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COMPACT

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

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SCHOOL OF FORESTRY OREGON STATE UNIVERSITY

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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tree species.[1] We have limited ourselves to the literature published from 1910 through 1981 and have excluded unpublished material from government agencies and companies as well as Master's and Doctoral theses.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

Common Name	Latin Name
Alaska-cedar	*Chamaecyparis nootkatensis* (D. Don) Spach
Bigleaf maple	*Acer macrophyllum* Pursh
Black cottonwood	*Populus trichocarpa* Torr. and Gray
Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco
Engelmann spruce	*Picea engelmannii* Parry ex Engelm.
Grand fir	*Abies grandis* (Dougl. ex D. Don) Lindl.
Incense-cedar	*Calocedrus decurrens* (Torr.) Florin.
Jeffrey pine	*Pinus jeffreyi* Grev. & Balf.
Lodgepole pine	*Pinus contorta* Dougl. ex Loud.
Mountain hemlock	*Tsuga mertensiana* (Bong.) Carr
Noble fir	*Abies procera* Rehd.
Oregon white oak	*Quercus garryana* Dougl. ex Hook
Pacific madrone	*Arbutus menziesii* Pursh
Pacific silver fir	*Abies amabilis* Dougl. ex Forbes
Ponderosa pine	*Pinus ponderosa* Dougl. ex Laws.
Red alder	*Alnus rubra* Bong.
Red fir, includes	
California red fir	*Abies magnifica* A. Murr.
and Shasta red fir	*Abies magnifica* var. *shastensis* Lemm.
Redwood	*Sequoia sempervirens* (D. Don) Endl.
Rocky Mountain ponderosa pine	*Pinus ponderosa* var. *scopulorum* Engelm.
Sitka spruce	*Picea sitchensis* (Bong.) Carr.
Subalpine fir	*Abies lasiocarpa* (Hook.) Nutt.
Sugar pine	*Pinus lambertiana* Dougl.
Tanoak	*Lithocarpus densiflorus* (Hook. & Arn.) Rehd.
Western hemlock	*Tsuga heterophylla* (Raf.) Sarg.
Western larch	*Larix occidentalis* Nutt.
Western redcedar	*Thuja plicata* Donn ex D. Don
Western white pine	*Pinus monticola* Dougl. ex D. Don
White fir	*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.

TABLE PREFIXES

Table prefix letter	Form of information	Table prefix letter	Form of information
A	Normal yield tables	G	Tree growth/mortality equations
B	Empirical yield tables	H	Whole-stand simulators
C	Stand growth tables	I	Single-tree/ distance-independent simulators
D	Tree growth tables		
E	Stand yield equations	J	Single-tree/ distance-dependent simulators
F	Stand growth/mortality equations		

INDEX 1. TABLES BY SPECIES AND FORM OF INFORMATION [1]

	Table prefixes and designate					
Species	A (Normal yield tables)	B (Empirical yield tables)	C (Stand growth tables)	D (Tree growth tables)	E (Stand yield equations)	F (Stand growth/ mortality equations)
	Table numbe					
Bigleaf maple		1				
Black cottonwood		1				
Douglas-fir	1,2,3,4,5	1,2,3,4,5,7		1,2,5	1,2,3,4	1,2,3,4,5,6, 7,8,9
Engelmann spruce		1				
Grand fir		1			15	22
Lodgepole pine		1,5			5,6	10
Mountain hemlock		1				
Noble fir						11
Pacific silver fir		1				
Ponderosa pine	6,7,8	1,6,7	1,2,3,4,5	3,4	7,8	12,13,14,15, 16
Red alder	9	1,8,9,10			9,10	
Red fir	10					
Redwood	11	11			11	17,18
Sitka spruce	12,13	1				
Subalpine fir		1				
Sugar pine		7	6,7			
Tanoak						
Western hemlock	12,13,14	1,5			12,13	
Western larch		1		5	14	19,20
Western redcedar		1,12				
Western white pine	15	1				21
White fir	16	7			15	22

[1]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 num bers are within the column. For example, Table B.6 summarizes an empirical yield table for pon derosa pine.

form of information

G (Tree growth/ mortality equations)	H (Whole-stand simulators)	I (Single-tree/ distance-independent simulators)	J (Single-tree/ distance-dependent simulators)	Species
				Bigleaf maple
				Black cottonwood
1,2,3,4,6,7	1,2,3	1,3	1,2,3,4	Douglas-fir
2,6,7		1		Engelmann spruce
2,5,6,7		1		Grand fir
2,6,7		1	5,6	Lodgepole pine
2,6,7		1		Mountain hemlock
				Noble fir
				Pacific silver fir
2,6,7,8		1,2		Ponderosa pine
4		3		Red alder
9				Red fir
4		3		Redwood
				Sitka spruce
2,6,7		1		Subalpine fir
				Sugar pine
4		3		Tanoak
2,6,7		1	3	Western hemlock
2,6,7		1		Western larch
2,6,7		1		Western redcedar
2,6,7		1		Western white pine
9				White fir

INDEX 2. TABLES BY LITERATURE REFERENCE

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	CORRESPONDING OUTPUT
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

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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	CORRESPONDING OUTPUT
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

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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

Even-Age
Age Range: 20-180 years
Years Measured: 1909, 1911, 1924-25

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	Even-Age	
Site Index Range:	80-200	Age Range:	20-180
Site Index Type:	McArdle and Meyer (1930)	Years Measured:	every 4-6 years for 30 years
Plot Sizes:	0.0625-4.0 acres		

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

REQUIRED INPUT	CORRESPONDING OUTPUT
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

Site Index Species: Douglas-fir
Site Index Range: 80-200
Site Index Type: McArdle et al. (1961)
Plot Sizes: 0.0625-4.0 acres
Notes: 1,916 plots from 245 tracts.

Even-Age
Age Range: 20-180 years
Years measured: 1909, 1911, 1924-25

REQUIRED INPUT	CORRESPONDING OUTPUT
Total age, site index	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.: Scribner board foot volume to an 8-inch top; International 1/4-inch board foot volume to an 8-inch top
	For all trees ≥15.6 inches d.b.h.: Scribner board foot volume to a 12-inch top
	For all trees: No. trees by 2-inch diameter classes
Quadratic mean diameter	No. trees, average height
	For all trees ≥1.5 inches d.b.h.: Total cubic volume
	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
Quadratic mean diameter, tree d.b.h.	Tree height
Total age, quadratic mean diameter	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	Plot Sizes:	0.05-1.0 acre
Site Index Range:	80-170	Even-Age	
Site Index Type:	Show (1925)	Age Range:	50-240 years

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

REQUIRED INPUT	CORRESPONDING OUTPUT
Total age, site index	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
Age at breast height	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	Even-Age	
Site Index Range:	40-120	Age Range:	30-180 years
Site Index Type:	Behre (1928a, b)	Plot Sizes:	0.0625-0.75 acre

Notes: 83 plots in northeast Washington and northern Idaho.

REQUIRED INPUT	CORRESPONDING OUTPUT
Total age, site index	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

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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)
Plot Sizes: <0.1-1.0+ acre

Even-Age
Age Range: 20-200 years
Years Measured: 1910-1938

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

REQUIRED INPUT	CORRESPONDING OUTPUT
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	CORRESPONDING OUTPUT
Age, site index	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

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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	CORRESPONDING OUTPUT
Total age, site index	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

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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	CORRESPONDING OUTPUT
Total age, site index	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

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

Site Index Species: Sitka spruce
Site Index Range: 60-200
Site Index Type: Meyer (1937)

Even-Age
Age Range: 20-200 years
Years Measured: 1933-1934

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

REQUIRED INPUT	CORRESPONDING OUTPUT
Total age, site index	For all trees ≥2.6 inches, or ≥11.6 inches, or ≥15.6 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 ≥15.6 inches d.b.h.: Cubic volume of the dominant stand, Scribner board foot volume to an 8-inch top, Scribner board foot volume to a 12-inch top
Quadratic mean diameter	No. trees, basal area, average height, cubic volume, International 1/8-inch board foot volume to a 8-inch top For all trees ≥11.6 inches d.b.h.: Scribner board foot volume to an 8-inch top
Total age, site index	No. trees by 2-inch diameter classes

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 Even-Age
Site Index Type: Taylor (1934) Plot Sizes: 0.1-1.0 acre
Notes: 288 plots Age Range: 30-150 years

REQUIRED INPUT	CORRESPONDING OUTPUT
Total age, site index	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 Type:	Barnes (1962)
Site Index Species:	Western hemlock	Even-Age	
Site Index Range:	100-210	Age Range:	20-300 years

Notes: Local tables for Oregon and Washington included.

REQUIRED INPUT	CORRESPONDING OUTPUT
Total age, site index	Average height 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	CORRESPONDING OUTPUT
Total age, site index	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
Quadratic mean diameter	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	Plot Sizes:	0.10-0.99 acre
Site Index Range:	25-95	Even-Age	
Site Index Type:	Schumacher (1926)	Age Range:	40-150 years

Notes: 157 plots from California.

REQUIRED INPUT	CORRESPONDING OUTPUT
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

Series B: Empirical Yield Tables

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.

REQUIRED INPUT	CORRESPONDING OUTPUT
Provincial Zone, forest type, site class, total age	For trees >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

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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.

REQUIRED INPUT	CORRESPONDING OUTPUT
Total age, site quality, stocking	For all trees >11.6 inches d.b.h.: Scribner board foot volume to an 8-inch top
Total age, stocking	Growth correction factor in percent

TABLE B.3

FORM OF INFORMATION: Empirical yield tables

SPECIES: Douglas-fir

REFERENCE: Barnes (1955)

DATA SOURCES

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

Even-Age
Age Range: 10-50 years

Notes: Derived from British yield tables.

REQUIRED INPUT	CORRESPONDING OUTPUT
Age, site quality	No. trees, basal area, cubic volume to a 3-inch top

---

TABLE B.4

FORM OF INFORMATION: Empirical yield tables

SPECIES: Douglas-fir

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	CORRESPONDING OUTPUT
Total age, site index	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

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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	CORRESPONDING OUTPUT
Yield class, total age	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	CORRESPONDING OUTPUT
Age, soil quality, species	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) Even-Age

Years Measured: 1912-1923

Notes: 311 plots. Six forest types recognized: ponderosa pine-fir, ponderosa pine-sugar pine, ponderosa pine-sugar pine-fir, sugar pine-fir, white fir--Dougals-fir, white fir-red fir. Data are from mixed conifer type of California.

REQUIRED INPUT	CORRESPONDING OUTPUT
Total age, site index	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	CORRESPONDING OUTPUT
Age	For all trees ≥0.0 inch or ≥8 inches d.b.h.: Basal area, No. trees, cubic volume to a 2-inch top, cubic volume of dominants For trees ≥8 inches d.b.h.: Board foot volume

---

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	CORRESPONDING OUTPUT
Age	For all trees ≥5 inches d.b.h.: Cubic volume to a 4-inch top For all trees ≥11 inches d.b.h.: Scribner board foot volume to a 10-inch top

---

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)
Plot Sizes: 10, 20, or 40 basal area factors

Even-Age
Age Range: 11-100 years old at breast height
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	CORRESPONDING OUTPUT
Site index, total age	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)

Uneven-Age
Years Measured: 1928-1930

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	CORRESPONDING OUTPUT
Site quality, residual board foot volume for all trees >9.6 inches d.b.h., No. years since thinning	For all trees >9.6 inches d.b.h.: Net change in residual board foot volume
Site quality, Keen age, residual basal area for all trees >9.6 inches d.b.h., No. years since thinning	For all trees >9.6 inches d.b.h.: Gross change in residual basal area
Site quality, d.b.h., No. years since thinning	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

Even-Age
Age Range: 20-100 years
Years Measured: 1949

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

REQUIRED INPUT	CORRESPONDING OUTPUT
Site quality, average diameter, age	10-year change in total cubic volume
Stocking, age	10-year gross change in total cubic volume, 10-year percent mortality of total cubic volume
Age, site quality	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	CORRESPONDING OUTPUT
Forest type, board foot volume	For sawtimber stands: Annual gross change in board foot volume
Forest type	Annual gross and net change in board foot volume
Species, d.b.h.	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	CORRESPONDING OUTPUT
Age	For each tree: Maximum, minimum, and average height; maximum, minimum, and average diameter growth
Age, soil quality, forest type	For all trees: Maximum board foot volume, maximum annual board foot volume growth
Age, species	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	CORRESPONDING OUTPUT
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	For trees >11.6 inches d.b.h.: Gross annual Scribner board foot volume growth
No. poles, percent poles in sugar pine and white fir, percent poles in tree class 1, average diameter of pole stand, site index	For trees >11.6 inches d.b.h.: Annual ingrowth in Scribner board foot volume from original pole stand
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	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

FORM OF INFORMATION: Tree growth tables

SPECIES: Ponderosa pine

REFERENCE: Briegleb (1943)

DATA SOURCES

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

Uneven-Age
Plot Sizes: 10 acres

Notes: 30 plots from eastern Oregon.

REQUIRED INPUT	CORRESPONDING OUTPUT
Age class, tree vigor	10-year change in d.b.h., 10 year percent mortality in board foot volume
Keen tree class, d.b.h. class	10-year change in d.b.h. and board foot volume, annual gross and net percent change in board foot volume
Site index	Correction of d.b.h. growth estimates

TABLE D.4

FORM OF INFORMATION: Tree growth tables

SPECIES: Ponderosa pine

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

Even-Age
Age Range: 20-100 years
Years Measured: 1949

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

REQUIRED INPUT	CORRESPONDING OUTPUT
Site quality, d.b.h., age	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

Site Index Species: Douglas-fir
Site Index Range: 110-200
Site Index Type: McArdle et al. (1949)
Plot Sizes: 0.4-1.0 acre

Even-Age
Age Range: 26-93 years
Years Measured: Up to 35-year records

Notes: 36 permanent plots.

REQUIRED INPUT

Site index, age

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

REFERENCE: Chambers and Wilson (1971), Chambers (1980)

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)

Plot Sizes: 20 basal area factor
Even-Age
Age Range: 20-120 years

Notes: 356 permanent plots and 30 temporary plots.

REQUIRED INPUT	CORRESPONDING OUTPUT
Age at breast height, site index	For trees ≥7 inches d.b.h.: Basal area
Percent normal basal area, age at breast height, site index	For trees ≥7 inches d.b.h.: No. trees, quadratic mean diameter total cubic volume, Scribner board foot volume to a 6-inch top
Basal area, quadratic mean diameter	For trees ≥7 inches d.b.h.: Total cubic volume, Scribner board foot volume to a 6-inch top
Age at breast height, site index	For trees ≥5 inches d.b.h.: Average height
Basal area, age at breast height, site index	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	CORRESPONDING OUTPUT
Quadratic mean diameter, thinned (yes or no), average height of site trees	For all trees >5.6 inches d.b.h.: Ratio of cubic volume to a 4-inch top to total cubic volume
Site index, age at breast height, No. trees	Quadratic mean diameter
Thinned (yes or no), age at breast height at time of thinning, site index, No. trees after thinning, age at breast height	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)

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

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	CORRESPONDING OUTPUT
Age at breast height, site index	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
Even-Age
Age Range: 0-120 years

REQUIRED INPUT	CORRESPONDING OUTPUT
Total age, site index	Change in gross annual total cubic volume, gross total cubic volume, net total cubic volume
Average diameter, basal area	Crown competiton factor

TABLE E.6

FORM OF INFORMATION: Stand yield equations

SPECIES: Lodgepole pine

REFERENCE: Dahms (1975)

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

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)

Even-Age
Plot Sizes: 0.025-1.0 acre
Years Measured: 1953-1954

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

REQUIRED INPUT	CORRESPONDING OUTPUT
No. trees, basal area, total age, average height of dominants	Stocking
Average height of dominants, total age, basal area	Future stocking and No. trees
Quadratic mean diameter, average height of dominants, No. trees, board foot/cubic foot ratio	Future board foot and cubic volume
Total age, site index	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

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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)

Plot Sizes: 0.05-0.1 acre
Even-Age
Age Range: 16-50 years

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

REQUIRED INPUT	CORRESPONDING OUTPUT
Age since planting, site index, spacing at initial planting	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

Even-Age
Age Range: 25-60 years

REQUIRED INPUT	CORRESPONDING OUTPUT
Total age, site index	For all trees ≥7 inches d.b.h.: Basal area
Percent of normal basal area, total age, site index	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
Site index, quadratic mean diameter, basal area	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	CORRESPONDING OUTPUT
Age at breast height, site index, basal area ≥11.5 inches, percent basal area in Douglas-fir	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
Notes: 277 permanent plots

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

REQUIRED INPUT	CORRESPONDING OUTPUT
Total age, site index	Basal area
Percent of normal basal area, total age, site index	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
Quadratic mean diameter, basal area	For all trees ≥7 inches d.b.h.: Total cubic volume, Scribner board foot volume to a 6-inch top

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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)

Plot Sizes: 1 acre or less
Even-Age
Age Range: 24-93 years

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

Even-Age
Age Range: 26-93 years
Years Measured: Up to 35 years of records

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	CORRESPONDING OUTPUT
Quadratic mean diameter before and after thinning, age, residual basal area	Percent change in residual basal area
Quadratic mean diameter before and after thinning	Change in average height per unit of change in d.b.h.
Quadratic mean diameter before and after thinning, age	Ratio of average height before thinning to average height after thinning

---

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	CORRESPONDING OUTPUT
Desired thinning age(s) and average 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)	No. of trees at thinning age(s), cubic volume removed at thinning age(s), cubic volume normality at thinning age(s)

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	CORRESPONDING OUTPUT
Basal area, age at breast height, site index	Gross total cubic volume growth
Total age, site index, basal area	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	CORRESPONDING OUTPUT
Age at breast height, site index	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)

Plot Sizes: 0.1 acre
Even-Age
Age Range: 10-50 years

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)

Plot Sizes: Single trees
Even-Age
Age Range: 10-100 years

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	CORRESPONDING OUTPUT
Age at breast height, site index	Average total height of 40 largest trees/acre
Age at breast height, site index, average total height of 40 largest trees/acre, pounds of nitrogen, time since fertilization	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	CORRESPONDING OUTPUT
Total age	Annual stand mortality in percent of total trees
Average diameter	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	CORRESPONDING OUTPUT
Basal area	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	CORRESPONDING OUTPUT
Age at breast height, site index	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	CORRESPONDING OUTPUT
Total age, site index	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	CORRESPONDING OUTPUT
Basal area, years since thinning	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

Species Composition: At least 80 percent redwood

Site Index Species: Redwood
Site Index Range: 100-200+
Site Index Type: Lindquist and Palley (1961)
Plot Sizes: 10, 20, or 40 basal area factor points

Even-Age
Age Range: 5-100 years old at breast height
Years Measured: 1958, 1959

Notes: 163 temporary plots in Del Norte, Humboldt, Mendocino, and Sonoma Counties of California.

REQUIRED INPUT	CORRESPONDING OUTPUT
Age at breast height, basal area	Net 10-year basal area growth for trees ≥4.5 inches d.b.h.
Age at breast height, basal area, site index	Net 10-year growth in cubic volume to a 4-inch top for trees ≥4.5 inches d.b.h.
	Net 10-year growth in International 1/4-inch board foot volume to an 8-inch top for trees ≥10.5 inches d.b.h.
	Net 10-year growth in International 1/4-inch board foot volume to an 8-inch top for trees ≥15.5 inches d.b.h.

TABLE F.18

FORM OF INFORMATION: Stand growth equations

SPECIES: Redwood

REFERENCE: Krumland and Wensel (1977a)

DATA SOURCES

Site Index Species: Redwood
Site Index Range: 70-140
Site Index Type: Krumland and Wensel (1977a)

Even-Age
Plot Sizes: Single-tree
Age Range: 10-80 years

Notes: 123 felled trees and 37 permanent plot records were used for analysis from Del Norte, Humboldt, and Mendocino counties of California.

REQUIRED INPUT	CORRESPONDING OUTPUT
Site Index, age at breast height	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	CORRESPONDING OUTPUT
Total age, site index	Height of dominant and codominant trees

---

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

Even-Age
Age Value: 55 years
Years Measured: 1970, 1974, 1979

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	CORRESPONDING OUTPUT
Basal area, thinning type, time since thinning	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
Site Index Range: 16-95
Site Index Type: Haig (1932)

Plot Sizes: 0.025-2.0 acre
Even-Age
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	CORRESPONDING OUTPUT
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
Site Index Range: 50-110
Site Index Type: Cochran (1979c)

Plot Sizes: Single-tree
Even-Age
Age Range: 10-100 years

Notes: Site index curves also presented; 2-5 trees on each of 34 plots were sectioned.

REQUIRED INPUT	CORRESPONDING OUTPUT
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

Years Measured: 1964-1970; 1968-1974

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

Species Composition: Douglas-fir
Site Index Species: Douglas-fir
Site Index Value: 69
Site Index Type: King (1966)
Plot Sizes: 0.1 acre

Even-Age
Age Range: 24-27 and 24-30 years
Years Measured: 1971, 1972 to 1974, 1975; 1971, 1972 to 1977, 1978

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

REQUIRED INPUT	CORRESPONDING OUTPUT
Level of fertilization, level of thinning, d.b.h.	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

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

Age Range: 10-100 years
Plot Sizes: 0.1-0.5 acre

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

REQUIRED INPUT	CORRESPONDING OUTPUT
Tree d.b.h., quadratic mean diameter of stand, average diameter of stand, No. trees in stand, species	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	CORRESPONDING OUTPUT
Crown ratio, height growth 1 year before release, crown diameter, height, height growth 5 years before release	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) Even-Age

Years Measured: 1957-1960

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	CORRESPONDING OUTPUT
Tree d.b.h., crown competition factor, average diameter, elevation, site index, age at breast height	10-year basal area increment

---

TABLE G.7

FORM OF INFORMATION: Tree growth equations

SPECIES: Lodgepole pine

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	CORRESPONDING OUTPUT
Habitat type, diameter growth, height, d.b.h., crown ratio	For each tree: 10-year change in height

---

TABLE G.8

FORM OF INFORMATION: Tree growth equations

SPECIES: Ponderosa pine

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	CORRESPONDING OUTPUT
Total age, site index, basal area of dominants and codominants, d.b.h., height	5- and 10-year change in cubic volume
Total age, basal area of dominants and codominants, d.b.h.	5-year radial growth, No. growth rings in last radial inch at breast height
Total age, site index	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	CORRESPONDING OUTPUT
Crown class, crown ratio, top condition, ragged crown percent, species	One-year probability of mortality

Series H: Whole-Stand Simulators

TABLE H.1

FORM OF INFORMATION: Whole-stand simulator

SPECIES: Douglas-fir

REFERENCE: Hoyer (1975)

DATA SOURCES

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

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 tarif, 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 tarif, 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 tarif, 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

Even-Age
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: 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

Series I: Single-Tree/Distance-Independent Simulators

TABLE I.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

Sample design information

Management information

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

TABLE I.2 FORM OF INFORMATION: Single-tree/distance-independent simulator

SPECIES: Ponderosa pine REFERENCE: Lemmon and Schumacher (1963)

DATA SOURCES

Site Index Species:	Ponderosa pine	Even-Age	
Site Index Range:	40-160	Age Range:	31-160 years
Site Index Type:	Meyer (1938)	Years Measured:	1954-1957

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

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TABLE J.3 FORM OF INFORMATION: Single-tree/distance-dependent simulator

SPECIES: Douglas-fir, western hemlock REFERENCE: Lin (1974)

DATA SOURCES

Vegetation Zones: Sitka spruce, western hemlock
Site Index Species: Douglas-fir or western hemlock
Site Index Range: 90-170
Site Index Type: McArdle et al. (1961) or Barnes (1962)
Even-Age Age Range: 15-70 years

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

Vegetation Zones: Sitka spruce
Site Index Species: Douglas-fir
Site Index Range: 100-130
Site Index Type: King (1966)
Even-Age Age Range: 5-60 years

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

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