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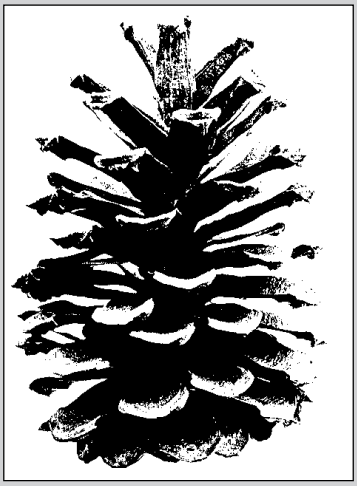
A Key to the Literature Presenting Site-Index and Dominant-Height-Growth Curves and Equations for Species in the Pacific Northwest and California

by

David W. Hann



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David W. Hann

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Introduction

This report is a summary of the site-index and dominant-height-growth curves and equations that have been developed and published for common tree species of California, Oregon, Washington, British Columbia, southeastern Alaska, Idaho, and western Montana. Site index is the total height of free-to-grow dominant (or, in some cases, dominant and codominant) trees in a stand at a prespecified base age. Because the height of dominant trees is relatively independent of stand density, site index has been widely used as a measure of site productivity.

A site-index curve/equation predicts site index from age (either total age, age from breast height, or recorded plantation age) and dominant height. A dominant-height-growth curve/equation predicts dominant height from age (either total, breast height, or plantation age) and site index. Depending upon the equation, the predictions of site index and/or dominant-height-growth can be for either individual tree values or an average value for the stand.

All of the early "site index" curves presented dominant height on the y-axis, age on the x-axis, and a different height-age curve for each site index; therefore, they were actually dominant-height-growth curves. To estimate the site index, the height-age pair for the tree or stand was located on the graph and the site index was determined by linearly interpolating between the two site-index values associated with the adjoining height-age curves.

Early developers of site-index equations took a similar approach; they developed a single equation that predicted dominant height as a function of age and site index, which was actually a dominant-height-growth equation rather than a site-index equation. To estimate site index, the dominant-height-growth equation was solved either algebraically or numerically to express site index as a function of age and dominant height.

Curtis, Herman and DeMars (1974) demonstrated that re-expressing a dominant-height-growth equation to predict site index produced different results than developing a second regression equation that directly predicted site index as a function of age and dominant height. Since then, many site-index studies have developed both a dominant-height-growth equation and a site-index equation. Therefore, to predict future dominant height of a tree or stand, site index is estimated from one equation, then entered, along with future age, into the dominant-height-growth equation to produce the desired prediction. One consequence of this approach is that if the site index—computed from the separate site-index equation using current actual dominant height and current age as independent variables—was entered into the dominant-height-growth equation along with current age, the predicted current dominant height would most likely be different from the actual current dominant height.

Methods of Constructing Site-Index and Dominant-Height-Growth Curves/Equations

There have been three general approaches used to develop site-index and dominant-height-growth curves/equations: the guide curve/equation method, the stem-analysis method, and the permanent-plot method.

The guide curve/equation method was extensively used for early growth and yield work in the United States. In this method, single pairs of height-age measurements are collected from a large number of independently sampled trees or stands. Each pair is plotted on graph paper with the x-axis being age and the y-axis being dominant height. A guide curve (or equation) is then drawn or fit by regression through these data. In most applications, this guide curve/equation is used to develop a proportional system of dominant-height-growth reference curves by multiplying the heights predicted from the guide curve/equation for each age by the ratio of the reference curve's site index divided by the guide curve/equation's site index. However, a few polymorphic systems of dominant-height-growth reference curves (e.g., Brickell 1968) have been developed from the guide curve/equation method by using the procedures of Osborne and Schumacher (1935).

In the stem-analysis method, a small sample of dominant (and perhaps codominant) trees (usually fewer than 100) is selected, felled, and sectioned at 4-to-8-foot (1.2-to-2.5-meter) intervals. The length and age of each section are measured. From these data, both the tree's site index and a detailed description of the tree's past height-growth rate can be determined for each tree sampled. These data can then be used to develop dominant-height-growth and site-index equations with regression analysis. The resulting equations can be either proportional or polymorphic in shape, however, most of the equations are generally polymorphic.

In the third method, observed trends of top height or dominant height are made on a number of long-term, remeasured permanent plots. With regression analysis, these data can then be used to develop a dominant-height-growth equation, which is either proportional or polymorphic in shape.

Monserud (1985a) used both the guide curve/equation method and the stem-analysis method to develop two sets of dominant-height-growth curves for Douglas-fir from northern Idaho and western Montana. His guide curves resembled those obtained by McArdle *et al.* (1961), Brickell (1968), and an unpublished study that also used the guide curve/equation method. Monserud also found that his stem-analysis curves were similar (but not equal) to those obtained by King (1966), Curtis *et al.* (1974), and Cochran (1979a). When he compared the curves from the guide curve/equation method to those from the stem-analysis method, however, he found the two to be greatly different. The guide curve/equation method predicted dominant heights that were too high below the base age and too low (and too flat) above the base age. Therefore, many of the site-index/dominant-height-growth curves developed with the guide curve/equation method are probably biased and their use should be looked upon skeptically.

Criteria for Including Publications in the Key

The two criteria used to select the publications for this report were:

1. The publication had to be available for use by the general public. This meant that it could be found in any well-furnished forestry library.
2. The parameters for the equations had to be included in the publication.

Many of the publications included in this key have received refereed peer review (i.e., they have been independently reviewed by other experts in the field). The practice of forestry has its basis in science, and a crucial element of the scientific method is the critical review of research results through the publications process. Refereed peer review should help to ensure that the equations are of reasonable form, that they were developed with statistically sound methods, and that they are statistically "significant." However, the user should be aware that errors do occur even in refereed publications, particularly in publications with many equations or with complicated equations. Inclusion of a publication in this key does not guarantee that it is error-free. Therefore, a user should critically evaluate any curve/equation before broad application.

How to Select an Appropriate Curve/Equation

Once it has been decided whether to predict site index and/or dominant-height growth, a person should select a curve/equation that was developed for the same population to which the equation is to be applied. Some of the attributes commonly used to define a population include tree species, geographic location, and the ranges in site quality and age found in the population. If the modeling (i.e., the curve/equation development) population and the application population do not match, then the user will have to explore whether any of the existing curves/equations can be safely extrapolated to the population of interest. Ideally, this should be done by collecting an independent data set and comparing predicted and actual values in order to validate the appropriateness of the equation for the new population. As a minimum, one should consider the following for selecting an appropriate equation/curve:

1. Examine equations for the same species from the nearest geographic area.
2. If no equations exist for a species, examine equations for other species with a similar dominant-height development form.
3. Graph the alternative equations over the full range of ages and site indices found in the application population, and examine the graphs for reasonableness of behavior—e.g., predicted dominant heights should not be negative, should increase monotonically (in a sigmoidal fashion) as age increases, and should increase

monotonically as site index increases; predicted site index should not be negative and, for a given age, should increase monotonically as dominant height increases, and for a given dominant height, should decrease monotonically as age increases.

4. Again, there is a strong likelihood that many of the site-index/dominant-height-growth curves developed with the guide curve/equation method are biased and should be used accordingly.

Using the Key

The key is organized by species, which are listed alphabetically by common name. Within a species, a separate listing is provided for each source of information. These sources are listed chronologically, and they provide the user with the following information:

1. "Reference" - This will provide the user with the means of finding the full citation in the Literature Cited section at the end of the publication.
2. "Modeling approach" - These include:
    a. Graphical analysis in which a guide curve fitted to data from single measurements of height and age on each tree/plot.
    b. Regression analysis in which a guide equation is fitted to data from single measurements of height and age on each tree/plot.
    c. Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot.
    d. Regression analysis in which data from permanent plots are used to provide multiple measurements of height and age on each plot.
3. "Types of curves/equations" - These can be site-index and/or dominant-height-growth curves/equations. Resulting predictions can be in either English or metric units.
4. "Base age used in curves/equations" - This is the reference age for determining site index. Common base ages are 50 and 100 years.
5. "Type of age used in curves/equations" - Age can be expressed as either a total or a breast-height age, in years.
6. "Geographic location of sample" - This attribute helps to define the population sampled during the development of the equation(s). Application of the equation(s) outside this area is an extrapolation of the equation(s). Therefore, the user should critically evaluate the equation(s) before applying beyond this geographic area.
7. "Number of trees/plots sampled" - This attribute indicates the strength of the data set used to develop the equation(s). In general, the larger the number of trees/plots sampled, the more likely the resulting equation(s) will adequately characterize the intended population.

8. "Range in age of sample" - This attribute helps to define the population sampled in the development of the equation(s). Application of the equations outside this range in age is an extrapolation of the equation(s). Therefore, the user should critically evaluate the equation(s) before applying beyond this range.
9. "Range in site index of sample" - This attribute helps to define the population sampled during the development of the equation(s). Application of the equation(s) outside this range in site index is an extrapolation of the equation(s). Therefore, the user should critically evaluate the equation(s) before applying beyond this range.

Site-Index and Dominant-Height-Growth Curves and Equations

California red fir, *Abies magnifica* A. Murr.

Reference: Schumacher (1928)

Modeling approach: Graphical analysis in which a guide curve is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth curves in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Total age
Geographic location of sample: Northern California
Number of trees/plots sampled: 149 plots
Range in age of sample: 20–60 years
Range in site index of sample: 30–170 feet

Reference: Dolph (1991)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth equation in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Southwestern Oregon and northern California
Number of trees/plots sampled: 1 tree/plot on 194 plots
Range in age of sample: 10–120 years
Range in site index of sample: 30–95 feet

California black oak, *Quercus kelloggii* Newb.

Reference: Powers (1972)

Modeling approach: Regression analysis in which five guide equations are fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Site-index equation in English units
Base age used in curves/equations: 50 years

Type of age used in curves/equations: Breast height age
Geographic location of sample: Northern California
Number of trees/plots sampled: 82 plots
Range in age of sample: Not available
Range in site index of sample: 37–65 feet

Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco

Reference: McArdle and Meyer (1930), McArdle *et al*. (1961)

Modeling approach: Graphical analysis in which a guide curve is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth curves in English units
Base age used in curves/equations: 100 years
Type of age used in curves/equations: Total age
Geographic location of sample: Western Washington and northwestern Oregon
Number of trees/plots sampled: 245 plots
Range in age of sample: 20–180 years
Range in site index of sample: 85–215 feet

Reference: Schumacher (1930)

Modeling approach: Graphical analysis in which a guide curve is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth curves in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Total age
Geographic location of sample: Northern California
Number of trees/plots sampled: 159 plots
Range in age of sample: 30–170 years
Range in site index of sample: Not available

Reference: King (1966)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth equation in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Western Washington
Number of trees/plots sampled: 10 trees per plot on 85 plots
Range in age of sample: 28–135 years
Range in site index of sample: 60–150 feet

Reference: Brickell (1968)

Modeling approach: Regression analysis in which a guide equation is fitted to data from single measurements of height and age on each tree/plot

Types of curves/equations:

1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years

Type of age used in curves/equations: Total age

Geographic location of sample: Idaho, western Montana, Wyoming, Utah, and Colorado

Number of trees/plots sampled: 3183 trees

Range in age of sample: 20–200 years

Range in site index of sample: Not available

Reference: Curtis *et al*. (1974), DeMars and Herman (1987)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot

Types of curves/equations:

1. Dominant-height-growth equation in English units
2. Site-index equation in English units
3. Dominant-height-growth equation in metric units
4. Site-index equation in metric units

Base age used in curves/equations: 100 years

Type of age used in curves/equations: Breast height age

Geographic location of sample: Cascade Range from Stevens Pass to McKenzie Pass

Number of trees/plots sampled: 52 trees

Range in age of sample: 10–400 years

Range in site index of sample: 60–150 feet

Reference: Cochran (1979a)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot

Types of curves/equations:

1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years

Type of age used in curves/equations: Breast height age

Geographic location of sample: Eastern Washington and eastern Oregon

Number of trees/plots sampled: 3–5 trees per plot on 32 plots

Range in age of sample: 10–100 years

Range in site index of sample: 53–106 feet

Reference: Bruce (1981)

Modeling approach: Regression analysis in which data from permanent plots are used to provide multiple measurements of height and age on each plot

Types of curves/equations: Dominant-height-growth equation in English units

Base age used in curves/equations: 50 years

Type of age used in curves/equations: Breast height age

Geographic location of sample: Southwestern British Columbia, western Washington, and northwestern Oregon

Number of trees/plots sampled: Not available
Range in age of sample: Not available
Range in site index of sample: Not available

Reference: Monserud (1984, 1985b)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units
3. Dominant-height-growth equation in metric units
4. Site-index equation in metric units

Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Northern Idaho and western Montana
Number of trees/plots sampled: 349 trees on 135 plots
Range in age of sample: 5–200 years
Range in site index of sample: 28–100 feet

Reference: Means and Helm (1985)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units
3. Dominant-height-growth equation in metric units
4. Site-index equation in metric units

Base age used in curves/equations: 100 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Dry sites on the Willamette National Forest
Number of trees/plots sampled: 27 trees
Range in age of sample: 10–280 years
Range in site index of sample: 90–160 feet

Reference: Hann and Scrivani (1987)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Southwestern Oregon
Number of trees/plots sampled: 89 trees
Range in age of sample: 10–136 years
Range in site index of sample: 66–140 feet

Reference: Means and Sabin (1989)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot

Types of curves/equations:

1. Dominant-height-growth equation in English units
2. Site-index equation in English units
3. Dominant-height-growth equation in metric units
4. Site-index equation in metric units

Base age used in curves/equations: 50 years

Type of age used in curves/equations: Breast height age

Geographic location of sample: Siuslaw National Forest

Number of trees/plots sampled: 55 trees

Range in age of sample: 10–120 years

Range in site index of sample: 95–162 feet

Reference: Thrower and Goudie (1992)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot

Types of curves/equations:

1. Dominant-height-growth equation in metric units
2. Site-index equation in metric units

Base age used in curves/equations: 50 years

Type of age used in curves/equations: Breast height age

Geographic location of sample: Interior British Columbia

Number of trees/plots sampled: 262 trees from 68 plots

Range in age of sample: 10–100 years

Range in site index of sample: 7.8–30.4 meters

Reference: Milner (1992)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot

Types of curves/equations:

1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years

Type of age used in curves/equations: Breast height age

Geographic location of sample: Western Montana

Number of trees/plots sampled: 46 plots

Range in age of sample: 10–85 years

Range in site index of sample: 27–91 feet

Grand fir, *Abies grandis* (Dougl. ex D. Don) Lindl.

Reference: Cochran (1979b)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot

Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Eastern Oregon and eastern Washington
Number of trees/plots sampled: 2–5 trees per plot on 34 plots
Range in age of sample: 10–100 years
Range in site index of sample: 63–130 feet

Incense-cedar, *Libocedrus decurrens* Torr.

Reference: Dolph (1983)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Sierra Nevada
Number of trees/plots sampled: 56 trees
Range in age of sample: 10–75 years
Range in site index of sample: 10–90 feet

Lodgepole pine, *Pinus contorta* Dougl. ex Loud.

Reference: Dahms (1975)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 100 years
Type of age used in curves/equations: Total age
Geographic location of sample: Central Oregon
Number of trees/plots sampled: 6 trees per plot on 19 plots
Range in age of sample: 10–130 years
Range in site index of sample: 61–101 feet

Reference: Milner (1992)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Western Montana
Number of trees/plots sampled: 39 plots
Range in age of sample: 10–110 years
Range in site index of sample: 31–86 feet

Mixed-conifer stands

Reference: Dunning and Reineke (1933)

Modeling approach: Graphical analysis in which a guide curve is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth curves in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Total age
Species mix: California red fir, Douglas-fir, incense-cedar, sugar pine, ponderosa pine, and white fir
Geographic location of sample: Northern California
Number of trees/plots sampled: 311 plots
Range in age of sample: 45–145 years
Range in site index of sample: 25–105 feet

Reference: Meyer (1937)

Modeling approach: Graphical analysis in which a guide curve is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth curves in English units
Base age used in curves/equations: 100 years
Type of age used in curves/equations: Total age
Species mix: Sitka spruce and western hemlock
Geographic location of sample: Southeastern Alaska, western British Columbia, western Washington, and western Oregon
Number of trees/plots sampled: 658 plots
Range in age of sample: 25–190 years
Range in site index of sample: 57–200 feet

Reference: Biging (1985), Biging and Wensel (1985)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth equation in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Species mix: California red fir, Douglas-fir, incense-cedar, sugar pine, ponderosa pine, and white fir
Geographic location of sample: Northern California
Number of trees/plots sampled: 15 California red fir, 68 Douglas-fir, 2

incense-cedar, 37 sugar pine, 97 ponderosa pine, and 124 white fir trees
Range in age of sample: 10–100 years
Range in site index of sample: 35–131 feet

Noble fir, *Abies procera* Rehd.

Reference: Herman *et al.* (1978)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units
3. Dominant-height-growth equation in metric units
4. Site-index equation in metric units

Base age used in curves/equations: 100 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Cascade Range from Stevens Pass to McKenzie Pass
Number of trees/plots sampled: 60 trees
Range in age of sample: 10–260 years
Range in site index of sample: 60–180 feet

Pacific madrone, *Arbutus menziesii* Pursh

Reference: Porter and Wiant (1965)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations: Site-index equation in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Total age
Geographic location of sample: Humboldt County, California
Number of trees/plots sampled: 25 trees
Range in age of sample: 28–71 years
Range in site index of sample: 53–95 feet

Pacific silver fir, *Abies amabilis* Dougl. ex Forbes

Reference: Mitchell and Polsson (1988)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth equation in metric units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: British Columbia
Number of trees/plots sampled: 191 trees

Range in age of sample: 20–150 years
Range in site index of sample: 20–32 meters

Reference: Hoyer and Herman (1989)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 100 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Cascade Range from Stevens Pass to McKenzie Pass
Number of trees/plots sampled: 40 trees from 39 plots
Range in age of sample: 10–240 years
Range in site index of sample: 46–115 feet

Ponderosa pine, *Pinus ponderosa* Dougl. ex Laws.

Reference: Behre (1928)

Modeling approach: Graphical analysis in which a guide curve is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth curves in English units
Base age used in curves/equations: 100 years
Type of age used in curves/equations: Total age
Geographic location of sample: Eastern Washington and northern Idaho
Number of trees/plots sampled: 83 plots
Range in age of sample: 30–163 years
Range in site index of sample: Not available

Reference: Meyer (1938)

Modeling approach: Graphical analysis in which a guide curve is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth curves in English units
Base age used in curves/equations: 100 years
Type of age used in curves/equations: Total age
Geographic location of sample: Oregon, Washington, California, Idaho, Montana, and South Dakota
Number of trees/plots sampled: 450 plots
Range in age of sample: 20–200 years
Range in site index of sample: 40–160 feet

Reference: Barrett (1978)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot

Types of curves/equations:

1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 100 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Eastern Oregon and eastern Washington
Number of trees/plots sampled: 177 trees from 30 plots
Range in age of sample: 20–130 years
Range in site index of sample: 72–145 feet

Reference: Powers and Oliver (1978)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth equation in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Total age
Geographic location of sample: Northern California
Number of trees/plots sampled: 135 trees from 26 plots
Range in age of sample: 20–80 years
Range in site index of sample: 31–117 feet

Reference: Hann and Scrivani (1987)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:

1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Southwestern Oregon
Number of trees/plots sampled: 41 trees
Range in age of sample: 10–148 years
Range in site index of sample: 62–113 feet

Reference: Milner (1992)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:

1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Western Montana
Number of trees/plots sampled: 31 plots
Range in age of sample: 10–85 years
Range in site index of sample: 41–84 feet

Red alder, *Alnus rubra* Bong.

Reference: Bishop *et al*. (1958), Johnson and Worthington (1963)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations: Site index equation in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Total age
Geographic location of sample: Western Washington
Number of trees/plots sampled: 43 trees from 16 plots
Range in age of sample: 10–80 years
Range in site index of sample: 62–111 feet

Reference: Porter and Wiant (1965)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations: Site-index equation in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Total age
Geographic location of sample: Humboldt County, California
Number of trees/plots sampled: 26 trees
Range in age of sample: 30–67 years
Range in site index of sample: 76–114 feet

Reference: Harrington and Curtis (1986)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units
3. Dominant-height-growth equation in metric units
4. Site-index equation in metric units

Base age used in curves/equations: 20 years
Type of age used in curves/equations: Total age
Geographic location of sample: Western Washington and northwestern Oregon
Number of trees/plots sampled: 156 trees
Range in age of sample: 2–56 years
Range in site index of sample: 8–23 meters

Redwood, *Sequoia sempervirens* (D. Don) Endl.

Reference: Lindquist and Palley (1961)

Modeling approach: Graphical analysis in which a guide curve is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth curves in English units
Base age used in curves/equations: 100 years

Type of age used in curves/equations: Breast height age
Geographic location of sample: Northern coastal California
Number of trees/plots sampled: 161 plots
Range in age of sample: 15–100 years
Range in site index of sample: 110–200+ feet

Reference: Arvanitis *et al*. (1964)

Modeling approach: Regression analysis in which a guide equation is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 100 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Westside of Sierra Nevada in California
Number of trees/plots sampled: 208 plots
Range in age of sample: 11–100 years
Range in site index of sample: 60–180 feet

Reference: Krumland and Wensel (1977)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth equation in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Northern coastal California
Number of trees/plots sampled: 123 trees and 4+ trees/plot from 37 permanent plots
Range in age of sample: 10–80 years
Range in site index of sample: 75–135 feet

Sitka spruce, *Picea sitchensis* (Bong.) Carr.

Reference: Farr (1984)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Southeastern Alaska
Number of trees/plots sampled: 71 plots
Range in age of sample: 10–150 years
Range in site index of sample: 45–115 feet

Reference: Mitchell and Polsson (1988)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot

Types of curves/equations: Dominant-height-growth equation in metric units

Base age used in curves/equations: 50 years

Type of age used in curves/equations: Breast height age

Geographic location of sample: British Columbia

Number of trees/plots sampled: 133 trees

Range in age of sample: 20–150 years

Range in site index of sample: 20–40 meters

Tanoak, *Lithocarpus densiflorus* (Hook. & Arn.) Rehd.

Reference: Porter and Wiant (1965)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot

Types of curves/equations: Site-index equation in English units

Base age used in curves/equations: 50 years

Type of age used in curves/equations: Total age

Geographic location of sample: Humboldt County, California

Number of trees/plots sampled: 30 trees

Range in age of sample: 32–71 years

Range in site index of sample: 47–86 feet

Western hemlock, *Tsuga heterophylla* (Raf.) Sarg.

Reference: Barnes (1962)

Modeling approach: Graphical analysis in which a guide curve is fitted to data from single measurements of height and age on each tree/plot

Types of curves/equations: Dominant-height-growth curve in English units

Base age used in curves/equations: 100 years

Type of age used in curves/equations: Total age

Geographic location of sample: Southeastern Alaska, western British Columbia, western Washington, and western Oregon

Number of trees/plots sampled: 549 plots

Range in age of sample: 10–250+ years

Range in site index of sample: 60–200 feet

Reference: Wiley (1978)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot

Types of curves/equations: Dominant-height-growth equation in English units

Base age used in curves/equations: 50 years

Type of age used in curves/equations: Breast height age

Geographic location of sample: Southwestern British Columbia, western

Washington, and northwestern Oregon
Number of trees/plots sampled: 1–10 trees/plot on 109 plots
Range in age of sample: 5–110 years
Range in site index of sample: 57–103 feet

Reference: Farr (1984)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Southeastern Alaska
Number of trees/plots sampled: 57 plots
Range in age of sample: 10–150 years
Range in site index of sample: 45–105 feet

Western larch, *Larix occidentalis* Nutt.

Reference: Schmidt *et al.* (1976)

Modeling approach: Regression analysis in which a guide equation is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth equation in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Total age
Geographic location of sample: Inland Empire
Number of trees/plots sampled: 142 plots
Range in age of sample: 20–200 years
Range in site index of sample: 30–80 feet

Reference: Cochran (1985)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Eastern Oregon and eastern Washington
Number of trees/plots sampled: 1–5 trees/plot on 23 plots
Range in age of sample: 10–100 years
Range in site index of sample: 54–105 feet

Reference: Milner (1992)

Modeling approach: Regression analysis in which data from stem analy-

sis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Western Montana
Number of trees/plots sampled: 37 plots
Range in age of sample: 10–115 years
Range in site index of sample: 50–97 feet

Western redcedar, *Thuja plicata* Donn ex D. Don

Reference: Mitchell and Polsson (1988)
Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth equation in metric units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: British Columbia
Number of trees/plots sampled: 151 trees
Range in age of sample: 20–150 years
Range in site index of sample: 20–32 meters

Western white pine, *Pinus monticola* Dougl. ex D. Don

Reference: Haig (1932)
Modeling approach: Graphical analysis in which a guide curve is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth curves in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Total age
Geographic location of sample: Northern Idaho and western Montana
Number of trees/plots sampled: 271 plots
Range in age of sample: 20–160 years
Range in site index of sample: 25–85 feet

Reference: Curtis *et al.* (1990)
Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units
Base age used in curves/equations: Both 50 years and 100 years

Type of age used in curves/equations: Breast height age
Geographic location of sample: Cascade Range in southern Washington and northern Oregon
Number of trees/plots sampled: 38 trees
Range in age of sample: 10–200 years
Range in site index of sample: 30–101 for base age 50 and 62–132 for base age 100

White fir, *Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.

Reference: Schumacher (1926)

Modeling approach: Graphical analysis in which a guide curve is fitted to data from single measurements of height and age on each tree/plot
Types of curves/equations: Dominant-height-growth curves in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Total age
Geographic location of sample: Northern Sierra Nevada
Number of trees/plots sampled: 157 plots
Range in age of sample: 40–150 years
Range in site index of sample: 30–90 feet

Reference: Cochran (1979b)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations:
1. Dominant-height-growth equation in English units
2. Site-index equation in English units

Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Eastern Oregon and eastern Washington
Number of trees/plots sampled: 2–5 trees per plot on 34 plots
Range in age of sample: 10–100 years
Range in site index of sample: 63–130 feet

Reference: Dolph (1987)

Modeling approach: Regression analysis in which data from stem analysis is used to provide multiple measurements of height and age on each tree/plot
Types of curves/equations: Site-index equation in English units
Base age used in curves/equations: 50 years
Type of age used in curves/equations: Breast height age
Geographic location of sample: Northern Sierra Nevada
Number of trees/plots sampled: 1 tree per plot on 77 plots
Range in age of sample: 10–75 years
Range in site index of sample: 40–120 feet

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