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Recycling of Wood and Paper Products in the United States

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Abstract

This report describes the current status of wood and paper recycling in the United States and predicts the production and market consequences of increased recycling. The results suggest that the rate of paper recycling will rapidly rise in the 1990s, mainly as a result of the competitive evolution of fiber markets and papermaking technologies. The consumption and export of paper and paperboard are also projected to grow, but imports are projected to generally decline. In the context of increased paper recycling, the production of lumber and structural wood panels is projected to increase. However, the greater demand for sawtimber, coupled with projected declines in timber harvest on National Forests, will result in higher softwood sawtimber stumpage prices.

The information presented here was prepared for the United Nations Economic Commission in June 1994. Historical data were derived from various sources, including government agencies and industry trade associations. Economic projections were developed by the author and others in the USDA Forest Service.

Keywords: Forest products, recycling, markets, trends

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Recycling of Wood and Paper Products in the United States

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Background

Large volumes of wood fiber have been recycled in the United States and worldwide for many years, principally in the pulp and paper sector. Market conditions and availability of technology have largely determined the evolution of wood and paper recycling in the United States, and such recycling has occurred primarily within the forest products sector. In the past decade, mounting concerns about waste disposal and legislative responses have also influenced markets and recycling rates.

In the United States, wood and wood fiber represent the largest material component of municipal solid waste (MSW), accounting for more than half of the total amount by weight according to United States Environmental Protection Agency (EPA). Wood and wood fiber appear in MSW chiefly in the form of discarded paper and wood product wastes, and also in the form of yard wastes. In the United States, paper (including paperboard) has long been the most heavily recycled component of MSW (accounting for more than two-thirds of the total amount of material recovered from MSW in 1990).

Recovery of paper for recycling has increased in recent years as a result of widespread expansion of paper collection and sorting (e.g., community-based curbside collection, sorting, and office wastepaper collection). The increase in collection and sorting has been directly or indirectly a response to declining availability of landfills; long-term environmental, economic, and human health problems associated with landfills and waste incineration; and increasing costs of waste disposal. By collecting and sorting material for recycling, disposal costs have been avoided. However, in simple economic terms, expansion of collection and sorting programs has led to cheaper and more abundant supplies of recovered paper, providing the market incentive for industrial expansion of paper recycling.

Prices for recovered paper vary in the United States over time and by category of recovered paper: old newspapers and mixed papers have the lowest prices, pulp substitutes and high grade

deinking grades of recovered paper the highest prices, and old corrugated containers intermediate prices. However, in general, prices for all the grades have been at historically low levels in the 1990s, as a result of increased collection and recovery. This is the so-called "glut" in recovered paper markets. The paper industry has responded to the market signal of sustained low prices for recovered paper by increasing the use of recycled fiber relative to virgin fiber. Since the late 1980s, there has been a significant and continuous upward shift in paper recycling rates in response to market conditions.

Evolution of Recycling Legislation

Understanding the evolution of legislation related to wood and paper recycling in the United States requires an understanding of the landfill crisis and how it evolved since the 1970s. In 1978, there were approximately 20,000 MSW landfills operating in the United States, but more than 14,000 were closed in subsequent years as a result of environmental risks, operating costs, or limits on capacity. By 1990, there were only about 6,000 MSW landfills in operation (Denison and Ruston 1990). In the United States, more than half the states are now projected to have less than 10 years of remaining landfill capacity (according to recent surveys by the National Solid Waste Management Association [NSWMA] 1992).

In the meantime, MSW volumes have increased to 178 million metric tonnes per year in the United States (EPA 1992), having doubled from the 1960s to 1990s (NSWMA 1992). The huge volumes of MSW generated in the United States have been projected to increase substantially in the years ahead. Without additional source reduction the amount of MSW generated will exceed 200 million tonnes by the year 2000 (EPA 1992). It was estimated that in 1990, 37.5 percent (by weight) of all MSW generated in the United States was paper and paperboard (EPA 1992). Paper and paperboard was by far the largest single component of MSW. These circumstances have led to a solid waste management

dilemma (that is, what to do about increasing volumes of waste, including substantial volumes of wastepaper, against a backdrop of limited landfill space and availability).

Current systems for MSW disposal in the United States are based on three principal approaches: landfilling, recycling, and incineration. While waste volumes have increased, recycling and incineration have increased proportionately faster than landfilling in recent years. In 1992, the EPA estimated that 17 percent of MSW was recovered for recycling or composting, 16 percent was incinerated, and 67 percent was landfilled or otherwise disposed of (EPA 1992). These percentages vary by type of waste material (e.g., higher proportions of paper are recovered for recycling, roughly 40 percent by 1993). However, landfilling remains a primary disposal mechanism despite the fact that landfill space and availability are declining.

Although landfilling was once viewed as a benign and efficient option for waste disposal, that perspective has substantially changed, both from a scientific and technical standpoint as well as from an economic and public perspective. Basic problems associated with landfills are now widely recognized, including potential for groundwater contamination by landfill leachate and landfill gas emissions. Surveys have shown that MSW landfill leachate may contain concentrations of toxic and carcinogenic substances that greatly exceed human health exposure standards (EPA 1988; OTA 1989). Contamination of groundwater by landfill leachate and surface water by landfill runoff is a serious concern in the United States, where virtually all municipal and rural drinking water comes from groundwater wells or surface water sources. Gas emissions include carbon dioxide and methane (hazardous as toxic and explosive) from decomposition of organic materials, and carcinogenic compounds such as benzene, vinyl chloride, and methylene chloride. Although severity and risk of these problems can vary significantly depending on materials placed in landfills, local climate (rainfall and temperature), soil conditions, elevation of the water table, and proximity to local population, such problems are in fact being encountered in all regions of North America where landfills have been sited in recent decades.

In the United States, cleanup costs for particularly hazardous sites are borne in part by Federal funding via the so-called "Superfund" administered by EPA, while local communities and states bear costs of cleaning up other less hazardous sites. In the United States, billions of dollars have been spent in recent years on remediation and cleanup of abandoned landfills, dumps, and other waste disposal sites. By 1988, more than 20 percent of toxic waste sites on the Superfund National Priority List (NPL) were MSW landfills (249 of 1,177 Superfund NPL sites), and 8 of the 20 worst Superfund NPL sites were MSW landfills (Denison and Ruston 1990). Many communities in the United States now face very substantial costs to clean up or remedy the contamination

problems associated with locally abandoned landfills, or to enhance the performance of existing waste management and disposal systems. Such costs can place very heavy financial burdens on local governments, which must also provide education, police protection, and other local community services. Thus, the landfill crisis has also contributed to problems of community welfare and stability in many localities. In addition, landfill sites tend to depress local real estate values as a result of the nuisance problems of equipment noise, odors, traffic congestion, drifting debris, and attraction of insects and birds.

Widespread recognition of the environmental, economic, and human health problems led to a significant decline in siting of new landfills in the 1980s and to siting of landfills in more remote locations (in neighboring states in some cases). As local availability of new landfills began to decline in the 1980s and landfills were located in more remote locations, fees increased substantially for disposal of waste in landfills. Such fees are called "landfill tipping fees." Tipping fees increased the most in the more densely urbanized U.S. North and East, but also substantially in the South and West. Between 1982 and 1990, tipping fees (measured in constant 1986 dollars) increased 386 percent in the North (nearly 500 percent in New England), 221 percent in the South, and 210 percent in the west (NSWMA 1992). Rapidly escalating tipping fees, along with concern about other economic, environmental, and health problems of landfills, prompted many local and state governments and other institutions to initiate programs for collection and sorting of materials for recycling, to divert waste from landfills and avoid disposal costs.

Between 1983 and 1991, 25 states enacted laws mandating that their local communities make provisions for recycling (i.e., collection of recyclables) or otherwise provide their citizens with the opportunity to recycle (Alig 1992). The number of communities with active collection programs soared from less than 1,000 in the late 1980s to more than 4,000 by 1992. Since paper and paperboard has generally represented the largest single component of MSW, it was natural that paper recovery would become a major focus of the new collection and sorting programs. Most community collection programs encompassed collection and sorting of paper or paperboard materials. In the meantime, countless business establishments and other institutions also initiated paper collection and recovery programs.

Ironically, increased collection of recyclable paper helped to create a glut of supply in U.S. markets for recovered paper by the early 1990s, as growing demand could not match the rapidly increasing supply. The glut in recovered paper markets has been most acute in the Northeast and upper Midwest in recent years, with prices significantly depressed for old newspapers (ONP), old corrugated containers (OCC), and mixed grades. In addition, the increased collection has

stimulated a significant increase in recycling, as the paper industry has been attracted to use of recycled fiber as a result of the sustained low prices. Generally, the collection programs have achieved the purpose of diverting significant quantities of materials from local landfills.

In the face of the market glut and depressed prices created by increased collection, some states have enacted laws aimed at further “stimulating” demand for recyclables, such as the minimum mandatory recycled content laws for newsprint that were passed by 12 states between 1989 and 1992. Such laws generally require newspaper publishers to certify that the newsprint they use in publishing newspapers contains a certain minimum percentage of recycled fiber (usually around 40%), with a graduated timetable for implementation of the law (usually by the year 2000). Voluntary agreements by publishers to use recycled newsprint exist in 13 other states. Similar state laws for telephone directories have been passed by a few states, but so far no other paper products have been thus regulated (Alig 1992). Consideration has been given to such regulation at the Federal level (most notably in bills submitted recently for reauthorization of the Resource Conservation and Recovery Act of 1972, and in proposals by various public interest groups), but no Federal action has been taken thus far that would directly regulate recycled fiber content of paper consumed in the private sector. In 1993, President Clinton issued an Executive Order to Federal government agencies specifying minimum recycled content in various grades of office paper purchased by the government (requiring 20 to 50 percent recycled content, depending on grade). However, government purchases are thought to be less than 3 percent of total consumption in those grades, and many government agencies already exclusively use office paper made with recycled fiber.

The most recent U.S. legislative and policy trends related to wood and paper recycling are related to government programs that will facilitate market development for recyclables or that will promote economic development based on technologies that use recycled materials. State legislatures have recently turned their attention away from landfill bans and collection programs toward programs that will help ensure utilization of recyclables (Miller 1994). Since 1993, the number of states considering and offering investment tax credits or other tax incentives for recycling technologies has increased. Tax credits or tax incentives for recycling technologies were available in 28 states by 1994. Also, by 1994, 16 states had market development councils to promote recycling

At the Federal level, the EPA recently launched the Recover America recycling program, which consists of an aggregate of projects and new initiatives that aim to protect the environment and conserve natural resources, and at the same time stimulate economic growth, corporate competitiveness, and job creation (Leroux–Duncan and Carr 1994). Goals and objectives of EPA include market development, by providing

assistance to recycling businesses, maximizing Federal purchases of recycled products, increasing access to Federal information and research, and fostering exchange of market development information. The EPA recycling programs are being implemented partly under the auspices of the Climate Change Action Plan (October 1993), which was developed in connection with the Rio Earth Summit. The Action Plan recognized a significant role for increased paper recycling and wood recycling in helping to stabilize or reduce greenhouse gas emissions in the United States. The Action Plan also announced increased funding for research on developing new technologies for paper and wood recycling.

Economic Trends in Paper and Wood Recycling

In the meantime, while there have been legislative and government attempts to grapple with waste disposal and recycling, the U.S. pulp and paper industry has responded to the increased collection of paper by substantially increasing the use of recovered paper in production processes. As late as 1986, recycled wood fiber (as recovered paper) accounted for less than one-fourth of fiber input to the U.S. pulp and paper industry. By 1993, recycled fiber accounted for nearly one-third of the fiber input, while the remainder was mostly “virgin” wood fiber. In 1993, around 32 million metric tonnes of paper and paperboard were recovered for recycling in the United States, with about 26 million tonnes used in domestic paper and paperboard mills, about 5 million tonnes exported, and almost 1 million tonnes used for miscellaneous products (such as insulation and molded pulp products).

In addition, in 1993 about one-third of the virgin wood fiber input to the U.S. pulp and paper sector consisted of wood residues (of 205 million cubic meters of pulpwood inputs, 73 million cubic meters were wood residues from sawmills and plywood mills). Residues were also used for particleboard (9 million cubic meters) and fuelwood (48 million cubic meters). However, residues are not considered to be a “recycled” material in the United States. Residues are considered to be “virgin” wood fiber since they are derived as by-products directly from the processing of sawlogs and veneer logs. In contrast to paper production, very little recycled wood fiber has been used in the production of “solid wood” products such as lumber and plywood or in end-uses for those products, such as in housing and furniture. The solid wood products rely primarily on virgin wood resources (or wood residues in the case of particleboard).

The sustained glut in recovered paper markets (by 1993, prices had been depressed for several years) provided strong economic incentive for substantial investment in recycling capacity by the pulp and paper industry in the 1990s. Although the capital investment and construction process was

prudently graduated in response to market conditions (recovered paper prices have historically been rather volatile and new paper mills represent large capital investments), it has become clear that the pulp and paper sector is experiencing a major upturn in recycling in the 1990s. According to the American Forest and Paper Association (AF&PA), by 1993 the pulp and paper industry had announced more than 140 major mill projects for expansion of existing capacity or siting of new mills for use of recycled fiber.

The addition of paper recycling capacity continues to be met by increased collection and recovery of paper for recycling. However, demand will gradually catch up with supply, resulting in price increases for recovered paper commodities. While much of the new recycling capacity has been added at integrated pulp and paper mills, much of the new capacity has been geared exclusively toward use of recycled fiber. This has created a growing source of inelastic demand for recycled fiber in North America, which will eventually result in higher prices for recovered paper commodities as demand gradually catches up with supply. It is now anticipated that the market glut for recovered paper will be eliminated, as demand comes more closely in line with growing supply toward the end of the 1990s. Recovered paper prices will be pushed at that time to significantly higher levels, perhaps obviating the intent of mandatory recycled content laws (designed to help create markets for recyclables).

In addition to recycling, incineration and other disposal options are alternatives to landfilling. Wood or wood fiber alone is a fairly clean combustion fuel, with insignificant quantities of sulfur compared to coal, for example, but with moderately low combustion heat value (approximately half to two-thirds that of low-grade coal on a dry weight basis). In the United States, incineration of wastepaper and waste wood occurs primarily in MSW incineration facilities. Two types of facilities are common, the so-called "mass-burn" facilities and refuse-derived fuel (RDF) facilities. Examples of each type of facility exist at many locations in the United States. The mass-burn facilities consume primarily unsorted MSW, which may contain substantial quantities of wastepaper. The RDF facilities operate with a presorting or classification system that separates the more highly combustible components of MSW for fuel (e.g., including wastepaper, plastics, and organics). By 1990, approximately 160 large waste combustion facilities were operating nationwide (Denison and Ruston 1990).

Such combustion facilities generally require enormous capital investments, in the range of hundreds of millions of dollars, largely to maintain adequate control over air emissions (Denison and Ruston 1990). In addition, as affirmed in a recent U.S. Supreme Court case, the ash residue from such combustion facilities may be regarded as a hazardous waste, requiring costly treatment and disposal mechanisms. Thus, the primary source of revenue at MSW incineration facilities

are payments received for accepting garbage (tipping fee revenues), while revenues from sale of energy generally cover only a small fraction of costs. A greater degree of fuel presorting can help remove the more hazardous materials prior to combustion, but sorting can be costly and may approach the cost of sorting required for recycling. Thus, it would appear that waste incineration will remain economical in the future only to the extent that MSW or refuse-derived fuels have low or negative values, and if payments (tipping fees) are received for accepting such materials, or energy prices increase dramatically. If prices for sorted recovered paper were to increase substantially in the future as expected, without energy price increases, use of recovered paper as fuel may become less economical.

Composting and similar uses are additional alternatives to landfilling, incineration, and recycling. In many communities, MSW or sorted organic material from MSW is composted, producing a relatively inert soil amendment or mulching material. Composting can be applied to wastepaper and waste wood. Composting of MSW is done most efficiently in composting facilities, which commonly feature a large composting vessel or digester that can reduce organic material to acceptable compost in a matter of weeks or days. An economic drawback to the composting option for wastepaper is the relatively low potential value of the end product, at most having the value of a gardening soil or mulching material. As with incineration, composting will remain economically viable only as long as the input waste materials have little or no alternative value, or if payment is received for accepting such materials (e.g., as tipping fees). As recycling increases and recyclables gain value as alternative raw materials for production processes, disposal options such as composting will likely become less economical.

Other utilization options that have been applied commercially to wastepaper include cellulose insulation, molded pulp products, animal bedding, paper mulch, packaging cushioning material, and wallboard panels. Actual use of recovered paper for molded pulp products (such as egg cartons and containers), cellulose insulation, and other uses is estimated to have nearly doubled between 1986 and 1991 (AF&PA), but the total quantity is still estimated to be only around 0.8 million tonnes per year. Many such products have low value, either because recovered paper is used as a substitute for other low-value materials such as animal bedding straw and garden mulch or because the cellulose products compete against materials with better perceived product performance (insulating materials such as foam or fiberglass, or foam plastics used in lightweight containers).

Exceptions to this rule include higher value composite products or structural products that can be made with recycled wood fiber. One example is the composite plasterboard wallboard panel, introduced recently in the United States as a substitute for conventional gypsum wallboard. The new

panels are a composite of recycled fiber (from old newspapers) and gypsum. Instead of having a solid gypsum core and recycled paperboard facing as in conventional gypsum wallboard, the new panels are made with a composite blend of gypsum and a large fraction of recycled fiber. They are reputed to have advantages of lighter weight and better fastening performance than conventional gypsum wallboard. Other types of composite products have been explored, including composites of recycled wood fiber with recycled plastics. Also, it has been demonstrated that certain types of molded structural products can be made from recycled wood fiber, using press drying technology; the products have been shown to have some excellent material properties. Thus, recycling paper or waste wood into higher value composite products or structural products might represent an economically viable option, even if recovered paper prices increase in the future.

However, current technological developments within the area of wood recycling (outside of paper recycling) are aimed mainly at nonwood markets, or at relatively small niche markets, mostly in the category of miscellaneous wood products that offer high value but limited volume. Very little development is aimed at direct competition in mass commodity markets of lumber, plywood, or oriented strandboard (OSB), although such development could begin in the future. Thus, at least within the next decade, it is unlikely that composite or structural products made with recycled wood fiber will capture a significant share of mass commodity markets for conventional wood products.

Trends in Supply and Demand for Wood Fiber

Increased paper recycling will reduce future growth in pulpwood demand and will extend timber supplies, making timber harvesting more economically attractive than it would be otherwise. Many trees that are “saved” by recycling will likely be harvested instead for other end-uses besides paper. Demand for wood and wood fiber always tends to equal supply. Thus, increased paper recycling will tend to favor greater overall consumption of forest products in domestic and overseas markets. However, other developments will also affect timber supply and demand. Ongoing efforts to preserve native ecosystems, particularly on public forest lands in the western United States, will involve less intensive forest management practices and reductions in timber harvest levels, which will constrain timber supplies.

Paper recycling rates have been increasing rapidly in the 1990s, and they are projected to increase throughout the decade, followed by more gradual increases into the next century. The rate of increase in recycling will tend to decline toward the end of this decade, as prices for recovered paper commodities increase. Roundwood pulpwood demand is projected to increase at a more modest rate than it has in

recent decades, as a result of increased paper recycling. In the early part of the next century, pulpwood supplies are projected to increase (particularly for softwoods) as a result of intensified tree planting programs of the past decade (particularly in the U.S. South). Consequently, pulpwood prices are expected to remain stable in the United States, or perhaps decline. The balance of trade in pulp and paper is projected to swing in favor of U.S. exports, as a result of the relative abundance of virgin and recycled fiber supplies in North America. In general, U.S. production of pulp, paper, and paperboard will continue to increase, with growth in fiber demands matched by growth in domestic fiber supplies.

Although increased recycling will extend pulpwood and fiber supply, the United States still appears to face serious supply problems for large dimension sawtimber, particularly softwood sawtimber. National Forest timber harvest levels have declined, particularly in the major softwood sawtimber producing region of the U.S. West, and National Forest harvests are expected to remain at levels much lower than experienced in the 1980s. Consequently, growth in domestic sawtimber supply is not expected to match growth in sawtimber demand. Softwood lumber prices are expected to increase in the 1990s, and indeed substantial price jumps have already been experienced. Softwood sawtimber prices are expected to increase substantially in the decades ahead, despite increased paper recycling. Increased paper recycling will help ameliorate timber price increases to some extent, but it will not solve the relative shortage of softwood sawtimber in the next decade or two. Thus, economic conditions will tend to favor development of alternative technologies that can substitute for conventional solid-wood products technologies, perhaps including new technologies based on recycled wood resources. However, difficulties are presented by the need to penetrate mass commodity markets that are traditionally based on solid wood products and that are encumbered by building codes and other constraints that may limit the immediate acceptance of recycled wood products. The following section discusses likely consequences of increased recycling in terms of overall wood and wood fiber utilization.

Consequences of Increased Recycling

Consequences of increased paper and wood recycling, in combination with other developments, can be understood by comparing the overall pattern of wood and wood fiber use at different points in time, including historical and projected points in time. Consequences are illustrated here by a series of figures showing overall wood and wood fiber inputs and outputs in the U.S. forest products sector at several points in time. The figures illustrate the wood and wood fiber inputs and primary product outputs for the entire forest product sector, including recycled wood and wood fiber, residues, and virgin timber resources. Timber and solid-wood product

volumes are shown in millions of cubic meters, solid volume. Paper, paperboard, and recovered paper volumes are shown in millions of metric tonnes.

Figure 1 shows historical data for the year 1986, a year prior to the recent acceleration in U.S. paper recycling rates. Figure 2 shows historical data for the year 1993, representing current conditions, and showing the consequences of increased recycling since 1986. Figures 3 and 4 show projections for the year 2005 under two alternative future scenarios. One scenario is a "Base" projection, based on likely market and technology evolution. The other is an alternative scenario ("ALT"), reflecting possible higher wood and paper recycling rates, potential effects of waste reduction policies, and introduction of new technologies for wood and paper recycling. Projections were based in part on timber supply and demand studies done recently for the USDA Forest Service, with some updated adjustments (Ince 1994).

Figure 1 illustrates volumes of wood and wood fiber raw materials and output commodities in the United States forest product sector for the year 1986. As Figure 1 shows, the pulp and paper sector consumed by far the largest volume of recycled wood fiber in 1986 (in the form of recovered paper), approximately 16.3 million tonnes, compared with 0.4 million tonnes recycled into miscellaneous products and 3.7 million tonnes exported. In 1986, 28 percent of paper and paperboard consumed in the United States was recovered for domestic recycling and export (20.4 million tonnes). The recyclable paper utilization rate in the U.S. pulp and paper industry was approximately 25 percent (tonnage of recovered paper recycled in proportion to tonnage of paper and paperboard output). The year 1986 was significant for two reasons. One reason was that substantial increases in paper recycling began to occur just after 1986. The other reason was that National Forest timber harvest levels also began to decline after 1986. In 1986, the National Forests provided a timber harvest of approximately 64 million cubic meters, of a total U.S. timber harvest of 493 million cubic meters. However, most of the National Forest timber harvest consisted of large diameter softwood sawtimber, used primarily for sawnwood and plywood production.

Figure 2 illustrates the volumes of wood and wood fiber raw materials and primary product outputs in the United States forest product sector for the year 1993. By that year, 40 percent of paper and paperboard consumed in the United States was recovered for domestic recycling and export (approximately 32.5 million tonnes, of which 26.4 million tonnes was recycled in domestic paper and paperboard mills, 5.3 million tonnes exported, and 0.8 million tonnes used in miscellaneous products). The recyclable paper utilization rate in the pulp and paper industry had climbed to approximately 34 percent by 1993. In comparison with Figure 1, the data shown in Figure 2 illustrate the fact that net U.S. production of primary pulp and paper products had increased substan-

tially between 1986 and 1993 (from around 70 million tonnes to nearly 84 million tonnes, a 19-percent increase, taking into account total paper and paperboard production plus production of market pulp for export). Nevertheless, as a result of increased paper recycling, pulpwood inputs to the pulp and paper sector grew very modestly (193 to 205 million cubic meters, an increase of only 6 percent). Thus, increased recycling helped to facilitate the substantial increases in pulp and paper production of recent years, without substantial increases in pulpwood consumption. In 1993, the National Forests provided a timber harvest of approximately 30 million cubic meters (less than half the National Forest harvest volume of 1986). The decline in National Forest timber harvest volume was one of several factors that contributed to recent softwood lumber price increases (upward spikes in lumber price occurred in 1992 and 1993, and softwood lumber and sawtimber price increases are expected in the years ahead).

Although National Forest timber harvest declined between 1986 and 1993, total U.S. timber harvest in 1993 remained at close to 500 million cubic meters, with declines in National Forest harvest volume being compensated mainly by increased harvest on private forest lands. Canadian softwood lumber imports were subjected to an injunctive (temporary) tariff in 1992 and 1993, and the tariff issue remains tied up in the dispute resolution process. By 1993, U.S. solid wood product imports (mostly softwood lumber imports from Canada) had reached a record high of approximately 42 million cubic meters, up from 39 million cubic meters in 1986). Exports of solid wood products, mostly lumber and plywood, increased as well (from 7 million cubic meters in 1986 to 11 million cubic meters in 1993). Apparent domestic consumption of solid wood products increased from 167 to 169 million cubic meters. The volume of domestic lumber production in 1993 (84 million cubic meters) was essentially the same as that in 1986, although domestic softwood lumber production had declined slightly and hardwood lumber production had increased. The OSB product output had increased substantially (from roughly 3 to 6 million cubic meters), while plywood and veneer product output had declined from 20 to 17 million cubic meters. The OSB products substitute for softwood plywood, and OSB can be generally made from smaller diameter timber than that required for plywood. Continued substitution of OSB for plywood is likely to occur as the prices of larger diameter softwood sawtimber increase in the future.

Base Projections

Figure 3 illustrates the Base projections of wood and wood fiber volumes for the year 2005. The Base projections were derived in part from economic analysis of supply and demand for timber and recycled material resources, including analysis

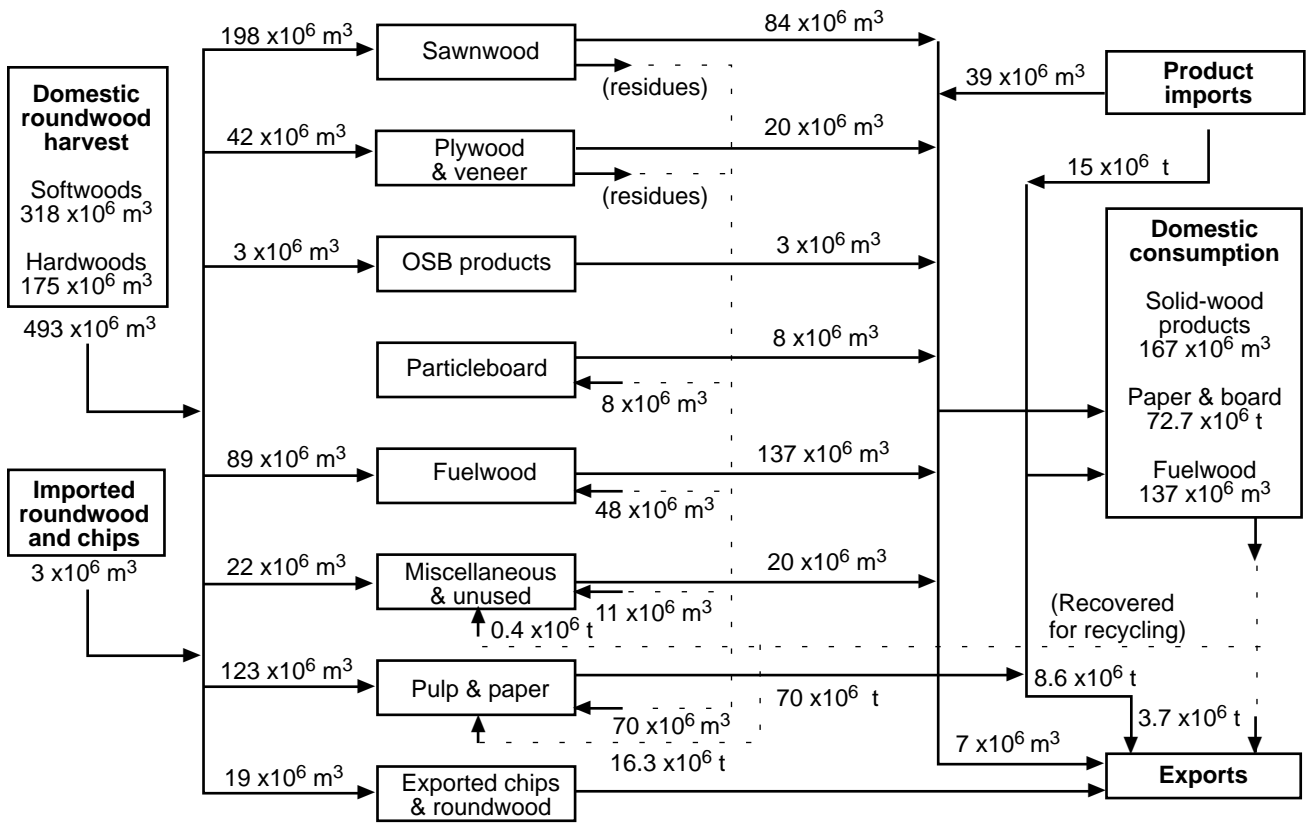


Figure 1—Wood and fiber inputs, primary product outputs, and recovery for recycling in U.S. forest products, 1986.

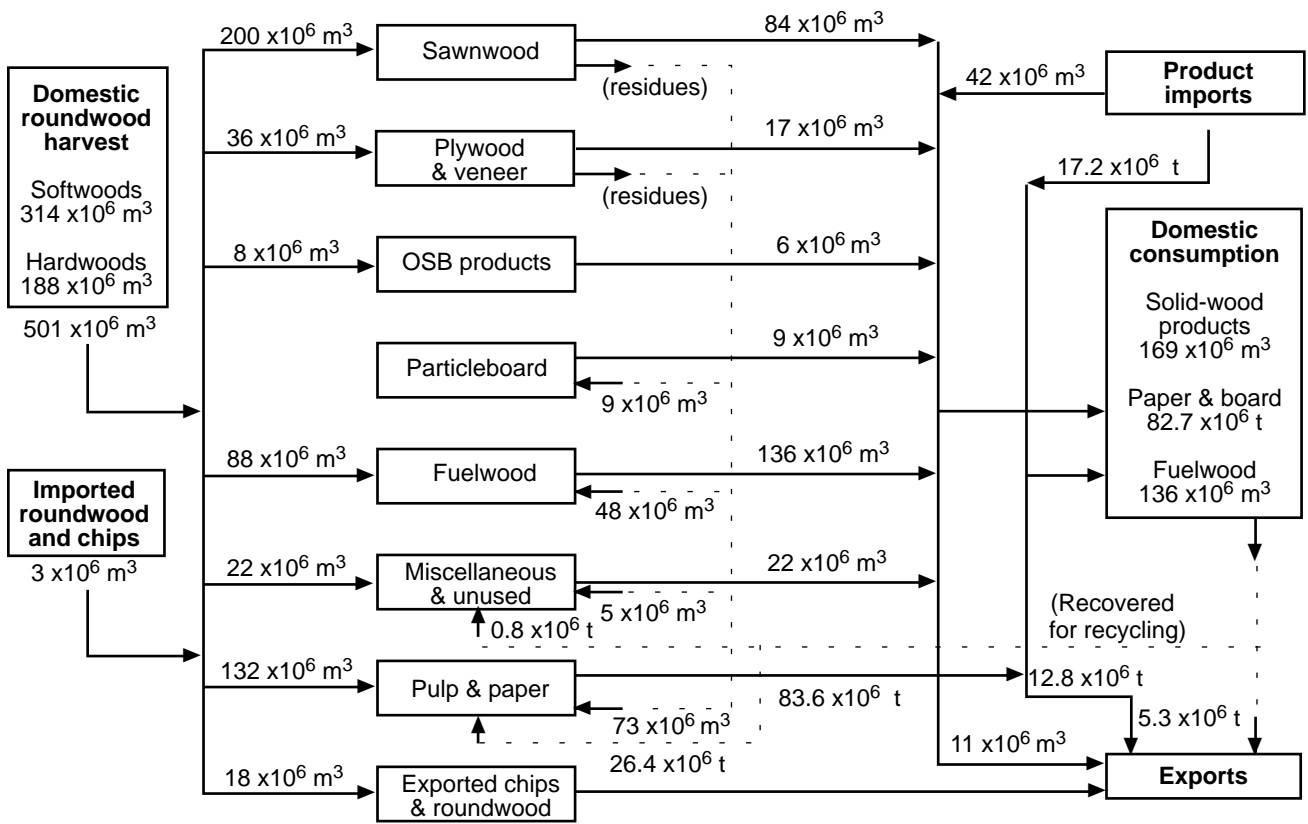


Figure 2—Wood and fiber inputs, primary product outputs, and recovery for recycling in U.S. forest products, 1993.

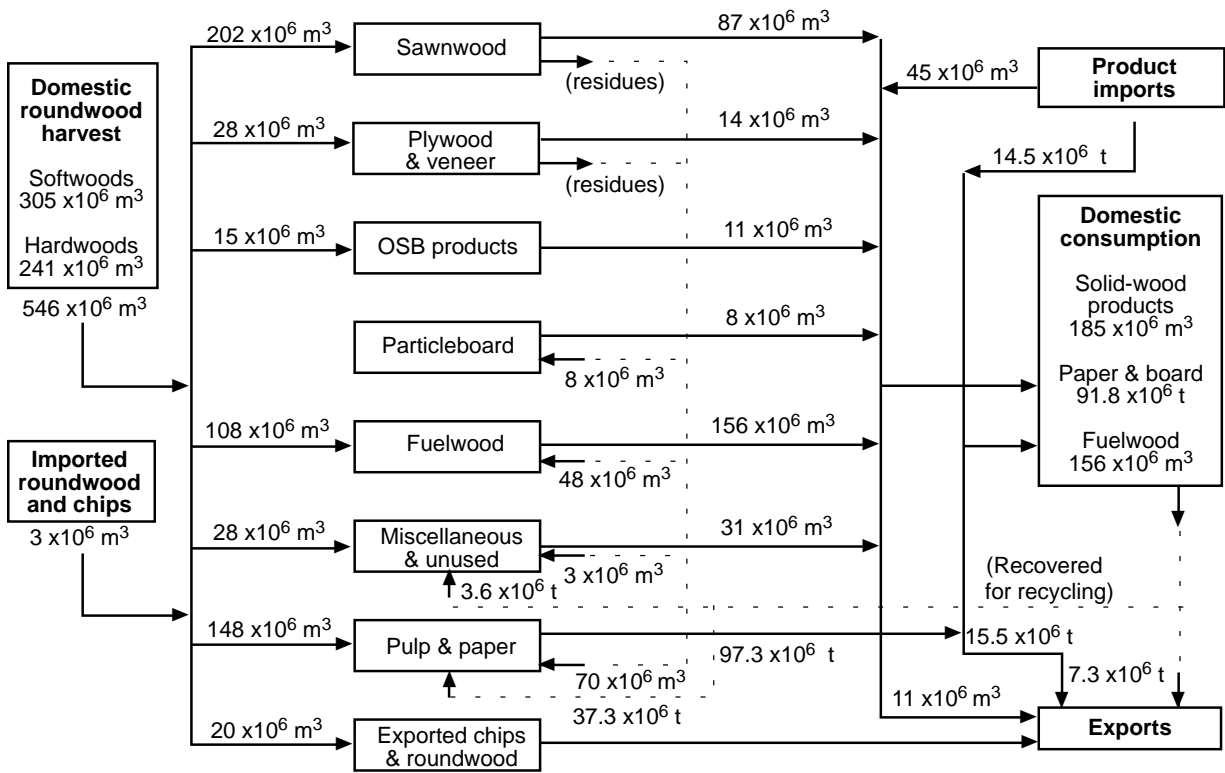


Figure 3—Wood and fiber inputs, primary product outputs, and recovery for recycling in U.S. forest products, 2005, Base scenario.

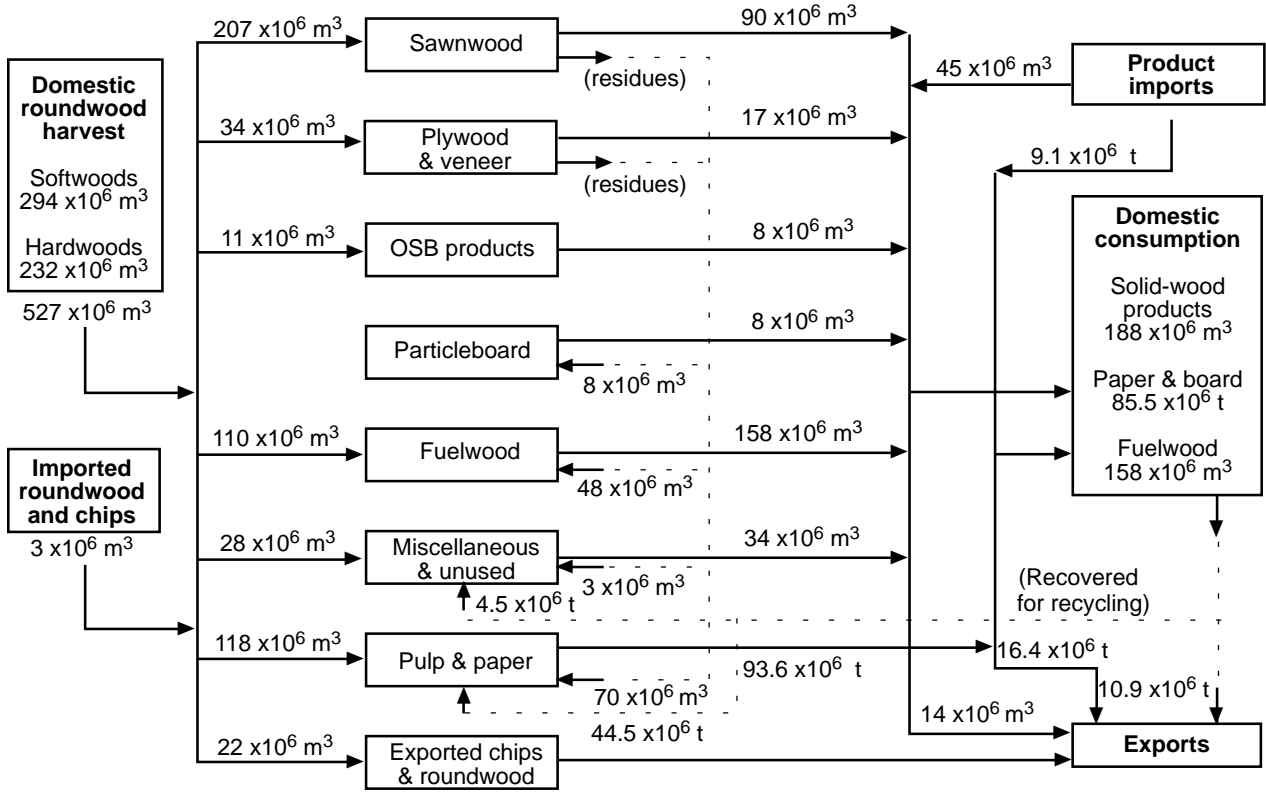


Figure 4—Wood and fiber inputs, primary product outputs, and recovery for recycling in U.S. forest products, 2005, ALT scenario.

of trends in paper recycling and other technological developments in the forest product sector. The Base projections indicate that by the year 2005, approximately 52 percent of paper and paperboard consumed in the United States will be recovered for domestic recycling and export. The recyclable paper utilization rate in the U.S. pulp and paper industry is expected to reach approximately 40 percent by 2005. In addition to recycling of paper into paper and paperboard products, it is anticipated that approximately 3.6 million tonnes of recovered paper will be recycled into products classified as "miscellaneous wood products" by 2005. These include various new composite recycled products and other recycled products. National Forest timber harvests are expected to remain at less than 30 million cubic meters annually throughout the period from 1993 to 2005, while total timber harvest increases by about 9 percent to approximately 546 million cubic meters.

Increased recycling will help sustain increases in paper and paperboard production in the United States, despite limited growth in timber supply. Exports of paper and paperboard products are projected to grow, while imports are projected to generally decline (particularly imports from Canada) as the United States becomes more self-sustaining in fiber needs with increased recycling. Net annual production of pulp, paper, and paperboard in the United States was around 84 million tonnes in 1993, and in the Base scenario it is projected to reach approximately 97 million tonnes by the year 2005 (an increase of more than 15 percent, including total domestic production of paper and paperboard, plus market pulp exports). In the Base scenario, rapid increases in paper recycling and slower growth in per capita paper and paperboard consumption contribute to relatively slow projected growth in pulpwood consumption (rising from 205 million cubic meters in 1993 to 218 million cubic meters by 2005). Roundwood pulpwood consumption and overall timber harvest are projected to increase. Supplies of pulpwood in the form of mill residues will be constrained as a result of limited projected growth in lumber and plywood production. Technological changes and market conditions are also projected to favor more use of hardwood pulpwood by the year 2005, with hardwood increasing from approximately 30 percent to approximately 40 percent of pulpwood supply.

Economic projections indicate that very substantial increases will occur in U.S. softwood sawtimber stumpage prices by the year 2005. Although the Base analysis projects very substantial increases in recycling, which will extend pulpwood supplies, other adjustments (particularly reductions in timber harvest on National Forests) have an offsetting impact on projected sawtimber markets. It is anticipated that real prices for softwood sawtimber stumpage could nearly double within the next decade. In the United States, imports of softwood lumber are mainly from Canada (around 99 percent of total softwood lumber imports were from Canada in 1993). The Base projections indicate that growth in U.S.

softwood lumber production will be constrained in the decade ahead, partly as a result of projected increases in sawtimber stumpage prices in the West and South. Total U.S. softwood lumber production is projected to remain relatively flat, while imports of softwood lumber (mainly from Canada) are projected to increase. Total U.S. imports of solid wood products are projected to reach 45 million cubic meters by the year 2005.

In recent decades, softwood plywood has been the dominant category of structural wood panel products produced in the United States. However, in the last decade, OSB has gained a substantial share of the market, as a substitute for softwood plywood. Technologically, softwood plywood production generally requires softwood veneer logs or larger-diameter sawtimber, whereas OSB can be made from a wider range of species (including hardwoods) and from smaller diameter pulpwood-quality logs. Thus, as softwood sawtimber prices are projected to increase substantially in the decades ahead, U.S. structural panel production is projected to shift toward greater OSB production. The projections are in line with historical trends of the past decade. Projections indicate that OSB production in the United States will reach 11 million cubic meters by 2005, while U.S. plywood production will decline to 14 million cubic meters.

Total U.S. timber harvest is projected to increase in the Base scenario, although the level of softwood timber harvest is projected to decrease slightly by the year 2005. Hardwood timber harvest is projected to increase by the year 2005, but remain less than softwood timber harvest.

Alternative Scenario

Figure 4 illustrates an alternative scenario (ALT) that includes somewhat reduced growth in paper product consumption, due in part to waste reduction efforts such as increased disposal fees and public education about waste disposal problems. The ALT scenario also assumes increased intensification of collection programs for recycling to reduce landfill burdens and increased recycling of paper and wood products. In addition, the ALT scenario assumes greater development of new wood recycling technologies, particularly in the category of miscellaneous wood products, such as hardboard, insulating paperboard, and composite wood panels. However, again, such opportunities are not likely to make significant inroads within conventional mass commodity markets (lumber, plywood, OSB) by the year 2005. Thus, by that year, the impacts of new wood recycling technologies aimed at niche markets are relatively minor in the overall context of wood and wood fiber consumption. It was anticipated in the ALT scenario that consumption of recycled wood fiber in miscellaneous wood products could increase from 3.6 million tonnes (Base) to 4.5 million tonnes (ALT), as a result of further development of the new technologies and niche markets for recyclables.

The impacts of the ALT scenario, shown in Figure 4, include a reduction in projected paper and paperboard consumption from roughly 92 million tonnes (Base) to only 85.5 million tonnes (ALT), an increase in utilization of recovered paper in the pulp and paper sector from roughly 37 million tonnes (Base) to 44.5 million tonnes (ALT), and an increase in export of recovered paper from roughly 7 million tonnes (Base) to 10.9 million tonnes (ALT). The effect of such changes would be to reduce projected roundwood pulpwood consumption from 148 million cubic meters (Base) to only 118 million cubic meters (ALT). In addition, such changes would facilitate substantial reductions in the MSW disposal burden of the United States by the year 2005, reducing the gross wastepaper disposal burden by about one-third relative to the Base scenario, by increasing the recycling and export of recovered paper.

The reduced roundwood pulpwood consumption of the ALT scenario (Figure 4) would also reduce timber harvest and extend overall timber supply. Softwood sawtimber prices are still projected to increase in the ALT scenario, but the sawtimber price increase would be somewhat less than that in the Base scenario. Consequently, projected sawnwood (lumber) and plywood production would be somewhat higher, and OSB production somewhat lower (as a result of reduced substitution for plywood).

Conclusions

In general, the results of this analysis suggest that rapid increases will occur in the rate of paper recycling in the 1990s, in line with current trends, mainly as a result of competitive evolution of fiber markets and available pulp and paper technology. Rapid increases in paper recycling rates and export of recovered paper will result in a recovery from the current market glut, with projected increases in most recovered paper commodity prices by the end of the 1990s. Paper recycling rates will continue to increase, but the rate of increase will subside toward the end of this decade and into the next century.

With more abundant fiber resources (as a result of increased recycling) paper and paperboard consumption in the United States and production of pulp, paper, and paperboard commodities are projected to increase by the year 2005. Exports of paper and paperboard products are also projected to grow, while imports are projected to generally decline (particularly those from Canada). Thus, although recycling rates are projected to increase, annual consumption of pulpwood is also projected to remain in the range of 190 to 220 million cubic meters in the decade ahead. Delivered pulpwood prices are projected to remain fairly stable, or perhaps decline slightly. Technological changes and market conditions will also favor more use of hardwood pulpwood.

In the context of increased paper recycling, the production of lumber and structural wood panels will increase in the United

States. However, increased demand for sawtimber, coupled with projected declines in timber harvest on National Forests, will result in substantial increases in softwood sawtimber stumpage prices, with roughly a doubling (in constant dollars) of real stumpage prices. Timber harvest in the United States will continue to shift from the West to the South and North. The bulk of timber harvest in the future will be on private nonindustrial timberland, as it has been in the past, with substantially lower harvest levels on National Forests.

New wood and paper recycling technologies offer the creation of new and interesting niche markets for recyclables, but apart from the ongoing increase in paper recycling based on conventional papermaking technology, new technologies and source reduction policies offer only modest opportunities to substantially change the volume or value of wood and wood fiber commodities consumed and produced in the forest product sector by the year 2005. However, waste reduction efforts and increased collection offer a potential to further increase paper recycling rates and to reduce the volume of wood and wood fiber in the MSW waste stream.

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