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RESEARCH NOTES

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SITE CLASSIFICATION FOR EVEN-AGED STANDS OF WESTERN HEMLOCK

By

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In 1937 normal yield tables were compiled by Meyer[2/] for even-aged stands of Sitka spruce and Western hemlock. The basic data from which the tables were compiled were collected over the entire coastal range of the species, extending from southern Oregon through Washington and British Columbia to southeastern Alaska. Data were obtained from temporary sample plots established in even-aged stands, the composition by species varying from pure hemlock to pure spruce. Douglas-fir and Western redcedar occurred to a minor extent on many of the plots.

1/ The author is gratefully indebted to the many cooperators who contributed to this study. Acknowledgement is due especially to members of the British Columbia Forest Service for data collected in that Province; to the Timber Management staff of Region 10 of the U. S. Forest Service for data collected in Alaska; to that of Region 6 of the U. S. Forest Service for assistance in locating stands from which additional data were collected; to Wilbur Engstrom and others of the Oregon State Forester's staff for assistance in collection and compilation of data--this being made possible by funds derived through the Forest Research and Experimental Tax Act of 1947; to Thomas G. Wright, formerly with the University of British Columbia, for additional data; to foresters of Crown Zellerbach Corporation and Weyerhaeuser Timber Company for help in locating suitable stands for additional sampling; and to Jack E. Wilson, graduate student at Oregon State College, for preliminary analyses.

2/ Meyer, W. H. Yield of even-aged stands of Sitka spruce and western hemlock. U. S. Dept. Agric. Tech. Bul. 544, 86 p. 1937.

In compilation of the base tables all the available data were treated as a single mass without any segregation by species composition or by geographic location. Thus, one set of site index curves was compiled, which was intended for use over the entire coastal range of the species and to pure stands as well as all mixtures of both spruce and hemlock.

Since publication and field test of the tables, numerous reports have been received that the site index schedules lead to erroneous site determination when applied to hemlock stands. Specific criticisms are to the effect that the curves are too low at ages of less than 100 years and too high at ages of more than 100 years. Observations of the Experiment Station have tended to confirm the reports.

In 1946 the matter was presented to the West Coast Forestry Procedures Committee. This body recommended that an attempt be made to explain the discrepancies, and that the tables be revised if it seemed necessary. In response, this present study was started.

Among the possible causes of the errors it was felt that the policy of combining data from such a wide range of territory and of species composition might be of greatest significance. On this account, Wilson, a graduate student at Oregon State College working under the author, conducted a preliminary investigation of the form of the site index curves with respect to geographic location and to species composition. A written report of this work was never filed, but the results gave direction to further analyses.

Analysis of Original Data

In Wilson's study the basic data used in compiling the original spruce-hemlock tables were segregated according to place and species composition. By place, Alaska, British Columbia, and Oregon-Washington were recognized. Species composition was evaluated according to the percentage of the total plot basal area contributed by hemlock and spruce. Percentage groups recognized were:

Hemlock - 80 to 100 percent, 60 to 80, and 40 to 60

Spruce - 80 to 100 percent and 60 to 80

A regression equation of the second degree was computed and plotted for each of the place and species groups showing the relation of total height of dominant and codominant trees to age of stand. The height used in the correlations was that of the hemlock trees only for the hemlock species group, and of the spruce trees only for the spruce group. Graphical comparison of the curves showed:

(1) Nowhere did the curves for the several composition classes of hemlock differ significantly from each other in either level or form. There seemed to be little justification, therefore, for recognizing the percentage groups of hemlock. Some difference appeared to exist in the form of the spruce composition percentage curves, but this phase of the investigation has not been carried far enough to reach a definite conclusion.

(2) When percentage composition was eliminated as a variable, the height-over-age curves from the different territories definitely occupied different levels. The Oregon-Washington curve assumed the highest position reaching a level of 153 feet at 100 years. The British Columbia curve reached 127 feet and the Alaska curve 104 feet at 100 years. This would indicate that better sites tend to prevail at the southern range and poorer sites at the northern range of the species. When these curves were adjusted[3/] to pass through a level of 130 feet at an age of 100 years on a percentage basis, their form was very similar. This indicated that there was no need of separate place curves, and that the differences in level were due only to differences in average site at the three places.

(3) There was considerable difference in the form of the hemlock and spruce curves, the spruce continuing to rise at a much higher rate after an age of 100 years than the hemlock. This indicated the need of separate site index curves for each species.

(4) Basic data for hemlock were very sparse above the age of 90 years, and below the age of 30 years. Most of the plots above 90 years of age were of the spruce group. In fact Meyer reported that in collecting the original data very few even-aged stands of hemlock over 100 years were found in Oregon and Washington, but were of more frequent incidence in British Columbia and Alaska. Since the original basic data were heavily weighted with spruce plots at ages over 90 years on the relatively good sites of Oregon and Washington, and since the height of spruce trees was used as the basis of site on these plots, the original site index curves were carried to too high a level for adequate determination of site on the basis of hemlock heights.

3/ Each place curve was adjusted to pass through a height of 130 feet at 100 years. The U. S. curve was reduced throughout its length by the ratio of 130/153 or by 85 percent. The B. C. curve was raised by the ratio of 130/127 or by 102 percent, and the Alaska curve by 130/104 or 125 percent so that the form of the curves could be compared directly.

Additional Data Gathered

Since Wilson's preliminary analysis showed a scarcity of data for hemlock in stands of 90 years and over and in stands 30 years and under, the writer with assistants used the summer season of 1947 to get further data in these age ranges. The young stands were found without difficulty but even-aged stands above 90 years were extremely rare, especially on the better sites. A few additional stands of more than 90 years were found at high elevations in the Coast Range and in the Olympics. These stands, of course, occupied relatively poor sites. Few even-aged stands beyond 100 years could be found for further sampling at the lower elevations and on good sites. In order to balance the data obtained on the poor sites, it was necessary finally to take some observations on trees that had always been dominant in uneven-aged partially stocked stands.

Method of Compilation

The standard procedure as described by Bruce and Schumacher[4/] was used in compiling the site index curves, using both the original data and the new data collected in 1947. Because of the wide geographic range from which the data were collected, however, it was found that the curve of height over age was better defined by compiling the Oregon-Washington, the British Columbia, and the Alaska data separately. Furthermore, there appeared to be some correlation between site and age when the entire mass of data was treated as a single unit. After curves for each place had been derived independently, each of them was adjusted proportionately to pass through a height of 100 feet at 70 years of age--70 years being the approximate average age of all the data. The three adjusted curves plotted very close together. Minor discrepancies were removed by merely taking an average of the three. This average curve was used in locating the final set of site index curves presented herewith, where site index is defined as the average total height attained or to be attained by dominant and codominant hemlock trees of the stand at an age of 100 years. See table 1 and figures 1 and 2.

The revised curves differ very little from Meyer's original up to 100 years of age, but beyond this point the differences continually increase to as much as 40 feet at 200 years of age for site index 200.

Continuation of Project

Further work of compiling the yield tables to accord with the revised site index classification continues. Much of this has already been completed and new yield tables for Western hemlock should be available within the year. Meanwhile, the new site index classification given in table 1 and figures 1 and 2 should be used for rating the productive capacity of hemlock lands.

Similar schedules may be compiled for stands which are predominantly spruce after the work on hemlock has been completed.

4/ Bruce, D. and F. X. Schumacher. Forest mensuration. McGraw-Hill, N. Y. 1935.

Table 1.--Site index classification for Western hemlock stands, based on the average total height of dominant and codominant trees at 100 years of age

Age (years)	Site index 60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
	Height in feet														
10	4	4	5	5	6	6	7	8	8	9	9	10	11	11	12
20	13	15	17	19	21	23	25	27	29	31	33	36	38	40	42
30	23	26	30	34	38	42	45	49	53	57	61	64	68	72	76
40	31	36	42	47	52	57	63	68	73	78	84	89	94	99	105
50	38	45	51	58	64	70	77	83	90	96	102	109	115	121	128
60	45	52	60	67	75	82	89	97	104	112	119	127	134	141	149
70	49	57	66	74	82	90	99	107	115	123	132	140	148	156	165
80	53	62	71	80	89	98	106	115	124	133	142	152	160	169	178
90	57	66	76	85	95	104	113	123	133	142	151	161	170	180	190
100	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
110	63	73	84	94	104	115	125	136	146	157	167	178	188	199	209
120	65	75	86	97	108	118	129	140	151	161	172	183	194	205	215
130	66	77	88	99	110	121	132	143	155	165	177	188	199	210	221
140	68	79	90	101	112	123	135	146	157	168	180	191	202	214	225
150	69	80	91	103	114	125	137	148	160	171	183	194	206	217	229
160	70	81	93	104	115	127	139	150	162	173	185	197	208	220	232
180	71	83	95	106	117	130	142	153	165	177	189	201	213	224	236
200	72	84	96	107	119	132	144	155	167	180	191	204	215	227	239
220	72	84	97	108	121	133	145	157	169	181	193	205	218	229	241
240	73	85	97	109	121	133	146	158	170	182	194	206	219	231	243
260	73	85	98	110	122	134	146	158	170	182	194	207	219	232	244
280	74	86	98	110	122	134	147	159	171	183	195	208	220	233	245
300	74	86	98	111	123	135	147	160	172	184	196	209	221	234	246

Compiled by Barnes, 1948, from data collected in Oregon, Washington, British Columbia, and Alaska.

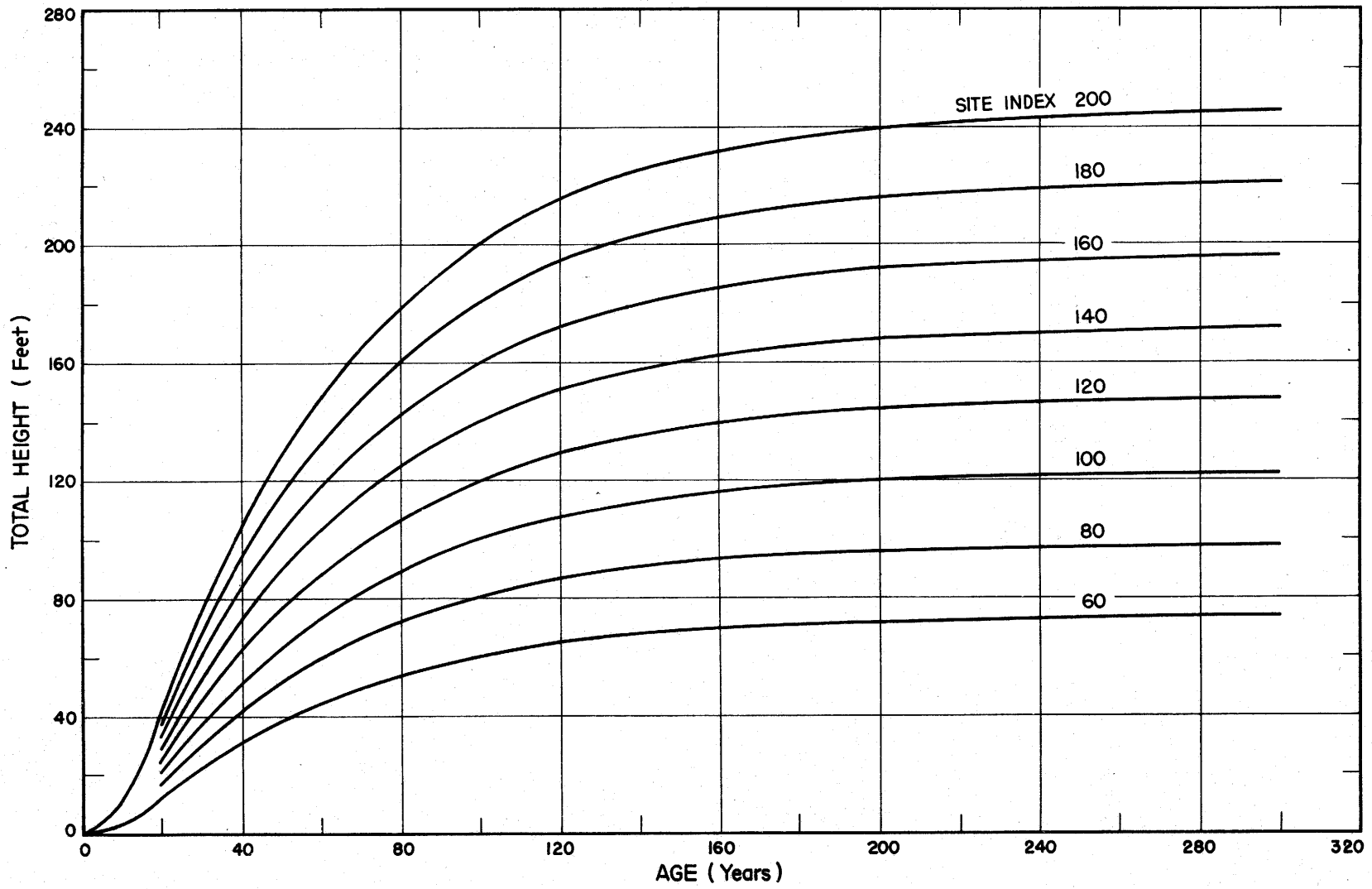

Figure No. 1 Height of dominant and codominant trees of average breast-height diameter.

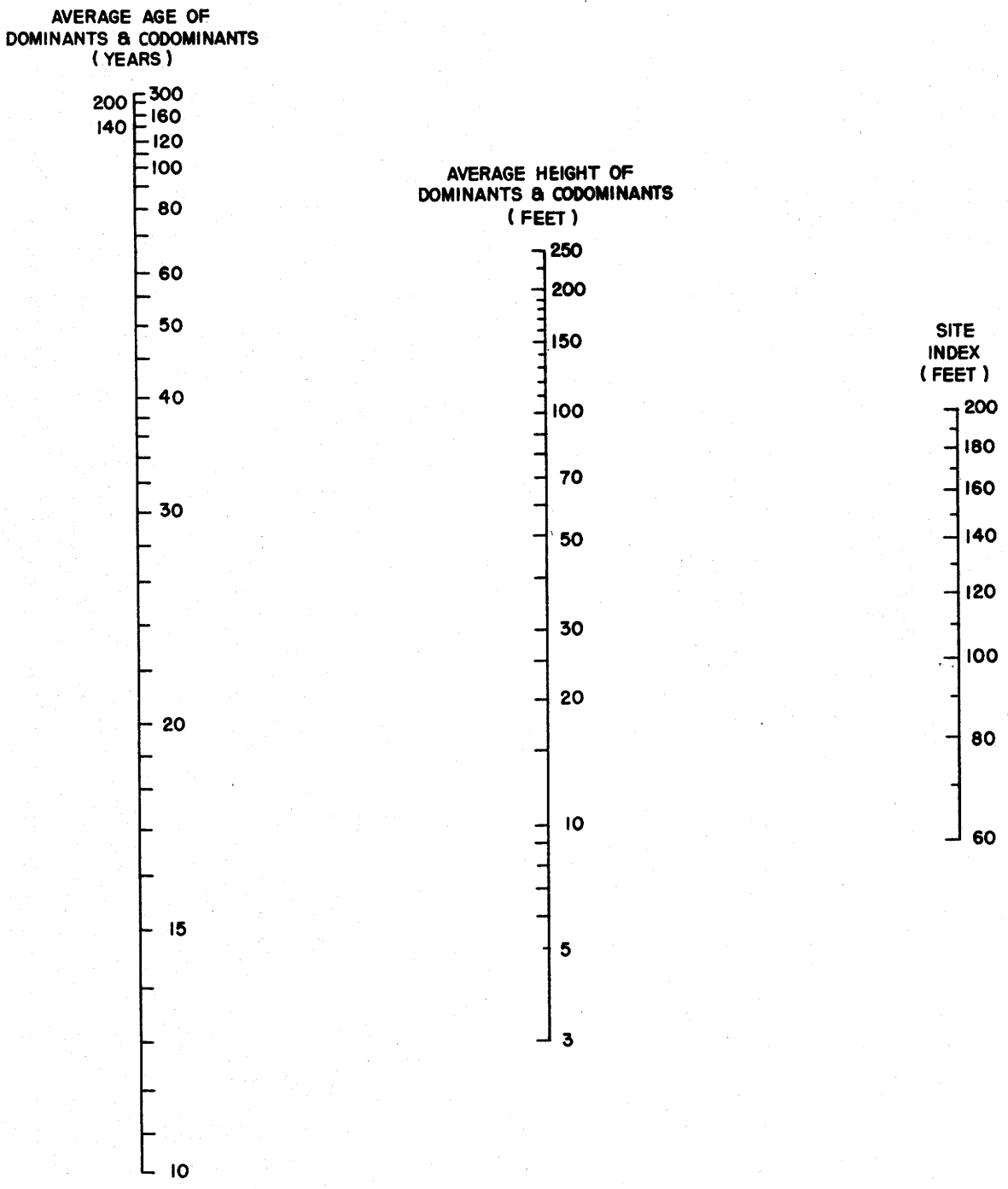

Figure No. 2 Alinement chart for determination of site index for Western hemlock