Price Trends in Forest Products and Stumpage

A Case Study in Sweden

By Thorsten Streyffert
Price Trends in Forest Products and Stumpage

A Case Study in Sweden

By Thorsten Streyffert
Rector emeritus
The Royal School of Forestry
Stockholm, Sweden
Preface

Present forest industry and public discussion of prices of public timber in the western United States, an area which probably will become more intense and more politically oriented during the next few years, makes this Swedish case study an especially appropriate opportunity for an intimate view of the development of standing timber values since the beginning of the century in a part of the world long familiar with intensive sustained yield forest management. The Swedish mature forest economy contrasts with the adolescent forest economy of western United States.

This opportunity results from Thorsten Streyffert’s recent visiting professorship at Oregon State University’s School of Forestry at Corvallis, from the publication of his lectures on *Forestry in Sweden* by the School of Forestry, and from the recent publication of his 180-page book entitled *Price Trends of Stumpage and Forest Products in Sweden*.

My years of friendship with Thorsten Streyffert have resulted in respect and admiration for him personally and for his work in the field of forest economics, especially in Sweden and western Europe, although worldwide as well. Streyffert was for years rector (dean) of the Royal School of Forestry in Stockholm, of which he is a graduate. He has received honorary degrees from other universities in Sweden and Germany, is internationally known as a top man in the field of forest economics, and has served with the Food and Agriculture Organization of the United Nations as forest economist. He is, of course, especially well informed in this field in Scandinavia and western Europe, and he also is well acquainted with conditions in most of the world through his travels in North America, the Soviet Union, India, Japan, and China. He is the author of several books and many articles in his field. In his most recent book covering standing timber and forest products values in Sweden since the beginning of the century, he places this subject under a microscope for all of us to see, and analyzes the phases and trends in this field. He accepted an invitation to review the principal features of the book, which are presented here in English by the School of Forestry of Oregon State University in Corvallis.

At Streyffert’s suggestion, the writer contrasts briefly similar developments in Sweden and western United States for the same
period. This contrast, it is hoped, will give a better understanding of both Swedish and American developments of stumpage prices over the past half century, and will help in visualizing probable future developments.

At the beginning of this century Sweden already had long managed its forests for raw material for the country's own use and for export to other parts of western Europe. At that time the forests of western United States practically were in a virgin condition, with only slight and unmanaged use to produce for the local needs of a population much smaller than now. The United States markets were so well supplied from relatively low-cost timber and lumber from the Lake States and the South that forest products of the West could not compete. The Panama Canal came into use in 1914. At that time in the West only trees most accessible to markets had value for immediate conversion into lumber and other products. Such accessible trees made up a small percentage of the total volume of western timber. During the first decade of the century standing timber values for investment increased rapidly, multiplying several times. This increase did not come from need for early cutting but from the then widely held belief that rapid cutting and burning of American forests would soon lead to timber shortage with high timber value. By the end of that first decade in the West most of the privately owned timber had greater investment value than was justified by subsequent events; little western timber had value due to relative accessibility for early conversion into forest products. In other words, at that time most such western timber had a substantial "wholesale" value, but had no "retail" value for immediate cutting. Sweden already had a mature forest economy while that in western United States was not yet in knee pants. Streyffert in his publication deals primarily with what may be called the "retail" value of standing timber.

In the past half century have come tremendous economic changes in this field caused by the greatly reduced ability of the Lake States and the South to provide national markets with an adequate supply of forest products. Western timber has taken over a great share of the national market. Increased use of western forests has occurred, as well as depletion of much privately owned timber. As long as the supply of private timber exceeded the market demand for forest products, such timber was cut mainly to escape carrying charges rather than to meet market demand. This practice caused flooding of markets both at home and abroad, and affected standing timber values not only in the United States but in some foreign countries as well. Western timber values remained relatively low, and demand was small for the cutting of public timber. This situation continued until about
the end of the second World War. Then came strongly increased
demand for forest products, calling for considerably increased pro-
duction. Now, however, the amount of timber available for annual
cutting was not greater than required by market demand.

By 1946 practically all public timber and a substantial part of
private timber had been placed on a sustained yield management
basis. The allowable annual cut for timber so managed, plus other
private timber available for annual cutting, was insufficient to supply
market demand for forest products. The condition resulted in the
great increase in both “retail” and “wholesale” timber values that
has since taken place.

Increased demand has hastened road development in public
forests to make possible the realization of the “allowable cut.” In-
creases in value have permitted and encouraged the use of previously
valueless material and tree species and the expansion of operation
into areas not previously economically accessible.

During the past decade relatively rapid cutting of private timber
not on a sustained yield basis has taken place, with a progressive
decline in the annual cut of such timber. The declining annual cut
of private timber has been partly, but not entirely, offset by
increased annual cut of public timber. In some areas, even where
much public timber is available, the declining volume of timber
available for annual cutting is increasing the difficulty in supplying
the existing mill capacity. In such areas competitive bidding for
public timber offered for sale has been strong, but moderated some-
what recently by increases in the allowable cut of such timber.

In Sweden, so it seems, the industry productive capacity has
been developed over the period under consideration with careful
regard for the volume of timber annually available from both public
and private forests under sustained yield management. This has
tended to prevent the high prices that have developed in some parts
of western United States because of extra hunger of plant capacity
excessive in relation to timber supply. Furthermore, in Sweden
relatively slow plant capacity expansion apparently has been met in
part by using species not previously used as well as trees of smaller
diameter.

Streyffert’s excellent statement of Swedish experience gives food
for thought as to what lies ahead in western United States as its
forest economy matures.

David T. Mason,
Chairman, South Santiam Educational
and Research Project Committee
# Contents

Introduction ................................................................. 7
The Swedish Study .......................................................... 8
  Prices of Forest Products ................................................. 9
  Table 1. ........................................................................ 9
  Figure 1. ....................................................................... 10
  Figure 2. ....................................................................... 11
  Roundwood Prices ............................................................. 12
  Table 2. ....................................................................... 14
  Figure 3. ....................................................................... 15
  Table 3. ....................................................................... 16
  Stumpage Values ............................................................... 16
  Figure 4. ....................................................................... 17
  Table 4. ....................................................................... 18
  Figure 5. ....................................................................... 19
  The Effect of Declining Volume Per Tree on Stumpage Values .... 20
  Stumpage Values in Central Sweden .................................... 21
  Delivery Price, Logging Cost, and Stumpage Value of Sawlogs and Pulpwood .................................. 22
  Wages for Woods Labor ....................................................... 23
  Table 5. ....................................................................... 24
  Table 6. ....................................................................... 24
  Past and Present Rationalization in Logging as a Means to Balance Rising Wages .................. 25
  Prospects for Future Stumpage Values in the Light of Rising Wages ........................................ 26
  Future Price of Forest Products ............................................ 28
  Future Supply of and Demand for Forest Products .................. 31
  Table 7. ....................................................................... 34
  Conclusions ..................................................................... 37
Introduction

In all countries where forests have been exploited for some time it is a common experience that the price of timber and of stumpage constantly increases. Thus it is only natural to presume that this trend should continue into the foreseeable future. However, at closer examination this turns out to be more complicated than apparent at first glance.

The question of the future trend of timber and of stumpage evidently has an important bearing on decisions regarding investments in forest property. As forestry passes from exploitation to sustained yield in a country, the question of the future trend of the price of forest products and of stumpage also will be of growing importance in allotting investments for maintaining a sustained yield. The latter has been especially important in countries where the financial return on such investments is low and thus needs to be motivated or stimulated by the anticipation of rising prices of forest products and stumpage. As a matter of fact, the Pressler theory of soil rent as a criterion for investment in reforestation and other silvicultural measures at an early stage had to adopt the concept of a long-term trend of rising prices for stumpage in order to motivate the lowering of the interest rate in its calculations on investments in reforestation and forest capital (rotation). This was found necessary in order to avoid the obvious clash with the prevailing opinion of what should be considered as good forestry.

Even if it seems natural or probable that trends so far prevailing in regard to prices of forest products and stumpage should continue for some time to come, it should be of interest, and for many parties rather urgent, that a forecast in this field be made. It should be founded on an analysis of factors that have a bearing on the prices of forest products and stumpage, not only on the somewhat primitive method of extrapolating the trends hitherto prevailing.

Such an analysis is best founded on a study made in a special locality or country. The results arrived at as expressed in numerical data will be valid only for this locality or country and for the period investigated, as it is true that conditions in this field vary considerably with place and time. On the other hand, there is a universal interplay between the agencies at work in the process that ultimately leads to the fixing of prices for forest products and stumpage as of all other prices. This makes for a certain conformity of the trends that result from such a study. A study of this nature made in Sweden should therefore be of considerable interest also to other countries in a similar position.
The Swedish Study

A study of the type previously described recently was completed for Sweden.1 It was carried as far back as 1909-13 to include conditions prevailing before the first World War. In this way also the great expansion in the pulp and paper industries, with their ensuing effect on the prices of roundwood and stumpage, was included. To carry the investigation further back was not considered of any great interest, as it is commonly known that no appreciable stumpage value was realized in Sweden as long as a hundred years ago.

The price of stumpage or the stumpage value arrived at from fellings in a forest ultimately are dependent upon the price of forest products in the market, and upon the costs of felling, transporting, and processing, and for bringing the products to market. In Sweden forest products principally are softwood lumber, pulp, paper, and fiberboard. Prices in the world market for forest products do not affect prices for Swedish forest products as much as prices in the British market. This latter is the most important single factor in the world’s import market for lumber, pulp, and paper.

The costs of felling, transporting, and processing vary greatly. Especially the cost of processing in representative undertakings is rather difficult to follow up for any length of time. However, roundwood prices represent a more uniform series that can be statistically traced at least as far back as 1909-13. So also can wages paid in the forests and in the forest industries be statistically traced. Because they are the principal cost factor and because of their rising trend, wages are of special interest.

Prices of Forest Products

The prices of forest products imported into the United Kingdom—softwood lumber, sulphite pulp, and newsprint—from 1901 to 1961 have been computed from the British Trade Statistics in Table 1. A better picture of the price trends in the past is shown in the graph in Figure 1, which has been brought back as far as 1880. It is also important to study the price trends after conversion with the wholesale price index, which is done in the corresponding graph in Figure 2.

The heavy price movements caused by the two World Wars and the Korean War dominate these graphs. Also they show that the return to prewar prices was better realized after the first World War than after the second. This implies that prices for forest products,

TABLE 1. PRICES OF SAWN SOFTWOOD, CHEMICAL WOODPULP, AND NEWSPRINT IMPORTED INTO THE UNITED KINGDOM 1901-1961, IN POUNDS AND SHILLINGS PER STANDARD OR TON.

<table>
<thead>
<tr>
<th>Year</th>
<th>Sawn softwood¹</th>
<th>Chemical woodpulp²</th>
<th>Newsprint</th>
<th>Wholesale price index³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pounds per standard⁴</td>
<td>pounds per ton⁵</td>
<td>pounds per ton⁵</td>
<td>1901-05=100</td>
</tr>
<tr>
<td>1901-05</td>
<td>8/11</td>
<td>8/5</td>
<td>12/10</td>
<td>100</td>
</tr>
<tr>
<td>1913</td>
<td>10/9</td>
<td>8/2</td>
<td>11/4</td>
<td>120</td>
</tr>
<tr>
<td>1920</td>
<td>39/7</td>
<td>38/4</td>
<td>50/7</td>
<td>373</td>
</tr>
<tr>
<td>1930</td>
<td>14/9</td>
<td>11/7</td>
<td>13/16</td>
<td>146</td>
</tr>
<tr>
<td>1940</td>
<td>25/17</td>
<td>18/15</td>
<td>19/11</td>
<td>200</td>
</tr>
<tr>
<td>1950</td>
<td>54/13</td>
<td>35/19</td>
<td>34/13</td>
<td>383</td>
</tr>
<tr>
<td>1955</td>
<td>83/6</td>
<td>49/13</td>
<td>52/16</td>
<td>496</td>
</tr>
<tr>
<td>1956</td>
<td>84/12</td>
<td>51/13</td>
<td>54/17</td>
<td>517</td>
</tr>
<tr>
<td>1957</td>
<td>82/13</td>
<td>50/18</td>
<td>56/2</td>
<td>507</td>
</tr>
<tr>
<td>1958</td>
<td>75/4</td>
<td>47/2</td>
<td>56/16</td>
<td>478</td>
</tr>
<tr>
<td>1959</td>
<td>69/11</td>
<td>45/13</td>
<td>55/13</td>
<td>483</td>
</tr>
<tr>
<td>1960</td>
<td>76/3</td>
<td>46/5</td>
<td>55/10</td>
<td>481</td>
</tr>
<tr>
<td>1961</td>
<td>78/19</td>
<td>48/4</td>
<td>55/3</td>
<td>478</td>
</tr>
</tbody>
</table>

Annual Statement of the Board of Trade of the United Kingdom.
¹ Coniferous wood, sawn (and planed)
² From 1935 only sulphite woodpulp (unbleached)
³ Converted from Sauerbeck and Statist 1901-1919, from Board of Trade 1920-1961.
⁴ One standard = 1980 Board feet
⁵ Long ton
FIGURE 1. Import prices for sawn softwood, woodpulp, and newsprint in Great Britain compared with wholesale price index for all commodities 1880-1960. 1901-05 = 100.
FIGURE 2. Import prices for sawn softwood, woodpulp, and newsprint in Great Britain after conversion with wholesale price index for all commodities 1880-1960. 1901-05 = 100
at least in the British market, have reached a new level after the second World War, whether stable or not.

As for the different forest products, certain characteristic features can be discerned from Figure 2, not counting the short fluctuations. Thus the price of softwood lumber had a slowly rising trend from 1880 to 1900 and then remained on the same level—not counting the first World War—up to the second World War. This long-term trend differs decidedly from the trend for sulphite pulp and newsprint that displayed a consistently downward trend. Following the second World War the price of softwood lumber has remained on a much higher level than sulphite pulp and newsprint.

It would go too far afield to try and explain these price movements from the market conditions at different times. Moreover, this is a thing of the past.

Swedish prices for roundwood and stumpage have developed within the framework set by the British import prices, which they follow rather closely.

**Roundwood Prices**

The prices of sawlogs and pulpwood can be followed with reasonable accuracy from the time before the first World War, as price data for Sweden have been collected and registered by the Forest Service at a number of localities in the country since the beginning of this century. While data for early years are somewhat uncertain, market prices gradually have been easier to determine. After the second World War prices generally have been the outcome of negotiations between the forest industries and the forest owners’ associations.

In northern Sweden the logs usually are floated to the mills at the river mouths, and thus log prices are quoted at river mouth, although the logs actually are delivered at river bank and paid for at a price reduced with the calculated cost of floating and sorting.

In southern Sweden there is no floating. Logs generally are delivered at truck road, to some extent at railway stations, and at the banks of the great lakes. Prices are quoted accordingly and by negotiation are determined uniformly for great districts without consideration of location in regard to the mills, which are located both on the coast and in the interior. Even for the whole of southern Sweden variations are rather small.

Most of the fellings from farm forests, comprising 50% of the total forest area, are disposed of in this way, while the rest is sold on the stump, often by auction arranged by the forest owners' associa-
tions. Also part of the fellings from state forests, comprising 18% of the total forest area, is sold to the forest industries as roundwood, cut and delivered by the Forest Service. The greater part, however, now is delivered to government-owned forest industries, formally organized as independent lumber and pulp companies, or sold on the stump, preferably by auction.

In Table 2 the prices for pine sawlogs have been computed for an important river in northern Sweden, the Angermanälven River, and for two localities in southern Sweden, Finnerödja (truck road) and Vänern (lake), and also may be studied from the graph in Figure 3. It can be seen from the index series that a substantial rise in price has taken place since 1913, even after conversion with the wholesale price index. Prices have risen more for small sizes than for the larger, both relatively and absolutely, although from the diminishing supply of large timber the opposite would be expected. The substitution of other construction materials for lumber, however, has affected the larger sizes more than the smaller.

This rise of sawlog prices should be compared with the corresponding development for lumber prices. No close correspondence can be established between the price trends of sawlogs and lumber, but the price series for lumber and sawlogs of pine, presented in Table 2, clearly indicate certain changes in the relationship. Thus it is obvious that the price of sawlogs has risen considerably more than the price of lumber between 1909-13 and 1935-38, but in comparison with the level thus attained present sawlog prices do not show the same gain in regard to lumber prices. Taking the period 1909-13 to 1960 as a whole, lumber prices have risen about seven times, while sawlog prices have risen between seven and eleven times.

Pulpwood prices have developed similarly, as may be seen from data presented in Table 3 and from the graph in Figure 4. The rise in price of wood pulp from 1909-13 to 1960 was four and a half times compared to nine times for the price of pulpwood. In the same period the wholesale price index increased four times.

That roundwood prices generally have developed more favorably than prices of lumber and wood pulp probably can be explained mainly by the fact that the processing industry has, by means of rationalization—this word taken in its widest sense—been able to pay these higher prices, which are, of course, ultimately determined by supply and demand of roundwood. Also, in the case of pulp and paper industries, these have been able to raise their profitability through a greater degree of integration and the production of new qualities of pulp and paper, as well as through larger plant capacities. Because of this it has been possible to pay a higher price for the
raw material, although the reduction in labor per manufactured unit has not in itself been enough to compensate for the accompanying rise in wages.

**TABLE 2. PRICES FOR SAWLOGS OF PINE IN NORTHERN SWEDEN (ÅNGERMANÄLVEN RIVER) AND IN SOUTHERN SWEDEN (LAKE VÄNERN, FINNERÖDJA) COMPARED WITH THE EXPORT PRICE OF LUMBER.**

<table>
<thead>
<tr>
<th>Year</th>
<th>$ per MBd ft.</th>
<th>Sawlogs of pine</th>
<th>Wholesale price index 1960=100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lumber (pine and spruce)</td>
<td>Angermanälv River</td>
<td>Lake Vänern</td>
</tr>
<tr>
<td></td>
<td>Cents per cubic foot (cylinder measure)</td>
<td></td>
<td>6&quot;</td>
</tr>
<tr>
<td>1909-13</td>
<td>14.30</td>
<td>4.3</td>
<td>5.9</td>
</tr>
<tr>
<td>1935-38</td>
<td>21.00</td>
<td>9.0</td>
<td>11.2</td>
</tr>
<tr>
<td>1955</td>
<td>103.50</td>
<td>56</td>
<td>62</td>
</tr>
<tr>
<td>1956</td>
<td>99.40</td>
<td>44</td>
<td>52</td>
</tr>
<tr>
<td>1957</td>
<td>99.00</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>1958</td>
<td>97.90</td>
<td>36</td>
<td>46</td>
</tr>
<tr>
<td>1959</td>
<td>86.70</td>
<td>44</td>
<td>50</td>
</tr>
<tr>
<td>1960</td>
<td>97.20</td>
<td>50</td>
<td>56</td>
</tr>
</tbody>
</table>

The prices in Swedish currency in this and following tables have been converted to U. S. currency at the present rate of one U. S. dollar = 5.25 Swedish Crowns, although the rate of exchange has changed during the period under consideration. Thus the rate of exchange was 3.73 until about 1949. This difference in exchange has not affected the Swedish prices of wood and wood products which are primarily dependent upon the British market, where the rate of exchange has taken another course. By using the same conversion factor through the whole period the real trend of the Swedish prices will be better represented than would be the case if the conversion factor were changed in accordance with the official rate of exchange.
FIGURE 3. Prices for sawlogs of pine at the mouth of the Angermanalven River. Cents per cubic foot cylinder measure.
TABLE 3. PRICES FOR PULPWOOD OF SPUCE IN NORTHERN SWEDEN (ÅNGERMANÄLVEN RIVER) AND IN SOUTHERN SWEDEN (LAKE VÄNERN, FINNERÖDJÄ), COMPARED WITH THE EXPORT PRICE OF UNBLEached SULPHITE PULP.

<table>
<thead>
<tr>
<th>Year</th>
<th>Unbleached sulphite pulp</th>
<th>Pulpwood of spruce (peeled)</th>
<th>Wholesale price index 1960=100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ per short ton</td>
<td>$ per cord</td>
<td></td>
</tr>
<tr>
<td>1909-13</td>
<td>21.50</td>
<td>2.80 $</td>
<td>3.40 $</td>
</tr>
<tr>
<td>1935-38</td>
<td>26.00</td>
<td>5.90 $</td>
<td>5.40 $</td>
</tr>
<tr>
<td>1955</td>
<td>110.50</td>
<td>28.20 $</td>
<td>28.00 $</td>
</tr>
<tr>
<td>1956</td>
<td>113.30</td>
<td>25.80 $</td>
<td>25.30 $</td>
</tr>
<tr>
<td>1957</td>
<td>108.40</td>
<td>23.00 $</td>
<td>23.00 $</td>
</tr>
<tr>
<td>1958</td>
<td>101.20</td>
<td>20.80 $</td>
<td>20.00 $</td>
</tr>
<tr>
<td>1959</td>
<td>93.90</td>
<td>22.40 $</td>
<td>22.70 $</td>
</tr>
<tr>
<td>1960</td>
<td>98.10</td>
<td>25.30 $</td>
<td>27.40 $</td>
</tr>
</tbody>
</table>

Index 1935-38=100

<table>
<thead>
<tr>
<th>Year</th>
<th>Unbleached sulphite pulp</th>
<th>Pulpwood of spruce (peeled)</th>
<th>Wholesale price index 1960=100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1935-38</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1955</td>
<td>426</td>
<td>475</td>
<td>487</td>
</tr>
<tr>
<td>1956</td>
<td>437</td>
<td>434</td>
<td>457</td>
</tr>
<tr>
<td>1957</td>
<td>418</td>
<td>387</td>
<td>398</td>
</tr>
<tr>
<td>1958</td>
<td>390</td>
<td>350</td>
<td>361</td>
</tr>
<tr>
<td>1959</td>
<td>361</td>
<td>377</td>
<td>388</td>
</tr>
<tr>
<td>1960</td>
<td>377</td>
<td>426</td>
<td>468</td>
</tr>
</tbody>
</table>

Stumpage Values

Stumpage prices actually paid can be studied best from the sale of stumpage from government forests. Most of the sale of stumpage is made by auction. These auctions serve rather as an indication of the trend of the timber market for the country as a whole. The greater part of the government forests is located in the northernmost part of Sweden, but stumpage is put on auction in all districts of the country. The following series of stumpage prices also include sales of stumpage not made by auction from the government forests. Stumpage sales totalled 92 million cubic feet as an average for 1909-13, corresponding to 81% of the total cut in the government forests, but since have declined to 60 million cubic feet in 1960, corresponding to 23% of the total cut in the same forests, and the more valuable part of the total cut.
FIGURE 4. Prices for pulpwood of spruce (peeled) at the mouth of the Angermanalven River. Dollars per cord.
Because of the great extension of Sweden from north to south—close to one thousand miles—and the ensuing difference in stumpage values, the price series in Table 4 have been computed for four different regions of the country (see map, Figure 5). When these prices are converted with the wholesale price index, the apparently great rise in actual prices is reduced considerably.

However, even the stumpage prices thus reduced do not represent the real trend of stumpage prices, as they are strongly influenced by the decrease in the average size of the trees cut during the period. This has been the case especially in the two northernmost regions.

### TABLE 4. STUMPAGE PRICES IN STATE FORESTS IN DIFFERENT PARTS OF SWEDEN.¹

<table>
<thead>
<tr>
<th>Year</th>
<th>Region I</th>
<th>Region II</th>
<th>Region III</th>
<th>Region IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1909-13</td>
<td>1.6</td>
<td>2.4</td>
<td>2.2</td>
<td>3.5</td>
</tr>
<tr>
<td>1935-38</td>
<td>2.1</td>
<td>2.8</td>
<td>3.2</td>
<td>4.3</td>
</tr>
<tr>
<td>1955</td>
<td>14.4</td>
<td>17.1</td>
<td>21.8</td>
<td>27.1</td>
</tr>
<tr>
<td>1956</td>
<td>9.2</td>
<td>11.8</td>
<td>16.6</td>
<td>22.1</td>
</tr>
<tr>
<td>1957</td>
<td>9.9</td>
<td>12.3</td>
<td>17.9</td>
<td>24.0</td>
</tr>
<tr>
<td>1958</td>
<td>8.3</td>
<td>8.7</td>
<td>13.8</td>
<td>19.6</td>
</tr>
<tr>
<td>1959</td>
<td>9.7</td>
<td>11.7</td>
<td>16.6</td>
<td>23.4</td>
</tr>
<tr>
<td>1960</td>
<td>12.5</td>
<td>13.1</td>
<td>17.9</td>
<td>25.6</td>
</tr>
<tr>
<td>1960²</td>
<td>8.8</td>
<td>9.5</td>
<td>12.7</td>
<td>18.0</td>
</tr>
</tbody>
</table>

¹ For regions see map fig. 5. Only auction sales.
² Calculated stumpage value of the total cut.
The import of this may be understood when it is learned that the average volume of the trees sold on a stumpage rate in the northernmost region has declined from 18 cubic feet in 1911 to 5 cubic feet in 1960. To put this in another way, the average diameter at breast height has declined from about 12 inches in 1911 to about 7 inches in 1960.

It should be observed further that fellings gradually have been extended into more distant forest tracts, with increasing difficulties for logging. On the other hand, these increased logging difficulties have been more or less balanced by an improved transportation system, especially by an extended network of truck roads into forests and by improved floating ways (river driving).

The Effect of Declining Volume Per Tree on Stumpage Values

The question of decline in average volume of the trees sold at auction could be dealt with reasonably if the distribution between diameter classes in the fellings were known. As all the trees to be sold are marked and recorded in diameter classes this could be collated from the records. Such a collocation was made and published earlier for the period 1911-28 for a Forest Service district in northernmost Sweden drained by the Skellefte River. For later years this was supplemented until 1957 from Forest Service records. With some knowledge of the prices of sawlogs and pulpwood and the logging and floating costs for average conditions it has been possible to calculate what the stumpage prices would have been if the timber sold at auction had had the same distribution between diameter classes during the whole period as at the beginning of the period (1911). All prices have been converted with the wholesale price index.

In this way it has been calculated that stumpage prices in this region have increased on an average 3.2% a year (compound interest). It has further been calculated that the stumpage value of a 12-inch tree has increased by 2.2%. Hence the smaller trees have increased their stumpage value correspondingly more as a result of the growing demand from the wood pulp industry. It was also discovered that the rise in stumpage prices corresponded to 1.1% per year between 1911 and 1939 and to 6.5% between 1939 and 1957.

The price trend thus calculated applies only to the conditions in question. It may be assumed that localities with a still lower initial rate of stumpage will show a higher percentage of price growth and
that, correspondingly, the southern parts of the country with higher stumpage values will show a lower rate of price growth for stumpage.

Another point to observe is that the price trend thus calculated does not take into account the growth in value from a whole forest because of the increasing possibility of marketing small trees that in the beginning of the period could not be sold at all. This could be calculated by evaluating the yearly cut by sustained yield from a model forest with an even distribution of age classes. Such a model can be composed by means of a yield table recording thinnings and final cuttings distributed by diameter classes. This has been done, using the yield tables prepared by the Forest Research Institute. An average pine site for northern Sweden has been chosen for this purpose, corresponding to a maximum yield of 48 cubic feet per acre per year. The rise in stumpage value of this yield between 1911 and 1957 was calculated at 4.4% (compound interest) at a rotation of 108 years. It should be remembered that part of this yield could not be marketed in the beginning of this period. Even at the end of the period a small percentage of the early thinnings could not be marketed. As a consequence, for a longer rotation yielding fewer small trees this percentage would be less, while for a shorter rotation it would be still higher.

**Stumpage Values in Central Sweden**

As already mentioned the rise of stumpage values on a percentage basis evidently should be greater in localities where the initial stumpage was low, such as in the interior of northern Sweden. Hence it should be lower in southern and middle Sweden where stumpage values have been higher than in northern Sweden. For this reason it should be of interest to study the rise of stumpage values in a more southerly part of the country. This should be possible in a forest that since old times has been managed by sustained yield and with the same rotation. Such forests are to be found in Bergslagen, the old mining and iron region in central Sweden, where sustained yield was early introduced in order to secure a steady supply of charcoal and mining timber for the iron industry. Such a forest situated at Malingsbo on the southern border of the province of Dalecarlia was bought by the state in 1899 from a mining company and then used by the Swedish School of Forestry for its field work. This forest and the management practiced on it has been considered **typical for rational forestry on big holdings in central Sweden** and for this reason is of considerable interest. A study of the sustained yield and its stumpage value was made in 1912.
It follows from this study and a comparison with the present yield that the stumpage value per cubic meter from before the first World War until 1958 has increased 81% at a constant price level, corresponding to a yearly increase of 1.3% (compound interest). It confirms that a certain increase has taken place in stumpage value during the period in question although considerably less than in northern Sweden. It can further be learned from the same investigation that the main part of this increase in stumpage value has taken place after the second World War. This fits in with the general rise in the price of forest products at this time. For this reason it can be assumed that the average volume of the trees cut has been approximately the same during the whole period.

It is interesting to note that the calculated cut per hectare in 1912 was almost the same as in 1958. This can be explained by the great demand for charcoal by the iron industry in early times, when charcoal was used exclusively in the Swedish iron and steel industry. Even the smallest trees could be used for this purpose; all the more so, as labor still was cheap.

At this early time, before the first World War, pulpwod could not be marketed from the interior of central Sweden because of low prices and poor transportation. At present practically no charcoal is made. Small logs—below 8 inches in top diameter for spruce and 5 inches down to 3 inches in top diameter for pine—are sold as pulpwod, bigger logs as sawlogs. Wood below 3 inches in top diameter is sold as board wood to the government-owned fiberboard mill at Skinnskatteberg, a few miles from Malingsbo. At this place the government also operates a fairly big sawmill and a mill for prefabricated houses. By rail the distance to the shipping port on the Baltic is about 100 miles and the cost of transportation for lumber is $8.00/standard, or $4.00/M board feet.

**Delivery Price, Logging Cost, and Stumpage Value of Sawlogs and Pulpwood**

The study of stumpage prices could be enlarged further by investigating their dependence on delivery prices and logging costs in typical cases. For this reason two such cases have been selected, one in northern Sweden (Ångermanälven River basin) and one in southern Sweden (Finneködja). In each case, delivery price, logging costs, and the ensuing stumpage value have been analyzed for a pine log 8 inches in top diameter during the period 1909 to 1960. Delivery prices are according to market quotations in the yearly report of the Forest Service. Logging costs are for the period after 1926 accord-
ing to piece rates determined after negotiations between the woods labor unions on one side and the Forest Service and other forest owners on the other side. For earlier years it has been assumed that logging costs followed the trend of daily wages of cutter and teamster, which since 1918 have been recorded officially. For an earlier period a special study of woods labor and wages was made in 1914.

It stands to reason that in calculating logging costs the same conditions in regard to logging site and length of transportation have been assumed for the whole length of the period in question. For northern Sweden a haul (by horse) of 3 km (1.9 miles) has been assumed in addition to the average cost of floating in the Angermanälven River. For southern Sweden the haul is shorter and a distance of 1.5 km (0.9 miles) has been used. No cost of floating has been deducted in this case, as floating seldom is practiced in this part of the country. The cost of truck transportation to the mills is paid by the buyer, i.e., the industries. The price at truck road is determined by negotiation and is almost the same for the whole of southern Sweden, irrespective of distance to a mill, as already mentioned.

In Table 5 delivery prices, cost of logging, and stumpage values have been collocated after conversion to 1960 price level. It can be read from this that the cost of logging and transportation in southern Sweden to truck road, and in northern Sweden to river mouth, has undergone a continuous increase. This implies that without a corresponding rise in delivery prices for roundwood a heavy decline in stumpage values would have occurred. Such a rise has taken place, however, and it has been great enough to allow a rise in stumpage values also. The foregoing does not take into full account the effect of mechanization and other rationalization measures in logging, which especially after the second World War have been rather important, with exception made for the use of power saws, which are owned by the cutters.

Wages for Woods Labor

As already has been shown, wages for woods labor have such an important bearing on stumpage values, and moreover on the whole economy of forestry, that a short account of the development of wages for woods labor in Sweden is justified. The more relevant data are in Table 6, which gives an account of the development of wages for woods labor in northern and southern Sweden since 1913-14, and also compares wages for woods, agricultural, and industrial
TABLE 5. Price, average logging cost, and corresponding stumpage for 8-inch sawlogs of pine in northern Sweden (Angermanälven River) and southern Sweden (Finnerödja). After conversion with wholesale price index. Base year 1960.

<table>
<thead>
<tr>
<th>Year</th>
<th>Angermanälven River</th>
<th>Finnerödja</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cent per cu. ft. (real volume)¹</td>
<td>Cent per cu. ft. (real volume)¹</td>
</tr>
<tr>
<td></td>
<td>Price</td>
<td>Cost</td>
</tr>
<tr>
<td>1909-13</td>
<td>18.6</td>
<td>5.4</td>
</tr>
<tr>
<td>1935-38</td>
<td>27.5</td>
<td>8.0</td>
</tr>
<tr>
<td>1957</td>
<td>41.8</td>
<td>13.4</td>
</tr>
<tr>
<td>1958</td>
<td>37.6</td>
<td>14.2</td>
</tr>
<tr>
<td>1959</td>
<td>41.4</td>
<td>14.4</td>
</tr>
<tr>
<td>1960</td>
<td>44.4</td>
<td>14.4</td>
</tr>
</tbody>
</table>

The costs include cutting and hauling with horse to river bank in northern Sweden and to truck road in southern Sweden and corresponding overhead. The calculated length of haul is 1.9 miles in northern Sweden and 0.9 miles in southern Sweden through the whole period. The cost of floating is included in the cost of logging in northern Sweden.

¹ Without bark.

TABLE 6. Average wages for woods labor (cutters) compared with wages in certain other lines of industry. After conversion with wholesale price index. Base year 1960.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cutter Northern Sweden</th>
<th>Agricultural labor</th>
<th>Sawmill workers¹</th>
<th>Pulpmill workers¹</th>
<th>Average in all industries¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dollars/ day</td>
<td>Dollars/ day</td>
<td>Dollars/ day</td>
<td>Dollars/ hour</td>
<td>Dollars/ hour</td>
</tr>
<tr>
<td>1913</td>
<td>2.70</td>
<td>2.10</td>
<td>1.85</td>
<td>0.32</td>
<td>0.33</td>
</tr>
<tr>
<td>1920</td>
<td>2.20</td>
<td>1.70</td>
<td>1.45</td>
<td>0.31</td>
<td>0.35</td>
</tr>
<tr>
<td>1930</td>
<td>3.70</td>
<td>2.60</td>
<td>2.70</td>
<td>0.62</td>
<td>0.72</td>
</tr>
<tr>
<td>1940</td>
<td>3.75</td>
<td>2.80</td>
<td>2.60</td>
<td>0.51</td>
<td>0.60</td>
</tr>
<tr>
<td>1950</td>
<td>5.75</td>
<td>4.40</td>
<td>4.20</td>
<td>0.66</td>
<td>0.72</td>
</tr>
<tr>
<td>1960</td>
<td>9.50</td>
<td>8.00</td>
<td>6.10</td>
<td>1.04</td>
<td>1.19</td>
</tr>
</tbody>
</table>

¹ Eight-hour day was introduced in the industries in 1920.
further mechanization, such as barking machines and tractor logging,
by building more truck roads in order to shorten the expensive
hauling, whether by horse or by tractor and, lastly, by concentrating
fellings and silvicultural work in areas big enough to allow an eco-
nomic application of mechanization. Thanks to these additional lines
of rationalization, stumpage values have undergone a better develop-
ment than can be read from the table included.

For the present, dependent upon the degree of mechanization,
By far the greatest item in the cost of logging and transportation in Sweden is the cost of labor. As wages are rising continuously, this complicates the dilemma of the forest owner in Sweden today. The objection may be raised here that wages always have been rising and that this dilemma should not be new. However, things have changed. As explained in the previous section on wages for woods labor, these wages after the second World War have risen to the same level as industrial wages and can be reckoned to follow the same rising trend as these in the future. Industrial wages, or possibly more, must be paid for work in the woods because it is of less desirable nature than work in industry.

The dilemma referred to can be stated briefly thus: that forestry...
cannot in the long run pay the same rising wages as industry if the price of roundwood cannot also be made to rise.

The first reason for this is that forestry does not offer the same opportunities for rationalization as industry. If rationalization mainly is a means to make the best use of technical developments, then it can be stated that insofar as mechanization is concerned forestry cannot carry this nearly as far as industry. While mechanization in industry can be carried even to the point of automation, anybody familiar with conditions in forestry can testify that substitution of manual labor by machines is limited after a certain stage of mechanization. When necessarily, economic considerations are taken into account, the limitations are still more narrow, although varying greatly with circumstances. For example, big and uniform forest tracts offer better opportunities for mechanization than small and scattered woodlots. An industrial undertaking generally offers more diversified opportunities for rationalization than a forest undertaking. In the latter, mechanization of fellings and of transportation and improvement of the transportation system are the principal means of rationalization in the foreseeable future. In this connection it should be mentioned that the extension of the truck road system in the forest tracts for the present represents the most profitable line of rationalization in Swedish forestry.

Increasing the size and capacity of the industrial plant in many industries offers a good opportunity to lower cost of production. In forestry, however, the total area of forest land in a country cannot be increased, and the opportunities to increase the individual holdings, in Sweden at least, are very limited, partly because of legislation. In these circumstances it is all the more important to concentrate scattered woodlots belonging to an owner, whether a company or an individual, into greater holdings, allowing better opportunities for mechanization and for employment of permanent woods labor. A very strong movement is under way in Sweden to reorganize the forest holdings in this way. According to a recent investigation 12 million acres, corresponding to 21% of the total forest area, would need such reorganization.

Still another factor in industry pertaining to technical developments is of deciding influence in improving the financial return and thus facilitating the payment of rising wages. This is the known fact that technical innovations make possible an everlasting flow of improved and further processed products and, above all, quite new products. This is a very important means of raising the general standard of living and thus, also, real wages. Only a limited number of products for consumption manufactured twenty-five years ago are
produced today. However, this way of improving the financial return is lacking in forestry because it always yields the same product—wood—with variations only in species, size, or quality.

However, wood is a raw material processed in the forest industries that should have just about the same opportunities for rationalization and for developing further processes and quite new products as other industries. So, at least within certain limits, it should be possible for forest industries to pay a rising price for roundwood, even without a rise in price for the processed products. To illustrate, in the period from 1913 to the outbreak of the second World War the prices of sawlogs and pulpwood rose despite the fact that the price of lumber was practically the same while the price of wood pulp had declined considering the rise in the general price level (see Tables 2 and 3). The more dynamic price movements after the second World War will not be dealt with here, as it is doubtful whether an equilibrium has yet been reached.

Regarding rationalization it should be reasonable to assume that this will have a greater effect in the pulp and paper industries than in the sawmill industry, in the foreseeable future as in the past.

The pulp and paper industries are of particular interest because of their strongly expanding production and international trade. Yet it may be questioned if rationalization can in the long run produce the same results as in the past, unless entirely new technical achievements revolutionize production, which may very well happen. On the other hand, the long-range possibilities of increasing the end value of the roundwood by processing should be as good as in the past, thereby increasing profitability and the possibility of paying a rising price for the roundwood on this account.

**Future Price of Forest Products**

The price of forest products, as of all other commodities, is dependent on a number of factors which ultimately lead up to the demand and supply in a given market during a certain period. By the agency of the price a sort of fluctuating equilibrium between supply and demand is then brought about at any given time.

The agencies that lead up to actual supply and demand in a given market have not only a short-term aspect but also a long-term phase. Most important in the latter respect is that the cost must be covered by the price, and more especially must the marginal cost be covered by the price.
Thus it was quite natural that in the beginning of this century when the competition from Russia grew in the market for lumber there was a rather common opinion in Sweden that the price for Swedish forest products in the world market would rise in the long run. Exploitation had to be extended to more remote virgin forest regions in Russia and elsewhere, with accompanying rising costs, to meet the world's increasing demand for forest products. In the more optimistic view, an increasing scarcity of wood was anticipated and even a world shortage.

These anticipations have not been fulfilled. In fact, the opposite has been the case, because increasing difficulties in logging and transportation in more remote regions have been balanced by combined effects of technical achievements, not only in logging and transportation, but also in processing and in transportation of processed products to consuming centers. Thus, technical achievements have been the mightiest agency in deciding prices of forest products, as of other commodities, not only by their effect on cost of production but also on demand.

As for the important bearing of technical developments on the cost of production, this varies for different commodities and for different raw materials. This circumstance is, in fact, the most important cause of the different price developments for lumber on the one side and for wood pulp and paper on the other side, as demonstrated in the British market. While the pulp and paper industry has lent itself admirably to far-reaching mechanization and technical and chemical innovations in plants of ever-increasing capacity, the sawmill industry has not had the same possibilities for rationalization. Indeed, after exploitation of virgin forests it has taken the opposite way towards small and middle-sized mills. Moreover, as the supply of suitable raw materials has been sufficient to meet the rapidly increasing demand for paper and other pulp products, the cost of the raw material at the mills has not prevented the declining trend of prices for these products. On the other hand, the sawmill industry has had to pay for its raw material at a minimum price set by another industry, viz., pulp and paper, while a price ceiling has been imposed upon lumber through the use of substitutes.

This explains why in countries where the sawmill industry has to compete with the wood pulp industry for raw material the financial return on investments in the former industry has been rather low and its possibilities to pay high sawlog prices have been limited. Exception from this general rule will, of course, occur where it is difficult to supply a local demand for lumber or where pulpwood prices still are low.
Another important factor governing price is substitution. This has had a very great influence on the price of all commodities, as it tends to check any strong tendencies to a rise in price for individual commodities. Active substitution for forest products has kept back a strong rise in price for lumber that otherwise would have occurred, or restrained the rise in price that has occurred in certain markets in relation to the price for other commodities. In the case of paper and other products of wood pulp, substitution has worked the other way, as pulp products have substituted for other products and materials as lumber and textiles, etc. On the other hand, a certain substitution by plastics has been noticeable lately. Further, it should be observed that wood for paper making can be replaced by other plant fibers. The extent to which this and other forms of substitution will be carried on depends on the suitability and price of competing commodities and production factors. In this respect technical developments have had a deciding influence.

Influence on substitution by the process of technical developments is brought about by a constant change in the utility and the cost of production of commodities and raw materials and, further, by the innovation of quite new commodities, raw materials, and sources of energy.

In considering the future prices of forest products in different markets it should be only natural to presume that the same basic agencies as those already dealt with also will be at work in the future. However, the final result of their interplay may be different. For example, will it be possible for the pulp and paper industry to keep up the cost-reducing rationalization and other measures and thus to resume its prewar trend of declining marginal cost in those regions where these industries are still expanding, and hence make possible a declining trend of pulp and paper prices? And will the forests of the world, together with other raw material resources for pulp and paper, be sufficient to prevent a rise in marginal cost for the raw material with its accompanying effect on the marginal cost of pulp and paper? These are questions that are not easy to answer as too little is known about the future.

To help in providing a basis for judgment, data are given in the next section on our present knowledge of the world's forest resources and our forecasts of future demand for such products.

**Future Supply of and Demand for Forest Products**

According to FAO the removals of wood from the world's forests in 1960 amounted to 1,732 million cubic meters, of which 1,022 million cubic meters were industrial wood. The latter figure
corresponds roughly to the world's consumption of wood for industrially processed products such as lumber, woodpulp and paper, plywood and fiberboard, etc., and also the consumption of non-processed wood such as ties, poles, posts, and wood for distillation.

The main part of these removals of industrial wood and also the corresponding consumption, took place in North America (358 million cubic meters), U.S.S.R. (261 million cubic meters), and Europe (210 million cubic meters). The remaining parts of the world contributed only a total of 173 million cubic meters. This is remarkable as these regions have a total population of 2,115 million as against only 840 million for the aforementioned regions (1960). This often is referred to as an indication of the great potential source of demand that these last mentioned regions represent.

For the future price of forest products, the future demand for such products evidently should be a matter of first importance. Forecasts about the demand for forest products and the corresponding requirements for industrial wood have been made from time to time for different regions and also for the world as a whole. Such forecasts always are deemed to be corrected by the actual course of events. This means only that new and revised forecasts must be made, as it is of prime importance to form as good a concept as possible about the future demand for such an important raw material as wood, that, moreover, will take a lifetime or more to produce.

In the case of single products, such as paper and board, and for a limited period ahead, it will be easier to make a forecast about the future demand. However, the dependence of demand upon the general economic development and the trend of population must not be ignored. What happens remains to be seen, with all the uncertainty which this implies.

In this connection it may be mentioned that FAO recently has made a forecast of world demand for paper and board in 1975, arriving at a total of 140 million tons as against 72 million tons in 1960, or an increase of 4.5% per year. This would require a further 200 million cubic meters of pulpwod or its equivalent, corresponding to an increase of 13 million cubic meters per year. This should be considered against the present consumption of industrial wood given at 1,022 million cubic meters in 1960 as stated above.

It generally is considered that the demand for lumber will increase at a slower rate in the future than in the past. This means that the consumption trend for lumber lags behind the trend of the general economic development, while the consumption trend of paper

---

and board is ahead of this. One reason for this difference is that substitution by other materials is felt more in lumber than in paper and board, where substitution so far mainly has worked the opposite way, i. e., to the advantage of paper and board.

Because of the great uncertainty in making forecasts for world demand for industrial wood it may be of interest to consider past developments in the field. The cut of industrial wood of coniferous species (softwood) for the world as a whole, as an average for the years 1925-27, was calculated by the author at 470 million cubic meters (without bark). From the 1960 cut of industrial wood, in all 1,022 million cubic meters, probably 80% or about 820 million cubic meters, was softwood. This corresponds to an increase of 350 million cubic meters or 10.5 million cubic meters a year in the 34-year period between 1925-27 and 1960, which should be compared with the anticipated increase for paper and board alone, amounting to 13 million cubic meters a year between 1960 and 1975, of which about 11 million cubic meters would be softwood.

The greater part of this increase has taken place in the Soviet Union. This great region is self-sufficient in forest products and has, moreover, a considerable surplus for other regions as need arises. It would therefore be of more interest to consider past developments in the world outside the Soviet Union. From the same source it may be found that the cut of softwood in this case has increased from 425 to about 580 million cubic meters, or 155 million cubic meters, from 1925-27 to 1960, corresponding to 4.6 million cubic meters a year on an average. When judging this increase it should be observed, though, that the period in question includes the world crisis in the early thirties and the second World War.

As for potential demand from industrially undeveloped countries, mostly in tropical and subtropical regions with three quarters of the world's population and with prospects for a further rapid increase of population, there always has been difficulty in meeting demand by imports because of currency difficulties. An anticipated industrial development in these regions is expected to give rise to a considerable demand for paper and board, among other wood products. At the same time these countries apparently will try their best to use their own raw material resources for integrated development of a domestic pulp and paper industry, thus saving their limited currency resources for more critical imports which they cannot produce as readily. It is true that their raw material resources are not

as suitable for pulp and paper making as are the conifers, nor even as the hardwoods of the temperate regions, but with further advance in the techniques of pulping and paper making these and other difficulties gradually will be overcome. Therefore, no spectacular rise in the imports of pulp and paper from these regions should be expected, but a continued modest increase of their import needs may well be anticipated.

The future supply of wood is equally difficult to foresee. As for the knowledge of the actual extent and nature of the world's forest resources, FAO has made a great contribution by its repeated world inventories, the last in 1958. By these FAO has brought together existing forest resource information from all countries into an overall picture of the forest resources of the world. This information is necessarily of greatly varying value, as only the minor part of the world's forest area has been the subject of a thorough survey. But on the other hand, information is more complete and reliable about the economically most important forest regions, in the first place Europe and North America, where also the main part of the world's fellings and consumption of forest products takes place.

This is not the place for any detailed discussion of the world's forest resources and their future yield. However, a few fundamental data may be helpful to provide at least a rough background to the subject treated. Those data have for convenience been collocated in Table 7. From this can be read that of the world's total forest area given at 10,887 million acres, more than half was accessible in 1955. From the accessible area, 6,755 million acres, somewhat more than half or 3,619 million acres, have so far been taken "into use," which does not mean, however, that the whole of this area has been subject to fellings in one way or another. The greatest area of interest is in Europe and North America, however. From a total forest area of 2,161 million acres in these regions, 1,330 million acres are classified as accessible and from this area practically all is reported to have been taken "into use." This means that considering the whole world, there are still big areas of virgin forest not touched by the axe, although mostly judged to be inaccessible so far. Only in Europe are the virgin forests virtually gone and practically the whole forest area accessible.

Several difficulties are encountered in appraising the future yield from the world's forests or from the forests in a certain region. First, there is no way of judging to what extent the forest area now classified as inaccessible will become accessible in the future by further technical achievements in the field of transportation or by rise in price for the wood delivered to the processing industries. For the present, likewise, there is no foreseeing how far it will be possible
TABLE 7. WORLD FOREST AREA ABOUT 1958 AND FELLINGS IN 1960. (According to FAO)

<table>
<thead>
<tr>
<th>Region</th>
<th>Total forest area</th>
<th>Million acres</th>
<th>Million m$^3$</th>
<th>Yearly fellings</th>
<th>Population in 1960</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Accessible area</td>
<td>Area in use</td>
<td>Coniferous forest</td>
<td>Total</td>
</tr>
<tr>
<td>North America</td>
<td>1,813</td>
<td>989</td>
<td>989</td>
<td>1,228</td>
<td>408</td>
</tr>
<tr>
<td>Europe</td>
<td>348</td>
<td>341</td>
<td>333</td>
<td>208</td>
<td>311</td>
</tr>
<tr>
<td>Soviet Union</td>
<td>2,795</td>
<td>2,795</td>
<td>1,134</td>
<td>2,215</td>
<td>369</td>
</tr>
<tr>
<td>Latin America</td>
<td>2,548</td>
<td>821</td>
<td>222</td>
<td>69</td>
<td>191</td>
</tr>
<tr>
<td>Africa</td>
<td>1,861</td>
<td>939</td>
<td>309</td>
<td>8</td>
<td>130</td>
</tr>
<tr>
<td>Asia</td>
<td>1,285</td>
<td>806</td>
<td>583</td>
<td>272</td>
<td>301</td>
</tr>
<tr>
<td>Oceania</td>
<td>237</td>
<td>64</td>
<td>49</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>10,887</td>
<td>6,755</td>
<td>3,619</td>
<td>4,020</td>
<td>1,732</td>
</tr>
<tr>
<td>Percent</td>
<td>100</td>
<td>62.0</td>
<td>33.2</td>
<td>36.9</td>
<td></td>
</tr>
</tbody>
</table>

$1 \text{m}^3 = 35.3 \text{cu. ft.}$

through improved pulping techniques to utilize for pulp and paper in the future the immense reserve of tropical hardwoods now lying idle. Lastly, there is no estimate on the future yield from the residual stands and the second growth forests that are gradually but with variable results replacing the former virgin forests.

As interest centers in North America and Europe, reference may be made to the very thorough appraisal, published recently by the U. S. Forest Service$^1$ of future supply and demand for wood in the United States. Some concern is expressed in the appraisal about the future yield of coniferous timber. However, if need be, it may be met by the apparent big surplus being established in Canada by the forest inventories now proceeding in the great northern expanses of that country.

As for Europe, a thorough study was made for this region by FAO in 1953.$^2$ It must rely on the sustained yield from its forests,


as no reserves of virgin forests of appreciable size are left. Consequently any future increase of its consumption of forest products must be met by an increase in sustained yield, or through a better utilization of this yield, or in the last instance by imports. There are certain possibilities for increasing the yield from the forests in the long term. In the short term, already, the production of wood pulp can be increased in the Nordic countries. Thus Sweden is now carrying out an expansion of her wood pulp production by 1.5 million tons in the next few years, and in Finland a similar expansion is on the way. Already the United States and Canada have a growing export of wood pulp to Europe in addition to Canada’s traditional export of lumber to this market. Finally, the Soviet Union may extend its traditional exports of lumber to Europe to include pulp and paper.

Apprehension of a world-wide timber shortage sometimes has been expressed, particularly regarding coniferous timber, which is of prime importance for present wood consumption. Today our knowledge of the world’s forest resources and their annual growth has shown that earlier appraisals of their future yield were low. Moreover, by new pulping processes the temperate hardwoods have been brought to industrial use and serious efforts are being made to exploit the enormous reserve of tropical hardwoods for pulp and paper. Fast-growing tree species have been planted extensively and demonstrate now the ample possibilities of growing industrial wood on a large scale in localities lacking natural forests or suitable species. Research in forest genetics has explored great possibilities to increase the yield of the forests in the long term. Within easy reach are great reserves of sawmill leftovers and other unused wood, indicating that pulpwood cut from the forest in many places still is available at a lower cost. Other raw materials than wood can be used for the manufacture of pulp and paper. Bagasse, bamboo, grasses, and agricultural waste products already have been employed in this production on an increasing scale. Therefore, no longer does there seem to be any reason to count on an increasing scarcity of raw materials above that which in the past has expressed itself in the exploitation of gradually less accessible logging sites and more distant forest tracts, until an eventual equilibrium has been reached some time in the future. In this connection, it also should be noted that in the future the greatest increase in consumption probably still will be for the products of the pulp industry, which is less exacting in its raw material demands than the sawmill industry.

In the long run, however, a point must be reached where the world’s timber requirements necessarily will be supplied in the main by sustained yield from the more well-situated parts of the forest
area of the world. If and when such a state of equilibrium is reached, it would mean that the marginal cost of forest products no longer would be influenced by rising costs of exploitation. This would in turn mean that continued technical progress could be entirely directed towards keeping back or even reducing costs, with a consequent tendency toward increased competition. Instead, the costs of sustained yield forestry with its silvicultural measures would enter the picture. To give an idea of the importance of this new factor in the marginal cost, it can be mentioned that in Sweden, where sustained yield already is ensured, the cost of reforestation amounts to some 6% of the stumpage value of the timber yield. It is then assumed that capital interest on silvicultural costs will not influence the marginal cost and the prices of forest products, although even the cost of capital interest admittedly should be borne by the stumpage value and must therefore to some extent influence the extent of silvicultural work.
Conclusions

In any given market the prices of roundwood and of stumpage will develop within the frame of the price of the forest products, as these have been discussed above, and also by the interplay of other cost factors, among which labor is wholly dominating. More important still is that the cost of labor constantly is growing and can be expected to do so in the future, as long as the general economic, and especially industrial development results in a rising standard of living and a corresponding rise in real wages. It has been maintained in the foregoing analysis that forestry has not the same possibilities as industry in general to meet the rising cost of labor by rationalization and the innovation of new products and other value-increasing measures. If stumpage values do not decline it is necessary in the long run that roundwood prices increase. This has been the case in the past as roundwood prices have increased in relation to the price of lumber and wood pulp. The explanation is that wood-using industries have a much wider field for rationalization than forest management, and, moreover, have the same possibilities as other industries to increase the value derived from the raw material by further processing and by the introduction of quite new products. Whether this can continue in the long run cannot be foretold. As a fair price of stumpage is necessary to keep up the rate of fellings, especially in marginal areas, it may well happen that the marginal cost of forest products will increase.

From these assumptions stumpage values arrived at in any region or country would, in the last instance, be dependent upon the possibility of meeting the rising cost of labor by rationalization and other cost-reducing measures and, moreover, by increasing the value derived from the wood by adapting the production to new products and new qualities of the old products. The possibilities to do this evidently will be much dependent upon the price that other
lines of the national economy will be able to pay for the use of labor and other factors of production. This will, then, ultimately decide the place of forestry and of wood in the national economy of every country. Incidentally it also will decide the prospects for wood-exporting countries to compete in world markets. In the last instance this will also determine the place of forestry in the world economy in competition with other commodities and raw materials.

From this it should be evident that the marginal cost of forest products does not alone decide their price. Although it is true, as throughout this study, that the marginal cost in the long run must be covered by the price, yet the price also has its effect on the marginal cost, considering that production will not be carried beyond the point where the marginal cost will not be covered by the anticipated price. Here substitution is a powerful agency in creating the interdependence of all prices in a given market and preventing the price of individual commodities from taking their own course. This refers especially to lumber, as lumber prices would be considerably higher if there were no substitution by other materials.

According to previous reasoning, the price of stumpage should in the long term also cover the cost of growing timber under the sustained yield forestry.

So far the price of stumpage has not been determined appreciably by the cost of growing timber. It should be more correct to say that it has been determined by the marginal cost of logging the virgin forest and that the growing cost of this raises stumpage values in better located regions and localities and for species subject to growing shortage. Even this is not a wholly accurate statement, for the necessity to extend exploitation to more remote regions and less accessible logging sites has been delayed by the yield from second growth forests, whether produced at a financial return or not.

It would be natural to expect, however, that the final exploitation of the world’s more accessible virgin forests would be followed by a rise in price of forest products and stumpage values. This probably will be more evident in those regions dependent upon yield from virgin forests, as for example the north Pacific Coast of the United States. For the world as a whole this will be a gradual procedure in the future as in the past and probably will not make any very marked impact on the price trends in the general world market as represented by the British market, than was previously the case.

As already shown, in the long run a sort of equilibrium is bound to develop when the world’s consumption of wood, in the main, must be obtained from the sustained yield of the logged-over areas, and especially from the better situated parts thereof. In this situation
it should be expected that the cost of growing timber should be covered by the stumpage values in this new equilibrium. As a matter of fact, in a perfect equilibrium the marginal cost of growing timber would be the same as the marginal cost of logging in the virgin forest.

First should be observed that, in favorable localities, in the future as in the past, a considerable growth can be obtained by nature unaided. It is the cost of increasing this yield that should be covered by the increase in stumpage value per acre.

In this respect forestry holds a peculiar position because of the long time that elapses between the establishing of a new stand and its final yield at the end of a rotation period. It is difficult to foresee stumpage prices in such a distant future as a guide to investment in reforestation. Moreover, the rate of interest as an important item of cost is vague and has constituted a stumbling block to the theory of Forest Economics. This makes the connection between cost and price rather vague and consequently leaves an opportunity for all variations of investment policy and even for the entire lack of such a policy. While this in many cases has resulted in obvious negligence of reforestation even when the financial return seems promising, it can also be stated that sustained-yield forestry, more or less regardless of the prospects of financial return, is the officially recognized forest policy in practically all countries where forestry is of any importance. Its enactment varies considerably, however. The same policy is practiced in their own interest by many forest owners who are dependent upon a sustained yield from their forests. This is above all the case with the pulp and paper industries who in this way try to safeguard their big investment in plant. All this has so far resulted in a marked increase in the interest in timber growing the world over.

While this undoubtedly tends to preserve the low financial result of timber growing that prevails in Sweden and other northerly countries, the consequences to the national economy of a decline of the yield of the forests would not allow any negligence in this respect. The same way of reasoning also may be valid in other countries and regions where forestry is an important integral part of the national economy.