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U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE—Circular 127.
GIFFORD PINCHOT, Forester.

Forest Tables—Western Yellow Pine.

COMPiled by

E. A. ZIEGLER,
Chief, Section of Computing.
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[Cir. 127]
FOREST TABLES FOR WESTERN YELLOW PINE.

INTRODUCTION.

Forest tables for western yellow pine include *Pinus ponderosa* proper, the variety *scopulorum*, and *Pinus jeffreyi*. In gathering the data no attempt was made to segregate the species, since the distinction is too slight to be reflected in form or growth tables. The data used in the construction of these tables were collected by field parties in connection with various projects mainly on the National Forests; they were not gathered according to a set plan, but nevertheless are sufficient for the immediate requirements of exploitation and forest management. Cooperation is requested in the collection of more complete measurements for extending and revising the tables. In the National Forests, technical assistants, timber-sale inspectors, and lumbermen supervising cuttings can render valuable aid in this direction.

The widely varying factors of temperature and rainfall in different parts of the western yellow pine region bring about a corresponding variation in the development of the tree. This affects both the rate of growth and the form, and necessitates the recognition of three regions in which the tree differs widely. These regions are: the isolated Black Hills region; Arizona, New Mexico, southern Colorado, and the lower and drier mountains of southern California; northern California, Oregon; Washington, and the moister parts of Montana.

The first two regions are marked by a light rainfall; there the tree makes slow growth, has a short full stem, and forms open stands. The third region has a much heavier rainfall, which makes more rapid growth, a more slender stem, and rather dense stands. These characteristics are most conspicuous in the volume tables, but can

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a The field parties for the different regions were under the direction of the following men:

Prescott National Forest, Ariz. (working plan), A. E. Cohoon (1901).
California and Oregon (sugar pine study), R. D. Swales (1901).
Black Hills, S. Dak. (western yellow pine study), Coert Dubois (1902).
Colfax Co., N. Mex. (study and planting plan), A. F. Hawes (1903).
Black Hills, S. Dak. (western yellow pine study), H. M. Curran (1904).
Archuleta County, Colo. (western yellow pine study), H. M. Curran (1904).
Butte and Madera counties, Cal. (western yellow pine study), A. W. Cooper (1904).
Flathead and Missoula counties, Mont. (western yellow pine study), S. J. Record (1904).
Stevens County, Wash. (working plan), A. K. Chittenden (1904).

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also be traced in the stand, height, and diameter-growth tables. The boundaries of the regions are not always sharply drawn and intermediate stands may occasionally be found that will require nice judgment in the use of the tables.

**STANDS.**

Five tables of stands containing western yellow pine are given. They illustrate the different regions, and give associated species and relative development as seen in the diameters attained. The size of the tree increases from the Black Hills to Arizona, to Colorado, to Montana, to eastern Washington, and finally makes a decided increase to the west slope of the Sierras in California and Oregon. While yellow pine attains its maximum size in the central and northern Sierras of California and Oregon in mixture with sugar pine and white fir, on the lower and drier foothills it occurs in pure stands, or with a few scrubby oaks, and has a form very similar to that found in Arizona.

Table 1 shows the average stand per acre on township 1 south, range 3 east, of the Black Hills National Forest. It shows a large percentage of "insect-killed" timber, but does not indicate an average loss from that source. The column of totals gives the stand before the invasion of the beetle. It shows a denser stand than is found in many parts of the Black Hills, and gives the possibilities of the region. The stands here are mainly pure, and mostly very open; diameters above 30 inches are infrequent and the greater part of the stand is under 18 inches.

[Cir. 127]
**Table 1.—Stand in township 1 south, range 3 east, Black Hills National Forest, South Dakota.**

[Altitude, 5,000-6,000 feet.]

**TREES 5 INCHES AND OVER, BREASTHIGH DIAMETER, ON 351 ACRES.**

<table>
<thead>
<tr>
<th>Diameter breast-high.</th>
<th>Average number of trees per acre.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>7.87</td>
</tr>
<tr>
<td>6</td>
<td>8.32</td>
</tr>
<tr>
<td>7</td>
<td>7.07</td>
</tr>
<tr>
<td>8</td>
<td>5.87</td>
</tr>
<tr>
<td>9</td>
<td>4.78</td>
</tr>
<tr>
<td>10</td>
<td>4.25</td>
</tr>
<tr>
<td>11</td>
<td>3.33</td>
</tr>
<tr>
<td>12</td>
<td>3.22</td>
</tr>
<tr>
<td>13</td>
<td>2.65</td>
</tr>
<tr>
<td>14</td>
<td>2.23</td>
</tr>
<tr>
<td>15</td>
<td>1.81</td>
</tr>
<tr>
<td>16</td>
<td>1.26</td>
</tr>
<tr>
<td>17</td>
<td>0.88</td>
</tr>
<tr>
<td>18</td>
<td>0.68</td>
</tr>
<tr>
<td>19</td>
<td>0.40</td>
</tr>
<tr>
<td>20</td>
<td>0.31</td>
</tr>
<tr>
<td>21</td>
<td>0.19</td>
</tr>
<tr>
<td>22</td>
<td>0.12</td>
</tr>
<tr>
<td>23</td>
<td>0.06</td>
</tr>
<tr>
<td>24</td>
<td>0.04</td>
</tr>
<tr>
<td>25</td>
<td>0.03</td>
</tr>
<tr>
<td>26</td>
<td>0.01</td>
</tr>
<tr>
<td>27</td>
<td>0.01</td>
</tr>
<tr>
<td>28</td>
<td>0.01</td>
</tr>
<tr>
<td>29</td>
<td>0.01</td>
</tr>
<tr>
<td>30</td>
<td>0.01</td>
</tr>
<tr>
<td>31</td>
<td>0.01</td>
</tr>
<tr>
<td>Total.</td>
<td>55.67</td>
</tr>
<tr>
<td>Per cent.</td>
<td>63.14</td>
</tr>
</tbody>
</table>

**TREES 12 INCHES AND OVER, BREASTHIGH DIAMETER.**

<table>
<thead>
<tr>
<th></th>
<th>Total.</th>
<th>Per cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches.</td>
<td>13.98</td>
<td>49.86</td>
</tr>
<tr>
<td>Per cent.</td>
<td>8.49</td>
<td>30.28</td>
</tr>
<tr>
<td>inches.</td>
<td>5.06</td>
<td>18.04</td>
</tr>
<tr>
<td>Per cent.</td>
<td>0.25</td>
<td>0.80</td>
</tr>
<tr>
<td>inches.</td>
<td>0.26</td>
<td>0.93</td>
</tr>
<tr>
<td>Per cent.</td>
<td>28.04</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**TREES 18 INCHES AND OVER, BREASTHIGH DIAMETER.**

<table>
<thead>
<tr>
<th></th>
<th>Total.</th>
<th>Per cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches.</td>
<td>1.93</td>
<td>39.79</td>
</tr>
<tr>
<td>Per cent.</td>
<td>1.60</td>
<td>32.99</td>
</tr>
<tr>
<td>inches.</td>
<td>1.22</td>
<td>25.16</td>
</tr>
<tr>
<td>Per cent.</td>
<td>0.65</td>
<td>1.03</td>
</tr>
<tr>
<td>inches.</td>
<td>0.05</td>
<td>1.03</td>
</tr>
<tr>
<td>Per cent.</td>
<td>4.85</td>
<td>100.00</td>
</tr>
</tbody>
</table>

[Cir. 127]
Table 2 gives a representative stand in the Prescott National Forest, Arizona. Western yellow pine is the principal timber tree. There are more trees 18 inches and over than in the Black Hills, and trees 30 to 40 inches are frequent. The forest here is usually more open than that in the Black Hills.

Table 2.—Stand in the Prescott National Forest.
[Altitude: 5,000-6,000 feet.]

TREES 5 INCHES AND OVER, BREASTHEIGHT DIAMETER, ON 128 ACRES.

<table>
<thead>
<tr>
<th>Diameter, breasthigh.</th>
<th>Average number of trees per acre.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>5.47</td>
</tr>
<tr>
<td>6.</td>
<td>2.24</td>
</tr>
<tr>
<td>7.</td>
<td>1.90</td>
</tr>
<tr>
<td>8.</td>
<td>1.81</td>
</tr>
<tr>
<td>9.</td>
<td>1.40</td>
</tr>
<tr>
<td>10.</td>
<td>1.42</td>
</tr>
<tr>
<td>11.</td>
<td>1.33</td>
</tr>
<tr>
<td>12.</td>
<td>1.40</td>
</tr>
<tr>
<td>13.</td>
<td>1.07</td>
</tr>
<tr>
<td>14.</td>
<td>1.23</td>
</tr>
<tr>
<td>15.</td>
<td>1.40</td>
</tr>
<tr>
<td>16.</td>
<td>0.36</td>
</tr>
<tr>
<td>17.</td>
<td>0.39</td>
</tr>
<tr>
<td>18.</td>
<td>0.39</td>
</tr>
<tr>
<td>19.</td>
<td>0.62</td>
</tr>
<tr>
<td>20.</td>
<td>0.17</td>
</tr>
<tr>
<td>21.</td>
<td>0.17</td>
</tr>
<tr>
<td>22.</td>
<td>0.48</td>
</tr>
<tr>
<td>23.</td>
<td>0.41</td>
</tr>
<tr>
<td>24.</td>
<td>0.36</td>
</tr>
<tr>
<td>25.</td>
<td>0.50</td>
</tr>
<tr>
<td>26.</td>
<td>0.11</td>
</tr>
<tr>
<td>27.</td>
<td>0.17</td>
</tr>
<tr>
<td>28.</td>
<td>0.12</td>
</tr>
<tr>
<td>29.</td>
<td>0.05</td>
</tr>
<tr>
<td>30.</td>
<td>0.06</td>
</tr>
<tr>
<td>31.</td>
<td>0.01</td>
</tr>
<tr>
<td>32.</td>
<td>0.02</td>
</tr>
<tr>
<td>33.</td>
<td>0.01</td>
</tr>
<tr>
<td>34.</td>
<td>0.01</td>
</tr>
<tr>
<td>35.</td>
<td>0.01</td>
</tr>
<tr>
<td>36.</td>
<td>0.01</td>
</tr>
<tr>
<td>37.</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>27.67</strong></td>
</tr>
<tr>
<td><strong>Per cent.</strong></td>
<td><strong>54.73</strong></td>
</tr>
</tbody>
</table>

TREES 12 INCHES AND OVER, BREASTHEIGHT DIAMETER.

| Total                   | 11.92  | 5.32  | 0.50  | 0.34  | 18.08  |
| Per cent.              | 65.98  | 29.42  | 2.77  | 1.88  | 100.00  |

TREES 18 INCHES AND OVER, BREASTHEIGHT DIAMETER.

| Total                   | 5.29  | 1.11  | 0.36  | 0.23  | 6.99  |
| Per cent.              | 75.68 | 15.88  | 5.15  | 3.29  | 100.00 |

Table 3 shows a stand of timber in Flathead and Missoula counties, Mont. Western yellow pine is the principal timber tree at the lower altitudes, and in favorable situations it occurs with Douglas fir, western larch, and lodgepole pine. Western yellow pine occurs here in much denser stands than in the Black Hills or in Arizona and

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reaches a larger diameter; in density of stand and in relation of height to diameter it more nearly approaches the development attained in California. There are, however, frequent open stands in the lower and drier foothills where the tree form more nearly resembles that of Arizona.

**Table 3.—Stand in Flathead and Missoula counties, Mont.**

*Altitude, 3,000-4,000 feet.*

| TREES 1 INCH AND OVER, BREASTHIGH DIAMETER, ON 13.6 ACRES. |
|---------------------------------|--|--|--|--|--|--|--|---|
| **Diameter, breast-high.** | **Western yellow pine.** | **Douglas fir.** | **Western larch.** | **Lodgepole pine.** | **Total.** |
| | **Sound.** | **Dead.** | **Cull.** | **Sound.** | **Dead.** | **Sound.** | **Dead.** | **Sound.** | **Total.** |
| **Inches.** | **No.** | **No.** | **No.** | **No.** | **No.** | **No.** | **No.** | **No.** | **No.** |
| 1-4 | 59.96 | 5.91 | | | | | | 10.66 |
| 5 | 13.29 | 5.91 | | | | | | 31.28 |
| 6 | 5.61 | 0.07 | 0.07 | 3.16 | 0.07 | 0.07 | 6.66 |
| 7 | 1.84 | 0.07 | | | | | | 1.25 |
| 8 | 1.62 | 0.29 | | | | | | 88.8 |
| 9 | 1.32 | 0.22 | 0.07 | 1.69 | 0.37 | 0.07 | 8.81 |
| 10 | 2.65 | 0.22 | 0.07 | 0.51 | 0.15 | 0.07 | 37.5 |
| 11 | 3.01 | 0.07 | 0.07 | 0.37 | 0.44 | 0.07 | 51.7 |
| 12 | 3.38 | 0.07 | 0.07 | 0.37 | 0.44 | 0.07 | 51.7 |
| 13 | 2.72 | 0.15 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 14 | 2.21 | 0.15 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 15 | 2.43 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 16 | 2.27 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 17 | 1.62 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 18 | 1.47 | 0.29 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 19 | 1.69 | 0.22 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 20 | 1.32 | 0.15 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 21 | 1.18 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 22 | .66 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 23 | .98 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 24 | .96 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 25 | .96 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 26 | .66 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 27 | .66 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 28 | .37 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 29 | .37 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 30-34 | 1.25 | 2.22 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 35-39 | .44 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 40-44 | .07 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| 45-47 | .07 | 0.07 | 0.07 | 0.37 | 0.36 | 0.07 | 30.2 |
| **Total.** | 108.00 | 10.28 | 34.92 | 35 | 19.07 | 0.57 | 16.97 | 206.39 |
| **Per cent.** | 53.20 | 4.98 | 30.61 | 17.96 | 6.07 | 5.1 | 8.23 | 100.00 |

**TREES 5 INCHES AND OVER, BREASTHIGH DIAMETER.**

| Total. | 72.64 | 4.47 | 0.63 | 20.07 | 0.28 | 6.79 | 0.57 | 6.31 | 111.76 |
| Per cent. | 65.00 | 4.00 | .56 | 17.96 | .25 | 6.07 | .51 | 5.65 | 100.00 |

**TREES 12 INCHES AND OVER, BREASTHIGH DIAMETER.**

| Total. | 30.57 | 2.05 | 0.35 | 6.10 | 0.21 | 4.15 | 0.26 | 0.87 | 44.66 |
| Per cent. | 68.45 | 4.39 | .78 | 13.66 | .47 | 9.29 | .81 | 1.95 | 100.00 |

**TREES 18 INCHES AND OVER, BREASTHIGH DIAMETER.**

| Total. | 14.25 | 1.09 | 0.14 | 2.78 | 0.07 | 2.25 | 0.22 | 20.80 |
| Per cent. | 68.31 | 5.34 | .67 | 13.37 | .34 | 10.81 | 1.06 | 100.00 |

**TREES 24 INCHES AND OVER, BREASTHIGH DIAMETER.**

| Total. | 6.31 | 0.37 | 0.14 | 1.60 | 0.07 | 0.85 | .85 | 8.75 |
| Per cent. | 72.12 | 4.22 | 1.60 | 11.54 | .80 | 9.72 | 100.00 |

[Cir. 127]
Table 4 shows a stand in eastern Washington that is very similar in composition to the forest in western Montana, though there are fewer trees per acre.

Table 4.—Stand on the Van Dissel tract, Stevens County, Wash.

[Altitude, 3,000-4,000 feet.]

TREES 2 INCHES AND OVER, BREASTHEIGHT DIAMETER, ON 20 ACRES.

<table>
<thead>
<tr>
<th>Diameter, breastheight</th>
<th>Average number of trees per acre.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-4</td>
<td>10.05</td>
<td>9.05</td>
</tr>
<tr>
<td>3</td>
<td>1.95</td>
<td>1.15</td>
</tr>
<tr>
<td>4</td>
<td>1.40</td>
<td>1.00</td>
</tr>
<tr>
<td>5</td>
<td>1.00</td>
<td>1.30</td>
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<tr>
<td>6</td>
<td>1.15</td>
<td>1.50</td>
</tr>
<tr>
<td>7</td>
<td>1.40</td>
<td>1.35</td>
</tr>
<tr>
<td>8</td>
<td>.80</td>
<td>1.05</td>
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<tr>
<td>9</td>
<td>.65</td>
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<td>16</td>
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<td>18</td>
<td>.80</td>
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<tr>
<td>19</td>
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<td>20</td>
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<td>22</td>
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<td>24</td>
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<td>30-34</td>
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<td>35-36</td>
<td>.65</td>
<td>.10</td>
</tr>
<tr>
<td>40-41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>28.65</td>
<td>23.70</td>
</tr>
<tr>
<td>Per cent</td>
<td>43.05</td>
<td>35.61</td>
</tr>
</tbody>
</table>

TREES 5 INCHES AND OVER, BREASTHEIGHT DIAMETER.

| Total | 18.60  | 14.65  | 3.70   | 4.20   | 41.15  |
|       | 45.20  | 35.60  | 8.90   | 10.21  | 100.00 |

TREES 12 INCHES AND OVER, BREASTHEIGHT DIAMETER.

| Total | 10.25  | 5.85   | 0.40   | 2.90   | 19.40  |
|       | 52.84  | 30.15  | 2.06   | 14.95  | 100.00 |

TREES 18 INCHES AND OVER, BREASTHEIGHT DIAMETER.

| Total | 6.65   | 2.95   | 1.85   | 11.45  |
|       | 58.08  | 25.70  | 16.16  | 100.00 |

Table 5 shows a stand of timber on the west slope of the Cascades in Klamath County, Oreg. This shows yellow pine in mixture with sugar pine and white fir. Douglas fir forms a large part of the forest here, but disappears farther south as shown in Table 6. Large diameters, occasionally exceeding 60 inches, are found in all species.

[Cr. 127]
The yield of this stand is estimated as follows:

<table>
<thead>
<tr>
<th></th>
<th>Per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western yellow pine</td>
<td>18,000</td>
</tr>
<tr>
<td>Sugar pine</td>
<td>12,000</td>
</tr>
<tr>
<td>Douglas fir</td>
<td>15,000</td>
</tr>
</tbody>
</table>

Table 5.—Stand at Polezana, Klamath County, Ore.
[Altitude, about 4,000 feet.]

TREES 5 INCHES AND OVER, BREASTHIGH DIAMETER, ON 84 ACRES.

<table>
<thead>
<tr>
<th>Diameter breast-high.</th>
<th>Average number of trees per acre.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Douglas fir</td>
</tr>
<tr>
<td>5.</td>
<td>0.70</td>
</tr>
<tr>
<td>6.</td>
<td>0.86</td>
</tr>
<tr>
<td>8.</td>
<td>0.79</td>
</tr>
<tr>
<td>10.</td>
<td>0.71</td>
</tr>
<tr>
<td>12.</td>
<td>0.80</td>
</tr>
<tr>
<td>14.</td>
<td>0.85</td>
</tr>
<tr>
<td>16.</td>
<td>0.85</td>
</tr>
<tr>
<td>18.</td>
<td>0.70</td>
</tr>
<tr>
<td>20.</td>
<td>0.68</td>
</tr>
<tr>
<td>22.</td>
<td>0.44</td>
</tr>
<tr>
<td>24.</td>
<td>0.40</td>
</tr>
<tr>
<td>26.</td>
<td>0.35</td>
</tr>
<tr>
<td>28.</td>
<td>0.47</td>
</tr>
<tr>
<td>30—34.</td>
<td>0.74</td>
</tr>
<tr>
<td>35—39.</td>
<td>0.42</td>
</tr>
<tr>
<td>40—44.</td>
<td>0.33</td>
</tr>
<tr>
<td>45—49.</td>
<td>0.62</td>
</tr>
<tr>
<td>50—54.</td>
<td>0.54</td>
</tr>
<tr>
<td>55—59.</td>
<td>0.74</td>
</tr>
<tr>
<td>60—64.</td>
<td>0.06</td>
</tr>
<tr>
<td>65—67.</td>
<td>0.01</td>
</tr>
<tr>
<td>Total</td>
<td>18.92</td>
</tr>
<tr>
<td>Per cent.</td>
<td>20.97</td>
</tr>
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</table>

TREES 12 INCHES AND OVER, BREASTHIGH DIAMETER.

<table>
<thead>
<tr>
<th></th>
<th>Per cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>13.20</td>
</tr>
<tr>
<td>Per cent.</td>
<td>31.08</td>
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</tbody>
</table>

TREES 18 INCHES AND OVER, BREASTHIGH DIAMETER.

<table>
<thead>
<tr>
<th></th>
<th>Per cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>9.47</td>
</tr>
<tr>
<td>Per cent.</td>
<td>30.46</td>
</tr>
</tbody>
</table>

TREES 24 INCHES AND OVER, BREASTHIGH DIAMETER.

<table>
<thead>
<tr>
<th></th>
<th>Per cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>6.00</td>
</tr>
<tr>
<td>Per cent.</td>
<td>27.78</td>
</tr>
</tbody>
</table>

Table 6 shows a stand farther south on the west slope of the Sierras in Madera County, Cal. The same species, except Douglas fir, are represented here as in Table 5. The diameters run very high, especially of yellow and sugar pine.

Lower down in the foothills of the Sierras there is an open stand of yellow pine which resembles that in Arizona and Colorado.
Table 6.—Stand at 5,000 feet elevation, Madera County, Cal.
TREES 1 INCH AND OVER, BREASTHIGH DIAMETER, ON 29 ACRES.

<table>
<thead>
<tr>
<th>Diameter, breast-high</th>
<th>Incense cedar</th>
<th>White fir</th>
<th>Western yellow pine</th>
<th>Sugar pine</th>
<th>California black oak</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
</tr>
<tr>
<td>Inches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1-4</td>
<td>8.60</td>
<td>7.75</td>
<td>2.70</td>
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<td>0.65</td>
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</tr>
<tr>
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<td>0.90</td>
<td>0.85</td>
<td>0.05</td>
<td></td>
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<tr>
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<td>1.15</td>
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<td>0.85</td>
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<td>0.75</td>
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<td>0.35</td>
<td>0.25</td>
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<td>0.35</td>
<td>0.25</td>
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<td>0.35</td>
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<td>0.25</td>
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<td>0.35</td>
<td>0.25</td>
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<td>1.35</td>
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<tr>
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</tr>
<tr>
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<td>0.50</td>
<td>0.45</td>
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</tr>
<tr>
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<td>38.15</td>
<td>24.60</td>
<td>29.65</td>
<td>19.25</td>
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</tr>
<tr>
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<td>19.62</td>
<td>18.29</td>
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</tr>
</tbody>
</table>

TREES 5 INCHES AND OVER, BREASTHIGH DIAMETER.

<table>
<thead>
<tr>
<th>Tree species</th>
<th>Number</th>
<th>Number</th>
<th>Number</th>
<th>Number</th>
<th>Number</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incense cedar</td>
<td>29.85</td>
<td>16.85</td>
<td>17.95</td>
<td>13.95</td>
<td>2.25</td>
<td>80.85</td>
</tr>
<tr>
<td>Per cent.</td>
<td>33.02</td>
<td>20.84</td>
<td>22.20</td>
<td>17.26</td>
<td>2.78</td>
<td>100.00</td>
</tr>
</tbody>
</table>

TREES 12 INCHES AND OVER, BREASTHIGH DIAMETER.

<table>
<thead>
<tr>
<th>Tree species</th>
<th>Number</th>
<th>Number</th>
<th>Number</th>
<th>Number</th>
<th>Number</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incense cedar</td>
<td>20.25</td>
<td>12.25</td>
<td>13.75</td>
<td>10.70</td>
<td>1.65</td>
<td>58.60</td>
</tr>
<tr>
<td>Per cent.</td>
<td>34.56</td>
<td>20.90</td>
<td>23.46</td>
<td>18.26</td>
<td>2.82</td>
<td>100.00</td>
</tr>
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</table>

TREES 18 INCHES AND OVER, BREASTHIGH DIAMETER.

<table>
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<th>Tree species</th>
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<th>Number</th>
<th>Number</th>
<th>Number</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incense cedar</td>
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<td>100.00</td>
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TREES 24 INCHES AND OVER, BREASTHIGH DIAMETER.

<table>
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<th>Number</th>
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<th>Number</th>
<th>Total</th>
</tr>
</thead>
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<td>Per cent.</td>
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<td>21.97</td>
<td>21.58</td>
<td>1.66</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**HEIGHT.**

Under like climatic conditions the height of a tree is an index of site quality. In Table 7 varying factors, such as density and rainfall, affect the form of the tree, and though yellow pine in the Black Hills has a greater height than in Arizona it is due entirely to a [Cir. 127]
denser stand, for the diameter growth is much less. Evidently this height table can not be used as a comparative index of site quality without constant reference to the diameter growth (Table 12, page 15) and the stand tables for the same regions.

The heights for Stevens County, Wash., were doubtless taken in a maximum stand and are greater than an average for the region. The average height for the region would more nearly approach that given for Montana.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
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<td>31</td>
<td>92</td>
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<td>96</td>
<td>0</td>
<td>25</td>
<td>62</td>
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<td>34</td>
<td>98</td>
<td>0</td>
<td>25</td>
<td>62</td>
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<td>Total</td>
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<td>852</td>
<td>1,828</td>
<td>838</td>
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<td>190</td>
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</tbody>
</table>

[Cir. 127]
Table 8 gives heights for Flathead and Missoula counties, Mont., classified in types. The basis for the smaller diameters is not sufficient to warrant the drawing of definite conclusions. The mixed slope type has poorest height growth. Douglas fir enters the mixture strongly on the west and south slopes, and that indicates a rather dry soil. Quality classes would seem to be a better method of classification. In this case the pure slope and mixed flat types might be thrown together as Quality I, pure flat as Quality II, and mixed slope as Quality III.

Table 8.—Height for various types in Flathead and Missoula counties, Mont.

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<thead>
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<td>17</td>
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<td>101</td>
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<td>40.</td>
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<td></td>
</tr>
<tr>
<td>Total.</td>
<td>134</td>
<td>159</td>
<td>234</td>
<td>317</td>
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</tbody>
</table>

CLEAR LENGTH.

Table 9 contains average "clear lengths" for yellow pine in Flathead and Missoula counties, Mont., Prescott National Forest, and the Black Hills National Forest. The first two are very similar. The Black Hills pine has a considerably larger clear length, due partly to its greater age, partly to other influences.

The interpretation of "clear length" by different field men will always cause confusion when results are to be compared; to some it will mean the length of trunk absolutely free from branches, to others it will mean the length free from living branches; to others still, the length to the first branch 2 inches in diameter, living or dead. The interpretation should be, that part of the tree which will furnish almost entirely clear lumber. This would allow an occasional small knot that might be eliminated without appreciable waste in cutting into logs or in sawing at the mill. The judgment of the measurer must always be exercised to some extent.

[Cir. 127]
**Table 9. — Clear length by regions.**

<table>
<thead>
<tr>
<th>Diameter, breast-high.</th>
<th>Flathead and Missoula counties, Mont.</th>
<th>Prescott National Forest, Arizona</th>
<th>Black Hills National Forest, South Dakota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inches.</strong></td>
<td><strong>Feet.</strong></td>
<td><strong>Trees.</strong></td>
<td><strong>Clear length.</strong></td>
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<td>1</td>
<td></td>
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<tr>
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<td>12</td>
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<tr>
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<td>14</td>
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<td>15</td>
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<td></td>
</tr>
<tr>
<td>35</td>
<td>38</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>577</strong></td>
<td><strong>2,233</strong></td>
<td><strong>1,690</strong></td>
</tr>
</tbody>
</table>

**Growth.**

**Height growth of seedlings.**

Table 10 shows averages of seedling height growth. This growth is affected to such an extent by local conditions that tables not based on a very large number of measurements, taken from all qualities of locality, can not be closely compared. The parallel columns will furnish a rough comparison and give some idea of development. All of the measurements indicate that the growth for the first six years is very slow.

[Gir. 127]
### Table 10.—Seedling height growth by types and regions.

<table>
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<td>0.3 3</td>
<td>1.0 2</td>
<td>1.3 2</td>
<td>0.1 4</td>
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<tr>
<td>3</td>
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<td>0.5 5</td>
<td>1.5 2</td>
<td>1.7 2</td>
<td>1.1 3</td>
</tr>
<tr>
<td>4</td>
<td>1.6 24</td>
<td>0.7 7</td>
<td>2.0 3</td>
<td>2.2 3</td>
<td>1.5 4</td>
</tr>
<tr>
<td>5</td>
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<td>1.0 10</td>
<td>2.5 5</td>
<td>2.7 5</td>
<td>2.1 6</td>
</tr>
<tr>
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<td>2.6 36</td>
<td>1.3 11</td>
<td>3.0 8</td>
<td>3.2 8</td>
<td>3.0 6</td>
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<tr>
<td>7</td>
<td>3.1 42</td>
<td>1.6 13</td>
<td>3.5 10</td>
<td>3.7 10</td>
<td>3.5 9</td>
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<tr>
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<td>4.0 8</td>
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<td>4.1 54</td>
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<td>5.6 18</td>
<td>5.5 5</td>
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<tr>
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<td>3.1 23</td>
<td>6.0 20</td>
<td>6.1 20</td>
<td>6.0 4</td>
</tr>
<tr>
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<td>3.4 25</td>
<td>6.6 22</td>
<td>6.7 22</td>
<td>6.6 3</td>
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<tr>
<td>14</td>
<td>6.6 84</td>
<td>3.7 27</td>
<td>7.1 24</td>
<td>7.2 24</td>
<td>7.1 2</td>
</tr>
<tr>
<td>15</td>
<td>7.1 90</td>
<td>4.0 29</td>
<td>7.6 26</td>
<td>7.7 26</td>
<td>7.6 1</td>
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<tr>
<td>16</td>
<td>7.6 96</td>
<td>4.3 31</td>
<td>8.1 28</td>
<td>8.2 28</td>
<td>8.1 0</td>
</tr>
<tr>
<td>Total</td>
<td>494</td>
<td>88</td>
<td>98</td>
<td>121</td>
<td>233</td>
</tr>
</tbody>
</table>

Table 11 gives averages of height growth by types for seedlings in Flathead and Missoula counties, Mont. Seedling growth is very slow in mixed stands, because of the dryness of the mixed slopes and the density of the mixed flats. On pure slopes and pure flats seedling height growth is almost identical.

### Table 11.—Seedling height growth for various situations in Flathead and Missoula counties, Mont.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.1 89</td>
<td>0.1 89</td>
<td>0.1 89</td>
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<td>0.8 123</td>
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<td>0.9 128</td>
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<td>1.0 133</td>
<td>1.0 133</td>
<td>1.0 133</td>
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<td>1.5 158</td>
<td>1.5 158</td>
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### Diameter Growth.

Table 12 contains averages of diameter growth from different regions. The Black Hills region shows the slowest growth, due mainly to lack of rainfall and a shorter growing season. Montana has the next slowest growth, with possibly a slightly larger rainfall than the Black Hills. Colorado and Arizona follow in order with approximately the same rainfall, but with longer growing seasons and more open forest, which increase diameter growth. The growth in Stevens [Cir. 127]
County, Wash., is excellent for the latitude and rainfall. The west slope of the Rocky Mountains must have a favorable effect on the moisture conditions there. The west slopes of the Sierras in central and northern California show a magnificent growth, which is auspicious for forest management. The rainfall there is heaviest in the entire range of yellow pine. Soil and other conditions no doubt have their influence on growth, but the extent is not yet ascertainable. In all measurements, and especially in diameter growth, it must be borne in mind that individual trees often greatly exceed the average. In the Black Hills it takes one hundred and twenty years for the average tree to reach the merchantable size of 10.5 inches, yet some individual trees reach that diameter in a much shorter time.

### Table 12.—Diameter growth by general regions.

<table>
<thead>
<tr>
<th>Age</th>
<th>Diameter breast-high</th>
<th>Basis</th>
<th>Diameter breast-high</th>
<th>Basis</th>
<th>Diameter breast-high</th>
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<tbody>
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<td>Inches</td>
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</tr>
<tr>
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<td>1.0</td>
<td></td>
<td>0.8</td>
<td></td>
<td>0.8</td>
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<td>10.1</td>
<td>Decade measurements on 371</td>
<td>13.8</td>
<td>Decade measurements on 130</td>
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<td>30</td>
<td>4.8</td>
<td>3-foot stumps 90-370 years old</td>
<td>11.2</td>
<td>3-foot stumps 80-383 years old</td>
<td>13.8</td>
<td>2-foot stumps 72-383 years old</td>
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<td>5.3</td>
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<td>14.7</td>
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<td>18.4</td>
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<table>
<thead>
<tr>
<th>Age</th>
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<th>Basis</th>
<th>Diameter breast-high</th>
<th>Basis</th>
<th>Diameter breast-high</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td>Inches</td>
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</tr>
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</tr>
<tr>
<td>20</td>
<td>4.3</td>
<td>Decade measurements on 189</td>
<td>4.5</td>
<td>Decade measurements on 210</td>
<td>7.1</td>
<td>Decade measurements on 422</td>
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<td>2-foot stumps 31-308 years old</td>
<td>6.3</td>
<td>3-foot stumps 55-308 years old</td>
<td>9.7</td>
<td>2.5-foot stumps 21-245 years old</td>
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<td>24.7</td>
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<td>29.7</td>
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</table>

[Cir. 127]
Table 13 gives the variation in diameter growth for different types of forest in Flathead and Missoula counties, Mont. As would be inferred from the growth of seedlings (Table 11, p. 14) and relation of height to diameter (Table 8, p. 12), the mixed slope type shows the poorest diameter growth. The mixed flat with its denser stand has a retarded diameter growth, but produces the tallest trees (Table 8). The pure stands on flat and slope have the best diameter growth, and the slope type leads in height up to 18 inches (Table 8), but the flat type leads in diameter growth.

Table 13.—Diameter growth in various types, Flathead and Missoula counties, Mont.

<table>
<thead>
<tr>
<th>Age</th>
<th>Mixed slope</th>
<th>Mixed flat</th>
<th>Pure slope</th>
<th>Pure flat</th>
</tr>
</thead>
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<tr>
<td>Years</td>
<td>Diameter breast high</td>
<td>Basis</td>
<td>Diameter breast high</td>
<td>Basis</td>
</tr>
<tr>
<td>20...</td>
<td>Decade measurements on 47 3-foot stumps 107-47.5 years old</td>
<td>Decade measurements on 51 3-foot stumps 143-470 years old</td>
<td>Decade measurements on 121 3-foot stumps 81-400 years old</td>
<td>Decade measurements on 92 3-foot stumps 103-269 years old</td>
</tr>
<tr>
<td>30...</td>
<td>0.8</td>
<td>1.7</td>
<td>2.7</td>
<td>3.9</td>
</tr>
<tr>
<td>40...</td>
<td>1.5</td>
<td>3.2</td>
<td>4.5</td>
<td>5.4</td>
</tr>
<tr>
<td>50...</td>
<td>2.1</td>
<td>3.2</td>
<td>3.4</td>
<td>3.0</td>
</tr>
<tr>
<td>60...</td>
<td>2.5</td>
<td>3.2</td>
<td>4.5</td>
<td>6.3</td>
</tr>
<tr>
<td>70...</td>
<td>3.0</td>
<td>4.5</td>
<td>7.8</td>
<td>8.5</td>
</tr>
<tr>
<td>80...</td>
<td>3.5</td>
<td>4.5</td>
<td>10.0</td>
<td>11.4</td>
</tr>
<tr>
<td>90...</td>
<td>4.0</td>
<td>4.5</td>
<td>12.5</td>
<td>14.9</td>
</tr>
<tr>
<td>100...</td>
<td>4.5</td>
<td>4.5</td>
<td>15.5</td>
<td>17.1</td>
</tr>
</tbody>
</table>

VOLUME.

VARIATION ACCORDING TO REGION.

With the great variation in form of western yellow pine as shown by the relation of height to diameter (Table 7, p 11), in diameter growth (Table 12, p. 15), and in density of stand, as shown in the stand tables (pp. 3 to 10), it is not surprising that there is a large variation in volume. In considering volume this variation requires that three general regions be distinguished: the Black Hills; Arizona, Colorado, and open stands in the Rocky Mountain region and southern California where there is a deficiency of moisture; and the west slope of the Sierras in central and northern California and in Oregon, and possibly the best stands in eastern Washington and western Montana.

[Cr. 127]
Each of the three general regions is represented by a volume table in board feet, to which is attached the top diameter cutting limit. The Black Hills region gives the largest volumes, with Arizona next, and California the smallest. Further, the utilization in the tops is closest in the Black Hills, Arizona next, and California least close. This is, to some extent, due to the form of the tree and to the difference of value of the poorer top logs in the different regions. However, this difference in utilization can account for only a part of the variation in volume, as shown by a comparison of the tables giving the volume of entire stem for California and the Black Hills.

Tables 14, 15, and 16 give, respectively, the board-foot contents for the three general regions. The Black Hills and the Arizona tables show volumes approaching each other rather closely, which is accounted for by the similarity in conditions in those regions. California, however, shows much smaller volumes. The smaller volume for California is best explained by the form tables on pages 22 and 23.

The tables were made up by scaling logs as cut by lumbermen. The logs varied in length from 10 to 18 feet. The larger part of the California trees were cut into 10-foot logs, and for that reason every advantage of taper gained by scaling short logs must be credited to the California table. The Black Hills table shows diameters down to 8 inches, since the smaller trees are merchantable there.

Trees much larger than 48 inches are found in California, but there were not sufficient data available for an extension of the table beyond that diameter. However, a fairly accurate estimate can be made by finding the volume of half the diameter, under the required height class, and multiplying by 4, since with equal heights the volumes vary as the squares of the diameters. As an illustration, in Table 16 a 24-inch, 150-foot tree contains 1,040 board feet; by the suggested method, a 48-inch tree, 150 feet high, should have $4 \times 1,040$, or 4,160 board feet. In the table it is given as 4,250. According to the table a 33-inch tree, 170 feet high, contains 2,330 board feet; a 66-inch tree of the same height should contain about 9,320 board feet. The volumes given for the larger diameters are conservative.

The relation between the Scribner scale and actual saw cut can not be given at this time. It varies with different saws, different log diameters, with the efficiency of the sawyers, and, most of all, with the kind of log. Rapidly tapering logs will give a larger overrun than cylindrical logs.

[Cir. 127]
Table 14.—Volume in board feet—Scribner rule—Black Hills National Forest, South Dakota.

<table>
<thead>
<tr>
<th>Diameter breast-high.</th>
<th>Height of tree, feet—</th>
<th>Diameter of top inside bark.</th>
<th>Basis.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inches.</strong></td>
<td>40.</td>
<td>50.</td>
<td>60.</td>
</tr>
<tr>
<td>8.</td>
<td>20</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>9.</td>
<td>25</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>10.</td>
<td>30</td>
<td>45</td>
<td>70</td>
</tr>
<tr>
<td>11.</td>
<td>35</td>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td>12.</td>
<td>40</td>
<td>70</td>
<td>110</td>
</tr>
<tr>
<td>13.</td>
<td>45</td>
<td>100</td>
<td>130</td>
</tr>
<tr>
<td>14.</td>
<td>50</td>
<td>125</td>
<td>130</td>
</tr>
<tr>
<td>15.</td>
<td>55</td>
<td>150</td>
<td>130</td>
</tr>
<tr>
<td>16.</td>
<td>60</td>
<td>175</td>
<td>150</td>
</tr>
<tr>
<td>17.</td>
<td>65</td>
<td>200</td>
<td>150</td>
</tr>
<tr>
<td>18.</td>
<td>70</td>
<td>225</td>
<td>175</td>
</tr>
<tr>
<td>19.</td>
<td>75</td>
<td>250</td>
<td>175</td>
</tr>
<tr>
<td>20.</td>
<td>80</td>
<td>275</td>
<td>175</td>
</tr>
<tr>
<td>21.</td>
<td>85</td>
<td>300</td>
<td>175</td>
</tr>
<tr>
<td>22.</td>
<td>90</td>
<td>325</td>
<td>175</td>
</tr>
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<td>23.</td>
<td>95</td>
<td>350</td>
<td>175</td>
</tr>
<tr>
<td>24.</td>
<td>100</td>
<td>375</td>
<td>175</td>
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<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 15.—Volume in board feet—Scribner rule—San Francisco Mountains National Forest, Arizona.

<table>
<thead>
<tr>
<th>Diameter breast-high.</th>
<th>Height of tree, feet—</th>
<th>Diameter of top inside bark.</th>
<th>Basis.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inches.</strong></td>
<td>40.</td>
<td>50.</td>
<td>60.</td>
</tr>
<tr>
<td>12.</td>
<td>30</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>13.</td>
<td>40</td>
<td>90</td>
<td>110</td>
</tr>
<tr>
<td>14.</td>
<td>50</td>
<td>120</td>
<td>130</td>
</tr>
<tr>
<td>15.</td>
<td>60</td>
<td>150</td>
<td>160</td>
</tr>
<tr>
<td>16.</td>
<td>70</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>17.</td>
<td>80</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>18.</td>
<td>90</td>
<td>240</td>
<td>240</td>
</tr>
<tr>
<td>19.</td>
<td>100</td>
<td>270</td>
<td>270</td>
</tr>
<tr>
<td>20.</td>
<td>110</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>21.</td>
<td>120</td>
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<td>330</td>
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<td>22.</td>
<td>130</td>
<td>360</td>
<td>360</td>
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<td>23.</td>
<td>140</td>
<td>390</td>
<td>390</td>
</tr>
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<td>24.</td>
<td>150</td>
<td>420</td>
<td>420</td>
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<td>25.</td>
<td>160</td>
<td>450</td>
<td>450</td>
</tr>
<tr>
<td>26.</td>
<td>170</td>
<td>480</td>
<td>480</td>
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<td>180</td>
<td>510</td>
<td>510</td>
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<td>540</td>
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<td>570</td>
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<tr>
<td>30.</td>
<td>210</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>31.</td>
<td>220</td>
<td>630</td>
<td>630</td>
</tr>
<tr>
<td>32.</td>
<td>230</td>
<td>660</td>
<td>660</td>
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<tr>
<td>33.</td>
<td>240</td>
<td>690</td>
<td>690</td>
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<tr>
<td>34.</td>
<td>250</td>
<td>720</td>
<td>720</td>
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<tr>
<td>35.</td>
<td>260</td>
<td>750</td>
<td>750</td>
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<tr>
<td>36.</td>
<td>270</td>
<td>780</td>
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<td>37.</td>
<td>280</td>
<td>810</td>
<td>810</td>
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<tr>
<td>38.</td>
<td>290</td>
<td>840</td>
<td>840</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Cir. 127]
The measurements for volume of entire stem are complete enough for accurate stem volumes for the Black Hills and for California. The Arizona data contained measurements on the merchantable part of the tree only; hence there is no table of stem volume for Arizona. The Black Hills table will apply, with possibly a small deduction.

The volumes for the Black Hills (Table 17) were made up from measurements at 4-foot points for the smaller diameters and 10-foot points for the larger. The California analyses had 10-foot tapers. Table 18 was constructed entirely from the best part of the California data and its basis is considerably less than the corresponding board-foot table. The tops of the trees were figured as cones. In the California data the taper was not carried as far into the top (except for the 13, 14, and 15 inch trees) as in the Black Hills; hence the part figured as a cone was longer and a larger error was introduced in the volume. However, this would not materially reduce the differences between the two tables. For the 13, 14, and 15 inch diameters the tapers were carried to equal points, and though the California

[Cir. 127]
trees are much younger the differences between the volumes in the two regions is very marked.

### Table 17. Volume of the entire stem, Black Hills, South Dakota.

<table>
<thead>
<tr>
<th>Diameter breast-high</th>
<th>Height of tree, feet</th>
<th>Basis.</th>
<th>Trees.</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.</td>
<td>40.</td>
<td>50.</td>
<td>60.</td>
</tr>
<tr>
<td>8.</td>
<td>5.7</td>
<td>5.4</td>
<td>5.9</td>
</tr>
<tr>
<td>9.</td>
<td>6.6</td>
<td>8.8</td>
<td>11.5</td>
</tr>
<tr>
<td>10.</td>
<td>7.8</td>
<td>11.3</td>
<td>14.3</td>
</tr>
<tr>
<td>11.</td>
<td>9.3</td>
<td>13.6</td>
<td>17.4</td>
</tr>
<tr>
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<td>11.4</td>
<td>15.6</td>
<td>21.1</td>
</tr>
<tr>
<td>13.</td>
<td>13.6</td>
<td>18.6</td>
<td>25.0</td>
</tr>
<tr>
<td>14.</td>
<td>15.8</td>
<td>20.8</td>
<td>25.0</td>
</tr>
<tr>
<td>15.</td>
<td>18.0</td>
<td>23.0</td>
<td>25.0</td>
</tr>
<tr>
<td>16.</td>
<td>20.2</td>
<td>25.0</td>
<td>25.0</td>
</tr>
<tr>
<td>17.</td>
<td>22.4</td>
<td>27.0</td>
<td>25.0</td>
</tr>
<tr>
<td>18.</td>
<td>24.6</td>
<td>29.0</td>
<td>25.0</td>
</tr>
<tr>
<td>19.</td>
<td>26.8</td>
<td>31.0</td>
<td>25.0</td>
</tr>
<tr>
<td>20.</td>
<td>29.0</td>
<td>33.0</td>
<td>25.0</td>
</tr>
<tr>
<td>21.</td>
<td>31.2</td>
<td>35.0</td>
<td>25.0</td>
</tr>
<tr>
<td>22.</td>
<td>33.4</td>
<td>37.0</td>
<td>25.0</td>
</tr>
<tr>
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<td>35.6</td>
<td>39.0</td>
<td>25.0</td>
</tr>
<tr>
<td>24.</td>
<td>37.8</td>
<td>41.0</td>
<td>25.0</td>
</tr>
<tr>
<td>25.</td>
<td>40.0</td>
<td>43.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Total</td>
<td>1,004</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** — The small number of trees and the long sections cut cause the form factor to vary irregularly, though within rather narrow limits (0.45 to 0.57), but the average, 0.53, when applied to a stand of varying diameters, will be within a maximum error of 5 per cent.

### Table 18. Volume of the entire stem, Butte and Madera counties, California.

<table>
<thead>
<tr>
<th>Diameter breast-high</th>
<th>Height of tree, feet</th>
<th>Basis.</th>
<th>Trees.</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.</td>
<td>60.</td>
<td>70.</td>
<td>80.</td>
</tr>
<tr>
<td>12.</td>
<td>16</td>
<td>19</td>
<td>23</td>
</tr>
<tr>
<td>13</td>
<td>19</td>
<td>23</td>
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<td>38</td>
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<td>51</td>
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<td>21</td>
<td>43</td>
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<td>57</td>
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<tr>
<td>25</td>
<td>55</td>
<td>63</td>
<td>70</td>
</tr>
<tr>
<td>Total</td>
<td>710</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** — The form factor varies from 0.38 to 0.45. The average, 0.42, will give very good results when applied to a stand composed of a number of diameter classes in the yellow pine-sugar pine belt.

[Cir. 127]
Western yellow pine is generally thick-barked, though the thickness varies with individual trees. Accurate computations on 189 trees in the Black Hills and 94 trees in California show very consistent results in the volume of bark. As in all trees, the percentage of bark in relation to the total stem volume decreases as the volume of the tree increases, or, in other words, the increase in the bark volume does not keep pace with the increase in stem volume. This difference in ratio is less marked in thin-barked species.\(^a\)

In relation to diameter, the percentage of bark for the Black Hills is much less than for California, partly due to the larger volume of the Black Hills trees. However, in the cubic feet of bark for the same diameter and height in both regions the difference is less marked.

Table 19.—Amount of bark of western yellow pine in per cent of total stem volume.

<table>
<thead>
<tr>
<th>Diameter breast-high.</th>
<th>Volume of bark.</th>
<th>Black Hills</th>
<th>California</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inches</strong></td>
<td><strong>Per cent.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>16</td>
<td></td>
<td></td>
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<tr>
<td>12</td>
<td>16</td>
<td>24</td>
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<td>14</td>
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<td>26</td>
<td>12</td>
<td>16</td>
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<td>28</td>
<td>12</td>
<td>15</td>
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<tr>
<td>30</td>
<td>12</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>12</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>40-44</td>
<td>12</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

The portion necessarily deducted from Tables 17 and 18 for unmerchantable material in top and stump will vary with the height of stump and with the diameter to which the top is utilized as well as with the size of the tree. The proportion of material that is lost is larger in small than in mature trees. For cordwood calculations the limb wood more than offsets the loss in top and stump. For saw-timber calculations cubic measure is seldom used. The unmerchantable part, allowing from 1-foot to 18-inch stumps and 8 to 10 inch tops, would vary from about 25 per cent in 12-inch trees to 15 per cent in 18-inch trees and 10 per cent in 24-inch trees for the Black Hills. For California it would be a little higher because of the longer tops. The amount to be deducted should be determined on the ground where the stump height and the closeness of utilization are known.

In case a deduction for both bark and “top and stump” is desired the top and stump should first be deducted and from the remainder a

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\(^a\) See Circular 126, Forest Tables, Lodgepole Pine.
second deduction made for the bark, because the inclusion of the two percentages in one deduction would be making a double deduction for the bark on the top and stump. This point becomes important, however, only in the smaller trees where the percentages of waste are high. For instance, for a 12-inch tree a bark deduction of 24 per cent and a top and stump deduction of 25 per cent added by the wrong method would give a total deduction of 49 per cent, whereas by first deducting 25 per cent for top and stump and then deducting 24 per cent of the remaining 75 per cent for bark, the bark deduction would be 18 per cent of the total volume and the total deduction only 43 per cent.

FORM.

Tables 20 and 21 give taper figures for the Black Hills; Table 22 gives these for California. Table 21 shows diameters outside the bark. A comparison of Tables 20 and 22 shows why the volumes in the two regions are so radically different. All heights are combined and the figures represent the characteristic developments of the two regions.

Table 20.—Taper, Black Hills National Forest, South Dakota.

[Diameter inside bark.]

<table>
<thead>
<tr>
<th>Diameter breast high</th>
<th>Height, feet—</th>
<th>Total height</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>8... 9... 10... 11... 12... 13... 14... 15... 16... 17... 18... 19... 20... 21... 22... 23... 24... 25... Total...</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Cfr. 127]
Table 21.—Taper, Black Hills National Forest, South Dakota.

[Diameter outside bark.]

<table>
<thead>
<tr>
<th>Diameter breast-high, inches.</th>
<th>Height, feet—</th>
<th>Total height.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.</td>
<td>10.</td>
</tr>
<tr>
<td>Inches</td>
<td>Feet</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
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<td>10</td>
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<td>25</td>
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<tr>
<td>Total</td>
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</tbody>
</table>

Table 22.—Taper, Butte County, Cal.

[Diameter inside bark.]

<table>
<thead>
<tr>
<th>Diameter breast-high, inches.</th>
<th>Height, feet—</th>
<th>Average height.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.</td>
<td>4.5.</td>
</tr>
<tr>
<td>Inches</td>
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<td>10</td>
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<td>Total</td>
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</table>

Approved: JAMES WILSON, Secretary of Agriculture.

WASHINGTON, D. C., October 18, 1907.

[Cir. 127]