

**A Survey of the Vegetation and
Fuels of Buxton Woods,
Cape Hatteras National Seashore,
North Carolina**

CPSU Technical Report No. 40

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September 1987

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ABSTRACT

Buxton Woods was dominated by loblolly pine (*Pinus taeda*). The most common hardwood was laurel oak (*Quercus laurifolia*). The woods were described by nine forest types, five of which were dominated by pine. The pine types included pine plantation, dating from plantings in the 1930's and 1960's; mature pine; pine/live oak; pine/ironwood; and a swamp type with pine as dominant. Hardwood types included evergreen forest border dominated by red bay and live oak; deciduous forest dominated by ironwood and dogwood; and mixed mature hardwood forest dominated by laurel oak. The edge of the forest was generally classified as live oak scrub. Unforested and savannah cover types included marshes and ponds, shrub savannah, shrub thickets dominated by bayberry, maritime pine forest, dune grasslands and bare sand. Five fire fuel models were identified: O, D, R, N, and A. In general the fuels for types N and O tend to be somewhat lower than for similar areas on the mainland and tend to be discontinuous. Type R, applied to hardwood forests, will only burn under very dry conditions and under most circumstances will inhibit fire spread. Fire is most likely to spread in mature pine and in sawgrass wetlands. Mature pine had 80% greater surface fuel weights than hardwood forest and 114% greater weights than live oak scrub. Succession in Buxton Woods will probably favor hardwoods. Management for hardwoods will eventually reduce surface fuel loadings and decrease the chances for a major fire in the woods.

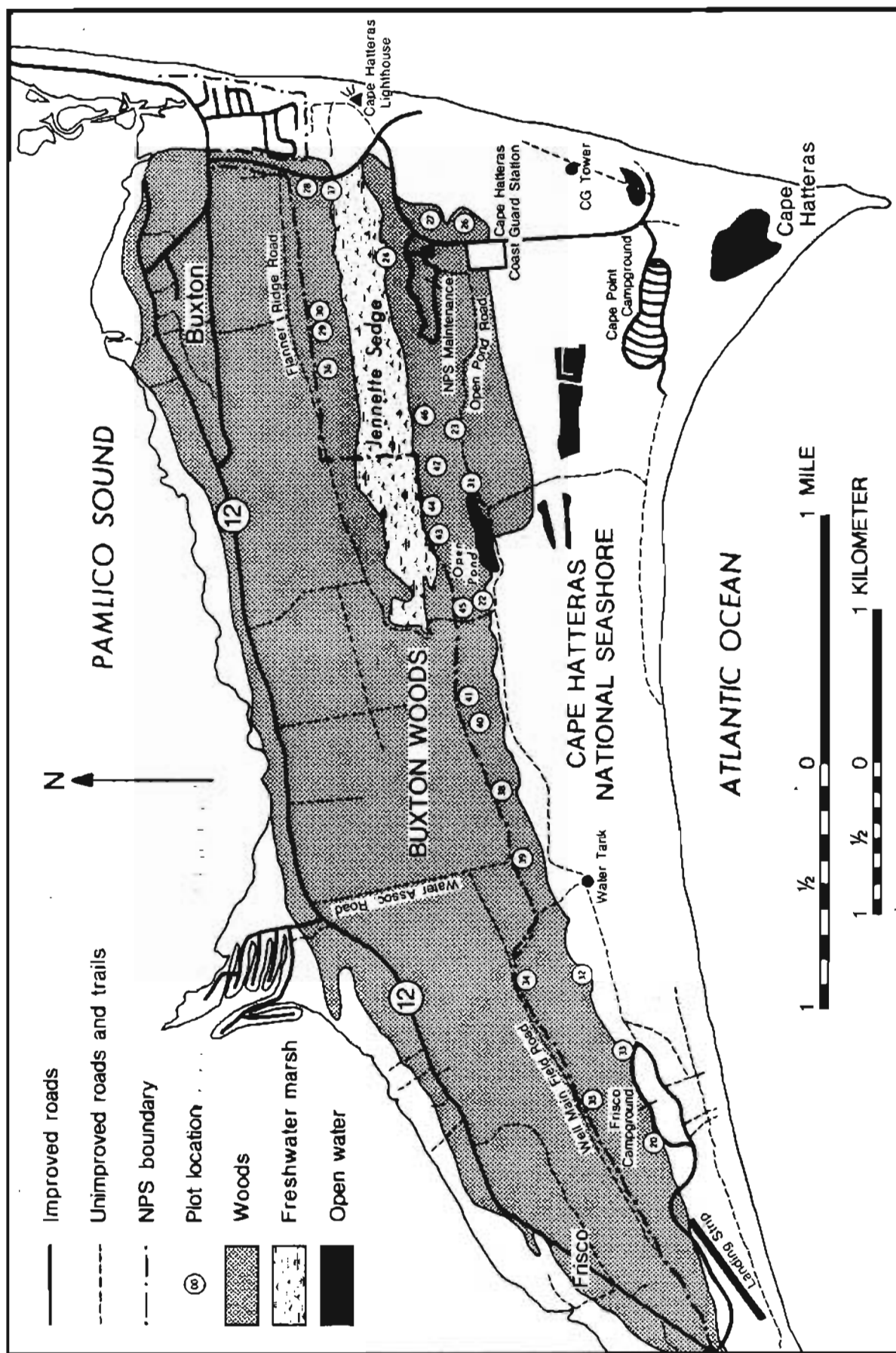


Figure 1: A map of Buxton Woods showing the locations of sample plots.

diameter and recorded as sound or rotten. Downed woody fuel biomass for the three smallest size classes was calculated from the combination of mean wood density values with the fuel volume estimate derived of the intersect tallies by the formula:

$$\text{BIOMASS} = ((N_i * \pi^2 * D_i^2) / 8L) * \text{WD}$$

where N_i is the number of twigs in size class i ; D_i is the geometric mean diameter of size class i ; L is the length of the transect (2 m) and WD is the mean wood density. Geometric mean diameters and mean densities used are presented in Table 1. Thousand hour fuel biomass is calculated by the formula:

$$((\pi D_i)^2 / 8L) * \text{WD}$$

where D_i is the diameter measurement of the individual logs, WD is the mean wood density; and L is the length of the transect (30 meters). Thousand-hour fuels were predominately fallen pines; therefore, the woody densities of sound pine (0.53 gm/cm^3) and of rotten pine (0.50 gm/cm^3) were used to estimate biomass of this class.

Within each plot, four litter and humus samples were collected from areas of 0.05 square meter, and placed in labeled paper bags. Depths of litter and humus, percent of litter that was pine needles, percent canopy closure, height to the lowest canopy branches, and heights of herb and shrub layers were recorded at each sample. Litter and humus were used to calculate densities that were averaged across the four subsamples to yield a single value per plot. Average dry weights of litter and humus were also used to yield a standing crop biomass of litter and humus for each plot.

All computations were done by SAS programs (Statistical Analysis System 1982) or by Ordiflex of Cornell Ecological Programs (Gauch 1972).

The northern park boundary, which extends approximately 10 km from the Lighthouse Entrance Road west to the intersection of Highway 12, was surveyed for species dominance using the Bitterlich method (Grosenbough 1952). A Spiegel relascope was used to tally by species in a 360° sample at 97 points spaced 100 meters apart. Proximity of private structures, swales and ridges, and locations of brass boundary markers were also noted. Point samples were also taken in several of the plots to obtain a relative estimate of sampling accuracy.

A base map of the Buxton Woods area was constructed from a tracing of the reflected and enlarged image of the U.S. Geological Survey 7.5 minute topographic plats of Buxton and Cape Hatteras, N.C., using a Kargel reflective projector. Images of the aerial infrared photos were

RESULTS

Forested Cover Types

Canopy basal area data were initially subjected to Principal Components Ordination in an attempt to objectively order plots into community types. Loblolly pine was so dominant, its distribution almost completely determined the axes of the ordination giving unsatisfactory results. A polar ordination was then applied which clearly separated six major stand types (Figure 2). Two plots among the twenty-five were substantially different in species composition and physiognomy from the types into which they fell by this ordination. This difference was not discriminated by the ordination because the majority of basal area within these plots was represented by pine and laurel oak. This seventh type was designated as swamp and is described among the successional pine/hardwood types.

Scrub types

Live oak scrub formed the naturally regenerating successional forest established on former dunes. This forest had a low profile, not exceeding 11 meters, and was more commonly 9 meters or less in height. The "canopy" trees were clumped and wind-formed, interspersed through areas of grass and bare sand. The lowest branches of the canopy often met the ground at the periphery of each clump, forming a dome of densely branched limbs and foliage. The interior of the domes was heavily shaded, and undergrowth was predominantly oak and other hardwood species. The grassy, open areas around the trees harbored a relatively high diversity of herb species. Because of these two distinct micro-environments, live oak scrub had the highest overall species diversity of the communities studies. Herb cover averaged 23%, woody species averaged 55%, and the remaining ground cover was bare sand (Tables 2 & 3).

Live oak (*Quercus virginiana*) was the dominant tree species, followed by laurel oak (*Q. laurifolia*). In the two stands sampled, 85% of the basal area was oak. Pine was locally abundant in areas where plantings had become established stands. Red cedar (*Juniperus virginiana*) was of variable importance. Bayberry (*Myrica cerifera*) was present as occasional small trees, and consistently present within the shrub layer. Species more frequently encountered in the better developed interior forests were also present in low densities (Table 4).

Although the largest scrub oak sampled was 50+ years old, most of the scrub oaks were the

same age as the surrounding pines, 20-45 years. Standing dead trees were predominantly small hardwoods, 2.5-5.0 cm dbh. Species represented among the standing dead trees were also well represented in the shrub layer and as small trees. Old aerial photos, and photos taken from the Lighthouse indicated that the scrub has expanded within the southeast corner of Cape Hatteras.

Pine types

Pine plantations have been established in some of the open sand flats and dune areas. These forests are young, dating from Civilian Conservation Corps plantings in the 1930's to more recent plantings in the 1960's. There was little in the canopy besides closely set pines which comprised 85% of the basal area. Hardwoods were of the same age or younger than the pines and reflected the topography in species composition. Red bay (*Persea borbonia*) was the dominant hardwood in low lying, mesic areas. Live oak was the most common hardwood in more xeric sites, although it was consistently present throughout this forest type (Table 4).

Pine trees within the size category of 5-15 cm dbh size category were most heavily represented by standing dead or leaning trees within the densely planted area sampled in plot 23. Plots 31 and 46 had little to no standing dead pine. However, these plots had few to no pines smaller than 15 cm dbh, and none contained pines smaller than 5 cm dbh. The standing dead hardwood within plot 31 was predominately bayberry. This species was observed to be declining, the larger specimens dead or dying, as canopy closure was more complete, especially in maturing pine stands.

Woody species cover averaged 30% dominated by hardwood shrubs in the interior plantation plots (23 and 31), and by summer grape (*Vitis aestivalis*) on the ridge (plot 46). Pine seedlings were most numerous under this forest type (1.69 seedlings/m²), were rare under mature pine (0.12 seedlings/m²), were rare under hardwoods and successional pine/mixed hardwoods, (0.03 seedlings/m²) in both these types. A variety of vines were encountered in low densities (Table 2). New shoots of cat-brier (*Smilax bona-nox*) were heavily browsed in plots 23 and 31, presumably by deer.

Herb cover also varied with topography and canopy openness, but did not exceed 15%. Areas of high pine density had deep litter, a closed canopy, and consequently a nearly nonexistent herb layer. This is best represented by plot 23. Herbs under pines planted along dune ridges were mostly grasses, similar to those found on open dune ridges and live oak scrub. The canopy of planted pines in low lying areas was often broken adjacent to small marshes. These areas supported ferns and sparse grasses under the pines (Table 3).

Pine/ironwood included one swamp plot (35) and three ridge plots (30,39,20). These plots had relatively high ironwood basal areas averaging $6.51 \text{ m}^2/\text{ha}$. Other hardwoods were present in variable amounts, and as a whole, dominated these plots. Pine was also of variable importance ($6.3\text{-}14.6 \text{ m}^2/\text{ha}$) which was the major distinction between this type and the hardwood forest type where the basal area of pine did not exceed $2.5 \text{ m}^2/\text{ha}$.

Pine/live oak also included one swamp plot (37) and one ridge plot (38). These plots contained large relict live oak trees (26-60 cm dbh), but few small live oak saplings or sprouts. Live oaks of this size were infrequent in Buxton Woods. Trees coming up through the understory and shrub layer were primarily laurel oaks and red bays. Plot 38 had a high basal area of pine ($25.6 \text{ m}^2/\text{ha}$) as was previously described, but was included among the successional types because of the strong presence of laurel and live oak.

Shrub and herb ground cover were essentially no different than from that of hardwood forest in species composition. Shrub cover was less dense (28% as compared to 41%) and was dominated more by red bay saplings than by yaupon shrubs.

Swamp forest occurred in the low-lying swales behind the ancient dunes. This forest type was unique in the number of exclusive species in all strata, and in the more overlapping form of the forest strata. Tree species such as red maple (*Acer rubrum*), willow (*Salix caroliniana*), swamp dogwood (*Cornus stricta*), and swamp bay (*Persea palustris*) were found only in swamps. Persimmon (*Diospyros virginiana*), red bay and bayberry were also common. In general, swamps were diverse, with dominance shared more equally among the species than in other forest types. Species common in hardwood forests were also present in variable amounts. The canopy of swamp forest had two layers with scattered pines, occasional live and laurel oaks, and red bays overtopping and understory of bayberry, swamp dogwood, willow and maple. The understory was continuous with both the canopy and shrub layer and was densely covered and intermixed with vines, especially catbrier and rattan vine (*Berchemia scandens*). Swamp forest graded into shrub marsh as topography fell, and into pine/mixed hardwoods as it rose in sharp zonation. Shrub marsh was of identical species composition to the swamp forest understory and was mapped as this type where the shrubs were higher than two meters.

Herb cover under swamp forest varied with canopy closure. Plot 37 was sampled from the shrub marsh to the ridge to record the wide variety of species along the topographic gradient. The first third of the line had four to 30 centimeters standing water and little to no canopy. Shrubs of red maple and willow were sparse through this zone, and sawgrass (*Cladium jamaicense*), giant foxtail (*Setaria magna*) and knotweed (*Polygonum punctatum*) were the dominant herbs. As the

Mixed mature hardwood forest was dominated by laurel oak (averaging 12.6 m²/ha) and occurred primarily on ridges. This was the most limited forest type in Buxton Woods, and most of the type lies within the privately owned lands. Mature hardwood ridges within the federally owned property were preferred recreational areas for local visitors, and consequently were often sites of major foot trails. The site of plot 42 was the only area located within the park having a stand of mature hardwoods not disturbed by trails or clearings. Pines near this area were between 40 and 60 years old, in a size range of 45-66 cm dbh. Other hardwood trees, especially dogwoods, ironwoods and hollies, were larger at this site than were commonly found throughout the Woods. The trees were more widely spaced so that total basal area of this plot was similar to that of the other hardwood forest samples (Table 11). For mapping purposes, all forest dominated by laurel oak was mapped as mature mixed hardwoods, although most of these areas were not as mature as the site of plot 42.

Shrub cover under hardwood forest was mostly yaupon with patches of red bay saplings. Vine cover was principally poison ivy (*Rhus radicans*), which carpeted the ground in certain areas under deciduous and evergreen border forests. Heavy vines of poison ivy and grapes (*Vitis* spp.) were more common in hardwood forests than in the other forest types. Other shrub and vine species common to the rest of Buxton Woods were present in low levels (Table 12).

Herb cover varied again with canopy openness, and was most developed under deciduous forest. Grasses and partridge berry (*Mitchella repens*) were the most abundant herbaceous species (Table 13).

Unforested Cover Types

These types were not sampled in this study, but were interpreted from aerial photos and field observations. Cover types in areas adjacent to the study area were taken from the Cape Hatteras Quadrangle Vegetation Map, drawn by the Cartography Laboratory of the North Carolina State University School of Forest Resources (Dec., 1984). A brief description of these types from that study is provided below.

Marshes and ponds

The marshes and ponds within Buxton Woods, of which Jeanette Sedge is the largest, were interpreted as one of three vegetation types. Open water included all such areas of salt, brackish and fresh water over which vegetation covered less than 1/3 of the area. Salt marsh included all emergent graminoid (grasses, sedges and rushes) and salt pan communities along Pamlico Sound.

(*Ipomoea saginata*) were common. species diversity increases with increasing distance from the ocean.

Bare sand described areas generally devoid of vegetation (0-15% cover) occurring primarily on the ocean and inlet shores. Pioneer species included sea rocket, dune spurge (*Euphorbia polygonifolia*) and sea oats. The few plants that were able to colonize the berm were often grouped around piles of debris, and were usually temporary depending on the frequency of storms.

Developed land

Developed land described areas where the density of homes was too great to show them individually. Piers, trailer parks, private campgrounds, Coast Guard Stations and complexes of motel/hotels were also labeled as developed land.

Fuel Characteristics and Classification

Average litter and humus bulk densities, and litter, humus and downed woody fuel standing crop estimates are presented by community in Tables 14-17. Analysis of variance of fuels data found no significant differences ($p > F = 0.35$) in humus weight among forest types, but differences in litter weights were significant ($p > F = 0.05$). The mature pine and planted pine forest types had 85% and 112% more litter, respectively, than did mature hardwoods. The successional forest types of pine/live oak, pine/ironwood, and live oak scrub all had litter weights within 90% of those of mature pine stands. Significant differences between forest types for downed woody fuels of any size could not be obtained using ANOVA. Type totals, however, indicate that live oak scrub lacks the larger (100- and 1000-hour) fuels. This is consistent with field observations. Mature pine had more 1000-hour fuels than other types, 1441 gm/m², as opposed to 150 gm/m² in planted pine. The total average fuel weight for mature pine was 87% greater than that of planted pine, 80% greater than that of mature hardwoods, and 114% greater than that of live oak scrub. The total basal area of pine in a stand gives a significant ($p > F = 0.05$) regression, with total fuel weight:

$$\text{Fuel (gm/m}^2\text{)} = 40 * (\text{basal area of pine m}^2\text{/ha}) + 1878$$

The eighteen vegetation cover types described in the Vegetation Map of Buxton Woods were each assigned to one of five fuel models according to dominant species, fuel loadings and community physiognomy. These models were developed for communities dissimilar to those of Buxton Woods in some aspects, and in most cases overestimated fire danger. Bare sand, open

aerial portion of the plants was dead. This fuel model, however, usually overestimates available fuel at Cape Hatteras, and may greatly overestimate dead materials. Marsh fuels are very patchy and will probably carry a fire for substantial distances only during dry or windy condition.

Fuel Model A. This model was applied to the dry dune grassland, and the two shrub savannah types. The dominant vegetation was coarse perennial grasses, with shrubs covering less than two-thirds of the area. When exposed to wind and direct sunlight, these fuels dry out rapidly. Park records indicated that ignitions, primarily from campfires, were frequent in dune grassland. Because of the continuous stretches of dry, fine fuels, and ever-present winds, ignitions catch readily and spread quickly. This fuel model is usually employed for western annual grasslands, but is appropriate here.

Boundary Survey

The northern park boundary through Buxton Woods extends predominantly along ridges. Pine was dominant over most of the boundary. Of the 97 points samples, pine occurred at 95%, and was dominant ($\geq 30\%$ of total basal area) at 76%. Laurel oak, the most common hardwood, occurred at 8% of the sample points, dominating 20%. Other well-represented species included: red bay, ironwood, dogwood and holly. Species represented with less frequency included all those which were encountered in plot sampling, except red maple, squawbush huckleberry (*Vaccinium stamineum*), and shadbush (*Amelanchier canadensis*). Two species encountered in the point samples, which did not occur in the plots, were devil's walking stick (*Aralia spinosa*) and winged sumac (*Rhus copallina*). These species are indicative disturbance and often occur where the canopy has been opened, as would happen in trail clearing.

Private development was concentrated at the ends of the boundary. Flanner Ridge houses extended over the first kilometer west of the Lighthouse Entrance Road. Forest cover along the boundary in this segment was predominately hardwood ridge, although pine and swamp vegetation of higher fire danger lie within 50 meters north and south of the ridge, and many of the houses were surrounded by pines and areas of Fuel Model D. Frisco houses were among pine ridge and drained swamp. The vegetation surrounding these houses was of moderate fire danger, also being primarily Fuel Model D. One house lay between these two areas off the Well Main Field Road, where the boundary comes north to meet the road. This house was on a ridge, surrounded by hardwood forest of low fire danger, in Fuel Model R.

Point samples compared very well to estimates of species dominance given by plot sample across nine sites (Table 18). Tallies of trees multiplied by 1.15 gave good basal area estimates by

further disturbed the woods. Loblolly pine and laurel oak have since replaced live oak as dominants (Bratton and Davison 1985).

In addition to the disturbance history, the isolation and small size of Buxton Woods may be a large factor in its low plant species diversity. These woods west of Cape Hatteras lie further from the mainland than any other forest on the Outer Banks. Burk (1962) presented an extensive species list of plants occurring on the Outer Banks which complemented and expanded earlier floristic studies of the maritime forests of North Carolina, previously listed in the introduction. These studies indicated that the scattered island forests north and south of Buxton Woods contain greater numbers of species as the distance to the mainland becomes smaller. Among the tree species found north and south of Buxton, but not encountered in this study were Carolina laurel cherry (*Prunus caroliniana*), water oak (*Quercus nigra*), and sweet bay (*Magnolia virginiana*). *Prunus caroliniana*, *P. serotina*, and *Q. nigra* were found by Burk in Buxton Woods in 1961, and may still be present in small numbers, since this study did not include a systematic search for uncommon species.

The successional forests which have grown up around the Cape Hatteras Lighthouse and south of the woods may influence the growth and development of the forest interior to its edges. Photos taken from the lighthouse in the 1930's and maps completed prior to 1940 show the scalloped evergreen forest border in the same location (and general size), but extending from the north edge of Open Pond all the way to the Lighthouse Entrance Road. South of the Border forest were dunes and sand flats, nearly barren of vegetation. The present live oak scrub, plantation pine and the stands of pine south of the woods from the Frisco Water Tank east to Open Pond have all become established since 1930. As these stands mature and close, a barrier to wind and salt spray will be formed adjacent to the evergreen border forest affording it better development. This process was well illustrated at the site of plot 42, a planted pine stand on a ridge adjacent to the interior forest. Both live and laurel oak were present; the largest trees of the latter species were found to be the same age as the pines in the stand. The interior forest adjacent to this site was of well developed mixed mature hardwoods to the northwest, and deciduous forest, dominated by large ironwoods to the northeast. The present height of the border forest hardwoods only slightly exceeds that of its protecting dune; future heights would not exceed that of the adjacent pines which also bore the marks of wind and salt damage. Larger live oaks, red bays and mulberries may thus become more common over the next fifty years, providing that a major storm does not remove the pioneer stands to the south of the border forest.

The majority of Buxton Woods was composed of the moderate fire-danger types, of swamp and pine forest. Fuel models O and D, selected to represent these communities were designed for pocosin and slash pine/gallberry/palmetto, respectively, and differed in some aspects from the types found in this study. Pocosin is a swamp community typically dominated by *Pinus serotina*, having

than adjacent pine dominated scrub, even during a fire swept by high winds on Cumberland Island Georgia. The fire, reaching the oak dominated forest as a crown fire simply went out as it came to the larger oaks (Davison 1984). Campground fires outside of the woods, therefore, present only a limited threat to Buxton Woods.

The last major fire in Buxton Woods spread from Jeanette Sedge, and although the cause was not recorded, it was probably man-induced. The continuous stretches of sawgrass along the Sedge and a connected stretch of marsh and swamp north of the Well Main Field Road are possibly the greatest fire threats to the Woods. The wetlands are an integral part of the woods and essentially connect every part. Dependent upon prevailing winds, a swamp fire could be extremely difficult to contain, and could threaten structures throughout the central portion of the island. Private property adjacent to the park boundary, especially those holdings with brush and pine litter surrounding the structures may be endangered by a crown fire through the pine communities. Fire breaks constructed along the boundary would be a prudent precautionary measure.

Fuel loadings of the various forest types in Buxton Woods were significantly correlated to the amount of pine in a given stand. This can be easily monitored over time, using the point sample method. This method was found to be a simple and very time efficient method of forest evaluation. The field equipment required for this type of sampling is light and inexpensive. A forest cruising prism may be used to periodically sample the woods (recommended 5-year intervals) and following major storms or other disturbance, to check pine dominance and potential fuel "hot spots". Coupled with litter depth measurements, this type of sample could be used to monitor changes in the forest fuels as succession progresses toward hardwood forest.

Although the maritime forest at Buxton Woods may never return to its pre-colonial state, management for hardwood succession is probably advantageous. This would serve to return the forest to a composition more similar to that of pre-colonial times, and would help to protect maritime hardwood forest, a limited resource. Replacement of pine by oaks and deciduous species would lower surface fuel loadings and reduce fire hazard. A hot fire that removed accumulated pine litter would kill young hardwoods and prepare the soil surface for further pine establishment. Any control burning, therefore, should consider its relative effects on young oaks and pines. As the pines age and die out, succession probably favors the hardwoods already established in the shrub layers.

TABLE 2. Percent ground cover of woody species in live oak scrub and planted pine forests.

TREE SPECIES	PLOT	PLANTED PINE			LIVE OAK SCRUB	
		31	23	46	26	27
<i>Pinus taeda</i>		1.2	0.8	0.3	0.3	0.2
<i>Persea borbonia</i>		7.7	2.0	0.4	1.0	0.1
<i>Myrica cerifera</i>		3.0	11.7	0.2	18.2	4.0
<i>Carpinus caroliniana</i>		0.6	1.1	0.1	7.5	
<i>Quercus laurifolia</i>			1.9	0.2	14.8	3.0
<i>Quercus virginiana</i>			2.8		6.4	30.0
<i>Ilex vomitoria</i>			0.6	0.1	1.2	0.1
<i>Juniperus virginiana</i>			0.2		2.8	7.7
<i>Vaccinium stamineum</i>		0.2	4.2			
<i>Ilex opaca</i>			0.1	0.2		
<i>Cornus florida</i>				0.1		
<i>Taxodium distichum</i>						0.1
SHRUB SPECIES						
<i>Hypericum hypericoides</i>		0.5	1.7		2.1	1.2
<i>Sabal minor</i>		0.1	0.1			
VINE SPECIES						
<i>Smilax bona-nox</i>		1.9	1.0	0.2	2.1	0.6
<i>Rhus radicans</i>		5.8	0.3	0.1		0.9
<i>Berchemia scandens</i>		1.2	0.4	0.1		0.4
<i>Ampelopsis arborea</i>		2.0		10.3	0.8	1.9
<i>Vitis rotundifolia</i>		1.9		0.6	1.0	1.0
<i>Parthenocissus quinquefolia</i>		4.0	0.4		0.3	
<i>Celsemium sempervirens</i>		0.7				
<i>Rubus</i> sp.		0.1				
<i>Vitis aestivalis</i>				19.5		
<i>Rhynchosia difformis</i>					0.5	
TOTAL		30.0	29.2	32.3	59.2	51.2

TABLE 4. Basal area (m²/ha) of tree species in planted pine and live oak scrub forests.

SPECIES	PLOT	PLANTED PINE			LIVE OAK SCRUB	
		31	23	46	26	27
<i>Pinus taeda</i>		24.19	33.34	23.90	0.22	0.34
<i>Quercus virginiana</i>		0.92	1.62	1.80	11.30	3.48
<i>Myrica cerifera</i>		1.46	1.12	0.95	0.08	0.08
<i>Persea borbonia</i>		3.66	0.15			0.01
<i>Quercus laurifolia</i>			0.27		2.94	3.02
<i>Juniperus virginiana</i>					0.04	2.28
<i>Carpinus caroliniana</i>		0.01			0.12	
<i>Ilex opaca</i>			0.01			
<i>Cornus florida</i>			0.02			
<i>Ilex vomitoria</i>		0.04	0.41			
<i>Vaccinium stamineum</i>		0.03				
<i>Rhus radicans</i>		0.92				
<i>Vitis rotundifolia</i>		0.04				
<i>Berchemia scandens</i>		0.04				
<i>Parthenocissus quinquefolia</i>						
<i>Vitis aestivalis</i>				0.10		
TOTAL		29.67	39.96		14.85	9.41
STANDING DEAD						
PINE		----	1.58	0.10	----	----
HARDWOOD		1.46	0.38	0.24	1.00	0.01
TOTAL		1.46	1.96	0.34	1.00	0.01

TABLE 6. Percent ground cover of woody species in secondary successional pine/mixed hardwood forest.

TREE SPECIES	PLOT	SWAMP		RIDGE			
		37	35	38	30	39	20
<i>Pinus taeda</i>		0.2					
<i>Persea</i> spp.		4.3	7.8	11.9	5.8	14.6	9.2
<i>Quercus laurifolia</i>		1.1	0.5	9.4	0.3	3.5	0.8
<i>Carpinus caroliniana</i>		0.3	0.6		5.6	0.3	0.9
<i>Ilex vomitoria</i>		14.9	6.8	4.9	1.4	5.3	14.1
<i>Ilex opaca</i>		0.2		2.2	5.7	0.9	1.3
<i>Vaccinium stamineum</i>			0.3	2.8			0.2
<i>Cornus florida</i>				1.1		0.2	1.8
<i>Myrica cerifera</i>		0.6	0.1	0.2			
<i>Quercus virginiana</i>		0.1		0.2			
<i>Osmanthus americana</i>						0.3	0.2
<i>Cornus stricta</i>		0.2	3.5				
<i>Acer rubrum</i>		2.0					
<i>Diospyros americana</i>		1.7					
SHRUB SPECIES							
<i>Callicarpa americana</i>				0.5	0.1	0.5	
<i>Sabal minor</i>			4.8				
<i>Hypericum hypericoides</i>		0.2					
VINE SPECIES							
<i>Rhus radicans</i>		12.6	1.5	10.3	4.9	15.7	11.3
<i>Smilax bona-nox</i>		0.8	1.3	0.5	2.0	6.3	1.1
<i>Parthenocissus quinquefolia</i>		1.0	0.5	0.7	2.6	0.2	1.0
<i>Vitis rotundifolia</i>		0.5	0.2	1.7	0.3	0.9	0.9
<i>Gelsemium sempervirens</i>		0.2	0.2	0.6	0.8	1.0	
<i>Berchemia scandens</i>		0.1	1.4				
<i>Ampelopsis arborea</i>		0.4	2.5				
<i>Lonicera sempervirens</i>		0.3					
<i>Rhynchosia difformis</i>		2.2					
<i>Rosa palustris</i>		0.7					
<i>Rubus</i> sp.			0.9				
TOTAL		44.6	32.9	47.0	32.8	63.4	29.7

TABLE 8. Basal area (m²/ha) of tree species in pine forests.

SPECIES	PLOT	IMMATURE			MATURE				
		29	36	45	34	41	44	40	43
<i>Pinus taeda</i>		35.29	19.47	28.39	20.08	19.90	31.69	27.68	33.6
<i>Persea borbonia</i>		0.25	0.61	0.87	1.54	0.84	0.24	1.05	0.08
<i>Quercus laurifolia</i>		1.49	5.32	3.29	5.29	9.64	1.20	5.71	1.07
<i>Carpinus caroliniana</i>		1.79	2.51	0.70	2.43	0.08	1.19	1.08	1.87
<i>Cornus florida</i>		1.71	1.27	3.48	1.55	0.08	3.34	0.23	6.00
<i>Ilex opaca</i>		0.02	0.11	0.89	0.45	0.22	0.06	0.01	0.04
<i>Ilex vomitoria</i>		0.36	0.91	0.25	0.03	0.12	0.34	0.19	0.48
<i>Myrica cerifera</i>		0.71	0.46	0.17			0.06		0.05
<i>Vaccinium stamineum</i>		0.01							
<i>Persea palustris</i>							0.35		
<i>Osmanthus americana</i>								0.05	
<i>Parthenocissus quinquefolia</i>								0.01	
<i>Gelsemium sempervirens</i>								0.01	
TOTAL		41.61	30.63	38.04	31.37	30.88	38.47	36.02	43.23
STANDING DEAD									
PINE		3.04	0.00	0.43	0.00	0.00	0.67	0.00	0.00
HARDWOOD		1.31	2.51	1.15	0.72	1.71	4.01	0.98	0.36
TOTAL		4.35	2.51	1.15	0.72	1.71	4.68	0.98	0.36
Ave. pine dbh (cm)		18	17	30	31	32	34	37	38
pines/800 m ² plot		100	66	21	19	20	26	20	21

TABLE 10. Percent ground cover of herb species in pine forests.

SPECIES	PLOT	IMMATURE				MATURE			
		29	36	45	34	41	44	40	43
<i>Mitchella repens</i>			0.9	2.7	4.2	0.2		2.4	0.3
<i>Uniola laxa</i>			0.2	1.0	1.7	1.5		0.6	
<i>Panicum</i> spp.					1.3	0.2			
<i>Scleria triglomerata</i>						0.7		3.4	
<i>Carex</i> spp.					1.1				
<i>Galium</i> spp.					0.3				
<i>Elephantopus nudatus</i>					0.2				
Other grasses					0.2				
TOTAL		---	1.1	3.7	9.0	2.6	---	6.4	0.3

TABLE 12. Percent ground cover of woody species in hardwood forests.

	PLOTS	33	32	42	28	24	22
TREE SPECIES							
<i>Pinus taeda</i>				0.4	0.2		
<i>Ilex vomitoria</i>		62.0	44.5	5.0	25.4	27.7	5.5
<i>Persea borbonia</i>		7.6	2.3	12.4	4.0	2.1	1.6
<i>Quercus laurifolia</i>		0.3	1.0	2.8	2.6	14.5	1.5
<i>Carpinus caroliniana</i>		1.8	0.8	0.8	4.0	2.2	0.5
<i>Ilex opaca</i>		2.1	0.6	1.2	2.6	0.2	0.9
<i>Cornus florida</i>		0.3	0.2	0.4	0.2	2.5	1.1
<i>Vaccinium stamineum</i>					0.1	1.2	
<i>Myrica cerifera</i>					0.2		
<i>Juniperus virginiana</i>						0.2	
<i>Osmanthus americana</i>			0.2	0.1		0.2	
<i>Morus rubra</i>		0.7				0.2	
SHRUB SPECIES							
<i>Callicarpa americana</i>		0.2	2.0	0.3	0.1	0.2	0.2
<i>Euonymus americana</i>						0.2	
<i>Sabal minor</i>			0.1				
VINE SPECIES							
<i>Rhus radicans</i>		10.8	6.2	3.0	36.5	42.5	1.8
<i>Parthenocissus quinquefolia</i>		1.9	1.2	0.3	7.2	0.8	1.0
<i>Smilax bona-nox</i>		3.0	2.7	0.2	3.7	1.4	0.2
<i>Vitis rotundifolia</i>		0.2	0.4	0.6	3.1	0.8	0.6
<i>Gelsemium sempervirens</i>			0.1	0.7	0.9	0.6	
<i>Lonicera sempervirens</i>		0.2	0.7	0.1	1.1	2.4	0.1
<i>Berchemia scandens</i>				0.1			0.5
<i>Rhynchosia difformis</i>		1.0			0.2		
<i>Anisostichus capreolata</i>						0.7	
<i>Vitis aestivalis</i>		0.3					
TOTAL		42.4	63.0	28.7	89.2	98.8	15.5

TABLE 14. Fuel characteristics of primary successional forests.
(DWF = downed woody fuels)

PLOT	PLANTED PINE			LIVE OAK SCRUB		
	31	23	46	26	27	
STANDING CROP(GM/m ²)						
HUMUS	4825	4888	1676	1163	762	
LITTER	1187	1223	1012	1124	1670	
1 HOUR DWF	32	30	34	65	72	
10 HR DWF	354	79	130	95	80	
100 HR DWF	431	269	108	0	0	
1000 HR DWF	450	0	0	0	0	
BULK DENSITIES (GM/cm ³)						
LITTER	.0200	.0334	.0189	.0335	.0340	
HUMUS	.0652	.1111	.0419	.0306	.0293	

TABLE 16. Fuel characteristics of pine forests.
(DWF = downed woody fuels)

PLOT	IMMATURE		MATURE						
	29	36	48	34	41	44	40	43	
STANDING CROP(GM/m ²)									
HUMUS	4043	2958	4220	3445	6601	2762	4422	2440	
LITTER	1662	1160	1366	1720	979	945	1269	1371	
1 HOUR DWF	22	28	39	20	89	63	96	32	
10 HR DWF	191	180	265	282	428	254	287	185	
100 HR DWF	323	377	162	216	323	216	485	108	
1000 HR DWF	4465	4486	0	132	74	936	74	1363	
BULK DENSITIES (GM/cm ³)									
LITTER	.0334	.0212	.0112	.0447	.0310	.0128	.0226	.0243	
HUMUS	.0697	.0986	.0367	.0749	.0805	.0789	.0725	.0581	

TABLE 18. Comparison of point and plot sampling for relative species dominance.

SPECIES	PLOT	PLANTED PINE				PINE/HARDWOOD			
		23		31		38		30	
		PT	PLOT	PT	PLOT	PT	PLOT	PT	PLOT
<i>Pinus taeda</i>		27.55	33.90	12.65	24.19	26.97	25.55	12.63	14.65
<i>Quercus laurifolia</i>						6.88	6.35	2.30	1.42
<i>Persea borbonia</i>				4.59	3.66	1.15	0.81		
<i>Carpinus caroliniana</i>								9.18	6.64
<i>Cornus florida</i>								1.15	0.54
<i>Quercus virginiana</i>		2.30	1.62	1.15	0.92	1.15	5.08		
<i>Ilex vomitoria</i>									
<i>Ilex opaca</i>						0.53	0.40		
<i>Myrica cerifera</i>				2.30	1.46				
<i>Osmanthus americana</i>									
TOTAL		29.85	36.96	20.69	29.67	36.74	39.32	25.26	26.59

SPECIES	PLOT	PINE				HARDWOODS					
		36		41		28		24		22	
		PT	PLOT	PT	PLOT	PT	PLOT	PT	PLOT	PT	PLOT
<i>Pinus taeda</i>		29.84	19.47	18.36	19.90	2.30	2.03	1.13	2.02		
<i>Quercus laurifolia</i>		5.74	5.32	13.80	9.64	2.30	1.49	8.03	2.32	4.59	2.55
<i>Persea borbonia</i>		0.58	0.61			1.15	1.62			2.30	1.70
<i>Carpinus caroliniana</i>		5.16	2.51			10.33	7.94	16.07	14.82	6.89	9.87
<i>Cornus florida</i>		2.87	1.27			5.74	2.03	2.30	1.41	18.37	10.48
<i>Quercus virginiana</i>						2.30	3.60				
<i>Ilex vomitoria</i>						2.30	0.76	2.30	1.14		
TOTAL		44.19	29.18	32.16	30.88	26.42	20.73	29.85	22.60	32.05	26.27

LATIN NAME**COMMON NAME****FAMILY NAME****VINES (cont'd.)**

Rosa palustris Marshall
Smilax bona-nox L.
Vitis aestivalis Michaux
Vitis rotundifolia Michaux

Swamp Rose
Cathrier
Summer Grape
Muscadine Grape

ROSACEAE
SMILACACEAE
VITACEAE
VITACEAE

TABLE 20. (cont'd.)

FORBS

Solidago sempervirens L.
Solidago sp.
Spiranthes praecox (Walter) Watson
Stipulicida setacea Michaux
Thelypteris palustris Schott
Typha spp.

Seaside Goldenrod
 Goldenrod
 Ladies Tresses
 Bent-wort
 Marsh Fern
 Cat-tails

ASTERACEAE
 ASTERACEAE
 ORCHIDACEAE
 CARYOPHYLLACEAE
 ASPIADACEAE
 TYPHACEAE

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