LONG-RANGE OUTLOOK FOR U.S. PAPER AND PAPERBOARD DEMAND, TECHNOLOGY, AND FIBER SUPPLY-DEMAND EQUILIBRIA

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ABSTRACT. This paper summarizes preliminary results of a long-range economic assessment of future U.S. paper and paperboard demand, technology, and fiber supply-demand equilibria, with projections to the year 2050. Slower growth is projected in U.S. population, with increasing gross domestic product per capita. While growth in paper and paperboard demand per capita is projected to decelerate, overall consumption is projected to increase with growing population. Trade is projected to increase in the long run, but future trade flows will remain small relative to domestic production. Slower growth is projected in rates of paper recovery and recycling as the United States reaches high levels of paper recycling. Wood residues are projected to decline in pulpwood supply, and pulpwood harvest and stumpage prices are projected to increase, particularly in the U.S. South. Short-rotation woody crop supply from agricultural land is projected to become increasingly important as an economical source of fiber supply in the long run.

KEY WORDS. Assessment, Pulp and Paper, Technology, Fiber Markets, Pulpwood

THE CONTEXT OF TIMBER RESOURCE ASSESSMENTS

The USDA Forest Service has prepared periodic national assessments of the forest and rangeland situation in the United States under the auspices of the Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974. The most recent RPA assessments were reported for 1989 and 1993 (USDA Forest Service 1989, 1994). These resource assessments have been supported by comprehensive timber assessments, which have included economic analysis of the timber supply-demand situation in the United States. Recent RPA timber analyses include the 1979 RPA analysis of the timber situation (Forest Service 1982), the 1989 RPA analysis of the timber situation (Haynes 1990), and the 1993 RPA timber assessment update (Haynes et al. 1995).

Quantitative analysis of product demands and fiber supply in the U.S. pulp and paper sector has been an integral part of Forest Service timber assessment studies for decades. However, the scope of analysis and the results have evolved as markets have matured and more sophisticated economic modeling techniques have been employed. Fairly simple methods were used for the 1979 RPA timber analysis. Pulpwood consumption was regarded as insensitive to price, trend analysis was used to project pulpwood production, and fixed assumptions regarding trends in wood and fiber use were used to derive projected pulpwood use. The 1979 RPA analysis predicted very limited gains in paper recycling. The use of recycled fibers per ton of paper and paperboard was projected to rise from 25% in the year 2000 to only 27% by 2030. By contrast, the recovered paper utilization rate actually reached 37% by 1996, according to American Forest & Paper Association estimates.

The 1989 RPA timber analysis was the first Forest Service timber analysis to be supported by a partial equilibrium model of markets in the pulp and paper sector, but the model was heavily

constrained to match historical trends in the RPA base projections. For example, although the economic model initially projected higher rates of paper recycling, the base projections were constrained to allow no more than 29% recycled fiber by the year 2040 (unconstrained projections were shown as an alternate "increased recycling" scenario in which recycled fiber use reached 39% by 2040). As rates of paper recycling actually began to increase significantly in the early 1990s, efforts were made to develop the economic modeling approach more fully. The result was the North American Pulp and Paper (NAPAP) model, which was employed in the 1993 RPA Update.

The NAPAP Model was a comprehensive economic model of the U.S. and Canadian pulp and paper sectors, jointly developed by the USDA Forest Service, Forestry Canada, and the University of Wisconsin. The NAPAP Model simulated competitive evolution of production by product, by process, and by region in North America, with annual product market equilibria, projected trade flows, and evolution in fiber supply and demand. The model produced fairly accurate projections of trends in paper recycling. (Model projections from the early 1990s of U.S. and Canadian paper recovery and recovered paper utilization rates have remained accurate to within 1 percentage point on average of actual trends through 1997, over a period when significant upward trends in paper recycling occurred.) The NAPAP Model was further developed in recent years, resulting in a new version known as the 1998 NAPAP Model, results of which are presented in this paper.

Comparison of the three most recently published RPA timber assessments shows a decline in projections of equilibrium supply-demand quantities for pulpwood (Fig. 1). The evolution in methods had some impact on results, and there was also a real trend toward maturing or decelerating pulpwood demand over time. Since the 1979 analysis was based on methods of trend analysis following robust growth trends through the mid- 1970s, it is not surprising that the 1979 pulpwood projections were the highest of recent assessments and higher than actual trends that evolved in the 1980s and 1990s. Equilibrium pulpwood supply-demand quantities were clearly overestimated in the 1979 assessment. The 1989 analysis employed an economic model for the first time, but recycling rates were constrained to low levels and consequently pulpwood equilibrium supply-demand quantities were again overestimated. The 1993 Update was the first assessment to use a less constrained economic model. The fairly accurate analysis of recycling rates and evolution of production technology resulted in the lowest projected equilibrium pulpwood supply-demand quantities among recent assessments. Pulpwood projections from the new 1998 NAPAP Model are fairly consistent with those in the 1993 Update with respect to equilibrium supply-demand quantities (Fig. 1). The following discussion highlights key aspects of the 1998 NAPAP Model and its results. These are preliminary results only, subject to change before review and publication of the next RPA timber assessment, scheduled for early 1999.

1998 NAPAP MODEL RESULTS

The 1998 NAPAP Model is a partial equilibrium economic model of the North American pulp and paper sector, similar to the earlier NAPAP Model (Ince 1994, Zhang et al. 1996). The 1998 NAPAP Model is an application of the price-endogenous linear programming system (PELPS) that was developed for economic modeling at the University of Wisconsin and Forest Products Laboratory (Zhang et al. 1993). The model is run in conjunction with the Forest Service TAMM/ATLAS Model, which computes equilibrium trends in lumber and wood panel markets and projects timber growth. The 1998 NAPAP Model has been carefully tested against historical trends, and it computes

fairly accurate annual production and market equilibria from a base year of 1986 to the present. Thus, model projections are validated in part by the ability of the model to track actual historical market equilibria and technological trends of the recent past. Some figures in this paper show how accurately the model tracks annual production and market equilibria from 1986 to present.

Demand for Paper and Paperboard

An integral part of the NAPAP Model is analysis of demand for paper and paperboard products in North America, including U.S. and Canadian domestic demands and export demands. U.S. demands are by far the largest component of demands, and therefore U.S. population and economic growth assumptions are crucial in the analysis. Slower but relatively steady U.S. population growth is assumed (based on Census Bureau projections) along with steadily increasing gross domestic product (GDP) per capita (Fig. 2). Paper and paperboard demands in the NAPAP Model are related by econometric equations to population and per capita GDP, historically good predictors of paper and paperboard demands. Demand functions for paper and paperboard are also modulated by elasticities with respect to price trends in plastic and electronic substitutes.

Growth in per capita paper and paperboard consumption is projected to gradually decelerate, as markets for most paper and paperboard commodities mature relative to GDP growth (Fig. 3). The projections reflect anticipated substitution of electronic media for some communication grades of paper. For example, U.S. per capita consumption of newsprint peaked in the 1980s and has actually declined in the ‘90s. Other grades of paper, such as uncoated free sheet paper used in electronic printers and copiers, are increasing in per capita consumption. Despite decelerating per capita demands, the overall tonnage of U.S. paper and paperboard consumption is projected to increase along with projected population growth (Fig. 4).

Production and Trade

Since 1970, U.S. paper and paperboard production has increased by 44 million metric tons, while imports and exports have each risen by 6 to 7 million tons. Although recent FAO projections predict a decline in U.S. paper and paperboard exports to the year 2010 (FAO 1997), U.S. exports and imports are both projected to increase in the long run after a near-term downturn (stemming from the Asian economic crisis). Nevertheless, projected U.S. trade flows remain small relative to domestic production (Fig. 5). U.S. paper and paperboard imports are projected to increase until around the year 2020, when projected imports level off along with slower growth in domestic paper consumption. Imports from Canada, primarily newsprint and printing & writing grades of paper, are projected to remain dominant (Fig. 6).

U.S. production of both paper and paperboard is projected to increase (Fig. 7). Paperboard production is projected to continue increasing linearly while paper production is projected to gradually level out with maturing market demand. The gradual shift from paper to paperboard production implies a shift toward higher yield pulping and increased use of recycled fiber.

The rate of recovery of paper for recycling (relative to total U.S. consumption) is projected to increase, but growth in the recovery rate will decelerate as the United States reaches a more balanced equilibrium between recycled fiber demand and supply (Fig. 8). Paper recovery for

recycling and export has increased significantly since the mid- 1980s, but the 1998 NAPAP Model indicates that paper recovery for recycling is approaching an equilibrium at the upper end of an historical sigmoid growth trend. Although a sustained recovery rate above 50% is projected beyond the turn of the century when U.S. recovery of paper for recycling will be in the range of current high rates of recovery in Japan and Europe, recovery will climb very slowly above the 50% level.

Distribution of U.S. paper and paperboard production capacity is shifting to a higher proportion of capacity based on processes that use 100% recycled fiber, but production capacity based mainly on virgin pulp is also projected to increase (Fig. 9). The domestic recovered paper utilization rate (ratio of recovered paper use to production of paper and paperboard) has increased significantly in the 1990s, but it is projected to increase much more gradually in the future with slower growth in equilibrium recovery rates (Fig. 10). Projected increases in U.S. paper and paperboard production coupled with decelerating rates of paper recycling imply increased demand for virgin wood fiber.

Equilibrium Fiber Raw Material Consumption

Figure 11 shows historical and projected roundwood equivalents of wood and fiber raw materials consumed annually in the entire U.S. pulp and paper sector over a 150-year span. Decelerating growth in equilibrium supply–demand quantities is attributable to maturing market demand, but the upward momentum of demand results in robust projections of fiber consumption well into the next century. Imports of fiber (pulpwood and wood pulp) are projected to increase but remain small relative to domestic sources of wood fiber. Use of recycled fiber has increased, and it is projected to increase at a somewhat slower pace in the future. Pulpwood harvest is projected to increase, along with increased paper and paperboard production, slower projected growth in rates of paper recycling, and declining wood residue supplies. Use of wood residues (chiefly byproducts of sawmills and plywood mills) peaked in the mid- 1980s and is projected to continue to decline in the future as more efficient sawmills and plywood mills generate less wood residue and as expansion occurs in newer composite wood panel products that do not generate wood residues, such as oriented strandboard (OSB) which is replacing plywood.

PULPWOOD MARKET OUTLOOK

The South has dominated in pulpwood supply and demand in recent decades, and it is projected to remain the dominant region in the future (Fig. 12). The South Central region has accounted for the largest share of growth in U.S. pulpwood supply; most growth in U.S. pulpwood supply and demand is projected to occur in this region (Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, and Texas). Pulpwood quantities discussed here exclude wood use in OSB.

Increased pulpwood demand in the U.S. South has been associated with significantly increased pulpwood stumpage values in recent years, particularly since the mid- 1980s. Historical and projected trends in real hardwood and softwood pulpwood stumpage prices are shown in Figure 13. Although stumpage prices for both hardwood and softwood have increased in the 1990s, the percentage of increase has been much greater for hardwood; in real prices, hardwood stumpage has approximately tripled in value since the early 1980s and now exceeds the market value of softwood pulpwood a decade ago. Hardwood and softwood equilibrium stumpage prices are both projected to more than double in the U.S. South in the next 10 years, according to the 1998 NAPAP Model.

This analysis is linked to the TAMM/ATLAS assessment of timber growth and timber supply, and results are sensitive to timber growth assumptions in the U.S. South. The Forest Service is in the process of revising and updating RPA timber growth assumptions for private timberlands in the U.S. South, and higher growth assumptions may result in somewhat smaller projected increases in pulpwood stumpage markets.

The current results indicate that it will become economically feasible in the future to grow significant volumes of hardwood short-rotation woody crops (SRWC) on agricultural land. Beyond the year 2010, the supply of hardwood pulpwood from agricultural lands (hardwood SRWC) is projected to increase significantly. Hardwood SRWC supply will reach an equilibrium of 20% of total pulpwood supply by the year 2050, substituting for harvest of hardwood pulpwood on forest lands. Figure 14 shows the historical and projected distribution of total U.S. pulpwood supply. Softwood and hardwood timber harvest provides the bulk of projected pulpwood supply, since wood residue supplies are projected to decline.

Hardwood SRWC technology has been applied by a number of U.S. forest product companies, primarily in the growth of hybrid poplars on leased agricultural land with harvest rotations of around 6 to 8 years. This analysis suggests that by 2050, the total agricultural land area devoted to growing such crops could approach 2 million hectares-an area perhaps 50 times greater than the current agricultural land area devoted to hardwood SRWC, but nevertheless less than 2% of total cropland in the United States. However, these results are sensitive to alternative assumptions regarding the intensity of future timber management on forest lands. If timber management and pulpwood production from forest lands increase in the U.S. South, there will be less likelihood for significant expansion of hardwood SRWC supply from U.S. cropland.

SUMMARY

This analysis revealed a gradual decline in fiber raw material use per ton of pulp, paper, and paperboard production in the United States since the 1950s, and a gradual decline is projected into the future with a shifting mix of production technologies and product outputs (from paper to paperboard, for example) (Fig. 15). Of particular note is the decline in use of pulpwood per ton of product output; total domestic pulpwood input (roundwood and residues) has declined from over 3 m^3/metric ton in the 1960s and 1970s to the current level of 2.3 m^3/metric ton. Domestic pulpwood input (including timber harvest, residues, and SRWC supply) is projected to be 1.6 m^3/metric ton of product output by 2050. Pulpwood input obtained from domestic forest harvest (exclusive of residues and imports) had reached 2.5 m^3/metric ton of product output by 1960, but it declined to only 1.7 m^3/metric ton in the latter part of the present decade and it is projected to decline to 1.1 m^3/metric ton by 2050 (excluding agricultural SRWC supply). Thus, technological progress, evolution of markets, and fiber substitution in pulp and paper have contributed greatly to conservation of forest resources in recent decades and are projected to contribute even more in the future. Nevertheless, total consumption of wood and wood fiber raw materials in pulp and paper is projected to increase in the future (Fig. 11), with resultant increases in supply and consumption of pulpwood (Figs. 12 and 14).

Consumption of wood and fiber raw materials in pulp, paper, and paperboard production has increased in the United States during this century and is projected to increase in the future at a

decelerating rate (Fig. 11), based on a detailed economic assessment of supply, demand, and production technology in the pulp and paper sector. The harvest of pulpwood on forest lands is the largest single source of wood fiber, followed by recycled fiber and wood residues. Since the mid-1980s, residues have declined in supply while use of recycled fiber has increased. The use of recycled fiber is projected to increase more steadily in the future, with slower growth in rates of recovery and utilization of recycled paper.

Based on supply-demand analysis, equilibrium pulpwood stumpage values are projected to increase, particularly in the U.S. South. Projected increases in the market value of pulpwood gradually improve the prospects for growing SRWC on agricultural land. Harvest of pulpwood on forest lands is nevertheless projected to provide the bulk of total U.S. pulpwood supply through the first half of the next century (60% to 70% of total supply) as wood residue supplies decline. Softwood pulpwood harvest in particular is projected to increase as supplies of softwood residues decline.

Most future growth in pulpwood equlibrium supply-demand quantities is projected to occur in the U.S. South, particularly the South Central region. The South is projected to remain the dominant region in pulpwood supply and production of pulp, paper, and paperboard products. Pulpwood supply-demand quantities are projected to remain relatively static in the U.S. North and West.

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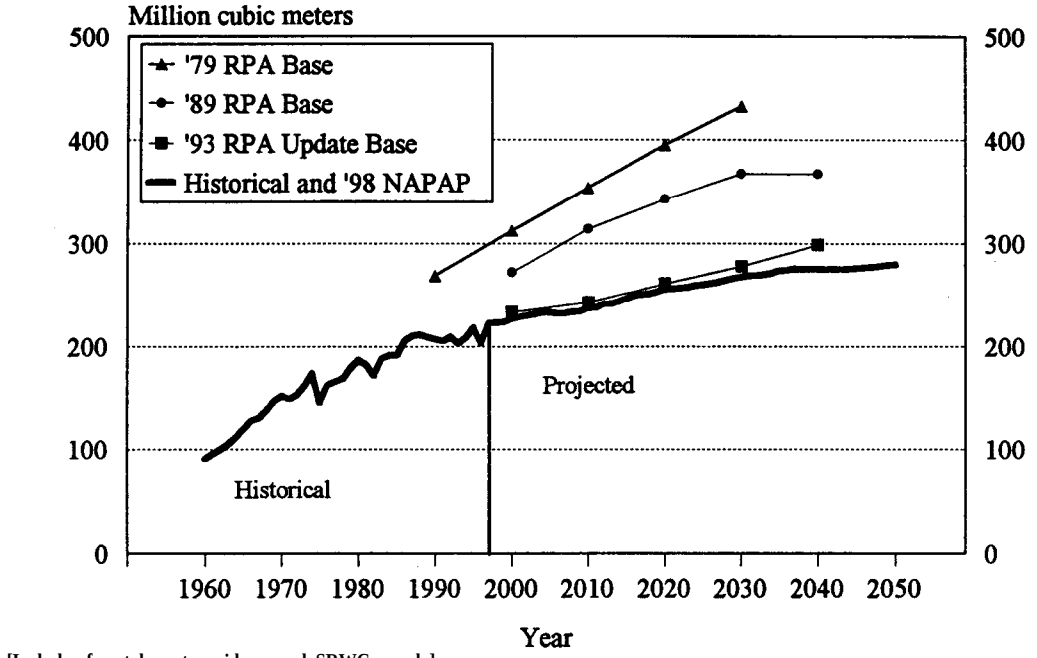


Figure 1 .–Pulpwood supply/demand equilibria in the United States. Comparison of RPA assessment projections and historical trend.

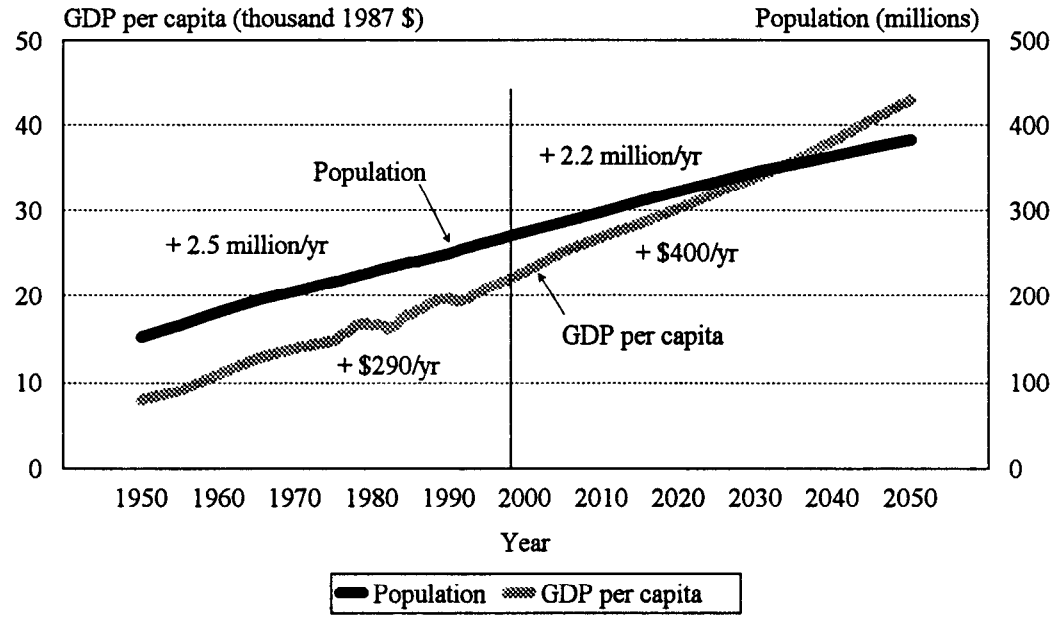


Figure 2.--U.S. population and gross domestic product (GDP) per capita.

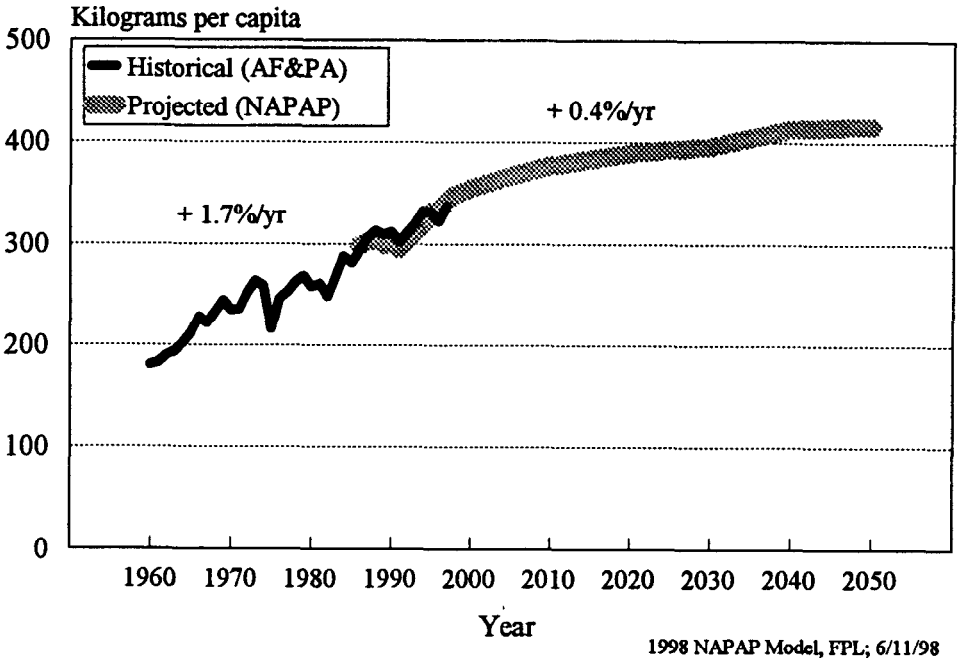


Figure 3 .–U.S. per capita paper and paperboard consumption.

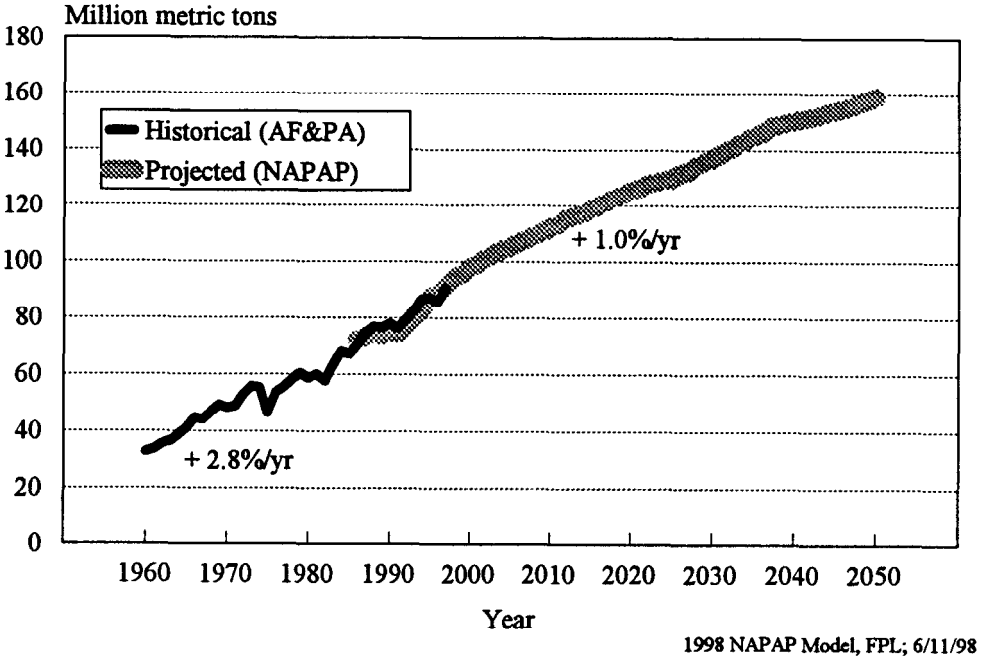


Figure 4.--Total U.S. paper and paperboard consumption.

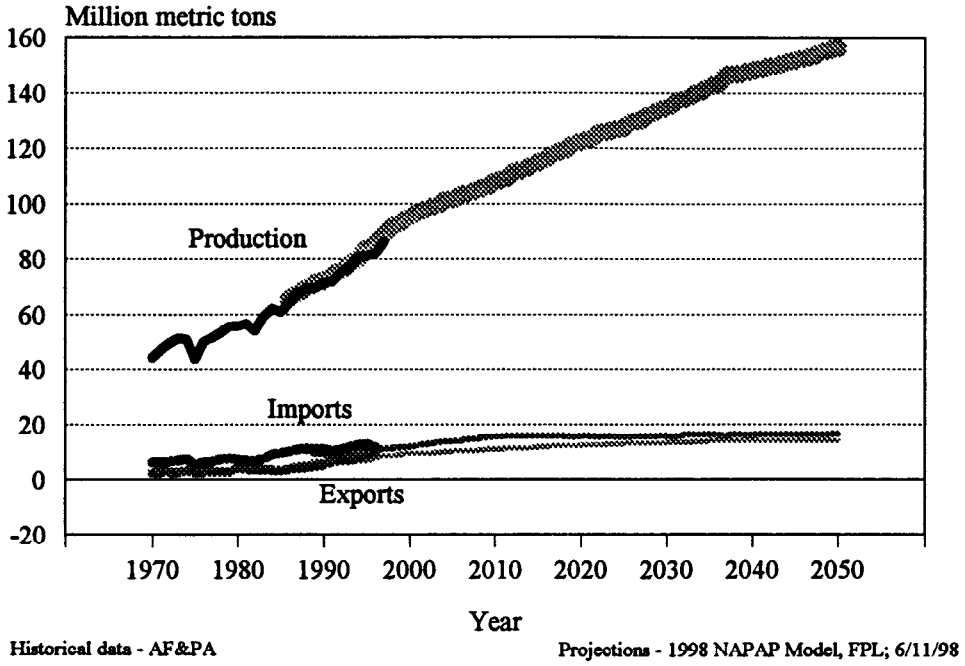


Figure 5.--U.S. paper and paperboard production and trade, historical and projected.

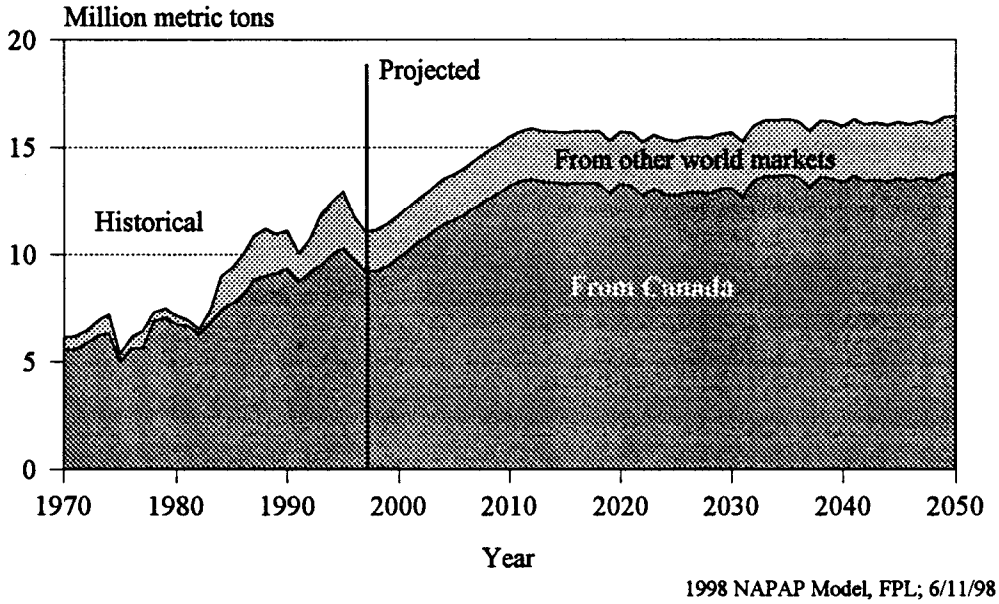


Figure 6.--U.S. imports of paper and paperboard, historical and projected.

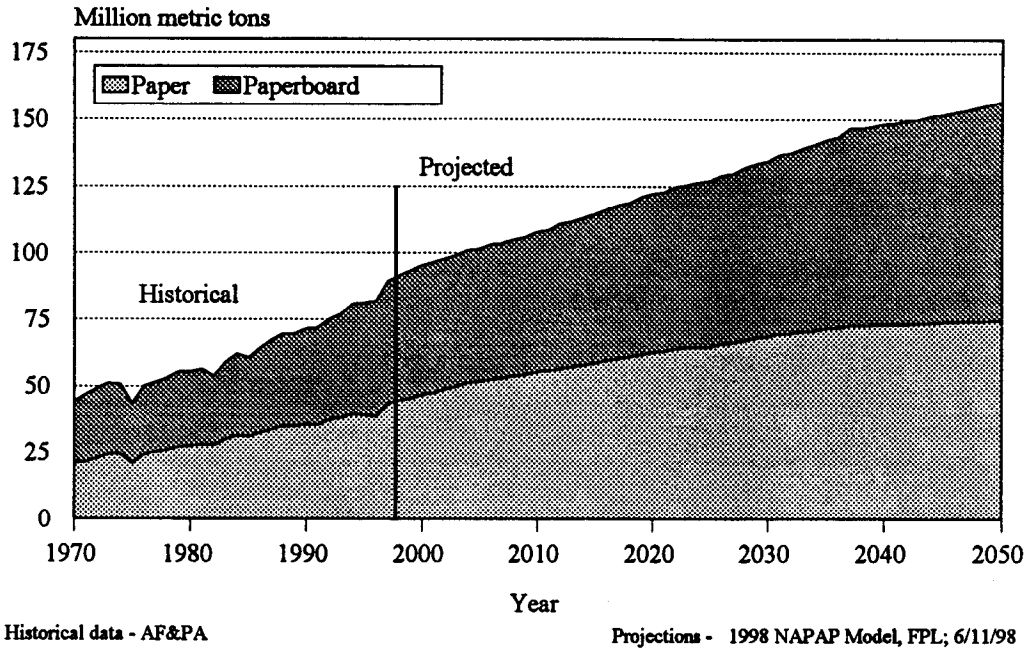


Figure 7.--U.S. paper and paperboard production, historical and projected.

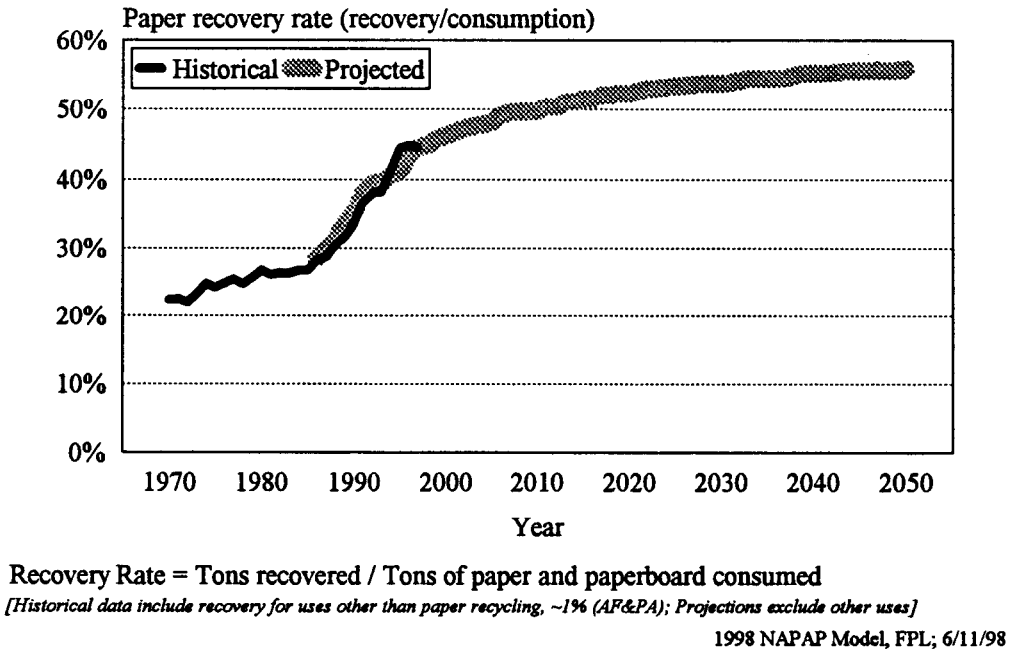


Figure 8.--U.S. rate of paper recovery for recycling, historical and projected.

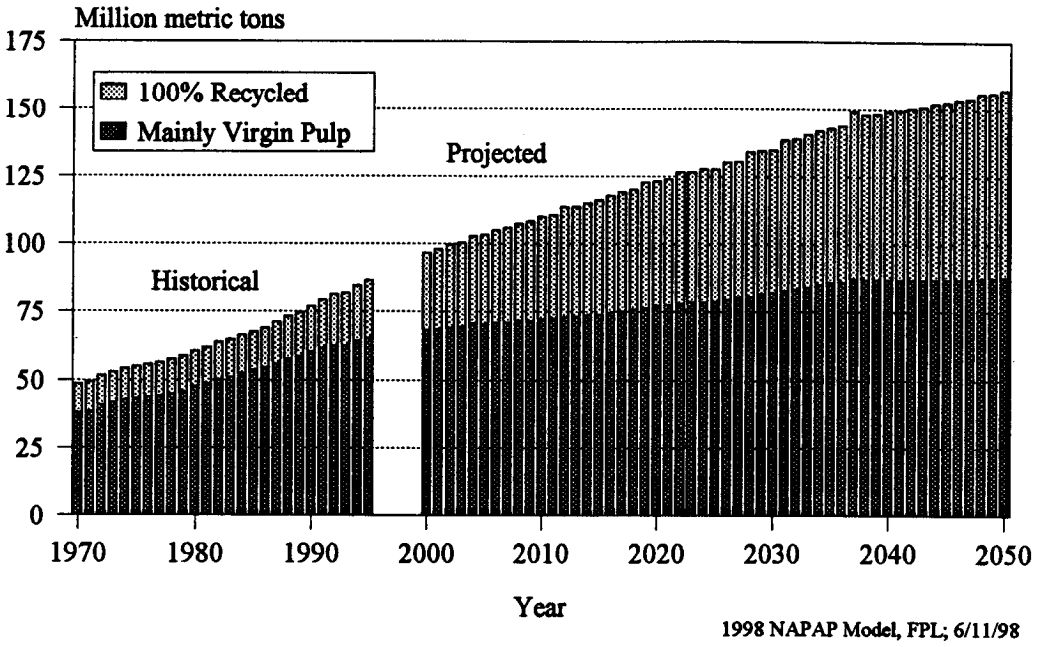
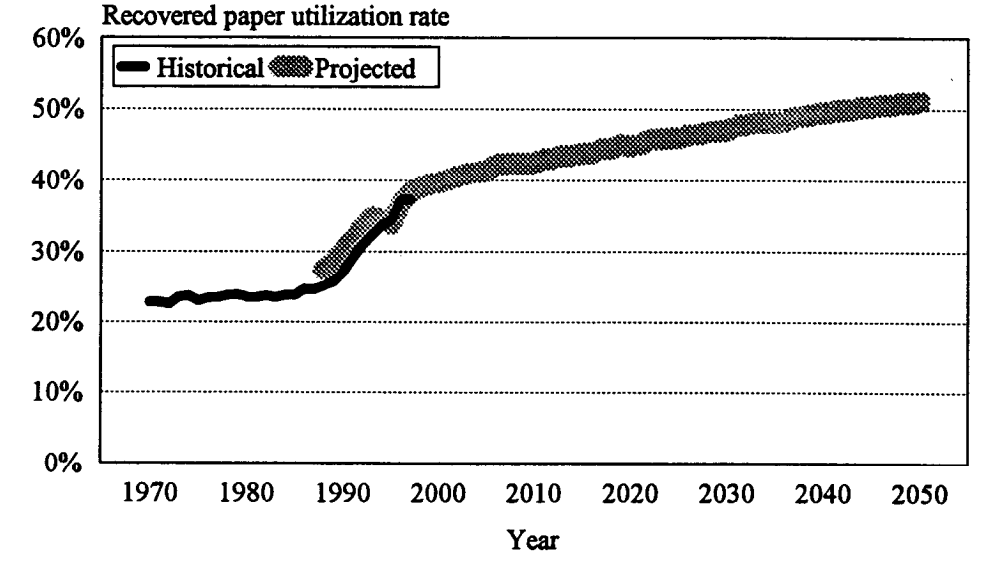


Figure 9.--Total U.S. paper and paperboard production capacity by type of process, historical and projected.



Utilization rate = Tons utilized at mills / Tons of paper and paperboard produced

1998 NAPAP Model, FPL; 6/11/98

Figure 10.--U.S. recovered paper utilization rate, historical and projected.

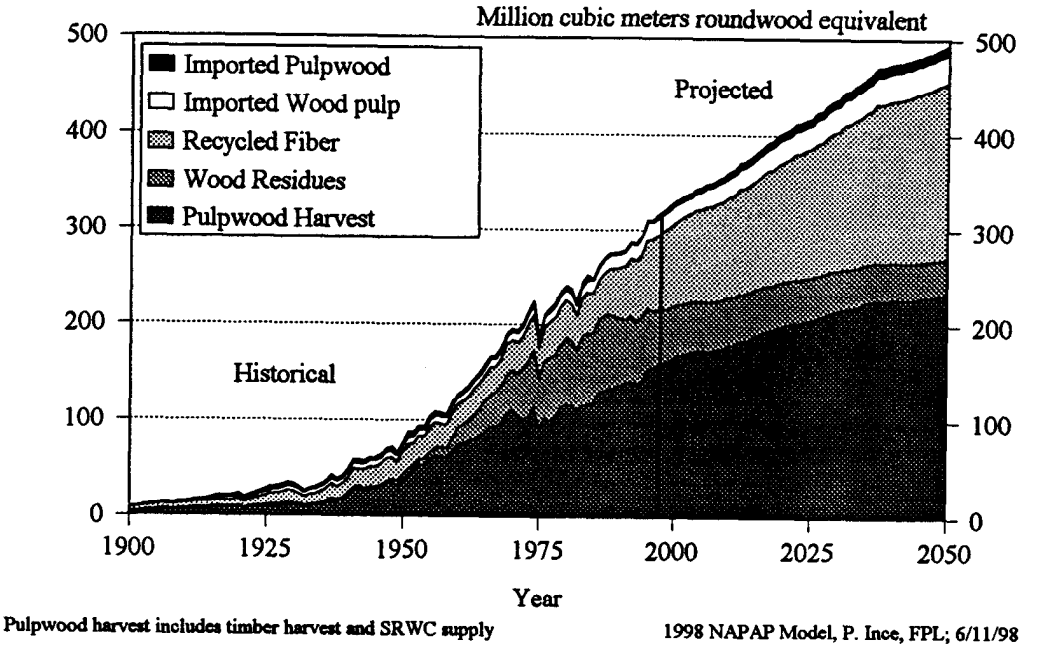


Figure 11.--Consumption of wood and fiber raw materials in pulp, paper and paperboard production in the United States, historical and projected.

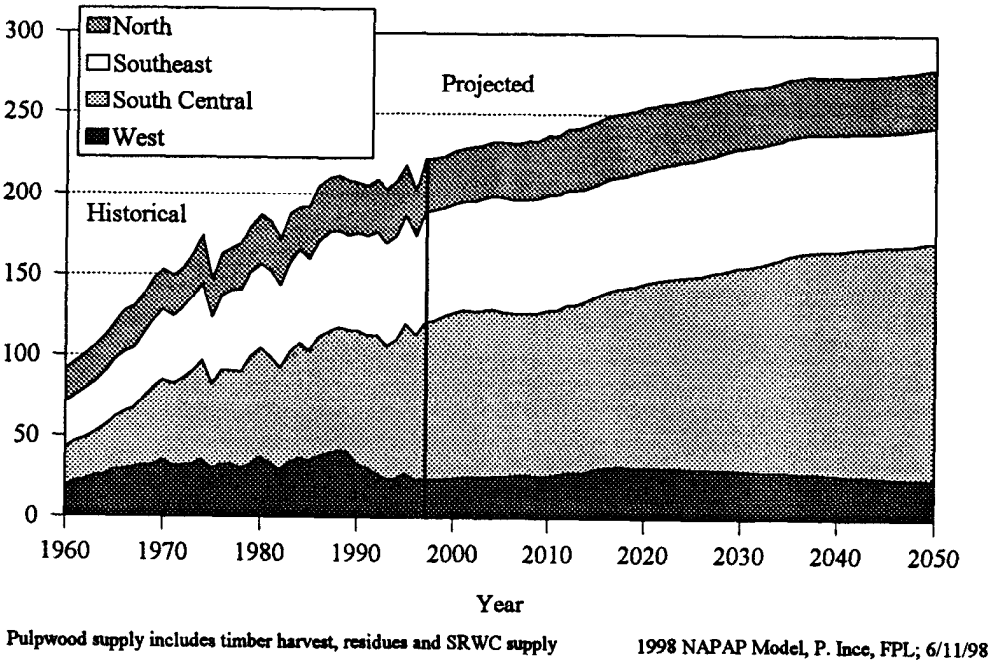


Figure 12.--Pulpwood supply by region in the United States, historical and projected.

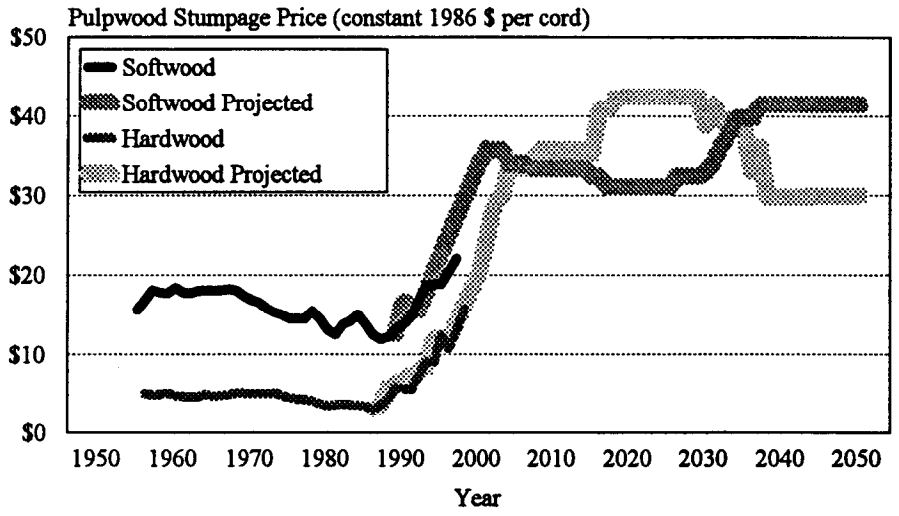


Figure 13.--Pulpwood stumpage market equilibrium trends in U.S. South for hardwood and softwood, historical and projected.

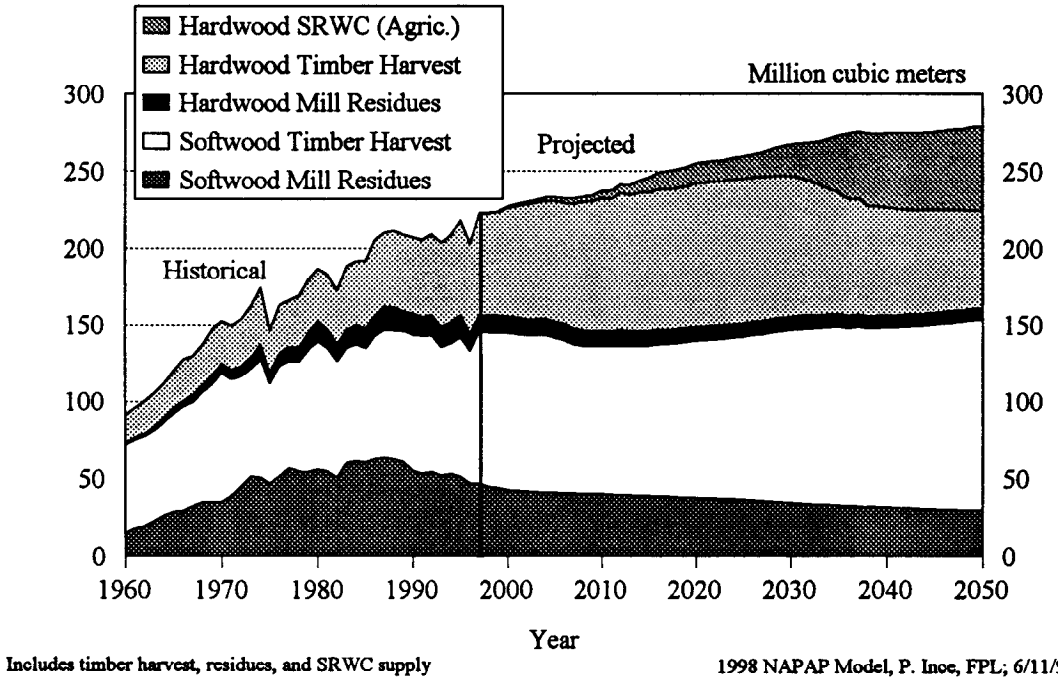


Figure 14.--U.S. Pulpwood supply by species group and category, historical and projected.

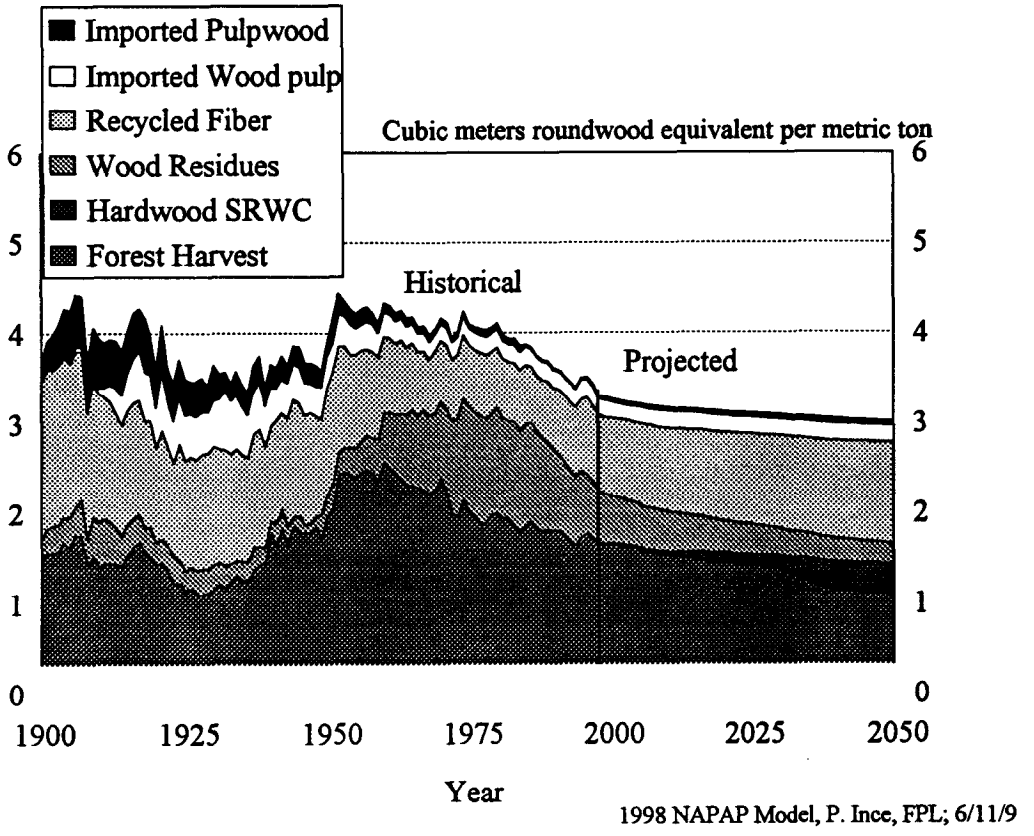


Figure 15.--Fiber raw material use per ton of pulp, paper and paperboard produced in the United States, historical and projected

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