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A New Technique of Site Selection for Hardwoods

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ABSTRACT. A problem foresters often face in establishing hardwood plantations is selecting proper sites for various species. Before planting, a forest manager should have confidence that a site is suitable for a particular species, and for investment planning he would like to have some idea of the site's potential productivity. This paper describes how to use a new technique of site selection for hardwoods that has recently been published by the Southern Forest Experiment Station.

In the past, accurate estimates of the growth potential of southern hardwoods on particular sites have been difficult and sometimes impossible to obtain. But with the technique described here and a copy of our recently published field guide (Baker and Broadfoot 1977), foresters can determine site index for any of eight hardwood species under practically any soil or site conditions that occur in the South. Soil series do not need to be identified and only a little knowledge about soils is necessary for using the method. Guidelines for improving sites are provided by the technique and, for cottonwood, estimates of potential volume at various ages can also be obtained.

The eight species for which the site evaluation technique can be used are cottonwood, sweetgum, sycamore, green ash, and Nuttall, water, willow, and cherrybark oaks. We shall use sycamore to illustrate how the method works, but first a little background information is essential.

Growth of hardwoods is dependent primarily on four major soil factors: (1) soil physical condition, (2) moisture availability during the growing season, (3) nutrient availability, and (4) aeration. Each of the major factors is subdivided into many soil-site properties that affect tree growth. The interaction of these properties within and among the major soil factors usually makes evaluation of a site a complex task.

The basis of our approach is the assumption that each of the major factors is responsible for a certain percentage of tree growth. In turn, the growth attributed to each major factor is the sum of contributions made by each of its soil-site properties.

HOW THE METHOD WORKS

In the field guide, we have assigned site-quality ratings (SQR's) to a range of soil-site conditions that would be likely to occur for each major soil factor (See table 1, the guide for sycamore). To obtain a site index for any of the eight species, examine the conditions of your area, compare them with the conditions listed for each soil-site

TABLE 1. Soil-site properties influencing the four major soil factors and thus sycamore growth.

Soil-site property	Soil-site condition and relative quality		
	Best	Medium	Poor
Factor 1. *Physical condition*			
Soil depth and presence of artificial or inherent pan	Deep soil (>4 feet); without pan [10][a]	Medium depth (2–4 feet), or a soil with a plowpan [5]	Shallow soil (<2 feet), or a soil with an inherent pan [–5]
Texture (in rooting zone)	Medium-textured; silty or loamy [8]	Coarse-textured; sandy [4]	Fine-textured; clayey [0]
Compaction (in surface foot)	No compaction; loose, porous, friable, bulk density < 1.4 g/cc [8]	Moderately compacted; firm, moderately tight, bulk density 1.4–1.7 g/cc [4]	Strongly compacted; tight, bulk density >1.7 g/cc [–2]
Structure (in rooting zone)	Granular; single-grained; massive (if sandy, loamy, or silty) [3]	Prismatic; blocky [1]	Massive (if clayey); platy [–3]
Past use and present cover	Undisturbed; near-virgin forest cover [3]	Moderate cultivation; cultivated <20 years, or open with grass [1]	Intensive cultivation; cultivated >20 years, or open and bare [0]
Factor 2. *Moisture availability during growing season*			
Water table depth	2–6′ [5]	1–2′; 7–10′ [2]	<1′ [Unsuitable]; >10′ [–5][a]
Artificial or inherent pans	No pans [5]	Plowpan [2]	Inherent pan [–5]
Topographic position	Floodplain or stream bottom [2]	Stream terraces or lower slopes [1]	Upland [–2]
Structure (in rooting zone)	Granular; massive (if silty, loamy, or clayey); stratified [1]	Prismatic; blocky [0]	Massive (if sandy); platy; single-grained [–1]
Microsite	Concave; depression, pocket, trough [2]	Level; flat [1]	Convex; ridge, mound [–2]
Texture (in rooting zone)	Silty or loamy (or stratified) [1]	Clayey [0]	Sandy [–1]
Flooding	Winter through spring [3]	Winter only [1]	None [–5]; Continuous [Unsuitable]
Past use and present cover	Undisturbed; near-virgin forest cover [1]	Moderate cultivation; cultivated <10 years [0]	Intensive cultivation; cultivated >10 years [–1]

TABLE 1. *(Continued)*

Soil-site property	Soil-site condition and relative quality		
	Best	Medium	Poor
Factor 3. *Nutrient availability*			
Geologic source	Mississippi River, Loess, Blackland [12]	Mixed Coastal Plain and other [8]	Coastal Plain [3]
Past use and present cover	Undisturbed; near-virgin, forest cover, cultivated <5 years [10]	Moderate cultivation; cultivated 5–10 years, or open with grass [6][c]	Intensive cultivation; cultivated >10 years, or open and bare [2][c]
Organic matter (A-horizon)	>2% [6]	1–2% [3]	<1% [0]
Depth of topsoil (A-horizon)	>6" or no profile development [6]	3–6" [2]	<3" [−4]
Soil age	Young, no profile development (Entisols) [4]	Medium, moderate profile development (Inceptisols) [2]	Old, well-developed profile, leached (Alfisols) [−1]
pH (in rooting zone)	5.5–7.5 [1]	4.5–5.5 or 7.6–8.5 [0]	<4.5 or >8.5 [−1]
Factor 4. *Aeration*			
Soil structure (in rooting zone)	Granular, porous; single-grained; or massive (if sandy, loamy, or silty) [7]	Prismatic; blocky [4]	Massive (if clayey); platy [−4]
Swampiness	Wet in winter only [10]	Wet January–July [8]	Waterlogged all year [Unsuitable]
Mottling	None to 18" depth [12]	None to 8" depth [10]	Mottled to surface [−5]
Soil color (A-horizon)	Black, brown, red [10]	Yellow, brownish-gray [8]	Gray [−5]

[a] *Each bracketed number indicates the site quality rating (SQR) of a particular soil-site condition.*

[b] *If the soil is a sand or loamy sand, then (−10).*

[c] *If cultural practices included annual fertilization, then [8].*

property for a particular species, and assign a rating to each property. Then merely add the SQR's.

For example, assume that a location to be evaluated is a recently abandoned old field in a Coastal Plain stream bottom that had been under moderate agronomic cropping with no fertilization for six years. The area is level and is subject to flooding during the winter only. The soil is a silt loam with moderate profile development, has an 8-inch A-horizon, and is granular in structure. The soil is deep, not compacted, and there are no pans. It is brown and mottled at 24 inches. A water table occurs at 5 feet during the growing season, pH is 5.0, and there is less than 1 percent organic matter in the A-horizon.

By assigning SQR's from the sycamore evaluation guide (Table 1), the site is evaluated as follows:

Major soil factors								
(1) Physical condition	SQR	(2) Moisture availability	SQR	(3) Nutrient availability	SQR	(4) Aeration	SQR
		Water table	5	Geologic source	3		
		Pans	5	Past use	6		
Soil depth and pans	10	Position	2	% organic matter	0	Structure	7
Texture	8	Structure	1	Topsoil	6	Swampiness	10
Compaction	8	Microsite	1	Soil age	2	Mottling	12
Structure	3	Texture	1	pH	0	Color	10
Past use	1	Flooding	1				
		Past use	0				
Total	30 ft.		16 ft.		17 ft.		39 ft.
(Total possible	(32 ft.)		(20 ft.)		(39 ft.)		(39 ft.)
						SITE INDEX =	102 ft.

This evaluation indicates that the site index for sycamore on this particular area is 102 feet at 50 years.

By comparing the values obtained for each major factor with the maximum values possible for an ideal site, we can determine which major factor limits growth. In the example, physical condition received 94 percent (30 of 32) of the points possible; moisture availability and aeration received 80 and 100 percent of the total points possible. Nutrient availability, however, received only 44 percent of its total possible points. Thus, a lack of nutrients would probably limit growth on this site, and fertilization might be used to improve the growth of sycamore.

WHEN IN DOUBT, ESTIMATE

A few hours of instruction from a soil scientist should enable any forester who is unfamiliar with soils to use the technique accurately. On the other hand, even the most experienced soil scientist will not always be able to determine a specific soil-site condition. Sometimes estimations will be necessary; but even a few inaccurate estimates probably will not cause serious errors in the final site quality rating.

Literature Cited

BAKER, JAMES B. and BROADFOOT, W. M. 1977. Site evaluation for eight important southern hardwoods, USDA For. Serv. Gen. Tech. Rep. SO-14. 31 p.

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