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Relationships of Selected Soil Properties and Community Species Composition in Turkey Hill Wilderness Area in East Texas

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RELATIONSHIPS OF SELECTED SOIL PROPERTIES AND COMMUNITY SPECIES COMPOSITION IN TURKEY HILL WILDERNESS AREA IN EAST TEXAS'

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Abstract-Sixty-nine different stands within 15 different previously managed communities were sampled in what is now the Turkey Hill Wilderness of the Angelina National Forest. Within each stand, 0.04 ha plots were randomly located, and the height, diameter, crown class and species of each tree recorded. Soil samples were collected in two locations within each plot, and the soil type confirmed at plot center. Soil samples were analyzed for selected soil chemical and physical properties. Due to the low occurrence (less than 4 times) of some communities, only six community types were analyzed in-depth. Analysis of the vegetation and soil data using Cluster, Principle Component and Pearson's Correlation Analyses showed some relationships between vegetation communities, species and the soil properties. This information may be useful toward development of better understanding about plant community relationships.

INTRODUCTION

Designated wilderness areas within National Forests in the eastern United States were commonly established on forestlands that had been managed for a number of years. Since wilderness designation, these areas have had no management in the traditional forestry sense. They provide an excellent laboratory to observe and quantify successional trends and soil/vegetation relationships.

The region known as the Piney Woods of East Texas is dominated by pine, pine-hardwood and bottomland hardwood forests. Dominant tree species may include Loblolly pine (*Pinus taeda*), Shortleaf pine (*Pinus enchinata*), Longleaf pine (*Pinus palustris*), Sweetgum (*Liquidambar styraciflua*), a number of elms (*Ulmus* spp.) and a wide variety of oaks (*Quercus* spp.). These forests are found over a wide range of soil types and landforms.

The objective of this study was to correlate vegetation communities and species within them to selected soil chemical and physical properties.

METHODS

Using color IR aerial photographs (nominal scale 1 :1 5,840) the 2140 ha Turkey Hill Wilderness was delineated into 69 stands of apparently different communities. Randomly located 0.04 ha plots were established within each stand, and vegetative data (species, height, d.b.h.) were collected. Cluster analysis was used to group the 69 stands into 15 overstory community types. Because some of these communities were only found a few times (less than 4), only 6 (table 1) were used for further study. These six communities covered 1605 ha (75 percent of Turkey Hill Wilderness area).

In two corners of each plot, soils were sampled from each of the surface horizons and the first B horizon and composited by horizon. Various soil chemical physical and chemical parameters were analyzed (table 2). Soil data was converted to a weighted mean for the profile. A soil profile description was also made at each plot center and each soil was classified (table 3) using an established soils legend for the area (USDA SCS 1980).

Principle Component Analysis was used to identify which soil parameters accounted for the variability among communities. Pearson's correlation was performed to correlate soil parameters to a species relative importance within a community, using Relative Basal Area (RBS) as reflecting importance. All statistical tests were performed using SAS (SAS Institute 1990).

RESULTS

Because of the large number of correlations found, we reduced these to those with a correlation of positive or negative > 0.80 and a p-value of less than or equal 0.05 (table 4).

On the more mesic sites (loblolly pine-hardwood and hardwood communities), a variety of soil-hardwood species correlations were observed.

Those communities we classified as shortleaf pine had a large number of shortleaf pine correlations with soil parameters, while the loblolly pine sites and shortleaf pine-loblolly pine sites showed hardwood species correlations, but not with pines.

Those old loblolly pine sites that were decimated by the Southern Pine Beetle (SPB) showed a few insignificant dogwood and red maple correlations. Five of the six areas were found on fine-textured Ultisols (Cuthbert, Kirvin, Sacul soils), while the other was found on a loamy textured Ultisol (Lilbert soil) (table 2).

DISCUSSION

In the shortleaf pine communities, the measured soil parameters appear to have little effect on other species other than shortleaf pine. When site conditions become

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Table I-The vegetative communities, area, and number of plots found on Turkey Hill Wilderness Area

Cover type	Area	Number of plots
	ha	
Mixed hardwood'	*700*	*20*
P. taeda-hardwood[a]	*305*	*10*
P. taeda[a]	*214*	*7*
Pinus echinata[a]	*206*	6
No overstory[a]	*102*	6
P. echinata-P. *taeda*[a]	78	*4*
P. palustris-P. taeda	80	3
P. taeda-Liquidambar styraciflua	*76*	2
P. echinata-Quercus sp.	*50*	2
Q. alba-Q. pagoda	*14*	2
Q. falcata	80	1
Q. alba	*67*	2
Q. spp.	*91*	2
Fagus grandifolia -hardwood	*40*	1
Q. michauxii-Q. pagoda	*35*	1

'Only the communities in bold type were used for statistical analysis.

Table P-Selected soil chemical and physical parameters analyzed

Parameters		
pH	Manganese	Bulk density
Total nitrogen	iron	Texture (percent sand, silt, clay)
Extractable phosphorus	Nickel	Magnesium
Potassium	Zinc	Depth of horizons
Calcium	Organic matter	Copper
Available soil water holding capacity		

more mesic and lobloiiy pine becomes a co-dominant species, a few of the soil parameters have negatively correlated to sweetgum (table 4).

The iobiolly pine communities in this study appear to be climax white oak types. These sites will continue to reflect the successional pressure of white oak on the lobioily pine. Similar NIPL stands across the region should be expected to exhibit the same type of successional pressures.

A mixed iobiolly pine-hardwood community in this area has a number of soil parameters that favor the hardwood components. Loblolly pine on these sites (and on the loblolly pine sites above) have greater plasticity in site requirements, and is hence not highly correlated to any on the soil parameters we measured.

Table 3—Soils used in the correlations

Soil series	Taxonomic classification
Cuthbert	Clayey, mixed, thermic typic hapludults
Sacul	Clayey, mixed, thermic aquic hapludults
Kirvin	Clayey, mixed, thermic typic hapludults
Lilbert	Loamy, siliceous, thermic arenic plinthic paleudults
Woodtell	Fine, montmorillonitic, thermic vertic hapludults
Keltys	Coarse-loamy, siliceous, thermic aquic glossudalfs
Darco	Loamy, siliceous, thermic grossarenic paleudults
Tenaha	Loamy, siliceous, thermic arenic hapludults
Joiner	Siliceous, thermic psammentic paleustalfs
luka	Coarse-loamy, siliceous, acid, thermic aquic udifluvents
Rentzel	Loamy, siliceous, thermic arenic plinthaquic paleudults
Tuscosso	Fine, mixed, thermic, dystric fluvaquentic eutochrepts

Table 4-Correlations between soil properties and species' within communities. Species proceeded by a "–" have negative correlation with the soil property

Soil variable	No overstory	Shortleaf/ loblolly	Shortleaf	Loblolly	Loblolly/ hardwood	Hardwood
Slope				-R maple	R maple	-Elm
Sand (percent)			-Shortleaf	-Wh oak	Dogwd	SR oak
Silt (percent)			Shortleaf	Wh oak	Wh. oak	Bjk. oak
Clay (percent)			Shortleaf	Wh oak	Bk oak	
AWC			Post oak			Hickory
P			Shortleaf			Hickory
Na		-Swtgum				
K	-Dogwd					
Ca	R maple		Shortleaf	-Bk gum	-R maple	
Mg	-Dogwd	-Swtgum	Shortleaf	Wh oak	-R maple	
Ni	-Dogwd		Shortleaf	Wh oak		
Mn				Wh oak		
Fe	-R maple			Wh oak	Bk Gum	Hickory
cu				Wh oak		
Zn					-Beech	
Sb[b]	R maple		Shortleaf	Wh oak	Bjk oak	
PH						Mix
OM						-Oaks
TN[c]	-Dogwd		Shortleaf			Hickory

[a] R maple = *Acer rubrum*; Elm = *Ulmus* spp.; Shortleaf = *Pinus echinata;* Wh oak = *Quercus alba*; SR oak = Q. *falcata;* Dogwd = *Comus* florida; Bk oak = *Q. velutina*; Bjk oak = *Q. marilandica*; Hickory = *Carya* spp.; Swtgum = *Liquidambar styraciflua*; Bk gum = *Nyssa sylvatica*; Beech = *Fagus grandifolia;* Mix = large mix of hardwood species; Oaks = *Quercus* spp.
[b] Sb = Sum of bases.
[c] TN = Total nitrogen.

Table !&Occurrence of soil series by community type

Soil series	No overstory	Shortleaf/ loblolly	Shortleaf	Loblolly	Loblolly/ hardwood	Hardwood
Cuthbert	3				1	3
Sacul	1	2		2	1	2
Kirvin	1				1	3
Lilbert	1					1
Woodtell		1	3	3	1	7
Keltys		1		1	2	
Darco			2			
Tenaha			1		2	
Joiner				1		1
luka					1	
Rentzel					1	
Tuscosso						3

All but one of the pine beetle spots occurred on fine-textured Ultisols, not on other fine-textured soils in the study **area.** The other beetle site occurred on a loamy Ultisol (table 5). The lack of management on these sites, combined with the increased competition from hardwoods, may pre-dispose these sites to loblolly mortality from beetle outbreak. The low nutrient status of these soils may be an additional stress factor influencing beetle susceptibility.

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