THE ENVIRONMENTAL IMPACTS OF WOOD ARE SUBSTANTIAL

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Proposals calling for a marked reduction in the harvest of wood from domestic forests are increasingly common. Such proposals are almost always based on concern for the environment, and are frequently promoted as part of what is described as a new ethical standard for forest management.

Reasons often cited for restricting the domestic harvest of timber include negative impacts upon aesthetics, wilderness values, tourism, wildlife values, water quality, plant and animal diversity, and long-term sustainability of the timber harvesting enterprise. Although there are definitely environmental impacts of harvesting timber, and a number of important factors that must be considered in planning a harvest, the impacts of gathering and processing alternative materials are quite substantial.

Moreover, alternate materials are largely imported, meaning that substitution of non-wood raw materials largely means that the environmental consequences of raw material gathering and processing are exported, usually to countries that have far less stringent environmental controls in place than the United States. An examination of realistic alternatives to sustainable domestic timber harvest suggests that restrictive protection of local resources without considering global consequences can translate to what amounts to irresponsible and unethical regional environmentalism, with adverse economic and strategic consequences. The requirements for materials and the need to protect the environment must be addressed jointly if workable solutions are to be found. When the world is viewed in this way, an inescapable conclusion is that the United States should be seeking to increase the sustainable production of wood from its forests.

Table 1 - Net Carbon Emissions in Producing a Ton of:

Material	(kg C/metric ton)
Framing Lumber	-460
Concrete	45
Concrete Block	49
Brick	148
Glass	630
Steel	1090
Aluminum	2400
Plastic	2810

Source: Honey & Buchanan, Dept. of Civil Engineering, University of Canterbury, Christchurch, NZ, 1992

Americans identifying themselves as environmental activists have, in recent years, increasingly taken the position that to protect the environment, any intensification of domestic raw material production -- whether timber, minerals, or energy resources -- must be resisted. This position has gained growing favor with a U.S. public that has generally lost an awareness of how much raw material it takes to sustain the economy, where raw materials come from, what the environmental impacts are of gathering and processing these materials, and the environmental tradeoffs involved in using one type of material instead of another. In view of the environmental basis for objections to development of resources, it is ironic that failure to develop domestic resources simply results in a shift of environmental impacts to other regions of the world where impacts are often more severe. In addition to the obvious moral and ethical issues that this situation raises, the environmental benefits are questionable. It is highly doubtful that the net impact on the global environment of interregional transfer of raw material extraction and processing is positive.

In this article, the harvest and use of wood will be examined in a global context, and assessed in light of demands posed by a growing human population. In all discussions of timber harvest, sustainable harvest levels are assumed.

Population growth: United States and worldwide

Table 2 - Forests Then, Now, and Future -- USA

Year	Population	Forest Area (million acres)	Forest Area per Capita(acres)
1785	3,000,000	1044	348
1850	23,300,000	926	40
1910	77,000,000	730	9.5
2000	274,000,000	737	2.7
2100	571,000,000	737	1.3

Source: personal communication with J.Bowyer

If environmental issues are to be effectively addressed, it is critical that plans and actions be based on rational thinking and realistic assumptions; planning must consider growing populations and the inevitable associated growth in raw material demand.

Birth rates worldwide are declining, continuing a long-term trend. However, the current average difference in birth and death rates is substantial, translating to a high rate of wood population growth (1), Even assuming a significant further decline in birth rates, the current world population of 6.1 billion is expected to rise to 11 billion or more by the end of this century. Most of the increase will occur in developing regions of the world: Africa, Asia (excluding Japan) and Latin America.

While the rate of population growth in the United States is relatively low, it is important to remember that populations continue to increase. With a current annual growth rate of 0.9 to 1.0 percent, some 2.3 to 2.5 million people are added to the U.S. population each year creating an additional Los Angeles every 3 years.

Domestic raw material demand and sources of supply

The United States economy is based on consumption of vast quantities of industrial raw materials. These materials are largely imported. An examination of Table 3 reveals that the United States is a net importer of the majority of raw materials used to sustain the economy, and often by a substantial margin. Table 3 also shows that developing nations appear frequently in the list of suppliers. An examination of recent trends indicates that the level of importation is increasing.

Table 3 - Net U.S. Imports Of Selected Materials As A Percent Of Apparent Consumption—1998, And By Major Foreign Sources[a/b/c/d/]

Material	% Imported	Principal Foreign Sources (1994-1997)
Columbium (Niobium)	100	Brazil, Canada, Germany, Thailand
Mica (natural)	100	India, Belgium, Germany, China
Manganese	100	South Africa, Gabon, Australia, France
Graphite	100	Mexico, Canada, China, Madagascar, Brazil
Strontium (Celestite)	100	Mexico, Germany
Bauxite/Alumina	100	Australia, Guinea, Jamaica, Brazil
Fluorspar	100	China, South Africa, Mexico
Yttrium	100	China, France, United Kingdom, Belgium
Thallium	100	Mexico, Belgium, Canada, Germany
Platinum Group	94	South Africa, United Kingdom, Germany, Russia
Palladium	88	Russia, South Africa, Belgium, United Kingdom
Tin	85	Brazil, Indonesia, Bolivia, China
Antimony	84	China, Mexico, Bolivia, South Africa
Tantalum	80	Australia, Thailand, China, Brazil
Potash	80	Canada, Russia, Belarus
Barium (Barite)	80	China, India, Mexico, Morocco
Chromium	79	South Africa, Kazakhstan, Turkey, Zimbabwe
Tungsten	78	China, Germany, Bolivia, Peru
Cobalt	77	Norway, Finland, Zambia, Canada
Iodine	72	Canada, Mexico, Spain, Peru
Zinc	70	Canada, Mexico, Spain, Peru
Nickel	65	Canada, Norway, Russia, Australia
Silver	--	Canada, Mexico, Germany, Peru
Diamond (industrial)	51	Ireland, China, Germany
Titanium	49	South Africa, Australia, Canada
Petroleum (Crude & Refined)	48	Saudi Arabia, Venezuela, Canada
Lumber	35	Canada, Finland, New Zealand, Chile
Silicon	32	Norway, Russia, Brazil, Canada
Magnesium Compounds	28	China, Canada, Mexico, Greece
Gypsum	26	Canada, Mexico, Spain
Aluminum	25	Canada, Russia, Venezuela, Mexico
Cadmium	21	Canada, Australia, Belgium, Mexico
Iron and Steel	18	EEC, Canada, Japan, Brazil, South Korea
Sulfur	18	Canada, Mexico, Germany
Iron Ore	17	Canada, Brazil, Venezuela, Australia, Mauritania
Portland and Masonry Cement	17	Canada, Spain, Venezuela, Greece, Mexico
Copper	16	Canada, Chile, Mexico
Asbestos	6	Canada
Wood & Wood Products (Total)	0.7	Canada, Brazil, Indonesia, Finland, Mexico, Malaysia

[a]Also significant import dependency for Andalusite, Arsenic, Bismuth, Caesium, Gallium, Gemstones, Germanium, Ilmenite, Indium, Iron and Steel slag, Kyanite, Lead, Leather, Lime, Lithium, Mercury, Mica, Natural Rubber, Nitrogen, Pumice, Pyrophyllite, Quartz, Rhenium, Rubidium, Rutile, Salt, Selenium, Sodium Sulfate, Stone (dimensional), Tellurium, Thorium, Vanadium, Vermiculite, Wool, Zirconium.

[b]U.S. Department of the Interior. 1996. Mineral Commodity Summaries. Geological Survey and Bureau of Mines.

[c]Data for wood, wood products, and wood pulp products are from U.S. Forest Service, Forest Products Laboratory and include logs, lumber, wood products of all kinds, pulp, paper, wastepaper, and chips.

[d]Petroleum data from U.S. Department of Energy, Energy Information Administration.

Wood and wood fiber is used in very large quantities in the United States, both in familiar forms such as poles, timbers, lumber, and plywood, and in less known products such as molded interior panel for autos, adhesives, paints, food additives, drapes, tires, and even ping pong balls. In total, some 18 billion cubic feet of wood were consumed in the United States in 2000, representing consumption of 74 cubic feet per capita, continuing a long-term rather than stable trend in per capita domestic wood use (Table 4).

Wood as a raw material

Table 4 - U.S. Consumption of timber products for selected years

Year	Total domestic consumption (million cubic feet roundwood equivalent	Per Capita Consumption
1970	11,995	61.1
1975	11,105	54.1
1980	13,020	70.8
1981	12,225	66.9
1982	11,930	65.7
1983	13,665	72.0
1984	14,830	77.9
1985	14,790	76.2
1986	15,920	78.8
1987 (est.)	16,510	80.1

Source: *U.S. Bureau of the Census Statistical Abstract of the United States, 1990 (Reference #3).*

Economic importance

Perhaps the most effective way to illustrate the economic importance of wood is to examine how much is used relative to other materials. Today, for example, the quantity (weight) of wood used annually in the United States is roughly equal to the annual consumption (weight) of all metals, all plastics, and Portland cement combined!

Energy consumption associated with wood use

A number of the significant environmental problems of today are traceable to consumption of energy. Energy use has major environmental impacts, ranging from acid rain and global warming, to oil spills. Thus when considering environmental tradeoffs associated with using one raw material versus another, it is useful to look at industrial materials in an energy context.

When materials are compared in relation to energy consumed in gathering, processing, and fashioning materials to final product, wood compares very favorably with other materials. An evaluation of energy inputs involved throughout the process from raw material extraction to finished product is on the order of 70 times higher for aluminum than for an equal weight of lumber, and 17, 3.1, and 3 times higher for steel, brick, and concrete block, respectively than for wood. A comparison of wood versus other materials used in a common product — such as in a wall section — show substantial energy advantages of wood materials (Table 5).

Table 5 - Energy Required in the Manufacture of Various Wall Systems	
Type of Wall	Energy to Manufacture 100 feet of wall (million BTU oil equivalent)
Plywood siding, no sheathing, 2 by 4 frame	1,988
MDF siding, plywood sheathing, 2 by 4 frame	2,541
Concrete building block, no insulation	17,087
Aluminum siding, plywood, insulation board, over 2 by 4 frame	4,953
MDF siding, plywood sheathing, steel studs	5,106
Brick veneer over sheathing	17,887
Calculations of energy consumption include logging (or extraction), manufacture, transport to house site, and erection. *Source: Committee on Renewable Resources for Industrial Materials, 1976 (reference #4).* *MDF = Medium Density Fiberboard*	

Growth versus harvest

It is generally acknowledged that substantially more wood is added in new growth in U.S. forests each year than is harvested. For softwood species the growth harvest ratio was estimated in 1996 as 1.35, meaning that 35 percent more was being added annually in net growth than was removed through harvest. For hardwoods, the growth/harvest ratio in 1996 was estimated to be 1.7! For the United States overall, considering both hardwoods and soft-woods, the growth removals balance was reported as a healthy 1.45 (5).

Options to harvest of domestic forests

In view of the fact that the United States annually consumes vast quantities of wood and wood fiber, and is today a net importer of most industrial raw materials, including wood, wood fiber, and wood products of all kinds, any decision to reduce the domestic harvest of timber has a number of economic, environmental, strategic, and ethical implications. It is important, then, that various options to domestic timber harvest, and the consequences of these options, be carefully considered.

Options to domestic harvest of timber are: 1) to shift to the use of raw materials other than wood; 2) to use wood, but to import needed supplies; 3) to reduce the rate of raw material consumption in general; and 4) to recycle to a greater extent than current efforts. Each of these options are explored in the following paragraphs.

Shift to non-wood raw materials

As discussed earlier, the United States is currently a net importer of most important raw materials, and in a great number of instances, by a wide margin. Further, the United States today annually uses roughly as much wood by weight as all metals, all plastics, and Portland cement combined. Therefore, if there is to be a substitution of other materials in order to reduce timber harvest, it will be a massive substitution. Moreover, the materials substituted will be largely imported and nonrenewable, and the gathering and processing of these substitute materials will, in general, result in the use of larger quantities of energy and in more severe environmental impacts than will the use of wood.

From an environmental perspective, the impacts of gathering and processing wood are generally less than for potential substitute materials. A shift to non-wood raw materials is largely unacceptable, not only from an environmental perspective, but from economic and equity perspectives as well. An increase in raw material imports would adversely affect the trade deficit. Such a move would also raise strategic questions; the primary issue here is whether a world which has roughly twice the current population will continue to be willing to export the level of resources as it now does to the United States, much less a great deal more. With regard to equity, it is important to realize that when we elect, by design or default, to have raw materials gathered and processed elsewhere, rather than in the United States, we are, in effect, exporting the associated environmental impacts.

Use wood -- but import raw material needs

In considering this option, questions must be asked about where substitute wood might come from. Substitute wood supplies could be obtained from one or more of several regions that have relatively abundant supplies of wood; 1) Canada; 2) Russia; 3) Central and South America; and 4) Oceania.

Of these regions, only Canada, the Russia, and Central and South America have large areas of well-stocked natural forests with those in the Americas largely in the environmentally sensitive tropics. In addition to these natural forests, there are relatively small but expanding areas of plantation forests around the world that could (and that likely will) supply a part of our future wood needs. Because of issues surrounding the harvest of tropical forests, and because of the environmental stress now felt by the tropical regions, it is unlikely that the natural forests of Central or South America will contribute substantially to the future U.S. demand for wood. Canada could possibly supply more of U.S. needs, though there are signs that production limits are being approached in at least some of Canada's forests. It is the forests of the Russia that are the most likely candidate as a source of supply, and these will undoubtedly be tapped in the future by U.S. manufacturers.

This option may be acceptable as a strategy for achieving some reduction in domestic timber demand. However, the same ethical and economic implications that are connected with increased use of imported, non-wood materials largely apply to this option as well.

Reduce the rate of raw material consumption

When considering the rate of raw material consumption in the United States it is easy to conclude that a reduction in the consumption rate, through taxation, voluntary conservation, or other means, represents a realistic means of reducing pressure on the world's raw materials. Some reduction in domestic per-capita consumption may even be possible, though it is realistically unlikely. Additionally, it is important to remember that the U.S. population is still growing.

An assessment of prospects for reducing raw material consumption globally shows little likelihood of reduced raw material use. A number of factors, in fact, suggest that

the future will bring significant increases in demand for raw materials of all kinds; among these factors are:

1. A likely near doubling of world population in the next 70 to 100 years.
2. A desire on the part of large segments of the world population for greater, rather than lesser, consumption of durable goods (e.g., Eastern Europe).
3. The fact that even modest increases in the standard of living for people now without adequate shelter and other basic necessities will translate to relatively larger increases in raw material demand.

It can be argued that improved technology leading to more efficient processing and increased recycling will serve to reduce future raw material demand. Gains in both areas are likely. In order to even maintain consumption of raw materials at current levels, however, it will be necessary to halve current per capita consumption, assuming a doubling of world population.

Table 6 - Per Capita Consumption of Key Raw Materials U.S. and Western Europe vs. World Average - 1998

	Average Per Capita Consumption (kg)			Average Per Capita Consumption Compared To World Average	
Raw Material	U.S.	W.Eur.	World	U.S.	W.Europe
Wood*	2.27	0.81	0.55	4.1x	1.5x
Steel	418	360	132	3.2x	2.7x
Aluminum	25.5	14.5	3.7	6.9x	3.9x
Cement	381	485	253	1.5x	1.9x
Plastics	154.2	102.6	24.2	6.4x	4.2x

Wood quantities in cubic meters
Source: Personal communication with Jim Bowyer

It is important to recognize that the United States uses vast quantities of industrial raw materials each year, and that the United States is a net importer of almost all important materials. Materials on the net import list include most metals, petrochemicals, and wood and wood products of all kinds. It is important as well to realize that world populations continue to grow at a rapid rate. Barring catastrophe, the world population will roughly double in the next 100 years. Similarly, demand for shelter and other goods are likely to at least double. Given this situation, is difficult to imagine that Americans would rationally seek to largely import future raw material needs, when environmentally responsible and sustainable options are available domestically. Beyond the issue of rationality is the fundamental question of whether a U.S. policy designed to create a pristine domestic environment through continued and increasing reliance on other regions of the world for heavy industrial activity is ethically and morally defensible.

Specifically with respect to forests and the harvest of timber, it is perhaps easy to conclude, in the absence of global or comprehensive thinking, that domestic harvest levels should be significantly reduced. Consideration of raw material options, and associated environmental impacts logically leads, however, to a much different conclusion. Wood is a critically important part of the U.S. raw material picture. Each year Americans consume roughly as much wood by weight as all metals, all plastics, and portland cement combined.

Moreover, the energy consumption associated with harvesting and processing of wood is substantially less than for potential substitute materials. Thus, if Americans choose, by default or otherwise, to produce far less timber than is possible on a perpetual yield basis, that decision leads to basically three alternatives:

1) use other raw materials (which will require a massive substitution of materials that are already largely imported and which will result in more serious global environmental consequences than the harvesting of timber);
2) use wood, but import our needs (thereby increasing the U.S. trade imbalance and stimulating timber harvest in places such as Russia or the environmentally sensitive Amazon region); or
3) drastically reduce our consumption of raw materials generally (through a reduction in production of everything from homes to furniture and/or increased emphasis upon recycling).

There is clearly much to be done in recycling our wastes and tremendous benefits to be gained from increased recycling. Though increased recycling will directly impact demand for virgin raw materials, the effects on current levels of demand may be modest.

When seeking to protect the environment, the lack of a global perspective can and does lead to what amounts to irresponsible and unethical regional environmentalism. We need to totally rethink our positions and approach to environmental issues, with global and comprehensive thinking and rational consideration of options key components of a new approach. To do otherwise would ill serve both the world's environment and its people.

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