A KEY TO THE LITERATURE ON FOREST GROWTH AND YIELD IN THE PACIFIC NORTHWEST: 1910-1981

D.W. HANN
K. RIITTERS

FOREST RESEARCH LAB

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The Authors

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Oregon State University, Forest Research Laboratory.
(Research bulletin)
INTRODUCTION

The practice of forest management has historically been based, to a large degree, on predictions of forest growth and yield. Yield tables have been used for most of this century to determine rotation lengths and to estimate harvest volumes. As the complexity of the questions faced by forest managers has increased, so has the sophistication of the information sources used to answer them. Today, computerized simulators of individual tree and stand growth provide a framework for the study of forest dynamics and make possible the analysis of management techniques ranging from harvest scheduling to pest control.

This key was compiled to aid forest managers in search of useful growth and yield information on Northwest tree species.\(^1\) We have limited ourselves to the literature published from 1910 through 1981 and have excluded unpublished material from government agencies and companies as well as Master's and Doctoral theses. We have also excluded publications dealing with Northwest species grown in other areas of the world (unless the results have been republished in the Northwest) and those that only provide average data on thinned or fertilized stands at a particular location.

Growth and yield information is available in three forms: tables, equations, and simulators. Tables are displays of average sample data, while equations are mathematical expressions describing a particular stand component on the basis of sample data. Simulators consist of several equations or tables and are usually designed to describe the basic processes of the forest (i.e., growth, death, and regeneration). Each of these forms has its own capabilities.

Yield tables are either "normal," which means that they represent natural stands that are fully stocked and undisturbed, or "empirical," which means that they represent managed stands under average conditions. The usual stand attributes described by yield tables include number of trees, basal area, average d.b.h., height, and volume. Examples of normal yield tables are those by Barnes (1962) for western hemlock and by McArdle et al. (1961) for Douglas-fir. Good examples of empirical yield tables are those by McKeever (1947) for Douglas-fir. Most National Forest management plans include empirical yield tables for specific management regimes (Al Lampi, personal communication).

While yield tables are commonly applied to even-aged stands, the description of periodic yield in uneven-aged stands is provided by growth tables. Two examples of growth tables are those for ponderosa pine by Meyer (1934) and Roe (1952).

It is sometimes desirable to develop equations that describe the growth and yield of forest stands. This is often done to smooth yield data from even-aged stands for presentation in tabular format (Dahms 1964, Chambers 1974). For uneven-aged stands, growth equations are more flexible than growth tables. Lemmon and Schumacher's (1962) growth equations describe changes in attributes of ponderosa pine stands.

When several growth equations are combined with equations that predict mortality (and sometimes regeneration in uneven-aged stands), the result is a simulator. Munro (1974) describes the advantages and disadvantages of three types of simulators:

1. Single-tree/distance-dependent,
2. Single-tree/distance-independent, and
3. Whole-stand/distance-independent.

The level of resolution of these simulators is either the individual tree or the stand; "distance-dependence" refers to the need for data on spacing between individual trees. Many simulators have been developed, but only a few are widely used. It is probable, however, that the future of growth and yield predictions lies in the development of simulators. Existing single-tree simulators that are distance-dependent include those developed for Douglas-fir by Arney (1974), Mitchell (1975), and Lin (1974). A single-tree/distance-independent simulator for northern Rocky Mountain species has been developed by Stage (1973). Programs DFIT (Bruce et al. 1977) and DFSIM (Curtis et al.

\(^{1}\)Northwest is defined as encompassing Oregon, Washington, southern British Columbia, northern California, Idaho, and western Montana.
1981) are examples of whole-stand/distance-independent simulators for Douglas-fir.

In the tables that follow, the published literature on growth and yield is sorted first by form of information, then by species, and finally by literature reference. On each table, these descriptions are followed by a listing (when available) of the data sources used to develop the information: species composition; site index species, range, and type; age distribution; plot sizes; measurement years; and vegetation zones (Franklin and Dyrness 1973). Vegetation zone is included because of recent interest in the use of habitat types or plant communities as a parameter of forest growth prediction (Hall 1973; Stage 1973, 1975; Volland 1976). Last, each table briefly lists the "required input" (the data needed to predict growth and yield) and the "corresponding output" (the data predicted) for each reference.

To aid the user, a list of scientific names of the tree species mentioned, a list of the letter prefixes used to group the tables according to form of information, and two indices precede the tables. The first index lists all tables by species and form of information. The second index lists all tables by literature reference. Literature Cited appears after the tables at the end of the report.

### TREE SPECIES MENTIONED

<table>
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<th>Common Name</th>
<th>Latin Name</th>
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<td>Chamaecyparis nootkatensis (D. Don) Spach</td>
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<tr>
<td>Bigleaf maple</td>
<td>Acer macrophyllum Pursh</td>
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<tr>
<td>Black cottonwood</td>
<td>Populus trichocarpa Torr. and Gray</td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>Pseudotsuga menziesii (Mirb.) Franco</td>
</tr>
<tr>
<td>Engelmann spruce</td>
<td>Picea engelmannii Parry ex Engelm.</td>
</tr>
<tr>
<td>Grand fir</td>
<td>Abies grandis (Dougl. ex D. Don) Lindl.</td>
</tr>
<tr>
<td>Incense-cedar</td>
<td>Calocedrus decurrens (Torr.) Florin.</td>
</tr>
<tr>
<td>Jeffrey pine</td>
<td>Pinus jeffreyi Grev. &amp; Balf.</td>
</tr>
<tr>
<td>Lodgepole pine</td>
<td>Pinus contorta Douglas ex Loud.</td>
</tr>
<tr>
<td>Mountain hemlock</td>
<td>Tsuga mertensiana (Bong.) Carr</td>
</tr>
<tr>
<td>Noble fir</td>
<td>Abies procera Rehd.</td>
</tr>
<tr>
<td>Oregon white oak</td>
<td>Quercus garryana Douglas ex Hook</td>
</tr>
<tr>
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<td>Pinus ponderosa Douglas ex Laws.</td>
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<td>Alnus rubra Bong.</td>
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<td>Red fir, includes</td>
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<td>California red fir</td>
<td>Abies magnifica var. shastensis Lemm.</td>
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<td>and Shasta red fir</td>
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<td>Rocky Mountain ponderosa pine</td>
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<td>Abies lasiocarpa (Hook.) Nutt.</td>
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<td>Pinus lambertiana Douglas.</td>
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<td>Sugar pine</td>
<td>Lithocarpus densiflorus (Hook. &amp; Arn.) Rehd.</td>
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<tr>
<td>Tanoak</td>
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## TABLE PREFIXES

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Each table is designated by a letter prefix indicating the form of information and by a number. In this index, the table prefixes are found at the top of the column headings and the table numbers are within the column. For example, Table B.6 summarizes an empirical yield table for ponderosa pine.

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Series A: Normal Yield Tables

TABLE A.1

FORM OF INFORMATION: Normal yield tables
SPECIES: Douglas-fir
REFERENCE: Hanzlik (1914)

DATA SOURCES

Vegetation Zones: Willamette Valley, Western hemlock
Site Quality Range: I-III
Site Quality Type: Soil quality
Notes: 598 plots
Plot Sizes: 0.0625-1.0 acre
Even-Age
Age Range: 20-140 years

REQUIRED INPUT

Soil quality, age
For all trees > 0.00 inch or > 12 inches d.b.h.:
Average height, No. trees, average diameter,
basal area, total cubic volume
For all trees > 12 inches d.b.h.:
Board foot volume

CORRESPONDING OUTPUT

TABLE A.2

FORM OF INFORMATION: Normal yield tables
SPECIES: Douglas-fir
REFERENCE: Schumacher (1930)

DATA SOURCES

Species Composition: Douglas-fir, ponderosa pine, redwood, white fir, sugar pine,
incense-cedar, grand fir
Site Index Species: Douglas-fir
Site Index Range: 75-214
Site Index Type: Schumacher (1930)
Even-Age
Age Range: 25-174 years
Notes: 159 plots from northern California.

REQUIRED INPUT

Total age, site index
For all trees > 0.5 inch d.b.h.:
Height of average dominant, No. trees,
basal area, average d.b.h., quadratic
mean diameter, total cubic volume
For all trees > 8 inches d.b.h.:
No. trees, International 1/8-inch
board foot volume to a 5-inch top
For all trees:
No. trees by 2-inch d.b.h. classes

CORRESPONDING OUTPUT
TABLE A.3  
FORM OF INFORMATION: Normal yield tables  
SPECIES: Douglas-fir  
REFERENCE: Briegleb (1948)  

DATA SOURCES

Vegetation Zones: Sitka spruce, western hemlock, Willamette Valley, Pacific silver fir
Species Composition: Douglas-fir, western hemlock, western redcedar, grand fir, Pacific silver fir, noble fir, western white pine, bigleaf maple, red alder, black cottonwood, Oregon white oak
Site Index Species: Douglas-fir  
Site Index Range: 80-200  
Site Index Type: McArdle and Meyer (1930)  
Plot Sizes: 0.0625-4.0 acres

Age Range: 20-180 years
Years Measured: 1909, 1911, 1924-25 (1930)

Notes: 1,916 plots from 245 tracts. These data represent a minor adjustment to the International 1/4-inch board-foot volume tables in McArdle and Meyer (1930).

REQUIRED INPUT  
CORRESPONDING OUTPUT

Total age, site index  
For all trees > 12 inches d.b.h.:  
International 1/4-inch board foot volume to an 8-inch top
TABLE A.4

FORM OF INFORMATION: Normal yield tables

SPECIES: Douglas-fir

REFERENCE: Bruce (1948)

DATA SOURCES

Vegetation Zones: Sitka spruce, western hemlock, Willamette Valley, Pacific silver fir
Species Composition: Douglas-fir, western hemlock, western redcedar, grand fir, Pacific silver fir, noble fir, western white pine, bigleaf maple, red alder, black cottonwood, Oregon white oak

Site Index Species: Douglas-fir
Site Index Range: 80-200
Site Index Type: McArdle and Meyer (1930)
Plot Sizes: 0.0625-4.0 acres

Age Range: 20-180
Years Measured: every 4-6 years for 30 years

Notes: 1,916 plots from 245 tracts. This diameter-based yield table was subsequently included in McArdle et al. (1949, 1961).

REQUIRED INPUT

Quadratic mean diameter
Average height

For all trees >1.5 inches d.b.h.: No. trees, total cubic volume
For all trees >5 inches or >7 inches d.b.h.: Cubic volume to a 4-inch top
For all trees >12 inches d.b.h.: Cubic volume to a 4-inch top, International 1/8-inch board foot volume to a 5-inch top, Scribner board foot volume to an 8-inch top

Quadratic mean diameter, total age
Net 10-year change in quadratic mean diameter

Quadratic mean diameter, tree d.b.h.
Tree height
### TABLE A.5

**FORM OF INFORMATION:** Normal yield tables

**SPECIES:** Douglas-fir

**REFERENCE:** McArdle and Meyer (1930), McArdle et al. (1949, 1961)

**DATA SOURCES**

- **Vegetation Zones:** Sitka spruce, western hemlock, Willamette Valley, Pacific silver fir.
- **Species Composition:** Douglas-fir, western hemlock, western redcedar, grand fir, Pacific silver fir, noble fir, western white pine, bigleaf maple, red alder, black cottonwood, Oregon white oak

<table>
<thead>
<tr>
<th>Site Index Species</th>
<th>Site Index Range</th>
<th>Species Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas-fir</td>
<td>80-200</td>
<td>Even-Age</td>
</tr>
<tr>
<td>McArdle et al. (1961)</td>
<td>Age Range: 20-180 years</td>
<td>Years measured: 1909, 1911, 1924-25</td>
</tr>
</tbody>
</table>

**Plot Sizes:** 0.0625-4.0 acres

**Notes:** 1,916 plots from 245 tracts.

#### REQUIRED INPUT

- Total age, site index
- Quadratic mean diameter
- Total age, quadratic mean diameter, tree d.b.h.

#### CORRESPONDING OUTPUT

- For all trees >1.5 inches or >6.6 inches or >11.6 inches d.b.h.:
  - No. trees, quadratic mean diameter, basal area, total cubic volume
- For all trees >5 inches d.b.h.:
  - Total cubic volume
  - For all trees >6.6 inches or >11.6 inches d.b.h.:
    - International 1/8-inch board foot volume to a 5-inch top
- For all trees >11.6 inches d.b.h.:
  - International 1/4-inch board foot volume to an 8-inch top
  - For all trees >15.6 inches d.b.h.:
    - International 1/8-inch board foot volume to a 5-inch top, Scribner board foot volume to an 8-inch top
- For all trees >5 inches or >7 inches or >12 inches d.b.h.:
  - Cubic volume to a 4-inch top
- For all trees >12 inches d.b.h.:
  - International 1/8-inch board foot volume to a 5-inch top, Scribner board foot volume to an 8-inch top
- For all trees >1.5 inches d.b.h.:
  - Total cubic volume
  - For all trees >7 inches or >12 inches d.b.h.:
    - Cubic volume to a 4-inch top
- For all trees >12 inches d.b.h.:
  - International 1/8-inch board foot volume to a 5-inch top, Scribner board foot volume to an 8-inch top
- For all trees:
  - No. trees by 2-inch diameter classes
- No. trees, average height
- Tree height
- Net 10-year change in quadratic mean diameter
TABLE A.6

**FORM OF INFORMATION:** Normal yield tables

**SPECIES:** Ponderosa pine

**REFERENCE:** Show (1925)

**DATA SOURCES**

Species Composition: Ponderosa pine, white fir

Site Index Species: Ponderosa pine

Site Index Range: 80-170

Site Index Type: Show (1925)

Plot Sizes: 0.05-1.0 acre

Even-Age

Age Range: 50-240 years

Notes: 175 plots in virgin stands from the Lassen National Forest.

**REQUIRED INPUT**

Total age, site index

Age at breast height

**CORRESPONDING OUTPUT**

For all trees:
- No. trees, basal area, quadratic mean diameter, height of dominants, total cubic volume, Clark International 1/8-inch board foot volume, board foot/cubic foot ratio

For white fir stands:
- Board foot volume

TABLE A.7

**FORM OF INFORMATION:** Normal yield tables

**SPECIES:** Ponderosa pine

**REFERENCE:** Behre (1928a,b)

**DATA SOURCES**

Site Index Species: Ponderosa pine

Site Index Range: 40-120

Site Index Type: Behre (1928a, b)

Even-Age

Age Range: 30-180 years

Plot Sizes: 0.0625-0.75 acre

Notes: 83 plots in northeast Washington and northern Idaho.

**REQUIRED INPUT**

Total age, site index

**CORRESPONDING OUTPUT**

For all trees >3 inches d.b.h.:
- No. trees, quadratic mean diameter, Average height, total cubic volume, International 1/4-inch board foot volume to a 4-inch top
### TABLE A.8

**FORM OF INFORMATION:** Normal yield tables

**SPECIES:** Ponderosa pine

**REFERENCE:** Meyer (1938)

### DATA SOURCES

**Vegetation Zones:** Ponderosa pine  
**Species Composition:** Ponderosa pine, lodgepole pine, white fir, Douglas-fir, western larch, Engelmann spruce

**Site Index Species:** Ponderosa pine  
**Site Index Range:** 40-160  
**Site Index Type:** Meyer (1938)  
**Age Range:** 20-200 years  
**Years Measured:** 1910-1938  
**Plot Sizes:** <0.1-1.0+ acre

**Notes:** 450 plots from Washington, Oregon, California, Idaho, Montana, and South Dakota.

### REQUIRED INPUT

| Total age; site index | For all trees >0.6 inch, or >6.6 inches, or >11.6 inches d.b.h.:  
|                       | No. trees, basal area, quadratic mean diameter, total cubic volume  
|                       | For all trees >6.6 inches d.b.h.:  
|                       | International 1/8-inch board foot volume to a 6-inch top  
|                       | For all trees >11.6 inches d.b.h.:  
|                       | Scribner board foot volume to an 8-inch top  
| Quadratic mean diameter | Percentage of total number of trees, percentage of total stand cubic volume and percentage of total stand Scribner board foot volume by 2-inch diameter classes.  

---
TABLE A.9

FORM OF INFORMATION: Normal yield tables

SPECIES: Red alder

REFERENCE: Smith (1968)

DATA SOURCES

Site Index Species: Red alder
Site Index Range: 70-130
Even-Age
Age Range: 10-60 years

Notes: From yield tables issued by the British Columbia Forest Service (1936).

REQUIRED INPUT

Average diameter, average height of dominants
For all trees >1 inch d.b.h.:
No. trees, total cubic volume
For all trees >6.6 inches d.b.h.:
British Columbia 3/8-inch board foot volume
to an 8-inch top

Average diameter

PERCENTAGE OF TOTAL NUMBER OF TREES BY
1-inch diameter classes

TABLE A.10

FORM OF INFORMATION: Normal yield tables

SPECIES: Red fir

REFERENCE: Schumacher (1928)

DATA SOURCES

Species Composition: Red fir, white fir, western white pine, lodgepole pine, ponderosa
pine, incense-cedar, sugar pine

Site Index Species: Red fir
Site Index Range: 20-60
Site Index Type: Schumacher (1928)
Plot Sizes: <0.1-0.8 acre
Even-Age
Age Range: 30-160 years

Notes: 149 plots from California.

REQUIRED INPUT

Average height, average diameter, basal
area, total cubic volume
No. trees by 2-inch diameter classes
For all trees >8 inches d.b.h.:
No. trees, International 1/8-inch board
foot volume to a 5-inch top
### TABLE A.11

**FORM OF INFORMATION:** Normal yield tables  
**SPECIES:** Redwood  
**REFERENCE:** Bruce (1923)

**DATA SOURCES**
- Species Composition: Redwood, Douglas-fir, white fir, sugar pine
- Site Quality Species: Redwood
- Site Quality Range: I-III
- Notes: 135 plots from California.
- Plot Sizes: 0.049-1.570 acres
- Even-Age
- Age Range: 20-67 years

**REQUIRED INPUT**
- Total age, site index

**CORRESPONDING OUTPUT**
- For all trees >2.6 inches d.b.h., and for all dominant and codominant trees:
  - No. trees, height of tree of quadratic mean diameter, quadratic mean diameter, basal area, total cubic volume, International 1/8-inch board foot volume to a 5-inch top, board foot/cubic foot ratio

**Site quality = II, age = 50**
- No. trees by 1-inch d.b.h. classes

**D.b.h.**
- Form factor
### TABLE A.12

**FORM OF INFORMATION:** Normal yield tables

**SPECIES:** Sitka spruce, western hemlock  
**REFERENCE:** Meyer (1937)

**DATA SOURCES**

<table>
<thead>
<tr>
<th>Vegetation Zones:</th>
<th>Sitka spruce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species Composition:</td>
<td>Western hemlock, Sitka spruce, Douglas-fir, western redcedar, Pacific silver fir</td>
</tr>
<tr>
<td>Site Index Species:</td>
<td>Sitka spruce</td>
</tr>
<tr>
<td>Site Index Range:</td>
<td>60-200</td>
</tr>
<tr>
<td>Site Index Type:</td>
<td>Meyer (1937)</td>
</tr>
<tr>
<td>Even-Age</td>
<td></td>
</tr>
<tr>
<td>Age Range:</td>
<td>20-200 years</td>
</tr>
<tr>
<td>Years Measured:</td>
<td>1933-1934</td>
</tr>
</tbody>
</table>

**Notes:** 658 plots from western Oregon, western Washington, and Alaska.

**REQUIRED INPUT**

**CORRESPONDING OUTPUT**

<table>
<thead>
<tr>
<th>Total age, site index</th>
<th>For all trees &gt;2.6 inches, or &gt;11.6 inches, or &gt;15.6 inches d.b.h.:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. trees, basal area, quadratic mean diameter, total cubic volume</td>
</tr>
<tr>
<td></td>
<td>For all trees &gt;6.6 inches d.b.h.:</td>
</tr>
<tr>
<td></td>
<td>International 1/8-inch board foot volume to a 6-inch top</td>
</tr>
<tr>
<td></td>
<td>For all trees &gt;15.6 inches d.b.h.:</td>
</tr>
<tr>
<td></td>
<td>Cubic volume of the dominant stand, Scribner board foot volume to an 8-inch top, Scribner board foot volume to a 12-inch top</td>
</tr>
<tr>
<td>Quadratic mean diameter</td>
<td>No. trees, basal area, average height, cubic volume, International 1/8-inch board foot volume to a 8-inch top</td>
</tr>
<tr>
<td></td>
<td>For all trees &gt;11.6 inches d.b.h.:</td>
</tr>
<tr>
<td></td>
<td>Scribner board foot volume to an 8-inch top</td>
</tr>
<tr>
<td>Total age, site index</td>
<td>No. trees by 2-inch diameter classes</td>
</tr>
</tbody>
</table>
TABLE A.13

FORM OF INFORMATION: Normal yield tables

SPECIES: Western hemlock, Sitka spruce

REFERENCE: Taylor (1934)

DATA SOURCES

Vegetation Zones: Sitka spruce
Species Composition: Sitka spruce, western hemlock, western redcedar, Alaska-cedar
Site Index Species: Western hemlock or Sitka spruce
Site Index Range: 50-150
Site Index Type: Even-Age
Notes: 288 plots

Plot Sizes: 0.1-1.0 acre
Age Range: 30-150 years

REQUIRED INPUT

Total age, site index

CORRESPONDING OUTPUT

No. trees by 1-inch diameter classes

For all trees >0.6 inch or >6.6 inches d.b.h.:
- Average height, No. trees, quadratic mean diameter, basal area

For all trees >0.6 inch d.b.h.:
- Total cubic volume

For all trees >6.6 inches d.b.h.:
- Cubic volume to a 6-inch top, International 1/8-inch board foot volume to a 5-inch top
TABLE A.14

FORM OF INFORMATION: Normal yield tables

SPECIES: Western hemlock

REFERENCE: Barnes (1962)

DATA SOURCES

Vegetation Zones: Sitka spruce
Site Index Species: Western hemlock
Site Index Range: 100-210
Site Index Type: Barnes (1962)
Even-Age
Age Range: 20-300 years

Notes: Local tables for Oregon and Washington included.

REQUIRED INPUT

Total age, site index

For all trees >1.5 inches d.b.h.:
No. trees, quadratic mean diameter, basal area, total cubic volume

For all trees >6.5 inches d.b.h.:
Total cubic volume, International 1/4-inch board foot volume to a 6-inch top

For all trees >11.5 inches d.b.h.:
Scribner board foot volume to an 8-inch top, International 1/4-inch board foot volume to a 6-inch top

Quadratic mean diameter

Average height

For all trees >1.5 inches d.b.h.:
No. trees, basal area, total cubic volume

For all trees >6.5 inches d.b.h.:
Total cubic volume, International 1/4-inch board foot volume to a 6-inch top

For all trees >11.5 inches d.b.h.:
Scribner board foot volume to an 8-inch top, International 1/4-inch board foot volume to a 6-inch top

Quadratic mean diameter, tree d.b.h.

Tree height
TABLE A.15

FORM OF INFORMATION: Normal yield tables

SPECIES: Western white pine

REFERENCE: Haig (1932)

DATA SOURCES

Species Composition: Western white pine, western larch, western hemlock, white fir, Douglas-fir, western redcedar

Site Index Species: Western white pine
Site Index Range: 40-70
Site Index Type: Haig (1932)
Plot Sizes: 0.05-2.0 acres

Even-Age Age Range: 20-160 years
Years Measured: 1909-1912, 1924-1926

Notes: 271 plots from northern Idaho and northwest Montana.

REQUIRED INPUT

Total age, site index

CORRESPONDING OUTPUT

For dominant and codominant trees:
Average height, quadratic mean diameter, total cubic volume

For all trees >0.6 inch, or >6.6 inches or >12.6 inches d.b.h.:
No. trees, quadratic mean diameter, basal area

For all trees >0.6 inch d.b.h.:
Total cubic volume

For all trees >6.6 inches d.b.h.:
International 1/8-inch board foot volume to a 5-inch top

For all trees >7.6 inches d.b.h.:
Scribner board foot volume to a 5-inch top

For all trees >12.6 inches d.b.h.:
International 1/8 inch board foot volume to a 5-inch top, Scribner board foot volume to a 5-inch top

Percentage of total number of trees, percentage of total stand basal area, percentage of total stand cubic volume and percentage of total stand board foot volume by species and 1-inch diameter classes.
TABLE A.16

FORM OF INFORMATION: Normal yield tables

SPECIES: White fir

REFERENCE: Schumacher (1926)

DATA SOURCES

Species Composition: White fir, sugar pine, Dougals-fir, ponderosa pine, red fir, incense-cedar

Site Index Species: White fir
Site Index Range: 25-95
Site Index Type: Schumacher (1926)

Plot Sizes: 0.10-0.99 acre
Even-Age
Age Range: 40-150 years

Notes: 157 plots from California.

REQUIRED INPUT

Total age, site index

For all trees ≥4 inches d.b.h.:
- No. trees, height of tree of quadratic mean diameter, quadratic mean diameter, basal area, total cubic volume

For all trees ≥8 inches d.b.h.:
- No. trees, height of tree of quadratic mean diameter, quadratic mean diameter, basal area, International 1/8-Inch board foot volume to a 5-inch top

Quadratic mean diameter

For all trees ≥4 inches d.b.h.:
- No. trees by 1-inch d.b.h. classes
### TABLE B.1

**FORM OF INFORMATION:** Empirical yield tables

**SPECIES:** Bigleaf maple, black cottonwood, Douglas-fir, Engelmann spruce, grand fir, lodgepole pine, mountain hemlock, Pacific silver fir, ponderosa pine, red alder, Sitka spruce, subalpine fir, western hemlock, western larch, western redcedar, white pine

**REFERENCE:** Fligg (1960)

**DATA SOURCES**

- **Years Measured:** 1953-1958
- **Notes:** 13,371 inventory clusters (composed of 4+ plots) located throughout British Columbia.

<table>
<thead>
<tr>
<th>REQUIRED INPUT</th>
<th>CORRESPONDING OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provincial Zone, forest type, site class, total age</td>
<td>For trees &gt;3.1 inches, 9.1 inches, 11.1 inches, and 13.1 inches d.b.h.: Cubic volume to a 4-inch top, cubic volume to a 4-inch top Periodic Annual Increment, cubic volume to a 4-inch top Mean Annual Increment</td>
</tr>
</tbody>
</table>

### TABLE B.2

**FORM OF INFORMATION:** Empirical yield tables

**SPECIES:** Douglas-fir

**REFERENCE:** McKeever (1947)

**DATA SOURCES**

- **Site Quality Species:** Douglas-fir
- **Site Quality Range:** I-V
- **Site Quality Type:** McArdle and Meyer (1930)
- **Even-Age**
- **Age Range:** 20-160 years

**Notes:** Data from Western Oregon and Washington.

<table>
<thead>
<tr>
<th>REQUIRED INPUT</th>
<th>CORRESPONDING OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total age, site quality, stocking</td>
<td>For all trees &gt;11.6 inches d.b.h.: Scribner board foot volume to an 8-inch top</td>
</tr>
<tr>
<td>Total age, stocking</td>
<td>Growth correction factor in percent</td>
</tr>
</tbody>
</table>
TABLE B.3

SPECIES: Douglas-fir

FORM OF INFORMATION: Empirical yield tables

REFERENCE: Barnes (1955)

DATA SOURCES

Site Quality Species: Douglas-fir
Site Quality Range: 1-IV
Site Quality Type: McArdle et al. (1949)

Even-Age
Age Range: 10-50 years

Notes: Derived from British yield tables.

REQUIRED INPUT

Age, site quality

CORRESPONDING OUTPUT

No. trees, basal area, cubic volume to a 3-inch top

TABLE B.4

SPECIES: Douglas-fir

FORM OF INFORMATION: Empirical yield tables

REFERENCE: Hoyer (1966)

DATA SOURCES

Site Index Species: Douglas-fir
Site Index Range: 70-150
Site Index Type: King (1966)

Even-Age
Age Range: 15-100 years

Notes: Data for tables from McArdle et al. (1961) and Curtis (1967).

REQUIRED INPUT

Total age, site index

CORRESPONDING OUTPUT

Height, optimal thinning intensity, average diameter of stand, average diameter of thinning removals, ratio of Scribner board foot volume to a 6-inch top to total cubic volume for removals, annual Scribner board foot volume to a 6-inch top in removals, 5-year total cubic volume in removals, 5-year Scribner board foot volume to a 6-inch top in removals
TABLE B.5
FORM OF INFORMATION: Empirical yield tables
SPECIES: Douglas-fir, lodgepole pine, and western hemlock
REFERENCE: Hoyer (1967)

DATA SOURCES

Even-Age
Age Range: 10-80 years
Notes: Data from British Forest Management Tables. Productivity is called yield class and is expressed as maximum Mean Annual Increment.

REQUIRED INPUT
Yield class, total age

CORRESPONDING OUTPUT
For main crop after thinning and for yields from thinning:
No trees, top height, average diameter, basal area, cubic volume to 3-, 7-, and 9-inch tops
For total production:
Basal area, cubic volume to a 3-inch top
For gross increment:
Current annual basal area, current annual cubic volume to a 3-inch top, mean annual cubic volume to a 3-inch top

TABLE B.6
FORM OF INFORMATION: Empirical yield tables
SPECIES: Ponderosa pine
REFERENCE: Terry (1910)

DATA SOURCES

Species Composition: Ponderosa pine, western larch, Douglas-fir
Site Quality Range: I-III
Site Quality Type: Soil quality
Notes: Data from western Montana.

REQUIRED INPUT
Age, soil quality, species

CORRESPONDING OUTPUT
No. trees, average diameter, average height, board foot volume
TABLE B.7

FORM OF INFORMATION: Empirical yield tables

SPECIES: Ponderosa pine, sugar pine, Douglas-fir, white fir mixture

REFERENCE: Dunning and Reineke (1933)

DATA SOURCES

Species Composition: Ponderosa pine, sugar pine, Douglas-fir, white fir, red fir, incense-cedar

Site Index Species: Douglas-fir, ponderosa pine, red fir, white fir

Site Index Range: 25-110
Age Range: 30-150 years

Site Index Type: Dunning and Reineke (1933)
Years Measured: 1912-1923

Even-Age


REQUIRED INPUT

Total age, site index

CORRESPONDING OUTPUT

For all trees >2 inches d.b.h. in the composite "stand:"
No. trees, quadratic mean diameter, basal area, total cubic volume

For all trees >8 inches d.b.h. in the composite "stand:"
Board foot/cubic foot ratio,
International 1/8-inch board foot volume to a 5-inch top

Actual stand:
Stand density index, ponderosa pine: percent of basal area, sugar pine: percent of basal area, Douglas-fir: percent of basal area, white fir: percent of basal area, incense-cedar: percent of basal area, red fir: percent of basal area

Correction to composite "stand" values to obtain estimates of actual stand:
Basal area, no. trees, total cubic volume

Quadratic mean diameter, No. trees

Stand density index
TABLE B.8

**FORM OF INFORMATION:** Empirical yield tables  
**SPECIES:** Red alder  
**REFERENCE:** Johnson et al. (1926)

**DATA SOURCES**

Vegetation Zones: Western hemlock  
Even-Age  
Age Range: 30-80 years  
Notes: 16 plots

**REQUIRED INPUT**

<table>
<thead>
<tr>
<th>Age</th>
<th>For all trees &gt;0.0 inch or &gt;8 inches d.b.h.:</th>
<th>Basal area, No. trees, cubic volume to a 2-inch top, cubic volume of dominants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For trees &gt;8 inches d.b.h.:</td>
<td>Board foot volume</td>
</tr>
</tbody>
</table>

TABLE B.9

**FORM OF INFORMATION:** Empirical yield tables  
**SPECIES:** Red alder  
**REFERENCE:** Douglas-fir Second-growth Management Committee (1947)

**DATA SOURCES**

Vegetation Zones: Western hemlock  
Even-Age  
Notes: Data from Lewis County, Washington.

**REQUIRED INPUT**

<table>
<thead>
<tr>
<th>Age</th>
<th>For all trees &gt;5 inches d.b.h.:</th>
<th>Cubic volume to a 4-inch top</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For all trees &gt;11 inches d.b.h.:</td>
<td>Scribner board foot volume to a 10-inch top</td>
</tr>
</tbody>
</table>
TABLE B.10
FORM OF INFORMATION: Empirical yield tables
SPECIES: Red alder
REFERENCE: Smith (1968)

DATA SOURCES
Site Quality Species: Douglas-fir
Site Quality Range: II-IV
Site Quality Type: McArdle et al. (1961)
Even-Age
Age Range: 10-60 years

Notes: Data from Powell River, British Columbia.

REQUIRED INPUT
Age, site quality

CORRESPONDING OUTPUT
For all trees >5 inches d.b.h.:
No. trees, quadratic mean diameter, basal area, cubic volume to a 4-inch top, average height of dominants

TABLE B.11
FORM OF INFORMATION: Empirical yield tables
SPECIES: Redwood
REFERENCE: Lindquist and Palley (1963)

DATA SOURCES
Species Composition: Redwood, Douglas-fir, Sitka spruce, grand fir, western hemlock, tanoak, Pacific madrone, red alder

Site Index Species: Redwood
Site Index Range: 101-200+
Site Index Type: Lindquist and Palley (1961)
Even-Age
Age Range: 11-100 years old
Plot Sizes: 10, 20, or 40 basal area factors
Years Measured: 1958, 1959

Notes: 152 plots from Del Norte, Humboldt, Mendocino, and Sonoma counties of California.

REQUIRED INPUT
Site index, age at breast height

CORRESPONDING OUTPUT
For trees >4.6 inches d.b.h.:
Basal area, quadratic mean diameter, No. trees, cubic volume to a 4-inch top

For trees >10.6 inches d.b.h.:
Basal area, quadratic mean diameter, No. trees, board foot/cubic foot ratio, International 1/4-inch board foot volume to an 8-inch top
### TABLE B.12

**Form of Information:** Empirical yield tables

**Species:** Western red cedar

**Reference:** Smith et al. (1961)

#### Data Sources

- **Site Index Species:** Western hemlock
- **Site Index Range:** 70–210
- **Site Index Type:** Barnes (1953)

**Even-Age**

**Age Range:** 15–96+ years

**Notes:** Data from 202 trees on the University of British Columbia Forest at Haney, British Columbia.

#### Required Input

- Site index, total age

#### Corresponding Output

- Average height of dominants and codominants, average diameter, No. trees, gross total cubic volume
Series C: Stand Growth Tables

TABLE C.1
FORM OF INFORMATION: Stand growth tables
SPECIES: Ponderosa pine
REFERENCE: Gallaher (1913)

DATA SOURCES
Notes: Data from second-growth stands on the west side of Sierra Nevada Mountains.

REQUIRED INPUT
CORRESPONDING OUTPUT

D.b.h. Height at age 50
Age For all trees:

Clark International 1/8-inch board foot
volume to a 5-inch top, total cubic volume
to a 5-inch top

TABLE C.2
FORM OF INFORMATION: Stand growth tables
SPECIES: Ponderosa pine
REFERENCE: Meyer (1934)

DATA SOURCES
Site Quality Species: Ponderosa pine
Site Quality Range: IV
Site Quality Type: Meyer (1934)

Notes: 179 plots from eastern Oregon and Washington.

REQUIRED INPUT
CORRESPONDING OUTPUT

Site quality, residual basal area,
No. years since thinning Change in residual basal area
Site quality, residual cubic volume,
No. years since thinning Change in residual cubic volume
Site quality, residual board foot
volume for all trees >11.6 inches
d.b.h., No. years since thinning For all trees >11.6 inches d.b.h.:
Change in residual board foot volume
Tree class, d.b.h., No. years since
thinning For each tree:
Change in d.b.h.
TABLE C.3

FORM OF INFORMATION: Stand growth tables

SPECIES: Ponderosa pine

REFERENCE: Roe (1952)

DATA SOURCES

Species Composition: Ponderosa pine, Douglas-fir

Site Quality Species: Ponderosa pine

Site Quality Range: IV-V

Site Quality Type: Meyer (1938)

Uneven-Age

Plot Sizes: 0.1-0.5 acre

Years Measured: 1947

Notes: 60 plots in western Montana.

REQUIRED INPUT

Site quality, residual board foot volume for all trees >9.6 inches d.b.h., No. years since thinning

Site quality, Keen age, residual basal area for all trees >9.6 inches d.b.h., No. years since thinning

Site quality, d.b.h., No. years since thinning

CORRESPONDING OUTPUT

For all trees >9.6 inches d.b.h.:

Net change in residual board foot volume

For all trees >9.6 inches d.b.h.:

Gross change in residual basal area

For each tree:

Future board foot volume
TABLE C.4

FORM OF INFORMATION: Stand growth tables

SPECIES: Ponderosa pine

REFERENCE: Lynch (1954)

DATA SOURCES

Species Composition: Ponderosa pine, lodgepole pine, Douglas-fir

Site Quality Species: Ponderosa pine
Site Quality Range: II-IV
Site Quality Type: Meyer (1938)
Plot Sizes: 0.1-1.0 acre

Age Range: 20-100 years
Years Measured: 1949

Notes: 50 plots from northeast Washington, northern Idaho, and northwest Montana.

REQUIRED INPUT

Site quality, average diameter, age
Stocking, age
Age, site quality

CORRESPONDING OUTPUT

10-year change in total cubic volume
10-year gross change in total cubic volume,
10-year percent mortality of total cubic volume
Stocking

TABLE C.5

FORM OF INFORMATION: Stand growth tables

SPECIES: Ponderosa pine

REFERENCE: Gedney et al. (1959)

DATA SOURCES

Species Composition: Ponderosa pine, Douglas-fir, western larch, white fir, Engelmann spruce, lodgepole pine

Plot Sizes: 0.1-0.5 acre

Years Measured: 1955 - 1956

Notes: Data from Middle Fork Working Circle, Malheur National Forest.

REQUIRED INPUT

Forest type, board foot volume
Forest type
Species, d.b.h.

CORRESPONDING OUTPUT

For sawtimber stands:
Annual gross change in board foot volume
Annual gross and net change in board foot volume
For sawtimber trees:
Annual gross change in board foot volume
TABLE C.6

FORM OF INFORMATION: Stand growth tables
SPECIES: Sugar pine
REFERENCE: Larsen (1916)

DATA SOURCES
Species Composition: Sugar pine, ponderosa pine, incense-cedar, white fir, Douglas-fir
Site Quality Species: Ponderosa pine
Site Quality Range: II
Site Quality Type: Soil Quality
Age Range: 10-400 years
Notes: Data from Sierra Nevada Mountains.

REQUIRED INPUT

Age

Age, soil quality, forest type

Age, species

CORRESPONDING OUTPUT

For each tree:
- Maximum, minimum, and average height;
- Maximum, minimum, and average diameter growth

For all trees:
- Maximum board foot volume, maximum annual board foot volume growth

For each tree:
- D.b.h., height, board foot volume
### TABLE C.7

**FORM OF INFORMATION:** Stand growth tables  
**SPECIES:** Sugar pine  
**REFERENCE:** Roy (1955)

**DATA SOURCES**

Species Composition: Sugar pine, ponderosa pine, Douglas-fir, white fir, incense-cedar  
Site Index Species: Ponderosa pine  
Site Index Range: 125-200  
Site Index Type: Dunning (1942) Uneven Age  
Notes: Data from California.

**REQUIRED INPUT**

- Residual board foot volume, percent residual board foot volume in sugar pine and white fir, percent residual board foot volume in tree class 1, site index, average board foot volume per tree
- No. poles, percent poles in sugar pine and white fir, percent poles in tree class 1, average diameter of pole stand, site index
- Residual board foot volume, percent residual board foot volume in white fir, percent residual board foot volume in tree classes 4 through 7, site index

**CORRESPONDING OUTPUT**

- For trees $>$11.6 inches d.b.h.:  
  Gross annual Scribner board foot volume growth  
- For trees $>$11.6 inches d.b.h.:  
  Annual ingrowth in Scribner board foot volume from original pole stand  
- For trees $>$11.6 inches d.b.h.:  
  Annual mortality in Scribner board foot volume
Series D: Tree Growth Tables

TABLE D.1

FORM OF INFORMATION: Tree growth tables

SPECIES: Douglas-fir

REFERENCE: Douglas-fir Second-Growth Management Committee (1947)

DATA SOURCES

Vegetation Zones: Western hemlock
Site Index Species: Douglas-fir
Site Index Range: 116-120
Site Index Type: McArdle and Meyer (1930)
Plot Sizes: 0.4 - 1.0 acre
Even-Age
Age Range: 30-150 years
Years
Measured: Every 4-6 years between 1909 and 1960

REQUIRED INPUT

Crown class, d.b.h., age, stocking

CORRESPONDING OUTPUT

10-year change in d.b.h., cubic volume, and board foot volume

TABLE D.2

FORM OF INFORMATION: Tree growth tables

SPECIES: Douglas-fir

REFERENCE: Stoate and Crossin (1959)

DATA SOURCES

Site Index Species: Douglas-fir
Site Index Range: 60-160
Site Index Type: McArdle et al. (1949)
Even-Age
Age Range: See Notes

Notes: Data from coastal British Columbia. For trees <24 ft in height.

REQUIRED INPUT

Total height, site index

CORRESPONDING OUTPUT

Annual height growth of dominant and codominant trees
TABLE D.3

**SPECIES:** Ponderosa pine

**FORM OF INFORMATION:** Tree growth tables

**REFERENCE:** Briegleb (1943)

**DATA SOURCES**

- **Site Index Species:** Ponderosa pine
- **Site Index Range:** 64-92
- **Site Index Type:** Meyer (1938)

**Notes:** 30 plots from eastern Oregon.

**REQUIRED INPUT**

- Age class, tree vigor
- Keen tree class, d.b.h. class
- Site index

**CORRESPONDING OUTPUT**

- 10-year change in d.b.h.
- 10 year percent mortality in board foot volume
- 10-year change in d.b.h. and board foot volume, annual gross and net percent change in board foot volume
- Correction of d.b.h. growth estimates

---

TABLE D.4

**SPECIES:** Ponderosa pine

**FORM OF INFORMATION:** Tree growth tables

**REFERENCE:** Lynch (1958a)

**DATA SOURCES**

- **Species Composition:** Ponderosa pine, lodgepole pine, Douglas-fir
- **Site Quality Species:** Ponderosa pine
- **Site Quality Range:** II-VI
- **Site Quality Type:** Meyer (1938)
- **Plot Sizes:** 0.1-1.0 acres

**Notes:** 50 plots from northeast Washington, northern Idaho, and northwest Montana.

**REQUIRED INPUT**

- Site quality, d.b.h., age

**CORRESPONDING OUTPUT**

- For each tree:
  - 10-year change in d.b.h.
TABLE D.5

**FORM OF INFORMATION:** Tree growth tables

**SPECIES:** Western larch, Douglas-fir

**REFERENCE:** Roe (1951)

## DATA SOURCES

Species Composition: Western larch, Douglas-fir, Engelmann spruce, lodgepole pine

Site Index Species: Western larch

Site Index Value: 83

Uneven-Age

Plot Sizes: 0.2 acre

Notes: 124 plots in 20 stands in western Montana.

### REQUIRED INPUT

D.b.h., species, tree vigor, No. years since cutting

### CORRESPONDING OUTPUT

For each tree >9.6 inches d.b.h.:
- Change in Scribner board foot volume since cutting
- Scribner board foot volume ingrowth since cutting for trees >9.6 inches d.b.h.
### Series E: Stand Yield Equations

**TABLE E.1**

**FORM OF INFORMATION:** Stand yield equations

**SPECIES:** Douglas-fir

**REFERENCE:** Staebler (1955)

### DATA SOURCES

Vegetation Zones: Western hemlock, Sitka spruce

<table>
<thead>
<tr>
<th>Site Index Species</th>
<th>Site Index Range</th>
<th>Site Index Type</th>
<th>Site Index Range</th>
<th>Years Measured</th>
<th>Age Range</th>
<th>Age Range</th>
<th>Age Range</th>
<th>Age Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas-fir</td>
<td>110-200</td>
<td>McArdle et al. (1949)</td>
<td>26-93 years</td>
<td>Up to 35-year records</td>
<td>0.4-1.0 acre</td>
<td>Even-Age</td>
<td>Site Index Range</td>
<td>Site Index Range</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>110-200</td>
<td></td>
</tr>
</tbody>
</table>

**Plot Sizes:** 0.4-1.0 acre

**Notes:** 36 permanent plots.

### REQUIRED INPUT

**CORRESPONDING OUTPUT**

For all trees >1.5 inches d.b.h.:
- Basal area, total cubic volume

For all trees >7 inches d.b.h.:
- International 1/8-inch board foot volume to a 5-inch top

For all trees >12 inches d.b.h.:
- Scribner board foot volume to an 8-inch top
TABLE E.2

FORM OF INFORMATION: Stand yield equations

SPECIES: Douglas-fir


DATA SOURCES

Vegetation Zones: Western hemlock
Species Composition: Douglas-fir, western hemlock, red alder, western redcedar, bigleaf maple, others

Site Index Species: Douglas-fir
Site Index Range: 80-150
Site Index Type: King (1966)
Age Range: 20-120 years

Plot Sizes: 20 basal area factor

Notes: 356 permanent plots and 30 temporary plots.

REQUIRED INPUT

Age at breast height, site index
Percent normal basal area, age at breast height, site index
Basal area, quadratic mean diameter
Age at breast height, site index
Basal area, age at breast height, site index

CORRESPONDING OUTPUT

For trees >7 inches d.b.h.: Basal area
For trees >7 inches d.b.h.: No. trees, quadratic mean diameter total cubic volume, Scribner board foot volume to a 6-inch top
For trees >7 inches d.b.h.: Total cubic volume, Scribner board foot volume to a 6-inch top
For trees >5 inches d.b.h.: Average height
For trees >7 inches d.b.h.: Net basal area growth
TABLE E.3

FORM OF INFORMATION: Stand yield equations

SPECIES: Douglas-fir

REFERENCE: Wiley and Murray (1974)

DATA SOURCES

Vegetation Zones: Western hemlock
Site Index Species: Douglas-fir
Site Index Range: 85-145
Site Index Type: King (1966)

Plot Sizes: 0.1-0.2 acre
Even-Age
Age Range: 10-35 years

Notes: 311 plots: 205 thinned, 106 unthinned.

REQUIRED INPUT

Quadratic mean diameter, thinned (yes or no), average height of site trees
Site index, age at breast height, No. trees
Thinned (yes or no), age at breast height at time of thinning, site index, No. trees after thinning, age at breast height

CORRESPONDING OUTPUT

For all trees >5.6 inches d.b.h.:
Ratio of cubic volume to a 4-inch top to total cubic volume
Quadratic mean diameter
For all trees >1.6 inches d.b.h.:
Average height of site trees, No. trees, quadratic mean diameter, basal area, total cubic volume, cubic volume to a 4-inch top
### TABLE E.4

**FORM OF INFORMATION:** Stand yield equations

**SPECIES:** Douglas-fir

**REFERENCE:** Cochran (1979a)

#### DATA SOURCES

- **Vegetation Zones:** Grand fir, Douglas-fir
- **Species Composition:** Douglas-fir, white fir, grand fir, western larch, Engelmann spruce, ponderosa pine, western white pine
- **Site Index Species:** Douglas-fir
- **Site Index Range:** 50–110
- **Site Index Type:** Cochran (1979b)

**Notes:** 26 plots were used for the equation for net basal area, 31 for the equation for net total cubic volume, 43 for the equation for net basal area Periodic Annual Increment, and 27 for the equation for gross total cubic volume Periodic Annual Increment.

#### REQUIRED INPUT

- Age at breast height, site index

#### CORRESPONDING OUTPUT

- Net per-acre estimates of:
  - Basal area, total cubic volume
- Gross per-acre estimates of:
  - Total cubic volume Periodic Annual Increment, basal area Periodic Annual Increment

### TABLE E.5

**FORM OF INFORMATION:** Stand yield equations

**SPECIES:** Lodgepole pine

**REFERENCE:** Dahms (1964)

#### DATA SOURCES

- **Vegetation Zones:** Ponderosa pine
- **Site Index Species:** Lodgepole pine
- **Site Index Range:** 60–110
- **Site Index Type:** Dahms (1964)

**Plot Sizes:** 0.1–0.2 acre

**Age Range:** 0–120 years

#### REQUIRED INPUT

- Total age, site index
- Average diameter, basal area

#### CORRESPONDING OUTPUT

- Change in gross annual total cubic volume, gross total cubic volume, net total cubic volume
- Crown competition factor
<table>
<thead>
<tr>
<th>TABLE E.6</th>
<th>FORM OF INFORMATION: Stand yield equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECIES: Lodgepole pine</td>
<td>REFERENCE: Dahms (1975)</td>
</tr>
</tbody>
</table>

**DATA SOURCES**

<table>
<thead>
<tr>
<th>Vegetation Zones:</th>
<th>Ponderosa pine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Index Species:</td>
<td>Lodgepole pine</td>
</tr>
<tr>
<td>Site Index Range:</td>
<td>30-70</td>
</tr>
<tr>
<td>Site Index Type:</td>
<td>Dahms (1964)</td>
</tr>
<tr>
<td>Notes:</td>
<td>94 plots</td>
</tr>
<tr>
<td>Plot Sizes:</td>
<td>0.1-0.2 acre</td>
</tr>
<tr>
<td>Even-Age</td>
<td></td>
</tr>
<tr>
<td>Age Range:</td>
<td>28-161 years</td>
</tr>
</tbody>
</table>

**REQUIRED INPUT**

| Total age, site index |

**CORRESPONDING OUTPUT**

| Change in gross annual basal area |

For all trees >1.0 inch d.b.h.:

| Net basal area, net total cubic volume, gross total cubic volume |
TABLE E.7

FORM OF INFORMATION: Stand yield equations

SPECIES: Ponderosa pine

REFERENCE: Lynch (1958b)

DATA SOURCES

Vegetation Zones: Ponderosa pine, Grand fir--Douglas-fir

Site Index Species: Ponderosa pine
Site Index Range: 50-110
Site Index Type: Meyer (1938)

Notes: 209 plots from northeast Washington, northern Idaho, and northwest Montana.

REQUIRED INPUT

No. trees, basal area, total age, average height of dominants
Average height of dominants, total age, basal area
Quadratic mean diameter, average height of dominants, No. trees, board foot/cubic foot ratio
Total age, site index

CORRESPONDING OUTPUT

Stocking
Future stocking and No. trees
Future board foot and cubic volume
For all trees >0.6 inch d.b.h.: No. trees, average height of dominants, basal area, quadratic mean diameter, total cubic volume, International 1/4-inch board foot volume to a variable top

TABLE E.8

FORM OF INFORMATION: Stand yield equations

SPECIES: Ponderosa pine

REFERENCE: Oliver and Powers (1978)

DATA SOURCES

Species Composition: Ponderosa pine
Site Index Species: Ponderosa pine
Site Index Range: 35-120
Site Index Type: Powers and Oliver (1978)

Notes: Data from 367 trees in 12 plantations in northern California.

REQUIRED INPUT

Age since planting, site index, spacing at initial planting

CORRESPONDING OUTPUT

Net total cubic foot volume (less stump)
TABLE E.9

FORM OF INFORMATION: Stand yield equations

SPECIES: Red alder

REFERENCE: Worthington et al. (1960)

DATA SOURCES

Vegetation Zones: Sitka spruce, western hemlock

Site Index Species: Red alder
Site Index Range: 60-120
Site Index Type: Worthington et al. (1960)
Plot Sizes: 0.025-0.2 acre
Notes: 428 plots

Even-Age
Age-Range: 10-80 years
Years Measured: 1956-1957

REQUIRED INPUT

Total age, site index

CORRESPONDING OUTPUT

For all trees >0.6 inch, or >5.6 inches, or >9.6 inches d.b.h.:
No. trees, quadratic mean diameter, basal area

For all trees >5.6 inches or >9.6 inches d.b.h.:
Cubic volume to a 4-inch top

For all trees >9.6 inches d.b.h.:
Scribner board foot volume to an 8-inch top
TABLE E.10

FORM OF INFORMATION: Stand yield equations

SPECIES: Red alder

REFERENCE: Chambers (1974)

DATA SOURCES

Vegetation Zones: Western hemlock, Sitka spruce
Species Composition: Red alder, Douglas-fir, western hemlock, bigleaf maple, western redcedar, Sitka spruce, others

Site Index Species: Red alder
Site Index Range: 70-120
Site Index Type: Worthington et al. (1960)
Plot Sizes: 20 basal area factor
Notes: 174 permanent plots

 REQUIRED INPUT

Total age, site index

Percent of normal basal area, total age, site index

Site index, quadratic mean diameter, basal area

 CORRESPONDING OUTPUT

For all trees >7 inches d.b.h.:
Basal area

For all trees >7 inches d.b.h.:
No. trees, quadratic mean diameter, total cubic volume, Scribner board foot volume to a 6-inch top

For all trees >7 inches d.b.h.:
Total cubic volume, total Scribner board foot volume
TABLE E.11

FORM OF INFORMATION: Stand yield equations

SPECIES: Redwood and Douglas-fir mixture

REFERENCE: Krumland and Wensel (1977b)

DATA SOURCES

Species Composition: Redwood, Douglas-fir
Site Index Species: Redwood or Douglas-fir
Site Index Type: Krumland and Wensel (1977a) or King (1966)

Plot Sizes: 0.1-0.5 acre
Even-Age
Age Range: 20-100 years

Notes: 159 permanent growth plots from Del Norte, Humboldt, and Mendocino counties of California.

REQUIRED INPUT

Age at breast height, site index, basal area >11.5 inches, percent basal area in Douglas-fir

CORRESPONDING OUTPUT

For trees >11.5 inches d.b.h.: Total cubic volume (less stump volume), Scribner board foot volume to a 6-inch top

TABLE E.12

FORM OF INFORMATION: Stand yield equations

SPECIES: Western hemlock

REFERENCE: Chambers and Wilson (1978)

DATA SOURCES

Vegetation Zones: Sitka spruce, western hemlock
Species Composition: Western hemlock, Douglas-fir, Pacific silver fir, Sitka spruce, western redcedar, others

Site Index Species: Western hemlock
Site Index Range: 70-150
Age Range: 30-100 years

Plot Sizes: 20 basal area factor
Even-Age
Age Range: 30-100 years

Notes: 277 permanent plots

REQUIRED INPUT

Total age, site index
Percent of normal basal area, total age, site index
Quadratic mean diameter, basal area

CORRESPONDING OUTPUT

Basal area
For all trees >7 inches d.b.h.: No. trees, quadratic mean diameter, total cubic volume, Scribner board foot volume to a 6-inch top
For all trees >7 inches d.b.h.: Total cubic volume, Scribner board foot volume to a 6-inch top
TABLE E.15

FORM OF INFORMATION: Stand yield equations

SPECIES: White fir or grand fir

REFERENCE: Cochran (1979a)

DATA SOURCES

Vegetation Zones: Grand fir, Douglas-fir
Species Composition: White fir, grand fir, Douglas-fir, western larch, Engelmann spruce, ponderosa pine, western white pine

Site Index Species: White fir, grand fir
Site Index Range: 50-110
Site Index Type: Cochran (1979c)

Plot Sizes: 0.1 - 0.2 acres
Even-Age
Age Range: 0-120 years

Notes: 26 plots were used for equation on net basal area, 37 for equations on net total cubic volume and gross total cubic volume Periodic Annual Increment, and 46 for equations on net basal area Periodic Annual Increment.

REQUIRED INPUT

Age at breast height, site index

CORRESPONDING OUTPUT

Net per-acre estimates of:
Basal area, total cubic volume

Gross per-acre estimates of:
Total cubic volume Periodic Annual Increment, basal area Periodic Annual Increment
Series F: Stand Growth/Mortality Equations

TABLE F.1

FORM OF INFORMATION: Stand growth equations

SPECIES: Douglas-fir

REFERENCE: Briegleb (1942)

DATA SOURCES

Site Index Species: Douglas-fir
Site Index Range: 98-203
Site Index Type: McArdle and Meyer (1930)

Notes: 45 plots distributed over western Oregon and Washington.

REQUIRED INPUT

Total age, current percent normality

CORRESPONDING OUTPUT

5-year change in percent normality for:
No. trees, basal area, cubic volume,
International board foot volume, Scribner
board foot volume

TABLE F.2

FORM OF INFORMATION: Stand mortality equation

SPECIES: Douglas-fir

REFERENCE: Staebler (1953)

DATA SOURCES

Vegetation Zones: Western hemlock, Sitka spruce

Site Index Species: Douglas-fir
Site Index Range: 110-200
Site Index Type: McArdle et al. (1949)

Plot Sizes: 0.4-1.0 acre

Notes: 36 permanent plots

REQUIRED INPUT

Total age, d.b.h., site index, crown class

CORRESPONDING OUTPUT

10-year mortality in percent of total number of trees by 2-inch diameter classes
TABLE F.3

FORM OF INFORMATION: Stand growth equations

SPECIES: Douglas-fir

REFERENCE: Warrack (1959)

DATA SOURCES

Even-Age
Age Range: 10–68 years

Notes: European case histories; British yield tables; 11 plots in British Columbia.

REQUIRED INPUT

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<thead>
<tr>
<th>QUADRATIC MEAN DIAMETER BEFORE AND AFTER</th>
<th>CORRESPONDING OUTPUT</th>
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</thead>
<tbody>
<tr>
<td>THINNING, AGE, RESIDUAL BASAL AREA</td>
<td>PERCENT CHANGE IN RESIDUAL BASAL AREA</td>
</tr>
<tr>
<td>QUADRATIC MEAN DIAMETER BEFORE AND</td>
<td>CHANGE IN AVERAGE HEIGHT PER UNIT OF CHANGE</td>
</tr>
<tr>
<td>AFTER THINNING</td>
<td>IN D.B.H.</td>
</tr>
<tr>
<td>QUADRATIC MEAN DIAMETER BEFORE AND</td>
<td>RATIO OF AVERAGE HEIGHT BEFORE THINNING TO AVERAGE HEIGHT AFTER THINNING</td>
</tr>
<tr>
<td>AFTER THINNING, AGE</td>
<td></td>
</tr>
</tbody>
</table>

TABLE F.4

FORM OF INFORMATION: Stand growth equations

SPECIES: Douglas-fir

REFERENCE: Staebler (1960)

DATA SOURCES

Site Index Species: Douglas-fir
Site Index Value: 170
Site Index Type: McArdle et al. (1949)
Even-Age

Notes: Western Oregon and Washington.

REQUIRED INPUT

<table>
<thead>
<tr>
<th>DESIRED THINNING AGE(S) AND AVERAGE</th>
<th>CORRESPONDING OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.B.H., TOTAL HEIGHT AT THINNING AGE(S), TOTAL CUBIC VOLUME PER TREE AT THINNING AGE(S), GROSS TOTAL CUBIC VOLUME AT THINNING AGE(S) (NORMAL YIELD)</td>
<td>NO. OF TREES AT THINNING AGE(S), CUBIC VOLUME REMOVED AT THINNING AGE(S), CUBIC VOLUME NORMALITY AT THINNING AGE(S)</td>
</tr>
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</table>
TABLE F.5

**FORM OF INFORMATION:** Stand growth equations

**SPECIES:** Douglas-fir

**REFERENCE:** Curtis (1967)

**DATA SOURCES**

Vegetation Zones: Western hemlock
Species Composition: At least 80 percent Douglas-fir

Site Index Species: Douglas-fir
Site Index Range: 60-150
Site Index Type: King (1966)

Plot Sizes: 0.05-1.0 acre
Even-Age
Age Range: 15-115 years

**Notes:** 80 permanent and 19 temporary plots in western Oregon and Washington.

**REQUIRED INPUT**

- Basal area, age at breast height, site index
- Total age, site index, basal area

**CORRESPONDING OUTPUT**

- Gross total cubic volume growth
- Gross basal area growth

---

**TABLE F.6**

**FORM OF INFORMATION:** Stand growth equations

**SPECIES:** Douglas-fir

**REFERENCE:** Curtis et al. (1974)

**DATA SOURCES**

Vegetation Zones: Pacific silver fir
Species Composition: Douglas-fir, Pacific silver fir, western hemlock, noble fir

Site Index Species: Douglas-fir
Site Index Range: 60-160
Site Index Type: Curtis et al. (1974)

Even-Age
Plot Sizes: Single tree
Age Range: 80-400 years

**Notes:** Data from 52 trees from 52 0.25-acre plots; site index curves also presented. Data were from stem analysis.

**REQUIRED INPUT**

- Age at breast height, site index

**CORRESPONDING OUTPUT**

- Height of dominants
TABLE F.7
FORM OF INFORMATION: Stand growth equations
SPECIES: Douglas-fir
REFERENCE: Turnbull and Peterson (1976)

DATA SOURCES
Vegetation Zones: Sitka spruce, western hemlock
Species Composition: At least 80 percent Douglas-fir

Site Index Species: Douglas-fir
Site Index Range: 76-152
Site Index Type: King (1966)

Notes: 87 installations with 6 plots in each.

REQUIRED INPUT
CORRESPONDING OUTPUT
Age at breast height, site index, basal area, No. trees
4-year cubic volume Periodic Annual Increment of untreated stands
Site index, pounds of nitrogen
Increase in 4-year cubic volume Periodic Annual Increment as a result of fertilization

TABLE F.8
FORM OF INFORMATION: Stand growth equations
SPECIES: Douglas-fir
REFERENCE: Cochran (1979b)

DATA SOURCES
Vegetation Zones: Grand fir and Douglas-fir

Site Index Species: Douglas-fir
Site Index Range: 50-110
Site Index Type: Cochran (1979b)

Notes: Site index curves also presented; 3-5 trees on each of 32 plots were sectioned.

REQUIRED INPUT
CORRESPONDING OUTPUT
Age at breast height, site index
Height of dominants
TABLE F.9

FORM OF INFORMATION: Stand growth equations

SPECIES: Douglas-fir

REFERENCE: Bruce (1981)

DATA SOURCES

Species Composition: At least 80 percent Douglas-fir

Site Index Species: Douglas-fir
Site Index Type: King (1966)
Even-Age
Age Range: 6-80 years old at breast height

Notes: 2,796 plot-growth period combinations from the data described in Curtis et al. (1981).

REQUIRED INPUT

Age at breast height, site index
Age at breast height, site index, average total height of 40 largest trees/acre, pounds of nitrogen, time since fertilization

CORRESPONDING OUTPUT

Average total height of 40 largest trees/acre
Average total height-growth rate of 40 largest trees/acre

TABLE F.10

FORM OF INFORMATION: Stand mortality equations

SPECIES: Lodgepole pine

REFERENCE: Lee (1971)

DATA SOURCES

Even-Age

Notes: Data for developing models came from British Columbia and Alberta yield tables (British Columbia Forest Service 1936, Smithers 1961)

REQUIRED INPUT

Total age
Average diameter

CORRESPONDING OUTPUT

Annual stand mortality in percent of total trees
Annual stand mortality in percent of total trees
TABLE F.11

FORM OF INFORMATION: Stand growth equations

SPECIES: Noble fir

REFERENCE: Herman et al. (1978)

DATA SOURCES

Vegetation Zones: Pacific silver fir
Site Index Species: Noble fir
Site Index Range: 60-160
Site Index Type: Herman et al. (1978)

Plot Sizes: Single-tree
Even-Age
Age Range: 10-400 years

Notes: Data from 60 trees on 60 0.25-acre plots. Site index curves also presented. Data collected from stem analyses.

REQUIRED INPUT

CORRESPONDING OUTPUT

Age at breast height, site index
Total height of dominants

TABLE F.12

FORM OF INFORMATION: Stand growth equations

SPECIES: Ponderosa pine

REFERENCE: Arvanitis et al. (1964)

DATA SOURCES

Site Index Species: Ponderosa pine
Site Index Range: 60-180+
Site Index Type: Arvanitis et al. (1964)

Plot Sizes: Single-tree
Even-Age
Age Range: 11-100 years old at breast height

Notes: 208 trees from Mineral to Sonora, California

REQUIRED INPUT

CORRESPONDING OUTPUT

Site index, age at breast height
Height of dominants
TABLE F.13  
FORM OF INFORMATION: Stand growth equations
SPECIES: Ponderosa pine
REFERENCE: Oliver (1972)

DATA SOURCES

Species Composition: Ponderosa pine, Jeffrey pine

Site Index Species: Ponderosa pine  
Site Index Range: 65-80  
Site Index Type: Meyer (1938)  
Plot Sizes: 0.12-2.00 acres

Even-Age  
Age Range: 28-70 years  
Years Measured: 1945-1970

Notes: 12 plots in Modoc and Lassen counties of California.

REQUIRED INPUT
Basal area

CORRESPONDING OUTPUT
D.b.h. Periodic Annual Increment, height Periodic Annual Increment, cubic volume Periodic Annual Increment

TABLE F.14  
FORM OF INFORMATION: Stand growth equations
SPECIES: Ponderosa pine
REFERENCE: Barrett (1978)

DATA SOURCES

Vegetation Zones: Ponderosa pine, Douglas-fir, grand fir

Site Index Species: Ponderosa pine  
Site Index Range: 72-145  
Site Index Type: Barrett (1978)  
Plot Sizes: Single trees

Even-Age  
Age Range: 10-180 years old at breast height

Notes: 177 trees on 30 1/5-acre plots. Data collected from stem analyses.

REQUIRED INPUT
Age at breast height, site index

CORRESPONDING OUTPUT
Height of tallest tree
TABLE F.15
FORM OF INFORMATION: Stand growth equations
SPECIES: Ponderosa pine
REFERENCE: Powers and Oliver (1978)

DATA SOURCES
Species Composition: Ponderosa pine
Site Index Species: Ponderosa pine
Site Index Range: 31-117
Site Index Type: Powers and Oliver (1978)
Plot Sizes: 0.05-0.5 acre
Even-Age
Age Range: 10-80 years

Notes: Data from 135 trees on 26 plots in northern California.

REQUIRED INPUT
Total age, site index

CORRESPONDING OUTPUT
Height of dominants

TABLE F.16
FORM OF INFORMATION: Stand growth equations
SPECIES: Ponderosa pine
REFERENCE: Oliver (1979)

DATA SOURCES
Species Composition: Ponderosa pine, Jeffrey pine
Site Index Species: Ponderosa pine
Site Index Range: 45-55
Site Index Type: Powers and Oliver (1978)
Plot Sizes: 0.75-2.00 acres
Even-Age
Age Range: 28-45 years
Years Measured: 1959, 1960 or 1961;
1966, 1970 or 1971;
1975

Notes: 6 plots in extreme northeastern California.

REQUIRED INPUT
Basal area, years since thinning

CORRESPONDING OUTPUT
5-year Periodic Annual Increment for:
average d.b.h., basal area, total cubic
volume (less stump)
### TABLE F.17

**FORM OF INFORMATION:** Stand growth equations  
**SPECIES:** Redwood  
**REFERENCE:** Lindquist and Palley (1967)

**DATA SOURCES**

<table>
<thead>
<tr>
<th>Species Composition</th>
<th>At least 80 percent redwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Index Species</td>
<td>Redwood</td>
</tr>
<tr>
<td>Site Index Range</td>
<td>100-200+</td>
</tr>
<tr>
<td>Site Index Type</td>
<td>Lindquist and Palley (1961)</td>
</tr>
<tr>
<td>Plot Sizes</td>
<td>10, 20, or 40 basal area</td>
</tr>
<tr>
<td>Notes</td>
<td>163 temporary plots in Del Norte, Humboldt, Mendocino, and Sonoma Counties of California.</td>
</tr>
</tbody>
</table>

**REQUIRED INPUT**

<table>
<thead>
<tr>
<th>Required Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at breast height, basal area</td>
</tr>
<tr>
<td>Age at breast height, basal area, site index</td>
</tr>
</tbody>
</table>

**CORRESPONDING OUTPUT**

<table>
<thead>
<tr>
<th>Corresponding Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net 10-year basal area growth for trees &gt;4.5 inches d.b.h.</td>
</tr>
<tr>
<td>Net 10-year growth in cubic volume to a 4-inch top for trees &gt;4.5 inches d.b.h.</td>
</tr>
<tr>
<td>Net 10-year growth in International 1/4-inch board foot volume to an 8-inch top for trees &gt;10.5 inches d.b.h.</td>
</tr>
<tr>
<td>Net 10-year growth in International 1/4-Inch board foot volume to an 8-inch top for trees &gt;15.5 inches d.b.h.</td>
</tr>
</tbody>
</table>

### TABLE F.18

**FORM OF INFORMATION:** Stand growth equations  
**SPECIES:** Redwood  
**REFERENCE:** Krumland and Wensel (1977a)

**DATA SOURCES**

<table>
<thead>
<tr>
<th>Site Index Species</th>
<th>Redwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Index Range</td>
<td>70-140</td>
</tr>
<tr>
<td>Site Index Type</td>
<td>Krumland and Wensel (1977a)</td>
</tr>
<tr>
<td>Notes</td>
<td>123 felled trees and 37 permanent plot records were used for analysis from Del Norte, Humboldt, and Mendocino counties of California.</td>
</tr>
</tbody>
</table>

**REQUIRED INPUT**

- Site index, age at breast height

**CORRESPONDING OUTPUT**

- Total height of dominants
TABLE F.19

**FORM OF INFORMATION:** Stand growth equations

**SPECIES:** Western larch

**REFERENCE:** Schmidt et al. (1976)

**DATA SOURCES**

Site Index Species: Western larch
Even-Age

Notes: Based on a re-analysis of Cummings' (1937) basic data.

**REQUIRED INPUT**

<table>
<thead>
<tr>
<th>Total age, site index</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>CORRESPONDING OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of dominant and codominant trees</td>
</tr>
</tbody>
</table>

**TABLE F.20**

**FORM OF INFORMATION:** Stand growth equations

**SPECIES:** Western larch

**REFERENCE:** Seidel (1980b)

**DATA SOURCES**

Vegetation Zones: Grand fir
Species Composition: Western larch, Douglas-fir, grand fir, Engelmann spruce, ponderosa pine

Site Index Species: Western larch
**Site Index Value:** 83
**Site Index Type:** Schmidt et al. (1976)
**Plot Sizes:** 0.286 acre

Notes: 16 plots: 4 density levels (50, 90, 130, and 170 square feet/acre); 2 types of thinning (above and below); and 2 replications.

**REQUIRED INPUT**

| Basal area, thinning type, time since thinning |

**CORRESPONDING OUTPUT**

| Periodic annual diameter growth, net and gross periodic annual basal area growth, periodic annual net and gross total cubic volume growth, periodic annual net and gross International 1/4-inch board foot volume growth for trees >10.0 inches d.b.h. |
TABLE F.21  

**FORM OF INFORMATION:** Stand growth equations  

**SPECIES:** Western white pine  

**REFERENCE:** Watt (1960)  

**DATA SOURCES**

| Species Composition: Western white pine, Douglas-fir, grand fir, western larch, western hemlock, lodgepole pine, western redcedar, subalpine fir | Site Index Species: Western white pine | Plot Sizes: 0.025-2.0 acre | Site Index Range: 16-95 | Even-Age | Site Index Type: Haig (1932) | Age Range: 16-125 years | Notes: 94 plots from northern Idaho, 88 plots used in equation for change in site index, 94 plots in equation for change in normality. |

**REQUIRED INPUT**

| Total age, site index | 5-year change in site index |
| Site index | 20-year change in site index |
| Total age, percent normality, species composition index | Percent change in normality for basal area, total cubic volume and Scribner board foot volume |

**TABLE F.22**

**FORM OF INFORMATION:** Stand growth equations  

**SPECIES:** White fir or grand fir  

**REFERENCE:** Cochran (1979c)  

**DATA SOURCES**

| Vegetation Zones: Grand fir, Douglas-fir | Site Index Species: White fir, grand fir | Plot Sizes: Single-tree | Site Index Range: 50-110 | Even-Age | Site Index Type: Cochran (1979c) | Age Range: 10-100 years | Notes: Site index curves also presented; 2-5 trees on each of 34 plots were sectioned. |

**REQUIRED INPUT**

| Age at breast height, site index | Height of dominants |
Series G: Tree Growth/Mortality Equations

TABLE G.1
FORM OF INFORMATION: Tree growth equations
SPECIES: Douglas-fir
REFERENCE: Flora and Fedkiw (1964)

DATA SOURCES
Site Index Species: Douglas-fir
Site Index Range: 110-200
Site Index Type: McArdle et al. (1961)

REQUIRED INPUT
Age, site index, d.b.h., number of rings in last breast-high radial inch

CORRESPONDING OUTPUT
For each tree:
Annual or 5-year change in Scribner board foot volume to a 6-inch top

TABLE G.2
FORM OF INFORMATION: Tree mortality equations
SPECIES: Douglas-fir, grand fir, western larch, western redcedar, western white pine
REFERENCE: Hamilton and Edwards (1976)

DATA SOURCES
Plot Sizes: 25 basal area factor points
Notes: Data from northern Idaho. Number of trees measured by species: Douglas-fir, 2,036; grand fir, 3,864; western larch, 784; western redcedar, 3,282; western white pine, 1,363. Equations also available for ponderosa pine, western hemlock, Engelmann spruce, subalpine fir, mountain hemlock, lodgepole pine.

REQUIRED INPUT
For Douglas-fir:
Tree height, tree d.b.h.

For grand fir and western redcedar:
Percent of tree that is defective, and crown class; or stand basal area, and tree d.b.h.

For western larch:
Stand age, tree height, tree d.b.h.

For western white pine:
Stand basal area, tree d.b.h.

CORRESPONDING OUTPUT
Annual mortality rate (as a proportion of total No. trees)
### TABLE G.3

**FORM OF INFORMATION:** Tree growth equations  
**SPECIES:** Douglas-fir  
**REFERENCE:** Crown et al. (1977), Hall et al. (1980)

**DATA SOURCES**

<table>
<thead>
<tr>
<th>Species Composition</th>
<th>Site Index Species</th>
<th>Site Index Value</th>
<th>Site Index Type</th>
<th>Plot Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas-fir</td>
<td>Douglas-fir</td>
<td>69</td>
<td>King (1966)</td>
<td>0.1 acre</td>
</tr>
</tbody>
</table>

**Notes:** 36 plots from Shawnigan Lake area of British Columbia.

**REQUIRED INPUT**

- Level of fertilization, level of thinning, d.b.h.

**CORRESPONDING OUTPUT**

- For 3 and 6 years:  
  - d.b.h. Periodic Annual Increment,  
  - basal area Periodic Annual Increment,  
  - height Periodic Annual Increment,  
  - total cubic volume Periodic Annual Increment

---

### TABLE G.4

**FORM OF INFORMATION:** Tree mortality equations  
**SPECIES:** Douglas-fir, red alder, redwood, and tanoak  
**REFERENCE:** Krumland et al. (1977)

**DATA SOURCES**

<table>
<thead>
<tr>
<th>Species Composition</th>
<th>Age Range</th>
<th>Plot Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redwood, Douglas-fir, white fir, western hemlock, Sitka spruce, tanoak, red alder, Pacific madrone, bigleaf maple</td>
<td>10-100 years</td>
<td>0.1-0.5 acre</td>
</tr>
</tbody>
</table>

**Notes:** 506 permanent plots from Del Norte, Humboldt, and Mendocino counties of California.

**REQUIRED INPUT**

- Tree d.b.h., quadratic mean diameter of stand, average diameter of stand, No. trees in stand, species

**CORRESPONDING OUTPUT**

- Probability that tree will die in the next year
TABLE G.5

FORM OF INFORMATION: Tree growth equations

SPECIES: Grand fir

REFERENCE: Seidel (1980a)

DATA SOURCES

Vegetation Zones: Grand fir
Species Composition: Grand fir, Douglas-fir, western larch, ponderosa pine, lodgepole pine

Site Index Species: White fir
Site Index Value: 45
Site Index Type: Cochran (1979c)

Plot Sizes: Single-tree
Years Measured: 1974, 1976, and 1979

Notes: 115 trees measured on a 40-acre stand. Released understory trees.

REQUIRED INPUT

Crown ratio, height growth 1 year before release, crown diameter, height, height growth 5 years before release

CORRESPONDING OUTPUT

2-year d.b.h. growth, 5-year d.b.h. growth, 2-year height growth, 5-year height growth

TABLE G.6

FORM OF INFORMATION: Tree growth equations

SPECIES: Lodgepole pine

REFERENCE: Cole and Stage (1972)

DATA SOURCES

Site Index Type: Alexander et al. (1977) Years Measured: 1957-1960
Even-Age

Notes: 264 trees on 88 permanent plots located in Idaho, Montana, Wyoming, and Utah.
Equations also available for Rocky Mountain ponderosa pine, Douglas-fir, western larch, western white pine, western redcedar, western hemlock, Engelmann spruce, subalpine fir, grand fir, mountain hemlock.

REQUIRED INPUT

Tree d.b.h., crown competition factor, average diameter, elevation, site index, age at breast height

CORRESPONDING OUTPUT

10-year basal area increment
TABLE G.7

SPECIES: Lodgepole pine

FORM OF INFORMATION: Tree growth equations
REFERENCE: Stage (1975)

DATA SOURCES

Plot Sizes: Single-tree

Years Measured: 1969-1972

Notes: 1,165 trees used to develop equations. Equations also available for Rocky Mountain ponderosa pine, Douglas-fir, western larch, western white pine, western redcedar, western hemlock, Engelmann spruce, subalpine fir, grand fir, mountain hemlock.

REQUIRED INPUT

Habitat type, diameter growth, height, d.b.h., crown ratio

CORRESPONDING OUTPUT

For each tree:
10-year change in height

TABLE G.8

SPECIES: Ponderosa pine

FORM OF INFORMATION: Tree growth equations
REFERENCE: Lemmon and Schumacher (1962)

DATA SOURCES

Site Index Species: Ponderosa pine
Site Index Range: 40-160
Site Index Type: Meyer (1938)

Even-Age
Age Range: 31-160 years
Years Measured: 1954-1957

Notes: Some single-tree plots. Data from Montana, Idaho, Washington, Oregon, California, and Arizona.

REQUIRED INPUT

Total age, site index, basal area of dominants and codominants, d.b.h., height
Total age, basal area of dominants and codominants, d.b.h.
Total age, site index

CORRESPONDING OUTPUT

5- and 10-year change in cubic volume
5-year radial growth, No. growth rings in last radial inch at breast height
No. trees, basal area, quadratic mean diameter, total cubic volume, International 1/8-inch board foot volume for the dominant stand
### TABLE G.9

**FORM OF INFORMATION:** Tree mortality equations

**SPECIES:** Red fir, white fir

**REFERENCE:** Ferrell (1980)

**DATA SOURCES**

Species Composition: White fir, red fir, grand fir

Plot Sizes: 1.0 and 20.0 acres

Years Measured: 1975-1977

Notes: 1,012 trees from 47 clusters composed of a 20-acre plot for measuring mortality and a 1.0-acre subplot of live trees in northern California.

**REQUIRED INPUT**

Crown class, crown ratio, top condition, ragged crown percent, species

**CORRESPONDING OUTPUT**

One-year probability of mortality
### Table H.1

**Species:** Douglas-fir  
**Vegetation Zones:** Western hemlock  
**Site Index Species:** Douglas-fir  
**Site Index Range:** 60-140  
**Site Index Type:** King (1966)  
**Notes:** 308 plots

**Form of Information:** Whole-stand simulator  
**Reference:** Hoyer (1975)

#### Data Sources

- **Even-Age**  
  - Age Range: 11-42 years

#### Required Input

- Total age, basal area, site index, nature and intensity of thinning, fertilization (yes or no)

#### Corresponding Output

- For all trees >1.5 inches d.b.h. before thinning:  
  - Average height, average tariff, No. trees, quadratic mean diameter, basal area, total cubic volume, Scribner board foot volume to a 6-inch top

- For all removals >1.5 inches d.b.h.:  
  - Average tariff, No. trees, quadratic mean diameter, basal area, total cubic volume, Scribner board foot volume to a 6-inch top.

- For residual trees >1.5 inches d.b.h.:  
  - Average tariff, quadratic mean diameter, total cubic volume, Scribner board foot volume to a 6-inch top, basal area, 5-year basal area growth.
TABLE H.2

FORM OF INFORMATION: Whole-stand simulator

SPECIES: Douglas-fir

REFERENCE: Bruce et al. (1977); Reukema and Bruce (1977)

DATA SOURCES

Vegetation Zones: Sitka spruce, western hemlock, Willamette Valley, Pacific silver fir

Species Composition: Douglas-fir, western hemlock, western redcedar, grand fir, Pacific silver fir, noble fir, western white pine, bigleaf maple, red alder, black cottonwood, Oregon white oak

Site Index Species: Douglas-fir

Site Index Range: 80-200

Site Index Type: McArdle et al. (1961)

Plot Sizes: 0.0625-4.0 acres

Age Range: 20-180 years

Years Measured: 1909, 1911, 1924-25

Notes: Based on a combination of data from McArdle et al. (1961) and more recent data from thinning experiments.

REQUIRED INPUT

Site index, merchantability standards, nature and intensity of:

Site index, merchantability standards, thinning, precommercial thinning, fertilization, genetic improvement

CORRESPONDING OUTPUT

For removals and residuals:

Quadratic mean diameter, basal area, No. trees, total cubic volume, cubic volume to a 4-inch top, International 1/4-inch board foot volume to a 5-inch top
TABLE H.3

**FORM OF INFORMATION:** Whole-stand simulator

**SPECIES:** Douglas-fir

**REFERENCE:** Curtis et al. (1981)

### DATA SOURCES

| Vegetation Zones: | Sitka spruce, western hemlock, Willamette Valley, Pacific silver fir |
| Species Composition: | At least 80 percent Douglas-fir |
| Site Index Species: | Douglas-fir |
| Site Index Range: | 52-162 |
| Site Index Type: | King (1966) |

**Plot Sizes:** 0.05-1.0 acre

**Even-Age **Age Range: 12-91 years

**Notes:** 203 installations consisting of 1,434 plots.

### REQUIRED INPUT

To project a regional "average" stand:
- Site index; stand origin (natural, seeded or planted); age and intensity of precommercial thinning; number, timing and type or intensity of commercial thinning; timing and quantity of fertilization; timing of final harvest.

Additional required input to project an existing stand:
- Total age and No. trees >1.6 inches d.b.h.; or total age and No. trees >1.6 inches d.b.h. and quadratic mean d.b.h. >1.6 inches; or total age, and quadratic mean diameter >1.6 inches, and basal area >1.6 inches at breast height; or total age and No. trees >1.6 inches d.b.h and basal area >1.6 inches at breast height.

### CORRESPONDING OUTPUT

For all trees >1.6 inches d.b.h.:
- Height of 40 largest trees, Lorey's height, quadratic mean diameter, basal area, No. trees, total cubic volume, net annual total cubic volume growth, net total cubic volume Mean Annual Increment, net cubic volume to a 4-inch top Mean Annual Increment for trees >5.6 inches d.b.h., net cubic volume to a 4-inch top Mean Annual Increment for trees >7.6 inches d.b.h.

For all trees >5.6 inches d.b.h.:
- Quadratic mean diameter, basal area, No. trees, total cubic volume, cubic volume to a 4-inch top

For all trees >7.6 inches d.b.h.:
- Quadratic mean diameter, basal area, No. trees, total cubic volume, cubic volume to a 4-inch top, cubic volume to a 6-inch top, International 1/4-inch board foot volume to a 6-inch top, Scribner board foot volume to a 6-inch top
### TABLE 1.1

**FORM OF INFORMATION:** Single-tree/distance-independent simulator  

**SPECIES:** Lodgepole pine  

**REFERENCE:** Stage (1973)

**DATA SOURCES**

**Site Index Type:** Alexander et al. (1967)

**Notes:** Adapted to the following northern Rocky Mountain species: ponderosa pine, Douglas-fir, western larch, western white pine, western redcedar, western hemlock, Engelmann spruce, subalpine fir, grand fir, mountain hemlock.

**REQUIRED INPUT**

- Stand characteristics:
  - Site index, habitat type, age, total area, elevation, latitude, slope, aspect

- Tree data from representative sample:
  - D.b.h., height, crown ratio, radial increment, species, expansion factor

**CORRESPONDING OUTPUT**

- For each stand:
  - Average diameter, No. trees, basal area, relative density, cubic volume, bole surface area, bole length

- For each tree:
  - D.b.h., height, crown ratio

**Sample design information**

**Management information**

---

### TABLE 1.2

**FORM OF INFORMATION:** Single-tree/distance-independent simulator  

**SPECIES:** Ponderosa pine  

**REFERENCE:** Lemmon and Schumacher (1963)

**DATA SOURCES**

- **Site Index Species:** Ponderosa pine
- **Site Index Range:** 40-160
- **Site Index Type:** Meyer (1938)  

**Notes:** Some single-tree plots. Data from Montana, Idaho, Washington, Oregon, California, and Arizona.

**REQUIRED INPUT**

- For normal stands at age 30:
  - Quadratic mean diameter, No. trees, basal area, site index, nature and intensity of thinning

**CORRESPONDING OUTPUT**

- Basal area, No. trees, quadratic mean diameter, cubic volume to a 4-inch top, International 1/8-inch board foot volume to an 8-inch top
TABLE 1.3

FORM OF INFORMATION: Single-tree/distance-independent simulator

SPECIES: Redwood, Douglas-fir, red alder, tanoak

REFERENCE: Krumland and Wensel (1980a, b, c, d; 1981)

DATA SOURCES

Species Composition: Redwood, Douglas-fir, white fir, western hemlock, Sitka spruce, tanoak, red alder, Pacific madrone, bigleaf maple

Site Index Species: Redwood and Douglas-fir

Site Index Type: Krumland and Wensel (1977a) or King (1966)

Plot Sizes: 0.1-0.5 acre

Notes: 512 plots from Del Norte, Humboldt, and Mendocino counties of California.

REQUIRED INPUT

Stand characteristics:
Age at breast height, site index, timing and type/intensity of cutting (both thinning and harvest)

Tree data from representative sample:
D.b.h., height, crown ratio, species, expansion factor

CORRESPONDING OUTPUT

For redwood, Douglas-fir, and the stand total:
Quadratic mean diameter, No. trees, basal area, total cubic volume, Scribner board foot volume to a 6-inch top, 5-year basal area growth, 5-year total cubic volume growth, 5-year Scribner board foot volume to a 6-inch top growth

For individual trees:
Species, d.b.h., height, crown ratio, expansion factor, 5-year d.b.h. growth, 5-year height growth, absolute fraction of normal height growth, absolute fraction of normal tree basal area growth
Series J: Single-Tree/Distance-Dependent Simulators

TABLE J.1

FORM OF INFORMATION: Single-tree/distance-dependent simulator

SPECIES: Douglas-fir

REFERENCE: Newnham and Smith (1964)

DATA SOURCES

Even-Age
Notes: Data from British Columbia

REQUIRED INPUT

For each tree:
Coordinates, species, d.b.h.
Nature and intensity of thinning

CORRESPONDING OUTPUT

For each tree:
D.b.h., height

For each stand:
No. trees, average diameter, basal area

TABLE J.2

FORM OF INFORMATION: Single-tree/distance-dependent simulator

SPECIES: Douglas-fir

REFERENCE: Arney (1974)

DATA SOURCES

Vegetation Zones: Western hemlock
Site Index Species: Douglas-fir
Site Index Range: 80-116

Site Index Type: King (1966)
Even-Age
Age Range: 25-60 years

REQUIRED INPUT

Site index, stem coordinates, No. years to reach breast height, nature and intensity of thinning

CORRESPONDING OUTPUT

Cubic volume, basal area, No. trees, quality and form classes
### TABLE J.3

**FORM OF INFORMATION:** Single-tree/distance-dependent simulator  
**SPECIES:** Douglas-fir, western hemlock  
**REFERENCE:** Lin (1974)  

**DATA SOURCES**  

<table>
<thead>
<tr>
<th>Vegetation Zones:</th>
<th>Sitka spruce, western hemlock</th>
<th>Site Index Type:</th>
<th>Mc Ardle et al. (1961) or Barnes (1962)</th>
<th>Ever-Age</th>
<th>Age Range: 15-70 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Index Species:</td>
<td>Douglas-fir or western hemlock</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site Index Range:</td>
<td>90-170</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** Data from western Oregon.

**REQUIRED INPUT**  
Site index, age, thinning specifications  
For each tree:  
- D.b.h., coordinates, past average space index, last space index, competition status, position status, species  

**CORRESPONDING OUTPUT**  
Stem map  
For each tree:  
- D.b.h., growing space index, cubic volume, status  

### TABLE J.4

**FORM OF INFORMATION:** Single-tree/distance-dependent simulator  
**SPECIES:** Douglas-fir  
**REFERENCE:** Mitchell (1975)  

**DATA SOURCES**  

<table>
<thead>
<tr>
<th>Vegetation Zones:</th>
<th>Sitka spruce</th>
<th>Site Index Type:</th>
<th>King (1966)</th>
<th>Ever-Age</th>
<th>Age Range: 5-60 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Index Species:</td>
<td>Douglas-fir</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site Index Range:</td>
<td>100-130</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** Data from 60 trees and 3 plots on Vancouver Island, British Columbia.

**REQUIRED INPUT**  
Species, age, coordinates, site index method, No. site trees/acre, sequence of ages to be simulated, nature and intensity of: thinning, fertilization, pruning, defoliation, genetic improvement  

**CORRESPONDING OUTPUT**  
For each tree:  
- D.b.h., height, upper stem diameters, crown sizes  
For each stand:  
- Basal area, cubic volume
TABLE J.5

FORM OF INFORMATION: Single-tree/distance-independent simulator

SPECIES: Lodgepole pine

REFERENCE: Newnham and Smith (1964)

DATA SOURCES

Vegetation Zones: Ponderosa pine
Site Index Species: Lodgepole pine
Site Index Range: 30-70
Site Index Type: Dahms (1964)
Notes: 94 plots

Plot Sizes: 0.1-0.2 acre
Even-Age
Age Range: 28-161 years

REQUIRED INPUT

For each tree:
- Coordinates, species, d.b.h.,
- Nature and intensity of thinning

CORRESPONDING OUTPUT

For each tree:
- D.b.h., height
For each stand:
- No. trees, average diameter, basal area

TABLE J.6

FORM OF INFORMATION: Single-tree/distance-dependent simulator

SPECIES: Lodgepole pine

REFERENCE: Lee (1967)

DATA SOURCES

Even-Age

REQUIRED INPUT

Average d.b.h. and standard deviation of d.b.h., average spacing

CORRESPONDING OUTPUT

For each tree:
- D.b.h., height, crown width, basal area, cubic volume
LITERATURE CITED


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Tables are presented that summarize 108 published articles on forest growth and yield in the Pacific Northwest. Each table describes the form of the information presented, the species to which the information is applicable, the data sources used to develop the information, the data needed to predict growth and yield, and the form of the predicted data.