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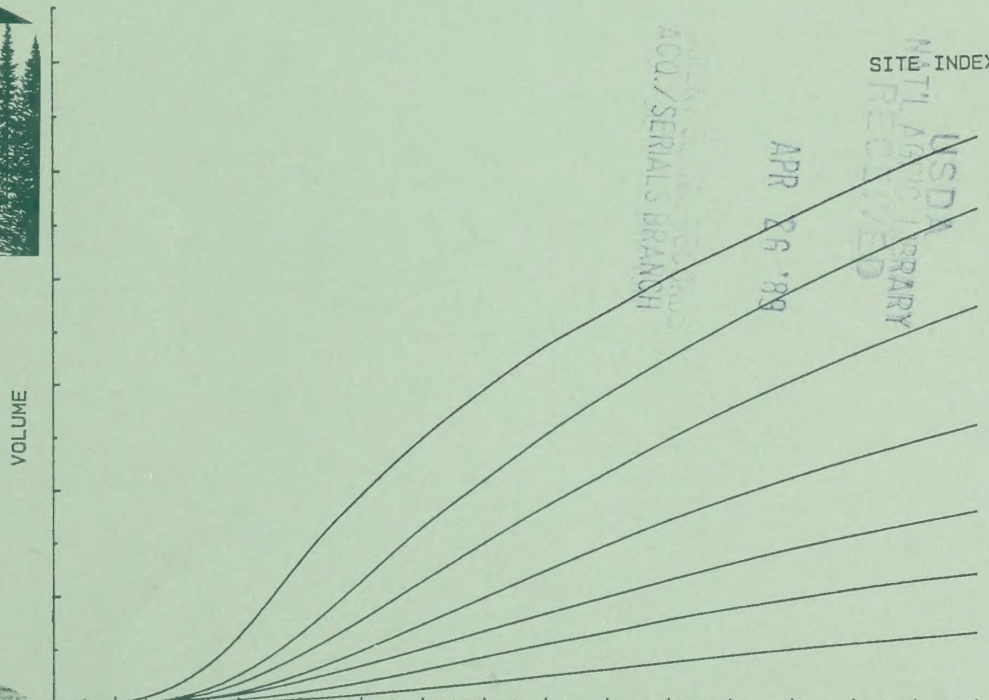
Selected Yield Tables for Plantations and Natural Stands in Inland Northwest Forests

Albert R. Stage
David L. Renner
Roger C. Chapman

CR=f₁(CCF)
 $B = \frac{1}{2} \int_0^x e^{-x/2} dx$
 $\ln(\Delta H) = f_2(\Delta DH, D)$
 MORT = $\frac{1}{1 + \exp(-B, X)}$
 $\ln(BAI) = f_3(D.b.h., Habitat, Crown)$



Q-cm(ASP)
 height = exp(B, X)
 $X \sim N(\mu, \sigma^2)$
 $P(S) = \frac{1}{1 + \exp(-X, \mu)}$
 Stocking = f(P, S)



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ACKNOWLEDGMENTS

Tabulation of yields by site index and age was requested by members of the Inland Northwest Growth and Yield Cooperative, who also specified the species and management regimes to be represented.

RESEARCH SUMMARY

Yields arrayed by site index and age have been tabulated for plantations of 500 trees per acre, with five thinning regimes, for each of three planted species: Douglas-fir, grand fir, and western larch. In addition, yields have been tabulated for naturally regenerated stands of the grand fir-cedar-hemlock ecosystem of the Inland Empire. The yields were estimated with the Prognosis Model for Stand Development, version 5.2, including the Regeneration Establishment Model. Each planted species and the natural regeneration were simulated for the full range of site, geographic, and ecologic variables represented in a random inventory of the National Forests of the Inland Empire. Site index was obtained from the simulations by extracting heights of the 20 tallest trees per acre when they accumulated 50 rings at 4.5 feet.

Individual simulations were sorted into 10-foot site index classes and average yields were calculated. Weights in the averaging were proportional to the relative frequency with which the sites occur in the forests of the Inland Empire.

Simulations showed great variation in yields for stands of the same site index. Furthermore, comparisons between these yield tables for natural stands and 102 permanent sample plots show that these tables give less accurate estimates of growth than the Prognosis Model from which they were derived. Therefore, these yield tables should be used only when use of the Prognosis Model is precluded by lack of data on the site, geographic, and ecologic factors.

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INTRODUCTION

This report contains yield tables arrayed by site index and age for average ecological and topographic situations in the Inland Empire. Yields were estimated by the Prognosis Model for Stand Development, version 5.2. Estimates are provided for plantations of Douglas-fir (*Pseudotsuga menziesii*), western larch (*Larix occidentalis*), and grand fir (*Abies grandis*) and for natural stands in the grand fir-cedar-hemlock ecosystem. Five thinning regimes are presented for the plantations.

Yield tables that represent estimates of volumes contained in forest stands have traditionally been presented with site index and stand age as the table stubs, and various attributes of the expected stand—merchantable volumes, total volumes, basal area, and mean diameter at breast height (d.b.h.)—in the body of the table.

Site index is only one factor influencing future yields. However, incorporating other productivity factors into the format of conventional yield tables, along with a multiplicity of alternative management regimes, would require extremely voluminous sets of tables. The obvious solution is to prepare the tables to specifications of the user with the Prognosis Model (Wykoff and others 1982).

Some information needs are not met by such yield-simulation procedures. In the most serious situation, the existing inventory may have been designed to provide only the traditional site index and age classification of the forest, precluding the use of the more definitive techniques.

Another information need—comparing yields between forest types or regions—is hampered if the forests being compared are not described by the same variables. Although site index and age definitions often vary from region to region and type to type, the problem is even more serious when the additional site variables are not used at all.

For these reasons, users or potential users of the Prognosis Model have asked to have yield information implicit in the Prognosis Model presented in the traditional format of site index and age. The tables in this publication are intended to meet that request.

APPLICABILITY

The tables presented here represent the forests of the Inland Empire, which includes northern Idaho, northeastern Washington, and western Montana.

Within the Inland Empire, the tables for natural stands represent the following habitat types:

Grand fir/pachistima
Cedar/pachistima
Hemlock/pachistima
Subalpine fir/pachistima

Yield estimates for Douglas-fir plantations represent, in addition to those for the naturally established stands, the following habitats:

Douglas-fir/ninebark
Douglas-fir/snowberry
Douglas-fir/pinegrass
Subalpine fir/menziesia
Subalpine fir/woodrush
Subalpine fir/twinflower
Mountain hemlock/menziesia

Yield estimates for western larch plantations represent, in addition to those for the naturally established stands, the following habitats:

Douglas-fir/ninebark
Spruce/pachistima
Grand fir/beargrass
Subalpine fir/devil's club
Subalpine fir/beargrass
Subalpine fir/twinflower
Subalpine fir/whortleberry
Mountain hemlock/beargrass
Mountain hemlock/menziesia

Yield estimates for grand fir plantations represent, in addition to those for the naturally established stands, the following habitats:

Grand fir/beargrass
Subalpine fir/menziesia
Subalpine fir/beargrass
Mountain hemlock/beargrass

Five management regimes are represented for plantations of each of the three species. Planting density and initial survival are assumed to provide 500 trees per acre 5 years after planting. In parentheses after each regime is a mnemonic code used to identify the regime on those figures that compare several regimes.

1. No thinning (000).
2. Precommercial thinning from below at 20 years to 250 trees per acre (P00).

3. Same as 2 with commercial thinning at 50 years to 100 trees per acre, such that the average d.b.h. before thinning is the same as after thinning (PC1).

4. Same as 3 but with commercial thinning from above at 50 years to 100 trees per acre (PCA).

5. Same as 3 but with commercial thinning from below at 50 years to 100 trees per acre (PCB).

Yields for natural stands are based on the clearcutting method of regeneration, with site preparation consisting of 64 percent of area burned and an additional 11 percent mechanically disturbed. No thinnings are scheduled.

METHODS

Growth and yield projections for 150 years were made using version 5.2 of the Stand Prognosis Model.

Geographic, topographic, and ecologic data to be used in the simulations were obtained from inventory plots that were a random sample of the forest. These plots represent the range and joint occurrence of site variables throughout the Inland Empire. The inventory plots were used to define the distribution of five major site variables influencing tree growth: geographic location (defined by National Forest), habitat type (Daubenmire and Daubenmire 1968), slope percentage, aspect (degrees from north), and elevation (hundreds of feet).

Combinations of these five variables constituted a "cell," each cell corresponding to a unique set of model coefficients in the Prognosis Model. The values used for the slope and elevation variables were the mean ± 1 standard deviation within the geographic and habitat type classes. Aspect variation is represented by two classes corresponding to the maximum and minimum of the aspect effect on increment for that species. The appendix contains detailed information on the combinations of these variables and the nominal values used for the three planted species and naturally regenerated stands.

Initial stand conditions were defined by the Regeneration Establishment Model (Ferguson and others 1986) component of the Prognosis Model.

Site index was calculated for each projection by monitoring the simulated height growth for each tree record. Height at 50 years (rings at 4.5 feet) was calculated for each tree, then site index calculated as the average of the 20 trees per acre having the greater 50-year heights.

However, to prevent management treatment from influencing site calculations, each cell was assigned the site index value derived for the planting-no thinning management regime for that species.

Yields from the simulation were then sorted by 10-foot site index classes and management treatment and a weighted average yield value was calculated. Weights for each cell were proportional to the frequency with which inventory locations fell within the cell.

Although the site variables define a wide range of site productivity, there is still substantial variability within a cell. To represent this variability, multipliers of basal area increment for trees larger than 3 inches d.b.h., and height increment for smaller trees (<3 inches d.b.h.), were assigned to each cell. The multipliers were entered with the BAIMULT and REGHMULT keywords (Wykoff and others 1982). Logarithm of BAIMULT was selected randomly

from a normal distribution having a mean of zero and standard deviation of 0.3. The choice of standard deviation was based on estimates of residual variation in growth histories of 102 permanent sample plots in northern Idaho (Stage 1987).

DEFINITIONS OF VARIABLES

Site index. Average height in feet of the tallest 20 trees per acre when the trees have 50 rings at 4.5 feet above ground level.

Age. Number of years from planting or from date of harvest or site preparation for natural-stand yields.

Top Height. Average height in feet of the 40 largest diameter (d.b.h.) trees per acre.

Volumes. Reported for three categories of size limits:

Total cubic feet includes all stems, from 1-foot stump to tip of main stem.

Merchantable cubic feet includes all stems greater than 7.0 inches d.b.h. from 1-foot stump to a top diameter inside bark of 4.5 inches.

Board feet Scribner (Kemp 1956) includes all stems greater than 7.0 inches d.b.h. from 1-foot stump to a top diameter inside bark of 4.5 inches.

Accretion (ACC in yield table headings). Periodic mean annual change in total cubic foot volume of trees surviving through the period, the length of which is indicated by column headed PRD yrs.

Mortality (MOR in yield table headings). Total cubic foot volume per year of trees dying in the period.

Total Yield. Standing volume plus volume removed by thinning, if any.

YIELD TABLES FOR NATURAL REGENERATION

Table 1 and figures 1, 2, and 3 represent the yields for the mix of species typically found in naturally regenerated stands of the grand fir-cedar-hemlock ecosystem. Grand fir is the most prevalent species followed by Douglas-fir and western white pine (*Pinus monticola*).

Entries for ages 5 and 10 represent only the established regeneration that would have been inventoried at age 5 years. From age 15 years on, the trees are those that would have been inventoried at age 15. Any subsequent regeneration is ignored.

Trends of tree d.b.h. with age and site index are displayed in figure 4.

The distribution of site indices represented in these simulated yields (fig. 5) was determined by the distribution of site variables in the inventory and by the range of the random variation of the growth multipliers.

Individual simulations showed surprising range in yield for the same site index. These variations are attributed to factors influencing initial stocking and time to reach 4.5 feet height. Figure 6, for example, shows a range in yield of approximately 10,000 cubic feet for site index class 60 at 120 years. This variation is nearly as large as the range of variation of the mean yields over the full range of sites represented in the yield tables.

Table 1—Yields of naturally regenerated stands in the grand fir-cedar-hemlock ecosystem

Site index	Age	Summary statistics														
		Volume per acre				Removals per acre				Growth						
		Trees/acre	Merchant-able volume		Merchant-able volume	Trees/acre	Merchant-able volume		Merchant-able volume	BA/acre	CCF	Top height	Growth			D
			Total volume	Merchant-able volume			Total volume	Merchant-able volume					PRD	ACC	MOR/year	
	<i>Ft</i> ³	<i>Ft</i> ³	<i>Bd ft</i>		<i>Ft</i> ³	<i>Ft</i> ³	<i>Bd ft</i>	<i>Ft</i> ²		<i>Ft</i>	<i>Yr</i>	<i>Ft</i> ³	<i>Ft</i> ³			
40	5	681	0	0	0	0	0	0	0	1	2	1	5	0	0	0.5
	10	666	2	0	0	0	0	0	0	1	2	4	5	1	0	0.5
	20	1427	12	0	0	0	0	0	0	3	7	8	10	3	0	0.6
	30	1232	38	0	0	0	0	0	0	6	13	14	10	9	0	0.9
	40	1072	116	0	0	0	0	0	0	14	28	21	10	16	1	1.6
	50	952	269	0	0	0	0	0	0	29	50	28	10	21	2	2.4
	60	851	465	6	16	0	0	0	0	43	69	32	10	26	4	3.1
	70	753	690	14	45	0	0	0	0	57	85	37	10	29	6	3.7
	80	663	921	76	236	0	0	0	0	68	97	42	10	32	8	4.3
	90	582	1163	327	1029	0	0	0	0	78	106	47	10	33	10	5.0
	100	514	1403	544	1801	0	0	0	0	87	113	52	10	33	12	5.6
	110	456	1613	748	2576	0	0	0	0	93	118	56	10	37	14	6.1
	120	406	1847	1075	3778	0	0	0	0	99	122	60	10	37	15	6.7
	130	366	2063	1413	5074	0	0	0	0	104	126	64	10	33	17	7.2
	140	330	2217	1630	6006	0	0	0	0	106	125	67	10	40	20	7.7
	150	297	2410	1917	7254	0	0	0	0	109	125	71	0	0	0	8.2
50	5	716	0	0	0	0	0	0	0	1	2	2	5	1	0	0.4
	10	687	4	0	0	0	0	0	0	1	3	6	5	1	0	0.5
	20	1125	32	0	0	0	0	0	0	5	12	14	10	10	0	0.9
	30	955	133	0	0	0	0	0	0	15	28	23	10	25	1	1.7
	40	820	370	4	13	0	0	0	0	34	55	31	10	37	2	2.8
	50	731	724	92	286	0	0	0	0	57	83	38	10	47	4	3.8
	60	645	1147	413	1331	0	0	0	0	77	107	44	10	58	8	4.7
	70	559	1649	926	3224	0	0	0	0	99	127	51	10	59	11	5.7
	80	486	2127	1460	5308	0	0	0	0	115	143	57	10	68	16	6.6
	90	424	2650	2053	7829	0	0	0	0	131	156	63	10	71	20	7.5
	100	372	3153	2645	10491	0	0	0	0	143	164	69	10	65	25	8.4
	110	328	3562	3119	12872	0	0	0	0	150	168	75	10	76	30	9.2
	120	289	4021	3629	15654	0	0	0	0	158	171	81	10	68	31	10.0
	130	258	4394	4040	18039	0	0	0	0	163	172	86	10	68	35	10.8
	140	230	4718	4397	20205	0	0	0	0	165	170	90	10	66	38	11.5
	150	206	4998	4707	22183	0	0	0	0	167	167	95	0	0	0	12.2
60	5	707	0	0	0	0	0	0	0	1	2	2	5	1	0	0.4
	10	677	4	0	0	0	0	0	0	1	4	7	5	2	0	0.6
	20	1262	43	0	0	0	0	0	0	7	16	15	10	14	0	1.0
	30	1061	186	1	3	0	0	0	0	21	38	27	10	34	1	1.9
	40	908	520	62	191	0	0	0	0	46	72	35	10	49	3	3.0
	50	801	976	324	1084	0	0	0	0	71	103	44	10	61	7	4.0
	60	682	1510	815	2900	0	0	0	0	94	127	52	10	70	12	5.0
	70	578	2090	1437	5361	0	0	0	0	114	147	59	10	76	18	6.0
	80	492	2673	2088	8152	0	0	0	0	131	161	66	10	81	24	7.0
	90	420	3241	2727	11157	0	0	0	0	145	169	71	10	87	30	7.9
	100	360	3809	3353	14313	0	0	0	0	155	174	77	10	88	35	8.9
	110	311	4340	3927	17462	0	0	0	0	164	176	82	10	91	40	9.8
	120	271	4853	4483	20773	0	0	0	0	170	177	87	10	92	43	10.7
	130	238	5339	5004	23906	0	0	0	0	176	177	91	10	95	48	11.6
	140	210	5815	5504	27005	0	0	0	0	180	176	96	10	91	50	12.5
	150	186	6220	5928	29690	0	0	0	0	182	175	100	0	0	0	13.4
70	5	684	0	0	0	0	0	0	0	1	2	2	5	1	0	0.4
	10	656	6	0	0	0	0	0	0	2	4	8	5	5	0	0.7
	20	1197	99	1	3	0	0	0	0	14	26	20	10	33	0	1.4
	30	1028	423	63	206	0	0	0	0	38	61	33	10	67	2	2.6
	40	887	1068	440	1506	0	0	0	0	76	108	44	10	93	7	4.0
	50	774	1933	1212	4485	0	0	0	0	116	152	53	10	112	15	5.2
	60	656	2907	2225	8744	0	0	0	0	152	185	61	10	124	25	6.5
	70	553	3896	3267	13626	0	0	0	0	180	207	69	10	137	37	7.7
	80	467	4896	4340	19069	0	0	0	0	203	222	76	10	140	46	8.9
	90	396	5834	5334	24513	0	0	0	0	220	230	82	10	144	56	10.1
	100	338	6717	6269	29969	0	0	0	0	233	234	88	10	148	64	11.2
	110	291	7551	7141	35191	0	0	0	0	242	236	94	10	149	71	12.4
	120	252	8324	7944	40077	0	0	0	0	250	236	99	10	153	77	13.5
	130	221	9081	8724	44842	0	0	0	0	256	235	104	10	153	82	14.6
	140	194	9798	9460	49326	0	0	0	0	260	234	109	10	150	86	15.7
	150	172	10442	10118	53321	0	0	0	0	264	233	114	0	0	0	16.8

(con.)

Table 1 (Con.)

Site index	Age	Summary statistics														
		Volume per acre			Removals per acre					BA/ acre	CCF	Top height	Growth			D
		Trees/ acre	Merchant-able volume	Merchant-able volume	Trees/ acre	Total volume	Merchant-able volume	Merchant-able volume	PRD				ACC	MOR/ year		
			<i>Ft</i> ³	<i>Ft</i> ³	<i>Bd ft</i>		<i>Ft</i> ³	<i>Ft</i> ³	<i>Bd ft</i>				<i>Ft</i> ²	<i>Ft</i>	Yr	
80	5	758	0	0	0	0	0	0	0	1	2	2	5	1	0	0.4
	10	724	7	0	0	0	0	0	0	2	5	8	5	6	0	0.7
	20	1186	147	9	31	0	0	0	0	19	33	23	10	57	0	1.7
	30	1024	714	257	900	0	0	0	0	58	85	37	10	119	4	3.2
	40	877	1863	1210	4713	0	0	0	0	117	149	50	10	157	19	4.9
	50	728	3245	2588	10922	0	0	0	0	168	196	61	10	186	38	6.5
	60	585	4724	4117	18396	0	0	0	0	208	226	70	10	202	57	8.1
	70	474	6172	5605	26255	0	0	0	0	238	244	79	10	213	75	9.6
	80	387	7549	7043	34278	0	0	0	0	259	253	87	10	214	85	11.1
	90	321	8833	8367	41931	0	0	0	0	275	259	95	10	223	99	12.5
	100	268	10078	9641	49370	0	0	0	0	287	262	102	10	218	108	14.0
	110	228	11180	10770	55888	0	0	0	0	295	263	108	10	221	117	15.4
	120	196	12217	11834	61974	0	0	0	0	301	262	114	10	215	121	16.8
	130	170	13153	12789	67494	0	0	0	0	305	261	120	10	219	128	18.2
	140	148	14067	13718	72720	0	0	0	0	308	259	125	10	216	130	19.5
	150	131	14922	14586	77586	0	0	0	0	311	257	130	0	0	0	20.9
90	5	671	0	0	0	0	0	0	0	0	2	2	5	2	0	0.4
	10	641	8	0	0	0	0	0	0	2	5	9	5	8	0	0.8
	20	1147	191	16	54	0	0	0	0	22	38	26	10	78	0	1.9
	30	982	962	436	1576	0	0	0	0	69	96	42	10	160	4	3.6
	40	841	2516	1858	7400	0	0	0	0	142	172	55	10	210	21	5.6
	50	694	4403	3770	16259	0	0	0	0	206	229	68	10	239	50	7.4
	60	553	6290	5705	26282	0	0	0	0	252	260	77	10	268	78	9.1
	70	439	8186	7642	37038	0	0	0	0	287	278	86	10	284	105	11.0
	80	350	9972	9476	47607	0	0	0	0	312	287	94	10	283	125	12.8
	90	284	11553	11086	56899	0	0	0	0	328	291	103	10	294	145	14.5
	100	233	13039	12600	65629	0	0	0	0	339	291	110	10	290	158	16.3
	110	195	14362	13958	73343	0	0	0	0	347	290	116	10	277	162	18.1
	120	166	15514	15129	80020	0	0	0	0	351	288	121	10	283	171	19.7
	130	142	16643	16271	86341	0	0	0	0	354	286	127	10	284	180	21.4
	140	123	17687	17324	92138	0	0	0	0	357	283	132	10	265	170	23.1
	150	108	18635	18279	97315	0	0	0	0	359	281	137	0	0	0	24.7
100	5	759	0	0	0	0	0	0	0	1	2	2	5	2	0	0.5
	10	727	12	0	0	0	0	0	0	3	8	9	5	16	0	0.9
	20	1099	352	36	117	0	0	0	0	35	54	30	10	132	1	2.4
	30	936	1656	1054	3960	0	0	0	0	108	137	43	10	220	14	4.6
	40	776	3711	3058	12437	0	0	0	0	193	217	58	10	318	44	6.7
	50	624	6445	5776	26291	0	0	0	0	278	281	68	10	345	95	9.0
	60	486	8934	8306	40218	0	0	0	0	329	308	81	10	326	139	11.1
	70	380	10807	10258	51281	0	0	0	0	352	312	92	10	333	172	13.0
	80	298	12427	11937	61128	0	0	0	0	364	310	99	10	342	188	15.0
	90	238	13964	13514	70172	0	0	0	0	371	305	108	10	337	200	16.9
	100	195	15336	14913	78207	0	0	0	0	376	300	116	10	343	215	18.8
	110	160	16615	16217	85752	0	0	0	0	380	295	124	10	315	199	20.8
	120	137	17772	17386	92360	0	0	0	0	381	290	130	10	322	209	22.6
	130	117	18906	18531	98686	0	0	0	0	382	287	136	10	330	222	24.4
	140	101	19989	19623	104649	0	0	0	0	383	284	140	10	307	211	26.3
	150	89	20952	20592	109801	0	0	0	0	383	282	144	0	0	0	28.1

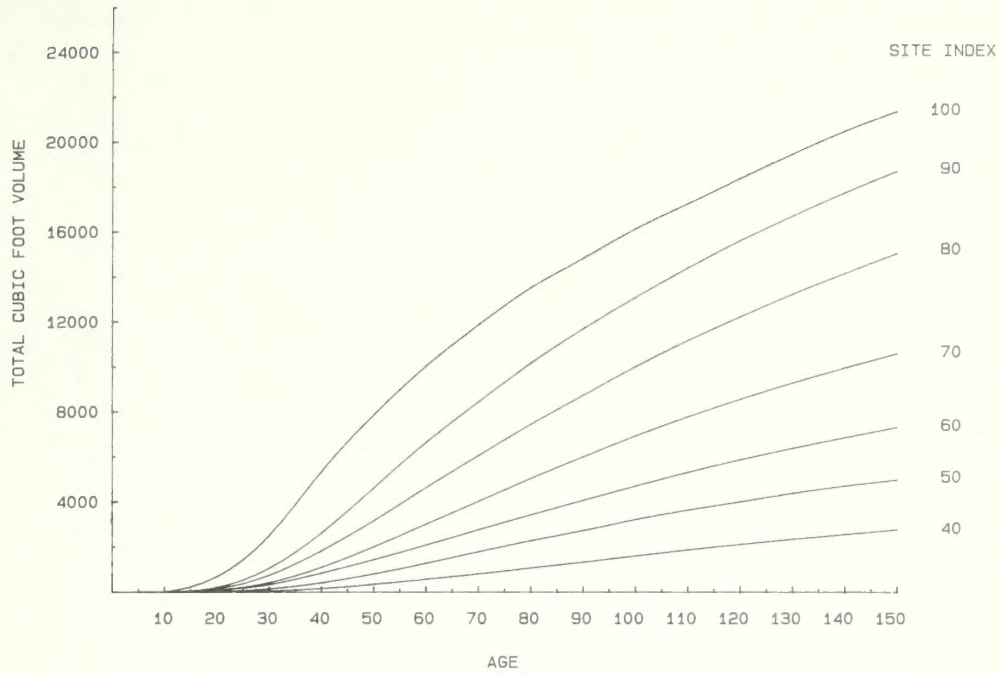


Figure 1—Natural regeneration yield curves for Inland Northwest forests of the grand fir-cedar-hemlock ecosystem (total cubic feet, all stems).

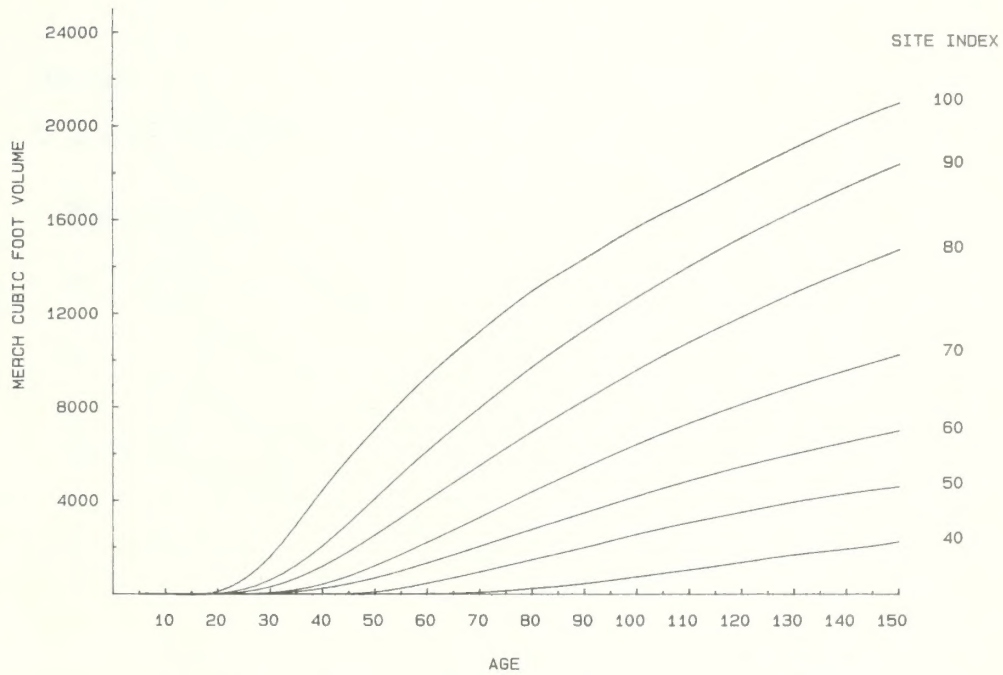


Figure 2—Natural regeneration yield curves for Inland Northwest forests of the grand fir-cedar-hemlock ecosystem (merchantable cubic feet, 4.5-inch top, stems greater than 7 inches d.b.h.).

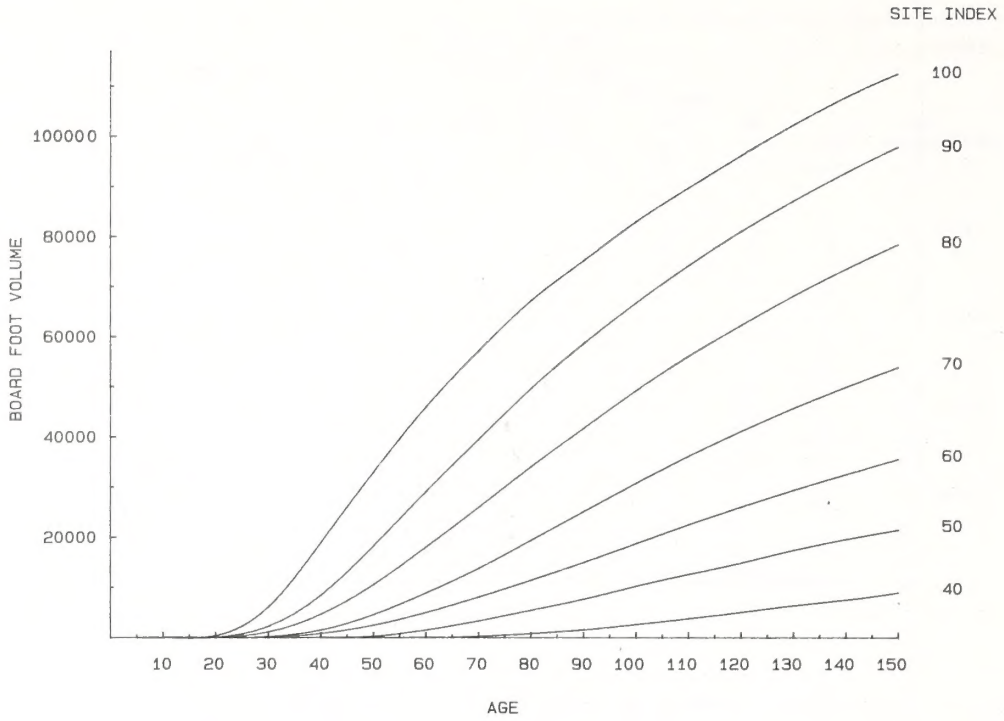


Figure 3—Natural regeneration yield curves for Inland Northwest forests of the grand fir-cedar-hemlock ecosystem (merchantable board feet [Scribner], 4.5-inch top, stems greater than 7 inches d.b.h.).

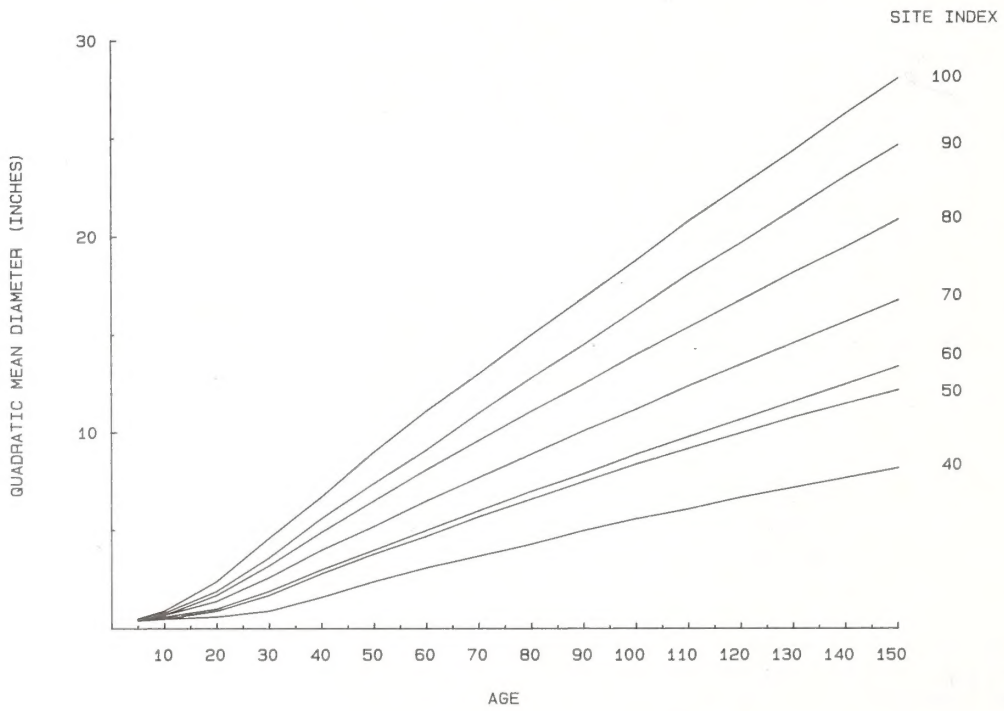


Figure 4—Quadratic mean diameter vs. age for natural regeneration in Inland Northwest forests.

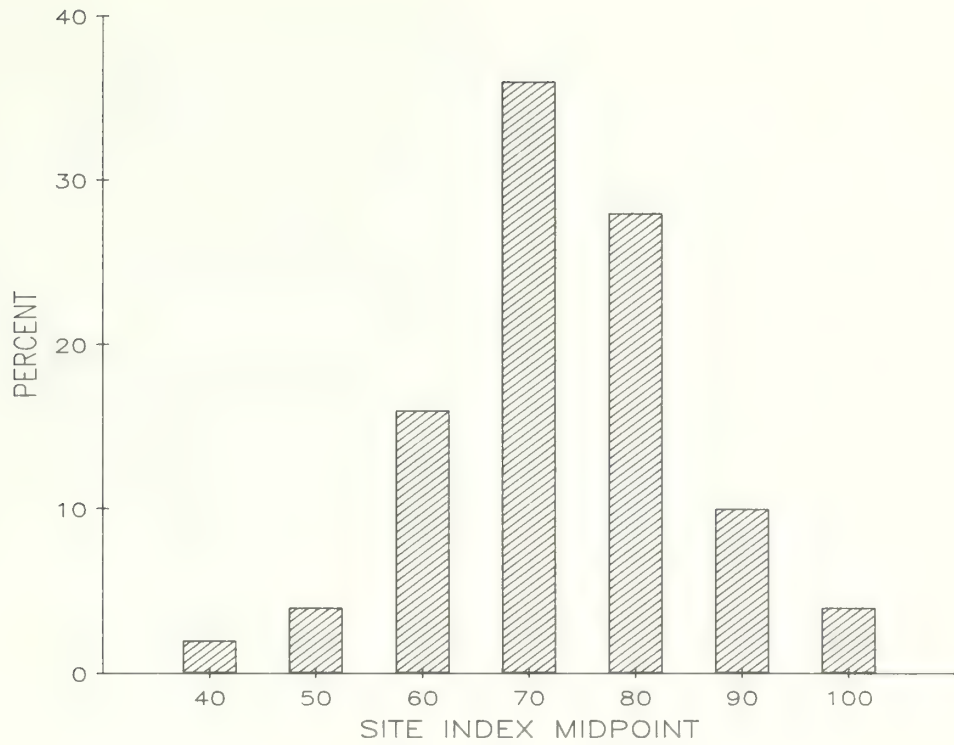


Figure 5—Distribution of natural regeneration site index values for Inland Northwest forests of the grand fir/cedar/hemlock ecosystem.

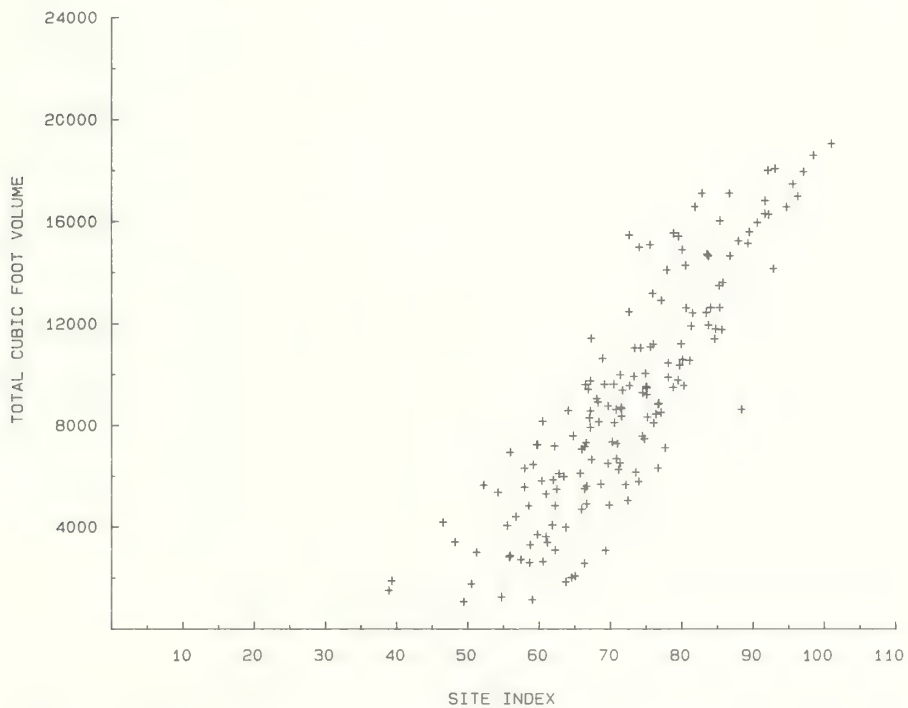


Figure 6—Natural regeneration yield vs. site index at 120 years of age (total cubic feet).

YIELD TABLES FOR PLANTATIONS

Yield estimates for plantations were produced assuming that there was **no** natural regeneration. On most sites in the Inland Empire, some natural regeneration can be expected. Therefore, the yields in these tables will apply only to stands in which early and repeated thinnings remove the natural regeneration. Simulation of the combined yields from planted as well as naturally regenerated trees would also be possible with the Prognosis Model.

Douglas-fir

Expected yields for plantations with 500 Douglas-fir trees per acre at 5 years are listed in tables 2 through 6 and figures 7 through 9 for the five management regimes. In comparison to the yields estimated for natural stands, Douglas-fir plantations are estimated to produce higher volumes at the early and middle ages because the height

growth is faster at the early ages. This difference in height growth can be seen by comparing top heights at early ages for the same site index (table 2).

Variation of yields between simulations for the same site index is less than for the natural-stand yields because initial stocking is uniformly 500 trees per acre at 5 years (figs. 10, 11).

Treatment effects on mean d.b.h. are shown in figures 12 through 16. As expected, thinning from below produces the largest diameters, but response is slight on the lower site qualities.

Effects of thinning regimes on standing volume are compared in figures 17 through 22 for total cubic and merchantable board foot volumes. Effects of thinning regimes on total yield are compared in figures 23 through 28. Total yield was nearly constant for site index 90. For site indices 50 and 70, however, none of the thinning regimes matched the total yield of the unthinned plantations.

Table 2—Yields of Douglas-fir plantations having 500 trees per acre surviving 5 years, no thinning

		Summary statistics														
Site index	Age	Volume per acre				Removals per acre				BA/ acre	CCF	Top height	Growth			
		Trees/ acre	Total volume	Merchant-able volume	Merchant-able volume	Trees/ acre	Total volume	Merchant-able volume	Merchant-able volume				PRD	ACC	MOR/ year	\bar{D}
			Ft^3	Ft^3	Bd ft		Ft^3	Ft^3	Bd ft				Ft^2	Ft	Yr	Ft^3
50	5	500	0	0	0	0	0	0	0	0	0	2	3	5	2	0.0
	10	473	10	0	0	0	0	0	0	1	5	8	10	4	0	0.7
	20	432	47	0	0	0	0	0	0	5	14	16	10	14	0	1.5
	30	391	186	0	0	0	0	0	0	18	34	25	10	30	0	2.9
	40	375	480	19	55	0	0	0	0	37	61	33	10	45	1	4.3
	50	359	913	251	767	0	0	0	0	61	88	41	10	54	4	5.6
	60	340	1413	755	2464	0	0	0	0	83	112	48	10	60	6	6.7
	70	321	1952	1370	4741	0	0	0	0	103	132	54	10	68	10	7.7
	80	300	2531	2051	7452	0	0	0	0	123	151	60	10	66	14	8.7
	90	281	3050	2648	10018	0	0	0	0	138	164	65	10	66	19	9.5
	100	262	3521	3172	12479	0	0	0	0	150	172	70	10	65	23	10.3
	110	242	3945	3650	14891	0	0	0	0	160	178	74	10	63	26	11.0
	120	224	4317	4053	17162	0	0	0	0	167	180	78	10	64	29	11.7
	130	207	4664	4419	19352	0	0	0	0	174	182	81	10	63	31	12.4
	140	192	4984	4751	21472	0	0	0	0	179	182	84	10	60	33	13.1
	150	177	5254	5032	23352	0	0	0	0	182	181	87	0	0	0	13.7
70	5	500	0	0	0	0	0	0	0	0	2	3	5	5	0	0.0
	10	478	27	0	0	0	0	0	0	4	10	12	10	20	0	1.2
	20	447	226	3	9	0	0	0	0	20	37	27	10	68	1	2.8
	30	416	898	218	705	0	0	0	0	61	90	40	10	107	3	5.2
	40	401	1939	1174	4041	0	0	0	0	110	144	50	10	126	11	7.1
	50	375	3090	2518	9263	0	0	0	0	153	186	60	10	134	24	8.7
	60	341	4187	3726	14645	0	0	0	0	187	215	67	10	139	38	10.0
	70	306	5192	4810	20115	0	0	0	0	212	231	75	10	136	50	11.3
	80	273	6052	5719	25276	0	0	0	0	229	238	81	10	130	60	12.4
	90	242	6759	6455	29831	0	0	0	0	240	240	86	10	130	68	13.5
	100	214	7378	7091	34084	0	0	0	0	248	237	91	10	126	73	14.6
	110	190	7914	7640	37871	0	0	0	0	253	234	96	10	122	76	15.6
	120	169	8374	8112	41226	0	0	0	0	255	228	101	10	116	79	16.7
	130	151	8748	8495	44068	0	0	0	0	256	222	105	10	110	80	17.7
	140	135	9053	8807	46422	0	0	0	0	256	216	108	10	109	81	18.6
	150	121	9340	9101	48605	0	0	0	0	255	210	112	0	0	0	19.6
90	5	500	0	0	0	0	0	0	0	0	2	4	5	16	0	0.0
	10	489	79	0	0	0	0	0	0	9	21	18	10	72	0	1.8
	20	472	801	253	771	0	0	0	0	54	83	40	10	171	3	4.6
	30	450	2484	1760	6211	0	0	0	0	131	169	56	10	200	18	7.3
	40	417	4306	3703	14366	0	0	0	0	197	232	69	10	200	44	9.3
	50	371	5863	5365	22468	0	0	0	0	241	265	78	10	211	73	10.9
	60	321	7239	6841	30564	0	0	0	0	271	281	85	10	209	94	12.5
	70	276	8385	8029	38071	0	0	0	0	291	284	93	10	187	101	13.9
	80	238	9246	8910	44064	0	0	0	0	301	281	98	10	188	112	15.2
	90	206	10005	9686	49320	0	0	0	0	307	275	102	10	182	115	16.5
	100	179	10675	10367	54156	0	0	0	0	312	268	107	10	181	121	17.8
	110	157	11275	10977	58378	0	0	0	0	314	262	112	10	174	120	19.2
	120	138	11820	11530	62202	0	0	0	0	316	255	116	10	166	118	20.5
	130	122	12299	12015	65560	0	0	0	0	317	249	119	10	158	118	21.8
	140	109	12697	12419	68274	0	0	0	0	317	243	123	10	147	114	23.1
	150	98	13028	12756	70585	0	0	0	0	316	237	126	0	0	0	24.3

Table 3—Yields of Douglas-fir plantations having 500 trees per acre surviving 5 years, precommercial thinning from below to 250 trees per acre at 20 years

Site index	Age	Summary statistics														D
		Volume per acre			Removals per acre				BA/ acre	CCF	Top height	Growth				
		Total volume	Merchant-able volume	Merchant-able volume	Trees/ acre	Total volume	Merchant-able volume	Merchant-able volume				PRD	ACC	MOR/ year		
		<i>Ft³</i>	<i>Ft³</i>	<i>Bd ft</i>		<i>Ft³</i>	<i>Ft³</i>	<i>Bd ft</i>				<i>Ft²</i>	<i>Ft</i>	<i>Yr</i>	<i>Ft³</i>	
50	5	500	0	0	0	0	0	0	0	0	2	3	5	2	0	0.0
	10	473	10	0	0	0	0	0	0	1	5	8	10	4	0	0.7
	20	432	47	0	0	182	8	0	0	4	11	16	10	12	0	1.8
	30	232	155	0	0	0	0	0	0	14	26	25	10	24	0	3.3
	40	225	396	37	108	0	0	0	0	29	45	34	10	36	1	4.9
	50	217	741	260	829	0	0	0	0	46	64	43	10	42	2	6.2
	60	209	1143	704	2362	0	0	0	0	62	81	50	10	50	4	7.4
	70	200	1603	1254	4457	0	0	0	0	78	97	57	10	54	6	8.4
	80	191	2076	1804	6714	0	0	0	0	93	110	63	10	53	9	9.4
	90	181	2515	2286	8947	0	0	0	0	105	121	68	10	53	12	10.3
	100	171	2918	2714	11051	0	0	0	0	115	128	73	10	54	16	11.1
	110	161	3304	3113	13164	0	0	0	0	124	134	77	10	55	18	11.9
	120	151	3670	3495	15336	0	0	0	0	132	138	81	10	56	21	12.7
	130	141	4020	3850	17453	0	0	0	0	139	141	84	10	55	23	13.4
	140	132	4340	4172	19518	0	0	0	0	145	142	88	10	54	25	14.2
	150	124	4635	4469	21502	0	0	0	0	150	143	91	0	0	0	14.9
70	5	500	0	0	0	0	0	0	0	0	2	3	5	5	0	0.0
	10	478	27	0	0	0	0	0	0	4	10	12	10	20	0	1.2
	20	447	226	3	9	197	40	0	0	15	28	27	10	55	0	3.4
	30	242	732	224	721	0	0	0	0	47	66	40	10	87	2	5.9
	40	236	1589	1163	4042	0	0	0	0	83	105	52	10	108	6	8.0
	50	226	2601	2332	8828	0	0	0	0	118	138	62	10	117	15	9.8
	60	212	3622	3395	13877	0	0	0	0	148	163	70	10	123	25	11.3
	70	196	4599	4378	19136	0	0	0	0	173	180	78	10	122	35	12.7
	80	179	5462	5241	24234	0	0	0	0	191	189	84	10	118	43	14.0
	90	163	6212	5990	28926	0	0	0	0	205	194	90	10	117	50	15.2
	100	149	6878	6656	33273	0	0	0	0	216	196	95	10	114	57	16.3
	110	135	7449	7228	37105	0	0	0	0	223	196	100	10	111	62	17.4
	120	123	7943	7724	40470	0	0	0	0	228	195	104	10	104	64	18.5
	130	111	8339	8122	43225	0	0	0	0	231	192	108	10	105	69	19.5
	140	101	8695	8482	45688	0	0	0	0	233	189	112	10	98	69	20.5
	150	92	8984	8774	47718	0	0	0	0	233	185	116	0	0	0	21.5
90	5	500	0	0	0	0	0	0	0	0	2	4	5	16	0	0.0
	10	489	79	0	0	0	0	0	0	9	21	18	10	72	0	1.8
	20	472	801	253	771	222	135	0	0	42	61	40	10	137	1	5.6
	30	245	2026	1670	5960	0	0	0	0	99	122	57	10	171	9	8.6
	40	234	3649	3400	13473	0	0	0	0	152	172	71	10	183	25	10.9
	50	218	5229	4991	21796	0	0	0	0	195	204	82	10	184	46	12.8
	60	198	6615	6365	29808	0	0	0	0	227	222	89	10	176	62	14.5
	70	179	7756	7499	36916	0	0	0	0	249	230	94	10	172	74	15.9
	80	161	8738	8477	43399	0	0	0	0	265	234	100	10	173	87	17.3
	90	144	9598	9337	49138	0	0	0	0	276	235	105	10	152	87	18.7
	100	130	10255	9994	53601	0	0	0	0	283	233	109	10	158	97	20.0
	110	117	10865	10605	57717	0	0	0	0	288	231	114	10	153	97	21.2
	120	106	11427	11169	61368	0	0	0	0	292	228	118	10	155	104	22.5
	130	96	11939	11683	64679	0	0	0	0	295	225	122	10	152	104	23.7
	140	87	12413	12159	67653	0	0	0	0	297	222	125	10	138	103	25.0
	150	79	12765	12514	69883	0	0	0	0	298	218	129	0	0	0	26.3

Table 4—Yields of Douglas-fir plantations having 500 trees per acre surviving 5 years, thinning from below to 250 trees per acre at 20 years, and thinning from below to 100 trees per acre at 50 years

Site index	Age	Summary statistics														
		Volume per acre					Removals per acre					Growth				
		Trees/acre	Merchant-able volume	Merchant-able volume	Trees/acre	Total volume	Merchant-able volume	Merchant-able volume	BA/acre	CCF	Top height	PRD	ACC	MOR/year	D	
			Ft ³	Ft ³		Bd ft	Ft ³	Ft ³						Bd ft		Ft ²
50	5	500	0	0	0	0	0	0	0	0	2	3	5	2	0	0.0
	10	473	10	0	0	0	0	0	0	1	5	8	10	4	0	0.7
	20	432	47	0	0	182	8	0	0	4	11	16	10	12	0	1.8
	30	232	155	0	0	0	0	0	0	14	26	25	10	24	0	3.3
	40	225	396	37	108	0	0	0	0	29	45	34	10	36	1	4.9
	50	217	741	260	829	117	263	1	2	28	37	43	10	26	1	7.2
	60	98	730	598	2033	0	0	0	0	38	47	50	10	30	2	8.4
	70	95	1012	915	3335	0	0	0	0	47	56	57	10	32	3	9.5
	80	92	1302	1213	4653	0	0	0	0	56	64	63	10	35	4	10.5
	90	89	1607	1517	6128	0	0	0	0	64	71	68	10	36	6	11.5
	100	86	1914	1822	7726	0	0	0	0	72	77	73	10	36	7	12.4
	110	82	2200	2106	9296	0	0	0	0	79	82	77	10	36	9	13.3
	120	79	2469	2373	10846	0	0	0	0	85	85	81	10	37	11	14.1
	130	75	2732	2633	12434	0	0	0	0	91	88	84	10	37	12	14.9
	140	72	2983	2882	14010	0	0	0	0	96	90	88	10	37	13	15.7
	150	68	3222	3119	15565	0	0	0	0	101	92	91	0	0	0	16.5
70	5	500	0	0	0	0	0	0	0	0	2	3	5	5	0	0.0
	10	478	27	0	0	0	0	0	0	4	10	12	10	20	0	1.2
	20	447	226	3	9	197	40	0	0	15	28	27	10	55	0	3.4
	30	242	732	224	721	0	0	0	0	47	66	40	10	87	2	5.9
	40	236	1589	1163	4042	0	0	0	0	83	105	52	10	103	6	8.0
	50	226	2601	2332	8828	126	993	817	2792	71	79	62	10	77	5	11.4
	60	97	2326	2219	9623	0	0	0	0	92	96	70	10	82	10	13.2
	70	92	3053	2935	13659	0	0	0	0	111	108	78	10	84	14	14.8
	80	88	3756	3628	17845	0	0	0	0	128	117	84	10	90	20	16.3
	90	83	4453	4316	22134	0	0	0	0	142	125	90	10	90	25	17.7
	100	78	5105	4961	26157	0	0	0	0	155	131	96	10	87	30	19.1
	110	73	5677	5528	29731	0	0	0	0	165	135	101	10	88	35	20.3
	120	68	6209	6055	32999	0	0	0	0	173	138	105	10	83	36	21.5
	130	64	6680	6523	35889	0	0	0	0	180	140	109	10	78	41	22.6
	140	60	7052	6893	38160	0	0	0	0	184	141	113	10	80	45	23.7
	150	56	7396	7237	40252	0	0	0	0	187	141	116	0	0	0	24.7
90	5	500	0	0	0	0	0	0	0	0	2	4	5	16	0	0.0
	10	489	79	0	0	0	0	0	0	9	21	18	10	72	0	1.8
	20	472	801	253	771	222	135	0	0	42	61	40	10	137	1	5.6
	30	245	2026	1670	5960	0	0	0	0	99	122	57	10	171	9	8.6
	40	234	3649	3400	13473	0	0	0	0	152	172	71	10	183	25	10.9
	50	218	5229	4991	21796	118	1855	1745	6717	120	117	82	10	132	15	14.8
	60	96	4549	4403	22039	0	0	0	0	148	134	90	10	143	25	16.8
	70	90	5734	5571	29357	0	0	0	0	174	148	97	10	143	34	18.8
	80	85	6828	6653	35963	0	0	0	0	195	159	104	10	125	40	20.6
	90	79	7684	7500	41164	0	0	0	0	210	166	109	10	139	55	22.0
	100	74	8532	8340	46226	0	0	0	0	223	171	114	10	118	52	23.6
	110	69	9192	8995	50138	0	0	0	0	233	174	118	10	119	61	24.9
	120	64	9770	9569	53534	0	0	0	0	240	176	121	10	113	64	26.2
	130	60	10269	10066	56440	0	0	0	0	244	177	125	10	121	71	27.3
	140	56	10763	10559	59378	0	0	0	0	249	177	128	10	104	65	28.7
	150	52	11153	10948	61649	0	0	0	0	252	176	131	0	0	0	29.8

Table 5—Yields of Douglas-fir plantations having 500 trees per acre surviving 5 years, thinning from below to 250 trees per acre at 20 years, and thinning from above to 100 trees per acre at 50 years

Site Index	Age	Trees/acre	Summary statistics													
			Volume per acre			Removals per acre					Growth					
			Total volume	Merchant-able volume	Merchant-able volume	Trees/acre	Total volume	Merchant-able volume	Merchant-able volume	BA/acre	CCF	Top height	PRD	MOR/year		D
														Ft ³	Ft ³	
50	5	500	0	0	0	0	0	0	0	0	2	3	5	2	0	0.0
	10	473	10	0	0	0	0	0	0	1	5	8	10	4	0	0.7
	20	432	47	0	0	182	8	0	0	4	11	16	10	12	0	1.8
	30	232	155	0	0	0	0	0	0	14	26	25	10	24	0	3.3
	40	225	396	37	108	0	0	0	0	29	45	34	10	36	1	4.9
	50	217	741	260	829	117	533	260	828	14	22	34	10	18	1	5.1
	60	95	376	114	351	0	0	0	0	21	29	43	10	25	1	6.4
	70	92	613	409	1374	0	0	0	0	30	38	52	10	30	2	7.7
	80	90	893	741	2670	0	0	0	0	39	47	60	10	31	2	8.9
	90	87	1180	1074	4079	0	0	0	0	47	55	67	10	32	4	10.0
	100	84	1462	1369	5458	0	0	0	0	54	61	72	10	33	5	10.9
	110	80	1738	1646	6868	0	0	0	0	61	67	77	10	36	7	11.8
	120	77	2032	1942	8491	0	0	0	0	69	71	82	10	34	8	12.8
	130	74	2298	2206	10021	0	0	0	0	75	75	85	10	36	10	13.6
	140	70	2561	2468	11624	0	0	0	0	80	78	89	10	36	11	14.5
	150	67	2814	2719	13210	0	0	0	0	85	81	93	0	0	0	15.3
70	5	500	0	0	0	0	0	0	0	0	2	3	5	5	0	0.0
	10	478	27	0	0	0	0	0	0	4	10	12	10	20	0	1.2
	20	447	226	3	9	197	40	0	0	15	28	27	10	55	0	3.4
	30	242	732	224	721	0	0	0	0	47	66	40	10	87	2	5.9
	40	236	1589	1163	4042	0	0	0	0	83	105	52	10	108	6	8.0
	50	226	2601	2332	8828	126	1869	1755	6894	35	44	53	10	54	4	8.0
	60	95	1233	1137	4262	0	0	0	0	51	60	64	10	69	4	9.9
	70	91	1878	1780	7321	0	0	0	0	69	76	74	10	78	7	11.8
	80	87	2591	2486	11119	0	0	0	0	88	89	82	10	82	11	13.6
	90	83	3304	3190	15294	0	0	0	0	105	100	89	10	87	15	15.2
	100	79	4023	3900	19632	0	0	0	0	120	109	96	10	83	19	16.7
	110	75	4660	4530	23525	0	0	0	0	133	115	101	10	84	26	18.0
	120	70	5242	5107	27123	0	0	0	0	143	120	106	10	82	29	19.3
	130	66	5774	5634	30399	0	0	0	0	152	124	111	10	82	33	20.5
	140	62	6261	6118	33358	0	0	0	0	159	126	115	10	78	35	21.7
	150	58	6691	6545	35980	0	0	0	0	165	128	119	0	0	0	22.8
90	5	500	0	0	0	0	0	0	0	0	2	4	5	16	0	0.0
	10	489	79	0	0	0	0	0	0	9	21	18	10	72	0	1.8
	20	472	801	253	771	222	135	0	0	42	61	40	10	137	1	5.6
	30	245	2026	1670	5960	0	0	0	0	99	122	57	10	171	9	8.6
	40	234	3649	3400	13473	0	0	0	0	152	172	71	10	183	25	10.9
	50	218	5229	4991	21796	118	3733	3588	16441	61	71	65	10	99	8	10.6
	60	94	2401	2296	9766	0	0	0	0	86	90	77	10	131	8	12.9
	70	91	3630	3506	16764	0	0	0	0	117	111	88	10	135	15	15.3
	80	87	4832	4690	24025	0	0	0	0	144	128	97	10	148	25	17.4
	90	82	6069	5911	31418	0	0	0	0	170	142	104	10	133	32	19.5
	100	78	7074	6904	37573	0	0	0	0	189	152	110	10	120	40	21.1
	110	73	7874	7696	42374	0	0	0	0	202	158	114	10	139	52	22.6
	120	68	8739	8553	47490	0	0	0	0	216	164	120	10	116	49	24.2
	130	64	9411	9221	51471	0	0	0	0	225	167	123	10	117	61	25.5
	140	59	9976	9781	54752	0	0	0	0	232	169	127	10	112	64	26.8
	150	55	10457	10262	57575	0	0	0	0	237	169	130	0	0	0	28.0

Table 6—Yields of Douglas-fir plantations having 500 trees per acre surviving 5 years, thinning from below to 250 trees per acre at 20 years, and thinning to 100 trees per acre at 50 years such that the mean d.b.h. before and after thinning is the same

Site index	Age	Summary statistics													
		Volume per acre			Removals per acre					Growth					
		Trees/acre	Merchant-able volume	Merchant-able volume	Trees/acre	Total volume	Merchant-able volume	Merchant-able volume	BA/acre	CCF	Top height	Growth			
			<i>Ft</i> ³	<i>Ft</i> ³			<i>Bd ft</i>	<i>Ft</i> ³				<i>Ft</i> ³	<i>Bd ft</i>	<i>Ft</i> ²	Yr
50	5	500	0	0	0	0	0	0	0	2	3	5	2	0	0.0
	10	473	10	0	0	0	0	0	1	5	8	10	4	0	0.7
	20	432	47	0	0	182	8	0	0	4	11	16	10	12	0 1.8
	30	232	155	0	0	0	0	0	0	14	26	25	10	24	0 3.3
	40	225	396	37	108	0	0	0	0	29	45	34	10	36	1 4.9
	50	217	741	260	829	117	400	140	448	21	30	41	10	22	1 6.2
	60	97	557	358	1203	0	0	0	0	30	38	49	10	28	1 7.5
	70	94	821	665	2379	0	0	0	0	38	47	56	10	31	2 8.7
	80	91	1107	984	3724	0	0	0	0	47	56	63	10	31	3 9.8
	90	88	1384	1277	5069	0	0	0	0	55	62	68	10	31	5 10.8
	100	84	1645	1549	6391	0	0	0	0	62	68	72	10	33	6 11.6
	110	80	1914	1822	7852	0	0	0	0	69	72	77	10	34	8 12.5
	120	77	2181	2089	9366	0	0	0	0	75	76	81	10	34	9 13.4
	130	73	2429	2335	10838	0	0	0	0	80	79	85	10	36	11 14.2
	140	70	2680	2584	12379	0	0	0	0	85	82	88	10	36	11 15.0
	150	66	2924	2828	13919	0	0	0	0	90	84	91	0	0	0 15.8
70	5	500	0	0	0	0	0	0	0	2	3	5	5	0	0.0
	10	478	27	0	0	0	0	0	0	4	10	12	10	20	0 1.2
	20	447	226	3	9	197	40	0	0	15	28	27	10	55	0 3.4
	30	242	732	224	721	0	0	0	0	47	66	40	10	87	2 5.9
	40	236	1589	1163	4042	0	0	0	0	83	105	52	10	108	6 8.0
	50	226	2601	2332	8828	126	1444	1294	4897	53	61	60	10	63	4 9.8
	60	96	1747	1646	6784	0	0	0	0	70	77	69	10	75	7 11.6
	70	92	2433	2326	10388	0	0	0	0	89	91	77	10	79	10 13.4
	80	87	3118	3003	14260	0	0	0	0	106	102	84	10	79	14 14.9
	90	83	3768	3645	18153	0	0	0	0	120	110	90	10	82	19 16.3
	100	78	4398	4267	21983	0	0	0	0	133	117	95	10	80	23 17.7
	110	74	4964	4828	25471	0	0	0	0	144	121	100	10	81	29 18.9
	120	69	5490	5350	28716	0	0	0	0	153	125	105	10	79	32 20.1
	130	65	5959	5815	31600	0	0	0	0	160	128	109	10	77	35 21.3
	140	60	6380	6234	34183	0	0	0	0	166	129	113	10	77	38 22.4
	150	56	6765	6617	36520	0	0	0	0	170	130	117	0	0	0 23.5
90	5	500	0	0	0	0	0	0	0	2	4	5	16	0	0.0
	10	489	79	0	0	0	0	0	0	9	21	18	10	72	0 1.8
	20	472	801	253	771	222	135	0	0	42	61	40	10	137	1 5.6
	30	245	2026	1670	5960	0	0	0	0	99	122	57	10	171	9 8.6
	40	234	3649	3400	13473	0	0	0	0	152	172	71	10	183	25 10.9
	50	218	5229	4991	21796	118	2816	2688	11723	90	94	77	10	113	10 12.8
	60	95	3444	3318	15780	0	0	0	0	116	112	86	10	123	15 15.0
	70	91	4530	4389	22187	0	0	0	0	142	127	93	10	123	22 16.9
	80	86	5540	5386	28284	0	0	0	0	163	140	100	10	132	32 18.6
	90	81	6541	6375	34388	0	0	0	0	182	149	106	10	118	37 20.3
	100	76	7348	7173	39220	0	0	0	0	197	156	111	10	126	47 21.8
	110	71	8145	7964	43986	0	0	0	0	209	161	115	10	125	51 23.3
	120	66	8887	8699	48393	0	0	0	0	220	165	120	10	125	58 24.7
	130	62	9554	9362	52290	0	0	0	0	229	168	124	10	121	62 26.1
	140	57	10150	9954	55795	0	0	0	0	236	170	127	10	111	64 27.5
	150	53	10617	10419	58533	0	0	0	0	241	170	130	0	0	0 28.7

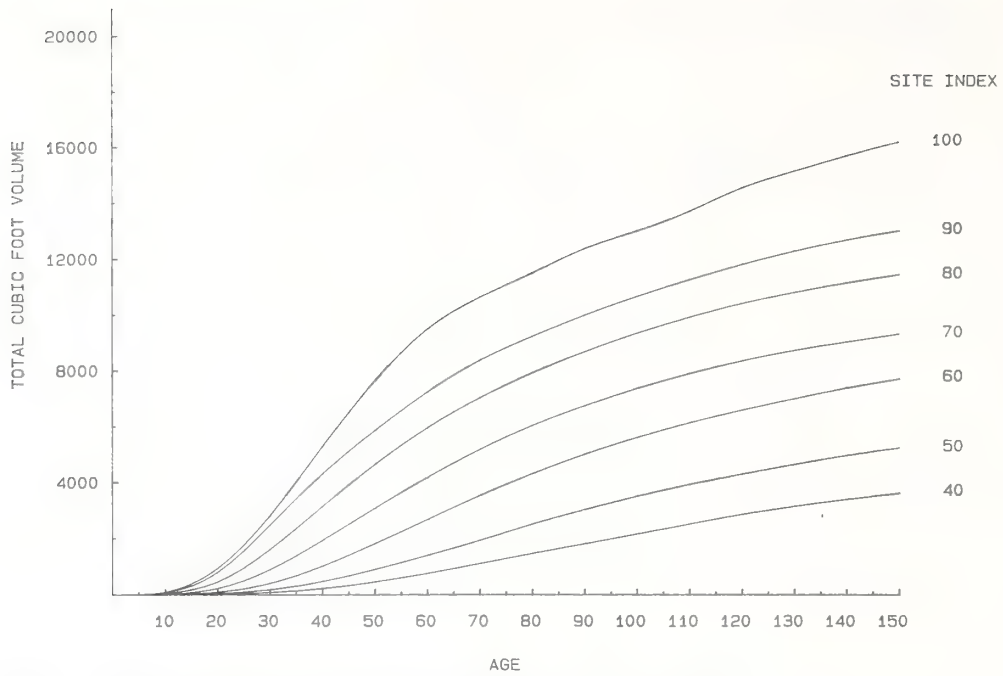


Figure 7—Douglas-fir yield curves for unthinned plantations in Inland Northwest forests (total cubic feet, all stems).

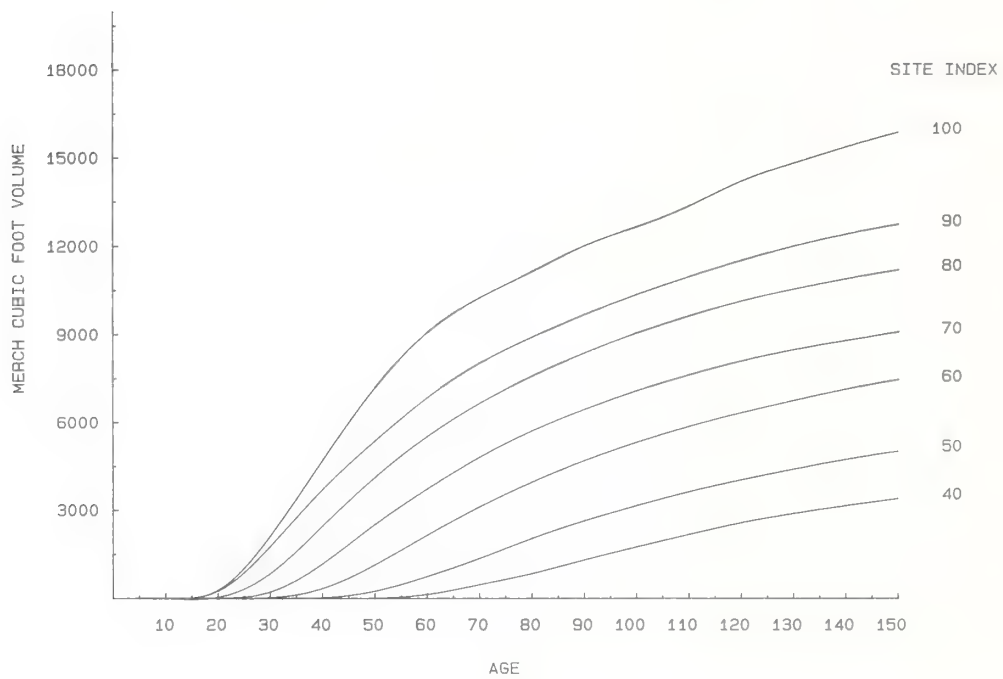


Figure 8—Douglas-fir yield curves for unthinned plantations in Inland Northwest forests (merchantable cubic feet, 4.5-inch top, stems greater than 7 inches d.b.h.).

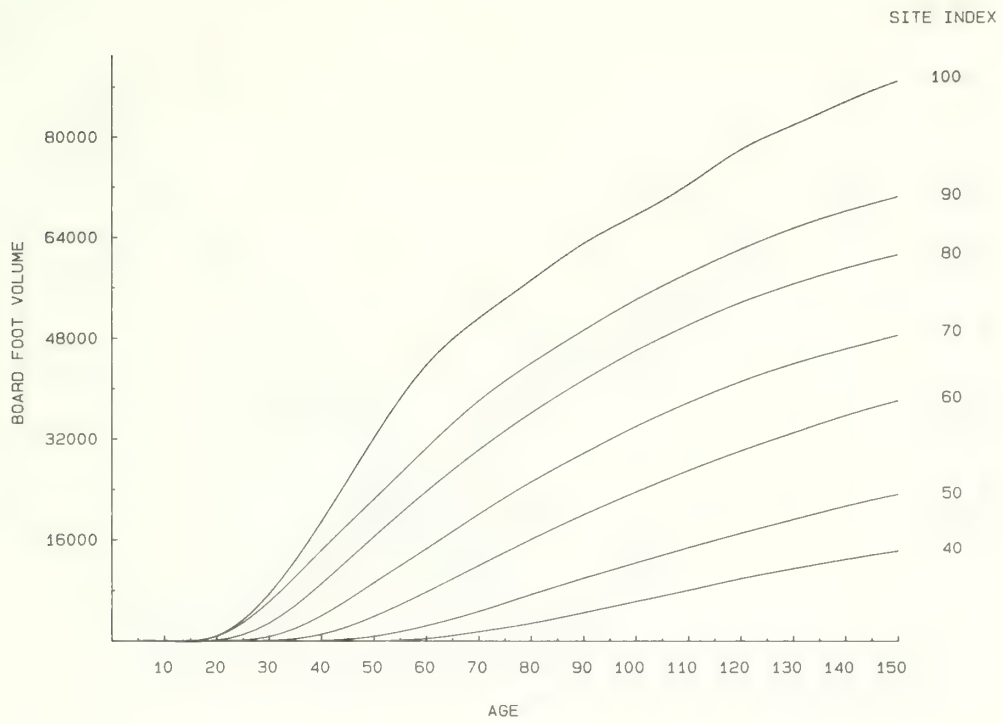


Figure 9—Douglas-fir yield curves for unthinned plantations in Inland Northwest forests (merchantable board feet [Scribner], 4.5-inch top, stems greater than 7 inches d.b.h.).

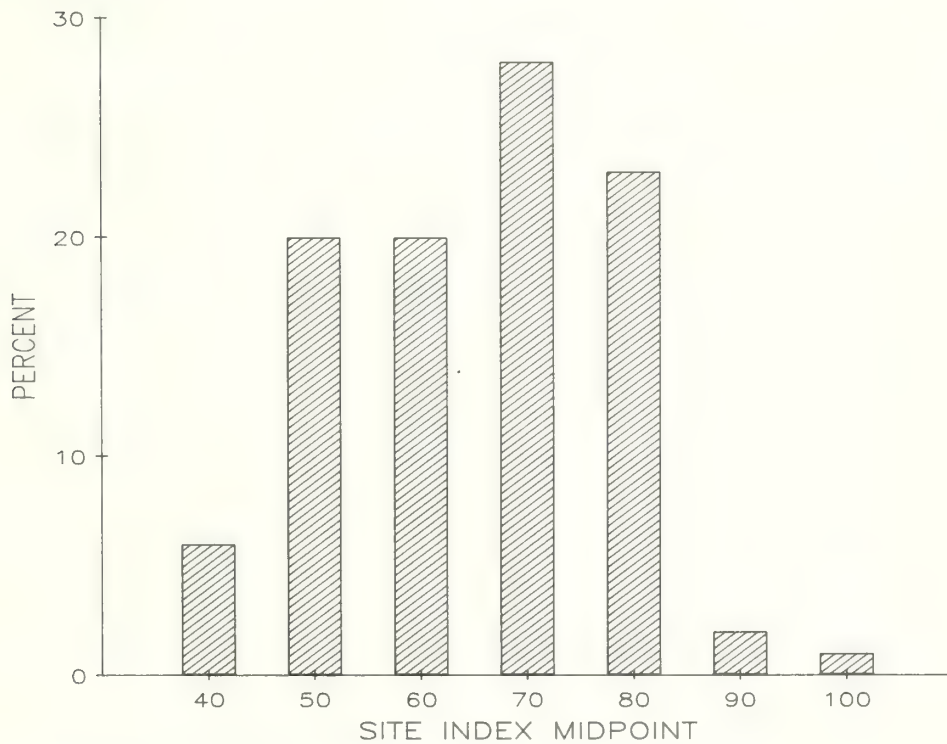


Figure 10—Distribution of Douglas-fir plantation site index values for Inland Northwest forests.

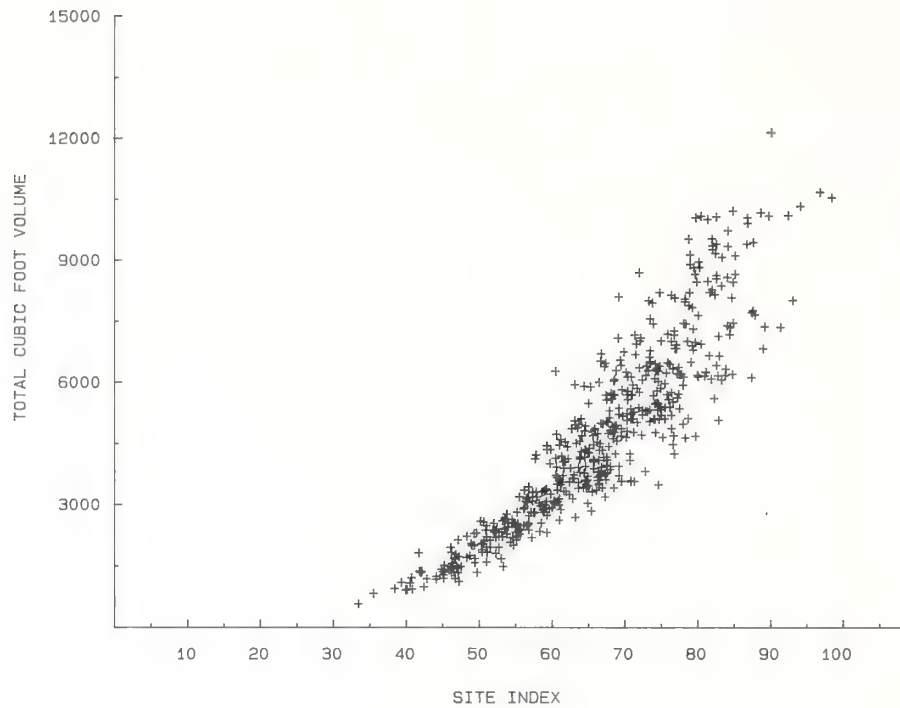


Figure 11—Douglas-fir yield vs. site index at 70 years of age (total cubic feet).

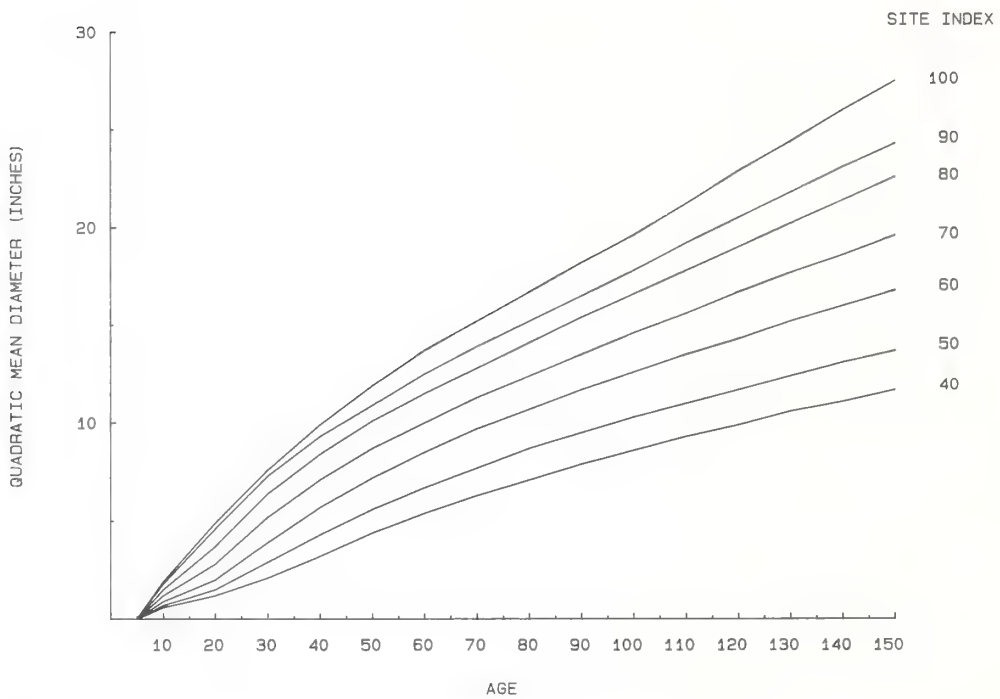


Figure 12—Quadratic mean diameter vs. age for Douglas-fir unthinned plantations in Inland Northwest forests.

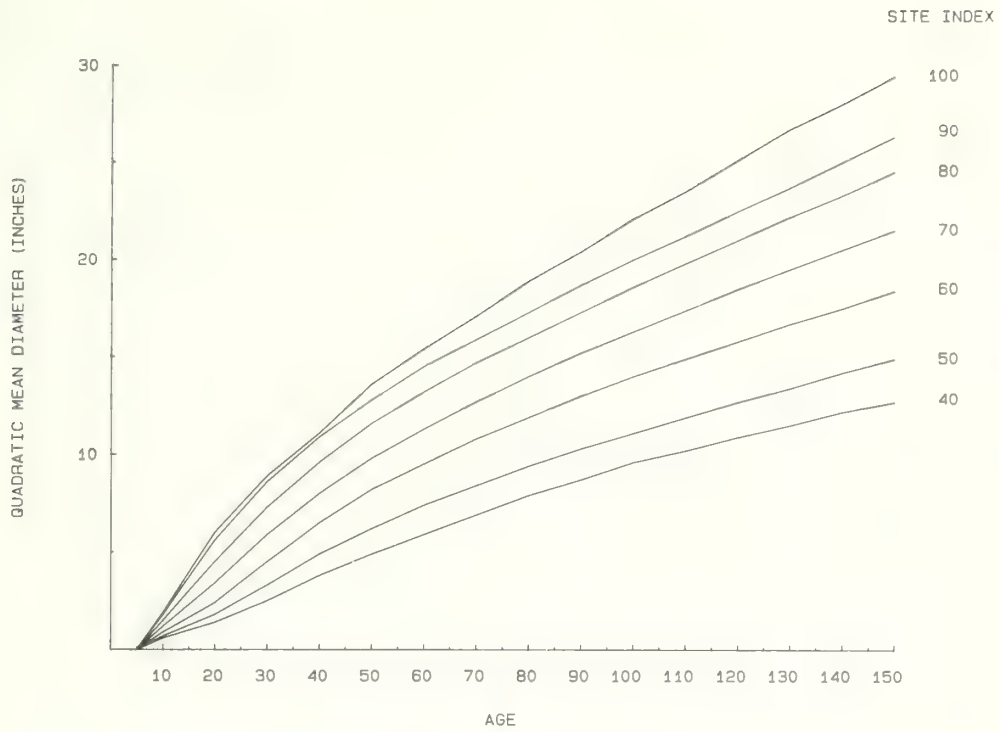


Figure 13—Quadratic mean diameter vs. age for Douglas-fir precommercial thinning to 250 trees per acre at 20 years in Inland Northwest forests.

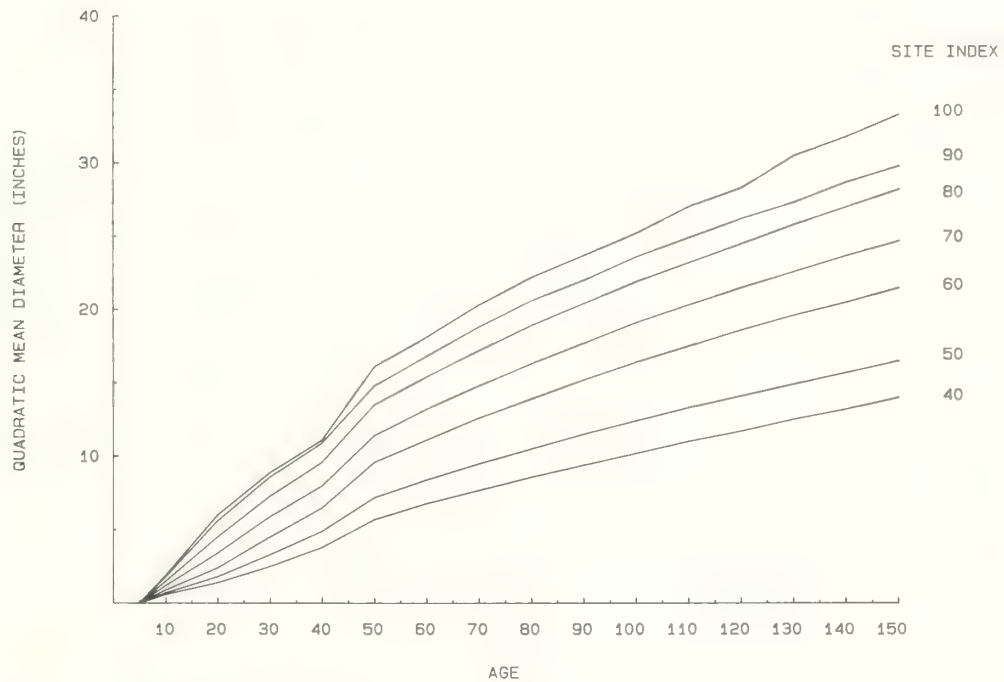


Figure 14—Quadratic mean diameter vs. age for Douglas-fir precommercial thinning to 250 trees per acre at 20 years and commercial thinning from below to 100 trees per acre at 50 years in Inland Northwest forests.

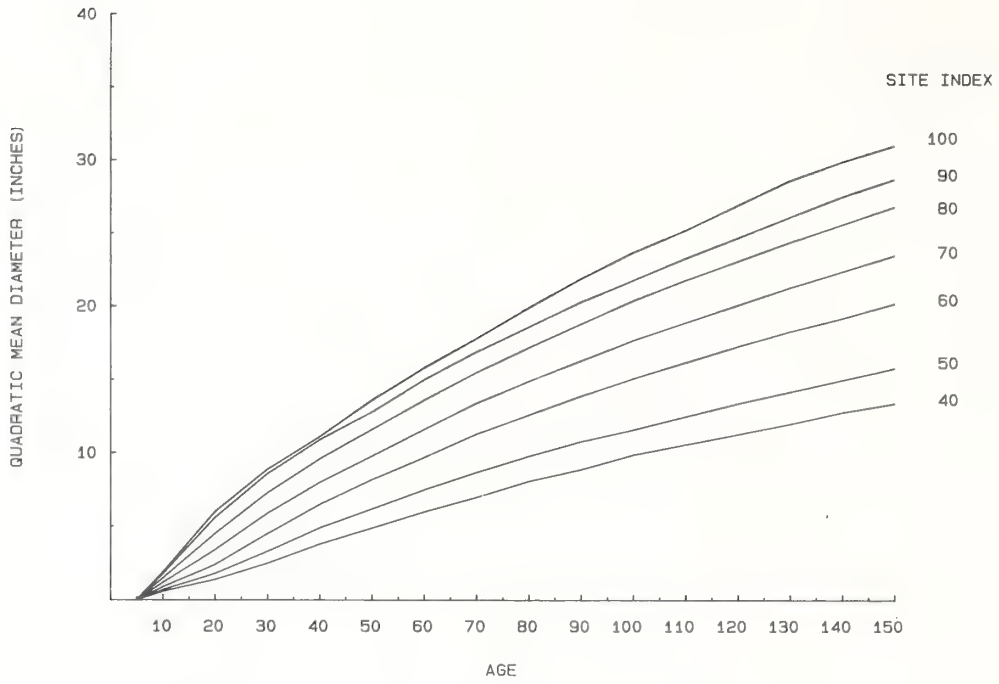


Figure 15—Quadratic mean diameter vs. age for Douglas-fir precommercial thinning to 250 trees per acre at 20 years and commercial thinning to 100 trees per acre at 50 years such that the mean d.b.h. before and after thinning is the same.

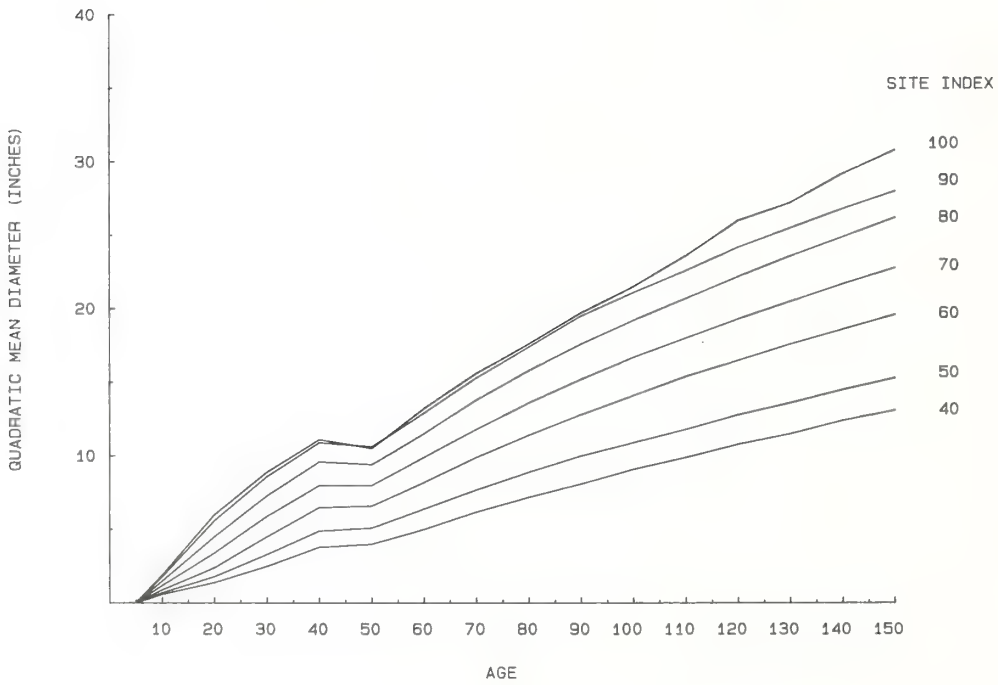


Figure 16—Quadratic mean diameter vs. age for Douglas-fir precommercial thinning to 250 trees per acre at 20 years and commercial thinning from above to 100 trees per acre at 50 years in Inland Northwest forests.

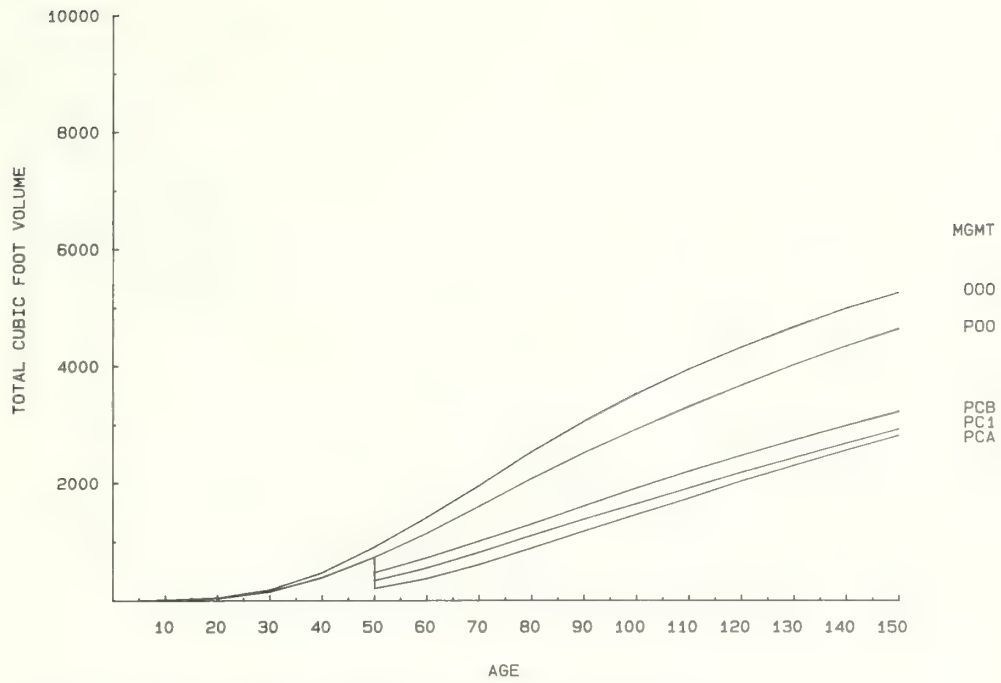


Figure 17—Effect of thinning on standing volume of Douglas-fir plantations (total cubic feet), site index 50.

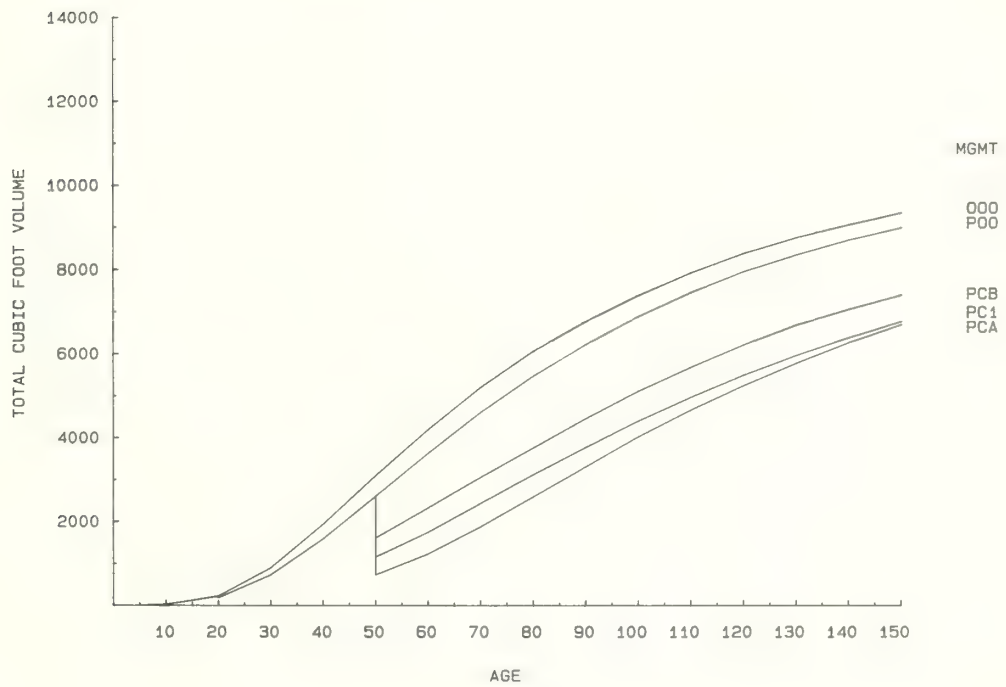


Figure 18—Effect of thinning on standing volume of Douglas-fir plantations (total cubic feet), site index 70.

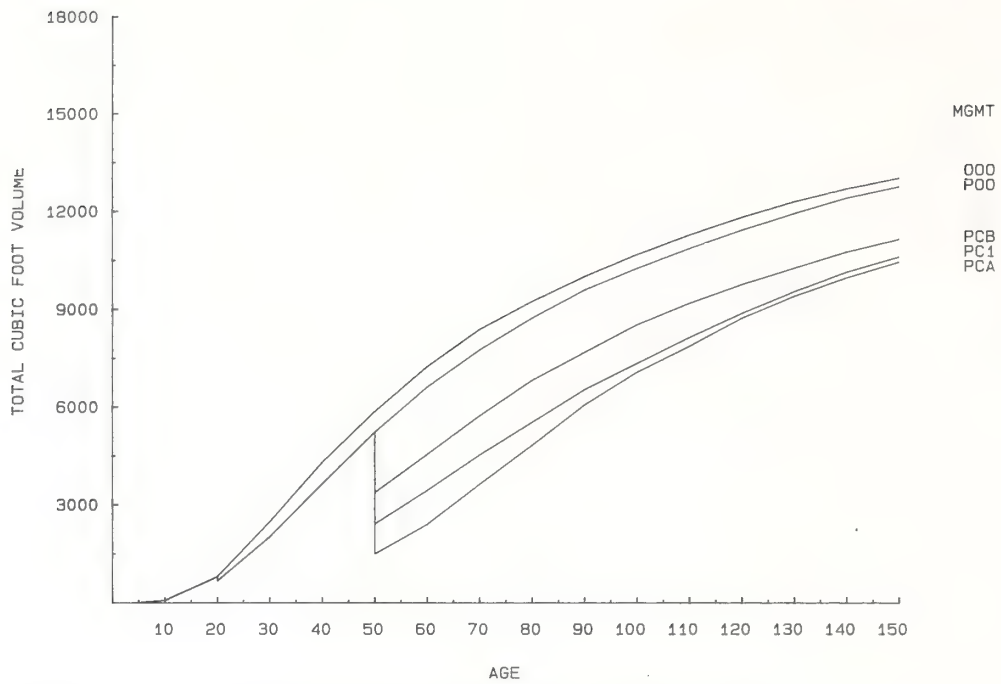


Figure 19—Effect of thinning on standing volume of Douglas-fir plantations (total cubic feet), site index 90.

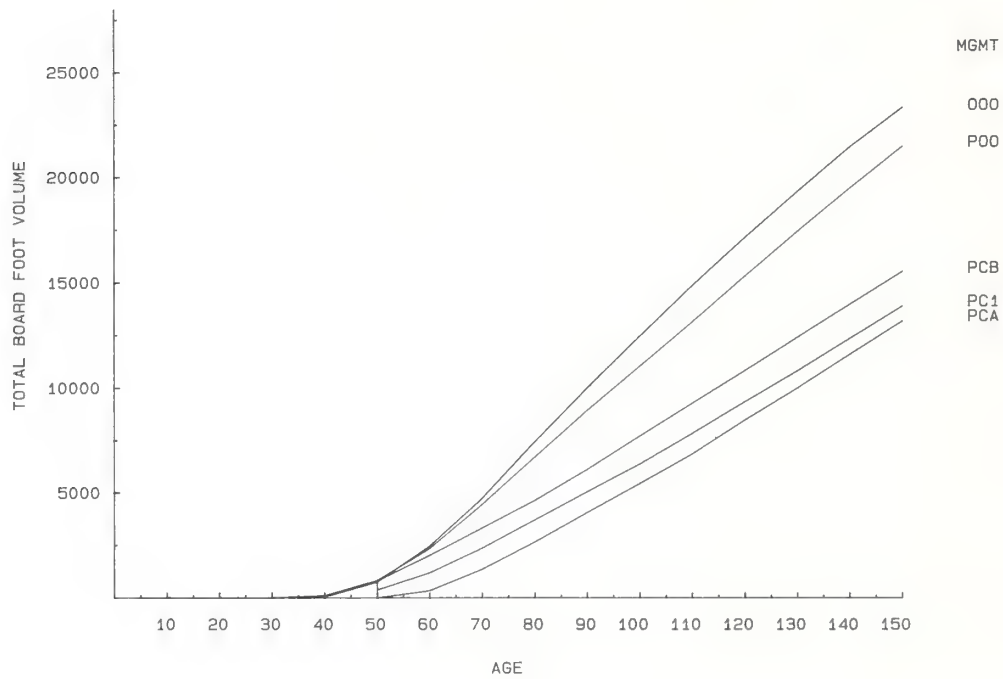


Figure 20—Effect of thinning on standing volume of Douglas-fir plantations (merchantable board feet [Scribner]), site index 50.

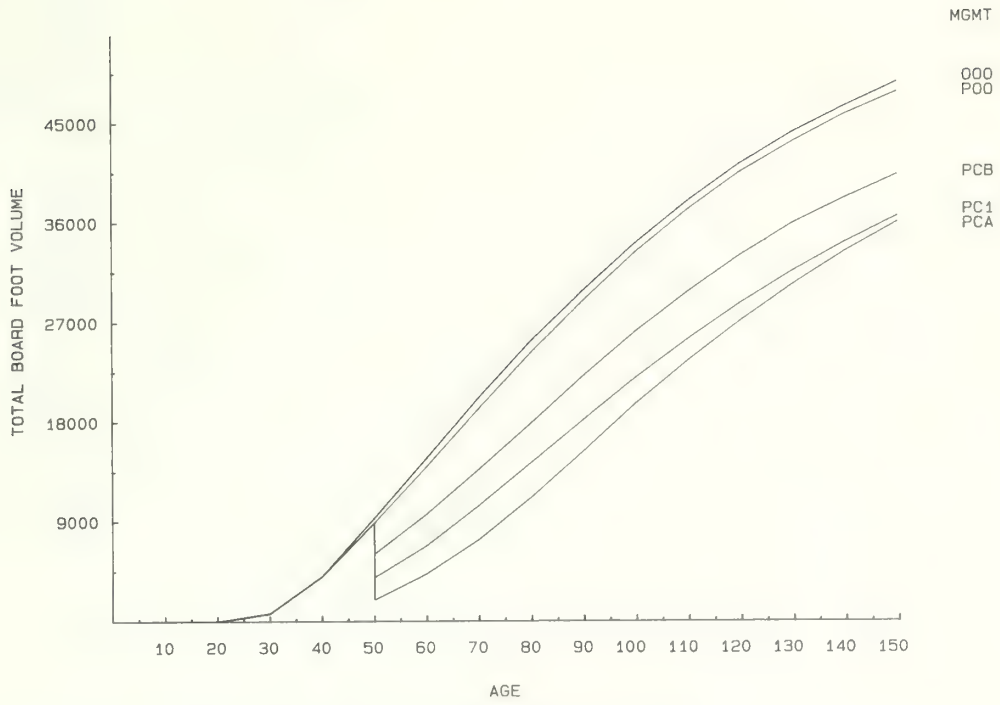


Figure 21—Effect of thinning on standing volume of Douglas-fir plantations (merchantable board feet [Scribner]), site index 70.

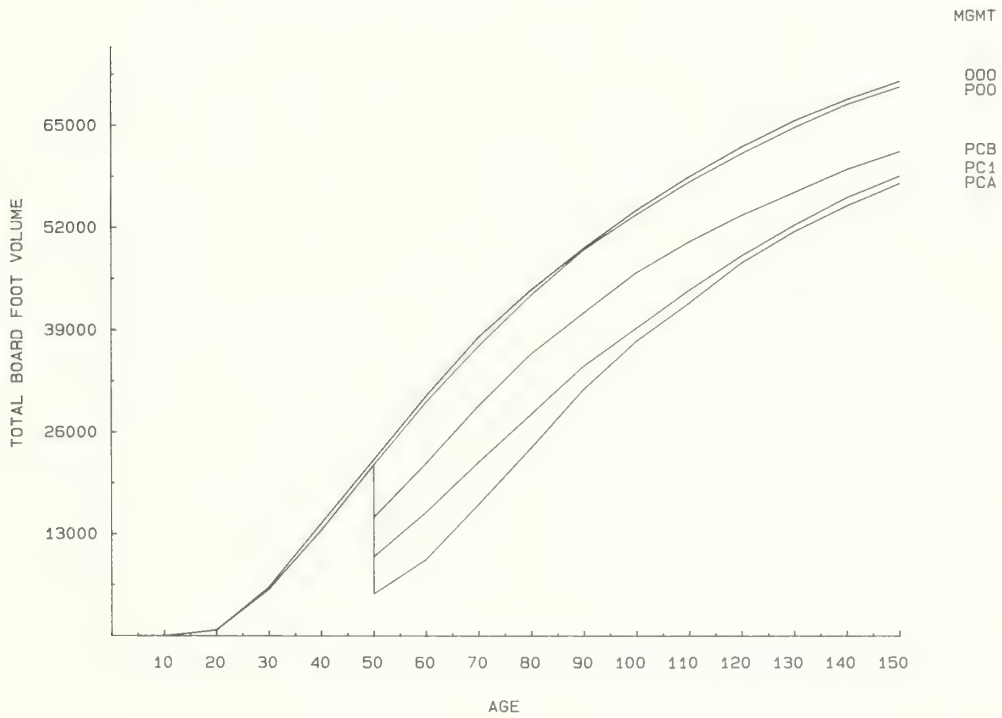


Figure 22—Effect of thinning on standing volume of Douglas-fir plantations (merchantable board feet [Scribner]), site index 90.

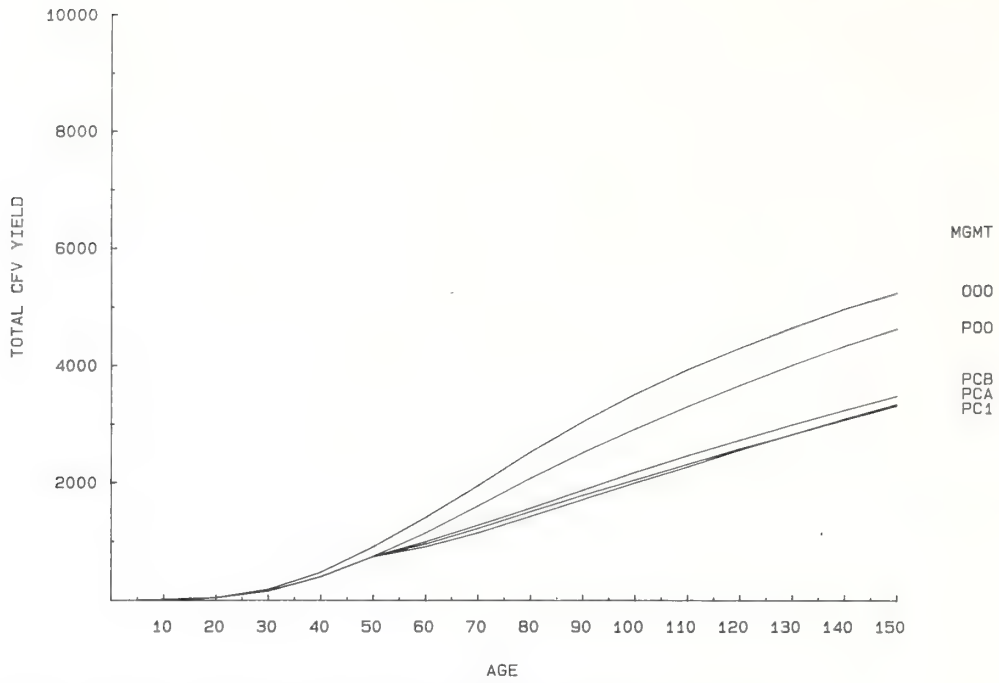


Figure 23—Effect of thinning on total yield of Douglas-fir plantations (total cubic feet), site index 50.

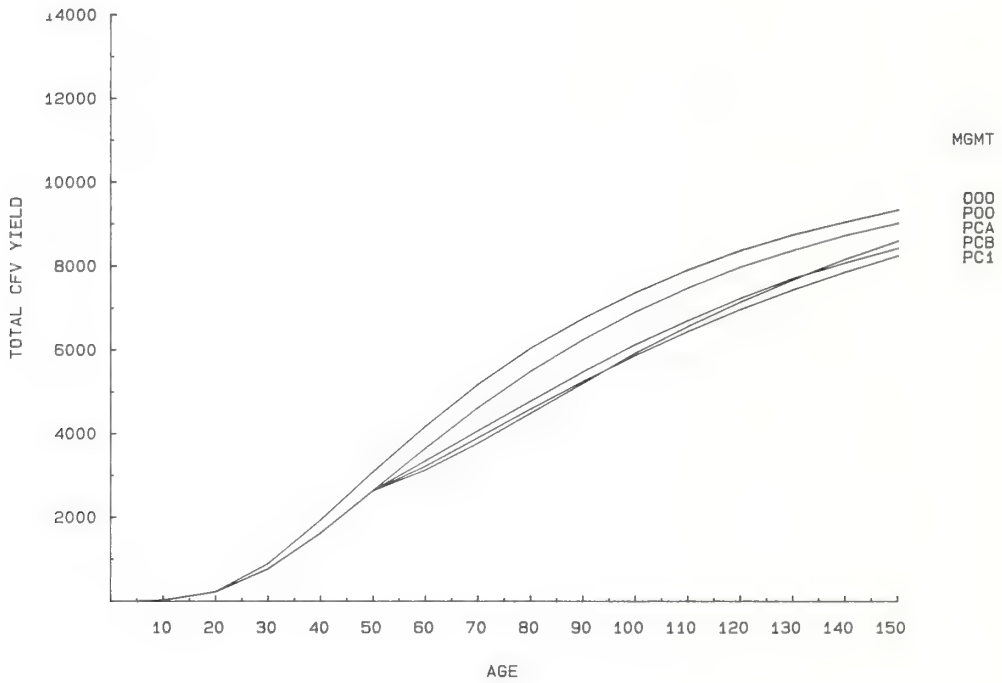


Figure 24—Effect of thinning on total yield of Douglas-fir plantations (total cubic feet), site index 70.

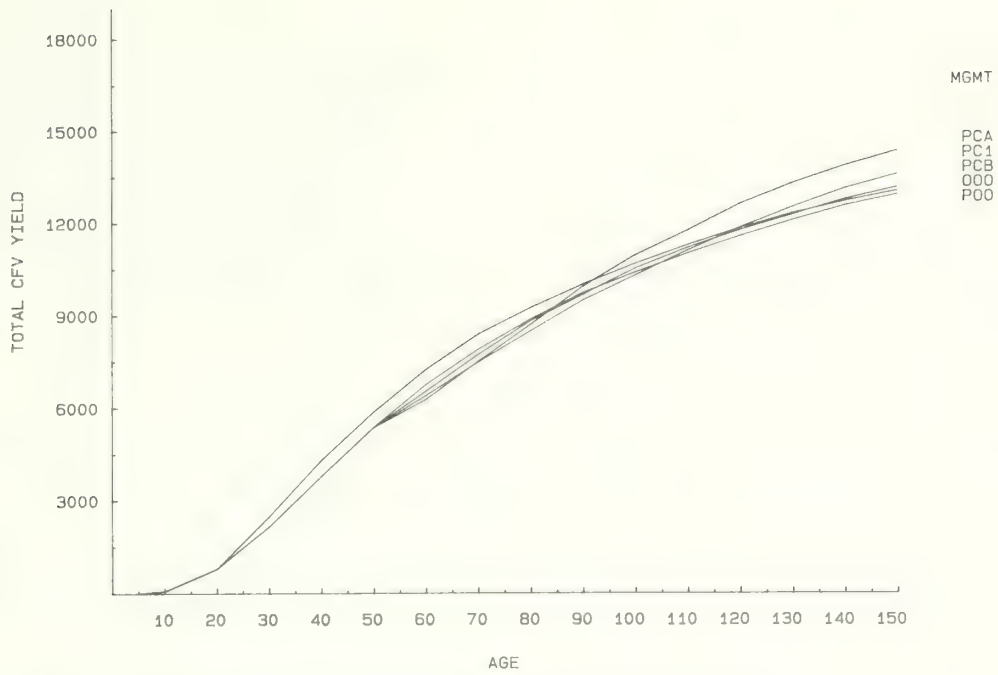


Figure 25—Effect of thinning on total yield of Douglas-fir plantations (total cubic feet), site index 90.

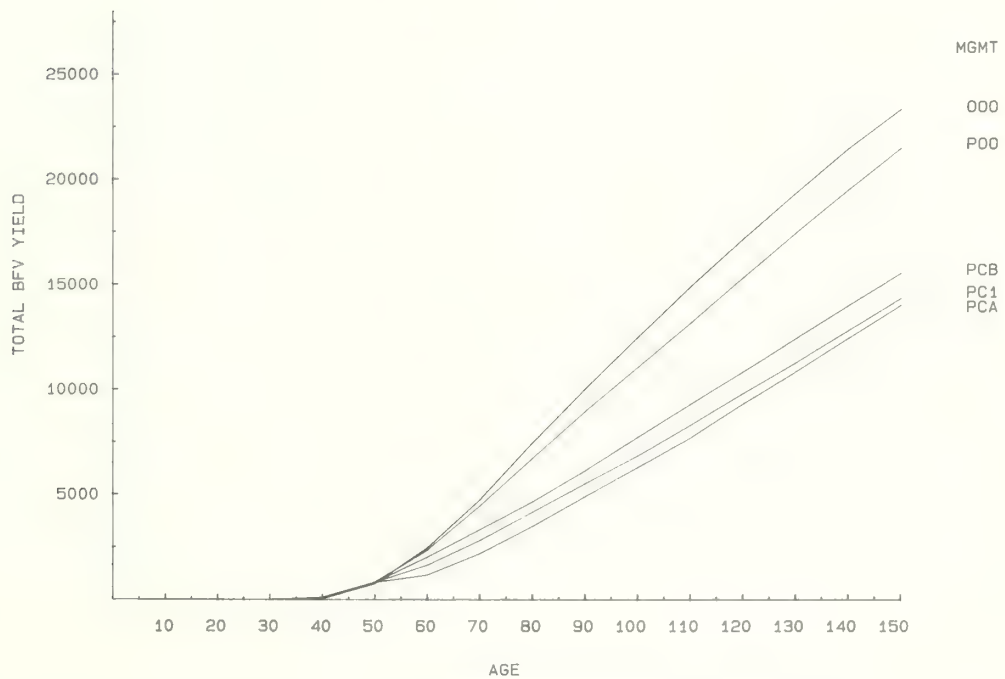


Figure 26—Effect of thinning on total yield of Douglas-fir plantations (merchantable board feet [Scribner]), site index 50.

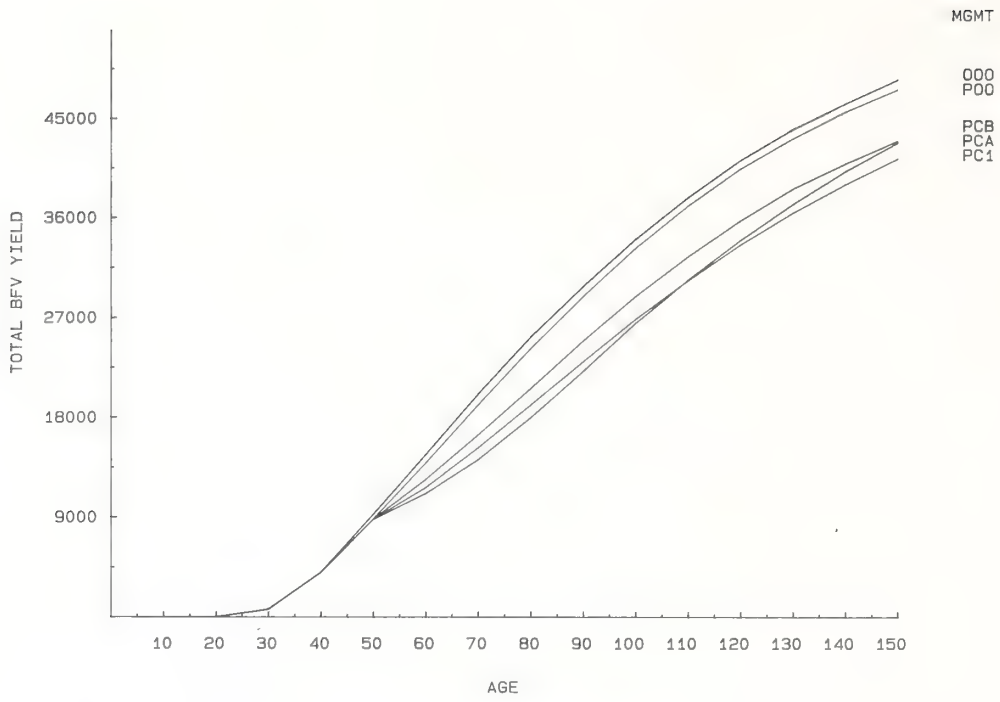


Figure 27—Effect of thinning on total yield of Douglas-fir plantations (merchantable board feet [Scribner]), site index 70.

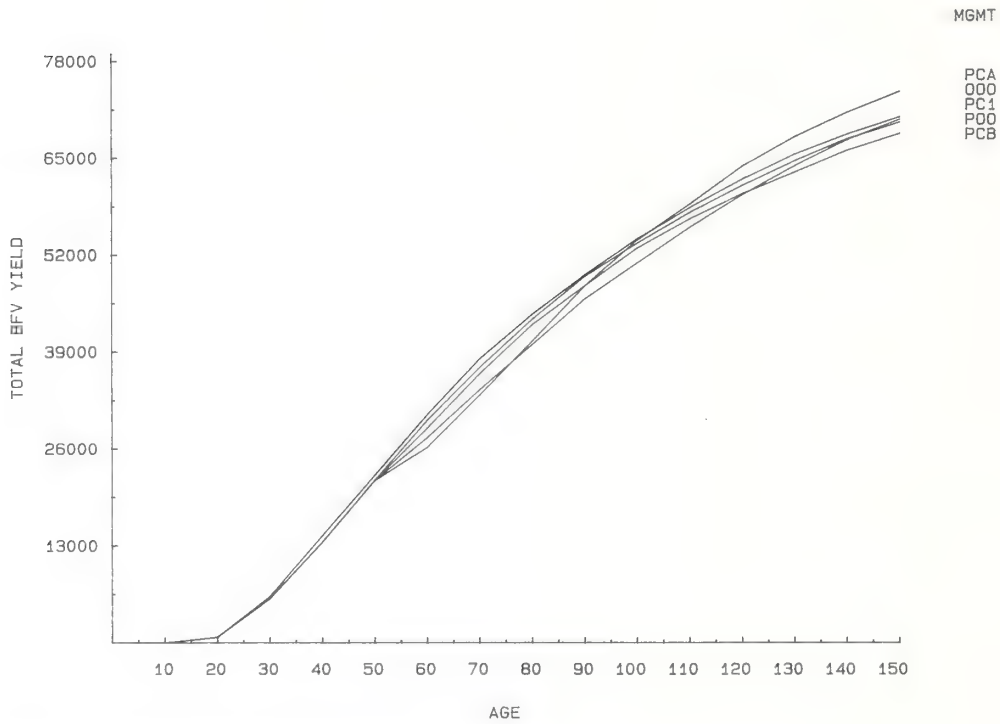


Figure 28—Effect of thinning on total yield of Douglas-fir plantations (merchantable board feet [Scribner]), site index 90.

Grand fir

Yields are summarized in tables 7 through 11 and figures 29 through 31.

In comparison to Douglas-fir plantations, early yields are lower for grand fir, but by 100 years the grand fir yields are higher for all site index classes.

Site indices for the simulations (figs. 32, 33) of grand fir plantations are lower than for either the natural regeneration simulations or for the Douglas-fir plantations.

The differences are attributable to data for initial heights

at age 5 represented in the Regeneration Establishment Model. Planting effect in the initial height estimation equation gives little height advantage to planted grand fir compared to Douglas-fir.

Mean d.b.h. of the grand fir plantations starts slower than Douglas-fir but surpasses it in later years (figs. 34 through 38). Grand fir plantations always have trees of larger diameter than the naturally regenerated stands, which also contain a substantial proportion of grand fir.

Effects of thinning regimes on standing volume are compared in figures 39 through 44. Effects of thinnings on total yield are compared in figures 45 through 50.

Table 7—Yields of grand fir plantations having 500 trees per acre surviving 5 years, no thinning

Site index	Age	Summary statistics														
		Volume per acre					Removals per acre					Growth				
		Trees/acre	Merchant-able volume	Merchant-able volume	Trees/acre	Total volume	Merchant-able volume	Merchant-able volume	BA/acre	CCF	Top height	PRD	ACC	MOR/year	D	
			<i>Ft</i> ³	<i>Ft</i> ³	<i>Bd ft</i>	<i>Ft</i> ³	<i>Ft</i> ³	<i>Bd ft</i>	<i>Ft</i> ²		<i>Ft</i>	<i>Yr</i>	<i>Ft</i> ³	<i>Ft</i> ³		
50	5	500	0	0	0	0	0	0	0	0	2	1	5	0	0	0.0
	10	447	2	0	0	0	0	0	0	1	3	6	10	1	0	0.6
	20	371	13	0	0	0	0	0	0	3	8	12	10	7	0	1.2
	30	316	79	0	0	0	0	0	0	11	23	21	10	23	0	2.5
	40	292	308	48	160	0	0	0	0	28	52	29	10	58	1	4.2
	50	276	872	439	1546	0	0	0	0	61	100	37	10	92	4	6.4
	60	262	1758	1378	5139	0	0	0	0	100	147	45	10	125	10	8.4
	70	246	2910	2601	10567	0	0	0	0	139	184	55	10	145	19	10.2
	80	229	4166	3899	17125	0	0	0	0	171	211	64	10	157	31	11.7
	90	210	5430	5172	24275	0	0	0	0	197	230	72	10	172	45	13.1
	100	192	6700	6443	31752	0	0	0	0	218	243	79	10	177	55	14.4
	110	174	7916	7656	38998	0	0	0	0	234	253	87	10	182	67	15.7
	120	158	9072	8809	45868	0	0	0	0	247	260	93	10	182	77	16.9
	130	143	10126	9862	52038	0	0	0	0	256	264	100	10	185	86	18.1
	140	130	11108	10844	57695	0	0	0	0	263	266	105	10	182	92	19.3
	150	118	12004	11741	62725	0	0	0	0	267	266	111	0	0	0	20.4
70	5	500	0	0	0	0	0	0	0	0	2	2	5	1	0	0.0
	10	454	4	0	0	0	0	0	0	2	5	7	10	4	0	0.8
	20	393	43	0	0	0	0	0	0	7	16	17	10	25	0	1.8
	30	344	292	31	107	0	0	0	0	27	53	30	10	93	1	3.8
	40	328	1216	735	2580	0	0	0	0	80	129	41	10	176	4	6.7
	50	312	2934	2543	9929	0	0	0	0	150	207	53	10	247	21	9.4
	60	289	5203	4852	21466	0	0	0	0	216	265	65	10	268	51	11.7
	70	259	7374	7038	33865	0	0	0	0	262	299	76	10	277	82	13.6
	80	228	9329	8997	45454	0	0	0	0	291	318	84	10	307	114	15.3
	90	198	11255	10921	56820	0	0	0	0	313	329	93	10	298	130	17.0
	100	174	12935	12603	66608	0	0	0	0	327	334	101	10	316	155	18.6
	110	151	14543	14211	75669	0	0	0	0	337	336	109	10	307	163	20.2
	120	133	15989	15658	83652	0	0	0	0	344	337	116	10	296	168	21.8
	130	118	17271	16942	90581	0	0	0	0	348	335	123	10	289	175	23.3
	140	105	18408	18083	96624	0	0	0	0	350	332	129	10	294	182	24.8
	150	93	19534	19210	102513	0	0	0	0	352	330	135	0	0	0	26.3
90	5	500	0	0	0	0	0	0	0	0	2	3	5	1	0	0.0
	10	459	6	0	0	0	0	0	0	2	6	8	10	8	0	1.0
	20	406	80	0	0	0	0	0	0	11	24	21	10	64	0	2.2
	30	366	717	321	1175	0	0	0	0	55	91	36	10	208	1	5.2
	40	351	2789	2335	9459	0	0	0	0	149	206	55	10	347	17	8.8
	50	323	6086	5695	26543	0	0	0	0	252	302	70	10	400	67	12.0
	60	284	9408	8994	44885	0	0	0	0	319	354	85	10	352	120	14.4
	70	245	11718	11324	58472	0	0	0	0	353	377	91	10	428	174	16.3
	80	207	14256	13869	73051	0	0	0	0	379	387	100	10	374	187	18.3
	90	178	16122	15735	83469	0	0	0	0	391	390	110	10	431	237	20.1
	100	150	18068	17689	94258	0	0	0	0	401	390	117	10	417	239	22.1
	110	129	19846	19469	103758	0	0	0	0	407	388	124	10	376	231	24.0
	120	113	21302	20927	111471	0	0	0	0	410	385	130	10	367	236	25.7
	130	101	22611	22240	118360	0	0	0	0	412	382	136	10	386	246	27.4
	140	89	24022	23651	125692	0	0	0	0	415	379	142	10	388	256	29.2
	150	79	25343	24974	132570	0	0	0	0	417	377	148	0	0	0	31.0

Table 8—Yields of grand fir plantations having 500 trees per acre surviving 5 years, precommercial thinning from below to 250 trees per acre at 20 years

		Summary statistics																
Site index	Age	Trees/acre	Volume per acre			Removals per acre					BA/acre	CCF	Top height	Growth				
			Total volume	Merchant-able volume	Merchant-able volume	Trees/acre	Total volume	Merchant-able volume	Merchant-able volume	BA/acre				PRD	ACC	MOR/year		\bar{D}
																Ft^3	Ft^3	
50	5	500	0	0	0	0	0	0	0	0	2	1	5	0	0	0.0		
	10	447	2	0	0	0	0	0	0	1	3	6	10	1	0	0.6		
	20	371	13	0	0	121	1	0	0	3	7	12	10	6	0	1.4		
	30	216	70	0	0	0	0	0	0	9	19	21	10	21	0	2.8		
	40	204	278	57	189	0	0	0	0	24	44	29	10	51	1	4.7		
	50	194	776	458	1617	0	0	0	0	52	82	37	10	84	2	7.0		
	60	186	1593	1344	5146	0	0	0	0	86	121	47	10	112	7	9.2		
	70	178	2644	2444	10267	0	0	0	0	119	152	56	10	134	15	11.1		
	80	167	3839	3645	16635	0	0	0	0	149	176	65	10	148	24	12.8		
	90	156	5074	4871	23646	0	0	0	0	174	195	73	10	158	35	14.3		
	100	145	6303	6090	30847	0	0	0	0	195	210	81	10	166	46	15.7		
	110	133	7509	7287	37917	0	0	0	0	212	222	88	10	169	56	17.1		
	120	123	8642	8413	44488	0	0	0	0	225	231	95	10	172	66	18.3		
	130	113	9707	9474	50532	0	0	0	0	235	237	101	10	174	74	19.6		
	140	103	10713	10476	56107	0	0	0	0	243	241	107	10	173	80	20.8		
	150	95	11643	11404	61157	0	0	0	0	249	244	113	0	0	0	21.9		
70	5	500	0	0	0	0	0	0	0	0	2	2	5	1	0	0.0		
	10	454	4	0	0	0	0	0	0	2	5	7	10	4	0	0.8		
	20	393	43	0	0	143	4	0	0	6	13	17	10	21	0	2.1		
	30	227	252	23	75	0	0	0	0	22	42	30	10	81	0	4.3		
	40	220	1051	678	2415	0	0	0	0	66	104	41	10	152	3	7.4		
	50	213	2541	2298	9110	0	0	0	0	123	163	53	10	206	12	10.3		
	60	202	4472	4244	19060	0	0	0	0	177	210	64	10	248	33	12.7		
	70	186	6623	6373	31436	0	0	0	0	223	247	75	10	280	60	14.8		
	80	169	8819	8547	44298	0	0	0	0	260	274	85	10	273	81	16.8		
	90	153	10735	10449	55334	0	0	0	0	284	291	94	10	294	112	18.5		
	100	136	12566	12270	65600	0	0	0	0	303	302	103	10	281	124	20.2		
	110	121	14136	13836	74108	0	0	0	0	315	308	110	10	289	140	21.8		
	120	109	15632	15327	82140	0	0	0	0	324	312	117	10	284	149	23.4		
	130	98	16985	16679	89283	0	0	0	0	331	314	124	10	278	158	24.9		
	140	88	18190	17884	95577	0	0	0	0	335	314	131	10	280	164	26.4		
	150	80	19349	19042	101548	0	0	0	0	339	314	137	0	0	0	28.0		
90	5	500	0	0	0	0	0	0	0	0	2	3	5	1	0	0.0		
	10	459	6	0	0	0	0	0	0	2	6	8	10	8	0	1.0		
	20	406	80	0	0	156	8	0	0	10	20	21	10	57	0	2.6		
	30	235	635	281	1027	0	0	0	0	46	74	36	10	207	1	6.0		
	40	229	2696	2438	10450	0	0	0	0	133	176	55	10	371	13	10.3		
	50	216	6268	5998	29285	0	0	0	0	233	263	74	10	283	47	14.0		
	60	199	8634	8333	42318	0	0	0	0	280	299	84	10	460	110	16.1		
	70	172	12127	11797	61876	0	0	0	0	333	339	96	10	401	146	18.8		
	80	151	14685	14340	75913	0	0	0	0	362	356	107	10	359	169	21.0		
	90	133	16585	16233	86302	0	0	0	0	376	363	113	10	397	203	22.8		
	100	116	18522	18166	96700	0	0	0	0	387	366	122	10	374	207	24.8		
	110	101	20182	19826	105655	0	0	0	0	393	366	128	10	407	234	26.7		
	120	90	21914	21556	114805	0	0	0	0	400	367	135	10	340	208	28.6		
	130	81	23229	22870	121656	0	0	0	0	404	368	141	10	385	240	30.3		
	140	72	24677	24317	129187	0	0	0	0	408	367	146	10	387	245	32.1		
	150	64	26094	25734	136479	0	0	0	0	411	365	153	0	0	0	34.2		

Table 9—Yields of grand fir plantations having 500 trees per acre surviving 5 years, thinning from below to 250 trees per acre at 20 years, and thinning from below to 100 trees per acre at 50 years

Site index	Age	Summary statistics																
		Volume per acre					Removals per acre					Growth						
		Trees/acre	Merchant-able volume		Merchant-able volume	Trees/acre	Total volume		Merchant-able volume		BA/acre	CCF	Top height	PRD	ACC	MOR/year		D̄
			Ft ³	Ft ³			Total volume	Total volume	Ft ³	Ft ³						Ft ³	Ft ³	
50	5	500	0	0	0	0	0	0	0	0	2	1	5	0	0	0.0		
	10	447	2	0	0	0	0	0	0	1	3	6	10	1	0	0.6		
	20	371	13	0	0	121	1	0	0	3	7	12	10	6	0	1.4		
	30	216	70	0	0	0	0	0	0	9	19	21	10	21	0	2.8		
	40	204	278	57	189	0	0	0	0	24	44	29	10	51	1	4.7		
	50	194	776	458	1617	94	207	40	133	36	55	37	10	60	1	8.1		
	60	98	1163	1062	4193	0	0	0	0	59	78	47	10	82	3	10.5		
	70	95	1946	1844	8115	0	0	0	0	82	98	57	10	100	7	12.6		
	80	91	2876	2759	13289	0	0	0	0	105	117	66	10	118	13	14.5		
	90	87	3928	3794	19360	0	0	0	0	126	135	75	10	124	19	16.3		
	100	83	4978	4832	25413	0	0	0	0	144	150	82	10	135	27	17.9		
	110	78	6061	5904	31489	0	0	0	0	161	162	90	10	145	34	19.4		
	120	73	7169	7000	37568	0	0	0	0	175	174	97	10	140	39	20.9		
	130	69	8180	8004	43020	0	0	0	0	187	182	104	10	150	48	22.3		
	140	65	9195	9011	48389	0	0	0	0	198	190	110	10	150	53	23.6		
150	61	10169	9978	53514	0	0	0	0	207	196	116	0	0	0	24.9			
70	5	500	0	0	0	0	0	0	0	0	2	2	5	1	0	0.0		
	10	454	4	0	0	0	0	0	0	2	5	7	10	4	0	0.8		
	20	393	43	0	0	143	4	0	0	6	13	17	10	21	0	2.1		
	30	227	252	23	75	0	0	0	0	22	42	30	10	81	0	4.3		
	40	220	1051	678	2415	0	0	0	0	66	104	41	10	152	3	7.4		
	50	213	2541	2298	9110	113	819	674	2405	80	96	53	10	144	4	12.1		
	60	98	3121	2994	14329	0	0	0	0	117	130	65	10	190	12	14.8		
	70	94	4901	4745	24711	0	0	0	0	155	162	76	10	209	24	17.4		
	80	89	6747	6566	35163	0	0	0	0	187	189	86	10	239	43	19.6		
	90	83	8703	8500	45783	0	0	0	0	217	212	96	10	235	54	21.8		
	100	78	10506	10285	55350	0	0	0	0	239	230	105	10	252	75	23.7		
	110	72	12275	12040	64575	0	0	0	0	259	244	112	10	265	91	25.6		
	120	67	14008	13761	73554	0	0	0	0	275	256	121	10	251	98	27.5		
	130	62	15547	15290	81522	0	0	0	0	288	265	127	10	249	110	29.2		
	140	57	16936	16672	88727	0	0	0	0	298	271	134	10	239	118	30.8		
150	53	18155	17887	95029	0	0	0	0	305	275	139	0	0	0	32.3			
90	5	500	0	0	0	0	0	0	0	0	2	3	5	1	0	0.0		
	10	459	6	0	0	0	0	0	0	2	6	8	10	8	0	1.0		
	20	406	80	0	0	156	8	0	0	10	20	21	10	57	0	2.6		
	30	235	635	281	1027	0	0	0	0	46	74	36	10	207	1	6.0		
	40	229	2696	2438	10450	0	0	0	0	133	176	55	10	371	13	10.3		
	50	216	6268	5998	29285	116	1367	1262	4808	168	175	74	10	249	18	17.5		
	60	96	7205	7005	37270	0	0	0	0	211	212	86	10	278	42	20.1		
	70	91	9578	9349	50117	0	0	0	0	248	241	97	10	355	73	22.4		
	80	83	12392	12134	65093	0	0	0	0	285	270	108	10	400	109	25.1		
	90	76	15299	15015	80242	0	0	0	0	319	296	117	10	431	148	27.8		
	100	69	18135	17831	95001	0	0	0	0	345	314	126	10	436	183	30.3		
	110	61	20666	20347	108111	0	0	0	0	364	327	134	10	349	172	33.0		
	120	57	22427	22101	117243	0	0	0	0	375	333	142	10	320	172	34.9		
	130	52	23903	23573	124896	0	0	0	0	382	336	147	10	248	155	36.7		
	140	49	24840	24510	129748	0	0	0	0	383	335	151	10	304	199	38.0		
150	44	25894	25564	135201	0	0	0	0	384	334	156	0	0	0	39.9			

Table 10—Yields of grand fir plantations having 500 trees per acre surviving 5 years, thinning from below to 250 trees per acre at 20 years, and thinning from above to 100 trees per acre at 50 years

		Summary statistics														
Site Index	Age	Trees/acre	Volume per acre			Removals per acre					CCF	Top height	Growth			
			Total volume	Merchant-able	Merchant-able	Trees/acre	Total volume	Merchant-able	Merchant-able	BA/acre			PRD	ACC	MOR/year	\bar{D}
				Ft^3	Ft^3			$Bd\ ft$	Ft^3							
50	5	500	0	0	0	0	0	0	0	0	2	1	5	0	0	0.0
	10	447	2	0	0	0	0	0	0	1	3	6	10	1	0	0.6
	20	371	13	0	0	121	1	0	0	3	7	12	10	6	0	1.4
	30	216	70	0	0	0	0	0	0	9	19	21	10	21	0	2.8
	40	204	278	57	189	0	0	0	0	24	44	29	10	51	1	4.7
	50	194	776	458	1617	94	557	422	1499	17	29	31	10	36	1	5.6
	60	96	573	422	1489	0	0	0	0	34	52	40	10	59	1	8.0
	70	93	1147	1045	4108	0	0	0	0	55	73	50	10	79	3	10.4
	80	90	1905	1804	7966	0	0	0	0	76	92	60	10	99	7	12.5
	90	87	2823	2710	13092	0	0	0	0	98	110	69	10	114	12	14.4
	100	83	3845	3718	19000	0	0	0	0	119	127	78	10	129	18	16.2
	110	79	4950	4809	25310	0	0	0	0	138	143	86	10	139	24	17.9
	120	75	6097	5944	31716	0	0	0	0	155	157	94	10	137	31	19.5
	130	71	7155	6992	37516	0	0	0	0	169	168	101	10	143	40	21.0
	140	66	8178	8006	43020	0	0	0	0	181	176	107	10	148	46	22.4
	150	62	9202	9023	48447	0	0	0	0	192	184	113	0	0	0	23.7
70	5	500	0	0	0	0	0	0	0	0	2	2	5	1	0	0.0
	10	454	4	0	0	0	0	0	0	2	5	7	10	4	0	0.8
	20	393	43	0	0	143	4	0	0	6	13	17	10	21	0	2.1
	30	227	252	23	75	0	0	0	0	22	42	30	10	81	0	4.3
	40	220	1051	678	2415	0	0	0	0	66	104	41	10	152	3	7.4
	50	213	2541	2298	9110	113	1862	1752	7185	37	57	45	10	91	2	8.2
	60	96	1571	1470	5978	0	0	0	0	66	84	58	10	145	4	11.2
	70	94	2979	2860	13740	0	0	0	0	103	115	69	10	190	10	14.1
	80	90	4785	4638	24083	0	0	0	0	141	148	82	10	228	23	16.9
	90	86	6838	6663	35595	0	0	0	0	177	179	93	10	251	39	19.4
	100	81	8961	8762	47095	0	0	0	0	208	205	102	10	245	54	21.7
	110	76	10868	10652	57206	0	0	0	0	233	224	111	10	242	71	23.7
	120	71	12583	12353	66225	0	0	0	0	251	237	119	10	238	82	25.5
	130	66	14146	13905	74315	0	0	0	0	266	247	126	10	265	108	27.1
	140	61	15720	15470	82470	0	0	0	0	279	256	133	10	251	111	28.9
	150	57	17126	16870	89740	0	0	0	0	289	262	138	0	0	0	30.6
90	5	500	0	0	0	0	0	0	0	0	2	3	5	1	0	0.0
	10	459	6	0	0	0	0	0	0	2	6	8	10	8	0	1.0
	20	406	80	0	0	156	8	0	0	10	20	21	10	57	0	2.6
	30	235	635	281	1027	0	0	0	0	46	74	36	10	207	1	6.0
	40	229	2696	2438	10450	0	0	0	0	133	176	55	10	371	13	10.3
	50	216	6268	5998	29285	116	5190	5009	25605	52	73	52	10	123	3	9.8
	60	97	2278	2171	9531	0	0	0	0	87	103	65	10	181	5	12.9
	70	95	4038	3903	19850	0	0	0	0	127	138	80	10	306	17	15.7
	80	90	6932	6754	36266	0	0	0	0	182	185	94	10	379	38	19.3
	90	85	10345	10125	54574	0	0	0	0	236	229	109	10	374	69	22.6
	100	79	13391	13141	70416	0	0	0	0	274	261	119	10	320	94	25.2
	110	73	15645	15377	82187	0	0	0	0	297	277	128	10	341	125	27.3
	120	67	17801	17518	93313	0	0	0	0	318	291	135	10	275	117	29.5
	130	62	19386	19095	101522	0	0	0	0	329	299	141	10	293	145	31.1
	140	57	20864	20567	109179	0	0	0	0	338	303	147	10	361	171	32.8
	150	53	22768	22463	119047	0	0	0	0	350	311	154	0	0	0	34.9

Table 11—Yields of grand fir plantations having 500 trees per acre surviving 5 years, thinning from below to 250 trees per acre at 20 years, and thinning to 100 trees per acre at 50 years such that the mean d.b.h. before and after thinning is the same

Site index	Age	Trees acre	Summary statistics														
			Volume per acre			Removals per acre						Growth					
			Total volume	Merchant-able volume	Merchant-able volume	Trees/acre	Total volume	Merchant-able volume	Merchant-able volume	BA/acre	CCF	Top height	PRD	ACC	MOR/year		D̄
				Ft ³	Ft ³			Ft ³	Ft ³						Ft ³	Bd ft	
50	5	500	0	0	0	0	0	0	0	0	2	1	5	0	0	0.0	
	10	447	2	0	0	0	0	0	0	1	3	6	10	1	0	0.6	
	20	371	13	0	0	121	1	0	0	3	7	12	10	6	0	1.4	
	30	216	70	0	0	0	0	0	0	9	19	21	10	21	0	2.8	
	40	204	278	57	189	0	0	0	0	24	44	29	10	51	1	4.7	
	50	194	776	458	1617	94	380	227	800	27	42	36	10	48	1	7.0	
	60	97	870	743	2856	0	0	0	0	46	64	45	10	70	2	9.4	
	70	94	1544	1442	6152	0	0	0	0	68	85	55	10	90	5	11.5	
	80	91	2398	2288	10710	0	0	0	0	90	104	64	10	106	9	13.5	
	90	87	3364	3241	16161	0	0	0	0	112	122	72	10	119	15	15.4	
	100	83	4398	4262	22099	0	0	0	0	131	138	81	10	129	22	17.0	
	110	78	5468	5320	28159	0	0	0	0	148	151	88	10	134	28	18.6	
	120	74	6525	6366	34033	0	0	0	0	163	163	96	10	140	36	20.1	
	130	70	7567	7399	39700	0	0	0	0	176	173	102	10	143	42	21.5	
	140	65	8574	8398	45086	0	0	0	0	187	181	109	10	144	49	22.9	
	150	61	9526	9344	50130	0	0	0	0	196	187	114	0	0	0	24.2	
70	5	500	0	0	0	0	0	0	0	0	2	2	5	1	0	0.0	
	10	454	4	0	0	0	0	0	0	2	5	7	10	4	0	0.8	
	20	393	43	0	0	143	4	0	0	6	13	17	10	21	0	2.1	
	30	227	252	23	75	0	0	0	0	22	42	30	10	81	0	4.3	
	40	220	1051	678	2415	0	0	0	0	66	104	41	10	152	3	7.4	
	50	213	2541	2298	9110	113	1348	1219	4834	58	77	50	10	115	3	10.3	
	60	97	2316	2203	10037	0	0	0	0	91	106	62	10	163	7	13.1	
	70	94	3871	3735	18846	0	0	0	0	127	137	74	10	209	17	15.7	
	80	90	5792	5628	29699	0	0	0	0	164	169	85	10	210	28	18.3	
	90	85	7611	7425	39757	0	0	0	0	193	192	95	10	242	48	20.4	
	100	79	9549	9343	50145	0	0	0	0	220	214	104	10	243	63	22.5	
	110	74	11346	11124	59627	0	0	0	0	241	229	112	10	250	79	24.5	
	120	68	13059	12824	68619	0	0	0	0	258	242	120	10	236	87	26.3	
	130	64	14543	14299	76333	0	0	0	0	271	251	126	10	226	98	28.0	
	140	59	15829	15579	82985	0	0	0	0	281	257	133	10	234	111	29.5	
	150	54	17057	16801	89358	0	0	0	0	289	261	139	0	0	0	31.2	
90	5	500	0	0	0	0	0	0	0	0	2	3	5	1	0	0.0	
	10	459	6	0	0	0	0	0	0	2	6	8	10	8	0	1.0	
	20	406	80	0	0	156	8	0	0	10	20	21	10	57	0	2.6	
	30	235	635	281	1027	0	0	0	0	46	74	36	10	207	1	6.0	
	40	229	2696	2438	10450	0	0	0	0	133	176	55	10	371	13	10.3	
	50	216	6268	5998	29285	116	3373	3227	15757	107	121	66	10	171	7	14.0	
	60	97	4537	4386	22400	0	0	0	0	145	153	78	10	340	22	16.6	
	70	91	7709	7512	39671	0	0	0	0	204	203	94	10	329	42	20.2	
	80	87	10585	10355	55221	0	0	0	0	247	239	105	10	309	70	22.9	
	90	81	12978	12725	68003	0	0	0	0	278	262	114	10	338	100	25.1	
	100	74	15354	15082	80565	0	0	0	0	303	281	123	10	325	116	27.4	
	110	68	17441	17155	91438	0	0	0	0	322	295	130	10	355	142	29.5	
	120	62	19569	19271	102467	0	0	0	0	339	306	137	10	306	141	31.5	
	130	58	21215	20907	110978	0	0	0	0	351	314	143	10	344	171	33.4	
	140	53	22944	22629	119944	0	0	0	0	361	320	149	10	341	177	35.4	
	150	48	24586	24265	128454	0	0	0	0	370	325	155	0	0	0	37.5	

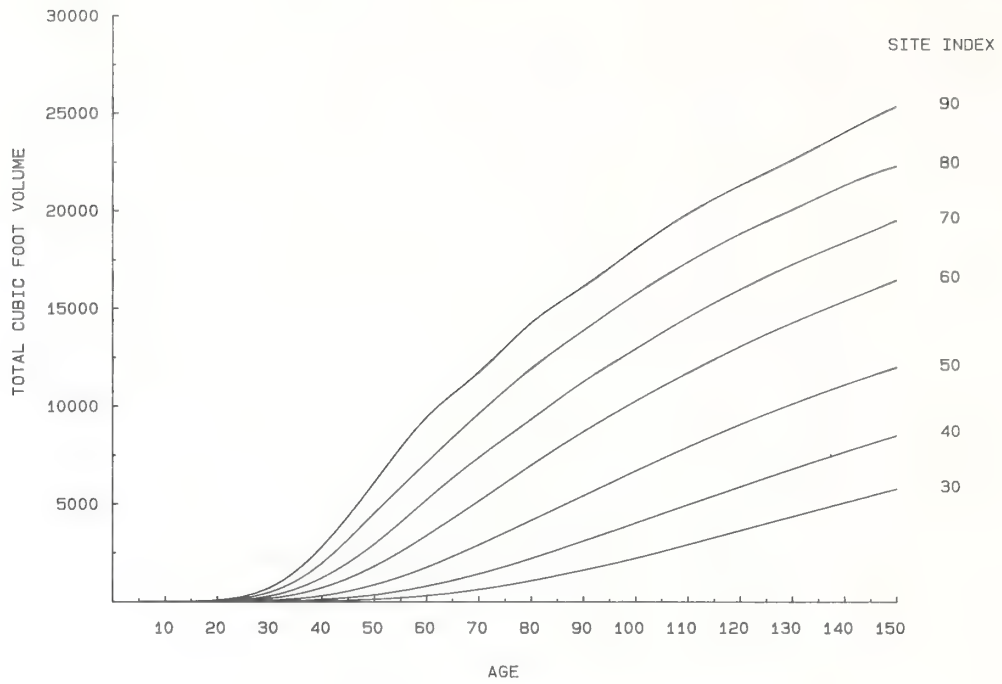


Figure 29—Grand fir yield curves for unthinned plantations in Inland Northwest forests (total cubic feet all stems).

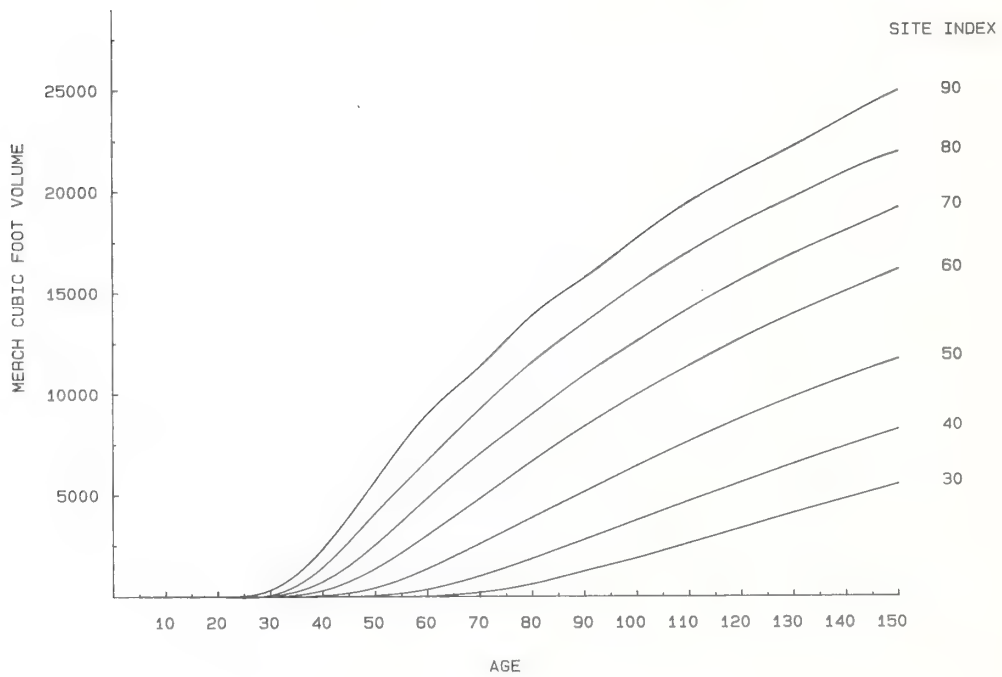


Figure 30—Grand fir yield curves for unthinned plantations in Inland Northwest forests (merchantable cubic feet, 4.5-inch top, stems greater than 7 inches d.b.h.).

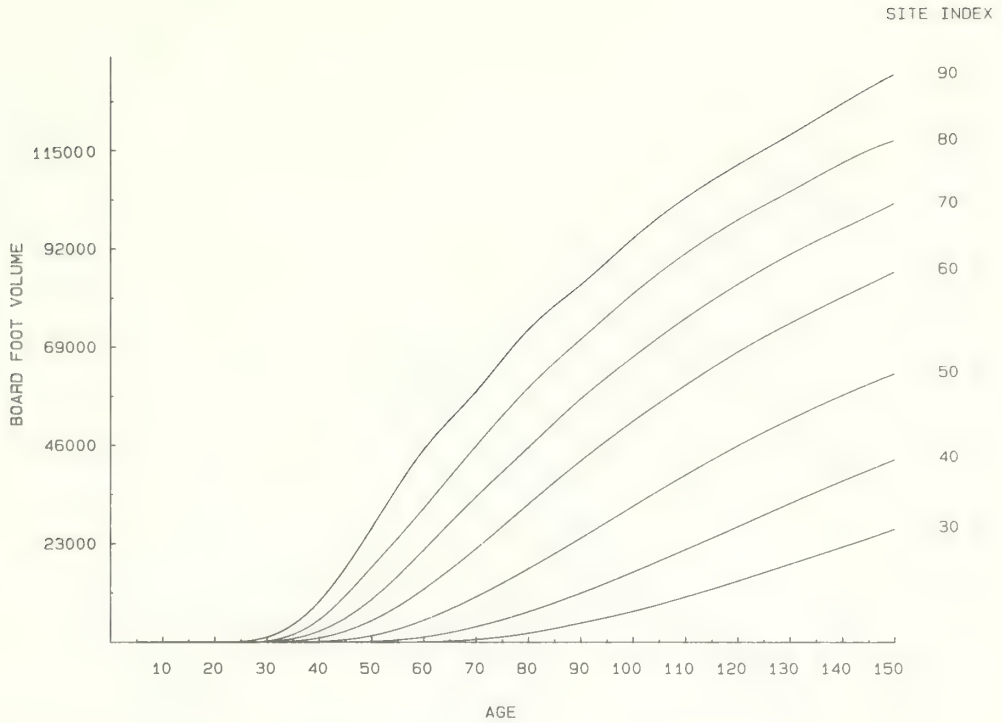


Figure 31—Grand fir yield curves for unthinned plantations in Inland Northwest forests (merchantable board feet [Scribner] 4.5-inch top, stems greater than 7 inches d.b.h.).

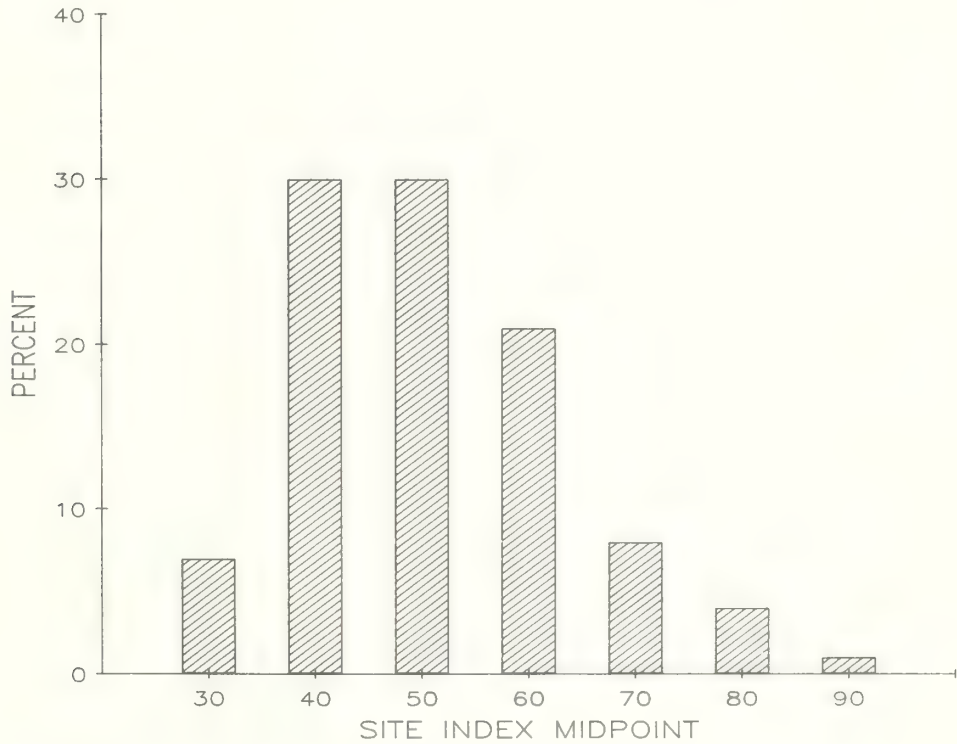


Figure 32—Distribution of grand fir plantation site index values for Inland Northwest forests.

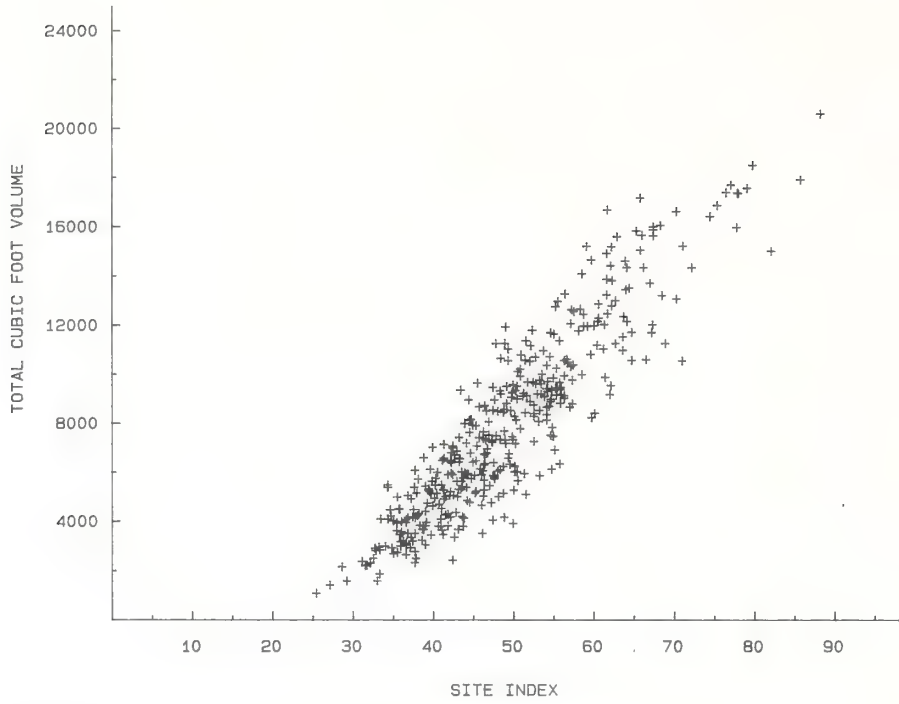


Figure 33—Grand fir yield vs. site index at 110 years (total cubic feet).

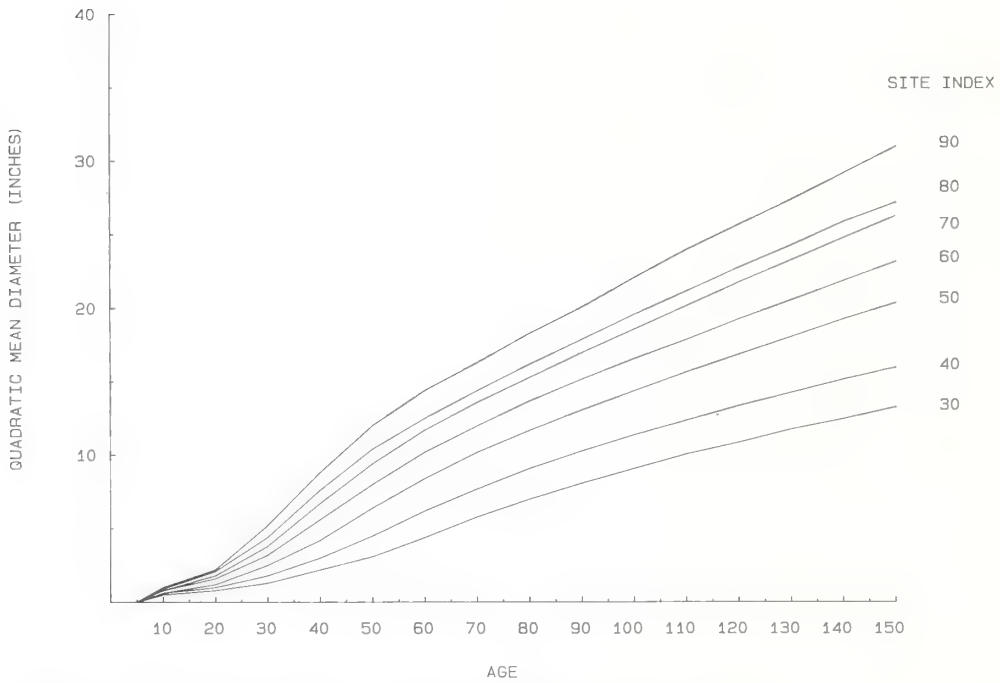


Figure 34—Quadratic mean diameter vs. age for grand fir unthinned plantations in Inland Northwest forests.

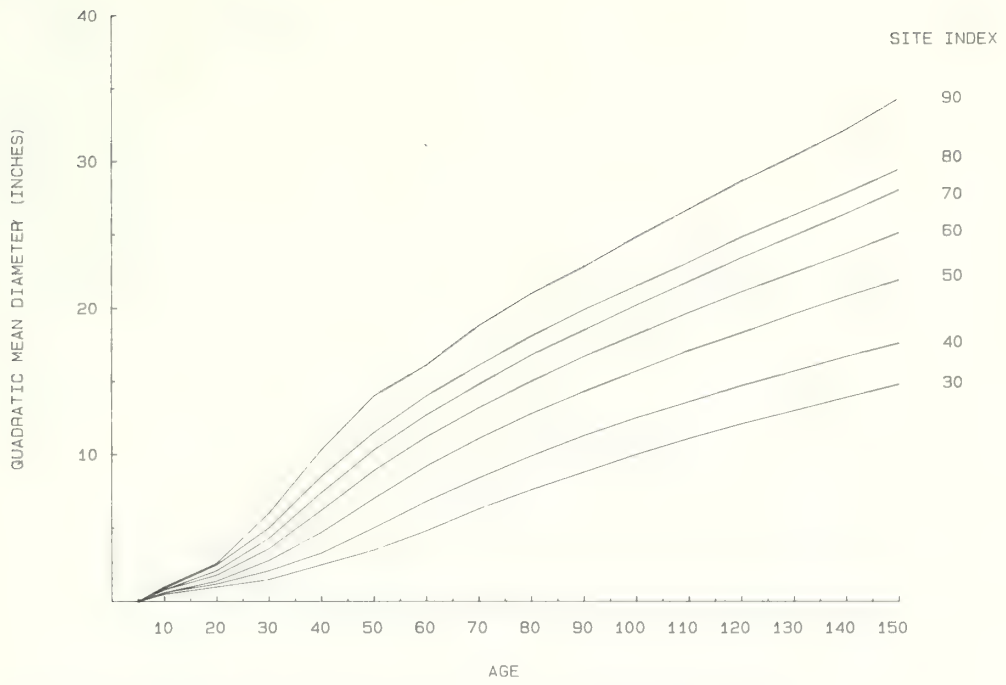


Figure 35—Quadratic mean diameter vs. age for grand fir precommercial thinning to 250 trees per acre at 20 years in Inland Northwest forests.

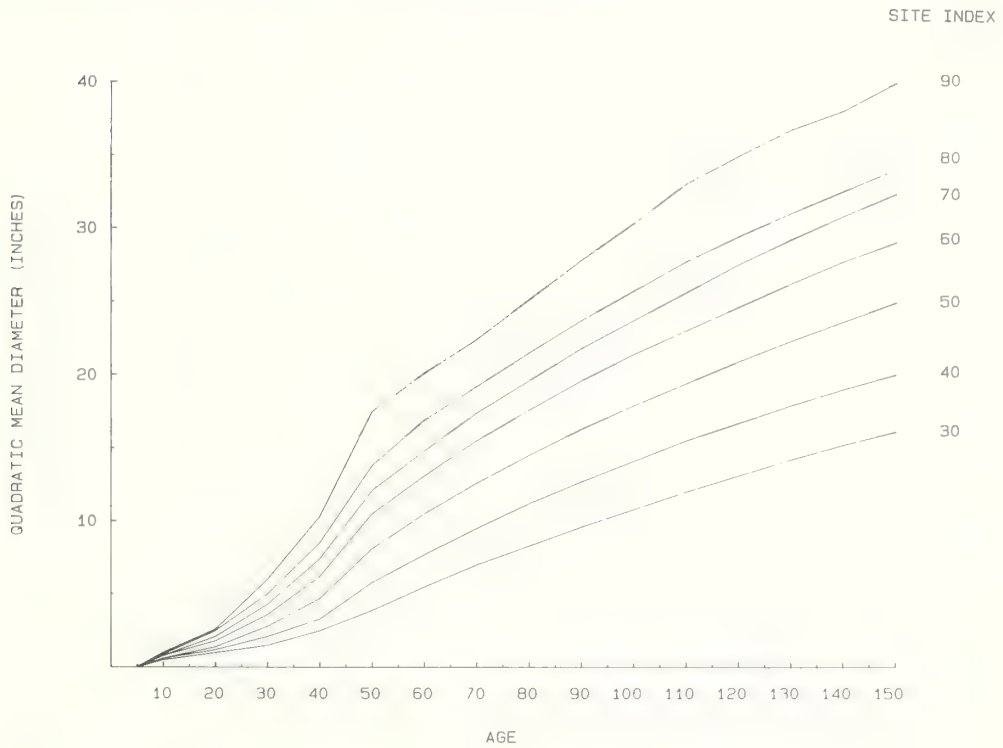


Figure 36—Quadratic mean diameter vs. age for grand fir precommercial thinning to 250 trees per acre at 20 years and commercial thinning from below to 100 trees per acre at 50 years in Inland Northwest forests.

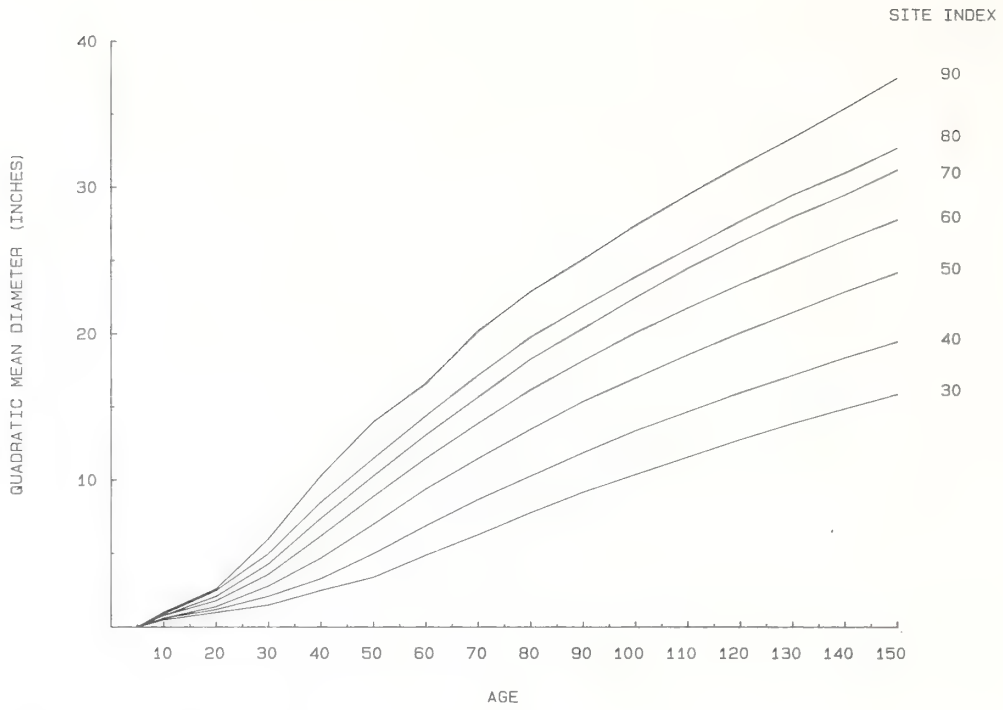


Figure 37—Quadratic mean diameter vs. age for grand fir precommercial thinning to 250 trees per acre at 20 years and commercial thinning to 100 trees per acre at 50 years such that the mean d.b.h. before and after thinning is the same.

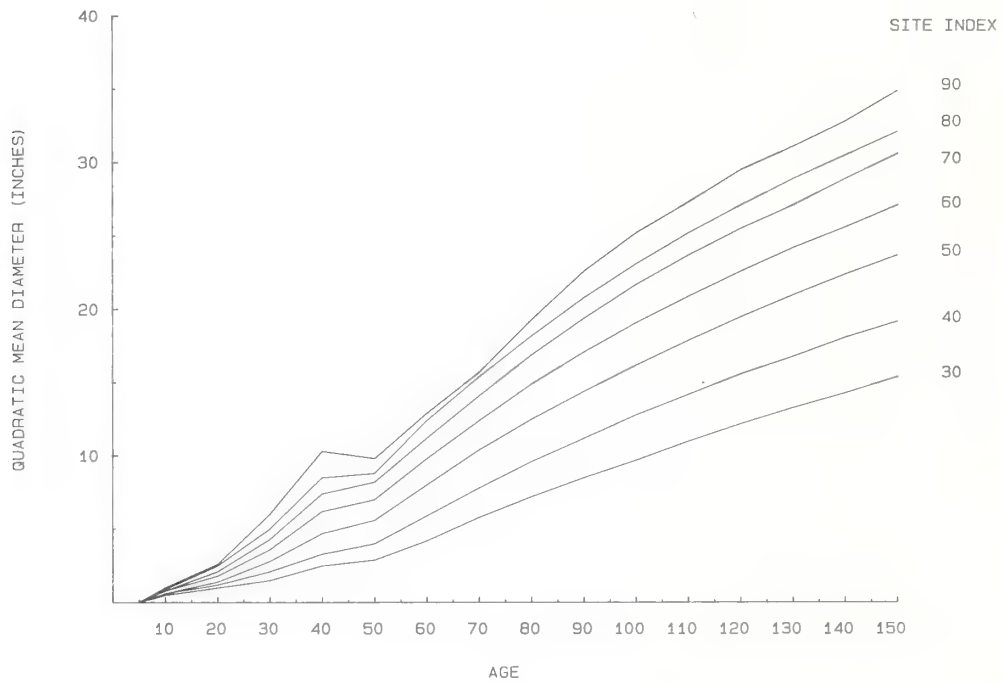


Figure 38—Quadratic mean diameter vs. age for grand fir precommercial thinning to 250 trees per acre at 20 years and commercial thinning from above to 100 trees per acre at 50 years in Inland Northwest forests.

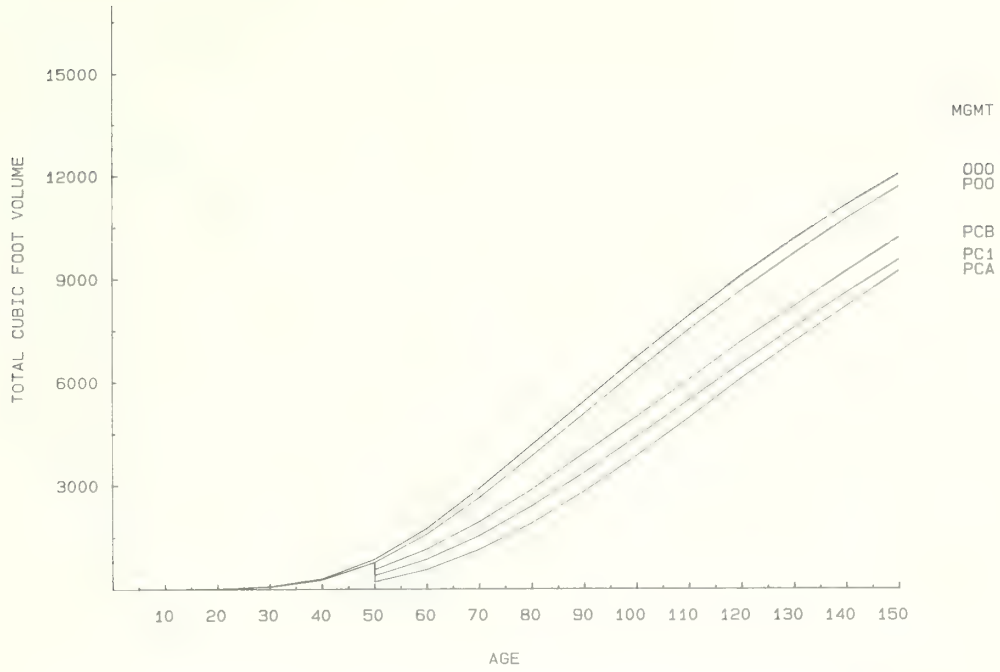


Figure 39—Effect of thinning on standing volume of grand fir plantations (total cubic feet), site index 50.

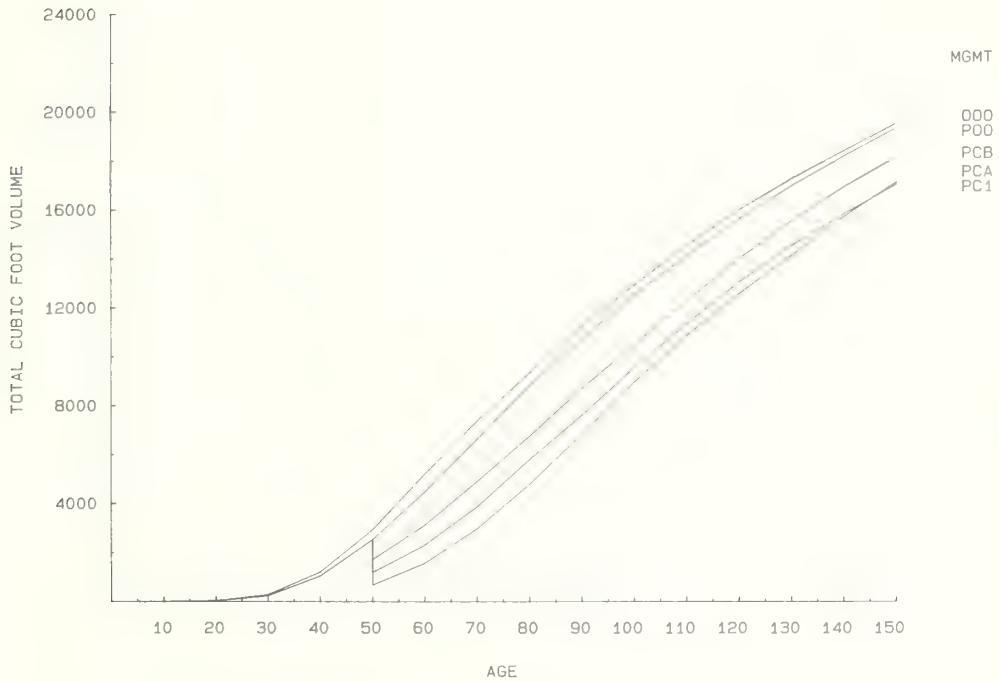


Figure 40—Effect of thinning on standing volume of grand fir plantations (total cubic feet), site index 70.

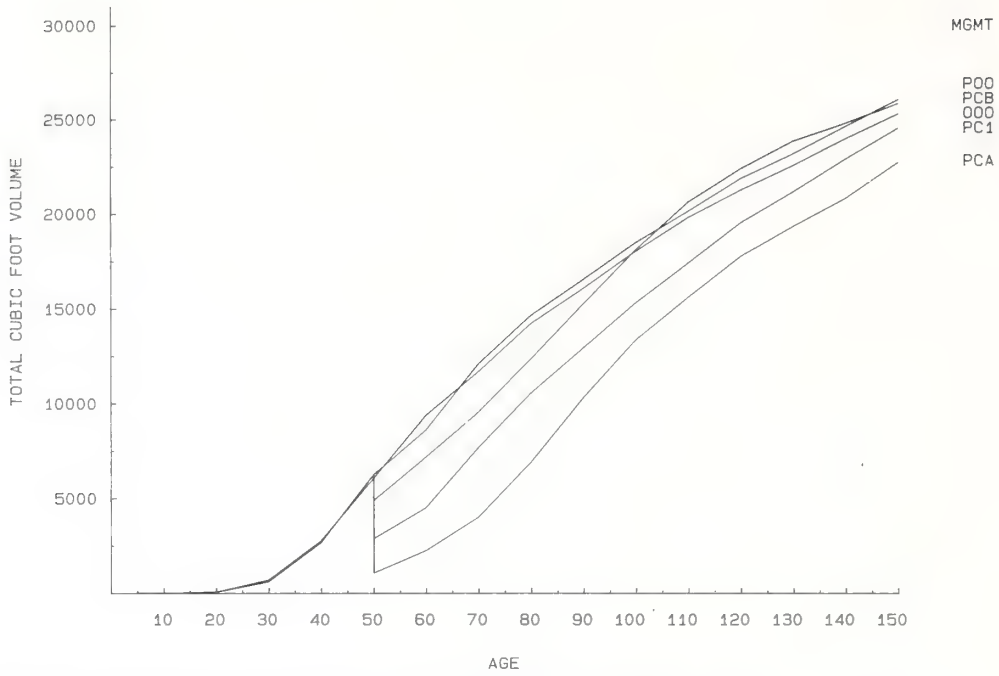


Figure 41—Effect of thinning on standing volume of grand fir plantations (total cubic feet), site index 90.

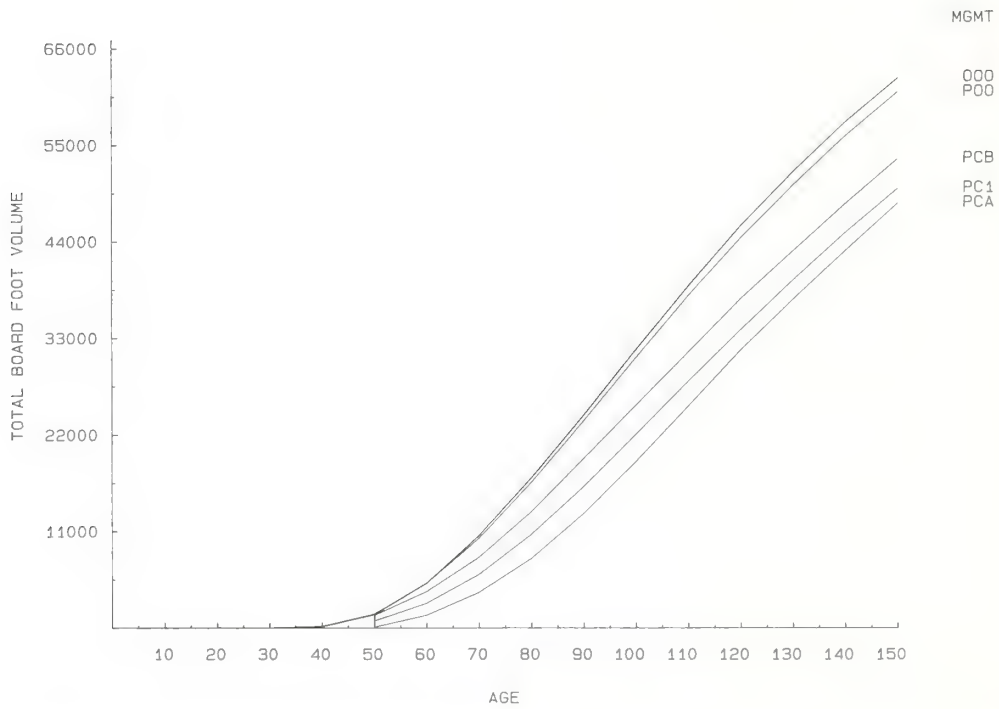


Figure 42—Effect of thinning on standing volume of grand fir plantations (merchantable board feet [Scribner]), site index 50.

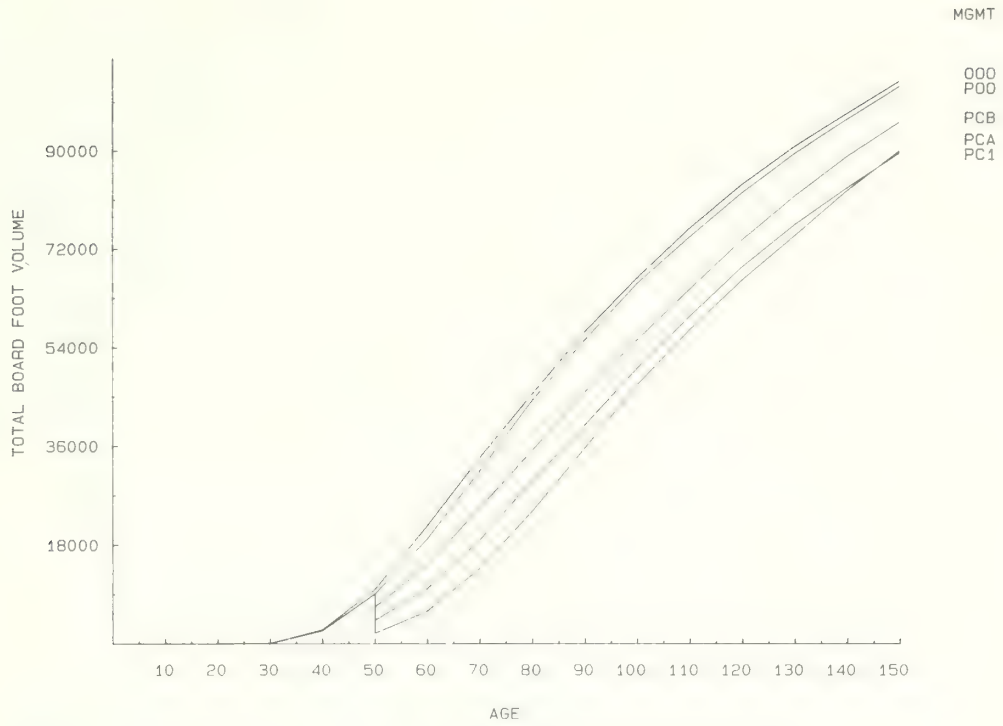


Figure 43—Effect of thinning on standing volume of grand fir plantations (merchantable board feet [Scribner]), site index 70.

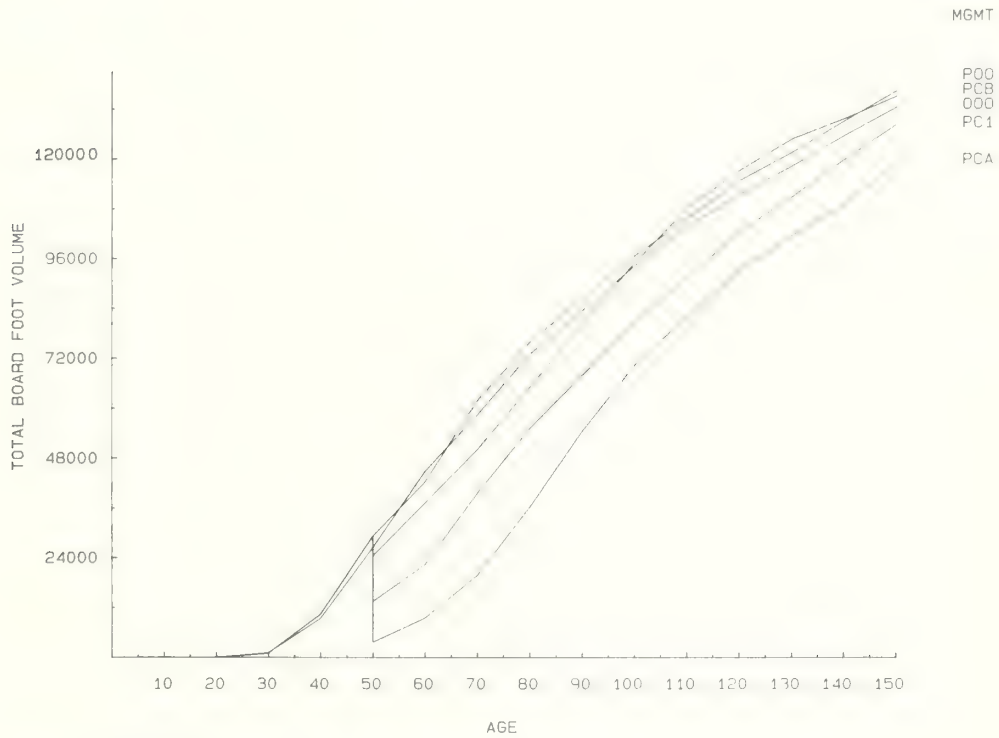


Figure 44—Effect of thinning on standing volume of grand fir plantations (merchantable board feet [Scribner]), site index 90.

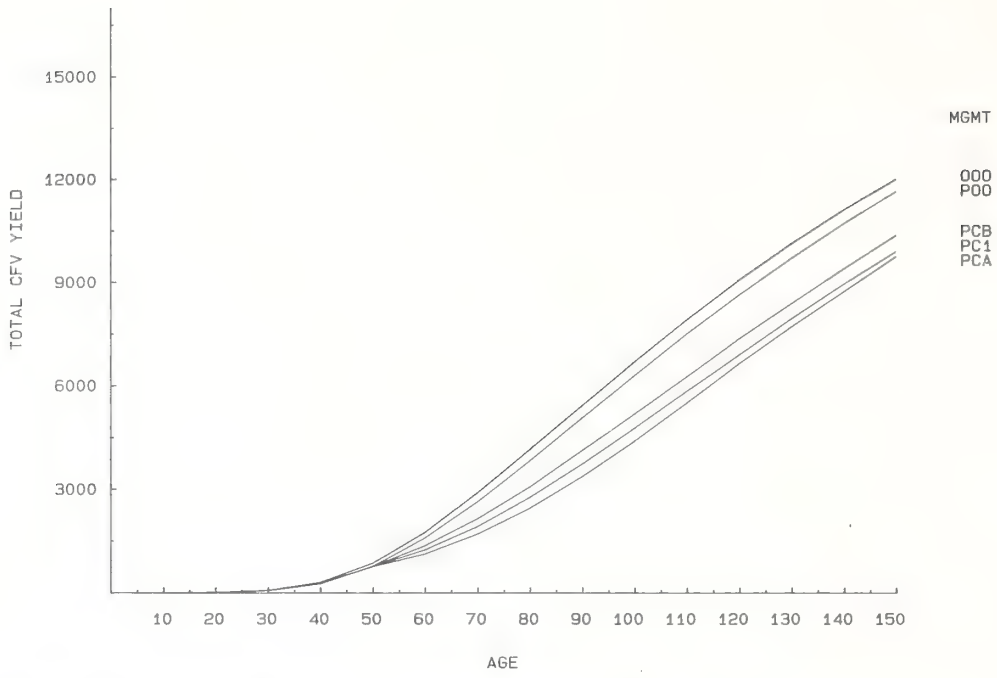


Figure 45—Effect of thinning on total yield of grand fir plantations (total cubic feet), site index 50.

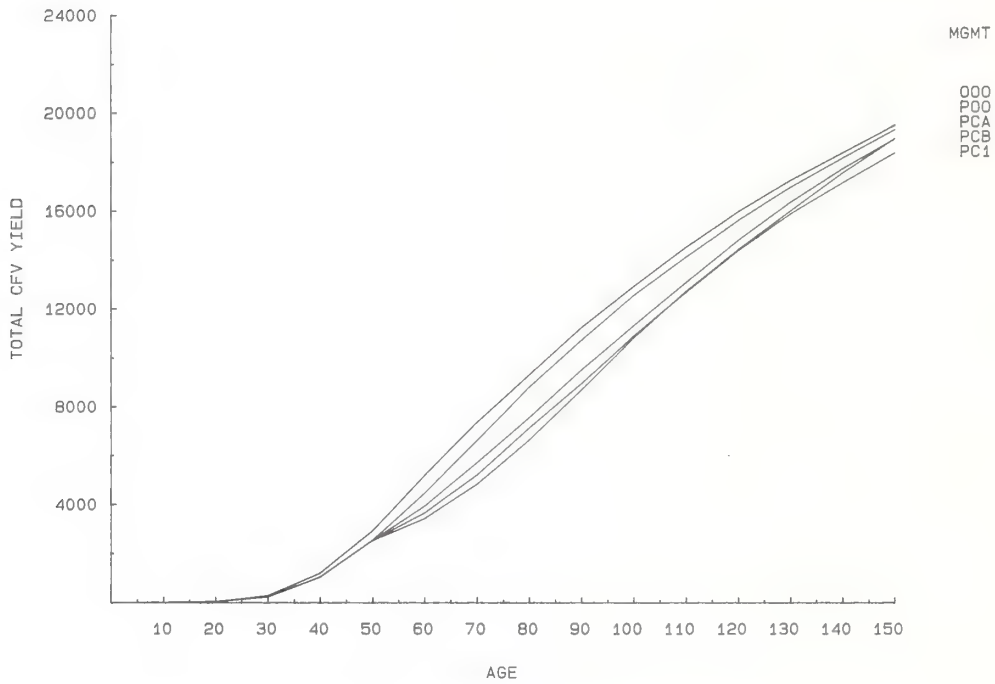


Figure 46—Effect of thinning on total yield of grand fir plantations (total cubic feet), site index 70.

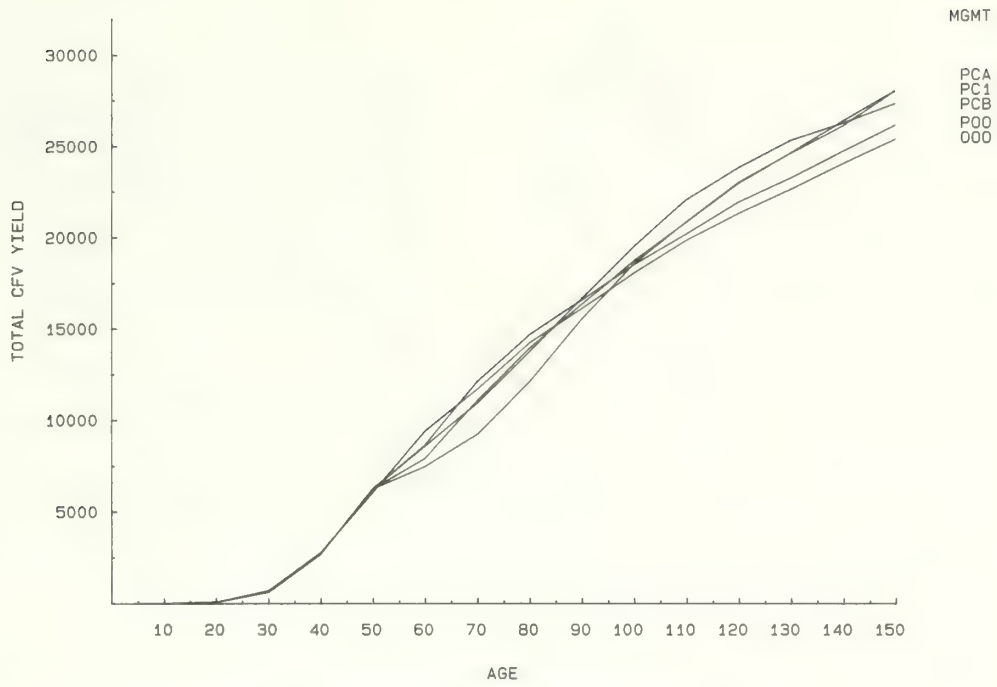


Figure 47—Effect of thinning on total yield of grand fir plantations (total cubic feet), site index 90.

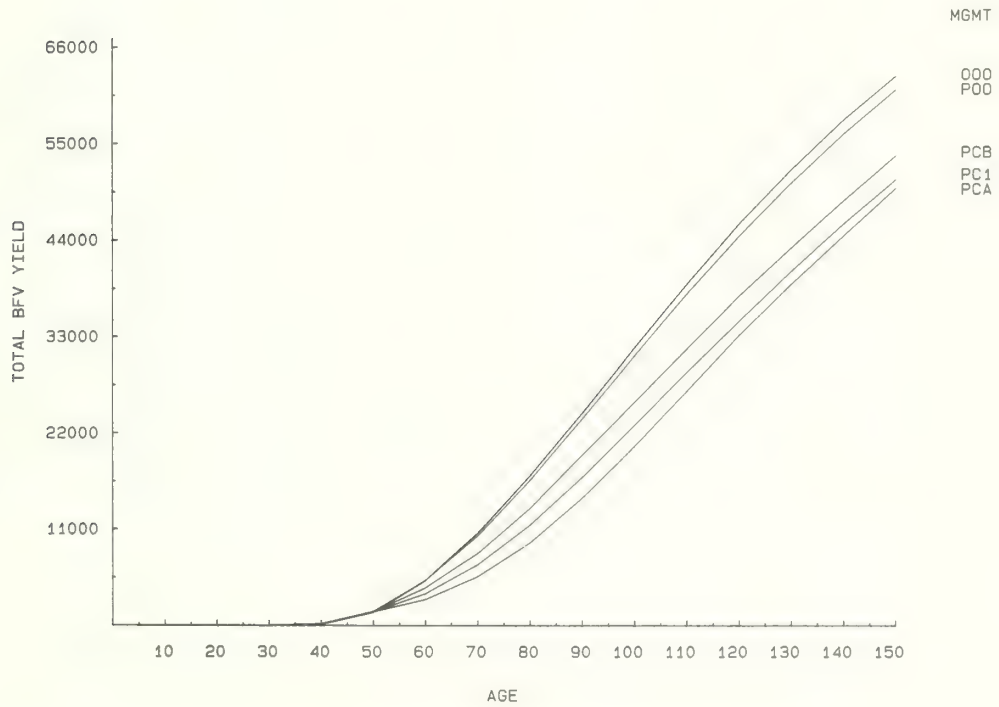


Figure 48—Effect of thinning on total yield of grand fir plantations (merchantable board feet [Scribner]), site index 50.

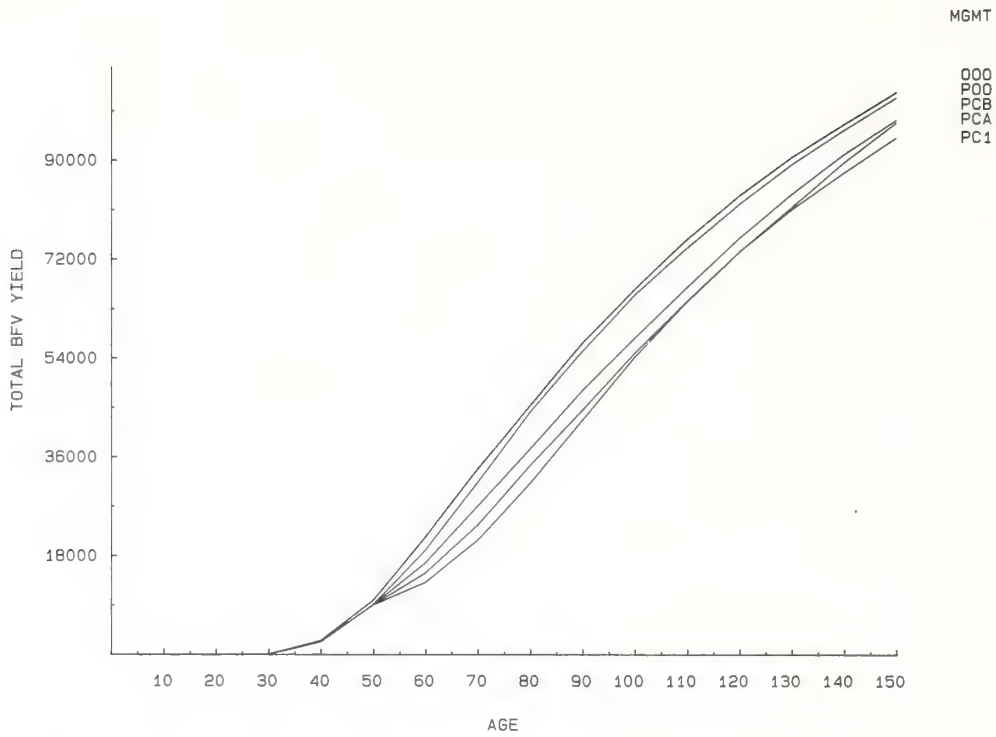


Figure 49—Effect of thinning on total yield of grand fir plantations (merchantable board feet [Scribner]), site index 70.

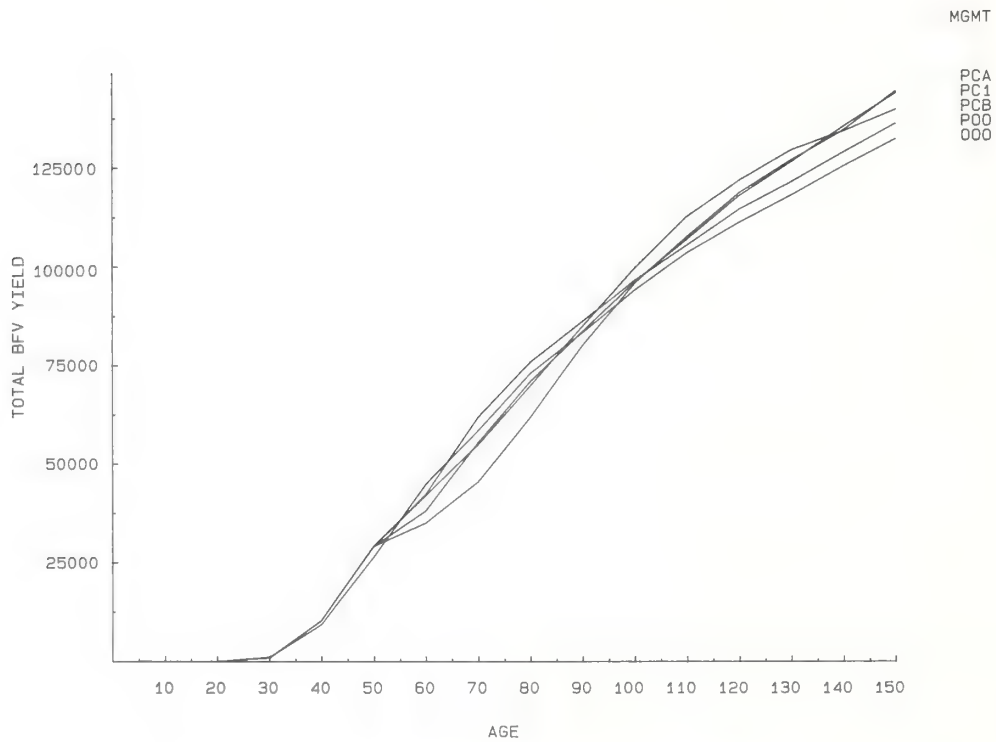


Figure 50—Effect of thinning on total yield of grand fir plantations (merchantable board feet [Scribner]), site index 90.

Western Larch

Yields predicted for western larch plantations in tables 12-16 are the lowest of all the species included in this collection. The lower yields must be attributed to lower levels of stocking because the distribution of site indices (figure 51) is comparable to the distribution for naturally regenerated stands (figure 5) and for Douglas-fir plantations (figure 10). The general shape of the yield curves (figures 52-54) is similar to the corresponding curves for the plantations of the other species. The reduced stocking

is attributable to both slower diameter growth (figs. 56 through 60) and higher mortality rates than for Douglas-fir or grand fir. Larch casebearer (*Coleophora laricella*) was a common pest of western larch throughout most of the Inland Empire during the period upon which the Prognosis Model was calibrated. Whether future stands of western larch will continue to be afflicted as much as these data indicate remains to be seen. Effects of thinning regimes on standing volume and total yield are compared in figures 61 through 64 and figures 65 through 68, respectively.

Table 12—Yields of western larch plantations having 500 trees per acre surviving 5 years, no thinning

Site index	Age	Summary statistics														
		Trees/acre	Volume per acre			Removals per acre					CCF	Top height	Growth			
			Total volume	Merchant-able	Merchant-able	Trees/acre	Total volume	Merchant-able	Merchant-able	BA/acre			PRD	ACC	MOR/year	D
				Ft ³	Ft ³			Ft ³	Ft ³							
50	5	500	0	0	0	0	0	0	0	0	1	3	5	0	0	0.0
	10	462	3	0	0	0	0	0	0	1	2	8	10	2	0	0.7
	20	405	19	0	0	0	0	0	0	5	6	16	10	7	0	1.4
	30	349	90	0	0	0	0	0	0	13	15	24	10	18	0	2.7
	40	327	262	4	14	0	0	0	0	28	29	33	10	30	1	3.9
	50	306	553	95	363	0	0	0	0	46	45	41	10	39	3	5.2
	60	287	918	369	1465	0	0	0	0	64	60	48	10	47	4	6.4
	70	268	1343	868	3545	0	0	0	0	81	75	55	10	53	7	7.5
	80	250	1795	1406	5902	0	0	0	0	97	88	61	10	56	11	8.4
	90	233	2248	1945	8334	0	0	0	0	110	98	66	10	56	15	9.3
	100	216	2660	2409	10522	0	0	0	0	120	106	72	10	58	19	10.1
	110	198	3050	2830	12595	0	0	0	0	128	111	77	10	57	22	10.9
	120	182	3395	3194	14491	0	0	0	0	134	115	81	10	57	25	11.6
	130	167	3712	3522	16329	0	0	0	0	138	117	85	10	54	28	12.3
	140	152	3969	3788	17965	0	0	0	0	141	118	89	10	53	31	13.0
	150	139	4189	4015	19451	0	0	0	0	142	118	93	0	0	0	13.7
70	5	500	0	0	0	0	0	0	0	0	1	3	5	2	0	0.0
	10	465	8	0	0	0	0	0	0	3	4	12	10	8	0	1.0
	20	420	83	0	0	0	0	0	0	12	14	25	10	33	0	2.3
	30	372	405	30	116	0	0	0	0	38	38	38	10	66	1	4.3
	40	354	1047	407	1621	0	0	0	0	73	69	49	10	87	6	6.2
	50	329	1855	1300	5387	0	0	0	0	107	98	58	10	97	15	7.7
	60	299	2677	2265	9701	0	0	0	0	134	119	67	10	104	26	9.1
	70	266	3464	3139	13885	0	0	0	0	153	135	75	10	100	35	10.3
	80	235	4111	3842	17486	0	0	0	0	166	142	82	10	99	45	11.4
	90	206	4645	4402	20645	0	0	0	0	173	146	88	10	94	51	12.4
	100	180	5071	4848	23490	0	0	0	0	176	146	93	10	91	56	13.4
	110	158	5421	5214	25957	0	0	0	0	177	145	99	10	89	59	14.4
	120	138	5717	5522	28175	0	0	0	0	177	142	103	10	85	61	15.3
	130	122	5959	5775	30072	0	0	0	0	175	139	108	10	79	62	16.3
	140	108	6129	5955	31427	0	0	0	0	173	136	112	10	77	63	17.2
	150	95	6265	6100	32516	0	0	0	0	169	132	116	0	0	0	18.1
80	5	500	0	0	0	0	0	0	0	0	1	3	5	3	0	0.0
	10	473	14	0	0	0	0	0	0	4	5	14	10	16	0	1.3
	20	437	177	0	0	0	0	0	0	21	22	31	10	66	1	3.0
	30	396	833	205	809	0	0	0	0	63	61	45	10	108	3	5.4
	40	376	1880	1208	4999	0	0	0	0	110	101	58	10	126	14	7.3
	50	341	3000	2502	10719	0	0	0	0	147	132	68	10	133	30	8.9
	60	301	4030	3650	16135	0	0	0	0	172	151	77	10	137	47	10.3
	70	259	4928	4615	21211	0	0	0	0	188	161	85	10	137	61	11.5
	80	221	5685	5410	25918	0	0	0	0	197	165	93	10	130	71	12.8
	90	188	6283	6035	29976	0	0	0	0	200	165	100	10	126	81	14.0
	100	160	6734	6506	33319	0	0	0	0	200	161	106	10	117	84	15.1
	110	137	7066	6855	35826	0	0	0	0	197	157	112	10	108	88	16.3
	120	117	7261	7065	37422	0	0	0	0	192	150	117	10	107	91	17.3
	130	101	7423	7240	38595	0	0	0	0	187	145	122	10	97	85	18.4
	140	88	7544	7372	39451	0	0	0	0	182	139	127	10	92	87	19.5
	150	77	7586	7425	39736	0	0	0	0	176	133	131	0	0	0	20.5

Table 13—Yields of western larch plantations having 500 trees per acre surviving 5 years, precommercial thinning from below to 250 trees per acre at 20 years

Site index	Age	Trees/acre	Summary statistics													
			Volume per acre			Removals per acre				BA/acre	CCF	Top height	Growth			D
			Total volume	Merchant-able volume	Merchant-able volume	Trees/acre	Total volume	Merchant-able volume	Merchant-able volume				PRD	ACC	MOR/year	
			<i>Ft</i> ³	<i>Ft</i> ³	<i>Bd ft</i>	<i>Ft</i> ³	<i>Ft</i> ³	<i>Bd ft</i>	<i>Ft</i> ²				<i>Ft</i>	<i>Yr</i>	<i>Ft</i> ³	
50	5	500	0	0	0	0	0	0	0	0	1	3	5	0	0	0.0
	10	462	3	0	0	0	0	0	0	1	2	8	10	2	0	0.7
	20	405	19	0	0	155	3	0	0	4	4	16	10	6	0	1.6
	30	221	75	0	0	0	0	0	0	10	11	25	10	14	0	2.9
	40	208	212	7	27	0	0	0	0	21	21	33	10	24	1	4.3
	50	197	444	102	394	0	0	0	0	35	34	41	10	32	2	5.7
	60	187	743	366	1468	0	0	0	0	49	45	48	10	37	3	6.9
	70	178	1088	791	3258	0	0	0	0	62	56	54	10	40	5	8.0
	80	169	1442	1220	5155	0	0	0	0	74	66	61	10	45	8	8.9
	90	159	1810	1638	7078	0	0	0	0	84	75	67	10	45	10	9.9
	100	149	2157	1999	8809	0	0	0	0	93	81	71	10	47	13	10.7
	110	138	2498	2350	10580	0	0	0	0	100	86	76	10	48	16	11.5
	120	129	2827	2682	12336	0	0	0	0	106	91	81	10	46	17	12.3
	130	119	3114	2973	13964	0	0	0	0	111	93	85	10	45	21	13.1
	140	110	3358	3220	15516	0	0	0	0	114	95	89	10	48	23	13.8
	150	102	3603	3468	17134	0	0	0	0	117	96	93	0	0	0	14.5
70	5	500	0	0	0	0	0	0	0	0	1	3	5	2	0	0.0
	10	465	8	0	0	0	0	0	0	3	4	12	10	8	0	1.0
	20	420	83	0	0	170	12	0	0	10	11	25	10	27	0	2.7
	30	233	336	29	113	0	0	0	0	29	29	38	10	53	1	4.8
	40	224	851	391	1566	0	0	0	0	55	52	49	10	73	4	6.7
	50	211	1540	1202	5050	0	0	0	0	82	74	60	10	84	10	8.4
	60	196	2277	2044	8893	0	0	0	0	105	93	69	10	87	17	9.9
	70	179	2971	2774	12439	0	0	0	0	122	106	77	10	89	26	11.2
	80	161	3603	3417	15873	0	0	0	0	135	115	84	10	87	33	12.4
	90	145	4142	3964	19095	0	0	0	0	144	120	90	10	84	39	13.5
	100	129	4595	4423	22036	0	0	0	0	150	122	96	10	84	44	14.6
	110	116	5000	4834	24714	0	0	0	0	154	124	101	10	79	47	15.6
	120	104	5322	5162	26984	0	0	0	0	156	124	106	10	78	51	16.6
	130	93	5598	5443	28934	0	0	0	0	157	123	110	10	76	52	17.6
	140	83	5834	5684	30492	0	0	0	0	157	121	115	10	70	54	18.5
	150	75	5989	5845	31505	0	0	0	0	155	119	119	0	0	0	19.5
80	5	500	0	0	0	0	0	0	0	0	1	3	5	3	0	0.0
	10	473	14	0	0	0	0	0	0	4	5	14	10	16	0	1.3
	20	437	177	0	0	187	29	0	0	16	17	31	10	52	0	3.4
	30	238	664	184	730	0	0	0	0	47	44	46	10	87	2	6.0
	40	229	1514	1111	4642	0	0	0	0	82	74	58	10	108	9	8.1
	50	213	2504	2233	9711	0	0	0	0	113	100	70	10	113	20	9.8
	60	194	3433	3217	14499	0	0	0	0	136	117	79	10	117	34	11.3
	70	173	4266	4061	19071	0	0	0	0	152	128	87	10	117	44	12.7
	80	152	4988	4791	23440	0	0	0	0	162	134	95	10	110	54	14.0
	90	134	5557	5368	27150	0	0	0	0	168	136	102	10	114	63	15.2
	100	117	6066	5885	30686	0	0	0	0	171	136	108	10	104	66	16.4
	110	103	6441	6267	33332	0	0	0	0	172	135	114	10	99	72	17.5
	120	90	6709	6544	35117	0	0	0	0	170	132	120	10	90	76	18.6
	130	79	6855	6699	36088	0	0	0	0	166	127	125	10	89	77	19.7
	140	69	6973	6825	36707	0	0	0	0	162	123	129	10	80	74	20.7
	150	61	7034	6893	36984	0	0	0	0	158	118	133	0	0	0	21.8

Table 14—Yields of western larch plantations having 500 trees per acre surviving 5 years, thinning from below to 250 trees per acre at 20 years, and thinning from below to 100 trees per acre at 50 years

Site index	Age	Trees/acre	Summary statistics													
			Volume per acre			Removals per acre				BA/acre	CCF	Top height	Growth			D
			Total volume	Merchant-able volume	Merchant-able volume	Trees/acre	Total volume	Merchant-able volume	Merchant-able volume				PRD	ACC	MOR/year	
			<i>Ft³</i>	<i>Ft³</i>	<i>Bd ft</i>		<i>Ft³</i>	<i>Ft³</i>	<i>Bd ft</i>				<i>Ft²</i>	<i>Ft</i>	<i>Yr</i>	
50	5	500	0	0	0	0	0	0	0	0	1	3	5	0	0	0.0
	10	462	3	0	0	0	0	0	0	1	2	8	10	2	0	0.7
	20	405	19	0	0	155	3	0	0	4	4	16	10	6	0	1.6
	30	221	75	0	0	0	0	0	0	10	11	25	10	14	0	2.9
	40	208	212	7	27	0	0	0	0	21	21	33	10	24	1	4.3
	50	197	444	102	394	97	144	1	2	22	21	41	10	21	1	6.4
	60	97	500	316	1279	0	0	0	0	31	28	48	10	25	2	7.6
	70	94	735	619	2592	0	0	0	0	39	35	56	10	28	3	8.8
	80	89	987	892	3839	0	0	0	0	47	42	63	10	28	4	9.8
	90	85	1225	1140	4999	0	0	0	0	54	47	68	10	32	6	10.8
	100	81	1485	1399	6257	0	0	0	0	60	52	73	10	32	7	11.7
	110	76	1732	1646	7547	0	0	0	0	66	56	78	10	33	9	12.6
	120	72	1969	1883	8880	0	0	0	0	71	59	83	10	34	10	13.4
	130	68	2208	2122	10282	0	0	0	0	75	62	87	10	33	12	14.2
	140	63	2422	2335	11616	0	0	0	0	79	64	91	10	32	13	15.1
	150	60	2613	2527	12925	0	0	0	0	81	65	95	0	0	0	15.8
70	5	500	0	0	0	0	0	0	0	0	1	3	5	2	0	0.0
	10	465	8	0	0	0	0	0	0	3	4	12	10	8	0	1.0
	20	420	83	0	0	170	12	0	0	10	11	25	10	27	0	2.7
	30	233	336	29	113	0	0	0	0	29	29	38	10	53	1	4.8
	40	224	851	391	1566	0	0	0	0	55	52	49	10	73	4	6.7
	50	211	1540	1202	5050	111	556	324	1301	50	45	60	10	53	4	9.6
	60	96	1480	1384	6121	0	0	0	0	65	57	69	10	60	8	11.2
	70	89	1997	1897	8715	0	0	0	0	78	66	78	10	64	12	12.7
	80	83	2509	2405	11556	0	0	0	0	90	74	85	10	64	17	14.1
	90	77	2980	2874	14484	0	0	0	0	99	80	92	10	63	21	15.3
	100	71	3403	3296	17102	0	0	0	0	106	84	98	10	63	26	16.6
	110	65	3777	3669	19479	0	0	0	0	111	87	103	10	62	28	17.7
	120	60	4119	4011	21622	0	0	0	0	115	89	108	10	58	30	18.8
	130	55	4400	4292	23317	0	0	0	0	118	90	112	10	58	33	19.9
	140	50	4652	4545	24741	0	0	0	0	120	91	117	10	57	35	20.9
	150	46	4869	4764	25851	0	0	0	0	121	91	121	0	0	0	21.9
80	5	500	0	0	0	0	0	0	0	0	1	3	5	3	0	0.0
	10	473	14	0	0	0	0	0	0	4	5	14	10	16	0	1.3
	20	437	177	0	0	187	29	0	0	16	17	31	10	52	0	3.4
	30	238	664	184	730	0	0	0	0	47	44	46	10	87	2	6.0
	40	229	1514	1111	4642	0	0	0	0	82	74	58	10	108	9	8.1
	50	213	2504	2233	9711	113	912	743	3118	69	60	70	10	70	8	11.2
	60	95	2218	2110	9693	0	0	0	0	84	71	79	10	79	17	12.8
	70	87	2842	2731	13176	0	0	0	0	98	80	87	10	82	21	14.4
	80	80	3449	3335	16987	0	0	0	0	108	87	96	10	85	27	15.8
	90	73	4030	3913	20658	0	0	0	0	118	93	103	10	81	33	17.2
	100	66	4507	4390	23645	0	0	0	0	124	96	109	10	80	40	18.5
	110	60	4912	4795	26092	0	0	0	0	127	97	115	10	77	44	19.7
	120	54	5240	5124	27913	0	0	0	0	129	98	121	10	70	47	20.9
	130	49	5466	5353	29046	0	0	0	0	129	97	125	10	71	51	22.0
	140	44	5662	5552	29865	0	0	0	0	129	96	130	10	65	50	23.1
	150	40	5816	5708	30426	0	0	0	0	128	94	135	0	0	0	24.2

Table 15—Yields of western larch plantations having 500 trees per acre surviving 5 years, thinning from below to 250 trees per acre at 20 years, and thinning from above to 100 trees per acre at 50 years

Site index	Age	Summary statistics														
		Volume per acre			Removals per acre				BA/ acre	CCF	Top height	Growth			D	
		Total volume	Merchant-able volume	Merchant-able volume	Trees/ acre	Total volume	Merchant-able volume	Merchant-able volume				PRD	ACC	MOR/ year		
		<i>Ft</i> ³	<i>Ft</i> ³	<i>Bd ft</i>		<i>Ft</i> ³	<i>Ft</i> ³	<i>Bd ft</i>				<i>Ft</i> ²	<i>Ft</i>	<i>Yr</i>		<i>Ft</i> ³
50	5	500	0	0	0	0	0	0	0	1	3	5	0	0	0.0	
	10	462	3	0	0	0	0	0	1	2	8	10	2	0	0.7	
	20	405	19	0	0	155	3	0	4	4	16	10	6	0	1.6	
	30	221	75	0	0	0	0	0	10	11	25	10	14	0	2.9	
	40	208	212	7	27	0	0	0	21	21	33	10	24	1	4.3	
	50	197	444	102	394	97	298	101	394	13	35	10	14	1	4.8	
	60	93	277	76	295	0	0	0	19	18	43	10	20	1	6.2	
	70	89	470	286	1162	0	0	0	27	25	51	10	25	1	7.5	
	80	86	701	581	2441	0	0	0	35	32	59	10	26	3	8.7	
	90	82	938	847	3651	0	0	0	43	38	66	10	30	4	9.7	
	100	78	1196	1114	4909	0	0	0	49	43	72	10	30	5	10.8	
	110	74	1446	1364	6148	0	0	0	56	48	77	10	33	7	11.7	
	120	70	1707	1625	7531	0	0	0	61	52	82	10	31	8	12.6	
	130	67	1938	1856	8836	0	0	0	66	55	87	10	34	10	13.5	
	140	63	2174	2092	10275	0	0	0	71	58	91	10	31	11	14.3	
	150	59	2378	2296	11543	0	0	0	74	60	95	0	0	0	15.1	
70	5	500	0	0	0	0	0	0	0	1	3	5	2	0	0.0	
	10	465	8	0	0	0	0	0	3	4	12	10	8	0	1.0	
	20	420	83	0	0	170	12	0	10	11	25	10	27	0	2.7	
	30	233	336	29	113	0	0	0	29	29	38	10	53	1	4.8	
	40	224	851	391	1566	0	0	0	55	52	49	10	73	4	6.7	
	50	211	1540	1202	5050	111	1066	952	4051	28	26	53	10	38	4	7.1
	60	92	819	696	2946	0	0	0	39	35	64	10	48	4	8.8	
	70	87	1255	1160	5089	0	0	0	52	46	74	10	54	7	10.5	
	80	82	1733	1641	7468	0	0	0	64	55	82	10	55	10	12.0	
	90	76	2184	2090	9891	0	0	0	74	62	89	10	57	14	13.3	
	100	71	2621	2525	12458	0	0	0	83	68	96	10	62	18	14.6	
	110	66	3067	2969	15299	0	0	0	91	73	102	10	60	20	15.9	
	120	61	3466	3367	17773	0	0	0	97	77	108	10	59	24	17.1	
	130	56	3812	3713	19922	0	0	0	102	79	113	10	59	27	18.3	
	140	52	4134	4035	21789	0	0	0	106	82	117	10	57	30	19.4	
	150	48	4411	4312	23334	0	0	0	109	83	122	0	0	0	20.5	
90	5	500	0	0	0	0	0	0	0	1	3	5	3	0	0.0	
	10	473	14	0	0	0	0	0	4	5	14	10	16	0	1.3	
	20	437	177	0	0	187	29	0	16	17	31	10	52	0	3.4	
	30	238	664	184	730	0	0	0	47	44	46	10	87	2	6.0	
	40	229	1514	1111	4642	0	0	0	82	74	58	10	108	9	8.1	
	50	213	2504	2233	9711	113	1735	1621	7155	37	34	62	10	53	7	8.3
	60	91	1224	1126	4904	0	0	0	50	44	74	10	68	8	10.0	
	70	84	1826	1729	7836	0	0	0	65	56	85	10	73	10	11.9	
	80	79	2458	2358	11301	0	0	0	79	66	93	10	75	17	13.6	
	90	73	3043	2940	14789	0	0	0	90	73	102	10	80	23	15.0	
	100	67	3609	3504	18314	0	0	0	99	79	109	10	76	27	16.5	
	110	61	4095	3989	21327	0	0	0	106	83	115	10	76	34	17.8	
	120	56	4519	4413	23856	0	0	0	111	86	121	10	72	36	19.1	
	130	51	4878	4773	25844	0	0	0	115	87	127	10	71	41	20.3	
	140	46	5173	5069	27336	0	0	0	117	88	132	10	68	45	21.5	
	150	42	5401	5298	28373	0	0	0	118	88	136	0	0	0	22.7	

Table 16—Yields of western larch plantations having 500 trees per acre surviving 5 years, thinning from below to 250 trees per acre at 20 years, and thinning to 100 trees per acre at 50 years such that the mean d.b.h. before and after thinning is the same

Site index	Age	Summary statistics														
		Volume per acre			Removals per acre						Growth					
		Trees/acre	Merchant-able volume	Merchant-able volume	Trees/acre	Total volume	Merchant-able volume	Merchant-able volume	BA/acre	CCF	Top height	PRD	ACC	MOR/year		D
			<i>Ft³</i>	<i>Ft³</i>			<i>Bd ft</i>	<i>Ft³</i>						<i>Ft³</i>	<i>Bd ft</i>	
50	5	500	0	0	0	0	0	0	0	1	3	5	0	0	0.0	
	10	462	3	0	0	0	0	0	1	2	8	10	2	0	0.7	
	20	405	19	0	0	155	3	0	0	4	4	16	10	6	1.6	
	30	221	75	0	0	0	0	0	0	10	11	25	10	14	2.9	
	40	208	212	7	27	0	0	0	0	21	21	33	10	24	4.3	
	50	197	444	102	394	97	221	52	202	18	17	39	10	18	5.7	
	60	95	390	198	797	0	0	0	0	25	24	47	10	22	7.0	
	70	91	597	448	1855	0	0	0	0	33	30	54	10	24	8.2	
	80	88	819	712	3027	0	0	0	0	40	36	61	10	28	9.2	
	90	83	1063	975	4248	0	0	0	0	48	42	67	10	29	10.2	
	100	79	1305	1220	5424	0	0	0	0	54	47	72	10	31	11.1	
	110	75	1549	1466	6669	0	0	0	0	59	51	78	10	31	12.1	
	120	71	1783	1700	7939	0	0	0	0	65	54	82	10	32	12.9	
	130	67	2012	1929	9267	0	0	0	0	69	57	87	10	32	13.8	
	140	63	2229	2146	10607	0	0	0	0	73	60	91	10	32	14.6	
	150	59	2434	2351	11912	0	0	0	0	76	62	94	0	0	15.4	
70	5	500	0	0	0	0	0	0	0	1	3	5	2	0	0.0	
	10	465	8	0	0	0	0	0	0	3	4	12	10	8	1.0	
	20	420	83	0	0	170	12	0	0	10	11	25	10	27	2.7	
	30	233	336	29	113	0	0	0	0	29	29	38	10	53	4.8	
	40	224	851	391	1566	0	0	0	0	55	52	49	10	73	6.7	
	50	211	1540	1202	5050	111	815	639	2686	39	35	58	10	46	8.4	
	60	94	1150	1039	4539	0	0	0	0	52	46	67	10	52	10.1	
	70	88	1607	1510	6825	0	0	0	0	64	55	76	10	55	11.6	
	80	82	2063	1966	9274	0	0	0	0	75	63	84	10	56	12.9	
	90	76	2495	2396	11731	0	0	0	0	84	69	90	10	58	14.2	
	100	70	2911	2812	14236	0	0	0	0	92	74	96	10	58	15.5	
	110	65	3294	3193	16690	0	0	0	0	98	78	102	10	58	16.6	
	120	60	3636	3536	18833	0	0	0	0	103	80	107	10	57	17.8	
	130	55	3940	3839	20698	0	0	0	0	107	82	111	10	54	18.8	
	140	51	4196	4096	22219	0	0	0	0	109	83	116	10	55	19.9	
	150	47	4438	4339	23539	0	0	0	0	111	84	120	0	0	20.9	
80	5	500	0	0	0	0	0	0	0	1	3	5	3	0	0.0	
	10	473	14	0	0	0	0	0	0	4	5	14	10	16	1.3	
	20	437	177	0	0	187	29	0	0	16	17	31	10	52	3.4	
	30	238	664	184	730	0	0	0	0	47	44	46	10	87	6.0	
	40	229	1514	1111	4642	0	0	0	0	82	74	58	10	108	8.1	
	50	213	2504	2233	9711	113	1331	1188	5164	53	47	68	10	63	9.8	
	60	93	1729	1626	7350	0	0	0	0	67	58	78	10	71	11.5	
	70	86	2329	2225	10549	0	0	0	0	81	68	87	10	76	13.2	
	80	79	2929	2822	14040	0	0	0	0	93	76	95	10	77	14.7	
	90	72	3481	3372	17451	0	0	0	0	102	82	102	10	78	16.1	
	100	66	3984	3875	20551	0	0	0	0	110	86	109	10	76	17.5	
	110	60	4415	4305	23153	0	0	0	0	115	89	115	10	73	18.8	
	120	54	4769	4660	25208	0	0	0	0	118	90	120	10	69	20.0	
	130	49	5036	4929	26646	0	0	0	0	119	90	125	10	65	21.1	
	140	44	5233	5128	27559	0	0	0	0	119	89	130	10	62	22.3	
	150	40	5376	5275	28153	0	0	0	0	118	88	135	0	0	23.3	

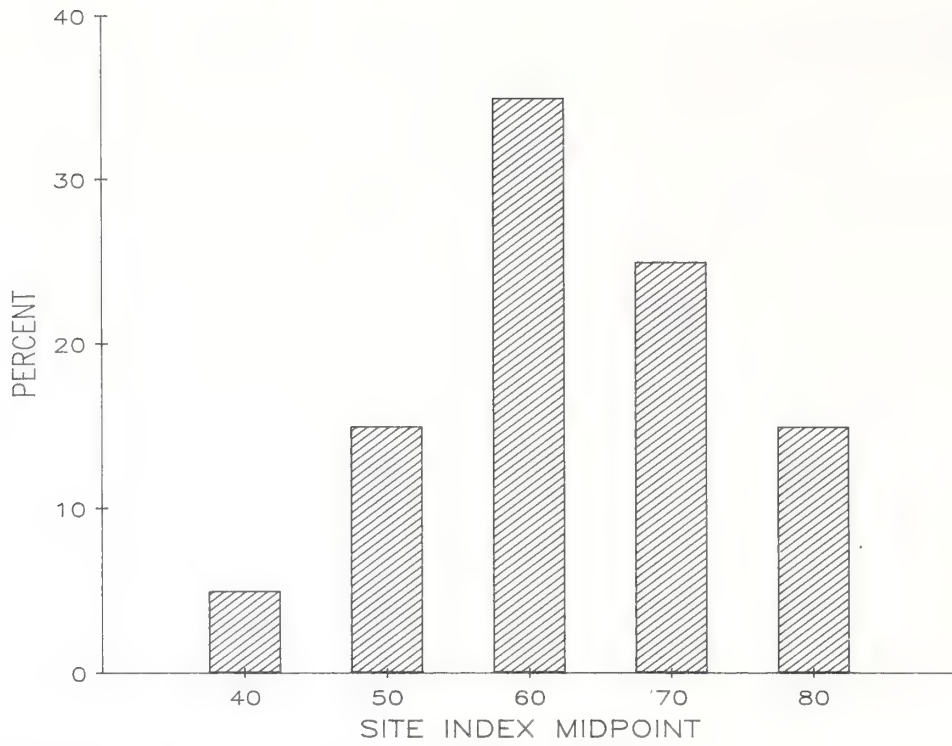


Figure 51—Distribution of western larch plantation site index values for Inland Northwest forests.

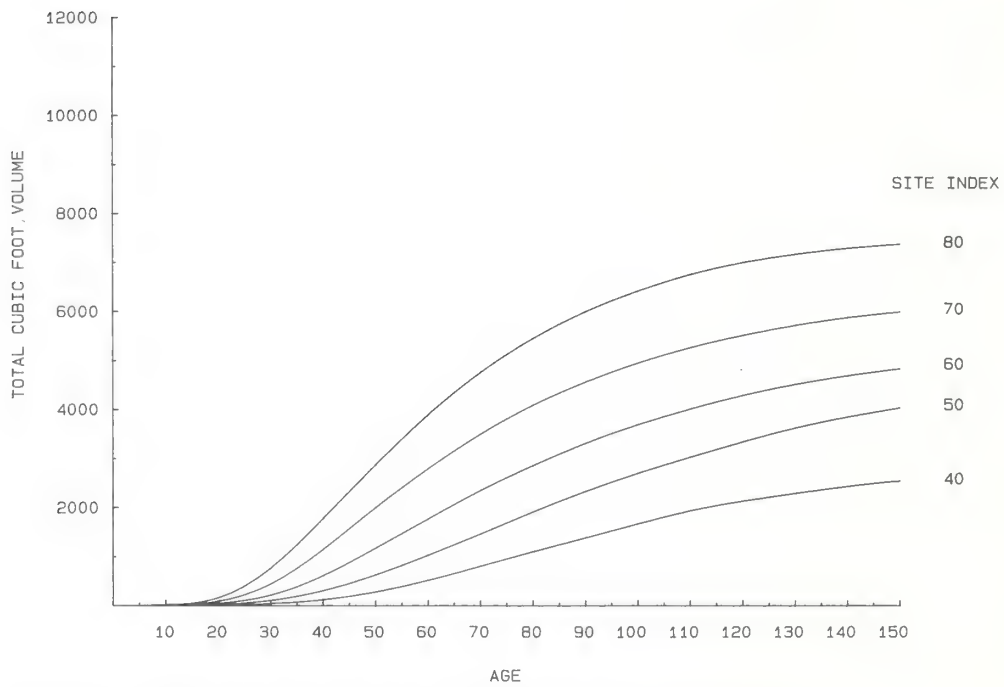


Figure 52—Western larch yield curves for unthinned plantations in Inland Northwest forests (total cubic feet all stems).

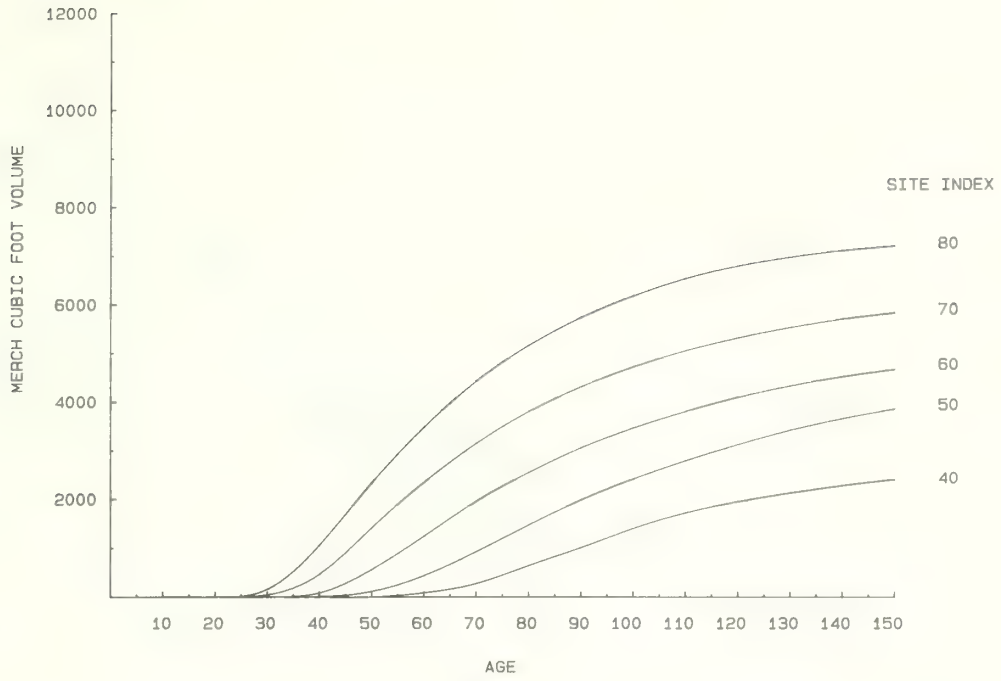


Figure 53—Western larch yield curves for unthinned plantations in Inland Northwest forests (merchantable cubic feet, 4.5-inch top, stems greater than 7 inches d.b.h.).

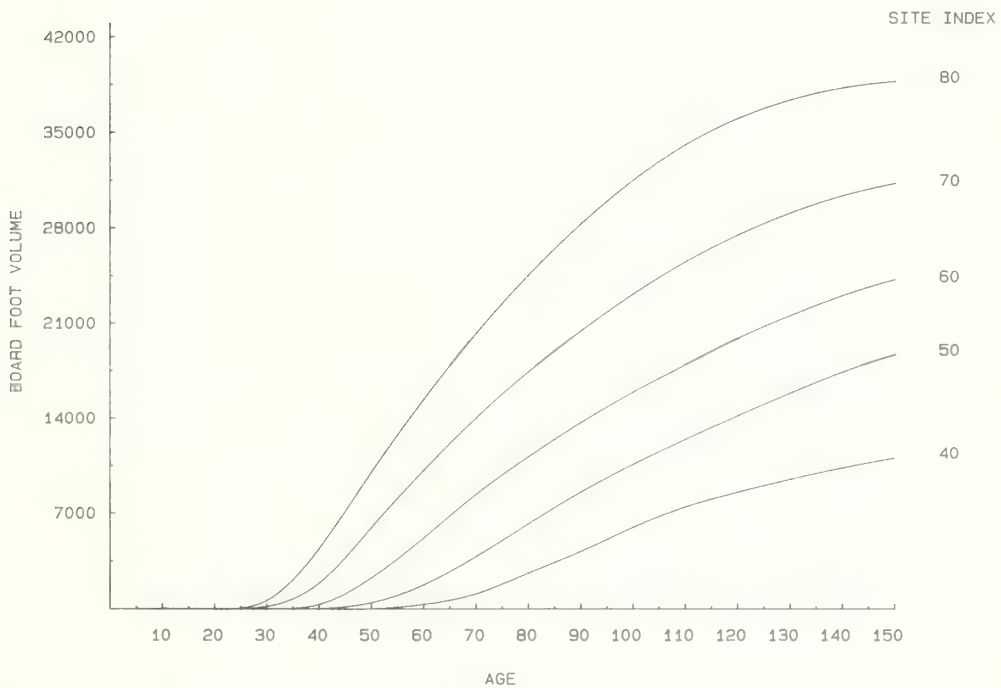


Figure 54—Western larch yield curves for unthinned plantations in Inland Northwest forests (merchantable board feet, 4.5-inch top, stems greater than 7 inches d.b.h.).

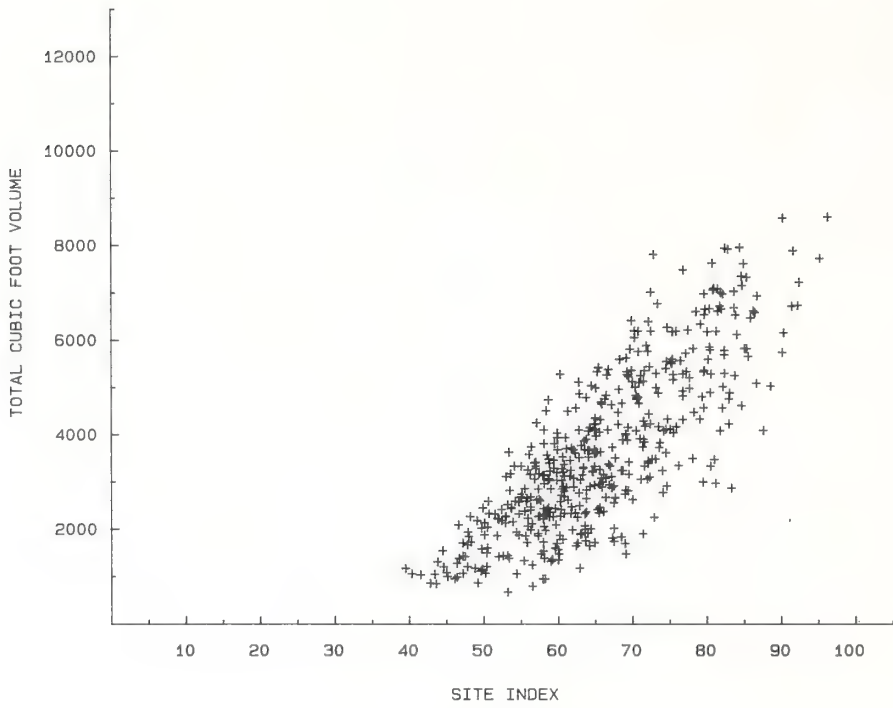


Figure 55—Western larch yield vs. site index at 80 years of age (total cubic feet).

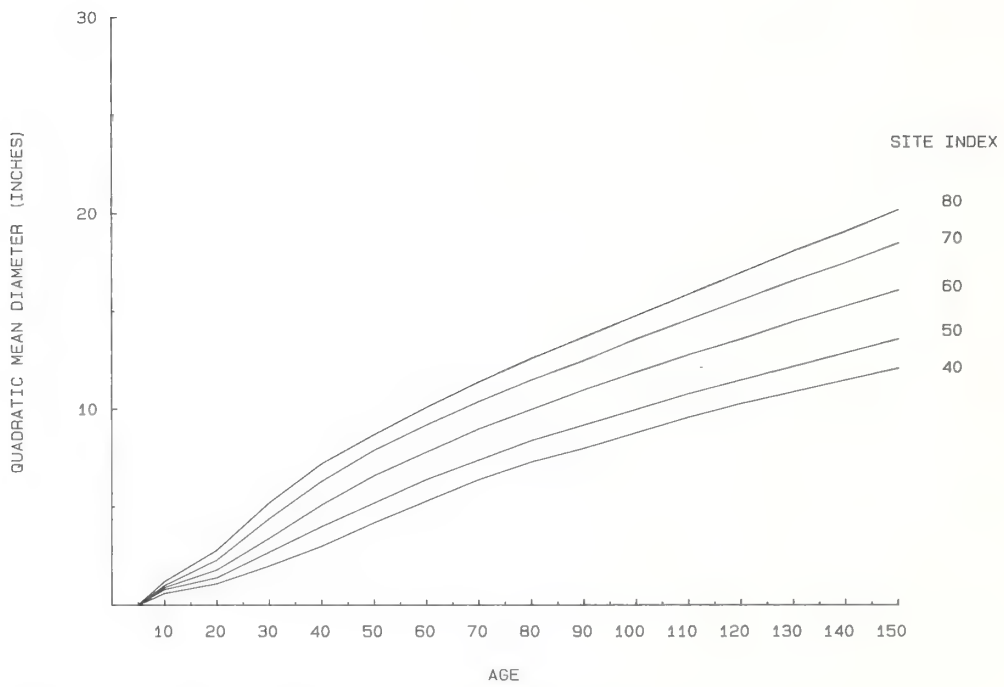


Figure 56—Quadratic mean diameter vs. age for western larch unthinned plantations in Inland Northwest forests.

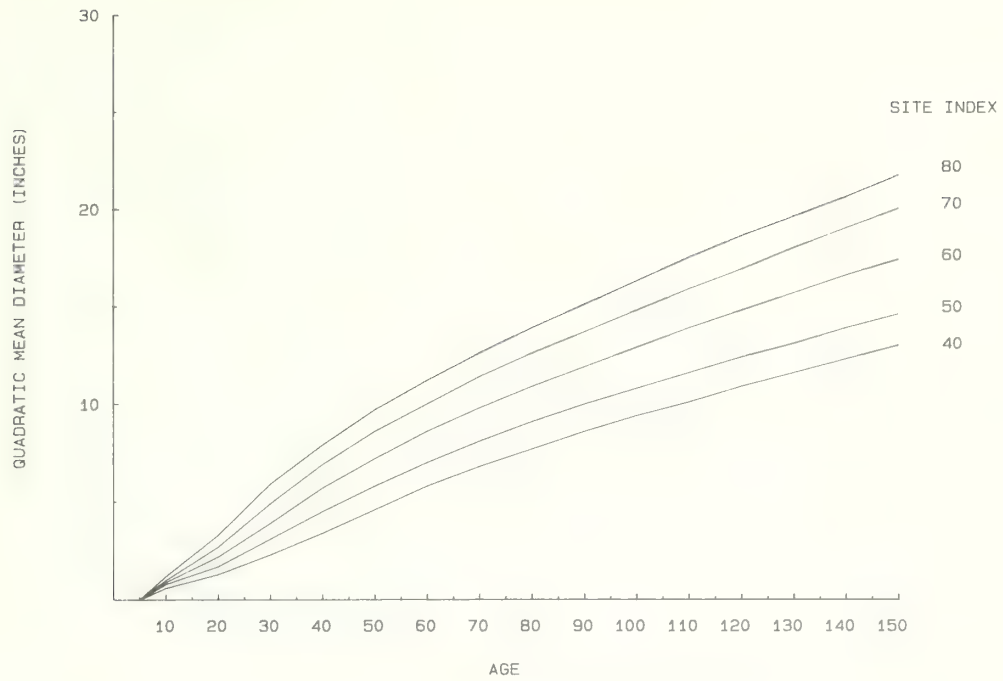


Figure 57—Quadratic mean diameter vs. age for western larch precommercial thinning to 250 trees per acre at 20 years in Inland Northwest forests.

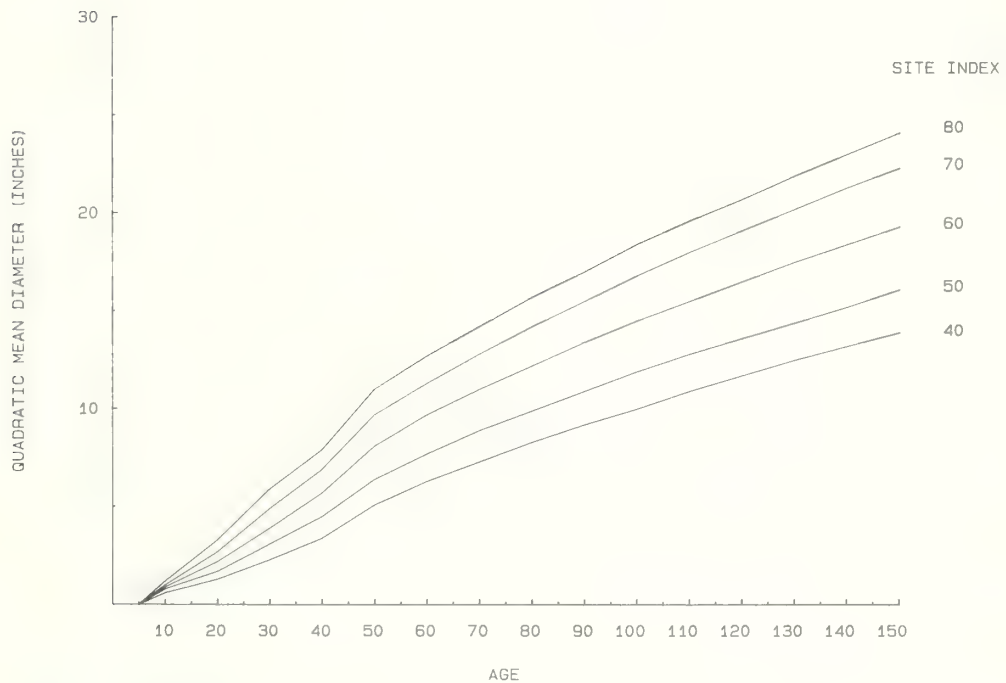


Figure 58—Quadratic mean diameter vs. age for western larch precommercial thinning to 250 trees per acre at 20 years and commercial thinning from below to 100 trees per acre at 50 years in Inland Northwest forests.

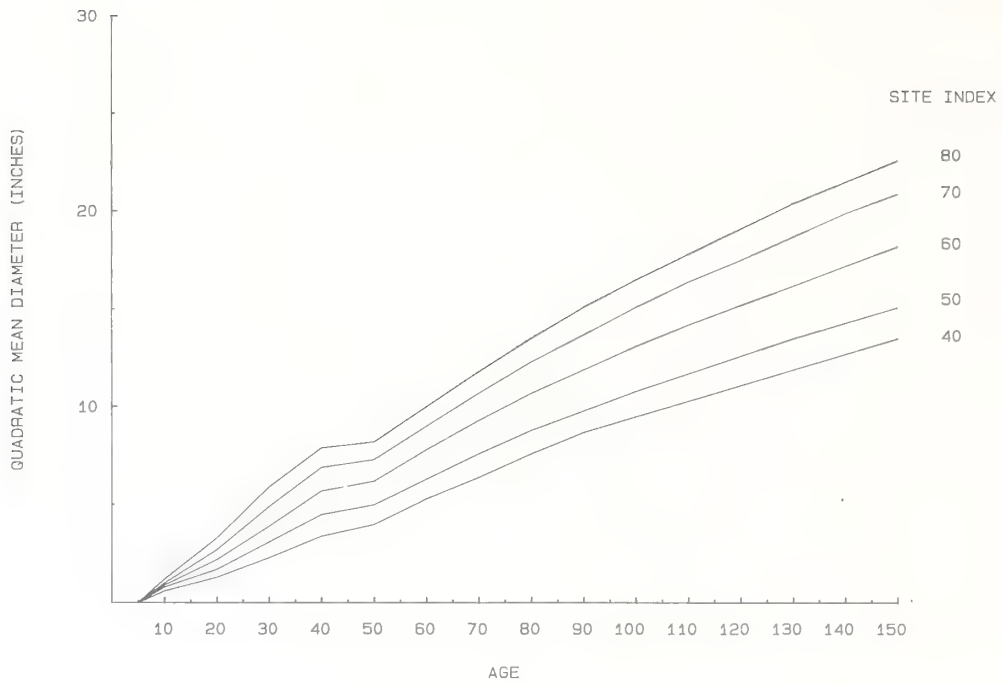


Figure 59—Quadratic mean diameter vs. age for western larch precommercial thinning to 250 trees per acre at 20 years and commercial thinning from above to 100 trees per acre at 50 years in Inland Northwest forests.

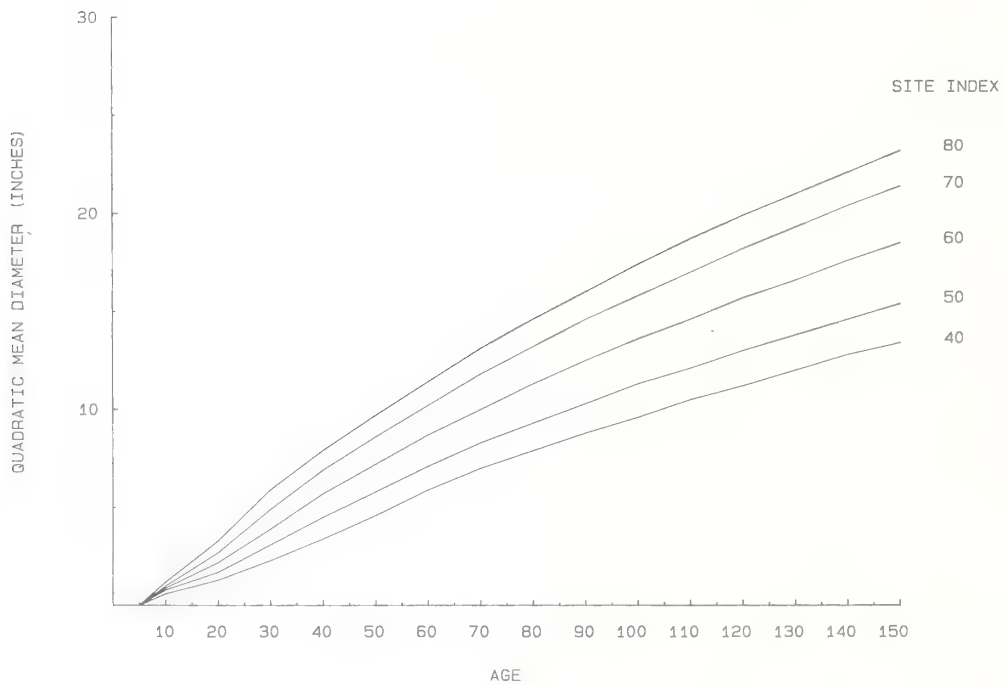


Figure 60—Quadratic mean diameter vs. age for western larch precommercial thinning to 250 trees per acre at 20 years and commercial thinning to 100 trees per acre at 50 years such that the mean d.b.h. before and after thinning is the same.

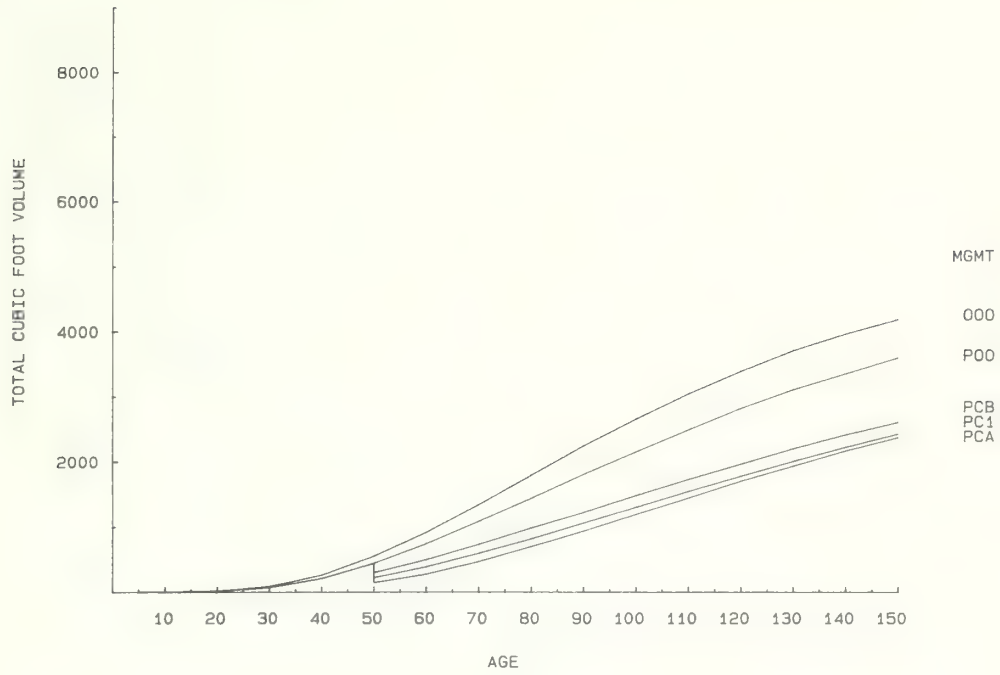


Figure 61—Effect of thinning on standing volume of western larch for Inland Northwest forests (total cubic feet), site index 50.

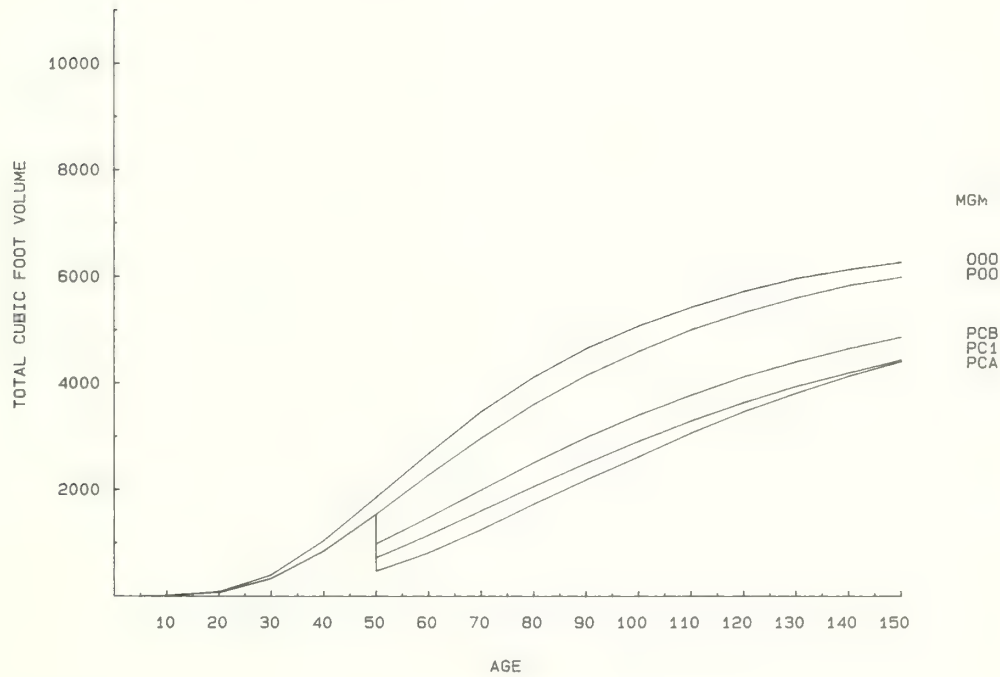


Figure 62—Effect of thinning on standing volume of western larch for Inland Northwest forests (total cubic feet), site index 70.

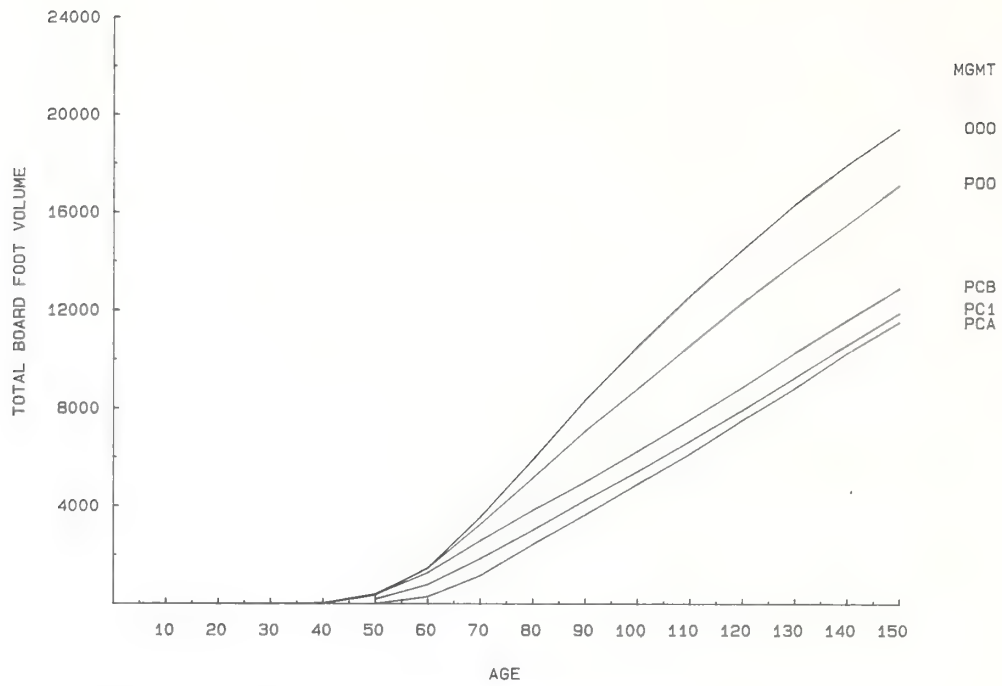


Figure 63—Effect of thinning on standing volume of western larch for Inland Northwest forests (merchantable board feet [Scribner]), site index 50.

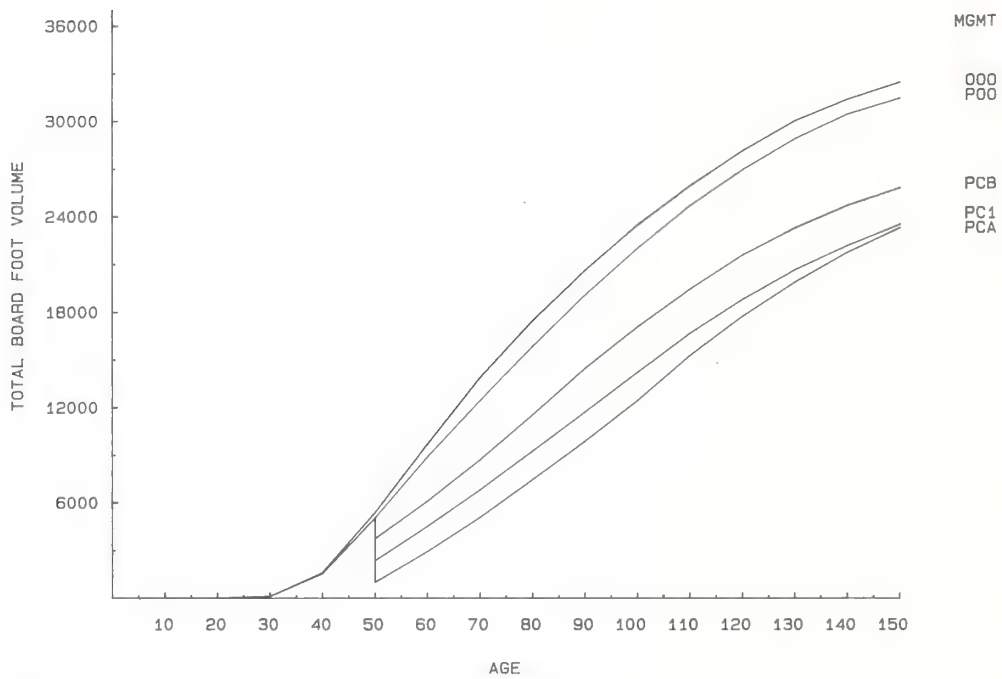


Figure 64—Effect of thinning on standing volume of western larch for Inland Northwest forests (merchantable board feet [Scribner]), site index 70.

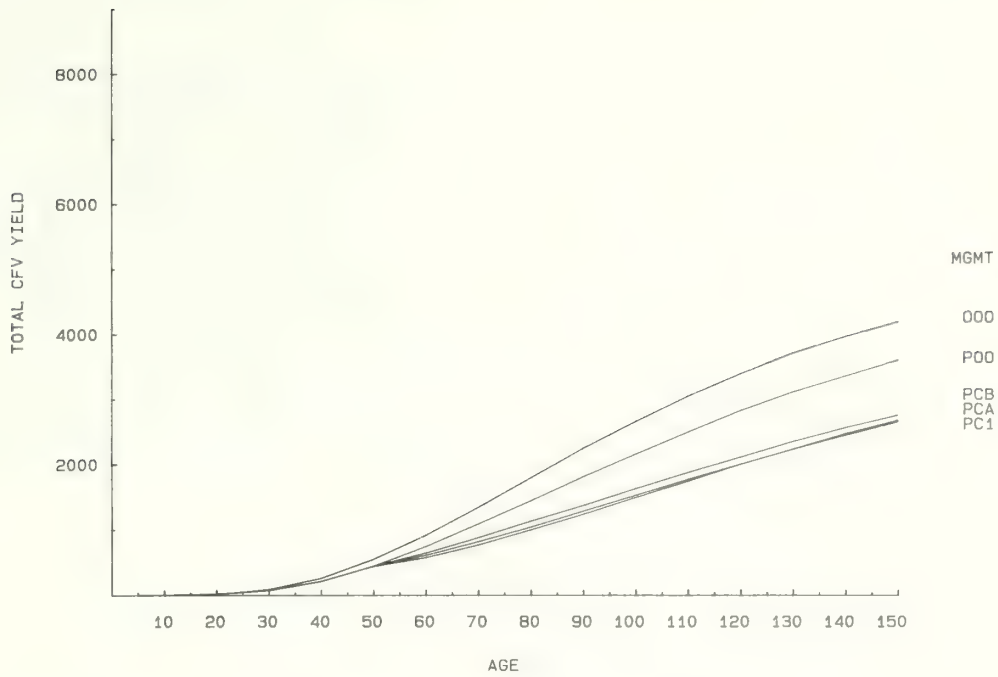


Figure 65—Effect of thinning on total yield of western larch plantations (total cubic feet), site index 50.

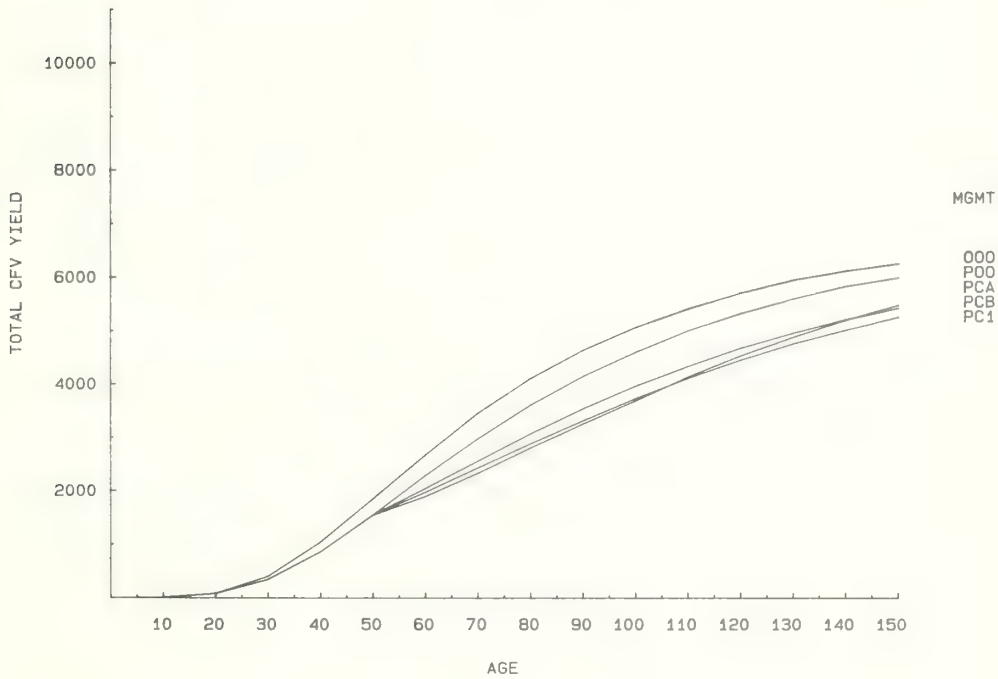


Figure 66—Effect of thinning on total yield of western larch plantations (total cubic feet), site index 70.

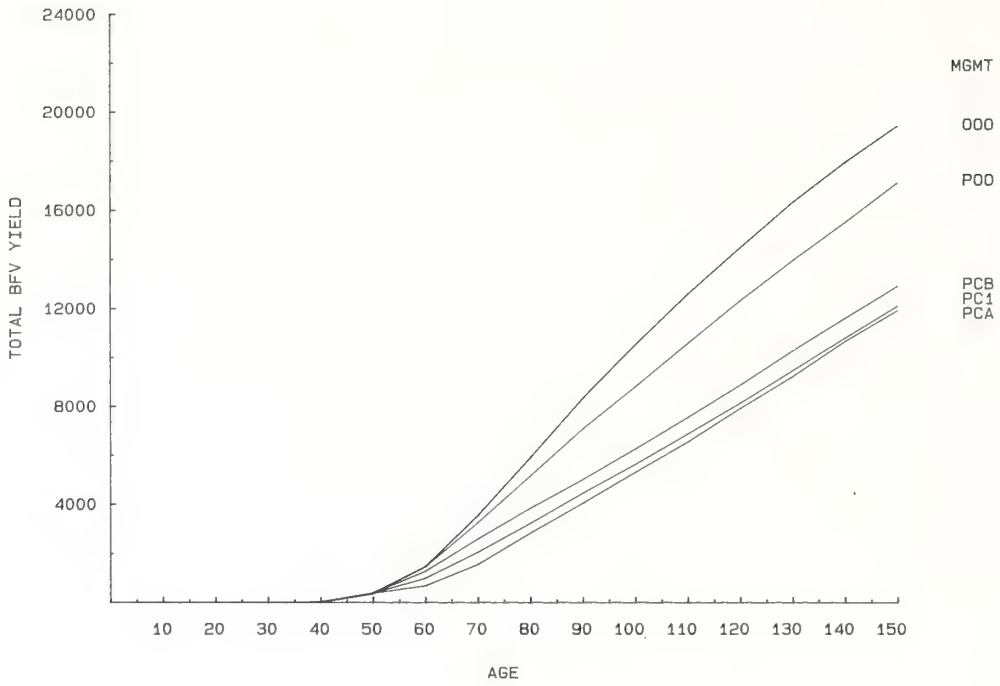


Figure 67—Effect of thinning on total yield of western larch plantations (merchantable board feet [Scribner]), site index 50.

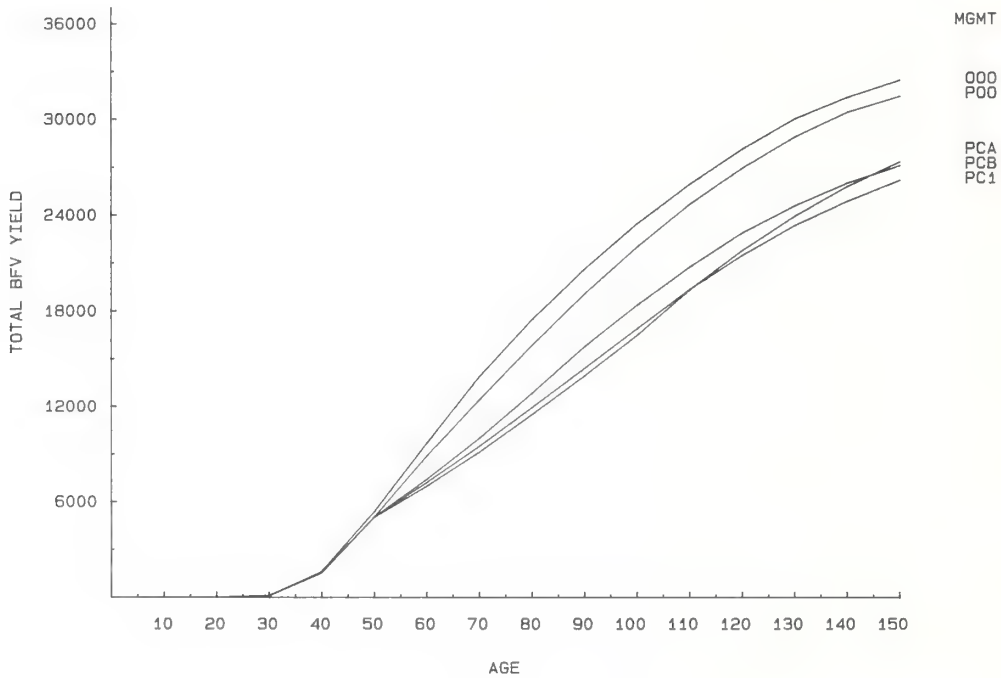


Figure 68—Effect of thinning on total yield of western larch plantations (merchantable board feet [Scribner]), site index 70.

COMPARISON TO RELATED YIELD ESTIMATES

Cochran (1979) has published estimates of net volume yields for natural stands of white (grand) fir and Douglas-fir east of the Cascades in Oregon and Washington. Although his samples were from natural stands, his rigorous screening for uniform spacing, minimal past mortality, and even-aged character of the stand would suggest that the yields he presents might also represent plantations. Furthermore, because his tables are arrayed by breast-high age, effects of the wide variation in early height growth found in natural stands would be reduced. Cochran's site index was defined as the height of the tallest tree on the $\frac{1}{5}$ -acre plot at 50 years age at breast height. Although his rate of selection of five trees per acre was less than the 20 trees per acre we used, the dif-

ference in site index definitions is estimated to be about 3 feet for site indices of about 70 feet. To shift our tables to a breast-high age basis, we estimated years to reach a height of 4.5 feet for plantations from the coefficients in table 13 of Ferguson and others (1986). For combinations of habitat types, elevations, slopes, and aspects that produce site index 70, time from regeneration treatment to 4.5 feet in height was estimated to be 10 years for Douglas-fir trees at +1 standard deviation in the distribution of heights and 16 years for grand fir.

A comparison of the yields reported by Cochran and those reported in this study is presented in figure 69. The curves for Douglas-fir are nearly identical, while for grand fir the Prognosis estimates are consistently higher. The difference in yields of grand fir seem reasonable because we expect grand fir in the Inland Empire to reach higher maximum densities than grand fir growing in eastern Oregon and Washington.

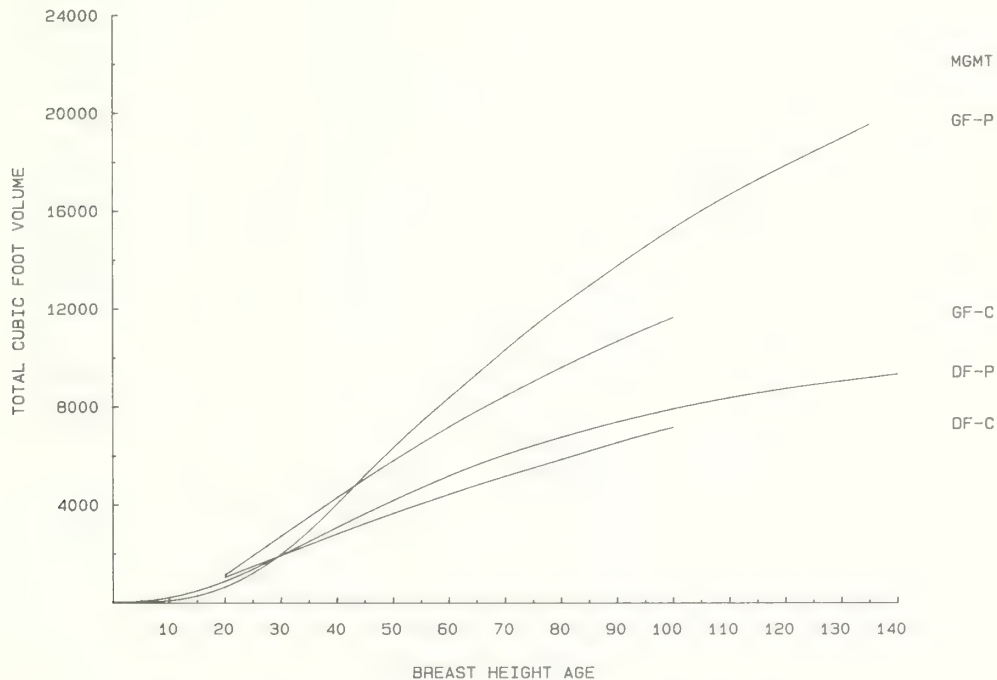


Figure 69—Comparison of Cochran and Prognosis yields for Douglas-fir and grand fir, site index 70. Management codes indicated on this figure are: GF-P = grand fir-Prognosis; GF-C = grand fir-Cochran; DF-P = Douglas-fir-Prognosis; DF-C = Douglas-fir-Cochran.

REFERENCES

- Cochran, P. H. 1979. Gross yields for even-aged stands of Douglas-fir and white or grand fir east of the Cascades in Oregon and Washington. Res. Pap. PNW-263. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 17 p.
- Daubenmire, R.; Daubenmire, J. 1968. Forest vegetation of eastern Washington and northern Idaho. Tech. Bull. 60. Pullman, WA: Washington Agricultural Experiment Station. 104 p.
- Ferguson, D. E.; Stage, A. R.; Boyd, R. J. 1986. Predicting regeneration in the grand fir-cedar-hemlock ecosystem of the Northern Rocky Mountains. For. Sci. Monogr. 26. Washington, DC: Society of American Foresters. 41 p.
- Kemp, P. D. 1956. Region 1 volume tables for cruise computations. Northern Region Handbook R1-2430-31. Missoula, MT: U.S. Department of Agriculture, Forest Service, Northern Region.
- Stage, A. R. 1987. Progress in yield estimation: a history and prescription. In: Chappel, H. N.; Maguire, D. A., eds. Predicting forest growth and yield: current issues, future prospects. Contrib. 58. Seattle, WA: University of Washington, College of Forest Resources, Institute of Forest Resources: 61-77.
- Wykoff, W. R. [In press.] Predicting Basal Area Increment for individual northern Rocky Mountain conifers. Submitted to Forest Science.
- Wykoff, W. R.; Crookston, N. L.; Stage, A. R. 1982. User's guide to the Stand Prognosis Model. Gen. Tech. Rep. INT-133. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 112 p.

APPENDIX TABLES: INVENTORY CLASSES USED FOR SIMULATION

Table 17—Class boundaries and corresponding mnemonic codes for Douglas-fir plantations

Variable	Class boundary values	Nominal value for class	
Aspect	123-203°	SE	
	204-22°	NW	
Habitat type	Ponderosa pine series	PSME/PHMA (260)	
	Douglas-fir series except PSME/SYAL, PSME/CARU		
	Englemann spruce series		
	Subalpine fir series except ABLA/OPHO, ABLA/CLUN, ABLA/LIBO, ABLA/MEFE, ABLA/LUHI		
	PSME/SYAL		PSME/SYAL (310)
	ABGR/CLUN		ABGR/CLUN (520)
	THPL/CLUN		THPL/CLUN (530)
	TSHE/CLUN		TSHE/CLUN (570)
	ABLA/CLUN		ABLA/CLUN (620)
	ABLA/LIBO		ABLA/LIBO (660)
	ABLA/MEFE		ABLA/MEFE (670)
	TSME/MEFE		TSME/MEFE (680)
	ABLA/LUHI		ABLA/LUHI (830)
	National Forest		Bitterroot } Lolo }
Clearwater		Clearwater (5)	
Coeur d'Alene		Coeur d'Alene (6)	
Colville		Colville (7)	
Flathead		Flathead (10)	
Kaniksu		Kaniksu (13)	
Kootenai		Kootenai (14)	
Nez Perce		Nez Perce (17)	
St. Joe	St. Joe (18)		

¹Aspect is included in class definitions because it is a major source of variation in Regeneration Establishment Model.

Table 18—Class boundaries and corresponding mnemonic codes for grand fir plantations

Variable	Class boundary values	Nominal value for class
Aspect	1337-157°	E
	158-336°	W
Habitat type	ABGR/XETE	ABGR/XETE (510)
	ABGR/CLUN	ABGR/CLUN (520)
	THPL/CLUN	THPL/CLUN (530)
	TSHE/CLUN	TSHE/CLUN (570)
	ABLA/CLUN	ABLA/CLUN (620)
	ABLA/MEFE	ABLA/MEFE (670)
	ABLA/XETE	ABLA/XETE (690)
	TSME/XETE	TSME/XETE (710)
National Forest	Bitterroot } Lolo }	Bitterroot (3)
	Clearwater	Clearwater (5)
	Coeur d'Alene	Coeur d'Alene (6)
	Colville	Colville (7)
	Flathead	Flathead (10)
	Kaniksu	Kaniksu (13)
	Kootenai	Kootenai (14)
	Nez Perce	Nez Perce (17)
St. Joe	St. Joe (18)	

¹Aspect is included in class definitions because it is a major source of variation in Regeneration Establishment Model.

Table 19—Class boundaries and corresponding mnemonic codes for western larch plantations

Variable	Class boundary values	Nominal value for class	
Aspect	1337-157°	E	
	158-336°	W	
Habitat type	Ponderosa pine series	PSME/PHMA (260)	
	Douglas-fir series		
	Subalpine fir series except ABLA/OPHO, ABLA/CLUN, ABLA/LIBO, ABLA/MEFE, ABLA/XETE, ABLA/VAGL, ABLA/VASC		
	Englemann spruce series		PIEN/CLUN (420)
	ABGR/XETE		ABGR/XETE (510)
	ABGR/CLUN		ABGR/CLUN (520)
	THPL/CLUN	THPL/CLUN (530)	
	THPL/OPHO	ABLA/OPHO (610)	
	TSHE/CLUN		
	ABLA/OPHO		
	ABLA/CLUN	ABLA/CLUN (620)	
	ABLA/LIBO	ABLA/LIBO (660)	
	ABLA/MEFE	TSME/MEFE (680)	
	TSHE/MEFE		
	ABLA/XETE	ABLA/XETE (690)	
	TSME/XETE	TSME/XETE (710)	
ABLA/VASC	ABLA/VASC (730)		
National Forest	Colville } Flathead }	Flathead (10)	
	Kootenai } Lolo }	Lolo (16)	
	Bitterroot	Bitterroot (3)	
	Clearwater	Clearwater (5)	
	Coeur d' Alene	Coeur d' Alene (6)	
	Kaniksu	Kaniksu (13)	
	Nez Perce	Nez Perce (17)	
	St. Joe	St. Joe (18)	

Table 20—Class boundaries and corresponding mnemonic codes for naturally regenerated stands

Variable	Class boundary values	Nominal value for class
Aspect	293-113°	N
	114-292°	S
Habitat type	ABGR/CLUN	ABGR/CLUN (520)
	THPL/CLUN	THPL/CLUN (530)
	TSHE/CLUN	TSHE/CLUN (570)
	ABLA/CLUN	ABLA/CLUN (620)
National Forest	Bitterroot } Flathead }	Bitterroot (3)
	Lolo } Clearwater }	Clearwater (5)
	Colville	Colville (7)
	Kaniksu	Kaniksu (13)
	Kootenai	Kootenai (14)
	Nez Perce	Nez Perce (17)

¹Aspect is included in class definitions because it is a major source of variation in Regeneration Establishment Model.

Stage, Albert R.; Renner, David L.; Chapman, Roger C. 1988. Selected yield tables for plantations and natural stands in Inland Northwest Forests. Res. Pap. INT-394. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 58 p.

Yields arrayed by site index and age have been tabulated for plantations of 500 trees per acre, with five thinning regimes, for Douglas-fir, grand fir, and western larch. Yields were also tabulated for naturally regenerated stands of the grand fir-cedar-hemlock ecosystem of the Inland Empire. All yields were estimated with the Prognosis Model for Stand Development, version 5.2, including the Regeneration Establishment Model.

KEYWORDS: plantation yields, site index, Douglas-fir, grand fir, western larch, natural stand yields, thinning, growth models

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