G3361

LAKE STATES WOODLANDS

Estimating and Interpreting Site Index

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How do you know if a site is suited for timber production, or if a species growing on a site will reach its full growth potential? How do you decide which timber stand has the best potential for investment and management?

Such questions are important because they have biological and economic implications for forest management. A site's capacity to grow trees is a major factor in determining stand productivity. Unfortunately, the questions above are often difficult to answer because a complex of factors including soil characteristics (texture, depth, fertility), water availability, slope, aspect and tree species determine site quality.

Foresters developed a concept called **site index** to simplify the process of forest stand evaluation and classification. For years, researchers have tried to develop a classification system superior to site index, but no alternative approach has gained the widespread acceptance of site index. Site index is not a perfect measure, but it is easy to estimate, easy to understand, and currently the standard approach that most foresters use to estimate site productivity.

Site index is the average height of dominant and codominant trees in a 50-year-old stand. For example, a site index of 70 indicates that the average tree height is 70 feet when the stand is 50 years old. During the same time period, good sites usually produce taller trees than do poor sites. Thus, the taller the trees at any given age, the higher the site index estimate.

Site index vanes according to tree species, geography and soils. Thus, foresters prepare site index curves for individual species or forest types within a specified geographical area.

Managers get the most accurate site index estimates from middle-aged dominant and codominant trees that were not suppressed or injured during their lifetime. Dominant trees have crowns that receive full, direct sunlight from the top and partly from the side; crowns of codominant trees receive direct light from only the top and comparatively little from the sides. Such trees grow in even-aged, fully stocked stands, such as plantations that have not been disturbed by past cutting, heavy grazing or repeated burning.

Although foresters developed the concept of site index for use in even-aged stands, it also can be used, if correctly applied, in uneven-aged stands. In uneven-aged stands, certain species are better candidates for measurement than others because they can survive only if growing free and unsuppressed. The beet species to measure include aspen, cottonwood, paper birch, jack pine and red pine. Because fire can repeatedly kill bur oak and white oak back to the ground during their early years, estimates derived from these species are less reliable. Hemlock and the maples are also less reliable because shade from an overstory can suppress their growth for prolonged periods.

Sometimes, you may want to know the site index of species not growing in a stand. In such cases, you may be able to estimate site index for another species and use that value to obtain the site index for the species of interest. Researchers have prepared various conversion charts to help you do this (Figure 1).

Estimating Site Index

For a sample, select from the stand at least five dominant or codominant trees of the species of interest. Measure the heights of the trees. For information on how to measure tree height, see UW-Extension bulletin G3332, *Lake States Woodlands: Measuring Trees and Estimating Volume.*

Next, determine tree age by felling the sample trees and counting the rings, by coring a standing tree with an increment borer—a hollow drill, or by consulting stand establishment records. If you count the rings on stumps, you need not add any additional years to each age estimate because the number of rings on a stump probably equals that tree's age.

If you use an increment borer, take a core at breast height (4.5 feet above ground level) from each tree for which you measured height. The reason for boring at breast height is that butt swell on most trees makes it difficult to reach the center. To estimate a tree's age, count the rings from the tree's center and add 3 to 10 years—the approximate number of years needed for the tree to grow 4.5 feet tall. The number of years to add is sometimes specified on site index curves.

Stand establishment records may be available from your forester or your own files. Such records work well for plantations, but can be inaccurate for natural stands.

After aging the trees, determine the optimum number of trees needed for a precise estimate. Stand size has little effect on the number of trees you need to sample. However, the more variable the slope, soil characteristics, species composition, or tree height, the more trees you

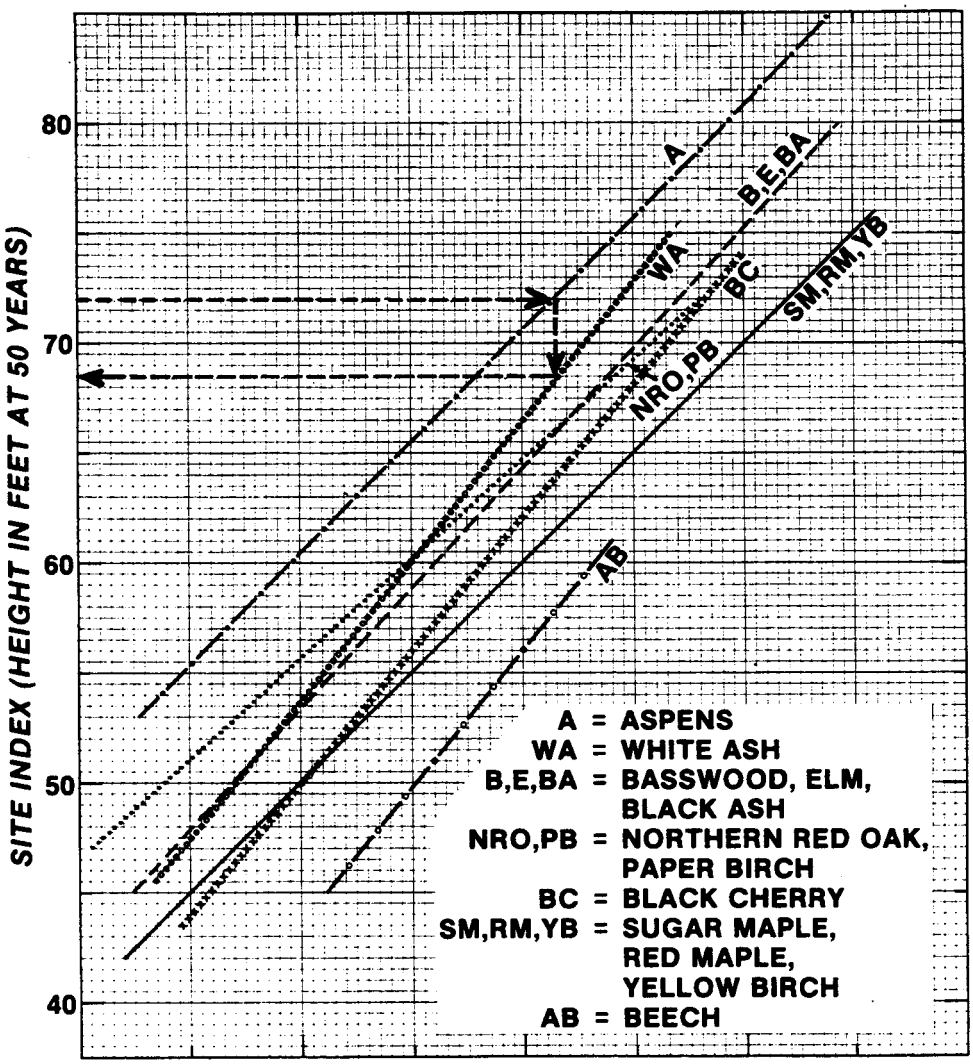

Figure 1. Site index comparison graphs for northern hardwood species in northern Wisconsin and Upper Michigan. You can use this graph to estimate site index for species absent from forest stands by using site-index estimates of tree species that are present. For example, suppose you would like to estimate the site index for white ash in a stand, but there are no white ash trees in that stand. However, suitable aspen trees are present and their average height and age measurements indicate that their site index is 72 (Carmean, 1978). So, on the graph, begin at 72 on the site-index scale and read right to the aspen line, then read straight down to the white ash line. Now read left to the site-index scale where you will find the estimated site index for white ash to be 68.5. You can also use the reverse of this procedure; for example, site index of 68.5 for white ash indicates a site index of 72 for aspen.

must measure to get a precise estimate. Here is an easy formula for calculating sample size:

$$n = 5 + (R^2/30)$$

where n is the number of trees you need to sample and R is the observed range of heights, or ages, in the stand. For example, assume that you measured the height of five trees and found a difference in height of six feet from the shortest to the tallest tree. Inserting that value into the formula yields n = 5 + 36/30, or n = 6. Because you already measured five trees, you should then find and measure one more to arrive at a reliable estimate.

Next, average both the height estimates and the age estimates. For example, assume that you measured six red pine trees with the following characteristics:

Tree #	Height (feet)	Age (years)
1	74	62
2	68	60
3	70	61
4	70	60
5	71	61
6	68	62

The average age then is 61 years; average height is 70 feet. Alternatively, you could determine site index for each sample tree—as in the following step—and then average these individual estimates.

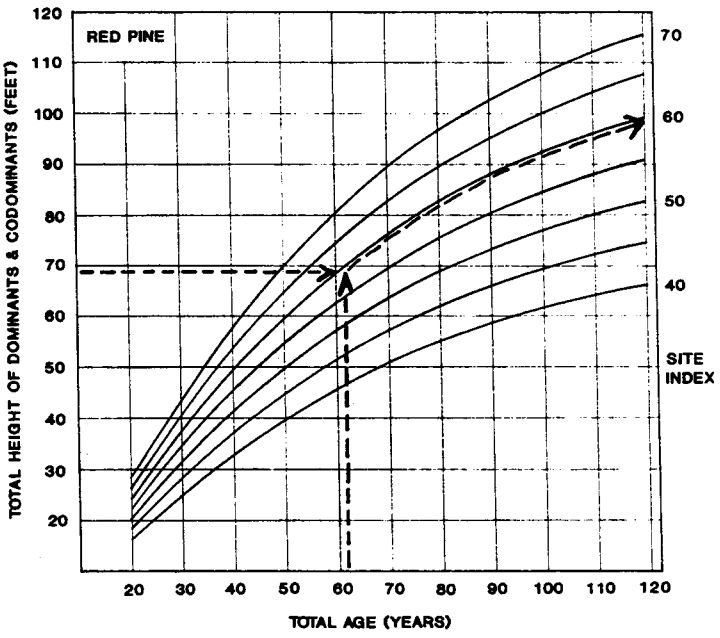

Figure 2. Site index curves for red pine.

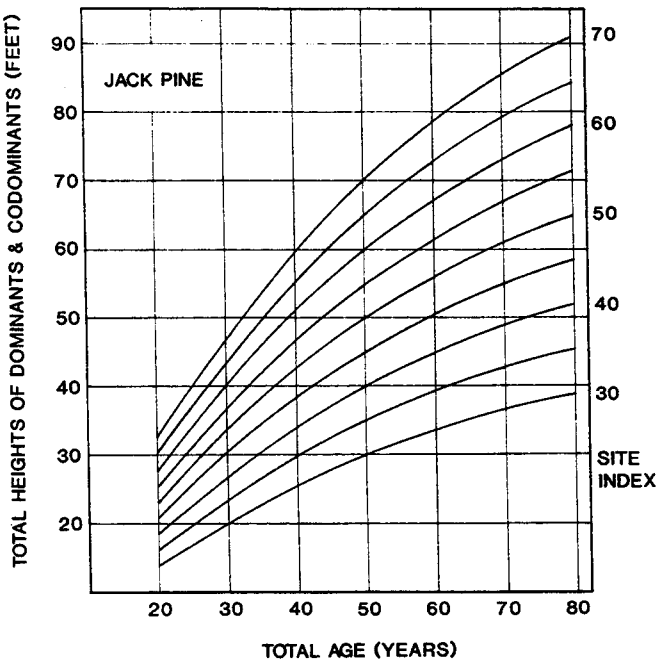

Figure 3. Site index curves for jack pine.

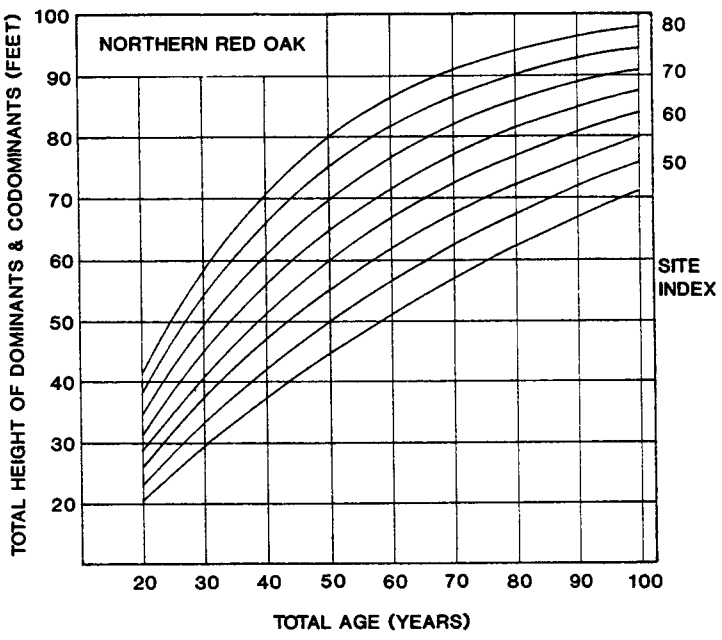

Figure 4. Site index curves for northern red oak.

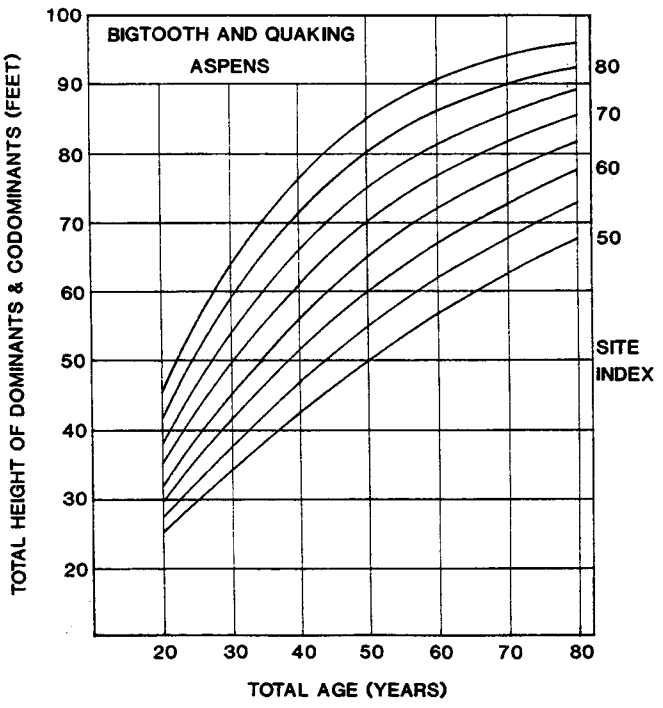

Figure 5. Site index curves for bigtooth and quaking aspen.

Finally, use the average values you calculated and the appropriate species curve to estimate site index. A large number of site index curves have been published and we reproduce some here (Figures 2-5). The list of references will help you find others.

For the example, look at the red pine graph. You can determine site index by drawing a vertical line up from the horizontal axis for the average age of the trees, and a horizontal line from the average height of your trees on the vertical axis. If the lines intersect on or near a curved line, follow the curved line over to the graph's right side. The number immediately next to that line is the site index value. If the lines intersect between two curved lines, interpolate to obtain site index. According to the graph, the example yields a site index of about 60.

An alternative method of calculating site index is to use published formulas instead of graphs. According to a formula published by Hahn and Carmean (1982), the site index for the above example is 62. To use this method most effectively, you need a programmable calculator or a computer. A

program for IBM (and compatible) microcomputers is available free from the Extension Forester, Department of Forestry, 1630 Linden Dr., UW-Madison, Madison, WI 53706. Just send in a blank, formatted diskette for a copy.

Interpreting Site Index Values

Foresters base some management decisions partially on site index values. Perhaps one of the most important uses for site index is determining which stands to manage. Because stands with high site indexes produce merchantable timber in a shorter time period than do stands with low site indexes, the former are more economical to manage. Not only do stands with high site indexes produce more wood, but the quality of the logs is generally better. Therefore, if you are choosing which stands to invest your money in, stands with high site indexes are the logical choice.

Another important use for site index is deciding whether you should plant or favor a certain species on a given stand, or if you should convert the stand to a different species. For example, consider how site index results can influence aspen stand management. According to the *Manager's Handbook for Aspen in the North Central States* (Perala, 1977), if the aspen site index in a stand is less than 60 and you want to produce timber, you should consider converting the stand to conifers. However, if the site index is 60 or greater, the stand is well suited to aspen timber management.

The situation is more complex for oaks. If the oak site index is 75 or greater and the stand is two-thirds or more in oak, you can manage the stand for oak successfully. If less than one-third of the stand is in oak, then other hardwoods eventually will take over the stand despite your efforts to the contrary. You might as well manage the stand for other hardwoods. If the oak site index is less than 75, but greater than 64, manage the stand for oaks, or a mixture of oak and other hardwoods. If the oak site index is between 55 and 64, manage for oak or a mixture of oak and pine; if below 55, either convert the stand to pine, or manage for objectives other than timber production.

With pines, managers use site index more for determining harvest age of a stand than for regulating species composition. For example, if the site index in a jack pine stand is 60 or greater, you can produce either pulpwood or poles and small sawtimber, depending on stocking density and other factors. If the site index is less than 60, the degree of risk of loss or injury from insects or diseases will affect harvest age. At low site index (or site quality), trees are less vigorous and more susceptible to attack by various pests. If such a stand is under high risk of attack, you should harvest it as soon as the stumpage is merchantable. If there is little or no risk of loss, you can let the stand mature.

Site index also indicates how likely you are to have difficulty regenerating the desired species. High site index values generally indicate that you need to work hard to control competing sod, shrubs and other trees when establishing new red pine stands.

Although site index values are relatively easy to calculate, at times they can be difficult to interpret and even more difficult to apply to management situations. Because of the great variety of stand and market conditions, always consult a professional forester for advice before making major management decisions.

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