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# Criterion 6, Indicator 33: Recovery or Recycling of Forest Products as a Percentage of Total Forest Products Consumption

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## Abstract

This indicator shows the trend in recovering wood and paper for reuse in products in the United States. This reuse can hold down the need to harvest wood to meet U.S. consumption needs. The paper recycling rate (utilization rate in producing new paper) increased from 22% to 38% between 1970 and 1996, but then stabilized at 37% to 38% between 1996 and 2006. This rate has been stable despite continuing increase in the recovery rate of paper in the 1990s though 2006 to 51% because increases in recovery after the mid 1990s have been exported. The effects of increasing recovery after the mid 1990s were felt primarily in offsetting harvest in other countries and not in the United States. The estimated recovered wood utilization rate is highly uncertain, but is estimated to have increased from an insignificant amount in 1990 to 10% in 2006. The recovered wood utilization rate for wood pallets alone has increased from 2% in 1993 to 34% in 2000 and 38% in 2006. A rough estimate of the recycling rate (utilization rate) of post-consumer wood and paper into burning with energy generation is 15% to 20% for the period 1990 to 2006.

Keywords: wood recycling, paper recycling, recovery rate, utilization rate, recycling rate

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# Criterion 6, Indicator 33: Recovery or Recycling of Forest Products as a Percentage of Total Forest Products Consumption

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## Indicator Background

The purpose of this report is to provide information on the rationale and data provided for Indicator 33 for the U.S. National Report on Sustainable Forests—2010. Information on the rationale for the Indicator and recommended data to be developed are taken from the report of the Technical Advisory Committee (TAC) of the Montreal Process (MP).

## Verbatim Montreal Process Technical Advisory Committee Notes

### Rationale

This indicator identifies the extent to which forest products are recycled or reused and provides a measure of the national efficiency of forest products usage. Recovered products are an important raw material for many forest products industries as well as some industries outside the wood products sector. Recycling forest products reduces the quantity of waste incinerated or deposited in landfills and enables a country to increase consumption of wood products without an increase in timber harvesting—both of which are positive influences on sustainability.

### Measurement

The measurements desired are as follows:

- The first measurement is the volume of paper and solid wood products reduced to wood fiber that is recovered from the post-consumer waste stream and used as a raw material by some other producer or end user. The fiber volumes for various products recovered and recycled should be converted into the same volume units used by the consumption indicator to facilitate computation of the percentage. Some recyclers may be forest products firms, whereas others may be outside the forest products sector. For example, recycled paper and cardboard are important feedstock for some paper makers. Recycled wood fiber is also used outside the forest sector; for example, to strengthen wood-plastic composites and as landscaping mulch and bedding for farm animals. To the extent that

fiber volumes for these uses outside the forest sector can be obtained, they may be included in this indicator.

- The next measurement is the volume of solid wood products recovered from the post-consumer waste stream that is reused again. Examples of solid wood products that are recovered and reused include shipping pallets reused in the manufacturing and transportation industries and lumber removed from the demolition waste stream and reused. This volume is reported as a percentage of the original production (e.g., percentage of shipping pallets reused as a percentage of total pallet production).
- The third measurement is the volume of wood fiber and solid wood products recovered from the post-consumer waste stream and used to produce wood-based energy. Conventional energy technologies typically rely on incineration, but emerging technologies to convert wood fiber into methanol/ethanol may also use recycled wood fiber and products. This volume is reported as a percentage of total forest biomass fuel feedstocks, under Indicator 5.c (Indicator 24).
- Although this indicator focuses on volumes because of the desire to represent recycling as a percentage of total consumption volume, information on the value of the recycled materials may also be available. Depending on national circumstances, reporting the available value information may help to illustrate the importance of recycling and recovery.

For many countries, official government sources report the quantity of paper and paper products recovered. Similar sources may also report the quantity of other wood-based products recovered/reused, such as products used in construction. Industry associations (notably in the pulp and paper sector) also collect and report similar information.

As used in this indicator, “recovery” means identifying wood fiber and wood products as part of the post-consumer waste stream and effectively removing it from that waste stream. Recovery may be made more efficient and effective

through regulations that require consumers to sort waste paper and wood products from other solid waste.

The word “recycling” means that recovered wood fiber and wood products are used as raw materials for another manufacturing process (e.g., used cardboard remanufactured into new cardboard) or through transformation into a new product (e.g., shredded paper reused as landscape mulch or animal bedding).

The word “reuse” means that a wood product is recovered after initial use and reused again for the same purpose without remanufacturing or transformation. For example, shipping pallets are often reused within the transportation industry.

This indicator also emphasizes recovery from the “post-consumer” waste stream. Often, primary or secondary manufacturers of wood products will generate waste as part of their production process and immediately recycle the waste back into their production process. Examples include plywood mills that convert peeler cores into chips for producing oriented strandboard or paper mill feedstock and paper mills that recycle waste paper from their paper-making or converting operations immediately back into the pulping operation.

The intent of this indicator is to compare recycling to consumption, so the volumes identified should be limited to volumes recovered from the post-consumer waste stream and should not attempt to estimate volumes recycled by manufacturers as part of their primary or secondary processing before products are used by consumers.

## Comments and Clarifications

### Additions and Clarifications to Rationale

The TAC guidance seems to focus on estimating the recovery rate for wood and paper—the amount of wood or paper recovered in a year divided by the amount consumed. This measure indicates the effectiveness of efforts to capture material after use for reuse in general—for both domestic use and export. However, it seems better to estimate the recycling rate (also termed utilization rate) in order to suggest the effectiveness of using recovered materials to offset use of virgin wood from U.S. forests for products. It seems there should be at least equal emphasis on estimating recycling rate (utilization rate) given the TAC interest in knowing what “enables a country to increase consumption of wood products without an increase in timber harvesting.” We focus on estimating recycling rate (utilization rate).

### Additions and Clarifications to Measurement

In the United States, the term “utilization rate” means the same as “recycling rate” used in the TAC guidance. We use both terms to indicate the amount of wood or paper that is used in making new products divided by total production in a given year.

When estimating recycling rate (utilization rate) of old pallet parts in making new pallets for the United States, we assume that the measure is for parts of pallets and that those would not be characterized as “reuse.” We assume that the old pallets that undergo some degree of repair are not “without remanufacturing or transformation” labels.

The TAC guidance asks for information on post-consumer wood fiber and wood products as a percentage of total forest biomass fuel feedstocks that is reported under indicator 5.c. (Indicator 24). For the United States, we know that some portion of wood and paper from the municipal solid waste stream and some portion of wood in construction and demolition waste is burned, but we have not obtained information on how much is burned for energy production.

## Indicator Development

### Data Used to Address Indicator

#### General Description

Data are obtained from industry and Federal government sources to estimate recovery rates and recycling rates (utilization rates) for paper and wood used to make products and from recycling rates (utilization rates) to make energy. All rates are for reuse of post-consumer wood and paper.

#### Specific Data Sources

Data are provided to estimate the following:

- Recovery rate of paper from domestic consumption, indicating which portions are used for domestic production (recycling rate/utilization rate) and for exports (Table 1, AF&PA 2002; Howard 2007).
- Recycling rate (utilization rate) for solidwood products into new products (Tables 2 and 3; Howard 2007; White 2004; USEPA 2007, 2008).
- Recycling rate (utilization rate) for paper products by region (Table 4, AF&PA 2007. [not in references])
- Recycling rate of wood and paper from municipal solid waste (MSW) into energy production (Tables 5 and 6). This is the percentage of total wood plus paper energy consumption that is from wood and paper in MSW (USEPA 2007; Howard 2007).

## Analysis Techniques

### Specific Steps Taken

To estimate the annual recycling rate (utilization rate) for solidwood products, a number of assumptions and steps are used. We assume that the following amounts of solidwood are recycled and appear (as weights) in the numerator of the recycling rate ratio (only post-consumer waste sources are included):

- The wood contained in all recycled wood pallets (Table 7).

**Table 1—Recovered paper consumption, imports, exports, recovery rate, and recycling rate (utilization rate), 1965–2006<sup>a</sup>**

Year	Paper and board, new supply <sup>b</sup> (1,000 tons) (1)	Paper and board production <sup>c</sup> (1,000 tons) (2)	Consumed at paper and board mills (1,000 tons) (3)	Consumed for molded pulp, insulation, and other uses		Exports (1,000 tons) (5)	Imports (1,000 tons) (6)	Total recovered paper (1,000 tons) (7) = (3) + (5) – (6)	Recovery rate (%) (8) = (7)/(1)	Utilization rate (%) (9) = (3)/(2)	Exported (%) (10) = (5)/(7)
				(1,000 tons) (4)	(1,000 tons) (4)						
1965	48,270	40,489	10,231	—	292	292	108	—	—	25.3	—
1966	52,118	43,904	10,564	—	246	246	113	—	—	24.1	—
1967	51,435	43,745	9,888	—	262	262	86	—	—	22.6	—
1968	54,351	47,085	10,222	—	253	253	93	—	—	21.7	—
1969	57,423	49,824	11,969	—	289	289	75	—	—	24.0	—
1970	55,969	48,719	11,803	418	408	408	67	12,562	22.4	24.2	3.2
1971	57,450	49,741	12,106	442	419	419	68	12,899	22.4	24.3	3.2
1972	62,040	53,842	12,925	447	415	415	88	13,699	22.1	24.0	3.0
1973	65,004	56,346	14,094	499	683	683	87	15,189	23.4	25.0	4.5
1974	63,308	55,756	13,982	489	1,307	1,307	89	15,689	24.8	25.1	8.3
1975	54,113	47,997	11,748	535	861	861	72	13,072	24.2	24.5	6.6
1976	62,014	54,993	13,622	630	1,273	1,273	106	15,419	24.9	24.8	8.3
1977	64,243	56,656	14,058	870	1,512	1,512	92	16,348	25.4	24.8	9.2
1978	67,787	58,571	14,760	502	1,613	1,613	70	16,805	24.8	25.2	9.6
1979	69,796	61,070	15,361	509	2,127	2,127	78	17,919	25.7	25.2	11.9
1980	67,166	61,042	14,922	472	2,636	2,636	87	17,943	26.7	24.4	14.7
1981	67,957	62,109	15,037	480	2,282	2,282	79	17,720	26.1	24.2	12.9
1982	64,730	59,290	14,433	487	2,233	2,233	74	17,078	26.4	24.3	13.1
1983	71,166	64,947	15,638	474	2,705	2,705	100	18,727	26.3	24.1	14.4
1984	76,937	68,449	16,724	459	3,456	3,456	110	20,530	26.7	24.4	16.8
1985	76,138	66,983	16,371	529	3,560	3,560	88	20,369	26.8	24.4	17.5
1986	79,755	70,905	17,934	594	4,093	4,093	99	22,521	28.2	25.3	18.2
1987	83,491	74,361	18,694	657	4,809	4,809	127	24,033	28.8	25.1	20.0
1988	85,718	76,587	19,685	703	5,953	5,953	161	26,179	30.5	25.7	22.7
1989	85,373	76,786	20,220	722	6,307	6,307	173	27,077	31.7	26.3	23.3
1990	86,796	78,679	21,736	994	6,505	6,505	123	29,112	33.5	27.6	22.3
1991	85,071	79,427	23,662	1,063	6,598	6,598	122	31,201	36.7	29.8	21.1
1992	88,273	82,868	26,185	1,137	6,782	6,782	150	33,954	38.5	31.6	20.0
1993	91,538	84,857	28,011	1,216	6,371	6,371	138	35,460	38.7	33.0	18.0
1994	95,718	89,080	30,670	1,300	7,974	7,974	253	39,691	41.5	34.4	20.1
1995	96,062	89,450	31,391	1,390	9,908	9,908	498	42,191	43.9	35.1	23.5
1996	94,490	90,450	33,981	1,487	8,084	8,084	474	43,077	45.6	37.6	18.8
1997	99,637	95,097	35,208	1,590	7,882	7,882	693	43,956	44.2	37.0	17.9
1998	101,137	94,586	35,770	1,700	8,117	8,117	511	45,076	44.6	37.8	18.0
1999	103,317	97,020	36,727	2,000	8,517	8,517	426	46,818	44.0	37.2	18.0
2000	102,811	94,491	35,447	2,200	10,272	10,272	608	45,111	43.9	37.5	22.8
2001	97,394	88,913	34,527	2,200	10,597	10,597	328	44,796	46.0	38.8	23.7
2002	98,976	89,687	34,579	2,200	11,267	11,267	411	45,435	45.9	38.6	24.8
2003	98,016	88,388	33,650	2,200	13,805	13,805	399	47,056	48.0	38.1	29.3
2004	101,882	91,901	34,736	2,200	13,910	13,910	558	48,088	47.2	37.8	28.9
2005	99,565	91,108	33,950	2,000	15,868	15,868	545	49,273	49.5	37.3	32.2
2006	100,198	92,224	34,471	2,000	17,501	17,501	483	51,489	51.4	37.4	34.0

<sup>a</sup>Sources: Howard (2007), table 47; AF&PA (2002), p. 4.<sup>b</sup>Production plus imports minus exports; includes paper, paperboard, wet machine board, and construction paper and board.<sup>c</sup>Production excluding wet machine board and construction paper and board.

- One-half of the wood that is recovered for reuse from municipal solid waste (we exclude the other half of wood from MSW because we assume it goes for uses that do not displace wood products use; e.g., mulch).

We assume that currently negligible amounts of wood recovered from demolition and construction sites go for reuse as solidwood products, and we do not include any part of them in the recycling rate numerator. We assume that recovered amounts in the numerator are all used in the United States with no exports.

The denominator of the recycling rate ratio is the weight of solidwood products produced in a year plus the products from waste wood as contained in the numerator (Table 2).

To estimate the recycling rate for wood and paper used to generate energy, we use the following steps to estimate the numerator and denominator. The numerator includes an estimate of wood and paper from municipal solid waste that is burned for energy (measured in energy content, quadrillion Btus). This estimate is made by multiplying total MSW used for fuel by the estimated fraction in 2006 that was from wood and paper (75%) (Tables 5 and 6). We assume all this recovered and burned amount was burned in the United States. The denominator includes all wood burned for energy (Table 8) plus the part of the numerator that is waste paper burned for energy (77%) (Table 6). The resulting recycling rate (utilization rate) is shown in Table 6.

### **Data Issues (Replicability, Availability, Precision and Potential Bias)**

Data used to estimate paper recovery rate and recycling rate (utilization rate) are based on continuing surveys of industry and are available replicable with known precision and judged to be unbiased. Data used to estimate recycling rate for solidwood products are based on intermittent surveys that may not be available or replicable in the future. Precision and bias are uncertain. Data used to estimate recycling rate for wood and paper in wood energy are based on continuing surveys that are expected to be available and replicable but use assumptions about categories and use rates where precision and bias are not known. It is likely that assumptions could be improved.

## **Indicator Interpretation and Discussion**

### **Indicator Results**

This indicator identifies the extent to which forest products are recycled or reused and provides a measure of the national efficiency of forest products usage. Recovered products are an important raw material for many forest products industries as well as some industries outside the wood products sector. Recycling forest products reduces the quantity of waste incinerated or deposited in landfills and enables a country to increase consumption of wood products without

an increase in timber harvesting—both of which are positive influences on sustainability.

Key sources of post-consumer wood and paper materials that are recovered for reuse in products include paper and paperboard, wood pallets, construction waste, demolition waste, and wood/paper in municipal solid waste. For this indicator, recovered amounts do not include amounts of waste wood and paper that are used for energy.

There are two basic measures used for this indicator:

- The recovery rate is the amount of wood or paper recovered for reuse in products (includes exports) divided by the amount of source products consumed in a year.
- The recycling rate (also termed utilization rate) is the amount of wood or paper recovered divided by the amount of products produced in a year.

The recycling rate indicates the degree to which use of recovered wood or paper holds down or substitutes for use of virgin wood in U.S. production of wood and paper products.

### **What Does the Indicator Show?**

The paper recycling rate (utilization rate) increased from 22% to 38% between 1970 and 1996, but then stabilized at 37% to 38% between 1996 and 2006. In contrast, the recovery rate for paper and paperboard increased from 22% in 1970 to 45% in 1999 and 51% in 2006. The recovery rate has continued to increase even though the utilization rate has been 37% to 38% because almost all the increase in recovery since 1996 has gone to exports. Exports of recovered paper have increased from 3% in 1970 to 18% in 1999 to 34% in 2006 (Fig. 1). For the purpose of comparison, in 1999 the total consumption of paper and paper products by all developed countries was 252 million tons annually, and their average recovery rate was 43%.

The utilization rate of recovered wood products (for reuse as wood products) is uncertain because of incomplete data. We estimate the amount of recovered wood that is reused for products to include all recycled wood pallets and one-half of the wood recovered from municipal solid waste. We further assume that (1) the other half of wood from municipal solid waste (MSW) is used for fuel or uses that do not displace wood products use; (2) wood recovered from demolition and construction sites goes for uses (e.g., fuel or mulch) that do not displace wood products use; (3) the amounts of wood recycled via deconstruction are still small; and (4) recovered amounts are all used in the United States with no exports. With these assumptions, the estimated recovered wood utilization rate has increased from an insignificant amount in 1990 to 10% in 2006 (Fig. 2). The recovered wood utilization rate for wood pallets alone has increased from 2% in 1993 to 34% in 2000 and 38% in 2006.

A rough estimate of the recycling rate (utilization rate) of post-consumer wood and paper into burning with energy generation is 15% to 20% for the period 1990 to 2006. It is

**Table 2—Recovered wood and paper recycling rate (utilization rate), 1990–2006 (1,000 tons or percentage)**

Year	Wood and paper production (1,000 tons)		Paper and paperboard consumed in U.S. pulp mills (1,000 tons)		From MSW (3)		From construction sites (4)		From demolition sites (5)		From wood pallets (6)		Total waste wood recycled for products (7) = (3 + 4 + 5 + 6)		Total wood and paper supply including recycled wood products (8) = (7 + 1)		Total wood and paper used in products (9) = (7 + 2)		Utilization as a percentage of total production (9) = (9/8)		Production of pulp, paper and paperboard (10)		Utilization as a percentage of wood production (8) = (7/1-10 + 7)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1990	176,164	21,736	130	—	—	—	130	176,294	21,866	12	85,307	0%												
1991	171,482	23,662	241	—	—	—	241	171,723	23,903	14	86,546	0%												
1992	180,125	26,185	352	—	—	202	554	180,679	26,739	15	90,885	1%												
1993	182,205	28,011	463	—	—	1,159	1,622	183,827	29,633	16	92,154	2%												
1994	188,569	30,670	574	—	—	2,545	3,119	191,688	33,789	18	96,595	3%												
1995	187,601	31,391	685	—	—	3,150	3,835	191,436	35,226	18	98,582	4%												
1996	189,362	33,981	796	—	—	4,007	4,803	194,165	38,784	20	98,334	5%												
1997	195,566	35,208	907	—	—	5,065	5,972	201,538	41,180	20	102,822	6%												
1998	196,569	35,770	1,018	—	—	5,645	6,663	203,232	42,433	21	101,262	7%												
1999	203,229	36,727	1,129	—	—	5,872	7,001	210,230	43,728	21	104,801	7%												
2000	193,159	35,447	1,240	—	—	6,199	7,439	200,598	42,886	21	100,900	7%												
2001	182,836	34,527	1,250	—	—	6,073	7,323	190,159	41,850	22	95,080	8%												
2002	185,987	34,579	1,260	—	—	7,157	8,417	194,404	42,996	22	95,890	9%												
2003	183,454	33,650	1,275	—	—	7,333	8,608	192,062	42,258	22	94,232	9%												
2004	192,318	34,736	1,290	—	—	7,560	8,850	201,168	43,586	22	98,124	9%												
2005	193,153	33,950	1,310	—	—	8,366	9,676	202,829	43,626	22	97,256	9%												
2006	190,996	34,471	1,310	—	—	9,450	10,760	201,756	45,231	22	98,025	10%												

Sources: Column 1, Howard 2007, table 9, Column 2, Table 1, Column 3, USEPA 2007, 2008, Column 4, Table 4.

Note: Wood pallets are assumed to contain 15 board feet of hardwood lumber with a weight of 1.68 tons per thousand board feet.

**Table 3—Recovered wood and paper recycling rates (utilization rates), separately and combined (percentage), 1990–2006**

Year	Wood	Paper	Total
1990	0	28	12
1991	0	30	14
1992	1	32	15
1993	2	33	16
1994	3	34	18
1995	4	35	18
1996	5	38	20
1997	6	37	20
1998	7	38	21
1999	7	37	21
2000	7	38	21
2001	8	39	22
2002	9	39	22
2003	9	38	22
2004	9	38	22
2005	9	37	22
2006	10	37	22

**Table 4—Recovered paper consumption, paper and paperboard production, and recovered paper recycling rate (utilization rate) by region, 2006<sup>a</sup>**

Region	Recovered paper consumption	Paper and paperboard production	Utilization rate (%)
North	13,420	27,090	50
South	15,379	53,340	29
Rocky Mountain	1,152	1,954	59
Pacific coast	4,777	9,839	49
U.S. average	34,728	92,223	38

<sup>a</sup>Source: AF&PA 2007.

assumed that the only source of post-consumer wood and paper that is burned for energy in significant quantities is from the municipal solid waste stream, and amounts burned from construction and demolition waste are currently small.

#### How Has It Changed Since 2003?

U.S. recovery of paper has increased from 45% in 1999 to 51% in 2006, with virtually all of the increase in recovered paper going for exports.

#### Regional Variation and Associated Issues

Total U.S. recovered paper consumed at U.S. mills increased by 2% between 2003 and 2006, from 33.7 to 34.5 million tons. Recovered paper consumption increased in mills in every region except the North. In 2006, the South had the highest recovered paper consumption, 15.4 million tons, but the lowest recovered paper recycling rate (utilization rate) at 29%. Next highest consumption was in the North (13.4 million tons) where the recycling rate (utilization rate) was the

highest at 50%, followed by the Pacific Coast at 4.8 million tons (49% recycling rate) (utilization rate) and the Rocky Mountains at 1.2 million tons (59% recycling rate) (utilization rate) (Fig. 3).

### Assessment of Ability to Measure Underlying Concern

It was possible to make estimates of recovery rate and recycling rate for post-consumer wood, paper for wood, paper in products, and in energy generation, but some estimates are rough.

#### Congruence of U.S. Results with TAC Recommendations

Recycling rate (utilization rate) estimates are emphasized in our measurements as a key way to evaluate how reusing post-consumer wood and paper may offset use of virgin wood rather than using recovery rate estimates as suggested by the TAC.

### Suggested Steps for Improvement

Data collection on pallet production and recycling may be needed to continue making estimates of recycling rate for solidwood products. Data collection may also be needed to determine how much construction and demolition waste is recycled into new products.

Estimates of use of wood and paper in MSW for energy may be improved by seeking more information about the make up of MSW that is burned for energy.

### Cross-Cutting Issues and Relation to Other Indicators

The recycling rates (utilization rates) for wood and paper influence the amounts and kinds of wood that is harvested in the United States (Indicator 13) and the effect of the harvest treatments on forest growth (Indicator 11). To the extent that recycling decreases harvest jobs, income and revenue to landowners are also affected (Indicators 36, 37, and 40). These rates also influence the amounts of carbon stored in forests (Indicator 22), the length of time carbon is stored in products (Indicator 23), and the energy that is obtained by burning post-consumer wood and paper (Indicator 24). The degree to which recovered paper is recycled in the United States rather than being exported depends on the competitiveness of using recycled paper in U.S.-based firms compared with having it used in foreign firms. This competitiveness is determined in part by the amount of U.S. investment in capital (Indicator 34) and in research and education (Indicator 35).

**Table 5—Generation of materials in MSW and recovery of wood and paper for combustion with energy generation, 2006 (million tons, except where noted)<sup>a, b</sup>**

Material	Weight generated (1)	Weight recovered (2)	Discards to landfill or to combustion with energy recovery (3) = (1)-(2)	Assumed to be a source for combustion with energy recovery (4)	Estimated combustion with energy recovery <sup>c</sup> (5) = (3) <sup>d</sup> (31.4/71.9)	Estimated energy content of wood and paper used for combustion (quadrillion BTU) <sup>e</sup> (6) = (5) <sup>d</sup> (17.2/1,000)
Paper and paperboard	85.3	44.0	41.3	yes	18.1	0.31
Glass	13.2	2.9	10.3	—	—	—
Metals						
Steel	14.2	5.1	9.1	—	—	—
Aluminum	3.3	0.7	2.6	—	—	—
Other nonferrous metals <sup>d</sup>	1.7	1.2	0.5	—	—	—
Total metals	19.1	7.0	12.2	—	—	—
Plastics	29.5	2.0	27.5	—	—	—
Rubber and leather	6.5	0.9	5.7	yes	2.5	—
Textiles	11.8	1.8	10.0	—	—	—
Wood	13.9	1.3	12.6	yes	5.5	0.09
Other materials	4.6	1.1	3.4	—	—	—
Total materials in products	184.0	61.0	123.0	—	—	—
Other wastes	—	—	0.0	—	—	—
Food, other <sup>f</sup>	31.3	0.7	30.6	—	—	—
Yard trimmings	32.4	20.1	12.3	yes	5.4	—
Miscellaneous inorganic wastes	3.7	Negligible <sup>g</sup>	3.7	—	—	—
Total other wastes	67.4	20.8	46.6	—	—	—
Total municipal solid waste (MSW)	251.3	81.8	169.5	71.9	31.4	0.41

<sup>a</sup>Includes waste from residential, commercial, and institutional sources.

<sup>b</sup>Source: USEPA 2007.

<sup>c</sup>To estimate wood and paper portions of combusted materials, we assume that the same fraction of each identified material is combusted and the total equals 31.4 million tons.

<sup>d</sup>Includes lead from lead-acid batteries.

<sup>e</sup>One ton equals 17.2 million BTU.

<sup>f</sup>Includes recovery of other MSW organics for composting.

<sup>g</sup>Less than 5,000 tons or 0.05%.

**Table 6—Energy from combustion of wood and paper portions of municipal solid waste (MSW) as a percentage of total wood energy consumption in the United States<sup>a</sup>**

Year	Total MSW combusted for energy (1)	Wood and paper combusted with energy (2) = (1) <sup>b</sup> (0.75)	Estimated energy content of wood and paper combusted (quadrillion BTU) (3) = (2) <sup>a</sup> (17.2/1,000)	Total wood energy production (quadrillion BTU) (4)	Total wood energy production plus burning of paper for energy (quadrillion BTU) (5) = (0.77) <sup>a</sup> (3)+(4)	Percentage (%) of total wood plus paper energy consumption that is from wood and paper in MSW (5) = (3/5)
1990	29.7	22.3	0.38	2.19	2.49	15
2000	33.7	25.3	0.43	2.26	2.59	17
2002	33.4	25.1	0.43	1.90	2.23	19
2004	34.4	25.8	0.44	2.02	2.36	19
2005	33.4	25.1	0.43	1.83	2.16	20
2006	31.4	23.6	0.41	2.11	2.43	17

<sup>a</sup>Sources: Column 1, EPA 2007; Column 4, Table 8.

<sup>b</sup>Note: We assume the wood and paper portion of MSW combustion for energy is 75% by weight for 1990 to 2005, as it was in 2006.

**Table 7—Estimated wood pallet production in the United States, 1990–2005<sup>a</sup>**

Year	Pallet shipments							
	(Million current \$ (1))	(Million 2000 \$) (2) = (1/producer price index (PPI))	New pallets		Recycled pallets		Total, all pallets	
			Million (3)	Per 2000\$ (4) = (3/2)	Million (5)	Per 2000\$ (6) = (5/2)	Million (7) = (3+5)	Per \$
1990	1,845	2,105	363	0.1724	—	—	363	—
1991	1,903	2,168	351	0.1619	—	—	351	—
1992	2,032	2,301	347	0.1508	8	0.0034	355	—
1993	2,330	2,600	370	0.1423	46	0.0177	416	—
1994	2,861	3,153	403	0.1278	101	0.0319	504	—
1995	3,051	3,247	411	0.1266	125	0.0385	536	—
1996	3,019	3,137	388	0.1237	159	0.0508	547	—
1997	3,093	3,216	438	0.1363	201	0.0624	639	—
1998	3,029	3,231	441	0.1364	224	0.0693	665	—
1999	3,154	3,335	454	0.1361	233	0.0699	687	—
2000	3,206	3,206	458	0.1429	246	0.0769	705	—
2001	2,880	2,848	427	0.1501	241	0.0845	668	—
2002	3,015	3,052	481	0.1576	284	0.0930	765	—
2003	2,959	2,844	471	0.1655	291	0.1023	761	—
2004	3,218	2,911	500	0.1718	300	0.1031	800	—
2005	3,478	2,932	504	0.1718	332	0.1134	836	—

<sup>a</sup>Data on new pallets and recycled pallets from 1995, 1999, and 2004 are from White 2004. For those years, we compute new pallets per 2000\$ of pallet shipments and recycled pallets per 2000\$ of shipments. The per dollar values are interpolated between 1995, 1999, and 2004. The interpolated per dollar values are multiplied by total value of shipments to obtain intermediate year estimates of new pallet production and recycled pallet production.

## Concluding Remarks

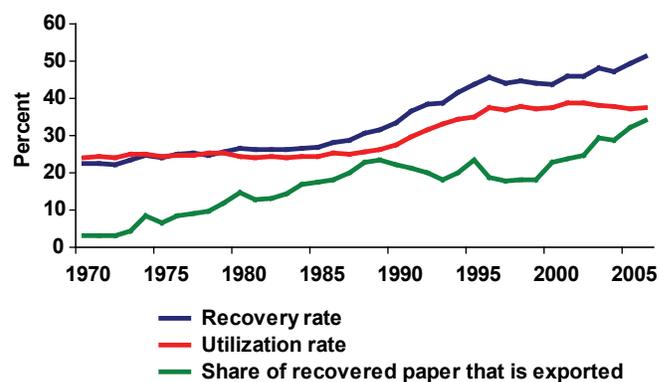
What does the information on recovery rates and recycling rates for wood and paper in products and energy mean for sustainable forestry and sustaining benefits from forests? The current recycling rates (utilization rates) for paper and wood back into product—37% and 10%, respectively—are notable, but there is room for these to increase. The continuing increase in recovery rate in the 1990s through 2006 at 51% was not matched by a continuing increase in recycling rate after the mid-1990s, as increases in recovery have been going largely for exports. The effects of increasing recovery after the mid-1990s were felt primarily in offsetting harvest in other countries, not in the United States.

## Literature Cited

AF&PA 2007. Paper, paperboard, and wood pulp, 2007 statistics (data through 2006). Annual statistical summary. Washington, DC: American Forest and Paper Association. 72 p.

AF&PA. 2002. Paper, paperboard, and wood pulp, 2002 statistics (data through 2001). Annual statistical summary. Washington, DC: American Forest and Paper Association. 82 p.

Howard, J.L. 2007. U.S. timber production, trade, consumption, and price statistics, 1965–2005. FPL–RP–637. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 91 p. [http://www.fpl.fs.fed.us/documnts/fplrp/fpl\\_rp637.pdf](http://www.fpl.fs.fed.us/documnts/fplrp/fpl_rp637.pdf).



**Figure 1. Paper and paperboard recovery rate, utilization rate, and share of recovered paper that is exported, 1970–2006. Source: Table 1.**

U.S. Environmental Protection Agency. 2007. Municipal solid waste generation, recycling, and disposal in the United States: facts and figures for 2006. EPA–530–F–07–030. Washington, DC. 11 p. <http://www.epa.gov/osw/nonhaz/municipal/pubs/msw06.pdf>.

U.S. Environmental Protection Agency. 2008. Municipal solid waste in the United States: 2007 facts and figures. EPA–530–R–08–010. Washington, DC. 167 p. <http://www.epa.gov/osw/nonhaz/municipal/pubs/msw07-rpt.pdf>.

White, M.S. 2004. Overview of the U.S. pallet industry. Presentation at ISO TC51 special seminar, Seoul, Korea. November 1, 2004. Blacksburg, VA: Virginia Polytechnic Institute and State University. <http://www.unitload.vt.edu/presentations/Korea.pdf>. Accessed 12/22/2010.

**Table 8—Wood energy use in the United States 1973–2006**

Trillion Btu					
Year	Total	Residential	Commercial	Industrial	Electric utilities
1973	1,527.0	354.1	6.7	1,164.9	1.4
1974	1,537.8	371.0	7.0	1,159.1	0.7
1975	1,496.9	425.4	8.1	1,063.3	0.2
1976	1,711.5	481.6	9.1	1,219.9	0.9
1977	1,836.5	541.8	10.3	1,281.2	3.2
1978	2,036.2	621.8	11.8	1,400.4	2.0
1979	2,149.9	728.1	13.8	1,404.9	3.1
1980	2,482.9	859.0	21.0	1,600.0	2.9
1981	2,494.6	869.0	21.0	1,602.0	2.6
1982	2,477.0	937.0	22.0	1,516.0	2.0
1983	2,639.3	925.0	22.0	1,690.0	2.3
1984	2,628.8	923.0	22.0	1,679.0	4.8
1985	2,575.8	899.0	24.0	1,645.0	7.8
1986	2,518.1	876.0	27.0	1,610.0	5.1
1987	2,465.2	852.0	29.0	1,576.0	8.2
1988	2,551.7	885.0	32.0	1,625.0	9.7
1989	2,637.1	918.0	36.0	1,583.6	99.6
1990	2,190.6	581.0	39.1	1,441.9	128.5
1991	2,189.7	613.0	41.1	1,409.8	125.8
1992	2,290.5	645.0	44.0	1,461.2	140.2
1993	2,226.9	548.0	45.9	1,483.2	149.8
1994	2,315.2	537.0	46.1	1,579.7	152.3
1995	2,419.6	596.0	46.1	1,652.1	125.4
1996	2,466.8	595.0	50.4	1,683.5	137.9
1997	2,349.5	433.0	48.9	1,730.6	137.0
1998	2,175.4	387.1	48.1	1,603.4	136.7
1999	2,223.7	413.9	52.3	1,619.5	138.0
2000	2,256.8	433.3	53.2	1,635.9	134.3
2001	1,979.5	370.0	40.5	1,442.6	126.4
2002	1,898.8	313.0	39.1	1,396.4	150.2
2003	1,929.4	359.0	39.8	1,363.3	167.3
2004	2,015.1	332.3	41.4	1,476.1	165.2
2005	1,825.5	332.3	41.4	1,284.1	167.6
2006	2,114.4	390.0	64.8	1,469.4	190.1

Source: Howard 2007, table 60.

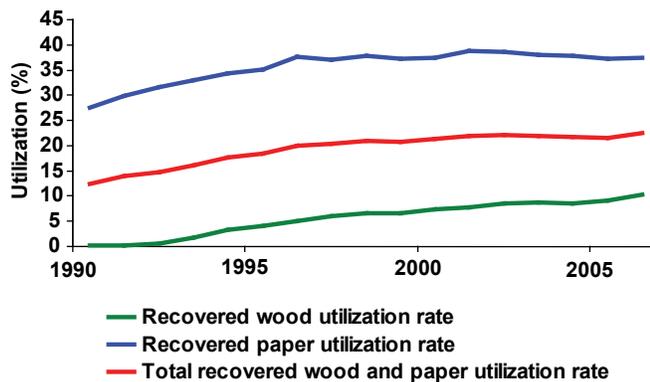


Figure 2. Recovered wood and utilization rates, separately and combined, 1990–2006. Source: Table 3.

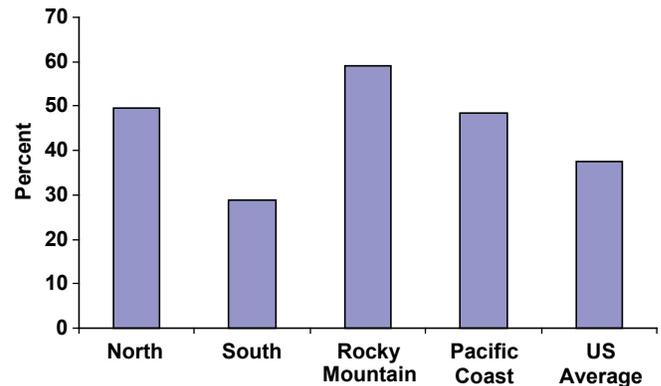


Figure 3. Recovered paper utilization rate by region, 2006. Source: Table 5.