Is The Northern Spotted Owl Worth More Than The Orangutan?

Donna Dekker-Robertson[1]

Abstract.—When policymakers choose to reduce the amount of wood harvested on National Forest lands, the demand for wood products must be met by reducing consumption, increasing recycling, substituting nonrenewable resources, or importing more wood. Reducing the amount consumed and increasing the amount recycled will not significantly impact global demand, and both substitution of nonrenewable resources and increased importation of wood products have negative consequences. Establishing high-yield plantations of genetically improved trees grown using intensive silviculture on federal lands may allow the United States to set aside other valuable areas without exporting environmental degradation or increasing carbon dioxide emissions.

I used the word "worth" in the title deliberately. To me it seems that we spend a lot of time thinking about what we want: clean air, clean water, biodiversity, nice houses, recreational opportunities, low taxes...But we aren't often asked "What's it worth to you? How much would you spend to have these things? Or what would you be willing to give up to have them?"

Is it worth more effort in recycling? Many of us agree and the amount of paper and other materials recycled is going up rapidly.

Is it worth keeping things longer and repairing them rather than replacing them? Hmm...

Would you give up having a new house when the one you have now is getting old or too small?

Would you give up your new deck, your new kitchen, your disposable diapers, your foods packaged in convenient cardboard boxes, those photos of the kids from the last vacation?

Is it worth curbing our consumption?

Or is it worth extinctions in places you may never visit nor even know much about?

A few years ago our Congress passed the Endangered Species Act when many people agreed that we wanted to save species from extinction, particularly extinction caused by our actions. Today hard questions are being asked about its unintended (and unforeseen) consequences. Our Senators and Representatives usually cast that debate in terms of job losses and infringements on the rights of private property owners. However, another unintended consequence of the Endangered Species Act and other legislation that changes the management objective of National Forest lands is to force us to look elsewhere to satisfy our demand for wood products.

I think that we resource professionals have read and thought about the impact of forest harvesting. I think that the American public has, too. We've heard from many of them loud and clear: they don't like it. They don't like clearcutting, they don't like road construction, they don't like loss of habitat. They don't even like it when we suggest thinning operations that will keep the forests in the West from going up in smoke every August. But we know from what they buy that they do like wood-framed single-family homes, toilet paper, wooden furniture, decks, cardboard boxes, fireplace fires, photographic film and Scotch tape...I believe that many American voters have lost the fundamental connectivity between everyday products and the raw materials used to make them, just like the urban kids who think that milk comes from boxes at the store.

Expand on that a moment. Where does that box come from? It's a paper product. Its parent material is wood. In the Pacific Northwest the odds are that it was made from residues generated at a sawmill, a sawmill that was cutting logs into lumber. Where did the sawmill get the logs? They were cut from a forest somewhere. Historically, those forests were also in the Pacific Northwest. But with the injunctions, the lawsuits, the appeals, and above all the uncertainty associated with this, sawmill owners are looking further afield, from Tierra del Fuego to Siberia (Sleeth 1994a,b).

According to wood scientist Jim Bowyer (1992), when we remove lands from timber harvest, we have three options. We can reduce our demand and recycle. We can substitute other materials for wood. Or we can import our wood from other countries.

OPTION ONE: REDUCE DEMAND AND RECYCLE

Worldwide reduction in the consumption of raw materials, including wood products, seems unlikely in view of global population trends. According to the U.N. (1996), the world's population is growing at 1.5 percent annually. As Jacques Cousteau (1992) noted in his address to the world's leaders at the summit in Rio, "Every 6 months, the equivalent of France (50 million) is added. Every 10 years, there is a new China born in the poorest regions of our Earth."

Global per capita consumption of wood has increased from 0.6 to 0.7 cubic meters per person per year from 1950 to 1989, an increase of 12 percent (FAO 1961; FAO 1991). Interestingly, even today more wood is harvested globally for fuel and subsistence use than industrial use, by about 53 to 47 percent. The amount used for fuelwood is projected to rise worldwide about 24 percent by 2010 (FAO 1993).

[1]Research Plant Geneticist, USDA Forest Service, Rocky Mountain Research Station, Moscow, ID.

Pulp and paper consumption has also increased substantially. Paper and paperboard production has increased threefold worldwide since 1960, and the FAO projects that by 2010 pulp and paperboard production will be five times what it was in 1960 (FAO 1994). The increased production will go predominantly to developing nations as their economies and populations grow (Barbier and others 1994).

The amount of wood used industrially worldwide will also rise between 15 and 40 percent. Overall, the world roundwood consumption (that is, wood harvested both for fuel and for wood products) is projected to increase about 32 percent by 2010 (FAO 1993), or one-third again what is presently consumed.

The suggestion is often made that we should just let the market take care of the problem, that as wood prices rise demand will fall. When people using a product are well-off, they will normally pay more or substitute another product when prices rise. When the people using the product are living submarginally, however, there may be no substitutes; the effect of diminished supply and rising prices is to force a drop in their standard of living. One unpleasant side effect of a decreased standard of living is that it promotes higher birthrates. Today Haiti is well on its way towards total deforestation; two-thirds of the island's forests are gone, and the remaining third is quickly being used for charcoal (Cousteau 1992). No substitute product is available, and the standard of living is among the lowest in the western hemisphere. The birthrate, however, is one of the highest. Is that the destiny we should bequeath to the world's children?

Here in the USA, per capita consumption of wood fiber is increasing, not decreasing as some have suggested. Since 1970, it has increased 30 percent to about 2.4 cubic meters per person per year; that is nearly 3.5 times the global average (Fig. 1) Total wood consumption in the United States has increased 50 percent since 1970, from 12.5 to 18.7 billion cubic feet per year (Haynes and others 1993).

Every year, every American consumes a tree 100 feet tall and 19 inches in diameter (derived from Haynes and others 1993). A forest of such trees, roughly 250 million of them, might cover some 3 million acres, or just under 5,000 square miles. That is an area roughly the size of Connecticut (4,872 sq. miles). In 1993, Americans consumed 20 billion cubic feet of wood and wood products. That may be visualized as a train of some two million fully loaded boxcars encircling Earth at the equator. Each year, enough trees must be harvested somewhere to load that train with the wood required to satisfy our national appetite (Daniels 1993).

Recycling is an important and growing source of fiber, slowing the rate at which virgin fiber is needed. Wastepaper utilization rates increased from 25 percent in 1986 to 30 percent in 1992 (Haynes and others 1993), and still continue to improve. However, because recycling degrades quality, there are limits to the number of times that paper can be recycled. For some uses it may be as many as 4 to 9 times through the process, but in any case some 15-20 percent of fibers are lost in each cycle. For that reason virgin fiber must be constantly added.

Solid-wood recovery programs are still uncommon although they may play a larger role in the future. Projects exist or are being researched that chip used pallets for particleboard, add them to municipal sewage sludge, or use them as feedstock for hardboard plants (Davis and Jansen 1992). Old wood may become more common in composite products used for road construction, sound barriers, posts, or solid cores for doors. Recycling either paper or solid wood has the added benefit of reducing landfills (Ince and others 1995).

Unfortunately, growth in demand for wood products worldwide cannot be met solely by recycling. Since populations continue to increase, the demand for fiber will simply outstrip the supply no matter how good the utilization rate becomes.

If global populations are rising at 1.5 percent annually, and each new person added uses 0.7 cubic meters of wood each year, then over the next 20 years we will need an additional 2.7 billion cubic feet **per year** to keep up with global demand. That's another British Columbia or 6 more New Zealands every year. And it is senseless to pretend that population growth won't produce 11 or 12 billion people on Earth in the next century; we need to plan now and plant now to meet their demands for natural resources.

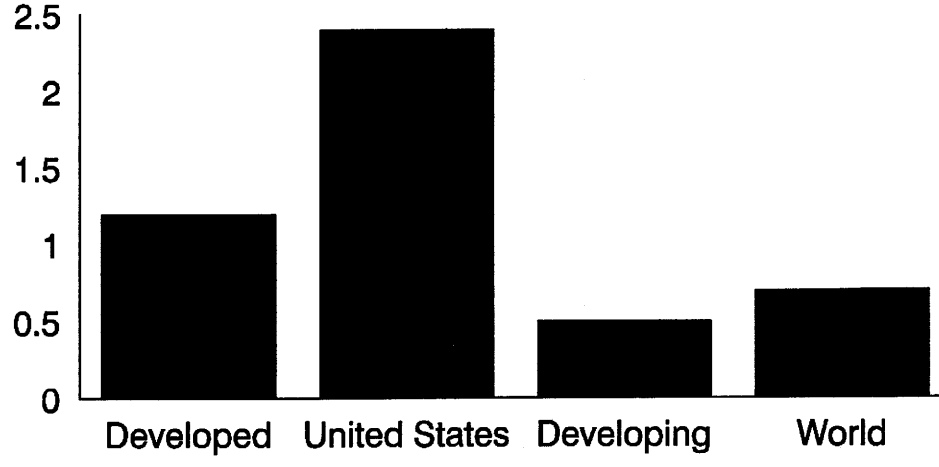

Figure 1.—Global per capita consumption of wood, in cubic meters. Each American uses 2.4 cubic meters of wood annually, which is twice the average of the developed nations and nearly 3.5 times the global average (FAO 1993).

OPTION TWO: SUBSTITUTE OTHER MATERIALS FOR WOOD

A second way that we could cope with declining wood supplies from National Forest lands would be to substitute other materials for wood. Other agricultural products may be used in lieu of wood fiber to make paper. Competing materials also exist for construction purposes, such as steel or aluminum studs, concrete slabs rather than floor joists, and vinyl siding. However, such substitutes may be less environmentally friendly than wood in a number of ways.

Paper is a versatile product that has been made from rags, flax, hemp, bagasse, kenaf, and a number of other materials. The desired end use determines the best composition of fibers, and wood fiber is well suited to a number of these uses. Nevertheless, it has been suggested that it would be more environmentally favorable to switch to crops such as bagasse and kenaf to make paper. Bagasse is a by-product of sugar cane cultivation and such by-products can and should be used where possible. But a plantation of sugar cane, or kenaf, or any annual crop is not as biodiverse as a plantation of trees which stays in place for many years (Libby 1994a). Furthermore, annual crops are generally grown with the assistance of chemicals, unlike plantations of forest trees on National Forest lands where chemical use is highly restricted. Should policymakers choose to press for more agricultural fiber in papermaking, they must consider that environmental costs will be shifted to agricultural lands rather than being eliminated.

One of the long-term goals of National Forest management is sustainability of the forest through time. Forests do grow back following all but the most damaging of disturbances, and it is undeniable that wood is the only building material (with very minor exceptions) that is renewable. Steel, aluminum, concrete and plastic are not, so deposits of the parent materials of these products must be continuously developed. The sites from which these materials are extracted must eventually be reclaimed. Lippke (1992) noted that, "logic and maybe even intuition would suggest that using renewable resources rather than nonrenewable resources would better protect the environment."

While substitutes for wood may in some cases be cheaper, the price does not always include another cost: energy requirements. In the 1970s a panel that reported to the National Science Foundation analyzed the amount of energy necessary to extract, transport, and convert various raw materials into finished products (CORRIM 1976). Since much of the world's power is generated by burning fossil fuels, they used the unit "a million Btu (oil equivalent)" as a uniform measure of expressing energy consumed. So, for instance, the production of a ton of softwood lumber is said to require 2.91 million Btu, or half a barrel of oil. The production of a ton of steel studs requires 50.32 million Btu, or about 8.5 barrels of oil.

Substituting other materials for wood products therefore comes at a high cost in terms of energy. The CORRIM panel compared the energy required to construct 100 square feet of either exterior wall, interior wall, or floor. They found that steel framing for an exterior wall requires 13 times more energy than wood framing, while aluminum framing for the same wall is nearly 20 times as energy intensive as wood framing. A floor built with steel joists requires 50 times as much energy as one built with wood joists. Interior walls framed with steel or aluminum studs use eight or twelve times, respectively, the energy of wood studs to perform the same function (Fig. 2). Brick siding uses 25 times more energy than wood-based siding materials (as well as requiring much more labor to install). Even details such as wall-to-wall carpeting with a pad rather than hardwood flooring add up; the carpet/pad combination uses four times as much energy as wood.

Straight across, ton-for-ton comparisons are even more significant. From raw material extraction to finished product, the energy input is 70 times greater for a ton of aluminum than for a ton of lumber; 17 times greater for steel; 3.1 times greater for brick; and 3 times greater for concrete blocks (CORRIM 1976).

Here in the United States we consume approximately 18.7 billion cubic feet of wood every year, and most of what we consume is used industrially (Haynes and others 1993). About half of the wood consumed is used for lumber and veneer, and about 60 percent of that is used for construction. To substitute other materials for wood in construction on a large scale would therefore involve a significant increase in energy consumption, at least some of which would be generated by burning fossil fuels.

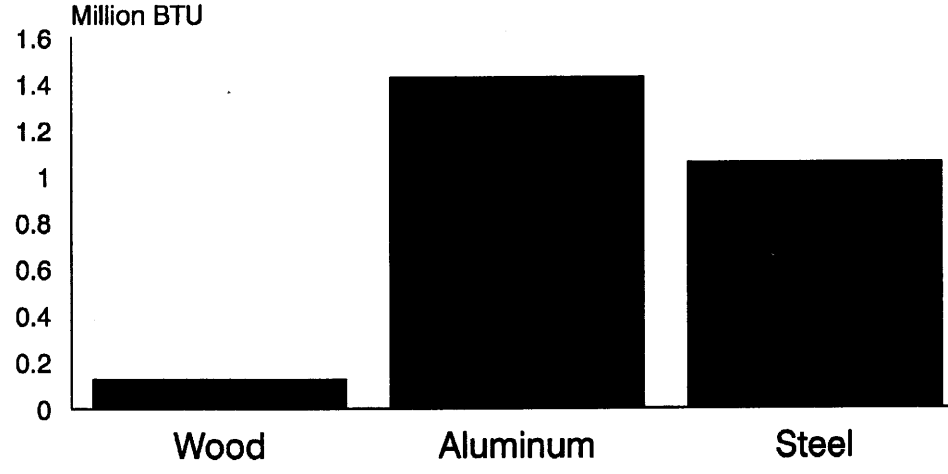

Figure 2.—Net energy consumed to extract, transport, manufacture and erect 100 square feet of interior wall using various framing materials (CORRIM 1976).

Each gallon of fuel oil burned adds 22.4 pounds of carbon dioxide to the atmosphere. Carbon dioxide is considered to be the most significant of the greenhouse gases that may contribute to global warming (Wigley and Raper 1992). Four of the most important global circulation models predict mean annual temperature increases of between 1.5 and 4.5 degrees Celsius as a result of carbon dioxide concentrations doubling. Scientists predict that could cause great ecosystem disturbances and losses, as the climate change would occur too quickly for the flora and fauna to either migrate or adapt (Monserud and others 1993).

Wood scientist Peter Koch (1992) estimated that for each 1 billion board feet of wood wholly replaced with manufactured substitutes, annual energy consumption increases by about 17 million barrels of oil, and carbon emissions increase by 7.5 million tons. In his worst-case scenario of an 8.25 billion board foot wood supply reduction from lands set aside in the Pacific Northwest, 141 million additional barrels of oil would be consumed to deliver the same products. That amounts to the cargoes of 117 supertankers the size of the Exxon Valdez, enough oil to fuel 11 million automobiles for a year. And, as a by-product of combustion, 62 million additional tons of carbon dioxide would be added to the atmosphere every year.

With marvelous serendipity, wood use has almost the opposite effect. Growing trees absorb carbon dioxide, sequestering the carbon and emitting the oxygen. The carbon remains stored in the wood for the life of the tree and beyond, after it is converted into products and used in the manufacture of structures. A number of preliminary analyses have even indicated that forest establishment and management as well as agroforestry could contribute to global carbon sequestration and reduce concentrations of atmospheric carbon dioxide (Schroeder and others 1993).

To sum up, Clive Whittenbury noted in the new book *Creating a Forestry for the 21st Century* (1997) that, "Wood has many well-described attributes, not the least being its manufacturing efficiency using solar energy. It is one of two large-scale converters of solar energy that meet the vast material needs of society; the other is agriculture. The vast collector areas of the forest inexpensively turn water and free carbon dioxide into vast quantities of biomass via solar energy. This is why wood is so important environmentally. Substitutes for wood used in construction start at a competitive disadvantage if they are evaluated using environmental criteria."

OPTION THREE: IMPORT MORE WOOD

So we've decided that demand isn't likely to fall and that substitution of other products for wood may not be environmentally friendly either. Our third option, then, is to import the wood we need from other countries.

What happens when we simply get our wood from somewhere else to replace wood from areas we've set aside in the United States? We begin to find out how connected the world really is. Ecologists from John Muir to the present have made statements that "everything is connected to everything." That couldn't be more true when discussing global trade issues.

In the global market, the United States is the world's largest importer of wood products (FAO 1993). The U.S. is also one of the largest exporters, second only to Canada (Brooks 1993). Oddly enough, we export some of the same products we import, notably softwood lumber. On balance, though, the U.S. is a net importer of wood products; nearly 20 percent of what is consumed domestically is imported (Haynes and others 1993). The vast majority of the wood imported is softwood lumber, almost exclusively from Canada (FAS 1996).

The largest markets for American wood products are Japan, Canada, Germany, South Korea, and Mexico. The value and volume of trade with Japan is more than twice the value and volume of trade with Canada, our second-largest export market. The largest single component of that trade is softwood logs, followed by softwood lumber (FAS 1996).

Softwood log exports from the United States as a whole peaked in 1988 and have been declining an average of 6.4 percent every year since then. In 1995 only 11.5 million cubic meters were exported, for an overall decline of 44 percent from the 1988 volume (20.8 million). Exports from the western region and Alaska have fallen at a rate of 8.2 percent annually and are only 51 percent of their 1989 peak (WWPA 1995). The vast majority of those logs go to the Pacific Rim, notably Japan (FAS 1996).

Softwood lumber exports show a similar pattern (Fig. 3). On average, the volume of softwood lumber exported from the United States has declined 7 percent every year since its peak in 1989, for an overall decline of 42 percent. Lumber exports from the western region and Alaska have declined by 8.9 percent annually since 1989 and have lost 53 percent of their peak volume (WWPA 1995). Again, the majority of the softwood lumber exported goes to Japan, although large amounts are also exported to Canada and Mexico (FAS 1996).

This presents some issues for policymakers to consider. It is probably a safe assumption that the steep decline in softwood exports has influenced the balance of trade between the U.S. and our trading partners in the Pacific Rim area, particularly Japan.

At the same time, the United States is increasing the volume of softwood log and lumber imports (FAS 1996). These markets are substantially influenced by housing starts in the United States, which bottomed out in the recession of 1991 before climbing again in the mid-90s (housing starts also dropped between 1994 and 1995) (WWPA 1995). In 1989 just after log exports peaked, about 95 thousand cubic meters of softwood logs were imported. In 1993, a year with a similar number of housing starts, 388 thousand cubic meters of softwood logs were imported, an increase of 410 percent. In 1988, in the run-up before the volume of softwood lumber exported peaked in 1989, the United States imported 33.5 million cubic meters of softwood lumber. In 1995, a year

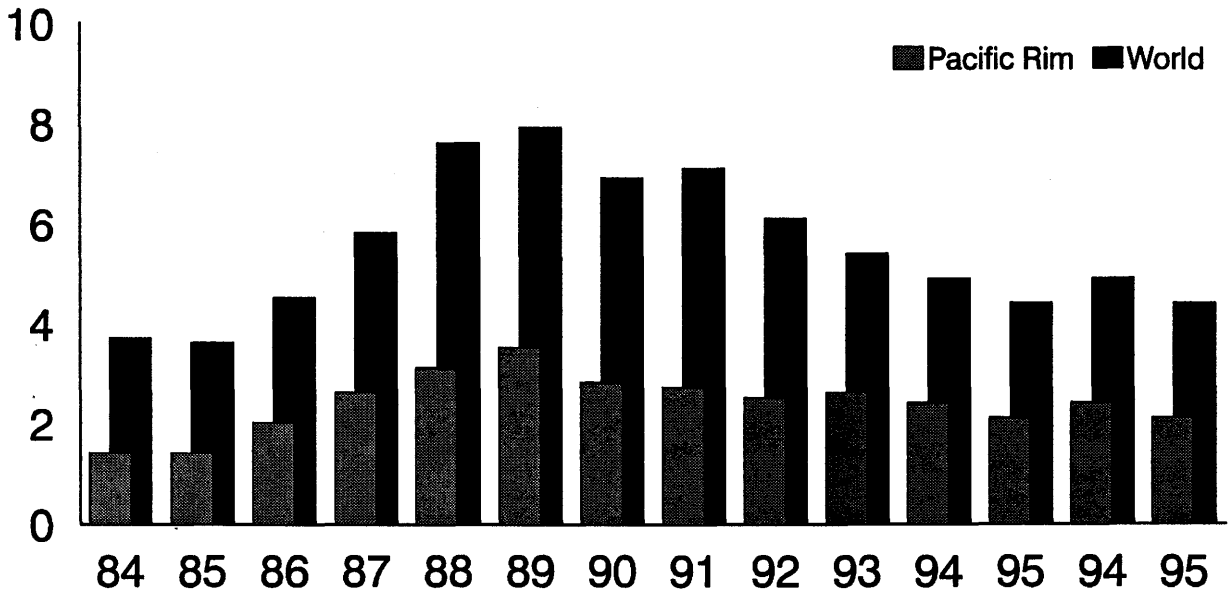

Figure 3.—Softwood lumber exports, in millions of cubic meters. Overall, volume has declined 42 percent from levels exported in the late 1980s (FAS 1996).

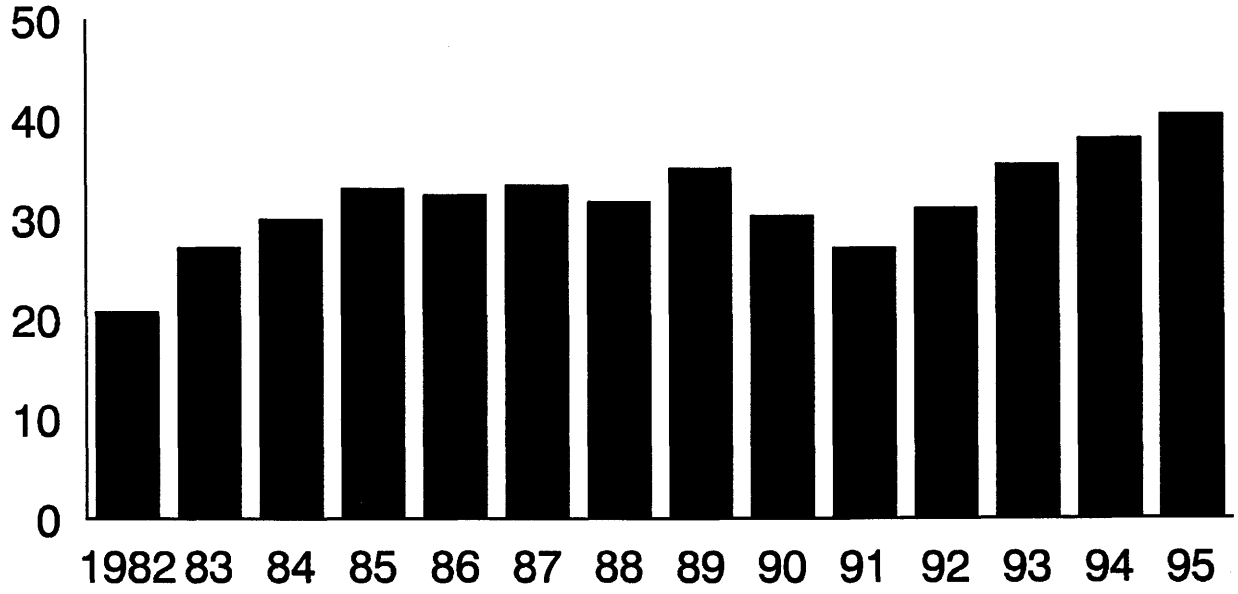

Figure 4.—Softwood lumber imports, in millions of cubic meters. Volume has increased by about 12 percent from levels imported in the late 1980s (FAS 1996).

with a similar number of housing starts, 38.1 million cubic meters were imported, an increase of 12% (Fig. 4) (WWPA 1995).

The steep decline in softwood volume exported and the steady increase in softwood volume imported should come as no surprise. Softwood harvests on Federal lands in the Douglas-fir subregion have declined by 86 percent from the levels of the late 1980s (Haynes, pers. comm.). In 1986, 3.14 billion cubic feet of softwoods were harvested in the Douglas-fir subregion, which was 27 percent of the U.S. total. In 1995, 1.49 billion cubic feet were harvested, or 23 percent of the U.S. total (WWPA 1995). By 2000, the total is projected to be 1.7 billion cubic feet, or 15 percent of the U.S. total (Haynes and others 1993).

It is clear that some portion of the wood that is no longer being harvested in the Pacific Northwest is being harvested somewhere else. Harvest levels in the Southern pine region have increased by about 400 million cubic feet since the mid-1980s, and now account for nearly half the softwood harvested in the United States. However, the South has not

fully made up the difference from the Pacific Northwest, and the amount imported has risen steadily through the 1990s (WWPA 1995). Since most of the wood imported is softwood lumber from Canada, it is likewise clear that the Canadian environment is now supporting some portion of the harvest pressure that used to be placed on American timberlands. The question then arises: is it morally right for environmentalists and others who would preserve American timberlands to shift that harvest pressure to other countries, namely Canada?

This is a ticklish question in a number of ways. Who are we to tell the Canadians how to manage their lands if they choose to harvest timber to satisfy the American market? And, if we decided we did have some sort of moral right to sanction the Canadians for the abuse of their environment, we'd run up against the philosophy of free trade promoted by the Administration. It is difficult to preach the virtues of free trade while erecting trade barriers designed to change behaviors; other countries might be tempted to reciprocate. At best they would correctly describe us as hypocrites.

In any case, it may not be necessary for us to scold the Canadians. Provinces such as British Columbia face many of the same issues as Washington, Oregon and Northern California, among them a large urban center full of active people who do not depend on timber revenues for their livelihoods, but do value forests managed for recreation, wildlife and aesthetics. Greenpeace was founded in Vancouver, and there have always been vocal critics of the province's annual harvest. Concerns have also arisen as to the sustainability and broader environmental impacts of timber management on the vast areas of public forest lands in Canada. A statement from the provincial government of B.C. (1994) noted that "...unless we change our approach [to forest management], the harvest could decline by 15 to 30 percent over the next 50 years." While the FEMAT report (1993), the 1993 RPA Timber Assessment (Haynes and others 1993), and other reports project a continuing supply of softwood timber from Canada, it may be wise for policymakers to consider other options.

Siberia may be one such possibility, and northwestern mill owners are already glancing avariciously overseas (Sleeth 1994a). Siberia holds 60 percent of the world's softwood timber supply (Backman and Waggener 1992). However, Siberian forests on average produce around 10 cubic feet per acre per year. Thirty to forty percent of that material is wasted as technology to use wood residues is lacking. Hence, 15 acres of Siberian forest would need to be harvested to produce as much wood as 1 acre of coastal Douglas-fir in the Pacific Northwest. If harvest is foregone on 100,000 acres in the Pacific Northwest each year to preserve it for spotted owls, 1.53 million acres would be required of the Siberian forest for the same harvest volume. Potentially, habitat losses in the Siberian forest would more than offset any habitat gains made in the Northwest. Additionally, the increased waste of mill residues and the increased hauling distances in the Russian Far East for delivery to markets consumes additional fossil fuel energy and increases the carbon dioxide emitted without producing products or energy value (Lippke 1992).

Since much of the Russian forest is boreal, regeneration may be difficult. Russian foresters may not be prepared to deal with artificial regeneration of thousands of acres. Furthermore, Russian forests are known to harbor the Asian gypsy moth and some 27 other species that may be damaging to North American forests should they be released when wood from Siberia is imported into this country (Goheen and Tkacz 1993; Campbell and Schlarbaum 1994). This prospect is alarming to me personally, since my research focus is on white pine blister rust, a pathogen that appears to have originated in Eurasia. Our ecosystems are centuries away from full recovery, and new disease and insect introductions may greatly compound our forest health problems.

At the same time as softwood imports are increasing, hardwood log and lumber imports are also increasing (FAS 1996). Now, it is important to put this in perspective. The volume of trade in these products is vastly less than in softwood products. Further, the balance of trade (exports minus imports) is positive: more is exported than imported. Nevertheless, the United States does buy an increasing volume of hardwood lumber from Canada, Brazil, Bolivia, Malaysia, Ecuador, and a number of other countries.

On the other hand, the balance of trade is negative for certain other hardwood products. The United States is importing more hardwood plywood and hardwood molding than it exports. According to Barbier and others (1994), the main wood product that the United States imports from the tropics is hardwood plywood, and America's main suppliers for tropical timber are Indonesia, Malaysia and Brazil.

The largest market in the world for tropical timber is Japan (Barbier and others 1994). While Japan has substantial timber resources, it imports almost 75 percent of the wood it consumes. Nearly all of the tropical timber Japan imports comes from Asia, primarily Malaysia and Indonesia. For the most part, tropical timber is imported to Japan in the form of logs, which are primarily converted into plywood. While hardwood plywood is not used for construction in North America, that is not the case in Japan. Hardwood plywood made from tropical timber is preferred over North American softwood plywood for concrete forms because it has no knots. It is also used to make furniture for the low-end market (Bevis 1995).

Here is the heart of the matter. Tropical forests are the most biologically diverse ecosystems on earth. The number of species that live in them has been variously estimated from 3 million to 30 million, and no one knows how many are at risk of extinction from logging and subsequent deforestation. What is known is that mature tropical forests are surprisingly unproductive. On average, they produce only between 5 and 35 cubic meters per hectare of merchantable wood (FAO/UNEP 1981). The reason for this is that much of the wood on any acre is too small, of the wrong species, and won't pay its way to the mill. For that reason, the first loggers in a virgin forest high-grade the stand, extracting perhaps one or two trees per acre (Bevis 1995). However, to get there they bulldoze a road, causing disturbance and edge effects. In

many parts of the world, these roads are subsequently used by small farmers who colonize newly accessible areas and clear the remaining forest for agriculture. Often deforestation is required for the farmer to gain land tenure (Barbier and others 1994).

Now, we can choose to scold Japan for its dependence on tropical timber. Again, we must deal with such ticklish issues as "do we have a moral right to tell anyone else what to consume?" If we decide that yes, we do have that right we run the risk of looking hypocritical. We may look considerably less hypocritical if we first consider our own consumption of imported wood from Canada and the costs to the Canadian environment. Additionally, we need to become active partners in multilateral organizations that seek to establish incentives for sustainable tropical (and, arguably, temperate) timber management. Finally, we may try to offer good alternatives to tropical timber rather than simply admonishing the Japanese for their destruction of tropical forests. However, if those alternatives include American softwoods, it may be difficult for the Japanese to make the switch from tropical timber if those alternatives have an uncertain future because of continued reductions in harvest levels.

Arguably, neither Canadian deforestation, Siberian regeneration, or Japanese tropical timber consumption are American problems. But if American consumption is driving the any of these processes, they are our problems. Even if it isn't, they are our problems if we consider ourselves citizens of the planet rather than narrow-minded regionalists. The rainforest on Borneo, oldest and second largest in the world, is home to the endangered orangutan. Environmentalists lay down in front of bulldozers to protect the spotted owls and "ancient forests" of the Pacific Northwest. Compared with this Malaysian rainforest, the forests of the Northwest began growing yesterday and the spotted owl is a recent arrival. If we are willing to chain ourselves to bulldozers to protect old growth in the Pacific Northwest, shouldn't we be willing to do the same for the ancient forests of Borneo? Or is the hidden agenda simply "not in my back yard?"

It is countries like ours, Japan, and the Western Europeans who are wealthy enough to resist the pressures to log our own lands indiscriminately and set forests aside as reserves. And the way that we accomplish that is, by and large, by importing wood from other countries and asking them to damage their ecosystems so that we can keep ours untouched. It's much like locating a landfill in another community that needs the money and is willing to put up with the smell.

OPTION FOUR: GROW OUR OWN WOOD

If demand is unlikely to fall, substitutes are environmentally unfriendly and imports damage the environment in other nations, one option remains: to grow the wood we need ourselves. Using genetically improved tree species coupled with intensive silviculture, we can meet our own needs for wood products. But we need to make it a policy issue and help the public realize the necessity for action.

What we need is a different way of looking at our wood. Every day, every man, woman and child on Earth consumes wood, just as they consume food and water. If we consider this wood as an item necessary for our survival, we may be able to take steps to ensure its supply.

Consider another product we cultivate, wheat. It is the staple food of the American diet, and we grow what is used here. However, I live in the Palouse region and I know the environmental price we pay for that wheat. A bushel of wheat equals a bushel of lost topsoil. But I hear very few people arguing that we should restore the Palouse - or the Great Plains - to their original condition. We need the wheat.

Wheat and trees are similar in other ways. Modern wheat varieties are the product of genetic improvement programs where strains were selected that are high-yielding and disease resistant. They are cultivated under specific growing regimes designed to maximize their growth potential. Together, genetics and cultivation techniques lead to phenomenal yields per acre, much more than the wild forebears of wheat.

In the same way, trees that are selected to be high-yielding and disease resistant have been developed. Intensive silviculture can be coupled with good genetics to establish high-yielding plantations that are much more productive in terms of cubic meters per acre per year than wild forests.

At the same time, just as not every acre of agricultural land is used for wheat, not every acre of forestland should be used for high-intensity plantation forestry. However, by establishing some proportion of our lands as plantations, it should be possible to relieve harvest pressure from many areas that are considered valuable for other reasons.

A case study with application to our situation:

In 1905, export of native woods, particularly of kauri and rimu, was an important component of the New Zealand economy. Annual cut peaked in that year and began a decline. A 1909 Royal Commission determined that changes in logging practices or milling technology couldn't reverse this decline. A 1913 Royal Commission found that New Zealand could not meet its anticipated domestic wood needs by selective cutting in its remaining native forest, and recommended that an aggressive program of intensive forest plantations be initiated. Thus began the world-famous New Zealand school of plantation silviculture. Today, New Zealand meets 100 percent of its net domestic wood needs from plantations, and about 30 percent of its original native forest is now in protected reserves. Furthermore, for every unit of wood used at home, another is shipped overseas. Many ships leaving New Zealand harbors display a green banner stating that the wood on board is helping to save tropical rainforests. Unlike the United States, most conservation organizations in New Zealand strongly support the plantation program, recognizing its part in saving both local and tropical native forests

This year in New Zealand, 247,000 acres will be replanted after harvest of plantations or will be newly established as

radiata pine plantations. Genetically improved stock will be used on much of this. A combination of healthier trees, faster growth and (perhaps most important) improved harvest index of these breeds will increase average harvest productivity of the previous plantation sites from about 385 cubic feet per acre per year to well over 430 cubic feet per acre per year. The newly established plantations are mostly on marginal farm and pastureland, and that change is from zero to over 400 cubic feet per acre per year (Libby 1994b).

In the Pacific Northwest, substantial increases in productivity are possible without importing exotic tree species. Coastal Douglas-fir, western hemlock, western white pine, and other species have the potential to grow over 400 cubic feet/acre/yr without the problems associated with exotic plantations (Hermann and Lavender 1990; Packee 1990; Graham 1990). At the same time, Americans can "have their cake and eat it too"—set aside large areas for the preservation of old growth habitat, recreational opportunities, etc. For that to occur, more wood must be produced on fewer acres. This is exactly what forest genetics and tree improvement programs strive to do (Daniels 1993).

Tree improvement programs are not a new concept in the United States. Many long-term investments have been made both by private industry and by the Forest Service. Cooperative programs have been developed, tests installed, and seed orchards established. Some intensive programs such as loblolly pine in the Southeast have realized first-generation gains of 12 percent in productivity and predict gains in excess of 40 percent over wild stands for advanced generations (NCSU 1996). At present, however, the National Forests are seriously cutting the funding for these programs. Reduced harvest levels and more partial harvests means fewer acres to be planted every year. Since the products of tree improvement programs are improved seedlings, it is difficult to justify expenditures for unnecessary seedlings.

Without tree improvement programs, certain species will become rare. In particular, the only headway that has been made against white pine blister rust in the West has come from selection and breeding for genetic resistance to the disease. In the future, coupling intensive silviculture with genetic resistance may make it possible to re-establish western white pine, sugar pine, and other white pines in their historic roles and frequencies.

The good news is that more wood **can** be grown without destroying natural forests in the process. By using tree improvement technology and intensive silviculture on a relatively small proportion of our forestland base, more wood could be produced on fewer acres, and the pressure to extend timber harvesting into forested areas that are ecologically sensitive or highly valued for other purposes could be reduced.

Jess Daniels, a forest geneticist in the spotted owl region, put it well. He said, "The bottom line is this: If we are going to continue using more and more wood, then we have a moral responsibility to grow more wood to meet that demand. By not striving to grow our own wood, we inevitably shift that burden to other nations and regions not able to do it as responsibly and sustainably as we do. That makes us a nation of hypocrites, preaching the virtues of environmental protection while encouraging other nations to disregard those virtues for our benefit." (Daniels 1993).

In this the day of ecosystem management, we know that ecosystems pay no attention to administrative or political boundaries. So if all of Earth is viewed as a mega-ecosystem, fragments can't be set aside in the United States without considering the consequences elsewhere. This global viewpoint has been lacking in the conservation dialogue. If policymakers can begin to "think globally" rather than just listening to those who "act locally," fragile forest ecosystems everywhere may be maintained for generations to come.

ACKNOWLEDGEMENT

Dr. William J. Libby of the Departments of Genetics and of Environmental Science, Policy and Management at UC-Berkeley (emeritus) provided many of the basic ideas in the development of this paper.

LITERATURE CITED

Backman, C. A.; Waggener, T. R. 1992. **The forest resources and export potential of the former Soviet Union.** *In:* Proceedings, Wood Product Demand and the Environment. November 13-15, 1991; Vancouver, British Columbia, Canada. Forest Products Research Society, Madison, WI. pp. 247-251.

Barbier, E. B. 1994. **The environmental effects of the forestry sector.** *In:* Organization for Economic Cooperation and Development (OECD). The environmental effects of trade. OECD, Paris.

Barbier, E. B.; Burgess, J. C.; Bishop, J.; Aylward, B. 1994. **The economics of the tropical timber trade.** Earthscan Publications, London, UK. 179 pp.

Bevis, W. W. 1995. **Borneo log: The struggle for Sarawak's forests.** University of Washington Press, Seattle. 245 pp.

Bowyer, J. L. 1992. **Alternatives to forest harvest and wood use: the environmental impacts are substantial.** *In:* Proceedings, Wood Product Demand and the Environment. November 13-15, 1991; Vancouver, British Columbia, Canada. Forest Products Research Society, Madison, WI. pp. 270-274.

Brooks, D. J. 1993. **U.S. forests in a global context.** Gen. Tech. Rep. RM-228. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 24 p.

Campbell, F. T.; Schlarbaum, S. E. 1994. **Fading forests: North American trees and the threat of exotic pests.** Natural Resources Defense Council, Inc. New York. 47 pp.

Committee on Renewable Resources for Industrial Materials (CORRIM) - National Research Council. 1976. **Wood for structural and architectural purposes.** Wood and Fiber 8: 1-72.

Cousteau, J. Y. 1992. **Convince to Conquer.** Address to the United Nations Conference on Environment and Development (UNCED); June 5, 1992; Rio de Janeiro, Brazil. Calypso Log August 1992: 3-6.

Daniels, J. D. 1993. **Forest Genetics & You: What's the Connection?** Forests Today & Forever 7(1): 4-5, 11.

Davis, P.; Jansen, C. 1992. **Career opportunities utilizing the urban wood fiber supply base.** *In:* Proceedings, Wood Product Demand and the Environment. November 13-15, 1991; Vancouver, British Columbia, Canada. Forest Products Research Society, Madison, WI. pp. 241-243.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. **Forest ecosystem management: an ecological, economic and social assessment.** Vol. 2: 59.

Food and agriculture organization of the United Nations (FAO). 1961. **Yearbook of forest products.** FAO, Rome.

FAO. 1991. **Global harvests, food and subsistence.** 1989-2010: Wood and wood products. FAO, Rome.

FAO. 1993. **Forestry statistics today for tomorrow.** FAO, Rome.

FAO. 1994. **Pulp and paper towards 2010.** Forestry planning and statistics branch, FAO, Rome.

FAO/UNEP 1981. **Tropical forest resources assessment project**, FAO, Rome.

FAS, 1996. **Wood products trade and foreign markets: annual statistical trade issue.** Foreign Agricultural Service circular series WP 1-96, April 1996. USDA Foreign Agricultural Service, Forest Products Division, Washington, D.C.

Goheen, D. J.; Tkacz, B. M. 1993. **Pest risks associated with importing unprocessed Russian larch logs to the United States.** Western Journal of Applied Forestry 8(3): 77-80.

Government of British Columbia. 1994. **Working in partnership, British Columbia's forest renewal plan.** Queen's Printer, Victoria, B.C. 3 pp.

Graham, R. T. 1990. **Western white pine.** *In:* Burns, R. M.; Honkala, B. H.; tech. coords. Silvics of North America: 1. Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, D.C. p. 385-394.

Haynes, R. W.; Adams, D. M.; Mills, J. R. 1993. **The 1993 RPA timber assessment update.** USDA Forest Service, Gen. Tech. Rep. RM-GTR-259. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 66 pp.

Hermann, R. K.; Lavender, D. P. 1990. **Douglas-fir.** *In:* Burns, R. M.; Honkala, B. H.; tech. coords. Silvics of North America: 1. Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, D.C. p. 527-540.

Ince, P. J.; McKeever, D. B.; Haynes, R. W. 1995. **The role of markets and technology in conservation of timber resources.** *In:* Proceedings of the 1995 International Environmental Conference. May 7-10 1995; Atlanta, GA. TAPPI PRESS, Atlanta, GA. p 315-325.

Koch, P. 1992. **Wood versus nonwood materials in U.S. residential construction: some energy-related global implications.** Forest Products Journal 42(5): 31-42.

Libby, W. J. 1994a. **Mitigating some consequences of giant sequoia management.** *In:* Aune, P., ed. Proceedings of the symposium on giant sequoias: their place in the ecosystem and society. June 23-25, 1992; Visalia, CA. General Technical Report PSW-GTR-151. USDA Forest Service, Pacific Southwest Research Station, Albany, CA. p. 142-148.

Libby, W. J. 1994b. **The role of production forestry in preventing tropical species extinctions.** *In:* Nimbyism, genetic improvement and plantation forestry: growing wood for the 21st century. March 10, 1994; Post Falls, ID. Inland Empire Tree Improvement Cooperative, University of Idaho, Moscow, ID.

Lippke, B. R. 1992. **Meeting the need for environmental protection while satisfying the global demand for wood and other raw materials: a North American and global trade perspective.** *In:* Proceedings, Wood Product Demand and the Environment. November 13-15, 1991; Vancouver, British Columbia, Canada. Forest Products Research Society. Madison, WI. p. 137-142.

Monserud, R. A.; Tchebakova, N. M.; Leemans, R. 1993. **Global vegetation change predicted by the modified Budyko model.** Climate Change 25: 59-83.

North Carolina State University (NCSU). 1996. **North Carolina State University -industry cooperative tree improvement program, annual report.** Department of Forestry, College of Forest Resources, North Carolina State University, Raleigh, NC. 24 pp.

Packee, E. C. 1990. **Western hemlock.** *In:* Burns, R. M.; Honkala, B. H.; tech. coords. Silvics of North America: 1. Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, D.C. p. 613-622.

Schroeder, P. E.; Dixon, R. K.; Winjum, J. K. 1993. **Forest management and agroforestry to sequester and conserve atmospheric carbon dioxide.** Unasylva 173, 44(2): 52-60.

Sleeth, P. 1994a. **Russian timber lures Northwest mills.** Associated Press, September 29.

Sleeth, P. 1994b. **Northwest mills set sights on South American forests.** Associated Press, October 3.

United Nations. 1996. **World Health Report.**

Western Wood Products Association (WWPA). 1995. **Statistical yearbook of the western lumber industry.** Western Wood Products Association, Portland, OR. 34 pp.

Whittenbury, C. G. 1997. **Changes in wood products manufacturing.** In: Kohm, K. A.; Franklin, J. F.; eds. Creating a forestry for the 21st century: the science of ecosystem management. Island Press, Washington, D.C. p. 303-314.

Wigley, T. M. L.; Raper, S. C. B. 1992. **Implications for climate and sea level of revised IPCC emissions scenarios.** Nature 357: 293-300.