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30. We thank P. N. Devreotes and M. C. Dinauer for discussions and K. J. Tomchik and G. S. Retzinger for technical assistance. This work was supported by grant GM 22321 from the Public Health Service, a postdoctoral fellowship from the Anna Fuller Fund (to R.L.C.), and a Faculty Research Award from the American Cancer Society to T.L.S.

Forests in the Long Sweep of American History

Marion Clawson

The current concern over forest policy, including policy with respect to the national forests, focuses on the recent past, the present, and the relatively near future to a degree that threatens to obscure longer and more basic trends in American forestry. To coin a phrase, the trees are obscuring the forest. Forestry is a long-term matter, as foresters and many others have long emphasized, but all too often the longer trends are overlooked or underestimated. A knowledge and understanding of the past is essential to sound public and private decisions on forest land use, forest investment, timber harvest, and other forest uses.

A quantitative history of forest land use, timber stands, timber growth, and timber harvest from 1800 to date, as presented in this article, is, like many other histories, limited by the paucity, suspected inaccuracy, and noncomparability of the available data (*1*). The best available data have been used in this article and are sufficient to sustain the interpretations drawn.

Summary. The role of forests in the American society and economy has changed greatly over the past 200 years, as is evidenced by data on acreage in forests, on volume of standing timber, on amount of annual wood growth, on amounts and form of wood utilization, and on prices for forest products. The two most dramatic facts in a long history of forest utilization have been the near fourfold increase in annual wood growth in the past 60 years and the persistent and major underestimate by the U.S. Forest Service of the wood production potential of American forests.

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Forests as a Land Use

Forests have always been important in the American economy and way of life. Ready building material and fuel were important to early pioneers even when much of the forest had a negative value and the land had to be cleared for cropping. As the nation expanded westward, the lumber from the forests provided a major share of the building materials. In more recent times, the forests have come to be more appreciated for their watershed, wildlife, recreation, wilderness, and esthetic values. There is good reason to believe that the role of forests in American life will increase in importance in the next several decades.

After a long and substantial decline in forest land area from 1800 onward, forest area has been approximately stabilized since 1920 (Fig. 1 and Table 1).

"When the explorers landed, America was trees . . . explorers looked down from the mountain tops to an ocean of trees that stretched in every direction as far as the eye could reach . . . filled them with awe. They felt besieged by the poignant immensity, the wild monotony" (*2*). In these words Lillard conveys at least some of the early reactions to the forests of the East. The early Spanish explorers coming into the Southwest from Mexico were overwhelmed, not by the forests, but by the immensity of the plains and deserts.

There is a fair amount of agreement as to the original forested areas of the United States (*3*). Using maps showing natural forested areas, workers have estimated the area of what today we call (erroneously) "commercial forest" at about 850 million acres at the time of the earliest colonization. While there was some land clearing before 1800, it was modest indeed. The original area of what today we call noncommercial forest is likewise estimated at about 100 million acres. I cannot but wonder if that was much too low, but the point is not important for the discussion in this article. These figures should be compared with the 1904 million acres of all land in the 48 contiguous states; roughly half of the area was originally forested.

Land clearing for farm cropland and improved pasture was comparatively small until the mid-19th century (Table 2). Thereafter, it proceeded more rapidly. Cropland area reached a high plateau in the interwar period of the 1920's and 1930's, but much of the increase in cropland area after about 1900 was in the Great Plains, a normally nearly treeless region. In 1909 Greeley (*4*) presented fig-

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ures showing that the forest area cut annually had increased from about 2 million acres in 1860 to more than 9 million acres by 1907. Some of this cutover land, of course, reverted to trees, sometimes after a considerable time lag, but some of it was used for cropland, though some of that also reverted to trees after a generation or so.

The area of commercial forest has been roughly stabilized since about World War I. By then, the great period of land clearing had largely ended. The apparent low point in commercial forest acreage was about 1940, but the reported differences before and after this date are not great and one cannot put much confidence in such small changes. Since 1940 losses of forest acreage have been brought about principally by clearing for farming (in some of the Mississippi Delta and other areas), by suburban growth, and by building of highways or electric transmission lines through forested areas. But there have been more than offsetting gains, primarily from the abandonment of cropping in the piedmont areas of the Southeast, the hillier areas of the Northeast, the upper lake states, and elsewhere. The farm abandonment process seems to have run its course, and the forest-farm balance is likely to shift back toward farming in some areas in the future.

The approximate stabilization of forest land area since about World War I is a part of a general stabilization in land utilization in the United States. In 1960, Held, Stoddard, and I (*5*, pp. 476–477) summed up this situation, and the prospects for the future, as follows:

1) Large shifts in land use, from one major use to another, are unlikely in the future, at least up to 2000. As a nation, we have "matured," as far as land use is concerned, and there will not again be large and rapid shifts in major land uses such as occurred before 1910.

2) But some changes in major uses of land will take place. They will tend to be localized.

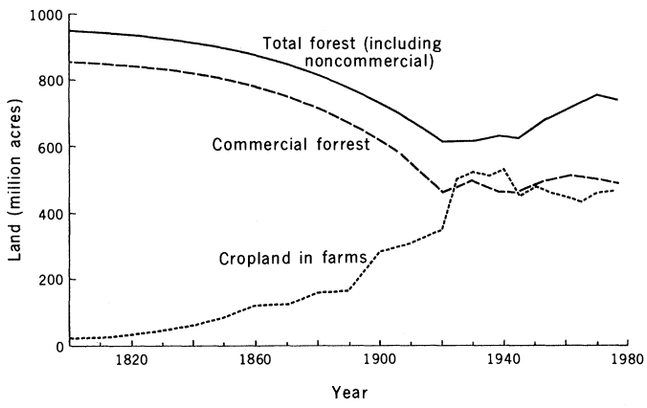

Fig. 1 (left). Land in all forests, commercial forests, and cropland in farms, in the United States, 1800 to 1975.

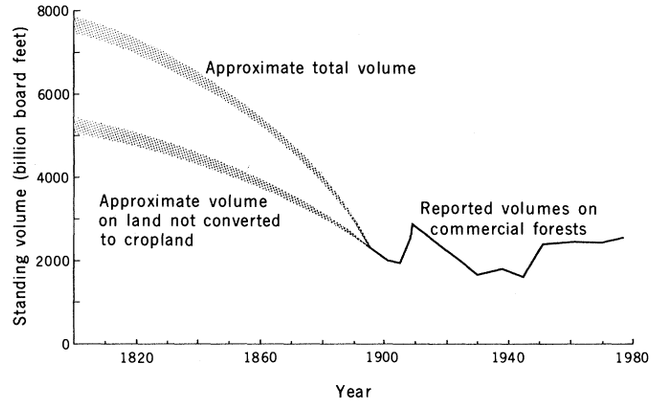

Fig. 2 (right). Standing volume of sawtimber at different dates in the United States, 1800 to 1977.

Table 1. Area of commercial and noncommercial forests, standing sawtimber volume, and net annual growth of timber in the United States, various dates, 1800 to 1977. Net growth and the distinction between growing stock and sawtimber are discussed in the text and in (*6*). Where no data are given, either the data were unavailable or they are included in another line.

Year*	Reference	Area of commercial forest (million acres)			Area of noncommercial forest (million acres)			Standing sawtimber volume (million acres)			Annual net growth	
		East	West	Total	East	West	Total	East	West	Total	Growing stock (billion cubic feet)	Sawtimber (billion board feet)
1630	(*12*)			850			100					
"Original"	(*13*)	683	145	828				5385	2240	7625		
"Original"	(*14*)	650	200	850				3400	1800	5200		
1800	(*15*)										0	0
1895	(*16*)									2300		
1900 to 1908	(*17*)										6.0	
1902	(*18*)									2000		
1905	(*19*)									1970		
1907	(*4*)			580								
1908	(*20*)									2500		
1909	(*21*)									2826		
1920	(*22*)			464			150			2215	6.0	9.7
1930	(*23*)			495			120			1668	8.9	11.7
1938	(*24*)			462			168			1764	11.3	32.0
1944	(*25*)			461			163			1601	13.4	35.3
1952	(*26*)			495			163	637	1775	2412	13.9	45.1
1962	(*27*)			508				726	1703	2430	16.4	52.3
1970	(*28*)			500			254	816	1605	2421	18.1	60.0
1977	(*29*)			488			252	964	1605	2569	21.9	73.6

*Area and volume data apply to the end of the year; growth data apply to the whole year.

3) Changes in major land use in the future will be made with more difficulty and will be accompanied with more stresses and strains, public and private, than past shifts in land use.

4) Change within each land use is likely to be more important than change between land uses.

The ownership of forest land changed over the decades, as did the use of the land. From an original situation of wholly public ownership (federal, state, or other), land ownership shifted substantially toward private owners by various routes. The establishment and extension of the national forests in the decade before and the decade after 1900 established a permanent federal ownership of forest land. Some states retained much of their forested grant land and some counties acquired forest land, largely by the tax foreclosure route. The public-private division of forest land ownership has been stabilized during the past few decades. The forest industry firms expanded their ownership of forest land a little toward the end of the 19th century and much more during the 20th century, including some just after World War II; but it appears from the latest available data that their ownership of forest land has also been nearly stabilized, at least for the present. There has been a substantial shift among the "other private" forest ownership class in the past 30 years or so, with a large decrease in farm forest acreage and an approximate equal increase in miscellaneous private ownership.

Inventory of Standing Timber

Timber inventory volume declined by perhaps two-thirds or more between 1800 and 1900 (Fig. 2 and Table 1) (*6*). Nearly half of the decline was on land cleared for cropping; it is probable that much of this timber was burned on the land where it grew, its value being less than zero because the land was worth more without the trees. Since about 1900, changes in timber inventory have been smaller and the low point in volume was apparently reached about 1945. Since 1952, when more accurate and reasonably comparable data began to be available, there has been a slight increase in total volume of standing timber. These overall statistics mask large regional and species differences.

Most of the great decline in inventory of standing timber was inevitable if some of the land was to be used for agricultural crops and if the timber was to be used for various purposes. The volume of timber standing on an area is a function of the age of the trees as well as of the forest species or type, the climate, the soil, and other factors. Good natural forestry, meaning (among other things) a fully stocked site, has an age-growth curve for timber volume with at least four distinctive stages (Fig. 3).

Stage A is where the inventory volume is the greatest the site and species will ever produce; at older ages, the stand as a whole would deteriorate and perhaps disintegrate entirely in a severe storm, or the individual trees would gradually be replaced by younger, smaller, and more rapidly growing ones, depending upon the species. Stage B contains the point at which the mean annual increment (MAI) of wood is at a maximum, as measured from the date of establishment of the stand. It is more accurate and meaningful to speak of a range of years within which maximum MAI probably falls than to speak of a precise age, because relationships change slowly for several years before and after the maximum is reached and until the peak is clearly passed there is always the possibility that growth rate is still increasing. Because costs are involved in forest management, the optimum economic age for harvesting (financial maturity) is always lower, the degree depending on whether costs are low (stage C) or high (stage D). Again, ranges rather than points are more reasonable. Similar curves, but higher and to the left, exist for intensive management of any forest site; each such curve has the same four stages. Private forest industry firms are spending a good deal of money in order to determine the precise location and shape of these curves of specific forest types and sites, but their interest is for the range between stages B and D on the curves.

Something like the curve for good natural forestry existed for all forest stands in the United States prior to significant white settlement. Some stands would have been to the right of stage A, because they were decadent and in the process of decay or replacement; others would have been near stage A; and still others, naturally regenerating after storm, fire, or other loss of the mature stands, would have been at various locations along the curve to the left of stage A, some even to the left of stage D. The average volume per acre for all forest stands was surely well above stage B, probably not far from stage A. Harvest of mature stands, even if regeneration is prompt and fully successful, results in significantly less volume of standing timber inventory on each site for a time, often for a few decades. Typically, forests of mature or high volume timber were cut.

Harvesting of the original mature tim-

Table 2. Total U.S. population, number of farms, and land use in farms, 1800 to 1975.

Year*	Population (millions)		Number of farms‡ (thousands)	Land in farms (million acres)‡		
	Total†	Farm‡		Total§	Cropland§	Pastureland
1800	5.8			(69)	(21)	
1810	7.2			(86)	(26)	
1820	9.6			(115)	(34)	
1830	12.9			(155)	(46)	
1840	17.1			(205)	(61)	
1850	23.2		1449	294	(88)	
1860	31.4		2044	407	(122)	
1870	39.8		2660	408	(123)	
1880	50.2	22.0	4009	536	(161)	
1890	62.9	24.8	4565	623	166	
1900	76.0	29.9	5740	841	283	
1910	92.0	32.1	6366	881	311	
1920	105.7	32.0	6454	959	349	
1925	115.8	31.2	6372	924	505	218
1930	122.8	30.5	6295	990	522	270
1935	127.2	32.2	6812	1054	514	311
1940	131.7	30.5	6102	1065	531	394
1945	139.9	24.4	5859	1142	451	481
1950	150.7	23.0	5388	1162	478	417
1955	165.3	19.1	4654	1202	460	460
1960	179.3	15.6	3962	1177	448	466
1965	194.3	12.4	3356	1140	434	490
1970	203.2	9.7	2954	1103	459	389
1975	213.6	8.9	2314	1107	467	

*Or nearest year for which data available. †See (*30*). ‡See (*31*). §Numbers in parentheses are my estimates, based on the relation of total farm area to total population and of cropland area to total farm area.

ber stands was a severe ecological shock to the areas involved. In many cases, soil erosion increased. Some forms of wildlife were adversely affected while others benefited from the vegetation changes following timber harvest. The appearance of the whole area was changed, in ways which today would be considered undesirable. Much of the timber harvest was wasteful in the sense that it inhibited natural forest regeneration. There was typically no concern to keep fires out and, in fact, fires were often set or encouraged on the assumption that the land would subsequently go into farm crops. From the perspective of today, these were undesirable effects associated with timber harvest, but they were not generally so regarded at the time. Even the most careful consideration for forest regeneration would have led to significantly reduced volumes of standing timber, if either the timber or the land was to be used at all.

The great decline in inventories of standing timber greatly disturbed many foresters and others, throughout the 19th century and well into the 20th century. Even today many devoted conservationists see only the cutting of the old stands, and the resultant slash and waste, and the fires, while largely ignoring the subsequent growth. The capacity of natural forest lands to regenerate timber stands and the capacity of timber to grow, even in the absence of man's help and often in spite of his wishes, tend to be overlooked or ignored.

Net Timber Growth

The really dramatic historical change in American forests has been the increase in annual net growth (Fig. 4 and Table 1) (*7*). Net growth of timber was zero or very close to it when the first colonists came to North America, and probably was not much if any above this as late as 1800. This was a direct consequence of the age and volume of the stands at that time. No real estimates of annual growth of timber nationally are available until 1900, when total wood growth was estimated at 6 billion cubic feet annually. The same estimate was made for 1920; these are, at best, approximations. By 1970, net annual growth had increased to more than 18 billion cubic feet and by 1977 had increased to almost 22 billion cubic feet. On the basis of these data, total annual wood growth in the United States increased more than three and one-half times in the 57 years from 1920 to 1977. Growth of sawtimber, shown in Table 1, followed a closely parallel course.

This great increase in annual net growth of timber was a direct consequence of the decline in standing volume, shown in Fig. 2. Net growth was possible only as original stands of timber were opened up by harvest. Many people realize that timber harvest cannot exceed net timber growth indefinitely, for this would deplete inventory, ultimately to the vanishing point. But fewer people seem to realize that net growth cannot exceed harvest for very long, since inventory accumulation proceeds to the level where no further net growth takes place. Timber growth is a function of timber harvest, as well as of other factors.

Figure 4 is noteworthy in showing how the U.S. Forest Service projections of timber supply relate to actual experience. In 1933, 1946, 1952, 1962, and in 1970, the Forest Service projected future

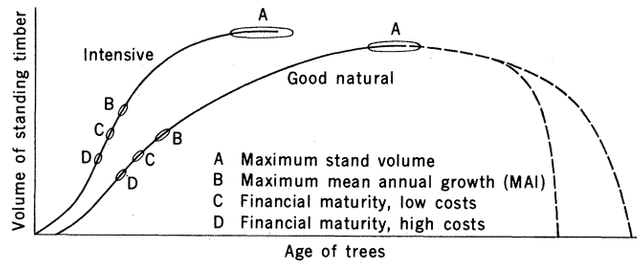

Fig. 3. Timber age-volume relationships, good natural, and intensive forestry.

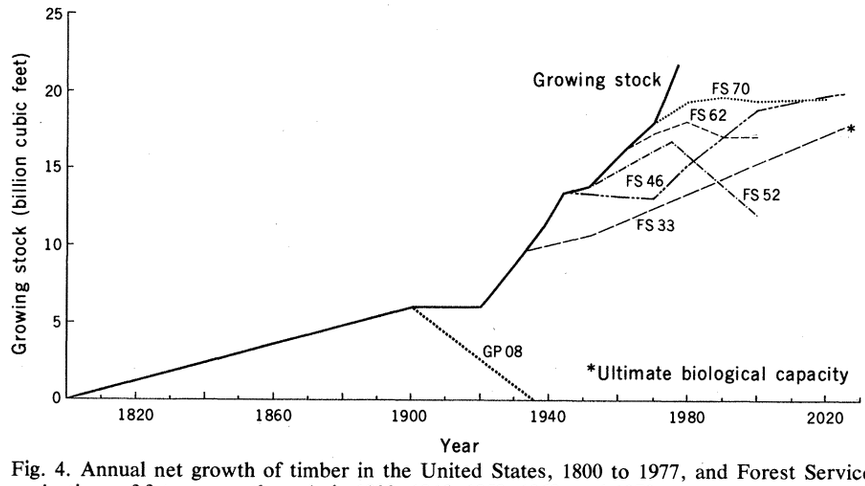

Fig. 4. Annual net growth of timber in the United States, 1800 to 1977, and Forest Service projections of future growth made in 1933, 1946, 1952, 1962, and 1970.

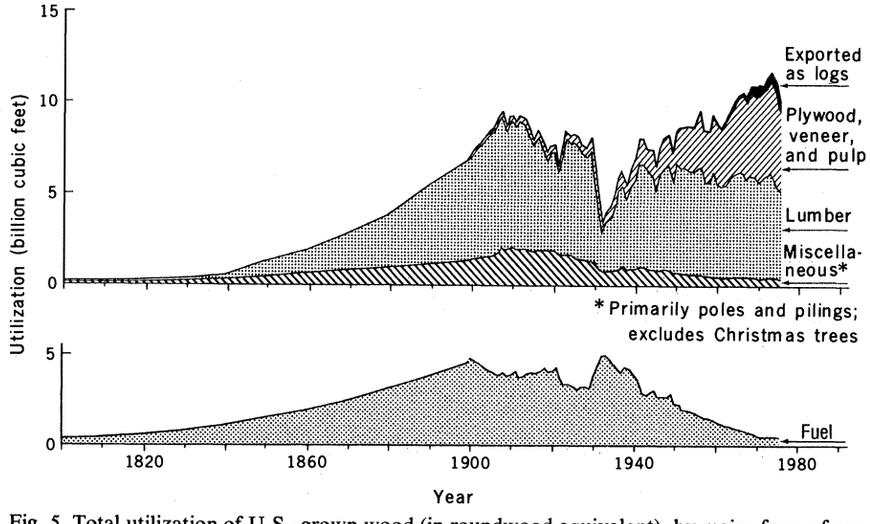

Fig. 5. Total utilization of U.S.-grown wood (in roundwood equivalent), by major form of use, 1800 to 1975.

timber growth at successively higher levels but at roughly the level of existent annual growth at each date; actual historical developments in each case substantially outran the projections. It will be interesting to see what happens in the next decade or two to these projections. In much earlier years the first head of the Forest Service Gifford Pinchot, President Theodore R. Roosevelt, and others made statements about future timber supplies which implied, but did not state quantitatively, very low or nearly zero projections of timber growth. Timber growth potential has been repeatedly and seriously underestimated.

Annual net growth of timber is a function of several factors. One is the age distribution of the trees in the region, as is apparent from Fig. 3. Forests with many trees in the rapidly growing ages will have higher net growth than forests with either much older or much younger trees. Rate of annual net growth can be affected greatly by management actions, particularly by ensuring prompt and full regeneration of sites after harvest or disturbance such as fire. This, in turn, is greatly influenced by the profit prospects from timber production which, in turn, are much affected by prices of timber harvested. A greatly increased total annual wood growth from a nearly fixed forest area obviously means a greater output per acre. Though specific data are lacking, one may reasonably assume that production inputs per acre have also increased.

Timber Harvest

The total timber harvest increased throughout the 19th century to a peak just after 1900 (Fig. 5) (*8*). Fully as striking as this trend in total wood utilization was the shift in end uses of the wood. Wood was the basic fuel in the United States until well into the latter 19th century; it remained the basic fuel on farms until the end of the 1930's. One reason for its long continued use on farms, in addition to the fact that it often could be obtained by the farmer's labor without much if any cash cost, was the fact that most farms lacked electricity until the latter 1930's, making the use of other fuels for cooking and heating difficult. As late as 1850, more wood was used for fuel than for any other purpose. Interestingly enough, fuel wood consumption reached its peak in 1933, when the slight downward trend after 1900 was briefly reversed in the depression of the 1930's. Once electricity was generally available in rural areas, fuel wood consumption nose-dived.

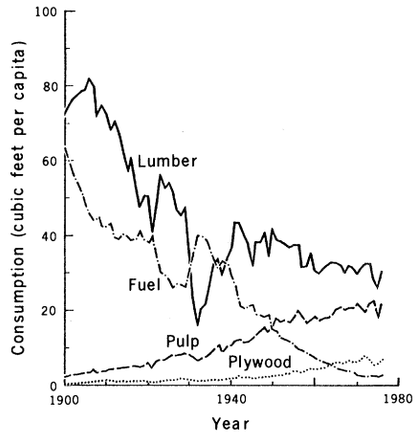

Fig. 6. Per capita consumption of timber products, by major product, United States, 1900 to 1976.

Lumber, the next big use of wood, was especially dominant in the last quarter of the 19th century and the first quarter of the 20th century. Lumber consumption, so closely tied to housing construction, fell in the depths of the depression of the 1930's to levels which it had reached as early as the end of the Civil War. Since World War II, lumber production and consumption have increased again and have remained fairly high and fairly steady, at levels not greatly below the level of the early 1900's. Plywood, pulp, and veneer have become major wood uses in the last 50 years or so. When the various forms of manufactured wood are considered as a whole, an irregular but significant upward trend over the whole period from 1800 to 1975 results. The high consumption of the early 1900's is then seen as an aberration from trend. While wood is no longer the dominant construction material it once was, its use in various forms continues to increase today. Although there has been much controversy about log exports, in the total wood utilization picture they have been quite modest.

The different uses of wood required different kinds of wood—different species to some extent, different sizes, and different qualities. Furthermore, the same use has required different qualities of logs at different times. Lumber and plywood are made today from species, log sizes, and log qualities which only a few years ago were considered quite unsuitable for these uses. Much of the wood burned in earlier days would be considered suitable for manufacture today.

Per capita consumption figures reflect changing total population as well as timber harvest and timber trade (Fig. 6). From the peak (since 1900) reached in 1906, lumber consumption per capita has declined to not much more than a third of the peak; and the decline since 1940 has been relatively modest. Part of the decline in per capita lumber consumption has been offset by the increase in plywood consumption per capita, since lumber and plywood are substitutes for many purposes. Per capita consumption of pulp (which is, of course, converted to paper) has increased so greatly that today pulp takes almost as much wood fiber as does lumber. The long and steep downward trend in per capita consumption of wood for fuel is evident.

A comparison of Figs. 4 and 5 will show that, at least since 1945, total timber harvest has been less than total timber growth annually. This broad comparison includes divergent situations by regions, species, and grades of logs; but a clear margin of growth over harvest is evident, overall. In the United States today we are not, in total, depleting our forests, but rather building them up.

Price of Wood Products

The price of wood products is the fifth and final factor whose course is traced from 1800 to the present in this article. The price of wood products such as lumber and paper includes not only the cost or price of the wood raw material but also the cost of other inputs such as labor, capital, and management. Much of the cost of such products delivered to the consumer consists of transportation costs, either from woods to mill or from mill to consumer, as well as actual transformation costs from log to product. The cost of these products is much influenced by the current technology of their transformation and transportation.

There has been a long upward trend in lumber prices in terms of constant dollars (Fig. 7) (*8*). The index (1967 = 100) has risen from under 10 in the first quarter of the 19th century to well over 100 in recent years (*9*). Lumber has frequently been cited by economists as one raw material whose real price, in terms of commodities generally, has risen steadily and persistently over the decades (*10*). While the general impression from Fig. 7 is one of a sustained rise in lumber price over nearly 200 years, a closer look shows that the rate of rise in price has not been uniform. There have been periods of steep rise, of plateaus, and even of declines over several years. An intensive study of these variations in price move-

ment, and of the reasons therefor, might be rewarding. Prices were relatively steady from 1800 to about 1818, from 1845 to about 1869, from 1920 to about 1932, and from 1950 to about 1967; they rose rather steadily and steeply from 1818 to 1845, from 1866 to perhaps 1911, and from 1932 to 1946; World Wars I and II were periods of very rapid rise; but 1856 to 1866 and 1911 to 1915 were periods of more or less sustained fall in real lumber prices.

The index of 100 on Fig. 7 corresponds to a wholesale lumber price of about $76 per 1000 board feet. On this basis, wholesale lumber prices in the very early 1800's were about $5.50 per 1000 board feet, in terms of 1967 prices, and, since the general price index was lower, much below this in current prices. At such a price for lumber, even considering the low real wages of that day, there obviously was not much value in the standing tree.

The price of paper has followed a very different course. Paper production from wood fiber began in a significant way only around 1900 and price data became available only in 1926. Since then, the price of paper has fluctuated in terms of the general price level but mostly within the bounds of 80 and 100 on the index. An index of 100 corresponds to a price of newsprint of about $140 per ton. For the whole period of record there is no clear trend: for the period since about 1946 there is only a modest upward trend in real prices.

The price of plywood followed a still different course. That price series begins only in 1947. Since then the real price of plywood, as measured by the general price index, has fallen almost in half. Plywood is increasingly being used in construction in ways that lumber once was used—for concrete forms, for flooring and siding, and in other ways. While greater economy in labor use is perhaps the major factor in the substitution of plywood for lumber, the divergent trends in prices of the two materials surely must have been one factor also.

Lumber, plywood, and paper are processed intermediate commodities made from wood, and their prices reflect inputs other than wood. The value of the standing tree in the woods, or stumpage, reflects the value of the resource before processing. It is largely rent, in the economist's sense of that term, although even the standing tree has some labor and often considerable capital embodied in it. Like all rents, stumpage prices reflect differences in location, especially in road and other transportation costs from woods to mill. There has always been some stumpage with a price in the woods of zero or less because the cost of getting it to the mill is greater than its value at the mill.

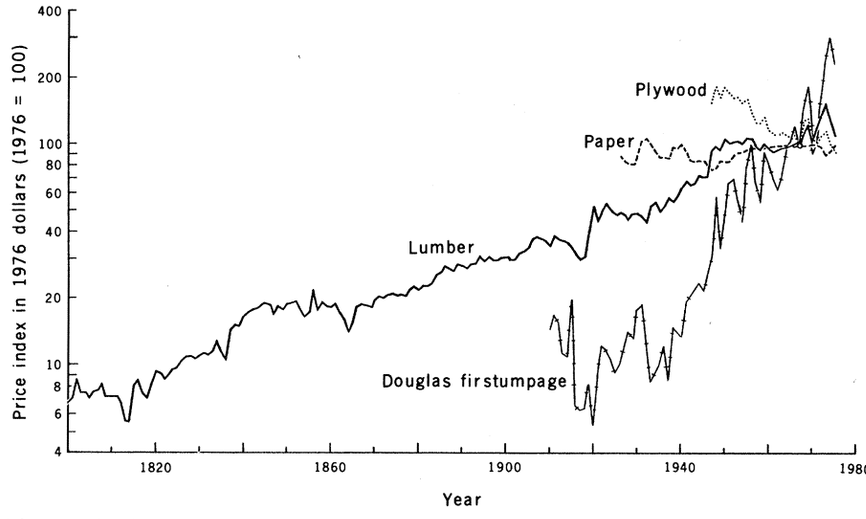

Fig. 7. Price indices, in terms of 1967 prices (1967 = 100) for lumber, paper, plywood, and Douglas fir stumpage, for years of record, 1800 to 1975.

For Douglas fir (the single most important species in the West) the reported stumpage price varied greatly from year to year but showed no clear upward trend from the earliest year of price record until the later 1930's. Since then the price of Douglas fir stumpage has increased irregularly with a very steep general upward trend, from an index of about 10 to over 300. An index of 100 for stumpage on Fig. 7 is a price of $41.70 per 1000 board feet. The index of less than 10 in the 1920's and early 1930's was a price in then current prices of less than $3, often less than $2. The trend in stumpage prices for southern pine has been similar to the trend for Douglas fir but not quite so steep. Southern pine prices were consistently higher, often double the Douglas fir prices in the 1920's and 1930's, but in more recent years they have often been below the Douglas fir prices. A generally tenfold increase in southern pine stumpage prices has taken place.

Forest Outputs Other Than Wood

In addition to wood, which is often the primary output, forests contribute wildlife, watershed, wilderness, esthetic, recreation, and other values. These nonwood values of the forest are widely recognized today, particularly as Americans have become more affluent and more urban, but considerably better data about them are needed, especially for private land. It is impossible to present any quantitative estimate of the output or value of any of these nonwood forest outputs over the long period since 1800. Despite attempts to discuss all forest outputs on an equal plane, discussions inevitably get down to wood first and often to wood alone, for simple lack of data on other outputs.

Some data, beginning with the mid-1920's, are available for some of the nonwood outputs from national forests. In the mid-1920's, total recreation visits to the national forests were about 6 million; today, the figure is about 200 million (*11*). For many years, recreation use increased at a rate close to 10 percent annually; as more people used the national forests more frequently, their desire to use them increased also. From the late 1920's to the period around 1970, numbers of big game killed annually from the national forests increased about two and one-half times; over a somewhat longer period, the Forest Service estimated that the amount of forage from national forests consumed by wild animals increased by about seven times. While the amount of water flowing off national forests has probably increased little or not at all, the amount of such water stored in dams, or used to generate hydroelectric power, or used for irrigation has increased substantially.

The Future

One objective in the study of past history is the perspective it provides on the present and the suggestions it gives for the likely course of events in the future. The foregoing analysis of past trends

suggests a few major conclusions, briefly stated as follows:

1) The total area of land in forests in the United States is now largely stabilized. There will continue to be some modest withdrawals of forest land for urban, transportation, recreation, and other miscellaneous uses, and it is possible that some forests will be cleared for agricultural crops. Net farmland abandonment may have ceased, at least temporarily, but some land may be shifted into forestry from other uses. The net changes in acreage will be modest, however, compared with the approximately 500 million acres of "commercial" forest now existent.

2) The volume of standing timber—the inventory—will continue to increase modestly over the next few decades or longer. This net trend will include some liquidation of inventory of old growth timber on the national forests, but this will be more than offset by increasing inventory from younger growing stands on all ownerships.

3) The trend toward increasing annual timber growth will continue, perhaps accelerate. Improved natural stand management will be supplemented by increasingly larger acreages of more intensively managed forest, on which the growth rate will be much higher. This projection does not assume that all the growth potentials of the forests will be realized; that would produce still more annual net growth.

4) There will be an increasing spread between relatively extensive natural forest management, including often the foregoing of timber harvest on the less productive timber sites, and much more intensive forest management on the more productive forest sites. Increasing output from relatively constant acreage suggests that the frontier in forestry tomorrow lies at the intensive, not at the extensive, margin of forest practice.

5) The use trends in wood products will continue to be diverse. Total consumption of lumber may have more or less stabilized; total consumption of plywood and of paper will continue to increase and in combination will shortly overshadow lumber as the major uses of wood fiber. While the use of wood for fuel may rise sharply on a relative basis, in terms of either its total volume or of its contribution to the total energy supply of the nation, the volume of wood for fuel will remain relatively minor.

6) For a few decades at least, trends in real prices are likely to continue as they have been in the past 30 years or so. That is, lumber and stumpage prices are likely to rise substantially, paper prices to rise slowly, and plywood prices to remain constant or to decline. Current prices will depend, of course, on inflationary and other factors affecting the general price level.

7) Public interest and concern about the nonwood outputs of the forest will continue to increase. One hopes that some means to reconcile wood and nonwood values and outputs will be found and accepted.

References and Notes

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2. R. G. Lillard, *The Great Forest* (Knopf, New York, 1947).
3. It is not clear when data on the forested area of southeastern Alaska were first included in the various data sources. Such data were clearly included by 1953, at which time the commercial forest area in southeastern Alaska was slightly in excess of 4 million acres. Data on commercial forests in central Alaska are included only in the 1977 data.
4. W. B. Greeley, in *Report of the National Conservation Commission*, Senate Document No. 676, 60th Congress, 2nd Session (1909), p. 633.
5. M. Clawson, R. B. Held, C. H. Stoddard, *Land for the Future* (Johns Hopkins Press for Resources for the Future, Baltimore, 1960), pp. 476–477.
6. Data on inventory of standing timber are less reliable and less comparable over time than are data on forest land area. For one thing, standards of what is to be measured have changed, partly as a result of changing technology and partly as a result of changing demand and supply relationships. Species, individual trees, and parts of logs which once would have been considered unusable or unmerchantable have come into use, with consequent changes in definitions. The data problem is further complicated by the use of growing stock, measured in cubic feet, as compared with sawtimber, measured in board feet (1 board foot is a unit of quantity for lumber equal to the volume of a board measuring 12 by 12 by 1 inches). The end product sets the standards for the resource inventory, to a large extent. The earliest figures are the most highly suspect and the most variable from one source to another, probably because of changing definitions of what was being measured.
7. Net timber growth is gross growth minus losses from natural causes such as blowdown, disease, insects, fire, and old age, but not including timber removals by timber harvest. Timber growth is much harder to measure than is forest area and somewhat harder to measure than inventory of standing timber, in part because growth is not so easily observable. It must be measured, typically on a sample basis, at intervals. There are obvious problems of sampling and of measuring. Data on timber growth may be as accurate today as data on forest area or on timber inventory volume, but this was not true some decades ago.
8. The data plotted in Figs. 5 and 7 may be obtained as tables from the author.
9. There are always difficult problems in making price comparisons over long periods of time. The unit of money typically changes in value, as measured by some price index. In this article I use an index of wholesale prices of all commodities as a deflator, but this process is not without its problems. The definition of the product may also change—modern lumber and paper differs from those same commodities a century or more ago, and some new commodities such as plywood have come into existence. Grades or qualities of products have changed greatly for forest products also. The location of the producing areas in relation to the location of the consumers has also changed. Much depends, therefore, on where the prices are measured and recorded—at the woods, or at the mill, or at the consumer location.
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13. C. H. Stoddard, in Clawson *et al.* (*5*). Stoddard does not indicate the source of figures.
14. R. S. Kellogg, in *Report of the National Conservation Commission*, Senate Document No. 676, 60th Congress, 2d Session (1909). Kellogg states that the original volumes were "at least" these amounts. He used the same figures in 1923 in his book, *Pulpwood and Wood Pulp in North America* (McGraw-Hill, New York, 1923). The same volume figures were also used by R. E. Marsh and W. H. Gibbons [Senate Document No. 12, 73rd Congress, 1st Session (1933) (The Copeland Report)], also with the statement "at least" these volumes.
15. See text for the basis of these figures.
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31. See Bureau of the Census (*30*), p. 457.