Quercus coccinea* Muenchh) and sweetgum (*Liquidambar styraciflua* L.) are the primary canopy associates in the pine cover type.

The natural/young stand type covers the most land area in the unit, 26% of the total. The overstory is quite patchy and at times completely absent, ranging in age from 8 to 24 years (mean age is 17 years). When present, canopy height is low, reaching 15 m. Loblolly pine dominates the overstory, comprising 15 m²/ha of basal area and 58% of the importance value in the stand type (Table 2). Scarlet oak is the second most dominant species, based on importance value. Secondary overstory species in the natural/young stand type include scarlet oak, sweetgum, and white oak (*Quercus alba* L.), each averaging about 1% of the basal area and having a relatively equal importance value. There is rarely evidence of southern pine beetle damage in these young stands, with the exception of a few isolated areas. The patchy overstory allows ample light to penetrate the canopy, resulting in a dense and highly diverse understory with 14,129 stems/ha (Table 3). Sweetgum, loblolly pine, and white oak are the prominent tree species growing in the understory, but winged sumac (*Rhus copallina* L.), sweet pepperbush (*Clethra alnifolia* L.), and highbush blueberry (*Vaccinium corymbosum* L.) are shrub species that are also very dense. Those tree species that are taller and moderately dense will most likely perform the best, and will comprise the future forest canopy. Tulip poplar (*Liriodendron tulipifera* L.), willow oak (*Quercus phellos* L.), and pignut hickory

Table 2. Overstory basal area, density, frequency, and importance value by species for the pine forest cover type at Five Forks, PNB, Virginia.

Stand Type	Species	Basal Area (m ² /ha)	Density (stems/ha)	Frequency (% plots)	Importance Value (%)
Natural/young (n=12)	loblolly pine	15.0	788	100	58
	scarlet oak	1.5	223	33	13
	sweetgum	1.7	335	17	12
	white oak	1.3	239	25	11
	northern red oak	0.2	22	8	2
	southern red oak	0.2	18	8	2
	black oak	0.2	9	8	2
	Total	20.0	1,634		100
Planted/young (n=6)	loblolly pine	18.3	1228	100	49
	scarlet oak	3.8	752	50	19
	American holly	0.4	621	17	9
	water oak	0.8	252	17	6
	white oak	0.8	185	17	5
	red maple	0.8	160	17	5
	sweetgum	0.4	99	17	4
	black oak	0.4	87	17	4
	Total	25.8	3,384		100

Table 3. Understory density, diameter at breast height (dbh), and height by species in the pine cover type at Five Forks, PNB, Virginia.

Stand Type	Species	Density (stems/ha)	Diameter (cm)	Height (m)
Natural/young (n=12)	sweetgum	4292	2.6	2.8
	winged sumac	1542	1.2	2.0
	sweet pepperbush	1208	1.0	1.9
	loblolly pine	750	4.2	1.7
	highbush blueberry	667	1.5	1.7
	white oak	625	3.2	2.8
	tulip poplar	542	3.5	3.5
	southern arrowwood	542	1.3	2.0
	black gum	500	2.3	2.7
	scarlet oak	417	4.1	3.1
	red maple	417	1.9	2.6
	pignut hickory	375	3.0	3.4
	mockernut hickory	167	2.9	2.8
	downy serviceberry	167	2.7	2.5
	eastern red cedar	167	2.5	2.2
	southern red oak	167	3.5	1.5
	willow oak	125	3.9	3.4
	flowering dogwood	125	3.4	2.3
	American holly	125	2.6	2.3
	azalea	125	1.2	2.1
	common persimmon	83	2.4	2.7
	American strawberry-bush	83	0.9	2.1
	American sycamore	42	4.8	5.0
	sassafras	42	0.5	4.5
	black cherry	42	4.1	3.1
	post oak	42	4.0	2.3
Total		13,379		

Table 3 (continued).

Stand Type	Species	Density (stems/ha)	Diameter (cm)	Height (m)
Planted/young (n=6)	red maple	1667	1.5	2.6
	sweetgum	1250	1.6	3.2
	tulip poplar	1083	1.5	2.7
	black gum	1083	2.0	2.6
	loblolly pine	750	1.8	3.0
	white oak	750	2.3	2.7
	American holly	583	3.2	3.0
	mockernut hickory	583	2.1	2.9
	southern red oak	500	4.4	3.9
	pignut hickory	333	2.4	2.5
	scarlet oak	250	1.7	3.3
	common persimmon	250	1.3	3.0
	Virginia pine	250	2.2	2.6
	winged sumac	250	1.7	1.9
	flowering dogwood	167	3.7	4.2
	black oak	167	2.3	4.2
	post oak	83	5.0	3.4
	willow oak	83	1.3	3.1
	southern arrowwood	83	1.8	2.8
	bitternut hickory	83	2.3	1.9
	northern red oak	83	0.6	1.7
	highbush blueberry	83	1.9	1.5
Total		10,414		

(*Carya glabra* (Mill.) Sweet) have characteristics of both density and height (Table 3). The regeneration stratum of the natural/young stand type is very dense, with about 13,000 tree seedlings/ha, of which sweetgum, red maple (*Acer rubrum* L.), and white oak comprise 68% of the total (Table 4). Woody and herbaceous ground vegetation covers about 12% of the forest floor in the natural/young stand type, which is comparatively less than in most of the other forest stand types in the Five Forks Unit (Table 5). Woody vegetation is primarily blueberry (*Vaccinium* spp.) and huckleberry (*Gaylussacia* spp.), while the herbaceous species are mainly greenbrier (*Smilax* spp.), muscadine grape (*Vitis rotundifolia* Michaux), spotted wintergreen (*Chimaphila maculata* (L.) Pursh), and miscellaneous grasses (Table 5).

The planted/young pine stand type is very similar to the natural/young stand type. Canopy height is slightly lower than that of the natural/young stand type at 14 m. Ages of the overstory range from 10 to 22 years; the mean age is 16 years. This stand type is dominated by two species, loblolly pine and scarlet oak. Loblolly pine again dominates the overstory, with 18 m²/ha of basal area (71% of the total) and nearly half of the total importance value (Table 2). Interestingly, the planted stands have over twice the number of stems/ha of the naturally regenerated stands; about a quarter of this difference is attributable to the pines. Overall, the understory of the planted/young stand type is less dense than that of the natural/young stand type, with 10,414 versus 14,129 stems/ha, respectively (Table 3). Red maple, sweetgum, tulip poplar, and black gum (*Nyssa sylvatica* Marshall) are prominent tree species in the understory stratum; however, southern red oak (*Quercus falcata* Michaux) and black oak (*Quercus velutina* Lam.) are the tallest species, at 3.9 m and 3.3 m in height, respectively (Table 3). Shrub species such as winged sumac and highbush blueberry are much sparser in the planted/young stand type. Seedling density is also somewhat less in the

Table 4. Average density of tree seedlings for all forest stand types at Five Forks, PNB, Virginia.

Species	Forest Stand Types ^a						
	PNY	PPY	PHNY	PHPY	PHNI	HNI	HNM
	----- seedlings/ha -----						
American beech	0	0	0	0	0	313	0
American holly	417	0	0	0	2500	1250	500
black cherry	209	0	0	0	0	0	0
black gum	209	3215	1112	2500	3750	0	500
black locust	834	0	0	0	0	0	0
black oak	834	0	0	0	0	0	0
blackjack oak	209	0	0	556	0	0	0
common persimmon	0	0	0	278	0	313	0
downy serviceberry	209	358	0	556	0	625	0
loblolly pine	0	0	1112	278	0	0	0
mockernut hickory	0	358	0	0	0	313	1000
northern red oak	0	0	0	0	0	313	0
pignut hickory	0	0	0	278	1250	625	0
red maple	2709	715	2500	6945	1250	2188	0
sassafras	625	358	2223	556	0	625	500
scarlet oak	0	1429	0	834	1250	938	0
southern red oak	417	0	0	0	5000	625	0
sweetgum	3959	1429	3889	6954	1250	1250	1000
tulip poplar	209	715	1667	834	0	313	500
water oak	0	0	0	0	0	0	2000
white oak	2292	1072	556	0	2500	5313	3500
willow oak	0	715	556	0	0	313	0
Total	13,132	10,364	13,615	20,560	18,750	15,317	9,500

^a PNY: Pine natural/young; PPY: Pine planted/young; PHNY: Pine-hardwood natural/young; PHPY: Pine-hardwood planted/young; PHNI: Pine-hardwood natural/intermediate; HNI: Hardwood natural/intermediate; HNM: Hardwood natural/mature.

Table 5. Average ground cover of woody and herbaceous vegetation for all forest stand types at Five Forks, PNB, Virginia.

Species	Forest Stand Types ^a						
	PNY	PPY	PHNY	PHPY	PHNI	HNI	HNM
	----- percent cover -----						
American strawberry-bush	P ^b	P	P	1	0	0	1
<i>Amorpha fruticosa</i>	P	0	0	0	0	0	0
<i>Apios americana</i>	0	0	0	P	0	0	0
bedstraw	0	0	0	P	0	0	0
black huckleberry	1	0	P	0	0	P	0
blackberry	1	1	3	4	0	0	0
blueberry	0	P	1	0	0	0	P
broomsedge	0	0	1	P	0	P	0
chinquapin	0	P	0	0	0	0	0
Christmas fern	0	0	0	P	0	0	P
clover	P	P	1	P	0	0	0
highbush blueberry	1	1	1	2	1	1	1
deerberry	1	1	0	1	1	P	0
Dutchman's pipe	0	0	0	P	0	0	0
dwarf huckleberry	0	0	0	0	0	0	P
early low blueberry	2	1	1	1	2	3	1
Elliot blueberry	0	0	P	0	0	0	0
five-fingers	0	0	P	1	0	0	0
goldenrod	P	1	1	1	0	P	0
miscellaneous grasses	1	P	4	3	0	P	P
greenbrier (<i>Smilax glauca</i>)	P	0	0	P	0	0	0
greenbrier (<i>Smilax rotundifolia</i>)	1	P	1	2	1	2	1
greenbrier (<i>Smilax</i> spp.)	0	0	0	P	0	0	P
ground pine	0	0	0	0	0	1	0
ground juniper	0	0	0	0	0	P	0
hazel alder	0	0	0	2	0	1	0

Table 5. Continued.

Species	Forest Stand Types ^a						
	PNY	PPY	PHNY	PHPY	PHNI	HNI	HNM
	----- percent cover -----						
heliotrope	0	0	P	0	0	0	0
huckleberry	P	2	1	1	2	1	0
jack-in-the-pulpit	0	0	0	P	0	0	0
Japanese honeysuckle	P	P	P	0	0	0	0
<i>Lespedeza</i> spp.	P	P	0	0	0	0	0
milkweed	0	0	P	0	0	0	0
muscadine grape	1	1	1	2	1	P	P
partridgeberry	0	0	0	0	1	0	0
pea family	P	0	P	P	0	0	0
pink moccasin flower	P	0	0	0	1	P	0
pinweed	0	P	0	P	0	0	0
poison ivy	P	P	P	1	0	P	0
sensitive fern	0	0	0	P	0	0	0
small jack-in-the-pulpit	0	0	0	0	0	0	P
smooth alder	0	0	0	1	0	0	0
Solomon's Seal ^d	0	0	0	P	0	P	0
southern arrowwood	P	1	P	1	0	P	P
spotted touch-me-not	P	0	P	P	0	P	0
spotted wintergreen	1	1	P	P	0	P	P
St. Andrew's Cross	0	0	P	0	0	0	0
strawberry	P	P	1	P	0	0	0
swamp azalea	0	0	0	P	1	0	0
swamp dogwood	0	0	0	P	0	0	0
swamp rose	0	P	0	0	0	0	0
sweet bay	0	0	0	0	0	P	0
sweet azalea	0	0	0	0	0	P	0
sweet pepperbush	1	0	0	1	0	2	6

Table 5 (continued).

Species	Forest Stand Types ^a						
	PNY	PPY	PHNY	PHPY	PHNI	HNI	HNM
	----- percent cover -----						
sweet pignut hickory	P	0	0	0	0	0	0
tall huckleberry	P	P	P	1	2	1	1
trailing bush clover	P	0	0	P	0	0	0
triangle-leaf violet	0	0	0	P	0	0	0
trumpet vine	P	P	P	P	0	0	0
vetch	P	0	P	0	0	0	0
veined skullcap	P	P	0	1	0	0	0
Virginia creeper	P	1	P	1	0	0	0
wild azalea	0	0	0	0	0	P	0
wild yam	P	P	P	P	1	P	P
winged sumac	P	P	1	2	0	0	0
other	1	1	4	2	4	1	5
Total	12	12	22	34	18	13	16

^a PNY: Pine natural/young; PPY: Pine planted/young; PHNY: Pine-hardwood natural/young; PHPY: Pine-hardwood planted/young; PHNI: Pine-hardwood natural/intermediate; HNI: Hardwood natural/intermediate; HNM: Hardwood natural/mature.

^b P - Present at < 0.5% coverage.

planted/young stand type than in the natural/young, with 10,364 seedlings/ha (Table 4). Black gum is clearly the most abundant species, with 3,215 seedlings present, followed by scarlet oak and sweetgum. Loblolly pine is not regenerating in these dense stands. There are generally fewer different species comprising the woody and herbaceous ground vegetation in the planted/young stand type. Total ground cover is the same as in the natural/young stand type, averaging approximately 12% (Table 5). Species such as huckleberry, muscadine grape, and Virginia creeper (*Parthenocissus quinquefolia* (L.) Planchon) are common ground species in the planted/young pine stand type.

Pine-Hardwood Cover Type: Three stand types are found in the pine-hardwood cover type: pine-hardwood natural/young, pine-hardwood planted/young, and pine-hardwood natural/intermediate. Loblolly pine, scarlet oak, and white oak comprise the primary canopy associates in this cover type. The pine-hardwood cover type is very diverse, and its tree regeneration strata are the most prolific in the entire unit.

The natural/young stand type covers approximately 43 ha of land, scattered in several small patches (Figure 1). These stands range in age from eight to 17 years, with an average canopy height of 13 m, when a canopy is present. Loblolly pine is the most important overstory species in the natural/young stand type, occupying 5.8 m²/ha, or 67% of the basal area (Table 6). The densest species, however, is scarlet oak, with well over 10,000 stems/ha. The mean age of trees in the natural/young stand type is 11 years, which explains the extremely high total overstory density of 15,096 stems/ha (Table 6). The high density also reflects the large number of smaller trees in this stand type compared to other types represented in the pine-hardwood forest cover type. Total understory density is 11,061 stems/ha, with tree saplings being the most abundant component (Table 7). Loblolly pine,

Table 6. Overstory basal area, density, frequency, and importance value by species for the pine-hardwood forest cover type at Five Forks, PNB, Virginia.

Stand Type	Species	Basal Area (m ² /ha)	Density (stems/ha)	Frequency (% plots)	Importance Value (%)
Natural/ young (n=9)	loblolly pine	5.8	1732	67	45
	scarlet oak	1.4	11180	11	33
	white oak	0.8	490	22	10
	tulip poplar	0.3	1443	11	7
	bigtooth aspen	0.3	251	11	5
	Total	8.6	15,096		100
Planted/ young (n=9)	loblolly pine	5.8	797	56	46
	scarlet oak	1.4	458	11	15
	sweetgum	0.6	332	22	13
	tulip poplar	0.6	141	22	9
	red maple	0.8	73	11	7
	sweet bay	0.6	77	11	6
	black gum	0.6	24	11	5
	Total	10.3	1,902		101
Natural/ intermediate (n=3)	loblolly pine	6.7	734	67	36
	white oak	4.2	451	100	29
	southern red oak	2.5	326	33	15
	willow oak	0.8	156	33	8
	Virginia pine	0.8	26	33	6
	scarlet oak	0.8	33	33	6
	Total	15.8	1,726		100

Table 7. Understory density, diameter at breast height, and height by species for the pine-hardwood cover type at Five Forks, PNB, Virginia.

Stand Type	Species	Density (stems/ha)	Diameter (cm)	Height (m)
Natural/young (n=9)	loblolly pine	1833	5.1	3.9
	tulip poplar	1667	2.4	2.4
	sweetgum	1556	2.5	2.5
	white oak	1167	3.9	3.0
	red maple	1000	1.9	2.4
	black gum	667	2.2	2.4
	winged sumac	667	1.6	1.6
	scarlet oak	389	4.2	2.8
	southern arrowwood	389	1.3	1.7
	flowering dogwood	333	2.6	2.6
	American holly	167	3.0	1.9
	sweet bay	167	2.3	1.7
	blueberry	167	1.4	1.4
	willow oak	111	6.4	4.0
	water oak	111	3.9	2.5
	southern red oak	111	1.2	2.3
	common persimmon	111	2.0	1.7
	bitternut hickory	56	3.5	3.6
	pignut hickory	56	3.5	2.6
	black oak	56	3.4	2.5
	mockernut hickory	56	2.4	1.6
	sassafras	56	0.8	1.5
	hawthorn	56	1.5	1.5
	downy serviceberry	56	1.3	1.5
	highbush blueberry	56	1.7	1.4
	Total	11,061		
Planted/young (n=9)	sweetgum	5500	2.6	2.8
	winged sumac	2500	1.9	2.7
	smooth alder	2389	2.8	3.2
	black gum	1111	2.8	2.6
	loblolly pine	1000	5.6	3.5
	white oak	944	4.9	3.1
	tulip poplar	722	2.5	2.5
	sweet pepperbush	667	1.3	1.8
	pignut hickory	611	3.3	3.0
	red maple	611	2.2	2.6
	flowering dogwood	556	2.8	3.0
	scarlet oak	500	4.3	3.0
	black oak	444	4.2	2.9
	sweet bay	333	2.7	2.6
	southern arrowwood	333	1.5	1.7
	highbush blueberry	333	1.5	1.6

Table 7 (Continued).

Stand Type	Species	Density (stems/ha)	Diameter (cm)	Height (m)
Planted/young (continued)	post oak	278	5.9	3.4
	willow oak	278	3.6	3.3
	southern red oak	278	4.0	2.8
	blackjack oak	222	4.8	2.9
	American holly	222	2.8	2.2
	downy serviceberry	111	1.0	1.5
	common persimmon	56	3.9	4.6
	mockernut hickory	56	5.3	4.3
	sassafras	56	1.5	2.1
	bitternut hickory	56	1.5	1.9
	Virginia pine	56	1.6	1.7
	swamp azalea	56	1.3	1.5
	Total	20,279		
Natural/ intermediate (n=3)	highbush blueberry	3833	1.8	2.0
	black gum	1833	3.4	2.8
	water oak	1000	1.9	2.5
	American holly	667	4.1	3.2
	sweetgum	667	1.7	2.0
	red maple	667	2.2	2.0
	southern red oak	500	3.5	3.1
	loblolly pine	333	4.7	4.2
	white oak	333	5.1	3.7
	early low blueberry	333	2.1	1.5
	flowering dogwood	167	5.5	4.8
	northern red oak	167	3.9	3.9
	scarlet oak	167	2.7	1.4
	Total	10,667		

tulip poplar, and sweetgum are the principal species, with willow oak and loblolly pine being the tallest at approximately 4 m (Table 7). This suggests an increase in willow oak and the persistence of loblolly pine in the future canopy. Southern arrowwood (*Viburnum dentatum* L.) and blueberry are the primary shrub species. The regeneration species in the pine-hardwood natural/young stand type are very similar in density and general composition to those in the pine natural/young stand type. Species that are densest include sweetgum, red maple, and sassafras (*Sassafras albidum* (Nuttall) Nees), comprising 63% of the total density of 13,615 seedlings/ha (Table 4). Because this stand type is generally very young, there is a good deal of bramble (*Rubus allegheniensis* Porter), miscellaneous grasses, and other herbaceous species that contribute to the large percentage of forest floor coverage with diverse woody and herbaceous ground vegetation. In fact, 22% of the forest floor in the natural/young stand type is occupied by ground cover (Table 5).

The planted/young stand type occupies 35 ha in the northeastern part of the unit (Figure 1). The average age of the canopy is 10 years, ranging from 7 to 16 years. There are many areas where the canopy is absent, and when present its height averages only 12 m. Dominant overstory species are similar to those found in the natural/young stand type. Loblolly pine comprises over half of the basal area, with scarlet oak and sweetgum following in importance (Table 6). The total overstory density in this stand type is significantly less than in the natural/young stand type, with only 1,902 stems/ha (Table 6). Just over 20,000 stems/ha grow in the species-rich understory of the planted/young stand type, which is nearly double that found in other stand types across forest cover types at the Five Forks Unit (Table 7). Sweetgum is the dominant understory tree species, with 5,500 stems/ha (Table 7). Shrub species are prominent in the understory, with winged sumac and hazel alder (*Alnus serrulata* Ehrhart) ranking second and third highest in density (Table 7). Other principal tree saplings

include black gum and loblolly pine. The planted/young regeneration stratum is the most prolific within the entire pine-hardwood forest cover type, with 20,560 seedlings/ha (Table 4). Sweetgum and red maple are by far the densest, each with nearly 7,000 seedlings/ha. Black gum is also prominent. Loblolly pine, white oak, and willow oak are among the taller species. The forest floor under the planted/young stand type is 34% covered by ground vegetation; this is the highest ground coverage found in any stand type at Five Forks (Table 5). The stratum is thick with bramble, greenbrier (*Smilax rotundifolia* L.), and muscadine grape.

Concentrated in one area in the southeast corner of the unit, the natural/intermediate stand type is 41 ha in size, with an average age of 40 years and average canopy height of 17 m (Figure 1). The pine component in this stand type is beginning to die out, leaving other deciduous species, such as white oak and scarlet oak, in the dominant canopy position. Pine species are represented by both loblolly pine and Virginia pine (*Pinus virginiana* Miller), which occupy 48% of the basal area (Table 6). Various oak species comprise the remaining basal area in this stand type, especially white oak, with 28% of the density and 100% frequency. The natural/intermediate stand type is represented by distinctly fewer understory species than either of the young stand types. Highbush blueberry is the densest species, occupying nearly a third of the total density (Table 7). Black gum and water oak (*Quercus nigra* L.) are the principal tree species, comprising 27% of the total density of 10,667 stems/ha (Table 7). These species provide an excellent habitat for many wildlife species. Loblolly pine and southern red oak (*Quercus falcata*) are the tallest species present, with moderate densities capable of attaining canopy status. A mixture of southern red oak, black gum, and white oak dominate the regeneration stratum in the natural/intermediate stand type.

The regeneration is the second densest in the unit, with 18,750 seedlings/ha (Table 4). The ground vegetation in the natural/intermediate stand type is the sparsest in the pine-hardwood cover type (Table 5). Early low blueberry and various huckleberry species, including tall huckleberry, dominate the ground stratum.

Hardwood Cover Type: The hardwood cover type consists of intermediate and mature natural stands found in the moister areas of the unit, along streams and in small depressions in the landscape. Nearly 95 ha of land comprise the hardwood cover type, located primarily in the northern section of the unit along two inlets of Hatcher's Run (Figure 1).

The natural/intermediate hardwood stand type has the larger overstory of the two stand types, covering approximately 71% of the hardwood cover type. Mean height of the canopy is 17 m, and the average age is 31 years. White oak and scarlet oak are the dominant overstory species, comprising 48% of the total basal area of 15 m²/ha (Table 8). Red maple ranks high in importance in the overstory, due to its relatively high density. Loblolly pine remains as a constituent in the canopy, represented by fewer large trees. The understory is dense, with 7,569 stems/ha that are fairly evenly distributed and thickly tangled with greenbrier (Table 9). Red maple, white oak, and black gum occupy a large portion of the understory, in which white oak and red maple rank among the taller tree species. Other tall tree species include black oak, mockernut hickory (*Carya tomentosa* (Poiret) Nuttall), and tulip poplar, standing at 4.0 m, 3.5 m, and 3.3 m in height, respectively (Table 9). These successional species are indicative of the future climax forest, because they are the most probable canopy replacement species. Regeneration in the natural/intermediate stand type is prolific and diverse, consisting mostly of white oak, red maple, and sweetgum (Table 4). White oak is clearly the dominant regenerating species, composing 5,313 seedlings/ha of the

Table 8. Overstory basal area, density, frequency, and importance value by species for the hardwood forest cover type at Five Forks, PNB, Virginia.

Stand Type	Species	Basal Area (m ² /ha)	Density (stems/ha)	Frequency (% plots)	Importance Value (%)
Natural/ intermediate (n=8)	white oak	4.7	850	88	29
	scarlet oak	2.5	203	63	14
	red maple	1.3	451	38	12
	loblolly pine	2.5	84	50	11
	sweetgum	0.9	412	25	10
	black gum	0.6	394	25	9
	black oak	0.9	108	38	7
	tulip poplar	0.6	14	25	4
	southern red oak	0.3	5	13	2
	mockernut hickory	0.3	24	13	2
	sweet bay	0.3	10	13	2
	Total	15.0	2,555		102
Natural/ mature (n=5)	white oak	7.5	629	100	30
	scarlet oak	1.5	502	60	17
	tulip poplar	4.5	59	80	13
	loblolly pine	5.0	62	40	11
	red maple	3.0	117	40	9
	sweetgum	2.0	8	40	6
	American holly	0.5	117	20	5
	black oak	1.0	7	20	3
	pignut hickory	0.5	25	20	3
	black gum	0.5	4	20	2
	Total	26.5	1,541		101

Table 9. Understory density, diameter at breast height, and height by species for the hardwood cover type at Five Forks, PNB, Virginia.

Stand Type	Species	Density (stems/ha)	Diameter (cm)	Height (m)
Natural/ intermediate (n=8)	red maple	938	2.5	3.0
	white oak	813	3.8	3.1
	black gum	813	3.1	2.8
	sweetgum	750	2.5	2.9
	American holly	625	2.1	2.1
	common winterberry holly	625	1.4	2.0
	tulip poplar	500	3.2	3.3
	flowering dogwood	500	2.6	2.6
	sweet pepperbush	375	1.3	1.6
	mockernut hickory	313	3.3	3.5
	highbush blueberry	313	1.9	1.8
	black oak	188	4.4	4.0
	southern red oak	188	4.0	3.0
	pignut hickory	188	1.9	2.1
	winged sumac	125	3.0	4.5
	smooth alder	63	2.8	3.5
	loblolly pine	63	4.4	2.8
	sassafras	63	1.0	1.8
	southern arrowwood	63	0.9	1.5
	scarlet oak	63	2.0	1.5
	Total	7,569		
Natural/mature (n=5)	sweet pepperbush	8125	1.2	2.0
	sweet bay	1125	1.9	3.8
	white oak	1125	3.3	3.3
	black gum	625	2.8	1.8
	red maple	500	2.2	3.1
	sweetgum	500	2.2	2.3
	pignut hickory	250	5.0	3.3
	American holly	250	4.7	3.3
	water oak	125	1.5	3.5
	southern arrowwood	125	2.0	2.6
	scarlet oak	125	6.5	2.3
	sassafras	125	0.7	1.9
	swamp azalea	125	1.5	1.7
	Total	13,125		

total 15,317 seedlings/ha (Table 4). The woody and herbaceous ground cover is relatively low, and consists mainly of early low blueberry (*Vaccinium vacillans* L.), sweet pepperbush, and greenbrier (Table 5).

The natural/mature stand type is located in several patches along the northwestern boundary and in the southeastern section of the unit, covering only 6% of the total land area (Figure 1). With ages averaging 51 years and a high canopy (23 m), these stands have the most basal area at Five Forks, 26.5 m²/ha (Table 8). As with the natural/intermediate stand type, white oak and scarlet oak are the most important species in the overstory. However, loblolly pine and tulip poplar collectively maintain a significant amount of basal area, nearly 10 m²/ha (Table 8). The understory of the natural/mature stand type is denser than that of the natural/intermediate stand type. Sweet pepperbush dominates the understory, comprising 62% of the density (Table 9). There are also smaller components of white oak, sweet bay (*Magnolia virginiana* L.), and black gum. Regeneration is the lowest of any stand type at Five Forks, with 9,500 seedlings/ha, 58% of which are white oak (Table 4). Sweet pepperbush dominates the ground vegetation, with 6% ground coverage in the natural/mature stand type (Table 5). Other ground vegetation species include American strawberry-bush (*Euonymus americanus* L.) and various ericaceous species such as highbush blueberry, early low blueberry, and tall huckleberry (*Gaylussacia frondosa* (L.) T. & G.).

Vegetation of the Main (Headquarters) Unit

The Main Unit is 84% forested with pines and hardwoods. These forests are mostly mature; however, there are patches of young forest. Three forest cover types were delineated in this unit: pine, pine-hardwood, and hardwood. The remaining area is in open fields maintained in grasses for historic interpretation purposes. This mosaic of field and forest provides excellent wildlife habitat. Many wildlife species are abundant, including songbirds,

white-tailed deer, raccoon, and fox. The more mature mast-producing forested areas also support such species as wild turkey, great-horned owl, and hawks. Two creeks, Harrison Creek and Poor Creek, flow north to south, dividing the unit into thirds.

Pine Cover Type: The pine cover type occupies 51% of the forested land and is subdivided into four stand types: natural/young, natural/intermediate, planted/intermediate, and natural/mature. The natural/young stand type occupies a small area of 21 ha located in two stands on the eastern boundary of the unit (Figure 2). The overstory stratum is intermittent, with the vegetation progressing from an old field to a pioneer forest. An extremely dense and low canopy characterizes the natural/young stand type, with nearly 2,300 stems/ha in the overstory (Table 10). Average canopy height is 14 m, and ages range from 11 to 14 years. Sweetgum, tulip poplar, and loblolly pine, in descending order of importance, are the only overstory species present in this stand type (Table 10). Although loblolly pine is not the dominant species sampled, aerial photographs indicate that this is the proper classification for this stand type. The understory of the natural/young stand type is almost three times as dense as those of the other pine stand types, with 10,000 stems/ha (Table 11). Pioneer species dominate the stand type, with 78% of the density in sweetgum. Eastern red-cedar (*Juniperus virginiana* L.) trees have the largest diameters and are the tallest trees in the understory stratum. Loblolly pine is present in small numbers in the understory and is of average height in the stratum. The ground stratum of these naturally regenerating stands is the highest in seedling density at the Main Unit, reaching 110,000 (Table 12). As in the understory, sweetgum is the dominant regenerating species, with nearly 65,000 seedlings/ha (Table 12). Tulip poplar and red maple also constitute a major component of the regeneration stratum; loblolly pine comprises only about 2% of the stratum. Miscellaneous grass species cover

National Park Service Petersburg National Battlefield Main Unit

Forest Cover Types and Forest Stand Types

-  NONFORESTED
-  PINE - natural/young
-  PINE - natural/intermediate
-  PINE - planted/intermediate
-  PINE - natural/mature
-  PINE-HARDWOOD - natural/mature
-  HARDWOOD - natural/mature
-  ROAD
-  RAILROAD

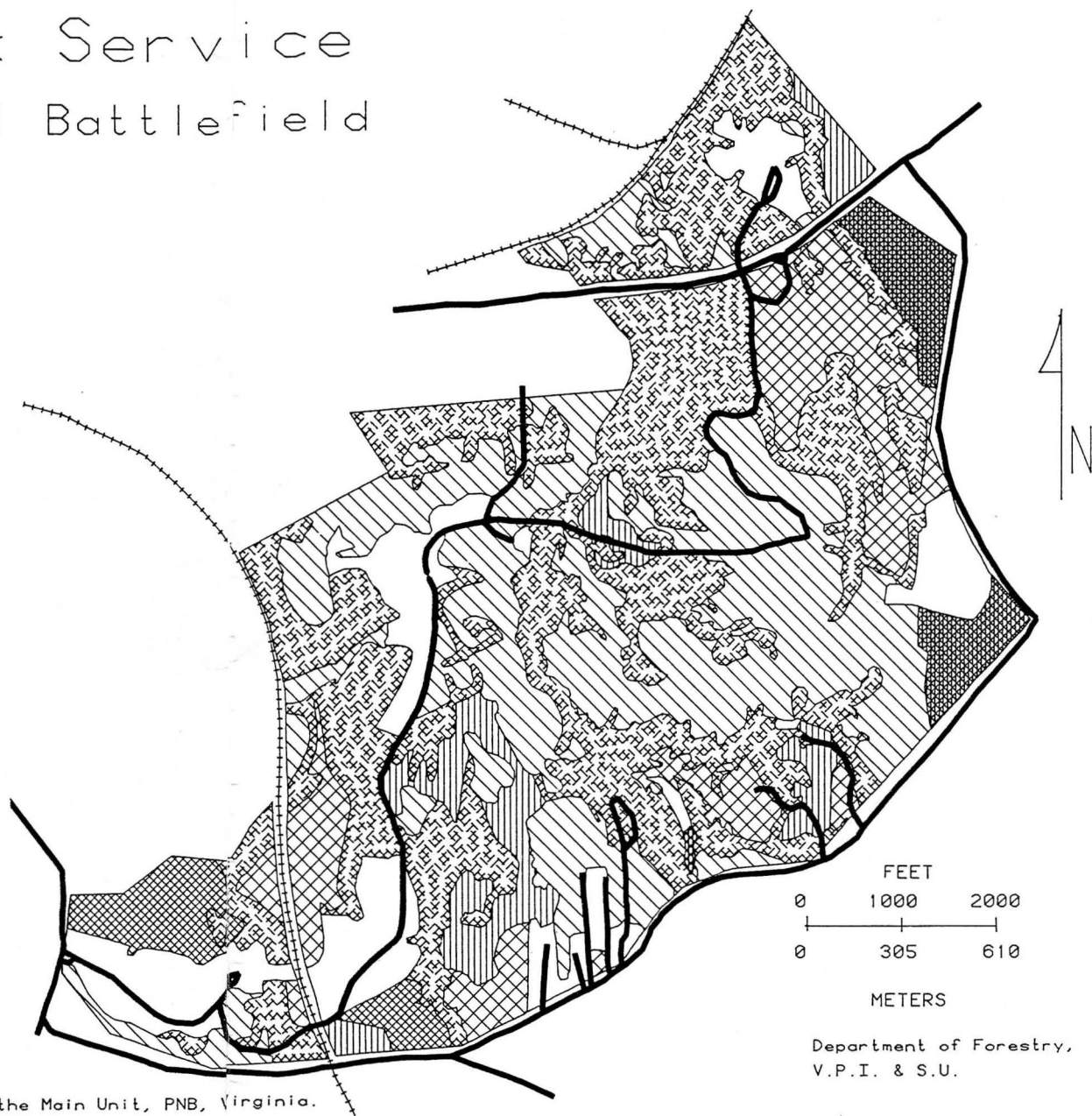


Figure 2. Forest cover and forest stand types at the Main Unit, PNB, Virginia.

Table 10. Overstory basal area, density, frequency, and importance value by species for the pine forest cover type at the Main Unit, PNB, Virginia.

Stand Type	Species	Basal Area (m ² /ha)	Density (stems/ha)	Frequency (% plots)	Importance Value (%)
Natural/ young (n=3)	sweetgum	6.7	1163	67	56
	tulip poplar	2.5	1086	33	32
	loblolly pine	0.8	41	33	12
	Total	10.0	2,290		100
Natural/ intermediate (n=9)	loblolly pine	21.9	287	100	43
	sweetgum	6.4	367	89	30
	tulip poplar	1.7	34	33	6
	black cherry	1.4	64	22	6
	black oak	0.6	35	11	3
	white oak	0.3	29	11	3
	southern red oak	1.1	6	11	2
	American sycamore	0.3	16	11	2
	sassafras	0.3	6	11	2
	water oak	0.3	3	11	2
	pignut hickory	0.3	2	11	1
	Total	34.6	849		100
Planted/ intermediate (n=3)	loblolly pine	33.3	787	100	89
	sweetgum	1.7	15	33	11
	Total	35.0	802		100
Natural/ mature (n=21)	loblolly pine	21.2	210	95	35
	sweetgum	4.9	189	90	19
	tulip poplar	3.0	40	52	9
	black gum	1.1	141	10	7
	black oak	0.7	84	19	5
	flowering dogwood	0.5	64	10	4
	red maple	0.1	92	5	4
	white oak	1.2	7	19	3
	southern red oak	0.4	24	19	3
	black cherry	0.8	21	5	2
	hackberry	0.2	28	5	2
	shortleaf pine	0.5	5	10	1
	mockernut hickory	0.2	4	10	1
	slippery elm	0.2	3	10	1
	willow oak	0.2	1	5	1
	eastern red-cedar	0.1	23	5	1
	water oak	0.1	10	5	1
	American elm	0.1	9	5	1
	northern red oak	0.1	2	5	1
	black walnut	0.1	1	10	1
	American beech	0.1	1	5	1
	Total	35.8	959		103

Table 11. Understory density, diameter at breast height, and height by species for the pine cover type at the Main Unit, PNB, Virginia.

Stand Type	Species	Density (stems/ha)	Diameter (cm)	Height (m)
Natural/young (n=3)	sweetgum	7708	3.3	3.1
	black cherry	1042	4.3	3.1
	eastern red-cedar	417	7.4	3.6
	loblolly pine	417	4.0	2.8
	tulip poplar	208	2.7	3.3
	common persimmon	208	2.7	2.9
Total		10,000		
Natural/ intermediate (n=9)	sweetgum	1250	3.0	2.7
	white oak	347	2.5	2.4
	southern red oak	278	3.5	3.0
	flowering dogwood	208	7.4	3.5
	mockernut hickory	139	3.3	3.6
	water oak	139	4.1	3.5
	scarlet oak	139	2.6	2.8
	black oak	139	4.5	2.6
	tulip poplar	139	2.0	2.6
	highbush blueberry	139	3.1	2.3
	eastern red-cedar	69	5.9	4.8
	sassafras	69	5.3	4.5
	willow oak	69	2.8	2.7
	American holly	69	4.0	2.6
	hawthorn	69	1.2	1.4
Total		3,262		
Planted/ intermediate (n=3)	sweetgum	3125	2.8	2.7
	eastern red-cedar	208	2.7	3.4
	black oak	208	2.6	1.5
Total		3,541		

Table 11 (Continued).

Stand Type	Species	Density (stems/ha)	Diameter (cm)	Height (m)
Natural/mature (n=21)	sweetgum	536	3.5	3.0
	red maple	208	3.2	2.8
	slippery elm	149	4.0	3.3
	white oak	119	5.6	4.2
	tulip poplar	119	6.4	3.4
	American holly	119	4.9	2.4
	black gum	89	5.8	3.9
	black oak	89	2.9	2.9
	southern red oak	89	4.1	2.8
	common waxmyrtle	89	2.6	2.7
	pignut hickory	60	3.8	3.1
	willow oak	60	4.2	3.0
	flowering dogwood	60	4.5	2.7
	black cherry	30	3.5	3.8
	water oak	30	4.9	3.6
	eastern red-cedar	30	2.9	3.3
	mockernut hickory	30	3.3	3.2
	ironwood	30	7.6	3.0
	downy serviceberry	30	2.7	2.5
	southern arrowwood	30	2.0	2.2
	Total	1,996		

Table 12. Average density of tree seedlings for all forest stand types at the Main Unit, PNB, Virginia.

Species	Forest Stand Types ^a					
	PNY	PNI	PPI	PNM	PHNM	HNM
	----- seedlings/ha -----					
red maple	14167	556	3333	1250	4000	3182
downy serviceberry	0	0	0	500	1500	227
flowering dogwood	0	278	0	250	500	114
American holly	0	278	0	0	2000	568
sweetgum	65833	23889	833	19125	2500	20796
tulip poplar	19167	556	0	4375	4500	6477
black gum	2500	833	0	25	1000	341
willow oak	833	1667	0	1000	1000	1705
sassafras	0	3056	0	125	2500	909
box elder	0	0	0	0	0	227
tree-of-heaven	0	0	0	0	0	227
ironwood	0	0	0	375	0	341
pignut hickory	0	0	0	375	0	455
mockernut hickory	0	278	833	250	0	568
American beech	0	0	0	0	0	114
water ash	0	0	0	0	0	114
common spicebush	0	0	0	250	0	11136
loblolly pine	1667	1944	0	2125	0	909
black cherry	0	8056	15000	750	0	2500
white oak	0	278	0	1375	500	8182
southern red oak	0	1389	0	500	0	341
black oak	0	3056	0	375	0	114
shingle oak	0	0	0	0	0	114
hophornbeam	0	0	0	125	0	0
slippery elm	2500	833	833	1000	0	114
eastern red-cedar	3333	0	0	0	0	0
common persimmon	0	556	0	0	0	0
northern red oak	0	278	0	0	0	0
water oak	0	0	0	0	500	0
scarlet oak	0	0	0	0	1,500	114
Total	110,000	47,781	20,832	34,150	22,000	59,889

^a PNY: Pine natural/young, PNI: Pine natural/intermediate, PPI: Pine planted/intermediate, PNM: Pine natural/mature, PHNM: Pine-hardwood natural/mature, HNM: Hardwood natural/mature.

approximately 7% of the ground stratum in the natural/young stand type, contributing to this type's high percent ground coverage (Table 13). In fact, this stand type is covered by about 14% woody and herbaceous ground vegetation, which is the highest at the Main Unit (Table 13).

The natural/intermediate stand type is found in small areas along the southern section of the unit, covering approximately 57 ha (Figure 2). The overstory is a mixture of pines, oaks, and other hardwood species, and is approximately 43 years old. Canopy height averages 25 m. Loblolly pine dominates these stands, occupying 63% of the basal area and maintaining a 100% frequency rate (Table 10). Another 7% of the basal area is occupied by oaks, principally southern red oak; sweetgum is the densest species, with 367 stems/ha. About a third of the understory stems are sweetgums, mixed with a significant component of oaks (Table 11). Collectively, the oaks make up another third of the understory stems, indicating an eventual shift in forest composition to the more tolerant oaks. Eastern red-cedar and sassafras are the tallest species; however, their population is not large enough to have a significant influence on overstory species composition. The remaining third of the understory is diverse, with a mixture of soft and hard mast-producing species. The largest component of the regeneration is sweetgum, which approaches 24,000 seedlings/ha (Table 12). Black cherry is second in abundance, with 8,056 seedlings/ha. Loblolly pine comprises only 4% of the regeneration. Total ground coverage is 10% for the natural/intermediate stand type, primarily muscadine grape and Japanese honeysuckle (*Lonicera japonica* Thunberg) (Table 13).

Located in the lower western part of the unit, the single pine planted/intermediate stand type occupies about 19 ha (Figure 2). Ages range from 24 to 34 years, with canopy heights reaching 23 m. Loblolly pine represents 95% of the basal area and has an 89% importance value; the remainder of the overstory is composed of sweetgum, and total density is 802

Table 13. Average ground cover of woody and herbaceous vegetation for all forest stand types at the Main Unit, PNB, Virginia.

Species	Forest Stand Types ^a					
	PNY	PNI	PPI	PNM	PHNM	HNM
	----- percent cover -----					
American strawberry-bush	0	P ^b	0	P	0	1
bedstraw	0	0	0	0	0	P
beggar's tick	0	0	0	0	0	P
blackberry	3	1	1	P	0	P
blueberry	0	0	0	0	0	P
butterfly pea	0	0	0	P	0	P
Christmas fern	0	1	0	P	0	P
clover	1	0	0	0	0	P
common waxmyrtle	0	0	0	P	0	P
highbush blueberry	0	p	0	0	P	P
<i>Cornus drummondii</i>	0	0	0	0	0	P
crownbeard	0	0	0	0	0	P
deerberry	0	P	0	P	P	P
early low blueberry	0	0	0	P	P	P
ebony spleenwort	0	0	0	P	0	0
false-nettle	0	0	0	0	0	P
false Solomon's Seal	0	0	0	0	0	P
grass	7	P	1	P	0	P
greenbrier (<i>Smilax glauca</i>)	0	0	0	P	0	P
greenbrier (<i>S. rotundifolia</i>)	0	P	1	1	P	2
ground pine	0	P	0	0	0	P
hackberry	0	0	0	0	0	P
<i>Impatiens spp.</i>	0	0	0	0	0	P
jack-in-the-pulpit	0	0	0	0	0	P
Japanese honeysuckle	1	2	2	2	P	3
large whorled pogonia	0	0	0	0	P	0
moneywort	0	0	0	0	P	P
muscadine grape	P	3	1	P	3	1
<i>Panicum spp.</i>	0	0	0	0	0	1
papooseroot	0	0	P	0	0	0
partridgeberry	0	0	0	0	0	P
pinweed	0	0	0	P	0	0
poison ivy	1	P	0	1	0	P
privet	0	0	P	0	0	0
rattlesnake fern	0	0	0	0	0	P
rattlesnake-weed	0	P	0	0	0	0
rough bedstraw	0	0	0	0	0	P
sensitive fern	0	0	0	0	0	P
small jack-in-the-pulpit	0	0	0	0	0	P
snakeroot	0	P	0	P	0	P
Solomon's Seal	0	0	0	P	0	P
southern lady fern	0	0	0	P	0	P

Table 13 (continued).

Species	Forest Stand Types ^a					
	PNY	PNI	PPI	PHN	PHNM	HNM
	----- percent cover -----					
spotted touch-me-not	0	0	0	P	0	P
spotted wintergreen	0	P	0	0	P	P
St. John's-wort	0	0	0	0	0	P
summer grape	0	0	0	P	0	0
sweet pepperbush	0	0	0	P	1	1
tall huckleberry	0	0	0	0	P	P
trumpet vine	P	1	1	P	0	P
violet	0	0	0	0	0	P
Virginia creeper	1	1	P	1	P	1
wild yam	0	0	0	0	0	P
woodfern	0	0	0	0	0	P
yarrow	0	P	0	0	0	0
Total	14	10	7	5	4	10

^a PNY -Pine natural/young, PNI -Pine natural/intermediate, PPI -Pine planted/intermediate, PNM -Pine natural/mature, PHNM Pine-hardwood natural/mature, HNM - Hardwood natural/mature.

^b P - present at < 0.5% coverage.

stems/ha (Table 10). Similarly, the understory is not very diverse. Sweetgum is the most abundant species, occupying 88% of the density. Eastern red-cedar and black oak are minor components (Table 11). Regeneration in the planted/intermediate stand type is low in species richness and density compared with other stand types at the Main Unit. Black cherry (*Prunus serotina* Ehrhart) is the most abundant species, with 15,000 seedlings/ha, or 71% of the total (Table 12). Only four other species are present in this stand type: red maple, sweetgum, mockernut hickory, and slippery elm (*Ulmus rubra* Muhl.). Japanese honeysuckle is the primary ground vegetation, with a mixture of greenbrier, muscadine grape, and trumpet vine (*Campsis radicans* (L.) Seemann) also contributing to the 7% ground coverage (Table 13).

The natural/mature pine stand type ranges in age from 53 to 86 years, and covers nearly a third of the land area in the unit (Figure 2). Because these stands are in a transitional successional stage, their overstory composition is the most diverse in the pine cover type, with 21 species present. Total density averages 959 stems/ha (Table 10). The canopy is a relatively high 30 m, allowing ample light to penetrate to the lower vegetation strata. Overall, the overstory is healthy, although there are patches of standing dead pines as a result of southern pine beetle activity in the center of the unit. Loblolly pine, shortleaf pine (*Pinus echinata* Miller), and eastern red-cedar constitute the conifer component in the natural/mature stand type. The overstory averages 36 m²/ha of basal area, of which 61% is pine (Table 10). Sweetgum and tulip poplar are the next most important species, and oaks as a group comprise 8% of the basal area. The understory is also high in species richness. Generally, the stratum is taller and less dense than in the other stand types in the pine cover type. Sweetgum and white oak are the dominant species in the understory, where sweetgum is more abundant than white oak, but shorter in stature (Table 11). The regeneration in the natural/mature stand type

is also very diverse and prolific (Table 12). Just over 34,000 seedlings/ha are present, 56% of which are sweetgum (Table 12). Tulip poplar and loblolly pine are successfully regenerating, generally in areas where whole trees or limbs have fallen from the canopy, creating small gaps. Nearly 10% of the seedling density is made up of oak species, which will most likely comprise these forest stands in the future. The ground vegetation in the natural/mature stand type is sparse, covering only 5% of the forest floor (Table 13). Primary species include Japanese honeysuckle, Virginia creeper, and greenbrier.

Pine-Hardwood Cover Type: The pine-hardwood cover type contains only one stand type, which is characterized as natural in origin and in the mature age class. Ages range from 48 to 87 years in five small stands, totalling 33 ha of land. Canopy heights average 28 m, and overstory species richness is low. Total basal area averages nearly 33 m²/ha (Table 14). Loblolly pine occupies just over half of the basal area and has 100% frequency, while tulip poplar is the most abundant species, ranking second in importance value. Oaks comprise 41% of the total number of stems. The understory is dominated by southern red oak, with 14% of the density, and it is the second tallest species in the stratum (Table 15). Willow oak is the tallest understory tree species, averaging 4.5 m in height, suggesting a future prominent role in the overstory. Understory shrubs include highbush blueberry and sweet pepperbush. Regeneration is adequate and relatively evenly distributed in terms of numbers of seedlings. Tulip poplar and red maple are the most abundant species, with 4,500 and 4,000 seedlings/ha respectively (Table 12). Muscadine grape is the dominant species in the ground stratum, with 3% ground cover (Table 13). The pine-hardwood cover type has the lowest percent ground coverage at the Main unit.

Table 14. Overstory basal area, density, frequency, and importance value by species for the pine-hardwood forest cover type at the Main Unit, PNB, Virginia.

Stand Type	Species	Basal Area (m²/ha)	Density (stems/ha)	Frequency (% plots)	Importance Value (%)
Natural/ mature (n=6)	loblolly pine	17.0	184	100	32
	tulip poplar	3.5	365	60	19
	sweetgum	7.5	162	60	18
	southern red oak	2.0	275	60	15
	black gum	1.0	109	20	6
	water oak	0.5	83	20	5
	white oak	0.5	29	20	3
	scarlet oak	0.5	2	20	2
Total		32.5	1,209		100

Table 15. Understory density, diameter at breast height, and height by species for the pine-hardwood cover type at the Main Unit, PNB, Virginia.

Stand Type	Species	Density (stems/ha)	Diameter (cm)	Height (m)
Natural/ mature (n=6)	southern red oak	500	4.0	3.6
	red maple	375	3.0	2.5
	mockernut hickory	375	3.0	2.5
	sweetgum	375	2.1	2.2
	water oak	250	2.8	3.2
	tulip poplar	250	2.5	3.0
	flowering dogwood	250	3.1	2.8
	black gum	250	3.9	2.2
	American holly	250	2.9	2.2
	sweet pepperbush	250	1.2	1.7
	willow oak	125	4.9	4.5
	sassafras	125	2.5	2.5
	highbush blueberry	125	1.4	1.5
Total		3,500		

Hardwood Cover Type: The hardwood cover type occupies approximately 208 ha of land. Because the forested areas are similar in origin and age class, only one stand type is delineated. The canopy is the tallest, at 33 m, and the most heterogenous at the Main Unit. No historic trees were noted during the inventory, since canopy tree ages range from 52 to 97 years. Tulip poplar is dominant, with the most basal area and the highest importance value in the overstory (Table 16). Oaks and sweetgum each comprise 7 m²/ha, or 21% of the total basal area. Large loblolly pine trees are scattered throughout the stands, occupying about 14% of the basal area. It is the only pine species present in this cover type. Mixed hardwoods such as hickory, beech (*Fagus grandifolia* Ehrhart), and sycamore (*Platanus occidentalis* L.) are minor species in the overstory, but their presence suggests an eventual shift of the forest composition toward a climax successional stage. Moist, fertile soil underlies the hardwood cover type, as evidenced by the species composition in the overstory and understory strata. For instance, the understory stratum is dominated by spicebush (*Lindera benzoin* (L.) Blume) and sweet pepperbush, both of which thrive in wet habitats and nutrient-rich soils. This stratum contains nearly 4,000 stems/ha, yet it is open and easy to hike through, with the average height of the vegetation being almost 3 m (Table 17). Oaks dominate the highest levels of the understory and comprise 17% of the density. Understory oaks, hickory, and beech also indicate a compositional change in species. Regeneration in the hardwood cover type is characterized as prolific and diverse, with 60,000 seedlings/ha representing 26 species (Table 12). Sweetgum comprises a third of the regeneration; white oak and tulip poplar are also important. Non-native species, such as tree-of-heaven (*Ailanthus altissima* (Mill.) Swingle), have infiltrated this cover type in numbers approaching 230 seedlings/ha, mostly in gaps and trail edges. Ground cover is lush, over 10% of the forest

floor, and high in species richness (Table 13). Japanese honeysuckle, greenbrier, and Virginia creeper are the primary species present, although 43 additional species are found.

Table 16. Overstory basal area, density, frequency, and importance value by species for the hardwood forest cover type at the Main Unit, PNB, Virginia.

Stand Type	Species	Basal Area (m ² /ha)	Density (stems/ha)	Frequency (% plots)	Importance Value (%)
Natural/ mature (n=22)	tulip poplar	9.2	99	67	20
	sweetgum	6.9	77	71	17
	loblolly pine	4.1	55	38	10
	white oak	2.2	37	43	8
	red maple	1.6	45	38	7
	willow oak	2.5	17	29	6
	black oak	1.1	26	24	5
	American beech	0.6	63	14	5
	pignut hickory	0.6	24	10	3
	slippery elm	0.3	40	10	3
	flowering dogwood	0.2	33	10	3
	red ash	0.6	13	5	2
	American sycamore	0.6	4	10	2
	scarlet oak	0.5	6	10	2
	southern red oak	0.3	1	14	2
	hackberry	0.2	7	10	1
	black gum	0.2	5	5	1
	post oak	0.2	3	5	1
	black walnut	0.2	1	10	1
	black cherry	0.1	3	5	1
	mockernut hickory	0.1	2	5	1
	northern red oak	0.1	1	5	1
Total		32.4	562		102

Table 17. Understory density, diameter at breast height, and height by species for the hardwood cover type at the Main Unit, PNB, Virginia.

Stand Type	Species	Density (stems/ha)	Diameter (cm)	Height (m)
Natural/ mature (n=22)	common spicebush	938	1.6	1.8
	sweet pepperbush	739	1.5	1.8
	sweetgum	597	2.6	2.5
	willow oak	483	3.7	2.8
	box elder	142	3.4	2.4
	black gum	114	4.0	3.0
	white oak	114	3.5	3.3
	pignut hickory	85	4.1	3.1
	mockernut hickory	85	3.6	2.8
	red maple	85	3.4	2.7
	smooth alder	85	2.1	2.4
	eastern red-cedar	57	6.8	3.0
	highbush blueberry	57	2.0	1.9
	American beech	57	6.0	2.6
	tulip poplar	57	2.7	2.4
	American holly	57	3.5	2.2
	ironwood	28	7.1	4.1
	slippery elm	28	6.1	4.0
	chestnut oak	28	2.5	2.3
	bitternut hickory	28	5.1	2.3
	southern red oak	28	5.6	4.4
	tree-of-heaven	28	1.2	1.5
Total		3,920		

Vegetation Buffer Zone Management

Petersburg National Battlefield, like many parks, is nested in an urban environment. As a result, the park setting and visitor experience are often negatively affected by reduced visual quality and noise pollution from the urban surroundings. Trees and shrubs absorb noise and provide a visual barrier around the perimeter of the park. This section will discuss uses of and recommendations for vegetative buffers at PNB.

Functions

Vegetative buffers are exceptionally well suited for use in parks with a forest and field patchwork. When screening is well planned, changes in the landscape are often gradual and less abrupt, creating a more pleasant environment for visitors. In addition to noise reduction and visual screening, plantings can be used as natural barriers to control visitor traffic in certain areas. For instance, footpaths, often found on earthworks, result in soil erosion and earthwork deterioration. A ground cover of small, stiff, thorny shrubs may deter visitors from walking on the earthworks. This cover protects the earthworks' integrity, while allowing the landscape to be visible. Plantings are also extremely useful in enhancing and defining special features in the park, such as informational signs or trailheads. Other functions of vegetative buffers include windbreaks, snow traps, and additional food and cover for wildlife.

Site and Species Selection

Several factors must be considered when choosing sites and species for vegetative buffers. The success of a buffer depends primarily on correctly matching the site with the appropriate species. Because temperature and precipitation are the limiting climatic factors in plant performance, it is important to select native species or species that can grow in the plant

hardiness zone of the site. Minimum winter temperature is another useful guideline for species selection. Knowledge of basic soil physical and chemical properties, such as soil type, available water, and pH are important in species selection and subsequent performance. Plant characteristics, including size, growth habit, growth rate, and seasonal aesthetics, must be considered for appropriate placement and function. Appendix 5 lists native trees and shrubs that may be used for buffers at PNB. Combinations of deciduous and evergreen trees and shrubs are recommended for long-term effectiveness and aesthetic beauty of barriers. Pest considerations are also important when selecting plant material for vegetation buffers. Both insects and disease can attack freshly planted trees and shrubs. Plants that have minimal pest problems increase the potential success of buffers.

Besides growth conditions, there is another consideration to note when choosing species for vegetative buffers. Some historical parks, such as PNB, are bound by regulations of the National Historic Preservation Act prohibiting any disruption to the preservation of the historical integrity of the park. These regulations could prohibit the introduction of species that are different from those known to be present during the preserved time period.

Establishing Forest Buffers

Shallow plowing is often needed to prepare the site for efficient planting; however, this can be done only in compliance with the National Historic Preservation Act. Although it will require more time, hand planting is also effective and less intrusive. Bare-root seedlings are recommended for use because they grow into the environment quickly and completely and are usually less expensive than other types of plants (i.e., containerized or bagged and burlapped), and a wider variety of native species can be found as bare-root seedlings. Figure 3 illustrates the proper technique for planting bare-root seedlings. Commercial nurseries should be

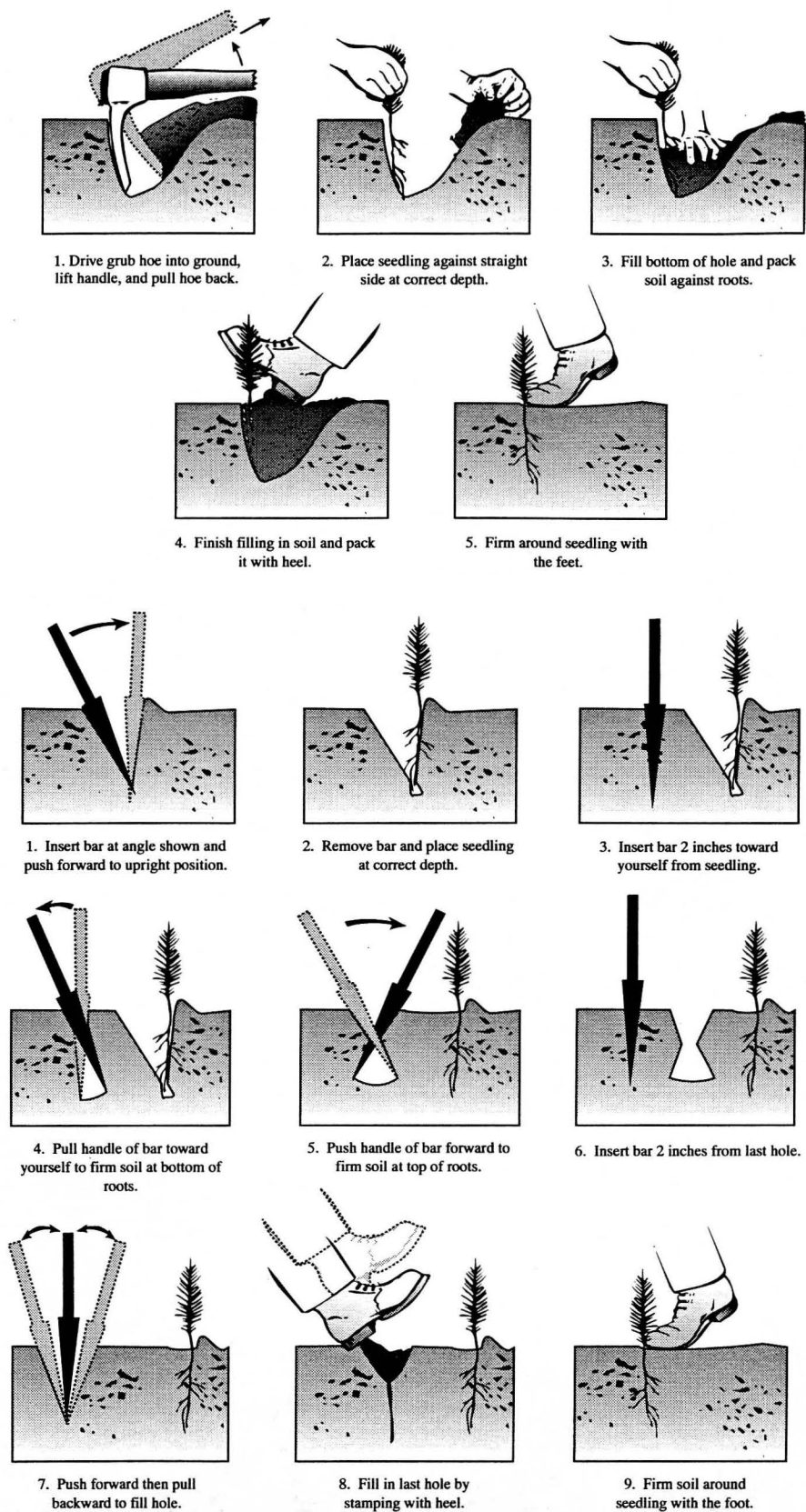


Figure 3. The side-hole (top) and bar-slit methods of tree planting (from Helm and Johnson 1995).

consulted for more detailed information on the care and transport of bare-root seedlings.

Small seedlings should be planted about 1 to 2 m apart in multiple rows that are offset from each other so that there are no holes in the buffer. In general, vegetation belts should be about 6 to 16 m wide, with smaller trees and shrubs on the exterior, followed by the taller trees on the interior. Placement of belts as close as possible to roadsides will better insulate the park from traffic noise. If buffers are designed with these considerations in mind, the atmosphere of the park should be enhanced and a sense of enclosure should be established, providing the visitor with a more favorable experience.

Enhancing Existing Buffers

Much of the perimeter of the Main Unit of PNB is currently mature, native forest. This forest may provide a suitable buffer, but often the understory is sparse and the screening effect is reduced. This is true of park boundaries that are bordered by residences. In the wetter areas, such as along the northwestern border near the service road, small- to medium-sized evergreens such as American holly (*Ilex opaca*) and common waxmyrtle (*Myrica cerifera* L.) should grow well. Deciduous trees that would also grow well include southern arrowwood, mapleleaf viburnum (*Viburnum acerifolium* L.), and highbush blueberry. There is also a section along the scenic road approaching the Crater in the Main Unit where a vegetative buffer could screen County Line Road from sight. Eastern red-cedar, a large-scale evergreen, should screen well in these drier areas.

Many sections along the perimeter of the park have a belt of grass between the road and the forest edge. Small tree plantings along these grass belts will provide a better visual buffer around the park. Another alternative is the careful removal of a few overstory trees, which will stimulate the growth of woody understory trees and shrubs. These plants will create a

denser understory and serve as a more effective visual barrier. The understory can be supplemented by additional plantings, if necessary. There are no recommendations for the Five Forks Unit, as visitor trails have not yet been developed.

Established buffers often require some maintenance. Occasionally a thinning is necessary to remove excess trees and allow the remaining trees to grow better. Damaged, diseased, or insect-infested trees may also need to be removed to prevent damage to other trees or risk to visitors. Buffers along park edges will often be invaded by exotic weeds like Japanese honeysuckle and kudzu. Control of these weeds may be necessary if they endanger overstory trees. However, vines like these can also add to a buffer if they remain close to the ground.

Historic Scene Restoration

Few battlefield parks have the potential for recreating a true historic scene because of a general lack of valid data or the historic scene's incompatibility with current land uses. The nature and timing of the acquisition of the Five Forks Unit presents a unique opportunity for PNB to display the historic scene of the battle of Five Forks in the spring of 1865. Records from a court-martial that occurred shortly after the end of the war and soldier's journals provide detailed information of the orientation and type of vegetation on the landscape (Figure 4). This information, coupled with the fact that the Five Forks area has remained in a rural setting since the time of the war, make the implementation of scene restoration and subsequent interpretive trails possible. The following will provide a description of the changes in the landscape that will be required and the alternatives available to achieve them.

Conversion of Forested Areas to Agricultural or Abandoned Fields

There are eight areas scattered within the Five Forks Unit that need to be converted from forest to various crops or abandoned fields, totalling nearly 68 ha (Figure 5).

Agricultural crops that were present in the historic scene include corn, tobacco, cotton, and other cultivated crops located in fields of various sizes (Table 18). Two abandoned fields, which cover 36 ha, were also documented in the unit in 1865.

The areas to be converted must first be delineated on the ground. The local state forester should be consulted to evaluate the marketability of the timber in the areas to be cut. Stands to be harvested are predominantly young pine and pine-hardwood stands, which may be used for pulpwood, and a small section of older hardwoods that may be merchantable sawtimber. This may provide some additional funds for the restoration project.

A clearcut is the simplest and most economical way to transform these areas to fields.

NATIONAL PARK SERVICE PETERSBURG NATIONAL BATTLEFIELD FIVE FORKS UNIT

HISTORIC VEGETATION (1865)

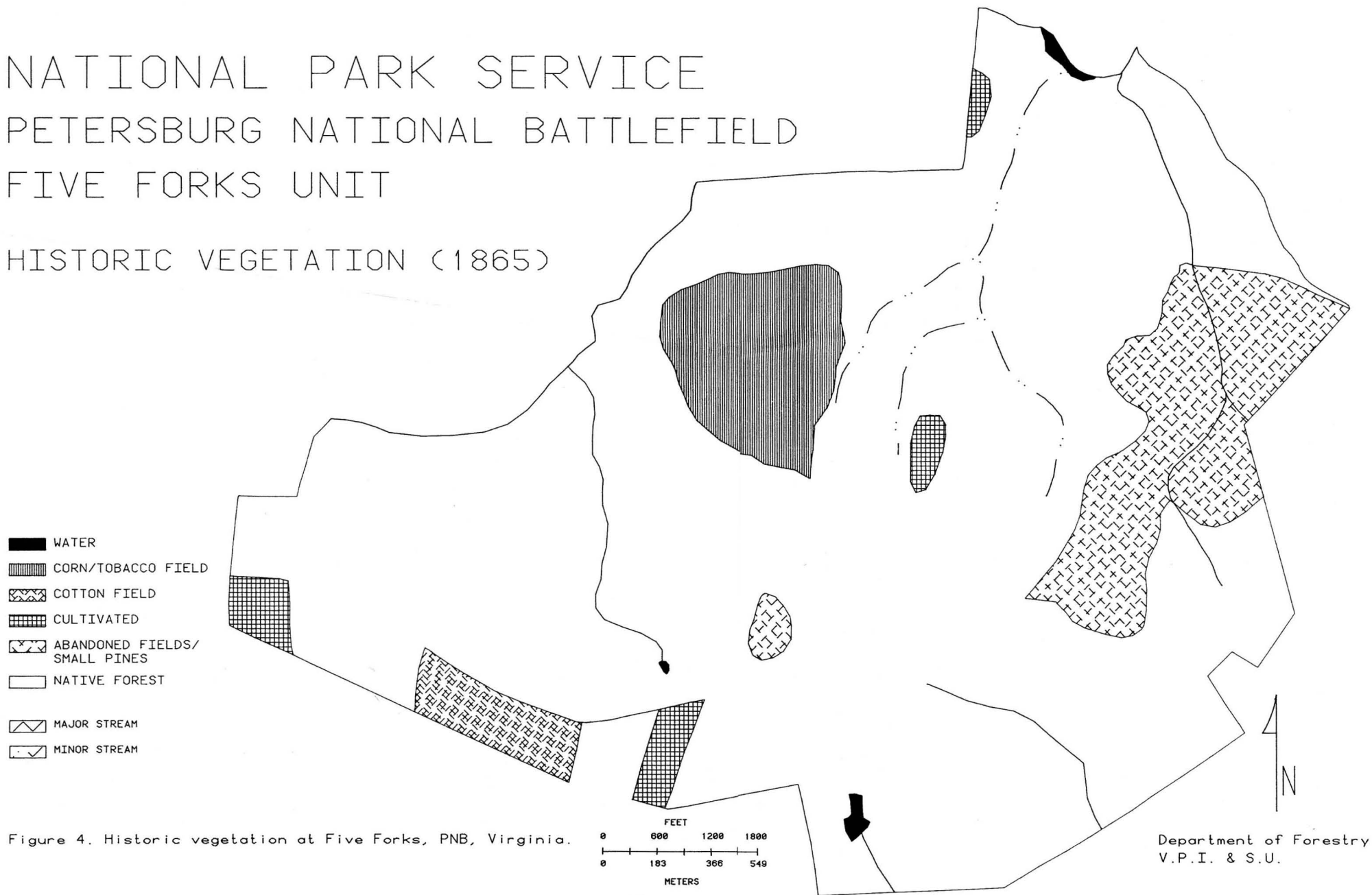


Figure 4. Historic vegetation at Five Forks, PNB, Virginia.

NATIONAL PARK SERVICE PETERSBURG NATIONAL BATTLEFIELD

FIVE FORKS UNIT

CURRENT AND HISTORIC VEGETATION OVERLAY

-  ABANDONED FIELDS/
SMALL PINES
-  CORN/TOBACCO
-  COTTON
-  CULTIVATED
-  FIELDS TO BE
FORESTED

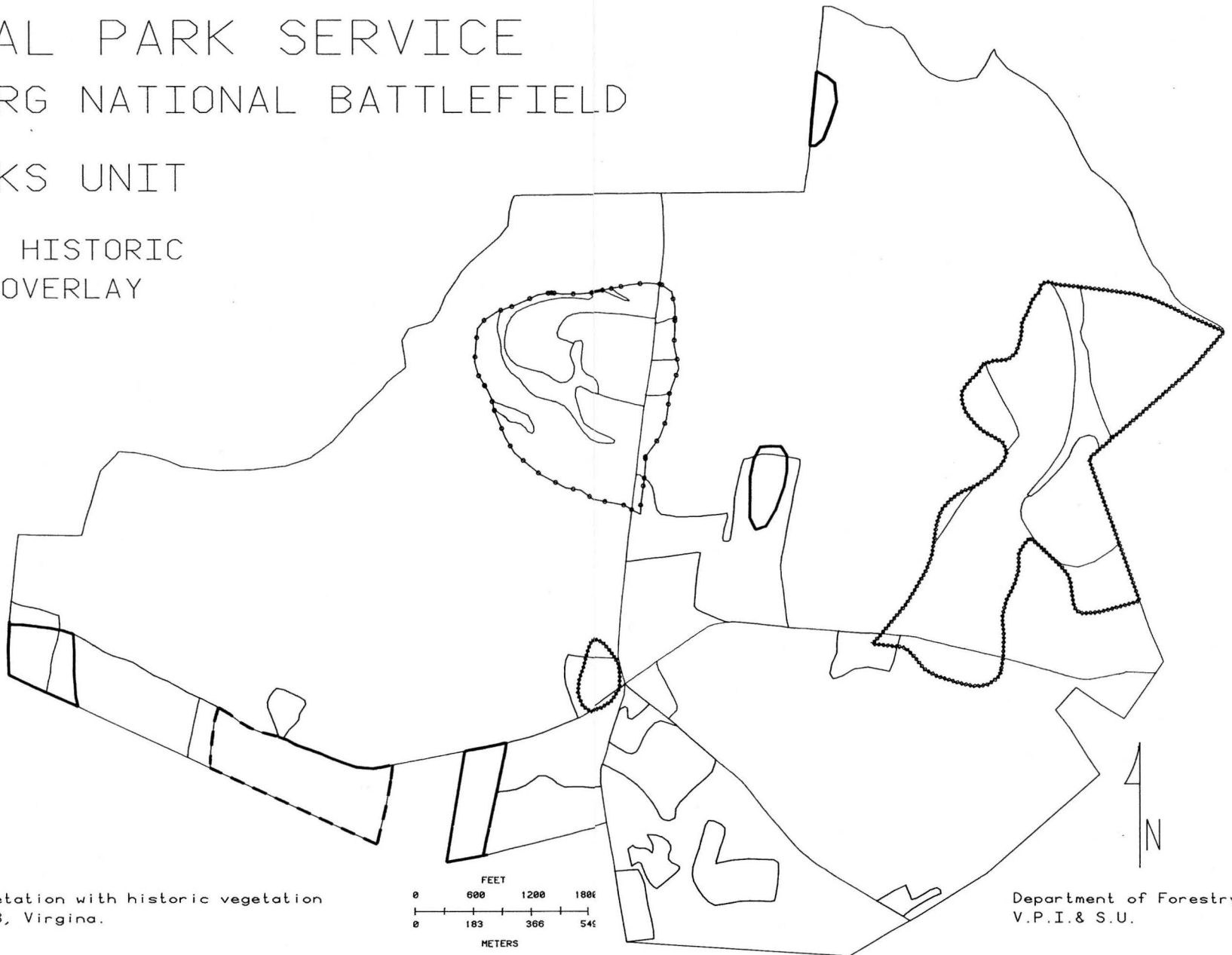


Figure 5. Current vegetation with historic vegetation areas highlighted, PNB, Virginia.

Table 18. Number of historic fields and area of forest to convert to fields by stand type at Five Forks, PNB, Virginia.

Agricultural Crop	No. Historic Fields	Area of Forest to Convert to Historic Fields by Stand Type (ha)^a						
		PNY	PPY	PHNY	PHPY	HNI	HNM	Total
Cultivated, crop unknown	4	1.8	1.8	0.8	0.0	0.0	0.0	2.6
Cotton	1	7.2	0.0	0.0	0.0	0.0	0.0	7.2
Corn/Tobacco	1	14.2	4.1	0.5	0.0	2.8	0.6	22.2
Abandoned fields, small pines	2	0.2	24.4	6.6	2.0	0.0	2.3	35.5
Total	8	21.6	30.3	7.9	2.0	2.8	2.9	67.5

^a PNY: pine natural/young; PPY: pine planted/young; PHNY: pine-hardwood natural/young; PHPY: pine-hardwood planted/young; HNI: hardwood natural/intermediate; HNM: hardwood natural/mature.

Dry periods in the fall and winter are the best time to perform a clearcut, as the trees are dormant and the least amount of damage will be incurred on the site (Helm and Johnson 1995). A chainsaw crew is suitable for cutting the smaller fields; however a contract with a local logging company should be considered for the larger tracts. The land should first be surveyed to determine if there are any jurisdictional wetlands on the property, as there are wet areas in the northeastern section of the unit. Because these areas are to be converted to an agricultural use for the most authentic scene, tree stumps will need to be removed with a stump grinder to allow the site to be planted with the appropriate crop or mowed, as appropriate. Otherwise, the tree stumps will have to be left to decay naturally, which could take as long as a decade, depending on the species. Herbicide treatments are recommended to control any unwanted woody regeneration the following spring, before planting agricultural crops (Table 19).

There are several alternatives for maintaining the crop fields. The fields could be an excellent opportunity for a living history program which depicts the farming practices of the time period. This program would also serve as a low-cost way to maintain the areas in an agricultural land use. Another alternative is to consult a local farmer about a leasing agreement for the maintenance of the crops. The final option is to maintain the areas as open fields or meadows to represent the agricultural fields. The meadows would increase plant diversity within the park, while the maintenance costs would be low, once established. Refer to Helm and Johnson (1995) and Smith (1980) for procedures, species recommendations, and seed sources for converting areas to meadows.

Conversion from Fields to Forest

In order for the historic scene restoration to be complete, 12 currently non-forested

Table 19. Forestry herbicides for stump treatments and general woody vegetation control (adapted from Helm and Johnson 1995)^a.

Herbicide Trade Name	Active Ingredient	Manufacturer	Species Controlled
Banvel CST EPA registration #876-441-AA	Dicamba	Sandoz Crop Protection Corp.	Tree-of-heaven, cedar, cherry, dogwood, elm, black gum, hawthorn, hickory, hornbeam, maple, oak, persimmon, sassafras, serviceberry
Garlon 3A EPA registration #62719-37	Triclopyr amine	DowElanco	Beech, black gum, cherry, chinquapin, choke cherry, hawthorn, dogwood, elm, locust, maples, mulberry, oaks, persimmon, pine, poison oak, sassafras, sweet bay, sweetgum, sycamore, yellow-poplar
Tordon 101R/Tordon RTU EPA registration #62719-31	Picloram	DowElanco	Tree-of-heaven, cedar, cherry, dogwood, elm, black gum, hawthorn, hickory, hornbeam, maples, oaks, persimmon, serviceberry, sweet bay
Tordon 101 Mixture EPA registration #62719-5	Picloram	DowElanco	Tree-of-heaven, cherry, elm, black gum, locust, maple, oak, persimmon, pine, sassafras, yellow-poplar

^a It is the user's responsibility to obtain and consult the most recent herbicide labels available.

areas, other than ponds, must be converted back to forests. They are generally located in the southern half of the unit and collectively cover nearly 31 ha (Figure 5).

There are basically two methods for afforesting a site: natural regeneration through succession and artificial planting. Natural regeneration is the most inexpensive alternative, although it will require 10-15 years for the forest to become established. If quicker results are desired, the site will need to be artificially planted with older seedlings. This method is considerably more expensive due to supply and labor costs involved. Also, a herbicide treatment or manual control of competing woody vegetation will be necessary on a regular basis until the trees are well established.

There are no existing specifications as to what forest types should be established in the currently non-forested sites located in the southern section of the unit. It is recommended that these sites be naturally regenerated by the seeds of the surrounding trees (Figure 5). The 9-ha tract near Burnt Quarters in the center of the unit was historically a stand of cedars and pines. A mixture of both artificial planting of loblolly pine and Virginia pine, and wind-carried seeding from the surrounding stands, should be allowed to regenerate this stand. Planting of pines should be concentrated in the left arm of the stand, where the adjacent stand is natural/young pine-hardwood. The two non-forested areas immediately to the west along Rt. 613 require artificial planting of loblolly and Virginia pine seedlings. Approximately 1,110 seedlings/ha should be planted on a random spacing in an attempt to create a natural-looking stand. Pine stands surround the remaining non-forested areas further west along Rt. 613, and it is recommended that they be left to return to pine forest via natural seeding.

Fuel Management

Fire is a powerful force that dramatically shapes the vegetation on the landscape. In a park setting, fire can destroy historical structures and be hazardous to visitors. In this situation, fire must be controlled. However, fire is a natural disturbance agent that can have positive effects on vegetation dynamics. This section provides a brief discussion of fire ecology, fuel loads, and recommendations for hazardous fuel management.

Fire Ecology

Fires, both natural and human-made, have historically been common across the eastern United States. The first pioneers documented many fires during their explorations (Lorimer 1992). Natural fires often ignited from lightning strikes after long, dry periods. Humans used fire as a management tool to clear land for grazing and agriculture. In addition, fire was used in the understory of the forest to create better hunting conditions (Lorimer 1992). Fire continues to be used today, especially in forest management, to reduce debris and undesirable woody competition with crop trees. In 1992, debris burning was the primary cause of forest fires in southeastern Virginia (Helm et al. 1994).

Because fire is a prevalent feature in natural forest ecosystems, many species have developed fire adaptations or fire dependence for reproduction. A primary characteristic of fire-adapted species is thick bark (Van Lear and Watt 1992). Many pine forests are maintained as a result of periodic fires. In the absence of fire, many pine forests would not naturally regenerate themselves. The success of oak regeneration has also been linked to frequently recurring fires (Lorimer 1992).

Fires can provide many benefits to forests. For example, ground fires prevent fuel accumulation, which precludes larger, more intense fires from occurring. The reduction in

litter mass provides a more conducive environment for seed germination and seedling establishment of some species. This "cleaning" effect of forest fires stimulates stand growth, releasing the stand from stagnation. In addition, there is generally an increase in nutrient availability for a short period of time after a forest fire. This increase does not necessarily equate to an increase in site quality, but is dependent on the original substrate quality and fire intensity. Forest fires also control the spread of insects and diseases, while simultaneously improving wildlife habitats. Fire suppression also shifts the vegetative species composition. Fire-sensitive species such as hickories, red maple, and black gum are more abundant on sites that are suppressed from fire, and the density of advanced oak regeneration is reduced (Van Lear and Watt 1993).

Fuel Models

Fuel load and depth are key variables in fire models that predict ignition probability, rate of spread, and intensity (Anderson 1982). Stand basal area and density are also reliable indicators of forest floor loads (Helm et al. 1994). Forest fuels include downed material such as leaf litter, branches, and boles.

In general, the fuel loads at PNB are scattered, with a few patches of concentrated downed material. This patchy characteristic of the forest fuels keeps fire hazard at a minimum. Severe weather conditions, however, can increase the probability of a forest fire, despite the low fuel levels and patchy distribution. Weather conditions such as high temperatures, low humidity, and high winds are most conducive to a potential forest fire.

Fuel models from the Fire Behavior Prediction and Fuel Modeling System (BEHAVE) were qualitatively assigned to each forest cover type at PNB. Forest stand types were not separately assigned fuel models, as the young stands generally produce light loads, presenting

little danger (Deeming and Brown 1975). The intermediate stand types are similar enough to the mature stands to allow them to be classified under the same fuel model. BEHAVE models eight through ten were most closely associated with the forest and fuel types found at PNB. A brief description of each model is as follows:

- Model 8:* Developed for closed-canopy forests with short-needle conifers or hardwoods in the canopy and a dense litter layer. In general, these forests support slow ground fires with low flame lengths. Fuels only become hazardous in severe weather conditions.
- Model 9:* Developed for long-needle conifers and hardwoods with a looser litter layer. Fires in these conditions are generally faster-burning than those in Model 8, with longer flame lengths. Spotting and crown fires are potential hazards in severe weather conditions.
- Model 10:* Developed for older stands that have insect or disease infestations resulting in heavy down material on the forest floor. Surface and ground fire intensity is greater than in fires represented in the other two models, as well as the potential for spot and crown fires.

Fuel loads for PNB have been extrapolated from those determined for Richmond National Battlefield Park (RNBP), as the forest conditions were very similar (Helm et al. 1994). When quantifying fuel loads, smaller loads such as woody material less than 7.6 cm in diameter are subdivided by diameter class and identified by a respective time-lag size class. The time-lag size class (T-L) is an index of the length of time required for the moisture content of material to drop, reaching a new equilibrium relative to its environment (Helm 1993). The associated T-L size class fuels are as follows: the 1-hr. T-L is material less than 0.6 cm in diameter; the 10-hr. T-L is material between 0.6 cm and 2.5 cm; and the 100-hr. T-L is material between 2.5 cm and 7.6 cm in diameter.

Pine cover types have the highest bole load and volume (Table 20). Values dramatically increase in pine stands with southern pine beetle activity, which tend to have high concentrations of downed boles and deep surface fuels. In these conditions, fires will burn

Table 20. BEHAVE fuel models and estimated fuel loads for forest cover types at PNB, Virginia.

Cover Type	Fuel Type	Mean Woody Fuel Load ^a Weight (kg/ha)	Mean Woody Fuel Load ^a Volume (m ³ /ha)	BEHAVE Model ^b
Pine	Bole	34,642	68.4	9 and 10
	1 hr. T-L	389	0.9	
	10 hr. T-L	1,997	4.3	
	100 hr. T-L	2,716	6.0	
	T-L total	5,082	11.2	
	Total	39,724	79.6	
Pine- hardwood	Bole	32,555	63.9	9
	1 hr. T-L	440	0.9	
	10 hr. T-L	1,990	4.1	
	100 hr. T-L	2,363	4.8	
	T-L total	4,793	9.8	
	Total	37,348	73.7	
Hardwood	Bole	23,251	42.5	8
	1 hr. T-L	571	1.1	
	10 hr. T-L	2,076	3.8	
	100 hr. T-L	2,618	4.7	
	T-L total	5,266	9.6	
	Total	28,517	52.1	

^a Estimated from a fuel survey study at Richmond National Battlefield Park (Helm et al.1994).

^b Anderson (1982).

more quickly and intensely than in other types of fuel loads found in the park, and have the potential of spotting and moving into the crown (Anderson 1982). The oak and mixed hardwood forests have lower fuel loads than the pine forests. Downed boles are dispersed in this cover type, in which the primary cause of tree death is attributed to windthrow. Litter in these forests is generally more basic and therefore more readily decomposed by a larger group of soil organisms than pine litter, resulting in faster decomposition rates and reduced fuel accumulation.

Fuel Reduction Recommendations

The concentration and arrangement of fuel loads are the primary factors influencing fire intensity and spread. In general, the fuel loads at PNB are not hazardous; however, there are some potential problem areas where concentrations of fuel are high. The primary areas associated with southern pine beetle activity are the mature pine stands between Batteries 8 and 9, and near the horse trail between Operations and Stedman field at the Main Unit. Beetle-infested areas generally produce dense accumulations of debris that can increase fire danger. In addition, areas where trees have been cut for visitor safety along trails may require attention. Fuel loads throughout the rest of the park are well dispersed, with no major concentrations noted.

There are two alternatives for reducing the probability of a large fire. The first is simply to remove the excess fuel from the areas where there is fuel build-up. The second is to rearrange the downed boles so that they are more dispersed and each bole is in contact with the forest floor. The dispersal of the boles decreases the probability of fire spread and keeps fires small and more easily controlled (Helm et. al 1994). The decomposition rate of the boles increases as a result of connection with the forest floor, reducing the flammability time

of the boles.

Because forest stands are a dynamic entity, a fuel monitoring program should be established. The schedule would require that stands be monitored at least after severe storms and disease or insect infestations. Particular attention should be paid to monitoring when severe fire weather conditions exist.

Integrated Pest Management for the Southern Pine Beetle

To analyze a pest problem in a forested ecosystem, it is necessary to understand the ecology of the pest and its host in relation to forest stand dynamics. The southern pine beetle (*Dendroctonus frontalis*), which attacks loblolly pine, is the most destructive insect in the South. This section provides a description of the ecology of the southern pine beetle (SPB), including the developmental stages of the insect's life cycle. Also, a description of SPB activity at PNB and integrated pest management alternatives for isolating the problem are provided.

Southern Pine Beetle Ecology

The natural range of the SPB closely matches the range of its host species. Virtually all pine species inhabiting the South are susceptible to SPB attack and colonization; however, loblolly and shortleaf pine are the preferred species. These two species alone cover just over 20 million ha of land in the South. Specifically, the SPB resides in the eastern U.S. from Delaware south to Florida and west to Texas (Thatcher and Barry 1982). In an undisturbed forest ecosystem, SPB outbreaks are typically cyclical, estimated at every 10 years. Insect population levels eventually reach an equilibrium as a result of natural forces (Smith et al. 1993). These forces include predators, such as the clerid beetle which feeds on SPB eggs and first and second instars. Parasitoids and mites feed on the SPB and reduce its mobility. Four species of woodpeckers prey heavily on the SPB, including the hairy, red-bellied, downy, and pileated woodpeckers (Berisford 1980, Waters 1985). Population increases of woodpecker species have been highly associated with SPB outbreaks, and they have actually been found to shift to infested areas from uninfested areas (Leuschner 1980, Waters 1985).

Forests are continually changing as a result of natural and man-made disturbances. A

native pest such as the SPB functions as one of these agents of change. Historically, SPB and wildfire have combined to create and maintain a mixture of pine and hardwood forests throughout the southeastern forest biome. In the absence of disturbance, a pine forest would not regenerate naturally and would convert to a mixed hardwood forest with relatively few pines in the canopy. An SPB infestation followed by wildfire permits pines to regenerate and remain as a dominant component of the canopy (Waters 1985, Coulson 1980). Wildfire naturally follows an SPB outbreak because of the subsequent fuel buildup on the forest floor (Figure 6). Some benefits of the SPB-wildfire interaction include overall increased stand growth through removal of less vigorous individuals, release of suppressed understory trees, and perpetuation of pine species in the stand (Waters 1985).

Host Selection and Aggregation

One reason the SPB has such a great impact on pine ecosystems is that, as with many insects, it has more than one generation per year. There can be as few as three generations in North Carolina and Virginia, and as many as nine generations further south (Payne 1980, Waters 1985). The female SPB selects a host tree randomly and through trial and error. The only preference appears to be that she land on a vertical object (Payne 1980). Once a female finds a suitable host, she bores into the tree, causing it to exude resin as its primary defense. Pitch tubes can also form when the female enters the tree, creating another defense mechanism. As the female is boring into the host tree, she releases two pheromones, frontalin and *trans*-verbenol, which attract males and females to the selected tree (Waters 1985). These pheromones, together with an odor called *alpha*-pinene that the host tree emits, maximize the mass attack signal to other beetles within range.

The primary means of communication among beetles is through the olfactory organs

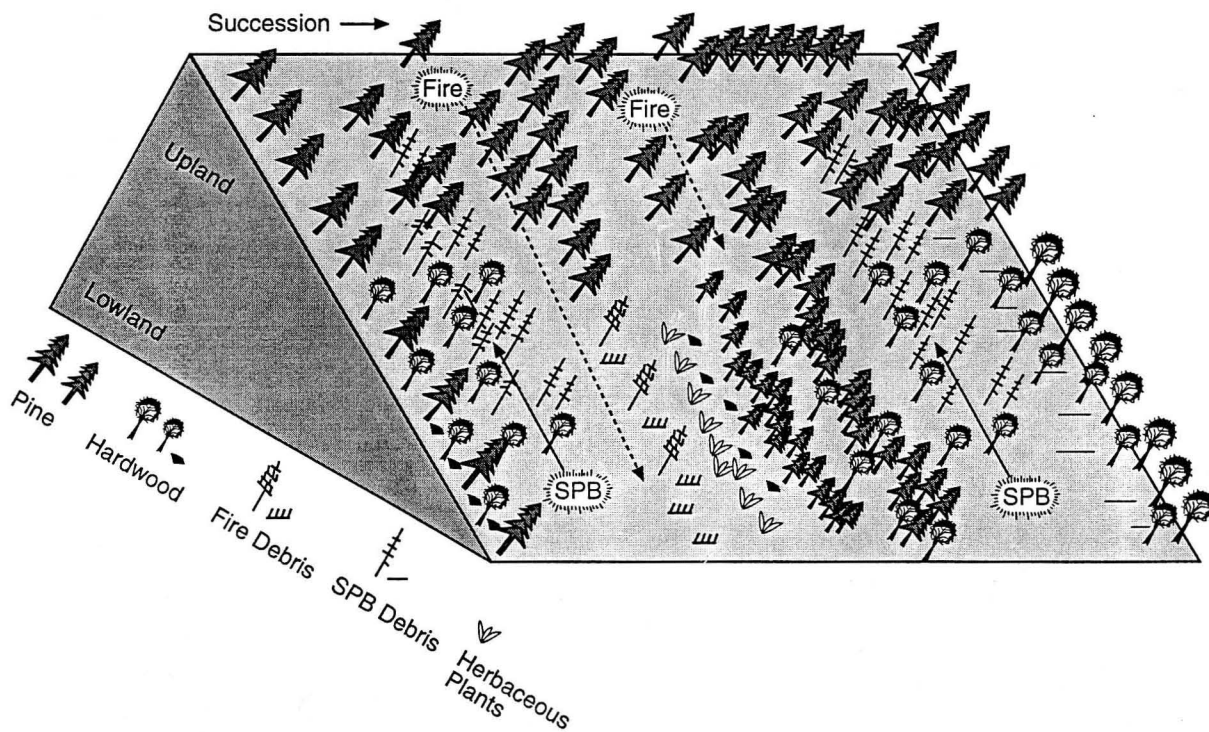


Figure 6. Southern pine beetle and wildfire ecology in the southeast forest ecosystem (from Coulson 1980).

located on their antennae. These organs transfer pheromone and host odors through the insect's central nervous system and communicate a behavior change (Payne 1980). Once the attack is well under way, another pheromone, verbenone, is emitted in order to inhibit other incoming males and even the sex ratio (Waters 1985, Payne 1980). After the tree has been colonized, pheromones are used again to signal movement of the mass to another portion of the tree. However, the SPB usually will not migrate far on the same host tree. There are four other species of beetles that move with the SPB, attacking the same host tree at different time intervals and different places. One such insect is the black turpentine beetle (*Dendroctonus terebrans*), which feeds on the lower trunk. The other three beetles are collectively known as the engraver beetles (*Ips* spp.), which occupy various other portions of the tree (Berisford 1980). These beetles, together with the SPB, form what is known as the southern pine beetle guild (Smith et al. 1993). Peak concentrations for the SPB are in the lower bole, between two and six meters from the ground (Smith et al. 1993, Berisford 1980). Pheromones may also signal a complete switch of the mass to the nearest tree where the cycle will repeat itself. The entire cycle of attack, colonization, and switching can take place in less than 10 days (Waters 1985, Payne 1980) (Figure 7).

Insect Life Stages

Immediately after a tree is attacked, the beetles construct galleries or tunnels in the inner bark and sapwood. Each gallery extends for about 10-24 cm and winds in a characteristic diagonal S-shaped pattern across the tree (Waters 1985, Thatcher and Barry 1982). After the appropriate pheromones have been released for male attraction, copulation occurs in the galleries and the colonization phase is initiated. Eggs are laid singly at sporadic intervals along the sides of the galleries. The length of this stage, as with each stage of development,

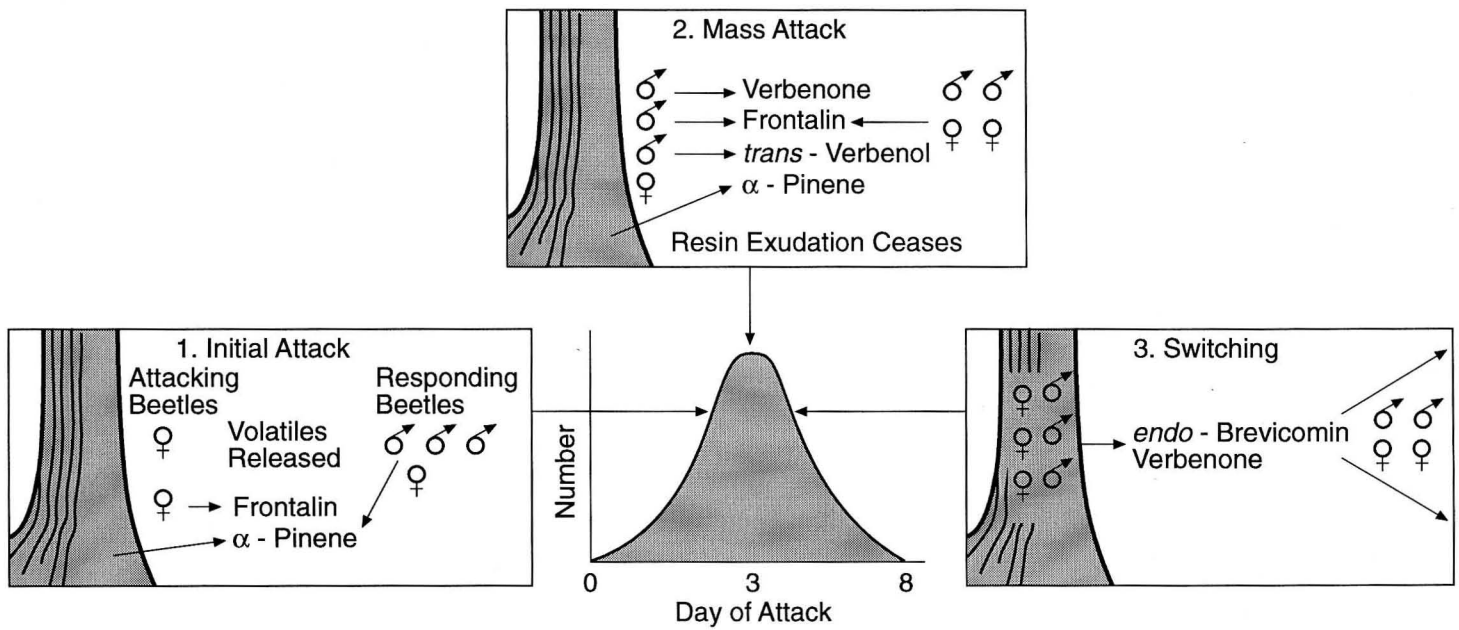


Figure 7. Role of behavioral chemicals in the aggregation phase of a southern pine beetle attack (from Payne 1980).

is temperature-sensitive. For instance, the egg stage usually lasts from 3 to 11 days when temperatures are between 15° to 30° C. At lower temperatures, the egg stage may last as long as 34 days (Payne 1980). Following the egg stage, the larval stage ensues. There are four larval instars which develop for 15-40 days at temperatures ranging from 15° to 25° C. The first three instars feed on the phloem, while the fourth instar bores to the outer bark for pupation. This pupal stage lasts for 5 to 17 days at temperatures between 15° to 30° C. New adults emerge within 6 to 14 days, are 2 to 4 mm in length, and are brownish-black in color. In most instances, there are representatives of each stage of development in one tree at any given time (Waters 1985, Payne 1980). Females may mate several times in one season with several males. All stages of development remain active, although they are markedly slowed during the winter months (Payne 1980). Interestingly, the entire brood is usually never absent from the forest; it is estimated that five trees in every 41 ha are infested, keeping the population alive and ready for the right conditions to prevail (Hicks 1980).

Insect Diagnostics

Some common characteristics of SPB presence can be found on and around host trees. Pitch tubes, which look like popcorn, are an initial sign of SPB. Emergence holes and fine reddish frass in bark crevices and around the base of the tree are additional signs. Beneath the bark, serpentine egg galleries diagonally trace the cambium. More advanced indicators are the color of foliage which generally fades from green to yellow to reddish brown, signalling tree death. Patches of dead trees indicate advanced stages of an outbreak.

Hazard Ratings

Several hazard ratings and models have been developed for the SPB in various

physiographic provinces of the South (Waters 1985). The models that have been developed can predict tree loss, but provide little information on how the stand dynamics and composition may be altered (Smith et al. 1993). On the Atlantic Coastal Plain, forests with high total density and pine basal area above 22 m²/ha have been consistently associated with SPB outbreaks. Very dense stands with a large portion of hardwood basal area are thought to cause a decrease in pine vigor, making the pines more susceptible to attack. As the age of a stand increases, so does the risk of attack. Pine forests associated with wet and waterlogged soils have been found to be more prone to attack by SPB, again due to the decreased vigor of the pine component (Hicks 1980, Belanger 1980, Thatcher and Barry 1982). In addition, pines on upland flats and ridges are more susceptible to attack (Hicks 1980). Well drained, slightly acidic soils are most conducive to vigorous growth of loblolly pine, therefore decreasing the susceptibility to a successful SPB attack.

Weather plays a functional role in determining the conditions for SPB attack. Wind, thunderstorms, and lightning strikes can damage small stands of trees, temporarily decreasing tree resistance to attack. Excessive hot and cold temperature fluctuations have been shown to increase host susceptibility, yet decrease brood survival (Belanger 1980). Amount of rainfall in extreme cases of drought and saturation have also been linked to SPB infestations along the Coastal Plain (Hicks 1980).

Southern Pine Beetle Presence in PNB

The Five Forks Unit has had three small infestation areas where trees were cut and removed in the winter of 1993. One spot infestation was found in the Main Unit in between Batteries 8 and 9. Removal of this spot is recommended, and fortunately it is located far enough inside the forest so that the damage is not visible to the public. Overall, the damage

at the Main Unit is minimal; however, there is the potential for further damage, as all of the older stands in the pine cover type are approaching or have surpassed the hazard pine basal area level and are increasing in age. Monitoring these stands is necessary to detect further SPB activity, and appropriate eradicating action may become necessary.

IPM Alternatives

Integrated pest management incorporates knowledge of pest ecology and control technology to protect the values of a resource (Wood et al. 1985). Three components need to be addressed when developing an IPM plan of action (Wood et al. 1985). The first is the natural control of the pest population. This includes host resistance, natural enemies, and weather conditions associated with declines in the pest population. The second is the use of control strategies that are the most economical. The third component is a level of control which is consistent with the overall objectives of the management of the resource.

Given the objectives of PNB, there are three alternatives for managing the SPB at the Main Unit. The first recommendation is a silvicultural treatment described by Belanger (1980) known as the cut-and-leave. This is a low-impact treatment designed to slow down the spread of the insect. It is recommended for spot infestations like the one at the Main Unit, which incorporate less than 100 trees. The cut-and-leave treatment requires all infested trees to be cut in such a way that the crowns are all felled towards the center of the spot infested area (Figure 8). In addition, a buffer strip of trees surrounding the spot must be cut in the same manner in order to stop spot expansion in the forest. By removing the most recently attacked trees, the source of the attractant pheromones will be eliminated. The buffer strip removes the nearest available tree for the beetles to potentially colonize. The best time of year to implement the cut-and-leave is in the summer or fall (Billings 1980). This

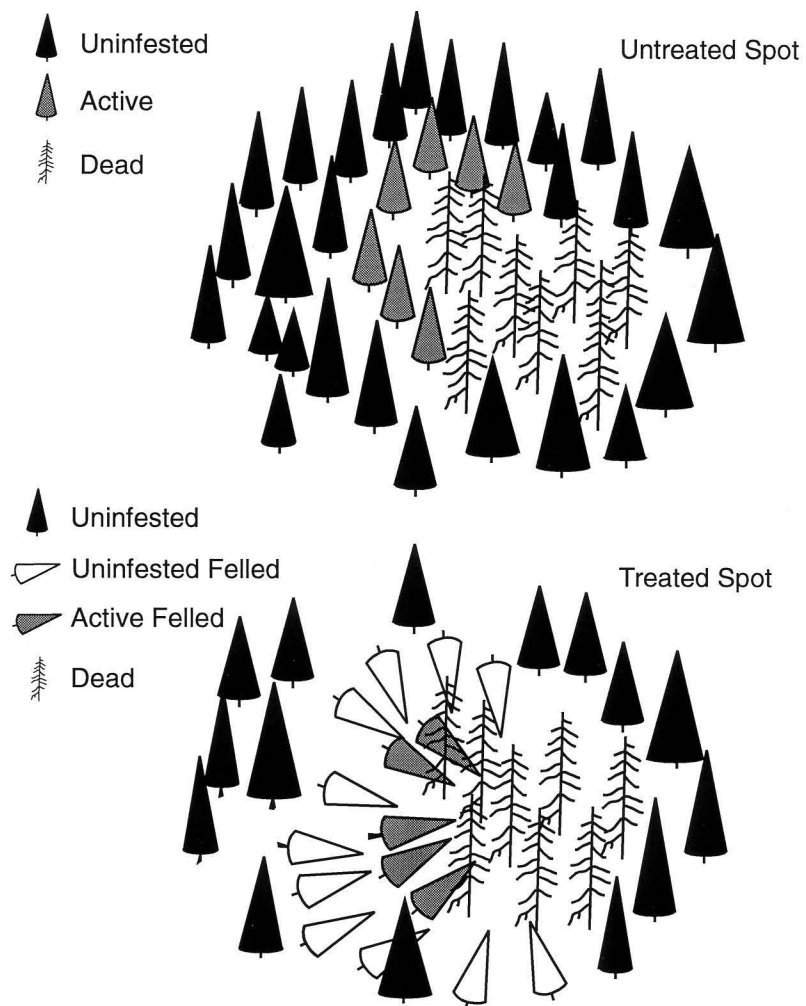


Figure 8. Cut-and-leave method for controlling southern pine beetle (from Billings 1980).

treatment is a simple and cost-effective way to control the spot infestation at the Main Unit, and is the recommended alternative.

The second alternative is to implement no action due to the small size of the spot infestation. Belanger (1980) recommends no silvicultural treatment for spot infestations with fewer than 10 trees. Because the spot infestation at the Main Unit is minimal, with the damage limited to about 15-20 trees, implementing no treatment may be a viable option. In addition, PNB is not managed for timber, the SPB spot is not visible to the public, and the population of natural predators such as woodpeckers is adequate for some SPB population control. The spot may contain itself. Leuschner (1980) summarized a compilation of studies that showed that spot infestations of SPB had a positive impact on several other wildlife populations. The no-treatment option has inherent risks and there is no guarantee that the outbreak will be contained, so further monitoring of the stands in the pine cover type will be necessary.

The third alternative involves the use of behavioral chemicals applied on single trees. The goal is to interrupt the aggregation phase of a mass attack by treating the buffer trees surrounding a spot infestation with a liquid polymer form of verbenone and cutting the newly attacked trees. This treatment lowers the attack density, thereby increasing tree resistance against a mass attack. The use of behavioral chemicals will not eradicate the population, but simply slow the rate of development (Payne et al. 1992, Salom et al. 1992).

Long-Term Vegetation Monitoring

Plant communities are dynamic, and long-term vegetation monitoring (LTM) with permanent plots is necessary to establish baseline data and to accurately document vegetation changes through time. Permanent plots provide more statistically sound data sets because of the smaller sample variation, as compared to other transitory sampling techniques. The reduced variation, coupled with the longer sampling period, allows more statistical power to determine rates of change in plant communities, species replacement patterns, and other subtle changes in the species composition that may otherwise be undetected. In addition, LTM allows resource managers to design their management strategies according to the resource base. The permanent nature of LTM also makes it possible to recognize causal relationships among management activities, visitor impacts, and shifts in plant communities. This section describes the procedures for establishing an LTM program at PNB, adapted from the guidelines of Russell (1993). Natural resource managers at the park can refine the program according to their objectives.

Number of LTM Plots

Forest cover type maps were developed from aerial photos in order to design a complete forest inventory strategy. The forest inventory was conducted not only to describe forest vegetation, but also to determine the variability of the tree species population within each cover type. The number of permanent plots established in each cover type was based on this variability and the area occupied by each cover type. A total of 74 LTM plots were established, 33 in the Five Forks Unit and 41 in the Main Unit (Table 21). The cover types with the largest number of plots, pine at both units, occupy the greatest amount of land area. If a lower allowable error or a probability level higher than 0.80 is desired, additional plots may need to be established based on the park's objectives for the LTM program.

Table 21. Number of installed LTM plots and allowable error for estimating overstory stand density at PNB, Virginia.

Cover Type	Five Forks Unit		Main Unit	
	No. of Plots	AE (%) ¹	No. of Plots	AE (%)
<u>Pine</u>	19	5	20	5
Stand Type ² :				
PNY	14		1	
PPY	5		--	
PNI	--		10	
PPI	--		--	
PNM	--		9	
<u>Pine-hardwood</u>	8	25	3	15
Stand Type:				
PHNY	3		--	
PHPY	1		--	
PHNI	4		--	
PHNM	--		3	
<u>Hardwood</u>	6	10	18	5
Stand Type:				
HNI	4		3	
HNM	2		15	
Total	33		41	

¹ AE = allowable error expressed as a (+/-) % of the mean at the 0.80 probability level.

² PNY - Pine natural/young, PPY - Pine planted/young, PNI - Pine natural/intermediate, PPI - Pine planted/intermediate, PNM - Pine natural/mature, PHNY - Pine-hardwood natural/young, PHPY - Pine-hardwood planted/young, PHNI - Pine-hardwood natural/intermediate, PHNM - Pine-hardwood natural/mature, HNI - Hardwood natural/intermediate, HNM - Hardwood natural/mature.

Location of LTM Plots

All LTM plots were randomly located in each forest cover type. Plot locations were established using a staff compass set to magnetic north, and a cloth tape for horizontal distance (Russell 1993). Bearings and distances from permanent landmarks, such as buildings and road intersections, were used as starting points. Large, healthy trees were marked with aluminum tags as line markers at intervals of about 10 to 20 meters along survey lines to the plot cluster. Trees used as line markers and other unique site features were documented on a Plot Cluster Landmark Form from Russell (1993) (Appendix 6).

Plot Layout

Plot design varied by topographic position in order to incorporate all of the vegetational variability in the sample. A 20 m x 20 m square plot design was used on slopes less than 10%, and a 10 m x 40 m rectangular design was used on steeper slopes. The rectangular plots were oriented with the long edge parallel to the slope. The four corners of each plot were staked with 1/2-inch PVC conduit driven 50 cm into the ground whenever possible. Distances to each corner stake were measured and adjusted to ensure that all plot angles were 90° for plot standardization. At each corner of the plot, the closest medium-sized trees were chosen as witness trees. These witness trees were marked with an aluminum tag engraved with the plot number and the witness tree number. Species, dbh, and horizontal distance and compass bearing from the stake to the witness tree were recorded at each corner on a Plot Cluster Location Form from Russell (1993) (Appendix 7).

The plots established at PNB form the framework for an LTM program. Only the overstory plots were installed. Delineations of the plot boundaries for the other vegetation layers should be nested within the overstory plot, according to Russell (1993).

Goals for Long-Term Vegetation Monitoring

Long-term monitoring is clearly designed to provide information on the health and response of natural ecosystems to stresses (both natural and man-made) and on ecological changes over time. Establishing a network of plots in each of the major forest cover types, as has been done at PNB, provides the opportunity to view changes along a normal successional gradient. Instead of viewing these changes in a subjective way, long-term monitoring provides hard data for quantifying the changes. For example, overstory measurements may quantify the decline of one or more tree species. This may be normal and expected; for example, the natural death of loblolly pine as it is out-competed by more tolerant, longer-lived deciduous species. It may also be naturally accelerated; for example, rapid death of loblolly pine caused by the southern pine beetle, or the decline of white oak caused by gypsy moth defoliation. Decline may be artificially accelerated, due to man-caused influences such as air pollution. Evaluation of understory and ground vegetation can provide very useful data as well. An example may be the invasion of exotic species. Long-term monitoring can quantify the encroachment of undesirable plant species into the forest, expressed by ground cover amount or number of individuals per unit area, and the effects of the encroachment on native plant numbers. Finally, monitoring can provide the manager with indicators as to problems such as excessive deer browsing, flooding caused by beavers, and others. Sometimes these occurrences may be acceptable, sometimes not. But the monitoring program helps to sort out what is happening in the forest and why, and provides useful data.

The question of how often to measure is directly related to the budget and the need for the information. Seldom is it justifiable to remeasure all plots each year. However, it may be reasonable to remeasure 20% of the plots each year, so that each plot is remeasured every 5 years. Another strategy that is feasible for a small park like PNB is to set a given year as an

LTM re-measurement year, and devote the resources to doing the work. Generally, plots should be remeasured every 5 to 10 years.

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Appendix 1. Forest canopy species list at Petersburg
National Battlefield, Virginia.

Common Name	Genus, Species
American beech	<i>Fagus grandifolia</i> Ehrhart
American holly	<i>Ilex opaca</i> Aiton
American sycamore	<i>Platanus occidentalis</i> L.
bigtooth aspen	<i>Populus grandidentata</i> Michaux
black cherry	<i>Prunus serotina</i> Ehrhart
black gum	<i>Nyssa sylvatica</i> Marshall
black oak	<i>Quercus velutina</i> Lam.
black walnut	<i>Juglans nigra</i> L.
eastern red-cedar	<i>Juniperus virginiana</i> L.
hackberry	<i>Celtis occidentalis</i> L.
loblolly pine	<i>Pinus taeda</i> L.
mockernut hickory	<i>Carya tomentosa</i> (Poiret) Nuttall
northern red oak	<i>Quercus rubra</i> L.
pignut hickory	<i>Carya glabra</i> (Mill.) Sweet
post oak	<i>Quercus stellata</i> Wang
red ash	<i>Fraxinus pennsylvanica</i> Marshall
red maple	<i>Acer rubrum</i> L.
sassafras	<i>Sassafras albidum</i> (Nuttall) Nees
scarlet oak	<i>Quercus coccinea</i> Muenchh
shortleaf pine	<i>Pinus echinata</i> Miller
slippery elm	<i>Ulmus rubra</i> Muhl.
southern red oak	<i>Quercus falcata</i> Michaux
sweet bay	<i>Magnolia virginiana</i> L.
sweetgum	<i>Liquidambar styraciflua</i> L.
tulip poplar	<i>Liriodendron tulipifera</i> L.
Virginia pine	<i>Pinus virginiana</i> Miller
water oak	<i>Quercus nigra</i> L.
white oak	<i>Quercus alba</i> L.
willow oak	<i>Quercus phellos</i> L.

Appendix 2. Forest understory species list at Petersburg National Battlefield, Virginia.

Common Name	Genus, Species
American beech	<i>Fagus grandifolia</i> Ehrh.
American holly	<i>Ilex opaca</i> Aiton
American strawberry-bush	<i>Euonymus americanus</i> L.
American sycamore	<i>Platanus occidentalis</i> L.
bitternut hickory	<i>Carya cordiformis</i> (Wang) K. Koch
black cherry	<i>Prunus serotina</i> Ehrhart
black gum	<i>Nyssa sylvatica</i> Marshall
blackjack oak	<i>Quercus marilandica</i> Muenchh
black oak	<i>Quercus velutina</i> Lam.
common highbush blueberry	<i>Vaccinium corymbosum</i> L.
common persimmon	<i>Diospyros virginiana</i> L.
common spicebush	<i>Lindera benzoin</i> (L.) Blume
common winterberry holly	<i>Ilex verticillata</i> (L.) Gray
common waxmyrtle	<i>Myrica cerifera</i> L.
downy serviceberry	<i>Amelanchier arborea</i> (Michaux f.) Fernald
early low blueberry	<i>Vaccinium vacillans</i> L.
eastern red-cedar	<i>Juniperus virginiana</i> L.
flowering dogwood	<i>Cornus florida</i> L.
hazel alder	<i>Alnus serrulata</i> Ehrhart
hawthorne	<i>Crataegus</i> spp. L.
loblolly pine	<i>Pinus taeda</i> L.
mockernut hickory	<i>Carya tomentosa</i> (Poiret) Nuttall
northern red oak	<i>Quercus rubra</i> L.
pignut hickory	<i>Carya glabra</i> (Mill.) Sweet
post oak	<i>Quercus stellata</i> Wang
scarlet oak	<i>Quercus coccinea</i> Muenchh
slippery elm	<i>Ulmus rubra</i> Muhl.
southern arrowwood	<i>Viburnum dentatum</i> L.
southern red oak	<i>Quercus falcata</i> Michaux
swamp azalea	<i>Rhododendron viscosum</i> (L.) Torrey
sweetgum	<i>Liquidambar styraciflua</i> L.
sweet pepperbush	<i>Clethra alnifolia</i> L.
tulip poplar	<i>Liriodendron tulipifera</i> L.
water oak	<i>Quercus nigra</i> L.
willow oak	<i>Quercus phellos</i> L.
winged sumac	<i>Rhus copallina</i> L.
white oak	<i>Quercus alba</i> L.

Appendix 3. Forest herbaceous and woody vine species list at Petersburg National Battlefield, Virginia.

Common Name	Genus, Species
American holly	<i>Ilex opaca</i> Aiton
no common name listed	<i>Amorpha fruticosa</i> L.
no common name listed	<i>Apios americana</i> Medicus
American strawberry-bush	<i>Euonymus americanus</i> L.
bedstraw	<i>Galium triflorum</i> Michaux
beggar's tick	<i>Desmodium</i> spp. Desvaux
black huckleberry	<i>Gaylussacia baccata</i> (Wang.) K. Koch.
blackberry	<i>Rubus allegheniensis</i> Porter
blueberry spp.	<i>Vaccinium</i> spp. L.
broomsedge	<i>Andropogon</i> spp. L.
butterfly pea	<i>Clitoria mariana</i> L.
chinquapin	<i>Castanea pumila</i> L.
Christmas fern	<i>Polystichum acrostichoides</i> (Michaux) Schott
clover	<i>Trifolium</i> spp. L.
highbush blueberry	<i>Vaccinium corymbosum</i> L.
common waxmyrtle	<i>Myrica cerifera</i> L.
crown-beard	<i>Verbesina occidentalis</i> L.
deerberry	<i>Vaccinium stamineum</i> L.
dutchman's pipe	<i>Aristolochia macrophyllia</i> L.
dwarf azalea	<i>Rhododendron atlanticum</i> L.
dwarf huckleberry	<i>Gaylussacia dumosa</i> HBK.
early low blueberry	<i>Vaccinium vacillans</i> L.
ebony spleenwort	<i>Asplenium platyneuron</i> L.
Elliot blueberry	<i>Vaccinium elliotii</i> L.
false Solomon's-seal	<i>Smilacina racemosa</i> L. Desf.
false-nettle	<i>Boehmeria cylindrica</i> L. Swartz
five-fingers	<i>Potentilla canadensis</i> L.
goldenrod	<i>Solidago</i> spp. L.
greenbrier	<i>Smilax glauca</i> L.
greenbrier	<i>Smilax rotundifolia</i> L.
greenbrier	<i>Smilax</i> spp. L.
ground juniper	<i>Juniperus communis</i> L.
ground pine	<i>Lycopodium obscurum</i> L.
hazel alder	<i>Alnus serrulata</i> Ehrhart
heliotrope	<i>Heliotropium</i> spp. L.
no common name listed	<i>Impatiens</i> spp. L.
jack in-the-pulpit	<i>Arisaema atrorubens</i> (L.) Schott
Japanese honeysuckle	<i>Lonicera japonica</i> Thumberg
large whorled pogonia	<i>Isotria verticillata</i> (Muhl. ex Willd.) Raf.
milkweed	<i>Asclepias</i> spp. L.
moneywort	<i>Lysimachia nummularia</i> L.
muscadine grape	<i>Vitis rotundifolia</i> Michaux
papoose root	<i>Caulophyllum thalictroides</i> L. Michaux

Appendix 3 (Continued).

Common Name	Genus, Species
partridgeberry	<i>Mitchella repens</i> L.
pink moccasin flower	<i>Cypripedium acaule</i> Aiton
pinweed	<i>Lechea minor</i> L.
poison-ivy	<i>Toxicodendron radicans</i> (L.) Kuntze
privet	<i>Ligustrum sinense</i> Lour
rattlesnake-weed	<i>Hieracium venosum</i> L.
rattlesnake fern	<i>Botrychium virginianum</i> (L.) Swartz
rough bedstraw	<i>Galium asprellum</i> Michaux
sensitive fern	<i>Onoclea sensibilis</i> L.
small jack-in-the-pulpit	<i>Arisaema triphyllum</i> (L.) Schott
smooth alder	<i>Alnus rugosa</i> Erhart
snakeroot	<i>Sanicula canadensis</i> L.
Solomon's seal	<i>Polygonatum biflorum</i> (Walter) Ell.
Solomon's seal	<i>Polygonatum pubescens</i> (Willd.)
southern arrowwood	<i>Viburnum dentatum</i> L.
southern lady fern	<i>Athyrium asplenoides</i> (Michaux) A.A. Eaton
spotted touch-me-not (jewel-weed)	<i>Impatiens capensis</i> Meerb.
spotted wintergreen	<i>Chimaphila maculata</i> (L.) Pursh
St. Andrew's cross	<i>Hypericum hypericoides</i> L.
St. John's-wort	<i>Hypericum densiflorum</i> Pursh
strawberry	<i>Fragaria</i> spp. L.
summer grape	<i>Vitis aestivalis</i> Michaux
swamp azalea	<i>Rhododendron viscosum</i> (L.) Torrey
swamp dogwood	<i>Cornus amomum</i> L.
swamp rose	<i>Rosa palustris</i> L.
sweet azalea	<i>Rhododendron canescens</i> (Michaux) Sweet
sweet bay	<i>Magnolia virginiana</i> L.
sweet pepperbush	<i>Clethra alnifolia</i> L.
sweet pignut hickory	<i>Carya ovalis</i> (Miller) Sweet
tall huckleberry	<i>Gaylussacia frondosa</i> (L.) T. & G.
trailing bush clover	<i>Lespedeza procumbens</i> Michaux
triangle-leave violet	<i>Viola emarginata</i> var <i>acutiloba</i> (Nuttall) Le Conte
trumpet vine	<i>Campsis radicans</i> (L.) Seemann
vetch	<i>Vicia</i> spp. L.
veined skullcap	<i>Scutellaria nervosa</i> Pursh
violet	<i>Viola papilionacea</i> Pursh
Virginia creeper	<i>Parthenocissus quinquefolia</i> (L.) Planchon
wild azalea	<i>Rhododendron nudiflorum</i> (L.) Torrey
wild yam	<i>Dioscorea villosa</i> L.
winged sumac	<i>Rhus copallina</i> L.
woodfern	<i>Dryopteris</i> spp. Adanson
yarrow	<i>Achillea millefolium</i> L.

Appendix 4. Forest seedling species list at Petersburg National Battlefield, Virginia.

Common Name	Genus, Species
American beech	<i>Fagus grandifolia</i> Ehrhart
black cherry	<i>Prunus serotina</i> Ehrhart
black gum	<i>Nyssa sylvatica</i> Marshall
black oak	<i>Quercus velutina</i> Lam.
blackjack oak	<i>Quercus marilandica</i> Muenchh
common persimmon	<i>Diospyros virginia</i> L.
common spicebush	<i>Lindera benzoin</i> (L.) Blume
downy serviceberry	<i>Amelanchier arborea</i> (Michaux f.) Fernald
eastern red-cedar	<i>Juniperus virginiana</i> L.
flowering dogwood	<i>Cornus florida</i> L.
hackberry	<i>Celtis occidentalis</i> L.
live oak	<i>Quercus virginiana</i> L.
loblolly pine	<i>Pinus taeda</i> L.
mockernut hickory	<i>Carya tomentosa</i> (Poiret) Nutt.
northern red oak	<i>Quercus rubra</i> L.
oak spp.	<i>Quercus</i> spp. L.
pignut hickory	<i>Carya glabra</i> (Mill.) Sweet
red ash	<i>Fraxinus pennsylvanica</i> Marshall
red maple	<i>Acer rubrum</i> L.
sassafras	<i>Sassafras albidum</i> (Nuttall) Nees
scarlet oak	<i>Quercus coccinea</i> Muenchh.
slippery elm	<i>Ulmus rubra</i> Muhl.
southern red oak	<i>Quercus falcata</i> Michaux
sweetgum	<i>Liquidambar styraciflua</i> L.
tree-of-heaven	<i>Ailanthus altissima</i> (Mill.) Swingle
tulip poplar	<i>Liriodendron tulipifera</i> L.
water oak	<i>Quercus nigra</i> L.
white oak	<i>Quercus alba</i> L.
willow oak	<i>Quercus phellos</i> L.

Appendix 5. Suggested native species for plantings as vegetative buffer zones (from Helm and Johnson 1995).

Small-Medium Sized Deciduous (with dense canopies)

Amelanchier arborea: Downy serviceberry

Amelanchier canadensis: Shadblow serviceberry

Size and Habit: Shrub to small tree; 4 m in 15 yrs, 12 m in 40 yrs

Light: Full shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-7

Comments: Select plants grown from material native to the region where they will be used for best results. Subject to fire blight and mites which can be controlled without difficulty; scale insects can also be a problem in warmer areas, yet this is not considered a high-maintenance tree.

Carpinus caroliniana: American hornbeam

Size and Habit: Small tree; 5 m in 25 yrs; 10 m in 65+ yrs

Light: Full shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-6.5

Comments: Relatively trouble-free and needs little maintenance.

Cornus florida: Flowering dogwood

Size and Habit: Small tree; 4 m in 18 yrs; 9 m in 35 yrs

Light: Full shade to partial sun

Soil Moisture: Moist to average

Soil pH: 4-6.5

Comments: Susceptible to borers but less so with good maintenance, which includes fertilization and irrigation in times of severe drought. Good soil drainage is essential. Transplanting is difficult at times and must be done carefully. Performs best with some shade in the south, but susceptible to dogwood anthracnose on moist, shady sites.

Corylus americana: American hazelnut

Size and Habit: Shrub; <3 m

Light: Partial shade to full sun

Soil Moisture: Moist to dry

Soil pH: 4-7

Comments: Grows well in poor, gravelly soils.

Morus rubra: Red mulberry

Size and Habit: Small tree; 6 m in 12 yrs; 14 m in 40 yrs

Light: Full sun

Soil Moisture: Average

Soil pH: 4-8

Comments: Requires little or no maintenance

Ostrya virginiana: Hop hornbeam, ironwood

Size and Habit: Small tree; 6 m in 25 yrs, 18 m in 80 yrs

Light: Partial shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-7

Comments: One of the most trouble-free deciduous trees. Hard wood result of slow growth rate. Difficult to transplant, so move in small sizes using container-grown seedlings if available.

Appendix 5 (Continued).

Vaccinium corymbosum: Highbush blueberry

Size and Habit: Shrub; 1.5 m in 6 yrs, 3 m in 20 yrs

Light: Partial shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-5.5

Comments: Tolerant of shade but requires full sun for best fruit production. For the fullness necessary for screening, the plants must grow vigorously; this requires sites where soil conditions are ideal. Several insects and diseases can be troublesome, depending on location. Iron chlorosis (leaf yellowing) is common in soils that are not sufficiently acidic; this can be corrected using chelated iron or foliage sprays.

Viburnum acerifolium: Mapleleaf viburnum

Size and Habit: Shrub; 2 m in 8 yrs, 3.5 m in 15 yrs

Light: Full shade to partial sun

Soil Moisture: Moist to dry

Soil pH: 5-6

Viburnum dentatum, *V. pubescens*, *V. recognitum*: Arrowwood

Size and Habit: Shrub; 2 m in 8 yrs, 3.5 m in 15 yrs

Light: Full shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-7

Comments: One of the most trouble-free viburnums.

Viburnum prunifolium: Black haw

Size and Habit: Shrub or small tree; 2.5 m in 10 yrs, 4.5 m in 25 yrs

Light: Partial shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-8

Comments: Unusually trouble-free but occasionally subject to insect problems. Scale insects and borers can be serious enough to require control measures.

Viburnum rufidulum: Rusty black haw

Size and Habit: Shrub or small tree; 8 m

Light: Partial shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-6.5

Comments: Southern counterpart of *V. prunifolium*, with more irregular, spreading growth habit. Select appropriate genetic material for region of use.

Small-Medium Sized Evergreens:

Ilex opaca: American holly

Size and Habit: Shrub or small tree; 3 m in 18 yrs; 12 m in 80 yrs

Light: Half shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-6

Comments: Grows well in full sun in half shade in summer, but for most compact growth full sun is best. Leaf miner is a serious insect pest that can be controlled with carefully timed sprays. Leaf-spot diseases are also troublesome. Many cultivars of *I. opaca* exist; local experience should be relied upon to select the best one for the area of use.

Appendix 5 (Continued).

Juniperus virginiana: Eastern red-cedar

Size and Habit: Shrub or tree; 4 m in 15 yrs, 20 m in 90 yrs

Light: Full sun

Soil Moisture: Moist to dry

Soil pH: 4.5-8

Comments: Susceptible to *Phomopsis* blight and is also a principal alternate host to the fungus causing cedar apple rust. This disease is a serious problem to the alternate host species (the pome fruits of apples and hawthornes), and selection of *J. virginiana* should be done with these susceptible species in mind. Avoid planting this species near commercial apple orchards.

Kalmia latifolia: Mountain laurel

Size and Habit: Shrub; 1 m in 10 yrs, 3 m in 30 yrs

Light: Full shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-5.5

Comments: In the south this is useful only in relatively cool sites -- shaded northern exposures. Relatively trouble-free, given a cool site and acidic soil, but susceptible to leaf-spot disease. Foliage of this is toxic to cattle, sheep, and humans.

Myrica cerifera, *M. caroliniensis*: Southern bayberry, waxmyrtle

Size and Habit: Shrub or small tree

Light: Full sun

Soil Moisture: Wet to average

Soil pH: 4-6.5

Comments: A low-maintenance plant for the south. Salt resistance makes it very useful in coastal areas.

Vaccinium arboreum: Tree huckleberry, sparkleberry, farkleberry

Size and Habit: Small tree; 6-8 m; requires pruning as screen

Light: Full sun

Soil Moisture: Average

Soil pH: 4-5.5

Comments: Requires pruning to produce thick foliage for screen. Select appropriate genetic material for area of use. Fruits are not edible.

Large-Scale Evergreens

Ilex opaca: American holly

Size and Habit: Shrub or small tree; 3 m in 18 yrs, 12 m in 80 yrs

See information in last section.

Juniperus virginiana: Eastern red-cedar

Size and Habit: Shrub or tree; 4 m in 15 yrs, 20 m in 90 yrs

See information in last section.

Magnolia grandiflora: Southern magnolia

Size and Habit: Tree; 8 m in 20 yrs; 24 m in 80 yrs

Light: Partial sun to full sun

Soil Moisture: Moist to average

Soil pH: 4-7

Comments: Free of problems. Many cultivars exist, so experience should be consulted for the area of use. Foliage burn occurs in some winters in the northern part of its range (Virginia).

Appendix 5 (Continued).

Pinus strobus: White pine

Size and Habit: Tree; 8 m in 22 yrs; 24 m in 75 yrs

Light: Full sun

Soil Moisture: Average

Soil pH: 4-7

Comments: Grows best in good soil of moderate moisture content. Not a good choice for roadsides, urban planting, very dry or windswept areas, or for very heavy soils. White pine blister rust is a serious disease that is eliminated by removal of the alternate host *Ribes* (currents) from the area. Very sensitive to road salt and ocean spray.

Pinus taeda: Loblolly pine

Size and Habit: Tree; 8 m in 20 yrs, 30 m in 50 yrs

Light: Full sun

Soil Moisture: Moist to very dry

Soil pH: 4-7

Comments: Fast but temporary screen. Tolerates very poor soil and exposed sites. One of the most durable and trouble-free of the southern pines in landscape use. Borers can be a problem on mechanically damaged trees. Difficult to transplant in larger sizes, so plant young seedlings or container-grown trees. Growth is so rapid that trees attain functional size even when started as young seedlings.

Prunus caroliniana: Carolina laurelcherry, cherry laurel

Size and Habit: Tree; 3 m in 8 yrs, 9 m in 30 yrs

Light: Half shade to full sun

Soil Moisture: Moist to average

Soil pH: 4-7

Comments: Unusually sensitive to poorly drained soil, tolerant of salt at seashore conditions. Requires pruning for maximum fullness as a screen.

Tsuga canadensis: Canada or Eastern hemlock

Tsuga caroliniana: Carolina hemlock

Size and Habit: Tree or shrub; 8 m in 22 yrs, 28 m in 80 yrs

Light: Partial shade to partial sun

Soil Moisture: Moist to average

Soil pH: 4-6.5

Comments: One of the finest evergreens for formal or informal hedges. Avoid windswept sites and dry soils, as the foliage is very susceptible to desiccation in winter and during dry periods in summer. Partial shade is recommended for the summer in the south. In the south, only select for areas with cool summers. Susceptible to damage by hemlock wooly adelgid.

Appendix 6. Plot cluster landmark form used in LTM program (from Russell 1993).

PLOT CLUSTER LANDMARK FORM

Plot Cluster # _____ Date _____ Personnel _____

General Plot Location (stand, compartment, district, etc.) _____

Landmark description: _____

Landmark location: _____

LINE MARKERS (Begin at landmark and proceed to plot cluster. If marker is not a tree, use the species and dbh columns to describe the object. Last bearing and distance should be to approximate plot cluster center.)

Marker #	Species	dbh (cm)	To Next Line Marker		Comments
			Compass Bearing	Distance (m)	
Landmark					
LM1					
LM2					
LM3					
LM4					
LM5					

Appendix 7. Plot cluster location form used in LTM program (from Russell 1993).

Plot Cluster # _____ Date _____ Personnel _____

General Plot Location (stand, compartment, district, etc.) _____

UTM Coordinates: _____ N _____ E

WITNESS TREES (from tree plot corners or center)

Witness Tree #	Species	dbh (cm)	Stake	From Stake to Tree		Comments
				Compass Bearing	Distance (m)	
1			Center ____ Corner ____			
2			Center ____ Corner ____			
3			Center ____ Corner ____			
4			Center ____ Corner ____			
5			Center ____ Corner ____			
6			Center ____ Corner ____			
7			Center ____ Corner ____			
8			Center ____ Corner ____			

NEIGHBORING PLOTS (Record approximate bearing and horizontal distance from this plot cluster to the two closest neighboring plot clusters.)

Bearing _____ Distance _____ m to Plot cluster # _____
 Bearing _____ Distance _____ m to Plot cluster # _____

Appendix 8. Overstory inventory plot data for 115 vegetation sample plots at Petersburg National Battlefield, Virginia.

<u>Variable</u>	<u>Definition</u>
Plot #	Plot number within unit
Stand #	Stand number within unit and in GIS database
Stand type:	
PNY	Pine natural/young
PPY	Pine planted/young
PNI	Pine natural/intermediate
PPI	Pine planted/intermediate
PNM	Pine natural/mature
PHNY	Pine-hardwood natural/young
PHPY	Pine-hardwood planted/young
PHNI	Pine-hardwood natural/young
PHNM	Pine-hardwood natural/mature
HNI	Hardwood natural/intermediate
HNM	Hardwood natural/mature
Species	The first three letters in code correspond with the first three letters of the genus name. The last three letters in code represent the first three letters in the species name (i.e. PIN = Pinus, TAE = taeda : loblolly pine)
dbh (cm)	Diameter at breast height measured in centimeters
I- D	Insect or disease damage
1	Slight
2	Holes in leaves or edges eaten, holes in bark, evidence of some frass
3	Leaves or stems badly damaged, enough to alter function
4	Total defoliation
CrCl	Crown class
S	Suppressed
I	Intermediate
C	Codominant
D	Dominant
ht (m)	Total height measured in meters
age	Age in years estimated from tree cores taken at breast height

Five Forks Overstory Plot Data

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
10(11)	HNI	PINTAE	13.0		I			84	50	2.5	11
10(11)	HNI	PINTAE	16.9		C	10.7	16				
10(11)	HNI	QUEALB	5.3		S			850	88	4.7	29
10(11)	HNI	QUEALB	5.7		I						
10(11)	HNI	QUEALB	8.5		I						
10(11)	HNI	QUEALB	9.5		I						
10(11)	HNI	QUEALB	13.8		C	9.8	14				
10(11)	HNI	QUEALB	18.1		D	12.2	31				
10(11)	HNI	QUECOC	12.7		C			203	63	2.5	14
10(11)	HNI	QUECOC	13.2		C						
10(11)	HNI	QUECOC	13.7		C						
11(32)	HNI	ACERUB	24.9	2	D			451	38	1.3	12
11(32)	HNI	LIQSTY	6.1		S			412	25	0.9	10
11(32)	HNI	LIQSTY	15.4		D						
11(32)	HNI	LIRTUL	28.5		D	22.6		14	25	0.6	4
11(32)	HNI	MAGVIR	19.1		D			10	13	0.3	2
11(32)	HNI	QUEALB	19.2		D						
11(32)	HNI	QUEALB	22.1		D	19.5	60				
11(32)	HNI	QUEALB	23.7		D						
14(39)	HNI	CARTOM	12.4		C			24	13	0.3	2
14(39)	HNI	NYSSYL	7.9		I			394	25	0.6	9
14(39)	HNI	QUEALB	11.5								
14(39)	HNI	QUEALB	21.8		D	17.4	28				
14(39)	HNI	QUECOC	8.8		I						
14(39)	HNI	QUEVEL	32.2		D			108	38	0.9	7
17(28)	HNI	ACERUB	8.2	2	I						
17(28)	HNI	LIRTUL	20.0		D	16.2					
17(28)	HNI	PINTAE	17.7		C						
17(28)	HNI	PINTAE	30.5		D	16.5	42				
17(28)	HNI	QUEALB	21.3		C						
17(28)	HNI	QUEALB	27.2	2	C						
18(40)	HNI	PINTAE	42.6		D	27.1					
18(40)	HNI	QUEALB	4.3		S						
18(40)	HNI	QUEALB	8.1		I						
18(40)	HNI	QUEALB	9.7		I						
18(40)	HNI	QUEALB	9.8		I						
18(40)	HNI	QUEALB	10.7		I						
18(40)	HNI	QUECOC	11.8		I						
18(40)	HNI	QUECOC	21.2		C	16.8	23				
18(40)	HNI	QUEVEL	6.8		I						
21(32)	HNI	ACERUB	3.3	2	S						
21(32)	HNI	ACERUB	8.1	2	S						
21(32)	HNI	QUEALB	17.8		I	14.6	39				
21(32)	HNI	QUEALB	32.8	BR	D						
21(32)	HNI	QUEALB	41.2		D	23.2	47+				
23(11)	HNI	LIQSTY	3.5		S						
23(11)	HNI	NYSSYL	3.3		S						

Five Forks Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
23(11)	HNI	PINTAE	17.7		C						
23(11)	HNI	PINTAE	18.5		C	11.3	19				
23(11)	HNI	PINTAE	19.4		C	11.9	16				
23(11)	HNI	QUECOC	19.0		D	25.3	18				
31(11)	HNI	QUEALB	18.4		C						
31(11)	HNI	QUEALB	20.0		C						
31(11)	HNI	QUEALB	20.2		C	15.2	68				
31(11)	HNI	QUEALB	25.5		D	17.1	36				
31(11)	HNI	QUECOC	8.7	2	I						
31(11)	HNI	QUEFAL	26.0		D	20.4	58	5	13	0.3	2
31(11)	HNI	QUEVEL	11.9	3	I						
20(27)	HNM	CARGLA	12.2	2	I			39	20	0.5	3
20(27)	HNM	PINTAE	17.2		C	12.2	17	99	40	5	11
20(27)	HNM	PINTAE	18.8		C	12.5	17				
20(27)	HNM	PINTAE	18.9		C						
20(27)	HNM	PINTAE	20.1		C	13.1	16				
20(27)	HNM	QUEALB	14.0		C			1006	100	7.5	30
20(27)	HNM	QUEALB	23.6		D	17.4	56				
20(27)	HNM	QUECOC	2.8		S			804	60	1.5	17
22(04)	HNM	ACERUB	28.1	BR	D			187	40	3	9
22(04)	HNM	ILEOPA	5.6		S			186	20	0.5	5
22(04)	HNM	LIRTUL	13.2		S			95	80	4.5	13
22(04)	HNM	LIRTUL	18.9		C						
22(04)	HNM	LIRTUL	29.9		C	23.2	33				
22(04)	HNM	QUEALB	27.9		C						
22(04)	HNM	QUEALB	31.5		C	19.8	53				
22(04)	HNM	QUEALB	37.2		D	21.9	73				
22(04)	HNM	QUECOC	12.5	2	I						
27(18)	HNM	LIQSTY	49.2		D	28.3	96	12	40	2	6
27(18)	HNM	LIQSTY	68.0	2	D						
27(18)	HNM	LIRTUL	35.5		D	28.3	60				
27(18)	HNM	PINTAE	21.7		S						
27(18)	HNM	PINTAE	30.9		C						
27(18)	HNM	PINTAE	36.7		D						
27(18)	HNM	PINTAE	41.5		D	28.3	72				
27(18)	HNM	PINTAE	43.1		D	27.4	75				
27(18)	HNM	PINTAE	47.9		D	32.6	66				
27(18)	HNM	QUEALB	25.4		C						
27(18)	HNM	QUEALB	26.3		C						
27(18)	HNM	QUEALB	35.5	2	D	28.3	80				
27(18)	HNM	QUEFAL	18.1		I			18	20	0.5	2
27(18)	HNM	QUEVEL	29.6		D						
27(18)	HNM	QUEVEL	33.7	2	C						
27(18)	HNM	QUEspp	20.0		I						
35(18)	HNM	LIRTUL	21.8		D	17.4	23				
35(18)	HNM	LIRTUL	24.2		D	20.1	40				
35(18)	HNM	QUEALB	11.3		S						
35(18)	HNM	QUEALB	14.7		I						
35(18)	HNM	QUEALB	14.9		I						
35(18)	HNM	QUEALB	16.0		I						
35(18)	HNM	QUEALB	26.3		D	17.4	54				
35(18)	HNM	QUEALB	27.4		D	17.1					
35(18)	HNM	QUECOC	16.8		C						
53(23)	HNM	ACERUB	9.5		S						

Five Forks Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
53(23)	HNM	ACERUB	11.0		I						
53(23)	HNM	ACERUB	13.5		I						
53(23)	HNM	ACERUB	14.5		I						
53(23)	HNM	ACERUB	29.5		I						
53(23)	HNM	LIQSTY	33.0		C						
53(23)	HNM	LIQSTY	43.0		D						
53(23)	HNM	LIRTUL	29.5		C	29.3	57				
53(23)	HNM	LIRTUL	40.0		D	30.5	73				
53(23)	HNM	LIRTUL	65.3		D	24.4	60+				
53(23)	HNM	NYSSYL	31.3		C			6	20	0.5	2
53(23)	HNM	QUEALB	2.8		S						
13(38)	PHNI	PINTAE	36.3		D	20.7	39	734	67	6.7	36
13(38)	PHNI	PINTAE	37.5	2	D	21.3	44				
13(38)	PHNI	PINTAE	38.2		D	20.4	39				
13(38)	PHNI	QUEALB	5.8		S			451	100	4.2	29
13(38)	PHNI	QUECOC	17.3		C	13.4	24	33	33	0.8	6
15(38)	PHNI	PINTAE	5.0		S						
15(38)	PHNI	PINTAE	8.2		I						
15(38)	PHNI	PINTAE	10.9		I						
15(38)	PHNI	PINTAE	11.1		I						
15(38)	PHNI	PINTAE	23.6		D	14.3	28				
15(38)	PHNI	QUEALB	41.1	2	D	19.2	93				
02(05)	PHNI	PINVIR	19.3		C	9.8	19	26	33	0.8	6
02(05)	PHNI	QUEALB	9.1		C						
02(05)	PHNI	QUEALB	20.7		D	13.7	30				
02(05)	PHNI	QUEALB	25.2		D						
02(05)	PHNI	QUEFAL	8.6		I			326	33	2.5	15
02(05)	PHNI	QUEFAL	9.3		I						
02(05)	PHNI	QUEFAL	10.9		C						
02(05)	PHNI	QUEPHE	7.9		I			156	33	0.8	8
28(17)	PHNY	NONE									
36(26)	PHNY	LIRTUL	1.5		C			1443	11	0.3	7
36(26)	PHNY	PINTAE	4.9		C			1732	67	5.8	45
36(26)	PHNY	PINTAE	5.8		D	14.3	12				
36(26)	PHNY	PINTAE	5.9		D	14.9	17				
36(26)	PHNY	PINTAE	6.3		D	13.7	12				
36(26)	PHNY	QUEALB	4.3	2	C	14.9	10	490	22	0.8	10
37(26)	PHNY	PINTAE	2.4		I						
37(26)	PHNY	PINTAE	6.3		D	14.6	10				
37(26)	PHNY	QUECOC	0.6		S			11180	11	1.4	33
37(26)	PHNY	QUECOC	1.7		I						
37(26)	PHNY	QUECOC	2.0		C						
37(26)	PHNY	QUECOC	5.4		D	18.3	10				
37(26)	PHNY	QUECOC	5.4		D	17.1	12				
38(26)	PHNY	PINTAE	7.3		I						
38(26)	PHNY	PINTAE	9.1		C						
38(26)	PHNY	PINTAE	10.8		D	14.3	12				
38(26)	PHNY	PINTAE	11.7		D	16.2	12				
38(26)	PHNY	PINTAE	12.3		D	15.2	9				
40(26)	PHNY	PINTAE	5.4		S						
40(26)	PHNY	PINTAE	6.0		S						
40(26)	PHNY	PINTAE	9.8		C						
40(26)	PHNY	PINTAE	10.1		C						
40(26)	PHNY	PINTAE	10.2		C						

Five Forks Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
40(26)	PHNY	PINTAE	10.4		C						
40(26)	PHNY	PINTAE	11.6		D	7.6	13				
40(26)	PHNY	PINTAE	12.7		D	7.0	11				
40(26)	PHNY	PINTAE	13.5		D	8.2	12				
40(26)	PHNY	POPGRA	3.6		I			251	11	0.3	5
05(09)	PHNY	NONE									
54(21)	PHNY	PINTAE	missing								
54(21)	PHNY	QUEALB	4.2	2	C						
54(21)	PHNY	QUEALB	5.0	2	D						
54(21)	PHNY	QUESTE	missing	2	C						
07(41)	PHNY	NONE									
08(19)	PHNY	PINTAE	5.3		D	3.7	8				
41(44)	PHPY	LIQSTY	3.6		S			332	22	0.6	13
41(44)	PHPY	PINTAE	7.9		I			797	56	5.8	46
41(44)	PHPY	PINTAE	9.7		I						
41(44)	PHPY	PINTAE	11.4		C						
41(44)	PHPY	PINTAE	11.5		C	10.1	10				
41(44)	PHPY	PINTAE	12.1		D	12.5	12				
41(44)	PHPY	PINTAE	13.4		D	10.7	16				
42(44)	PHPY	PINTAE	7.3		D		7				
43(44)	PHPY	PINTAE	9.2		C						
43(44)	PHPY	PINTAE	13.7		D	11.0	10				
43(44)	PHPY	QUECOC	4.0		I			458	11	1.4	15
43(44)	PHPY	QUECOC	6.8		C						
43(44)	PHPY	QUECOC	6.9		I						
43(44)	PHPY	QUECOC	7.1		C						
43(44)	PHPY	QUECOC	7.9		D	11.9	10				
44(44)	PHPY	LIQSTY	6.3		C						
44(44)	PHPY	LIRTUL	4.8		C			141	22	0.6	9
44(44)	PHPY	PINTAE	6.9		I						
44(44)	PHPY	PINTAE	13.3		C	16.8	11				
45(44)	PHPY	NONE									
46(44)	PHPY	PINTAE	4.1		S						
46(44)	PHPY	PINTAE	8.5		I						
46(44)	PHPY	PINTAE	9.2		I						
46(44)	PHPY	PINTAE	9.8		C						
46(44)	PHPY	PINTAE	12.4		C						
46(44)	PHPY	PINTAE	12.7		C						
46(44)	PHPY	PINTAE	13.0		D	11.9	10				
46(44)	PHPY	PINTAE	13.3		C						
46(44)	PHPY	PINTAE	14.8		D	12.8	10				
46(44)	PHPY	PINTAE	15.4		C	12.2	10				
47(44)	PHPY	ACERUB	6.9		S			73	11	0.8	7
47(44)	PHPY	ACERUB	24.9	2	D						
47(44)	PHPY	MAGVIR	8.4	2	I			77	11	0.6	6
47(44)	PHPY	MAGVIR	10.2	2	I						
47(44)	PHPY	NYSSYL	14.3		D	10.4		24	11	0.6	5
47(44)	PHPY	NYSSYL	20.3		D	14.6					
48(44)	PHPY	NONE									
49(44)	PHPY	NONE									
01(01)	PNY	NONE									
12(08)	PNY	LIQSTY	3.2		S			335	17	1.7	12
12(08)	PNY	PINTAE	13.7		I			788	100	15	58
12(08)	PNY	PINTAE	14.6		C						

Five Forks Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
12(08)	PNY	PINTAE	18.1		C						
12(08)	PNY	PINTAE	19.9		C						
12(08)	PNY	PINTAE	20.7		C						
12(08)	PNY	PINTAE	21.8		C						
12(08)	PNY	PINTAE	23.2		D	16.8	20				
12(08)	PNY	PINTAE	23.4		D	16.2	21				
12(08)	PNY	PINTAE	23.4		D						
12(08)	PNY	PINTAE	24.9		D						
12(08)	PNY	PINTAE	26.9		D	18.3	19				
16(29)	PNY	PINTAE	13.5		C						
16(29)	PNY	QUEALB	4.9		S			239	25	1.3	11
16(29)	PNY	QUEALB	12.7		D						
16(29)	PNY	QUECOC	6.4		I			223	33	1.5	13
16(29)	PNY	QUECOC	7.0	2	I						
24(54)	PNY	NONE									
25(12)	PNY	LIQSTY	8.2		S						
25(12)	PNY	LIQSTY	12.9		C						
25(12)	PNY	LIQSTY	13.9		I						
25(12)	PNY	LIQSTY	14.6		C						
25(12)	PNY	LIQSTY	16.0		C						
25(12)	PNY	LIQSTY	17.9		C	14.9	18				
25(12)	PNY	LIQSTY	21.7		D	16.2	17				
25(12)	PNY	PINTAE	16.9		C						
25(12)	PNY	PINTAE	18.5		C	15.8	17				
25(12)	PNY	PINTAE	21.1		D	23.8	17				
25(12)	PNY	PINTAE	21.2		D	17.7	18				
26(55)	PNY	PINTAE	6.9		S						
26(55)	PNY	PINTAE	15.9		C						
26(55)	PNY	PINTAE	22.2		C	14.3	14				
26(55)	PNY	PINTAE	22.8		C	14.3	18				
26(55)	PNY	PINTAE	27.0		D	15.8	22				
29(10)	PNY	PINTAE	12.1		I						
29(10)	PNY	PINTAE	14.4		C						
29(10)	PNY	PINTAE	16.2		C	14.3	18				
29(10)	PNY	PINTAE	16.6		C	13.7	17				
29(10)	PNY	PINTAE	19.6		D	13.4	18				
29(10)	PNY	QUEALB	8.1		I						
29(10)	PNY	QUEALB	12.3		I						
29(10)	PNY	QUEALB	14.8		C	13.4	17				
29(10)	PNY	QUEVEL	16.8		D	14.3	18	9	8	0.2	2
03(06)	PNY	PINTAE	6.2		S						
03(06)	PNY	PINTAE	8.0		S						
03(06)	PNY	PINTAE	8.8		S						
03(06)	PNY	PINTAE	9.1		I						
03(06)	PNY	PINTAE	11.4		I						
03(06)	PNY	PINTAE	12.7		C						
03(06)	PNY	PINTAE	14.9		C						
03(06)	PNY	PINTAE	15.7		C						
03(06)	PNY	PINTAE	16.4		C						
03(06)	PNY	PINTAE	16.6		C	12.2	13				
03(06)	PNY	PINTAE	17.2		D	13.4	18				
03(06)	PNY	PINTAE	21.1		D	13.4	24				
03(06)	PNY	QUECOC	15.1		C						
30(10)	PNY	PINTAE	13.2		I						

Five Forks Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
30(10)	PNY	PINTAE	15.9		C						
30(10)	PNY	PINTAE	16.0		C						
30(10)	PNY	PINTAE	17.4		C						
30(10)	PNY	PINTAE	17.9		D						
30(10)	PNY	PINTAE	18.4		D						
30(10)	PNY	PINTAE	20.6		D	14.9	23				
30(10)	PNY	PINTAE	20.8		D						
30(10)	PNY	PINTAE	21.8	2	D	15.2	17				
30(10)	PNY	PINTAE	22.2		D	14.3	9				
30(10)	PNY	QUECOC	10.8		I						
30(10)	PNY	QUECOC	12.0		I	14.0	18				
04(06)	PNY	PINTAE	11.9	2	S						
04(06)	PNY	PINTAE	12.8		C						
04(06)	PNY	PINTAE	13.4		I						
04(06)	PNY	PINTAE	15.8		C						
04(06)	PNY	PINTAE	17.1		C						
04(06)	PNY	PINTAE	19.1		D						
04(06)	PNY	PINTAE	20.1		D						
04(06)	PNY	PINTAE	20.7		D						
04(06)	PNY	PINTAE	22.9		D						
04(06)	PNY	PINTAE	23.0		D	14.3	16				
04(06)	PNY	PINTAE	23.4		D	14.0	20				
04(06)	PNY	PINTAE	24.0		D	14.6	17				
04(06)	PNY	QUERUB	10.5		I			22	8	0.2	2
06(10)	PNY	PINTAE	10.4		S						
06(10)	PNY	PINTAE	11.3		I						
06(10)	PNY	PINTAE	12.4		I						
06(10)	PNY	PINTAE	15.5		I						
06(10)	PNY	PINTAE	17.1		I						
06(10)	PNY	PINTAE	18.4		C						
06(10)	PNY	PINTAE	19.3		D	14.3	10				
06(10)	PNY	PINTAE	19.8		D	13.4	8				
06(10)	PNY	QUEALB	6.5		S						
09(06)	PNY	PINTAE	13.6		C						
09(06)	PNY	PINTAE	20.2		D	12.8	9				
09(06)	PNY	PINTAE	20.5		D	13.7	9				
09(06)	PNY	PINTAE	21.0		D	13.7	18				
09(06)	PNY	QUECOC	8.2	2	C						
09(06)	PNY	QUECOC	9.2	2	C						
09(06)	PNY	QUEFAL	11.6		I			18	8	0.2	2
32(22)	PPY	ILEOPA	2.8	2	S			621	17	0.4	9
32(22)	PPY	PINTAE	5.4		I			1228	100	18.3	49
32(22)	PPY	PINTAE	9.0		C	13.4	10				
32(22)	PPY	PINTAE	11.8		D	16.2	11				
32(22)	PPY	QUECOC	5.8		I			752	50	3.8	19
32(22)	PPY	QUECOC	6.9		C						
32(22)	PPY	QUECOC	7.8		C						
32(22)	PPY	QUECOC	9.1		C	18.3	10				
33(42)	PPY	PINTAE	7.9		I						
33(42)	PPY	PINTAE	8.7		I						
33(42)	PPY	PINTAE	10.9		C						
33(42)	PPY	PINTAE	10.9		C	10.1	20				
33(42)	PPY	PINTAE	14.3		D	13.4	14				
33(42)	PPY	PINTAE	14.7		D	12.2	10				

Five Forks Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	L/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
34(22)	PPY	PINTAE	17.5		D	14.0	19				
34(22)	PPY	PINTAE	20.5		D	13.7	22				
34(22)	PPY	QUECOC	7.5		S						
34(22)	PPY	QUECOC	8.3	2	S						
34(22)	PPY	QUECOC	13.4		D	12.8	20				
34(22)	PPY	QUECOC	13.6		D	13.4	19				
34(22)	PPY	QUENIG	5.6		I			252	17	0.8	6
34(22)	PPY	QUENIG	7.1		I						
50(24)	PPY	ACERUB	7.0		S			160	17	0.8	5
50(24)	PPY	ACERUB	9.0	2	I						
50(24)	PPY	LIQSTY	7.0		S			99	17	0.4	4
50(24)	PPY	PINTAE	14.2		C						
50(24)	PPY	PINTAE	16.5		C						
50(24)	PPY	PINTAE	16.7		C						
50(24)	PPY	PINTAE	16.7		C						
50(24)	PPY	PINTAE	18.2		D						
50(24)	PPY	PINTAE	19.5		D	12.8	17				
50(24)	PPY	PINTAE	19.7		D	12.5	16				
50(24)	PPY	PINTAE	22.2		D	13.4	17				
50(24)	PPY	QUEALB	6.8		I			185	17	0.8	5
50(24)	PPY	QUEALB	7.8		I						
50(24)	PPY	QUEVEL	7.5		I			87	17	0.4	4
51(24)	PPY	PINTAE	9.5		S						
51(24)	PPY	PINTAE	12.0		I						
51(24)	PPY	PINTAE	13.6		C						
51(24)	PPY	PINTAE	14.0		I						
51(24)	PPY	PINTAE	16.4		C						
51(24)	PPY	PINTAE	16.5		C						
51(24)	PPY	PINTAE	16.9		C						
51(24)	PPY	PINTAE	17.4		C						
51(24)	PPY	PINTAE	19.4		D						
51(24)	PPY	PINTAE	19.9		C						
51(24)	PPY	PINTAE	20.0		D	13.7	14				
51(24)	PPY	PINTAE	20.4		D	13.1	17				
51(24)	PPY	PINTAE	20.6		D	14.3	15				
51(24)	PPY	QUECOC	5.6		I						
52(24)	PPY	PINTAE	7.4		S						
52(24)	PPY	PINTAE	11.3		I						
52(24)	PPY	PINTAE	15.5		C						
52(24)	PPY	PINTAE	15.6		C						
52(24)	PPY	PINTAE	17.3		C						
52(24)	PPY	PINTAE	18.2		C						
52(24)	PPY	PINTAE	19.0		D						
52(24)	PPY	PINTAE	19.0		D	14.9	17				
52(24)	PPY	PINTAE	19.3		D						
52(24)	PPY	PINTAE	19.3		D	13.7	18				
52(24)	PPY	PINTAE	20.7		D						
52(24)	PPY	PINTAE	23.9		D	14.6	16				

Main Unit Overstory Plot Data

Plot(stand)	Stand Type	Species	dbh	L/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
01(03)	HNM	LIQSTY	39.6		C			77	71	6.9	17
01(03)	HNM	LIQSTY	45.7		D						
01(03)	HNM	PINTAE	18.9		dead			55	38	4.1	10
01(03)	HNM	PINTAE	33.3		D	24	54				
01(03)	HNM	PINTAE	35.2		C						
01(03)	HNM	PINTAE	35.9		C						
01(03)	HNM	PINTAE	42.9		D	22	60				
01(03)	HNM	PINTAE	55.3	2	D	24	66				
01(03)	HNM	QUEALB	13.3		S			37	43	2.2	8
01(03)	HNM	QUEALB	32.7		C						
01(03)	HNM	QUEPHE	69.6		D			16	29	2.5	6
01(03)	HNM	QUEVEL	8.5		S			26	24	1.1	5
01(03)	HNM	QUEVEL	33.3		C	27	54				
01(03)	HNM	QUEVEL	35.5		C	21	62				
01(03)	HNM	QUEVEL	39.2		C	27	67				
02(01)	HNM	ACERUB	32.1		I			45	38	1.5	7
02(01)	HNM	ACERUB	41.1	i2br	I						
02(01)	HNM	LIQSTY	66.9		D						
02(01)	HNM	LIRTUL	63.2	i2	C			99	67	9.2	20
02(01)	HNM	LIRTUL	64.1		C	16	100				
02(01)	HNM	LIRTUL	71.9		D	17	87				
02(01)	HNM	LIRTUL	73.2	i2	D	20	50				
02(01)	HNM	LIRTUL	76.1	i2	D						
02(01)	HNM	LIRTUL	92.6		D						
02(01)	HNM	LIRUTL	57.8		C						
02(01)	HNM	QUEALB	10.1		S						
02(01)	HNM	QUEALB	39.3		I						
02(01)	HNM	QUEALB	79.9		D						
02(01)	HNM	QUEVEL	45.1	2	I						
02(01)	HNM	QUEVEL	93.5	2	D						
03(01)	HNM	ACERUB	61.4		D						
03(01)	HNM	CARTOM	25.8		I			2	5	0.1	1
03(01)	HNM	LIQSTY	50.7		C	34	82				
03(01)	HNM	LIQSTY	57.7		D	27	80				
03(01)	HNM	LIRTUL	18.3	2	I						
03(01)	HNM	LIRTUL	47.5		C						
03(01)	HNM	QUEALB	55.9		D	34	86				
03(01)	HNM	QUEALB	57.4	2	D						
03(01)	HNM	QUEPHE	54.9		D	32	51				
04(05)	HNM	ACERUB	9.5		S						
04(05)	HNM	LIQSTY	23.4		I						
04(05)	HNM	LIQSTY	25.4		I						
04(05)	HNM	LIQSTY	31.7		C						
04(05)	HNM	LIQSTY	32.0		C						
04(05)	HNM	LIQSTY	37.5		C						
04(05)	HNM	LIQSTY	42.0		D						
04(05)	HNM	LIQSTY	45.5		D	32	81				
04(05)	HNM	LIQSTY	46.1		C	36					

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
04(05)	HNM	LIQSTY	47.1		D	30	61				
04(05)	HNM	LIRTUL	31.0		C						
04(05)	HNM	LIRTUL	39.3		D						
04(05)	HNM	LIRTUL	45.8		D						
04(05)	HNM	LIRTUL	73.3	2	I						
04(05)	HNM	PINTAE	40.9	2	D	29	49				
04(05)	HNM	PINTAE	51.8	3	D						
04(05)	HNM	QUEALB	40.6		D						
04(05)	HNM	QUEPHE	36.9		C						
06(10)	HNM	ACERUB	8.1		S						
06(10)	HNM	ACERUB	28.1		I						
06(10)	HNM	ACERUB	28.1		I						
06(10)	HNM	ACERUB	47.5		D						
06(10)	HNM	LIQSTY	44.6		C						
06(10)	HNM	LIQSTY	64.7		D						
06(10)	HNM	LIQSTY	75.8		D						
06(10)	HNM	LIQSTY	107.5	2	D						
06(10)	HNM	LIRTUL	58.4		D						
06(10)	HNM	LIRTUL	81.5		D						
06(10)	HNM	QUERUB	51.1		C			1	5	0.1	1
08(15)	HNM	QUEALB	60.5		C						
08(15)	HNM	QUEALB	60.5		C						
08(15)	HNM	QUEALB	75.2		D	27	52				
09(10)	HNM	CARGLA	7.8		S			24	10	0.6	3
09(10)	HNM	CARGLA	41.7		C	29	95				
09(10)	HNM	CARGLA	54.8		D	27	80				
09(10)	HNM	CARGLA	60.1		D	37	117				
09(10)	HNM	CELOCC	27.0		C			7	10	0.2	1
09(10)	HNM	JUGNIG	45.1	2	C			1	10	0.2	1
09(10)	HNM	NYSSYL	19.2	2	S			5	5	0.2	1
09(10)	HNM	NYSSYL	31.3	2	I						
09(10)	HNM	QUEALB	62.9		D						
09(10)	HNM	QUEALB	74.9		D						
09(10)	HNM	QUEFAL	80.2		D			1	14	0.3	2
14(10)	HNM	LIQSTY	19.1		I						
14(10)	HNM	LIQSTY	20.9		I						
14(10)	HNM	LIQSTY	21.0		I						
14(10)	HNM	LIQSTY	24.8		I						
14(10)	HNM	LIQSTY	30.3		C	24	33				
14(10)	HNM	PINTAE	12.5		I						
14(10)	HNM	PINTAE	29.4		C						
14(10)	HNM	PINTAE	31.0	2	C						
14(10)	HNM	PINTAE	31.3		D						
14(10)	HNM	PINTAE	34.5		D						
14(10)	HNM	PINTAE	35.9		D						
14(10)	HNM	PINTAE	35.9		D	27	62				
14(10)	HNM	PINTAE	42.4	3	D	26	66				
14(10)	HNM	PINTAE	45.9		D	27	55				
15(10)	HNM	ACERUB	34.7	2	C						
15(10)	HNM	CORFLO	8.5		S			33	10	0.2	3
15(10)	HNM	LIQSTY	30.6		C						
15(10)	HNM	LIQSTY	35.7		C						
15(10)	HNM	QUEALB	13.2	2	S						
15(10)	HNM	QUEALB	33.5	2	C						

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
15(10)	HNM	QUECOC	40.1		C	31	71	6	10	0.5	2
15(10)	HNM	QUECOC	46.2		D	32	69				
15(10)	HNM	QUECOC	56.6	2	D	28	79				
15(10)	HNM	QUEFAL	71.0	2	D						
24(10)	HNM	LIRTUL	59.3		C	37	98				
24(10)	HNM	LIRTUL	62.5	2	D	36	95				
24(10)	HNM	LIRTUL	73.4	2	D						
24(10)	HNM	QUEALB	44.3		C	28	78				
24(10)	HNM	QUEALB	47.8	3	C						
24(10)	HNM	QUEFAL	39.9	2	C						
24(10)	HNM	QUESTE	25.8	3	I			3	5	0.2	1
24(10)	HNM	QUESTE	41.0	2	C						
24(10)	HNM	QUEVEL	57.5	2	D						
24(10)	HNM	UNKNOW	dead								
24(10)	HNM	UNKNOW	dead								
25(10)	HNM	ACERUB	42.1		C						
25(10)	HNM	FAGGRA	28.2		I			63	14	1	5
25(10)	HNM	LIQSTY	21.0		C						
25(10)	HNM	LIQSTY	22.9	2	C						
25(10)	HNM	LIQSTY	24.8		C						
25(10)	HNM	LIQSTY	26.7		C						
25(10)	HNM	LIQSTY	27.1		C						
25(10)	HNM	LIQSTY	31.3		C						
25(10)	HNM	LIQSTY	32.4		C						
25(10)	HNM	LIQSTY	35.2		C						
25(10)	HNM	LIQSTY	37.7		C	36	52				
25(10)	HNM	LIQSTY	44.4		D						
25(10)	HNM	LIQSTY	47.7		D	37	71				
25(10)	HNM	LIRTUL	30.8		C						
25(10)	HNM	LIRTUL	33.9	2	C						
25(10)	HNM	LIRTUL	37.3		C						
25(10)	HNM	LIRTUL	50.9	2	D	37	60				
25(10)	HNM	PINTAE	62.2	3	D						
25(10)	HNM	QUECOC	17.1		I						
25(10)	HNM	QUEPHE	19.9		I						
25(10)	HNM	QUEPHE	68.6		D						
25(10)	HNM	UNKOWN	dead								
28(10)	HNM	CELOCC	16.5		S						
28(10)	HNM	LIQSTY	42.7		I						
28(10)	HNM	LIQSTY	49.6		C						
28(10)	HNM	LIQSTY	55.4		D						
28(10)	HNM	LIQSTY	60.6		D						
28(10)	HNM	LIRTUL	24.6		I						
28(10)	HNM	LIRTUL	30.8	2	C						
28(10)	HNM	LIRTUL	33.9		C						
28(10)	HNM	LIRTUL	36.5		S						
28(10)	HNM	LIRTUL	50.1		D		47				
28(10)	HNM	LIRTUL	50.1		D						
28(10)	HNM	LIRTUL	56.1		D	38	65				
28(10)	HNM	LIRTUL	56.9		D	39	64				
28(10)	HNM	PINTAE	45.0		D	33	65				
28(10)	HNM	PINTAE	45.9		D	27	59				
28(10)	HNM	PINTAE	56.4		D	31	55				
29(10)	HNM	CARGLA	39.4		I						

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
29(10)	HNM	JUGNIG	41.9	2	C						
29(10)	HNM	LIQSTY	23.3		I						
29(10)	HNM	LIQSTY	38.8		I						
29(10)	HNM	LIQSTY	57.6		D						
29(10)	HNM	LIQSTY	69.6		C						
29(10)	HNM	LIRTUL	10.3		S						
29(10)	HNM	LIRTUL	14.6		S						
29(10)	HNM	LIRTUL	28.3		I						
29(10)	HNM	LIRTUL	41.4	2	C						
29(10)	HNM	LIRTUL	44.9	2	C						
29(10)	HNM	LIRTUL	52.8		D	37		83			
29(10)	HNM	LIRTUL	61.4		D	35		77			
29(10)	HNM	LIRTUL	72.4		D	39		71			
29(10)	HNM	LIRTUL	86.8	2	D						
29(10)	HNM	LIRTUL	96.7	2	D						
29(10)	HNM	LIRTUL	105.0		D						
30(34)	HNM	CORFLO	9.7		S						
30(34)	HNM	FAGGRA	21.6		I						
30(34)	HNM	FAGGRA	63.5	2	D						
30(34)	HNM	LIQSTY	27.8		I						
30(34)	HNM	LIQSTY	43.0	2	C						
30(34)	HNM	LIQSTY	46.7		C						
30(34)	HNM	LIQSTY	74.1	2	C						
30(34)	HNM	LIRTUL	24.2		I						
30(34)	HNM	LIRTUL	41.0		C						
30(34)	HNM	LIRTUL	47.6		C						
30(34)	HNM	LIRTUL	49.6		C						
30(34)	HNM	LIRTUL	53.2		C						
30(34)	HNM	LIRTUL	62.2		C	37		73			
30(34)	HNM	LIRTUL	69.2		D	38		75			
30(34)	HNM	LIRTUL	74.3		D						
30(34)	HNM	LIRTUL	74.3		D	39		67			
30(34)	HNM	LIRTUL	81.0	2	D						
35(10)	HNM	LIQSTY	31.3		I						
35(10)	HNM	LIQSTY	35.8		C						
35(10)	HNM	LIQSTY	47.1		C						
35(10)	HNM	LIQSTY	76.4	2	D						
35(10)	HNM	LIRTUL	38.9		C						
35(10)	HNM	LIRTUL	56.8	2	C						
35(10)	HNM	LIRTUL	57.7		D	42		75			
35(10)	HNM	LIRTUL	62.5		D	42		96			
35(10)	HNM	LIRTUL	74.0	2	D						
35(10)	HNM	PINTAE	52.0		D	34		80			
35(10)	HNM	PINTAE	55.9		D	35		79			
35(10)	HNM	PINTAE	63.8		D	38		84			
35(10)	HNM	QUEALB	45.7	2	C						
35(10)	HNM	QUEALB	53.0		D						
35(10)	HNM	QUEVEL	57.2	2	C						
36(10)	HNM	ACERUB	dead								
36(10)	HNM	ACERUB	47.2	3	I						
36(10)	HNM	LIQSTY	11.0		S						
36(10)	HNM	LIQSTY	58.1		C						
36(10)	HNM	LIRTUL	59.1		D	43		59			
36(10)	HNM	LIRTUL	64.0		C	40		86			

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
36(10)	HNM	LIRTUL	71.1		D	44	104				
36(10)	HNM	LIRTUL	75.5		D						
36(10)	HNM	LIRTUL	84.6		D						
41(46)	HNM	FRAPEN	18.4		S			13	5	1	2
41(46)	HNM	FRAPEN	20.3	2	I						
41(46)	HNM	FRAPEN	22.9	2	I						
41(46)	HNM	FRAPEN	24.9		I						
41(46)	HNM	FRAPEN	32.3		C						
41(46)	HNM	LIQSTY	26.5	2	C						
41(46)	HNM	LIQSTY	40.3		C	33	54				
41(46)	HNM	LIQSTY	50.8		D	33	55				
41(46)	HNM	PINTAE	dead								
41(46)	HNM	PINTAE	41.3		C						
41(46)	HNM	PINTAE	53.4	2	S						
41(46)	HNM	PINTAE	56.4		D	34	60				
41(46)	HNM	PINTAE	60.5		D	34	55				
41(46)	HNM	PLAOCC	47.2		D			4	10	1	2
41(46)	HNM	PLAOCC	52.0		D						
41(46)	HNM	ULMRUB	6.3		S			40	10	0.3	3
41(46)	HNM	ULMRUB	15.1		S						
46(20)	HNM	LIQSTY	51.1		C	34	62				
46(20)	HNM	LIQSTY	53.1		C	33	55				
46(20)	HNM	PINTAE	12.4		I						
46(20)	HNM	PINTAE	14.9		I						
46(20)	HNM	PINTAE	17.9		C						
46(20)	HNM	PINTAE	21.8		C						
46(20)	HNM	PINTAE	64.1		D	32	88				
46(20)	HNM	QUEPHE	66.7		D						
46(20)	HNM	QUEPHE	86.4		D						
46(20)	HNM	QUEPHE	90.7		D						
47(20)	HNM	QUEPHE	26.2	2	I						
47(20)	HNM	QUEPHE	32.5	2	I						
47(20)	HNM	QUEPHE	34.2	2	I						
47(20)	HNM	QUEPHE	37.9	2	C						
47(20)	HNM	QUEPHE	43.6	2	C						
47(20)	HNM	QUEPHE	45.9	2	D						
47(20)	HNM	QUEPHE	46.8	2	D						
47(20)	HNM	QUEPHE	47.0	2	I						
47(20)	HNM	QUEPHE	47.4	2	C						
47(20)	HNM	QUEPHE	48.5	2	D	33	62				
47(20)	HNM	QUEPHE	51.4	2	D	32	67				
47(20)	HNM	QUEPHE	55.7	2	D	29	67				
47(20)	HNM	QUEPHE	59.2	2	D	35	65				
47(20)	HNM	QUEPHE	71.0	2	D						
49(10)	HNM	ACERUB	dead								
49(10)	HNM	ACERUB	37.6	3	I						
49(10)	HNM	ACERUB	63.3	3	C						
49(10)	HNM	ACERUB	67.5	2	D						
49(10)	HNM	LIQSTY	65.0		D	34	74				
49(10)	HNM	LIRTUL	11.4		I						
49(10)	HNM	LIRTUL	12.1	2	S						
49(10)	HNM	LIRTUL	32.0		C						
49(10)	HNM	PINTAE	61.9		D	31	73				
49(10)	HNM	PINTAE	69.0		D	33	59				

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
49(10)	HNH	PRUSER	21.0	2	C			3	5	0.1	1
49(10)	HNH	ULMRUB	39.7	2	I						
51(10)	HNH	LIRTUL	22.3		I						
51(10)	HNH	LIRTUL	29.2		C						
51(10)	HNH	LIRTUL	42.0	2	C						
51(10)	HNH	LIRTUL	44.6		D						
51(10)	HNH	LIRTUL	45.4	2	D	35	64				
51(10)	HNH	LIRTUL	47.1	2	C						
51(10)	HNH	LIRTUL	50.6	2	D	33	73				
51(10)	HNH	LIRTUL	67.4		D	37	69				
51(10)	HNH	PLAOCC	25.9	2	S						
51(10)	HNH	PLAOCC	45.5	2	C						
51(10)	HNH	PLAOCC	58.4	2	D						
60(21)	HNH	FAGGRA	4.8	2	S						
60(21)	HNH	FAGGRA	107.3		D						
60(21)	HNH	LIQSTY	37.4		C						
60(21)	HNH	LIRTUL	11.7	2	S						
60(21)	HNH	LIRTUL	32.1	2	C						
60(21)	HNH	LIRTUL	43.6		C						
60(21)	HNH	LIRTUL	44.6		D						
60(21)	HNH	LIRTUL	45.7		D						
60(21)	HNH	LIRTUL	46.7		D	35	57				
60(21)	HNH	LIRTUL	55.2		D	36	54				
60(21)	HNH	LIRTUL	56.5		D	39	55				
60(21)	HNH	LIRTUL	100.4		D						
60(21)	HNH	PINTAE	dead								
60(21)	HNH	PINTAE	51.5	2	D	37	112				
60(21)	HNH	QUEVEL	23.7		I						
60(21)	HNH	QUEVEL	76.1	2	C						
10(65)	PHNM	LIQSTY	16.9		I			162	60	7.5	18
10(65)	PHNM	LIQSTY	18.2		I						
10(65)	PHNM	LIQSTY	19.4		I						
10(65)	PHNM	LIQSTY	22.1		I						
10(65)	PHNM	LIQSTY	31.4		C						
10(65)	PHNM	LIQSTY	31.4		C						
10(65)	PHNM	LIQSTY	32.4		C						
10(65)	PHNM	LIQSTY	35.6		C						
10(65)	PHNM	LIQSTY	37.6		C	34	48				
10(65)	PHNM	LIQSTY	39.7		C	29	41				
10(65)	PHNM	LIQSTY	40.5		D	26	45				
10(65)	PHNM	LIRTUL	19.0	2	I			365	60	3.5	19
10(65)	PHNM	LIRTUL	37.4		D	35	51				
10(65)	PHNM	PINTAE	22.8		C			184	100	17	32
10(65)	PHNM	PINTAE	29.9		C						
38(28)	PHNM	LIQSTY	29.1		C						
38(28)	PHNM	LIRTUL	4.9		S						
38(28)	PHNM	LIRTUL	11.9		I						
38(28)	PHNM	LIRTUL	14.7		I						
38(28)	PHNM	LIRTUL	16.2		I						
38(28)	PHNM	PINTAE	22.9		I						
38(28)	PHNM	PINTAE	30.4		C						
38(28)	PHNM	PINTAE	30.4		C						
38(28)	PHNM	PINTAE	33.5		C						
38(28)	PHNM	PINTAE	35.2		D						

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
38(28)	PHNM	PINTAE	36.1		D						
38(28)	PHNM	PINTAE	37.7		C						
38(28)	PHNM	PINTAE	40.6		D						
38(28)	PHNM	PINTAE	41.1		D	27	48				
38(28)	PHNM	PINTAE	46.7		D	29	47				
38(28)	PHNM	PINTAE	49.5		D	28	49				
39(28)	PHNM	PINTAE	dead								
39(28)	PHNM	PINTAE	dead								
39(28)	PHNM	PINTAE	18.9		I						
39(28)	PHNM	PINTAE	20.7		C						
39(28)	PHNM	PINTAE	25.3		C						
39(28)	PHNM	PINTAE	28.7		C						
39(28)	PHNM	PINTAE	29.7		D						
39(28)	PHNM	PINTAE	35.4		D	25	43				
39(28)	PHNM	PINTAE	38.6		D	24	48				
39(28)	PHNM	PINTAE	44.9		D	25	49				
39(28)	PHNM	QUEFAL	5.5	2	S			275	60	2	15
39(28)	PHNM	QUEFAL	9.0		S						
39(28)	PHNM	QUENIG	8.4	2	S			83	20	0.5	5
56(28)	PHNM	LIQSTY	12.9	2	S						
56(28)	PHNM	LIQSTY	23.0		C						
56(28)	PHNM	LIQSTY	23.9	2	C						
56(28)	PHNM	LIRTUL	24.1		C						
56(28)	PHNM	PINTAE	24.4		C						
56(28)	PHNM	PINTAE	33.6		C						
56(28)	PHNM	PINTAE	34.5		D	21	57				
56(28)	PHNM	PINTAE	37.1		D	24	57				
56(28)	PHNM	PINTAE	38.5		C						
56(28)	PHNM	PINTAE	40.0		C						
56(28)	PHNM	PINTAE	40.0		C	26	56				
56(28)	PHNM	QUEFAL	43.2		D	23	36				
57(28)	PHNM	NYSSYL	8.8	3	S			109	20	1	6
57(28)	PHNM	NYSSYL	13.3	3	S						
57(28)	PHNM	PINTAE	45.8		C						
57(28)	PHNM	PINTAE	50.0		D						
57(28)	PHNM	PINTAE	53.6		D						
57(28)	PHNM	PINTAE	57.1	2	D	34	91				
57(28)	PHNM	PINTAE	58.3		D	32	83				
57(28)	PHNM	PINTAE	61.7	2	D	30	100				
57(28)	PHNM	QUEALB	14.3	2	S			29	20	0.5	3
57(28)	PHNM	QUECOC	50.3		D	28	74	2	20	0.5	2
57(28)	PHNM	QUEFAL	29.4		C						
11(13)	PNI	LIQSTY	19.8		I			367	89	6	28
11(13)	PNI	LIQSTY	23.2	2	I						
11(13)	PNI	LIQSTY	27.4		C	20	36				
11(13)	PNI	LIRTUL	22.9	2	I			33	122	2	13
11(13)	PNI	PINTAE	dead								
11(13)	PNI	PINTAE	dead								
11(13)	PNI	PINTAE	dead								
11(13)	PNI	PINTAE	28.8	2	C			286	100	22	41
11(13)	PNI	PINTAE	30.6	2	C						
11(13)	PNI	PINTAE	33.3	2	C						
11(13)	PNI	PINTAE	38.6		D						
11(13)	PNI	PINTAE	39.6	2	D						

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
11(13)	PNI	PINTAE	42.0	2	C						
11(13)	PNI	PINTAE	44.6	2	D						
11(13)	PNI	PINTAE	48.8	4	D						
11(13)	PNI	PINTAE	52.0		D	27	44				
11(13)	PNI	PINTAE	52.9		D	27	48				
11(13)	PNI	PINTAE	57.2	2	D						
13(13)	PNI	LIQSTY	50.9		D	38	72				
13(13)	PNI	LIQSTY	56.8		C	26	88				
13(13)	PNI	LIRTUL	11.7		S						
13(13)	PNI	PINTAE	36.7		C						
13(13)	PNI	PINTAE	40.1		C						
13(13)	PNI	PINTAE	40.3		D	29	60				
13(13)	PNI	PINTAE	41.5		D	34	55				
13(13)	PNI	PINTAE	43.9		C	31	65				
13(13)	PNI	QUEFAL	27.9	2	I			5	11	1	2
13(13)	PNI	QUEFAL	69.1		C						
13(13)	PNI	QUEFAL	94.1	2	C						
13(13)	PNI	QUEFAL	107.8		D						
13(13)	PNI	SASALB	24.0		I			6	11	0.3	1
13(13)	PNI	UNKNOW	dead								
32(35)	PNI	JUNVIR	dead								
32(35)	PNI	LIQSTY	7.1		S						
32(35)	PNI	LIQSTY	24.5		I						
32(35)	PNI	LIQSTY	28.9	2	C						
32(35)	PNI	PINTAE	dead								
32(35)	PNI	PINTAE	dead								
32(35)	PNI	PINTAE	17.7		C						
32(35)	PNI	PINTAE	18.8		S						
32(35)	PNI	PINTAE	24.4		C						
32(35)	PNI	PINTAE	25.1		C						
32(35)	PNI	PINTAE	31.5		C						
32(35)	PNI	PINTAE	32.4		D						
32(35)	PNI	PINTAE	36.6		C						
32(35)	PNI	PINTAE	41.1		D						
32(35)	PNI	PINTAE	41.4		C						
32(35)	PNI	PINTAE	43.8		D	28	47				
32(35)	PNI	PINTAE	45.6		C	25	46				
32(35)	PNI	PINTAE	48.2		D	23	46				
32(35)	PNI	QUENIG	35.3	2	D			3	11	0.3	1
34(33)	PNI	LIQSTY	23.2		I						
34(33)	PNI	LIQSTY	31.2		C						
34(33)	PNI	LIQSTY	34.4		C	28					
34(33)	PNI	LIQSTY	36.4		C	30					
34(33)	PNI	PINTAE	20.4		C						
34(33)	PNI	PINTAE	30.2		C						
34(33)	PNI	PINTAE	31.0		C						
34(33)	PNI	PINTAE	31.1		C						
34(33)	PNI	PINTAE	35.6		C						
34(33)	PNI	PINTAE	36.9		D	27	46				
34(33)	PNI	PINTAE	45.4		D	27	57				
34(33)	PNI	PINTAE	47.7		D	28	55				
34(33)	PNI	QUEALB	10.7	3	S			28	11	0.3	2
34(33)	PNI	QUEVEL	12.2	2	I			35	11	0.6	3
34(33)	PNI	QUEVEL	15.7	2	I						

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
42(40)	PNI	LIQSTY	6.7	2	S						
42(40)	PNI	LIQSTY	11.9	3	S						
42(40)	PNI	LIQSTY	13.9	2	S						
42(40)	PNI	LIQSTY	19.5	2	S						
42(40)	PNI	PINTAE	32.8		C						
42(40)	PNI	PINTAE	35.7	2	C						
42(40)	PNI	PINTAE	35.8		C						
42(40)	PNI	PINTAE	36.2		D						
42(40)	PNI	PINTAE	41.6		C						
42(40)	PNI	PINTAE	46.3		D	26	42				
42(40)	PNI	PINTAE	46.5		D	31	45				
42(40)	PNI	PINTAE	49.6	3	C						
42(40)	PNI	PINTAE	49.8	2	D	29	57				
58(25)	PNI	LIQSTY	6.1		S						
58(25)	PNI	LIQSTY	16.3		I						
58(25)	PNI	LIQSTY	20.7		C	15	22				
58(25)	PNI	LIQSTY	23.2		C	18	21				
58(25)	PNI	PINTAE	12.0		S						
58(25)	PNI	PINTAE	17.9		I						
58(25)	PNI	PINTAE	22.9		C						
58(25)	PNI	PINTAE	26.7		C						
58(25)	PNI	PINTAE	27.8		C						
58(25)	PNI	PINTAE	28.7		D						
58(25)	PNI	PINTAE	32.0		D						
58(25)	PNI	PINTAE	32.1		D	19	26				
58(25)	PNI	PINTAE	35.9		D	19	26				
58(25)	PNI	PINTAE	46.8		D	22	24				
59(25)	PNI	PINTAE	24.0		C						
59(25)	PNI	PINTAE	24.5		C						
59(25)	PNI	PINTAE	24.8		D						
59(25)	PNI	PINTAE	26.9		C						
59(25)	PNI	PINTAE	27.1		C	15	21				
59(25)	PNI	PINTAE	31.1		D	16	21				
59(25)	PNI	PINTAE	38.4		D	16	23				
59(25)	PNI	PRUSER	12.0	2	I			64	22	1	6
62(38)	PNI	LIQSTY	23.1		C	22	38				
62(38)	PNI	LIQSTY	41.7	2	D	25					
62(38)	PNI	PINTAE	17.8		I						
62(38)	PNI	PINTAE	25.8		C						
62(38)	PNI	PINTAE	32.8		C						
62(38)	PNI	PINTAE	42.3		D						
62(38)	PNI	PINTAE	45.8		D	26	41				
62(38)	PNI	PINTAE	46.4		D	22	43				
62(38)	PNI	PINTAE	53.7		D						
62(38)	PNI	PLAOCC	14.4	2	I			16	11	0.3	2
62(38)	PNI	PRUSER	14.8	2	I						
62(38)	PNI	PRUSER	16.6	2	I						
62(38)	PNI	PRUSER	18.9		C						
62(38)	PNI	PRUSER	24.1		C						
63(33)	PNI	CARGLA	54.4		D			1	11	0.3	1
63(33)	PNI	LIQSTY	14.4		I						
63(33)	PNI	LIRTUL	46.9		D	33	57				
63(33)	PNI	LIRTUL	63.7		D						
63(33)	PNI	LIRTUL	70.0		D						

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
63(33)	PNI	LIRTUL	97.3		D						
63(33)	PNI	PINTAE	17.7		I						
63(33)	PNI	PINTAE	17.7		I						
63(33)	PNI	PINTAE	20.4		I						
63(33)	PNI	PINTAE	30.7		C						
63(33)	PNI	PINTAE	31.1		C	20	45				
63(33)	PNI	PINTAE	34.1		I						
63(33)	PNI	PINTAE	39.0		D	27	42				
63(33)	PNI	PINTAE	44.3		D	28	48				
63(33)	PNI	PINTAE	44.9		D						
63(33)	PNI	PINTAE	45.7		D						
05(08)	PNM	LIQSTY	12.4		I			189	90	4.8	19
05(08)	PNM	LIRTUL	65.8		D	30	57	39	52	3	9
05(08)	PNM	LIRTUL	71.3		D	37	47				
05(08)	PNM	LIRTUL	71.8		D	34	56				
05(08)	PNM	NYSSYL	4.2	2	S			141	10	1	7
05(08)	PNM	PINTAE	43.7	2	C	26	57	210	95	21.1	35
17(17)	PNM	LIQSTY	36.7		D						
17(17)	PNM	PINTAE	28.8	2	C						
17(17)	PNM	PINTAE	31.9		C						
17(17)	PNM	PINTAE	39.4		C						
17(17)	PNM	PINTAE	47.6	2	D						
17(17)	PNM	PINTAE	48.1		D	29	51				
17(17)	PNM	PINTAE	48.6		D	22	51				
17(17)	PNM	PINTAE	58.8		D	29	58				
17(17)	PNM	dead									
18(17)	PNM	PINTAE	dead								
18(17)	PNM	PINTAE	40.1		C						
18(17)	PNM	PINTAE	40.2		C						
18(17)	PNM	PINTAE	42.5		C						
18(17)	PNM	PINTAE	46.3		C						
18(17)	PNM	PINTAE	46.3		C						
18(17)	PNM	PINTAE	51.1	2	D						
18(17)	PNM	PINTAE	51.3		D	26	53				
18(17)	PNM	PINTAE	56.4		D	29	58				
18(17)	PNM	PINTAE	57.6		D	29	55				
18(17)	PNM	QUEFAL	10.3		I			24	10	0.4	2
18(17)	PNM	QUEFAL	13.1		I						
18(17)	PNM	QUENIG	12.1	2	I			10	5	0.1	1
18(17)	PNM	QUEVEL	14.1	2	I			84	19	0.7	5
19(17)	PNM	LIQSTY	27.8		C						
19(17)	PNM	LIQSTY	31.2		D	27	30				
19(17)	PNM	LIQSTY	33.6		C	28	39				
19(17)	PNM	LIQSTY	41.9		D	29	37				
19(17)	PNM	LIRTUL	35.6		C						
19(17)	PNM	NYSSYL	12.4		S						
19(17)	PNM	NYSSYL	13.2		S						
19(17)	PNM	NYSSYL	14.3	2	S						
19(17)	PNM	NYSSYL	14.6		I						
19(17)	PNM	NYSSYL	17.1		S						
19(17)	PNM	NYSSYL	20.0		I						
19(17)	PNM	PINTAE	30.0	2	C						
19(17)	PNM	PINTAE	33.2		C						
19(17)	PNM	PINTAE	35.7		C						

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
19(17)	PNM	PINTAE	36.2	2	C						
19(17)	PNM	PINTAE	36.9		D						
19(17)	PNM	PINTAE	39.8	2	C	26	39				
19(17)	PNM	PINTAE	44.3	2	D	29	42				
19(17)	PNM	PINTAE	45.8	2	D	27	42				
20(17)	PNM	LIQSTY	17.4		I						
20(17)	PNM	LIRTUL	20.6		C						
20(17)	PNM	PINTAE	32.8		C						
20(17)	PNM	PINTAE	36.1	2	C						
20(17)	PNM	PINTAE	37.6		C						
20(17)	PNM	PINTAE	38.0		C						
20(17)	PNM	PINTAE	39.5		D						
20(17)	PNM	PINTAE	39.6		C						
20(17)	PNM	PINTAE	39.8		C	26	62				
20(17)	PNM	PINTAE	39.8		D						
20(17)	PNM	PINTAE	43.1		C						
20(17)	PNM	PINTAE	43.8	2	D	30	46				
20(17)	PNM	PINTAE	47.3	2	D	29	66				
20(17)	PNM	QUEVEL	6.8	2	S						
20(17)	PNM	QUEVEL	8.7	2	I						
20(17)	PNM	QUEVEL	14.3	2	I						
21(17)	PNM	LIQSTY	49.2	2	C						
21(17)	PNM	LIRTUL	20.0	2	I						
21(17)	PNM	LIRTUL	28.0		I						
21(17)	PNM	LIRTUL	56.9		D						
21(17)	PNM	PINTAE	dead								
21(17)	PNM	PINTAE	34.4		C						
21(17)	PNM	PINTAE	34.9	2	C						
21(17)	PNM	PINTAE	35.4		C	38	53				
21(17)	PNM	PINTAE	37.1		C						
21(17)	PNM	PINTAE	38.4		C						
21(17)	PNM	PINTAE	41.3		C						
21(17)	PNM	PINTAE	43.0		D						
21(17)	PNM	PINTAE	46.1		D						
21(17)	PNM	PINTAE	47.3	3	C						
21(17)	PNM	PINTAE	47.6		D	31	66				
21(17)	PNM	PINTAE	49.7		D	32	61				
21(17)	PNM	PINTAE	51.3		D						
21(17)	PNM	PINTAE	52.7		D	35	72				
22(17)	PNM	LIQSTY	11.6	2	S						
22(17)	PNM	LIQSTY	13.5		I						
22(17)	PNM	LIRTUL	20.3	2	I						
22(17)	PNM	LIRTUL	38.9		C						
22(17)	PNM	LIRTUL	57.5		D	31	49				
22(17)	PNM	PINTAE	31.5		C						
22(17)	PNM	PINTAE	34.2		C						
22(17)	PNM	PINTAE	37.2		C						
22(17)	PNM	PINTAE	39.1		C						
22(17)	PNM	PINTAE	42.9		D	24	61				
22(17)	PNM	PINTAE	43.7		D	28	66				
22(17)	PNM	PINTAE	44.8		D	26	58				
23(17)	PNM	CORFLO	9.5		I			64	10	0.5	4
23(17)	PNM	LIQSTY	11.4		I						
23(17)	PNM	PINTAE	dead								

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
23(17)	PNM	PINTAE	12.4		I						
23(17)	PNM	PINTAE	12.9		I						
23(17)	PNM	PINTAE	15.0		I						
23(17)	PNM	PINTAE	20.1		C						
23(17)	PNM	PINTAE	21.2		C						
23(17)	PNM	PINTAE	21.5		C						
23(17)	PNM	PINTAE	24.2		C						
23(17)	PNM	PINTAE	25.1		C						
23(17)	PNM	PINTAE	32.0		C	21	42				
23(17)	PNM	PINTAE	42.4		D	22	57				
23(17)	PNM	PINTAE	44.5		D	24	66				
26(17)	PNM	LIQSTY	18.1		I						
26(17)	PNM	PINTAE	27.3		D						
26(17)	PNM	PINTAE	30.5	2	I						
26(17)	PNM	PINTAE	30.5		C						
26(17)	PNM	PINTAE	35.8		C						
26(17)	PNM	PINTAE	36.4		D						
26(17)	PNM	PINTAE	39.2		C						
26(17)	PNM	PINTAE	39.7		D						
26(17)	PNM	PINTAE	39.9		D						
26(17)	PNM	PINTAE	42.6	2	D	28	64				
26(17)	PNM	PINTAE	50.4		D	27	51				
26(17)	PNM	PINTAE	51.7		D	29	51				
27(17)	PNM	LIQSTY	6.5		S						
27(17)	PNM	LIQSTY	10.9		S						
27(17)	PNM	PINTAE	6.6		I						
27(17)	PNM	PINTAE	45.9		C						
27(17)	PNM	PINTAE	48.6		C						
27(17)	PNM	PINTAE	48.9		C						
27(17)	PNM	PINTAE	49.8		C						
27(17)	PNM	PINTAE	50.2		C						
27(17)	PNM	PINTAE	51.5	2	D						
27(17)	PNM	PINTAE	52.4		D						
27(17)	PNM	PINTAE	55.9		D	33	69				
27(17)	PNM	PINTAE	57.2	2	D	27	63				
27(17)	PNM	PINTAE	57.8		D	31	61				
27(17)	PNM	PINTAE	60.1	2	D						
27(17)	PNM	PINTAE	62.4		D						
31(17)	PNM	LIQSTY	27.5		C						
31(17)	PNM	PINTAE	29.2		C						
31(17)	PNM	PINTAE	31.8		C						
31(17)	PNM	PINTAE	36.9		C						
31(17)	PNM	PINTAE	37.1		C						
31(17)	PNM	PINTAE	38.9		C						
31(17)	PNM	PINTAE	38.9		D						
31(17)	PNM	PINTAE	40.0	2	D						
31(17)	PNM	PINTAE	42.6		D						
31(17)	PNM	PINTAE	44.2		D	30	66				
31(17)	PNM	PINTAE	50.5		D	31	54				
31(17)	PNM	PINTAE	53.2		D	33	57				
31(17)	PNM	QUEVEL	8.1	2	S						
33(17)	PNM	CORFLO	8.5		S						
33(17)	PNM	CORFLO	8.6		S						
33(17)	PNM	CORFLO	11.4		S						

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
33(17)	PNM	JUGNIG	35.1	2	S			1	10	0.1	1
33(17)	PNM	LIQSTY	18.6		S						
33(17)	PNM	LIQSTY	43.5		C						
33(17)	PNM	LIRTUL	31.1		C						
33(17)	PNM	LIRTUL	40.9		C						
33(17)	PNM	LIRTUL	56.8		D	40	76				
33(17)	PNM	LIRTUL	60.2		D	38	73				
33(17)	PNM	LIRTUL	62.8		D						
33(17)	PNM	LIRTUL	66.4		D	40	83				
33(17)	PNM	LIRTUL	77.8		C						
33(17)	PNM	PINTAE	25.6		I						
33(17)	PNM	PINTAE	29.0	2	I						
33(17)	PNM	PINTAE	42.8		D	32	64				
33(17)	PNM	QUEALB	38.0	2	C			7	19	1	3
37(32)	PNM	CARTOM	34.7	2	C			3	10	0.2	1
37(32)	PNM	FAGGRA	54.0	2	D			0	5	0.1	1
37(32)	PNM	LIQSTY	38.0		C						
37(32)	PNM	LIRTUL	19.2		I						
37(32)	PNM	QUEALB	40.8	2	I						
37(32)	PNM	QUEALB	41.7	2	C						
37(32)	PNM	QUEALB	41.9	2	C	24	54				
37(32)	PNM	QUEALB	63.9	3	D						
37(32)	PNM	QUEALB	64.6	2	D	35	73				
37(32)	PNM	QUEVEL	49.8		D						
45(19)	PNM	LIQSTY	28.9		I						
45(19)	PNM	LIQSTY	51.5		D	35	81				
45(19)	PNM	LIRTUL	23.5		I						
45(19)	PNM	PINTAE	36.7		C						
45(19)	PNM	PINTAE	39.3		C						
45(19)	PNM	PINTAE	40.8		C						
45(19)	PNM	PINTAE	43.0		C						
45(19)	PNM	PINTAE	49.5	2	D						
45(19)	PNM	PINTAE	51.3		C						
45(19)	PNM	PINTAE	52.4		D						
45(19)	PNM	PINTAE	53.9		D	34	55				
45(19)	PNM	PINTAE	55.4		D	31	50				
45(19)	PNM	PINTAE	56.0		D	30	51				
45(19)	PNM	ULMRUB	25.4		I			3	10	0.2	1
48(19)	PNM	LIQSTY	15.3	2	I						
48(19)	PNM	LIQSTY	16.0	2	I						
48(19)	PNM	PINTAE	34.0		C						
48(19)	PNM	PINTAE	36.7		C						
48(19)	PNM	PINTAE	44.6		D						
48(19)	PNM	PINTAE	45.5		C						
48(19)	PNM	PINTAE	45.8		C						
48(19)	PNM	PINTAE	46.0	2	C						
48(19)	PNM	PINTAE	48.5		D						
48(19)	PNM	PINTAE	50.8		D						
48(19)	PNM	PINTAE	51.6		D						
48(19)	PNM	PINTAE	52.1	2	D						
48(19)	PNM	PINTAE	52.5		D	30	92				
48(19)	PNM	PINTAE	53.9	2	D						
48(19)	PNM	PINTAE	54.4	2	D	31	69				
48(19)	PNM	PINTAE	65.8		D						

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
48(19)	PNM	QUEALB	dead								
48(19)	PNM	QUEALB	41.7		C						
48(19)	PNM	QUEALB	46.2		C						
48(19)	PNM	QUEALB	50.7		D	40	96				
48(19)	PNM	ULMspp	12.3	2	I			9	5	0.1	1
50(17)	PNM	JUNVIR	7.8		S			23	5	0.1	1
50(17)	PNM	LIQSTY	11.4	2	S						
50(17)	PNM	LIQSTY	31.8		C						
50(17)	PNM	LIQSTY	34.5		C						
50(17)	PNM	LIQSTY	47.3	2	C	33	51				
50(17)	PNM	NYSSYL	8.8	2	S						
50(17)	PNM	NYSSYL	16.5	2	S						
50(17)	PNM	PINTAE	dead								
50(17)	PNM	PINTAE	dead								
50(17)	PNM	PINTAE	32.0		C						
50(17)	PNM	PINTAE	36.1		I						
50(17)	PNM	PINTAE	45.0		D						
50(17)	PNM	PINTAE	48.1	2	D	30	56				
50(17)	PNM	PINTAE	48.8		C						
50(17)	PNM	PINTAE	51.1	2	D						
50(17)	PNM	PINTAE	52.2		D	34	67				
50(17)	PNM	PINTAE	52.4		C						
50(17)	PNM	PINTAE	54.0	4	D						
50(17)	PNM	PINTAE	56.6		D	30	71				
50(17)	PNM	QUERUB	29.4	2	C			2	5	0.1	1
52(19)	PNM	ACERUB	3.9	2	S			92	5	0.1	4
52(19)	PNM	LIQSTY	34.0		I						
52(19)	PNM	LIQSTY	38.1		I						
52(19)	PNM	LIQSTY	58.0		D	36	87				
52(19)	PNM	PINTAE	dead								
52(19)	PNM	PINTAE	35.6		C						
52(19)	PNM	PINTAE	40.6		C						
52(19)	PNM	PINTAE	42.0		C						
52(19)	PNM	PINTAE	43.5		D						
52(19)	PNM	PINTAE	44.9	2	D						
52(19)	PNM	PINTAE	46.6		C						
52(19)	PNM	PINTAE	47.0		D	33	69				
52(19)	PNM	PINTAE	47.0	2	D						
52(19)	PNM	PINTAE	51.9	2	D						
52(19)	PNM	PINTAE	52.2		D	33	70				
52(19)	PNM	PINTAE	55.2		D	34	67				
53(17)	PNM	CARTOM	24.5	2	C						
53(17)	PNM	LIQSTY	9.3		S						
53(17)	PNM	PINECH	26.6		C			5	10	0.5	1
53(17)	PNM	PINECH	34.0		C						
53(17)	PNM	PINECH	40.6		D						
53(17)	PNM	PINTAE	31.3		C						
53(17)	PNM	PINTAE	35.5		D	33	62				
53(17)	PNM	PINTAE	36.7		C						
53(17)	PNM	PINTAE	36.8		C						
53(17)	PNM	PINTAE	44.0		C						
53(17)	PNM	PINTAE	45.0		D	31	70				
53(17)	PNM	PINTAE	46.2	2	C						
53(17)	PNM	PINTAE	52.6	3	D	31	69				

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	I/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
53(17)	PNM	QUEALB	39.1	2	C	28	64				
53(17)	PNM	QUEFAL	21.2	2	I						
54(19)	PNM	LIQSTY	23.7		I						
54(19)	PNM	LIQSTY	38.6		D	29	56				
54(19)	PNM	LIQSTY	39.6		I						
54(19)	PNM	LIQSTY	39.8		C						
54(19)	PNM	LIQSTY	45.6		C						
54(19)	PNM	LIQSTY	53.7		D	36	78				
54(19)	PNM	LIQSTY	53.8		C	28	57				
54(19)	PNM	LIRTUL	12.6		S						
54(19)	PNM	LIRTUL	53.1	2	C						
54(19)	PNM	LIRTUL	81.9		D						
54(19)	PNM	PINECH	41.6		D						
54(19)	PNM	PINTAE	33.3		I						
54(19)	PNM	PINTAE	41.4		C						
54(19)	PNM	PINTAE	53.1		D	35	65				
54(19)	PNM	PINTAE	55.8		D	32	63				
54(19)	PNM	PINTAE	62.5		D	35	59				
54(19)	PNM	QUEPHE	49.0	2	I			1	5	0.2	1
54(19)	PNM	QUEPHE	56.7	2	D						
55(19)	PNM	LIQSTY	7.7		S						
55(19)	PNM	LIQSTY	21.6		I						
55(19)	PNM	LIQSTY	23.4		I						
55(19)	PNM	LIQSTY	34.3		C	22	44				
55(19)	PNM	LIRTUL	23.1		I						
55(19)	PNM	PINTAE	28.2		C						
55(19)	PNM	PINTAE	28.4		I						
55(19)	PNM	PINTAE	28.9	2	C						
55(19)	PNM	PINTAE	29.8		C						
55(19)	PNM	PINTAE	32.0		C						
55(19)	PNM	PINTAE	32.2	2	C						
55(19)	PNM	PINTAE	33.6		D						
55(19)	PNM	PINTAE	35.3		D						
55(19)	PNM	PINTAE	35.8	2	C						
55(19)	PNM	PINTAE	37.0		D						
55(19)	PNM	PINTAE	41.0	2	D						
55(19)	PNM	PINTAE	44.1		D	30	54				
55(19)	PNM	PINTAE	44.6		D	29	57				
55(19)	PNM	PINTAE	55.2		D	103	57				
61(19)	PNM	CELOCC	8.7	2	S			28	5	0.2	2
61(19)	PNM	CELOCC	12.2	2	S						
61(19)	PNM	LIRTUL	31.0	2	C	22	36				
61(19)	PNM	PINTAE	55.8	2	D	26	62				
61(19)	PNM	PRUSER	16.9	2	I			21	5	0.8	2
61(19)	PNM	PRUSER	18.2	2	I						
61(19)	PNM	PRUSER	20.2		I						
61(19)	PNM	PRUSER	21.3	2	C						
61(19)	PNM	PRUSER	26.5	2	D						
61(19)	PNM	PRUSER	26.7	2	I						
61(19)	PNM	PRUSER	31.6	2	C						
61(19)	PNM	ULMRUB	47.5		D						
07(16)	PNY	LIQSTY	8.9		C			1163	67	6.6	56
07(16)	PNY	LIQSTY	9.0		D	9	8				
07(16)	PNY	LIQSTY	9.4		I						

Main Unit Overstory Plot Data (continued)

Plot(stand)	Stand Type	Species	dbh	L/D	CrCl	Ht	Age	Mean Density (stems/ha)	Frequency (%)	Mean Dominance (m ² /ha)	Importance Value (%)
07(16)	PNY	PINTAE	15.4		C	8	13	41	33	0.8	12
12(64)	PNY	LIQSTY	6.1	3	S						
12(64)	PNY	LIQSTY	6.3		I						
12(64)	PNY	LIQSTY	8.5		C						
12(64)	PNY	LIQSTY	9.7	2	C						
12(64)	PNY	LIQSTY	12.4	2	D	18	14				
12(64)	PNY	LIRTUL	3.1		I	20	15	1086	33	2.5	32
12(64)	PNY	LIRTUL	16.2		D	14	15				
12(64)	PNY	LIRTUL	16.6		D		13				
16(64)	PNY	NONE									
40(45)	PPI	PINTAE	20.5		C			787	100	33.3	89
40(45)	PPI	PINTAE	22.5		D						
40(45)	PPI	PINTAE	24.2		D						
40(45)	PPI	PINTAE	24.5		C						
40(45)	PPI	PINTAE	25.3		C						
40(45)	PPI	PINTAE	25.5		C						
40(45)	PPI	PINTAE	25.6		D						
40(45)	PPI	PINTAE	26.6		D						
40(45)	PPI	PINTAE	28.2		D	63	24				
40(45)	PPI	PINTAE	29.0		D	69	24				
40(45)	PPI	PINTAE	32.6		D	65	25				
43(39)	PPI	PINTAE	dead								
43(39)	PPI	PINTAE	16.5	2	D						
43(39)	PPI	PINTAE	16.9	2	I						
43(39)	PPI	PINTAE	17.6		C						
43(39)	PPI	PINTAE	17.8		C						
43(39)	PPI	PINTAE	18.0		C						
43(39)	PPI	PINTAE	18.4		D						
43(39)	PPI	PINTAE	18.9	2	C						
43(39)	PPI	PINTAE	19.7		C						
43(39)	PPI	PINTAE	20.7		D						
43(39)	PPI	PINTAE	21.0		C						
43(39)	PPI	PINTAE	21.5		C						
43(39)	PPI	PINTAE	21.5		D						
43(39)	PPI	PINTAE	21.9		D						
43(39)	PPI	PINTAE	22.1		D						
43(39)	PPI	PINTAE	23.8		C						
43(39)	PPI	PINTAE	24.1		C						
43(39)	PPI	PINTAE	24.2		D	22	25				
43(39)	PPI	PINTAE	24.5		D	21	27				
43(39)	PPI	PINTAE	27.1		D	20	24				
44(45)	PPI	LIQSTY	28.3		D	24	39	15	33	1.7	11
44(45)	PPI	LIQSTY	58.3		D	38	50				
44(45)	PPI	PINTAE	16.8		I						
44(45)	PPI	PINTAE	20.7		C						
44(45)	PPI	PINTAE	21.3		C						
44(45)	PPI	PINTAE	24.6		C						
44(45)	PPI	PINTAE	25.7		C						
44(45)	PPI	PINTAE	26.2		C						
44(45)	PPI	PINTAE	27.3		D	23	26				
44(45)	PPI	PINTAE	27.8		C						
44(45)	PPI	PINTAE	31.3		C	23	26				
44(45)	PPI	PINTAE	31.6		D	24	29				