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WOODY RESIDUES AND SOLID WASTE WOOD AVAILABLE FOR RECOVERY IN THE UNITED STATES, 2002

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ABSTRACT

Large amounts of woody residues and solid wood waste are generated annually in the United States from the extraction of timber from forests, from forestry cultural operations, in the conversion of forest land to nonforest uses, in the initial processing of roundwood timber into usable products, in the construction and demolition of buildings and structures, and in the manufacture, use, and disposal of solid wood products in the municipal solid waste stream (MSW). Much of this material is indeed waste, but large, increasing shares are now becoming valuable resources. Here we examine the two major sources of waste wood from roundwood in the United States-woody forest residues and primary timber processing mill residues. These two sources generated a combined total of nearly 178 million metric tons of woody residues in 2002, with 86 million metric tons being unused and deemed available for recovery. In comparison, urban waste wood in the MSW stream and the construction and demolition (C&D) of buildings and structures generated 63 million metric tons of waste wood, with 27 million metric tons remaining unused and deemed available for recovery. These estimates are based on published waste generation rates and recoverability, measures of economic activity, and trends in virgin wood use in specific markets. Waste wood from lesser sources and from catastrophic natural events that may be disposed of outside of the normal waste streams are not examined here.

Keywords: forest residues, mill residues, municipal solid waste, construction and demolition waste, wood recycling

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INTRODUCTION

Large amounts of woody residues and solid wood waste are generated annually in the United States. In 2002, an estimated 240 million metric tons was generated during the extraction of timber from the Nation's forests, from forestry cultural operations, in the conversion of forest land to nonforest uses, in the initial processing of roundwood timber into usable products, in the construction and demolition of buildings and structures, and in the manufacture, use, and disposal of solid wood products in the municipal solid waste (MSW) stream'. All residues are measured in metric tons as generated and vary in moisture content from green for forest residues, to air dry for primary timber processing mill residues, and to bone dry for a large portion of urban waste.

This waste wood is typically not considered to be an important recyclable commodity. However, wood residues from primary timber processing facilities have been made into usable products for decades. Nearly all particleboard produced in the United States, for example, is made from such residues. Wooden pallets, once destined for landfills after only a few usages, are now being repaired and recycled at an increasing rate. About one-third of all pallets produced annually are made from recycled wood. Waste wood from construction and demolition sites and from the MSW stream is also gaining importance as a wood resource.

An important step in developing waste wood into a viable resource is to quantify the amounts that are available by source and type of material. Two major categories of waste wood exist in the United States—wastewood from timber harvesting and processing, and urban waste wood from the production, use, and disposal of finished wood products. Waste wood from timber harvesting and processing includes woody forest residues and primary timber processing mill residues. Urban waste wood includes MSW (from residential, commercial, institutional, and industrial sources) and construction and demolition (C&D) waste. Each source generates distinct types of waste wood, with differing degrees of recyclability.

This paper presents estimates of the total amount of waste wood generated from woody forest and primary timber processing residues in 2002, the amount recovered or combusted, and the amount available for recovery. These estimates are principally based on information collected by the USDA Forest Service?. The estimates are then compared with estimates of C&D and MSW waste reported at this and other conference[1,3] . Waste wood from lesser sources and from catastrophic natural events that may be disposed of outside the normal waste streams are not examined here.

Although woody forest residues and primary timber processing residues are not strictly included in the mission of COST E31, they are presented to provide a more complete picture of the waste wood resource in the United States and to provide a means to compare the magnitude of different categories of waste wood.

WASTE WOOD FROM TIMBER HARVESTING AND PROCESSING

Waste wood from timber harvesting and processing consists of two sources: (a) woody forest residues and (b) primary timber processing mill residues. Each generates large amounts of waste, but they differ dramatically in the amounts currently being recovered.

Woody Forest Residues

Large amounts of woody forest residues are generated annually in the United States. Woody forest residues are categorized as "logging residues" if generated during timber harvesting operations or as "other removals residues" if the result of forest cultural operations or land conversion. Woody forest residues are typically in the form of tree topsibranches and trees cut or knocked down and left on site. The USDA Forest Service compiles information on the volume of both logging residues and other removals every 5 years[2]. The most recent information is for the year 2001. Estimates for 2002 are based on 2001 residue volumes adjusted by changes in industrial roundwood production between 2001 and 2002[4].

Another source of woody forest residues is the material being removed from the forest to reduce the risk of catastrophic wildfires and improve forest health. The Healthy Forest Restoration Act* authorizes the use of Federal money for high priority thinning and forest restoration. Amounts of these "fuel reduction residues" are not included in either "logging residues" or "other removals residues" statistics because they are removed from the forest for use or disposal. National estimates of the amounts of these removals are not currently available, but the amounts are expected to increase in the next 5 to 10 years.

Logging Residues

Logging residues are materials removed from growing stock and other timber sources during timber harvesting and left unutilized on site. Growing stock is a "classification of timber inventory that includes live trees of commercial species

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* For additional information on the Healthy Forest Restoration Act, visit www.fs.fed.us/projects/hfi/

meeting specified standards of quality or vigor. Cull trees are excluded. When associated with volume, includes only trees 5.0 inches (12.7 cm) in diameter at breast height (dbh) and larger[2]." Other timber sources are "non-growing stock sources, and include salvable trees, rough and rotten trees, trees of noncommercial species, trees less than 12.7 cm in dbh, and roundwood from nonforest land[2]." Based on these definitions, logging residues are growing stock and other wood cut and knocked down during harvest but left on site, sound tops above the 10.2-cm growing stock top, stems smaller than 12.7 cm in dbh, and unutilized trees cut or knocked down, including dead and cull trees. All material must be sound enough to chip. Stumps and limbs are not included in logging residue volumes. Based on these definitions, 55.0 million metric tons of logging residues was generated in 2002. However, stumps and limbs are also a usable resource, and contain a sizable amount of wood. On average, softwood residue volumes increase by about 14%, and hardwood volumes by about 24% if stumps and limbs are included. Their inclusion increases the amount of logging residues generated in 2002 by 11.2 to 66.2 million metric tons (Table 1).

By definition, no logging residues were recovered. If, on average, 10% of

Table 1. Timber Harvesting and Processing Residues Generated, Recovered, Combusted or Not Usable, and Available for Recovery in the United States, 2002

	Generated			Recovered	Combusted	Not usable	Total	Available for recovery		
Source	(106 t)	(%)	% total	(106 t)	(106 t)	(106 t)	(106 t)	(106 t)	(%)	% total
Logging & other removals residues										
Logging residues	66.2	71	37	–	–	6.6	6.6	59.6	71	69
Other removals residues	27.2	29	15	–	–	2.7	2.7	24.5	29	29
Total	93.4	100	53	–	–	9.3	9.3	84.1	100	98
Primary timber processing residues										
Wood residues	62.0	74	35	42.0	18.8	--	60.8	1.2	69	1
Bark residues	22.2	26	12	4.5	17.1	--	21.6	0.5	31	1
Total	84.1	100	47	46.5	35.9	--	82.4	1.7	100	2
Total										
Logging & other removals	93.4	53	53	–	–	9.3	9.3	84.1	98	98
Primary timber processing	84.1	47	47	46.5	35.9	-	82.4	1.7	2	2
Total	177.5	100	100	46.5	35.9	-	91.8	85.8	100	100

logging residues were considered to be unusable because of size, location, or other reasons, then about 59.6 million metric tons of logging residues would have been available for recovery in 2002.

Other Removals Residues

Other removals are defined as growing stock and other timber sources cut or otherwise killed in the process of converting forest land to nonforest uses. Also included is growing stock removed in forestry cultural operations such as precommercial thinning. Characteristics of other removals residues are the same as characteristics of logging residues. In 2002, 22.4 million metric tons of other removals residues were generated. Stumps and limbs contributed another 4.8 million metric tons for a total of 27.2 million metric tons (Table 1).

As with logging residues, no other removals residues were recovered. If, on average, 10% were considered to be unusable because of size, location, or other reasons, then 24.5 million metric tons of other removals residues would have been available for recovery in 2002.

Total Woody Forest Residues

Overall, 93.4 million metric tons of woody forest residues were generated in 2002 during timber harvesting operations, forestry cultural operations, and conversion of forest lands to nonforest uses (Table 1). By definition, all of this wood was sound and left on site; none was recovered. Assuming that about 10% of the wood may not be usable because of size, location, condition, or other reasons, the recoverable supply of woody forest residues in 2002 totaled 84.1 million metric tons.

Fuel Reduction Residues

Many forests in the western United States are succumbing to years of drought and insect attack. The dead and dying timber is adding to already high fuel levels caused by decades of fire suppression. National estimates of the amounts of this wood being removed to reduce fuel burdens are not available, but the amounts are large. In a three-county area in Southern California, for example, an estimated 142,000 ha of public and private lands are in various stages of vegetation mortality[5]. In August 2003, an estimated 600 metric tons per day of dead and dying timber was removed from high-risk areas. Removals are expected to increase to 1,500 metric tons per day and last for 5 years or more. Poor wood quality and high transportation costs limit the options for high-value uses of this material. Some is being chipped or ground and being used for erosion control and biomass fuel[6]. Some is simply being burned for disposal. Efforts are underway to attract business ventures such as pallet manufacturers, portable

sawmill operations, and biomass-to-energy producers to better use the material. This is but one of many examples of many locations throughout the country where large quantities of residues are being created from fuel reduction activities.

Primary Timber Processing Mill Residues

Primary timber processing mills are facilities that convert logs, bolts, and other roundwood timber products into other wood products, such as lumber, plywood, and woodpulp. These mills annually generate large amounts of residues in the form of bark, sawmill slabs and edgings, sawdust, and peeler log cores. The USDA Forest Service compiles information on the volumes of these residues every 5 years. The most recent compilation was for the year 2001[2]. Estimates made here for 2002 are based on 2001 residue volumes adjusted by changes in industrial roundwood production between the years 2001 and 2002[4].

Wood Residues

An estimated 62 million metric tons of wood residues was generated by primary timber processing mills in 2002 (Table 1). Of this amount, 60.8 million metric tons (98%) was recovered—42.0 million metric tons for products such as woodpulp and nonstructural panels and 18.8 million metric tons for fuel. Just 1.2 million metric tons remained after recovery, all of which could be recovered.

Bark Residues

In 2002, 22.2 million metric tons of bark residues were generated by primary timber processing mills (Table 1). Nearly 98% (21.6 million metric tons) was recovered for other products, such as shredded mulch, or fuel. The remaining 0.5 million metric tons of bark residues was considered available for further recovery.

Total Primary Timber Processing Mill Residues

In 2002, nearly 230 million metric tons of products (excluding fuelwood) was produced from industrial roundwood by primary timber processing mills in the United States[4]. In so doing, these mills generated more than 84 million metric tons of wood and bark residues, of which nearly three-fourths was wood (Table 1). These mills are very efficient in terms of complete utilization of the resource. Of the total residues generated, less than 2% was not used in the production of other wood products or as fuel. Just 1.7 million metric tons of residues remained unused in 2002. And although these residues could conceivably be recovered, it is very unlikely that they will be.

Total Timber Harvesting and Processing Waste Wood

Overall, nearly 178 million metric tons of residues was generated by timber harvesting and processing in the United States in 2002 (Table 1). Amounts were nearly equally divided between logging and other removals (53%) and primary timber processing (47%). Of these residues generated, nearly 92 million metric tons was either recovered (47 million metric tons), combusted (36 million metric tons), or deemed unusable (9 million metric tons). By definition, all logging and other removals residues are left on site, resulting in all recovery and combustion being attributable to the primary timber processing industries and all unusable volumes to logging and other removals. Nearly 86 million metric tons of residues remained for further recovery, of which 98% was from logging and other removals.

URBAN WOOD WASTE

In general, urban wood waste is waste wood generated by the production, use, and disposal of finished wood products. Sources include the "wood" and the "woody yard trimmings" components of the MSW stream as well as the waste wood generated during the construction of new buildings and structures, the repair and remodeling of existing buildings and structures, and the demolition of existing buildings and structures (C&D waste). Estimation procedures and detailed analyses of these urban waste wood sources can be found in the keynote address of this conference and other sources[1,3,7].

In 2002, 62.5 million metric tons of urban wood waste was generated in the United States (Table 2). This consisted of 26.8 million metric tons of wood in MSW and 35.7 million metric tons in C&D waste. More than half the MSW waste wood was in the form of woody yard trimmings (wood chips, logs, stumps, tree tops, and brush), which more closely resembles forest residues than MSW waste wood (wooden furniture and cabinets, pallets and containers, scrap lumber and wooden panels, and wood from manufacturing facilities). Demolition waste was the largest individual category (25.2 million metric tons), slightly less than all waste wood in MSW. More than half (57%) of all urban waste wood was either recovered for recycling, combusted, or deemed unacceptable for recovery for other uses because of excessive contamination, commingling with other waste, size and distribution of material, or other reasons. The remaining 27.1 million metric tons of urban waste wood was considered to be available for further recovery. Of this amount, about one-third was MSW (37% woody yard trimmings) and two-thirds from the construction and demolition of buildings and structures (57% demolition waste).

OTHER SOURCES

Other sources of waste wood include chemically treated wood from railroad ties, telephone and utility poles, and pier and dock timbers; chipped brush and limbs from utility, highway, and railroad right-of-way maintenance; and industrial waste wood outside typical waste streams. Some of this material is being reused, burned, or disposed of in hazardous waste landfills. but much is being left on site. Chemical treatments and costs of collection make much of this material difficult to recover. The amounts of wood available from these sources are fairly small compared to the four major waste wood sources reported here.

SUMMARY AND CONCLUSIONS

An estimated 240 million metric tons of waste wood was generated in the United States in 2002 in the form of timber harvesting and processing residues and from urban waste wood sources (Table 2). Much of this waste was used to produce new products or fuel, or was not suitable for recovery. Of the total amount generated, 113 million metric tons (47%) was deemed suitable for further recovery for recycling or reuse, about three-fourths of which was green weight. In comparison, an estimated 230 million metric tons of roundwood timber was produced in the United States in 2002 (excluding fuelwood)[2]. Reco-

Table 2. Waste Wood Generated, Recovered, Combusted, or Not Usable and Available for Recovery in the United States, 2002

	Generated		Recovered, combusted, or not usable		Available for recovery	
Source	(106 t)	(%)	(106 t)	(%)	(106 t)	(%)
Timber harvesting and processing residues						
Logging & other removals	93.4	39	9.3	7	84.1	75
Primary timber processing	84.1	35	82.4	65	1.7	1
Total	177.5	74	91.8	72	85.8	76
Urban wood waste						
Municipal solid waste	26.8	11	18.2	14	8.7	8
Wood component	12.0	–	6.5	–	5.5	–
Woody yard trimmings	14.8	–	11.6	–	3.2	–
Construction & demolition	35.7	15	17.3	14	18.4	16
Construction waste	10.5	–	2.7	–	7.8	–
Demolition waste	25.2	–	14.6	–	10.6	–
Total	62.5	26	35.5	28	27.1	24
Total, all waste wood	240.1	100	127.2	100	112.8	100

verable waste wood was therefore about half of roundwood timber production.

Timber harvesting and processing accounted for about three-fourths of all waste wood generated, recovered, combusted, or not usable and available for recovery in 2002 (Fig. 1). Waste wood from the logging and other removals portion of timber harvesting and processing was by far the single largest source of waste wood available for recovery, constituting 75% of all available waste wood. Currently, nearly all of this material remains in the forest, and it contributes to excessively high levels of fuel loading. Better utilization of this material, coupled with removal of dead and dying timber and brush, could greatly reduce fuel burdens and subsequent risk of catastrophic wildfires, while providing employment for local communities. Waste wood from C&D activities is a distant second, at about 16% of total availability.

Although advances in waste wood collection, processing, and utilization are being made, many more technical and economic obstacles need to be overcome before much of the recoverable waste wood can be recycled. Waste wood is finding limited niche markets for furniture and other consumer goods, is beginning to be used to supplement traditional sources of furnish in nonstructural panel manufacturing, and is being used to produce both garden and hydro mulch products. Solid wood waste, once a disposal problem for producers and consumers alike, is rapidly becoming a valuable resource and is increasingly

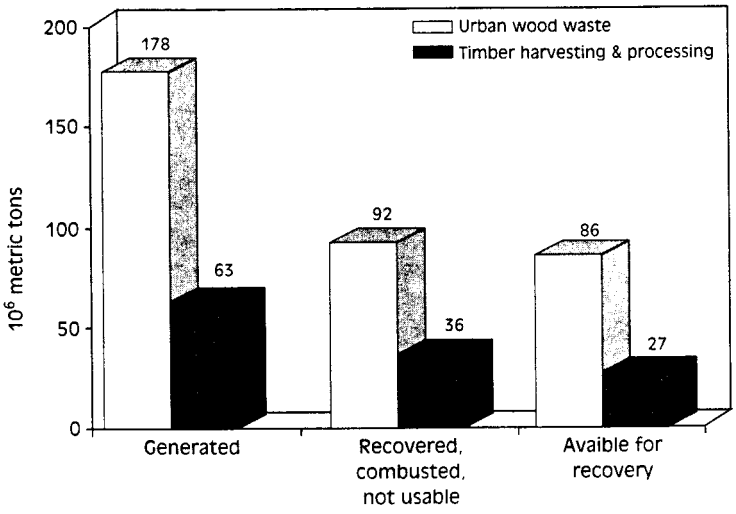

Figure 1. *Waste wood generated, recovered, combusted or not usable, and available for recovery in the United States, by type, 2002.*

playing a more important role in satisfying consumer demands for wood-based products.

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