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## Global Trends and the Future of National Forests

Nels C. Johnson

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# **GLOBAL TRENDS AND THE FUTURE OF NATIONAL FORESTS**

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## **THE NATIONAL FOREST MANAGEMENT ACT IN A CHANGING SOCIETY, 1976-1996**

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Natural Resources Law Center  
University of Colorado  
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Boulder, Colorado

# GLOBAL TRENDS AND THE FUTURE OF NATIONAL FORESTS

by Nels C. Johnson<sup>1</sup>

*We should all be concerned about the future  
because we will have to spend the rest of our lives there.*

Charles Franklin Kettering (Seeds For Thought, 1949)

## I. Summary

Many of the forest policy landmarks in the United States were established to help Americans shape the future of their forests. These policies were driven by growing public concern over troubling contemporary trends. Gifford Pinchot was able to convince the public, members of Congress, and his patron in the White House, Theodore Roosevelt, that the country needed a professional forest management agency by warning darkly of a looming “timber famine” if the excesses of the timber barons went unchecked. Half a century later, Senator Hubert Humphrey persuaded Congress to pass the Multiple Use-Sustained Yield Act (MUSY - 1960). MUSY expanded the agency’s mandate to include recreation, fisheries, and wildlife and the sustained future production of timber and non-timber benefits alike on National Forest lands -- a policy supported by the agency itself as conflicts between logging and other public non-timber benefits began to emerge in the 1950s (Lyden et al. 1990). Fifteen years later, spurred by a growing environmental movement and reacting to clearcutting controversies on the Bitterroot National Forest in Montana and the Monongehela National Forest in West Virginia, Congress passed the Forest and Rangelands Resource Planning Act (RPA - 1974) and the National Forest Management Act (NFMA - 1976) in quick succession. The creation of these forest policy landmarks was driven almost exclusively by domestic issues and trends.

Today, the U.S. forest sector is becoming less isolated from economic and forest resource trends in other parts of the world. While the stock of forests (and their products and services) is essentially stable in the United States, the demands on them are, and will continue, rising rapidly.

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<sup>1</sup> This paper is based in part on research conducted jointly with Daryl Ditz for the U.S. Sustainability Project at the World Resources Institute..

Most of these demands are domestically driven -- 95% of U.S. wood production is consumed domestically -- and domestic factors will continue to be the most important in determining the mix of forest outputs in the United States. However, three sets of trends are working to ensure that international issues will play a more important future role in U.S. forest policy and management. First, as the United States begins to consume more wood products than it has available for harvest -- a prospect that seems increasingly likely -- regional wood shortages are emerging and prompting growing reliance on wood imports and greater investment by American forest product companies overseas. On the other hand, as cheap sources of wood fiber are exhausted in other parts of the world, especially in Asia, countries that depend heavily on wood imports are searching for supplies around the world including in the United States. Finally, the sustainable management and conservation of forests has become an international political issue driven by concerns about biodiversity loss, climate change, and deforestation and forest degradation.

It's most useful to think of the international trends affecting U.S. forests in terms of four categories. First, there are the *basic trends that affect the global demand and supply of forest resources*. For example, a number of global trends are driving increased demand for wood products. The most important of these are steady population growth and economic gains in countries with relatively low per capita consumption of wood products, especially in the emerging economies of Asia. At the same time, several trends are influencing the supply of wood products. Deforestation and forest degradation -- mostly in tropical countries -- are transforming an increasing number of countries from wood fiber exporters to wood fiber importers and lowering the potential supply of wood products. Meanwhile, other countries -- most notably Brazil, Chile, New Zealand, and Australia -- are aggressively developing tree plantations to supply international markets. Finally, demands for non-timber forest resources and services -- from nuts and medicinal plants to watershed protection and nature-based tourism -- are escalating while the natural forest areas that supply many of these resources shrink.

Questions about global demand and supply for wood products are used today in debates over

how to manage National Forests. For example, as U.S. policy on federal lands shifts emphasis from timber production to conservation of endangered species, non-timber products, and environmental services, will our demand for fiber contribute to unsustainable forest harvests in other countries (ie., is the U.S. exporting its sustainability problems)? Would the net global conservation benefit be greater if we maintained higher harvests on the National Forests so that demand did not migrate to areas with higher levels of biodiversity and less capacity to manage forests? As a country that consumes just over a quarter of the world's wood products (excluding fuelwood) but has less than 5% of the world's population, should we place more emphasis on managing domestic demand?.

Second, around the world *forest ecosystems are being stressed by widespread human manipulation of the environment*. Climate change, air pollution, the spread of invasive and exotic species (including destructive insects and diseases), the loss of biodiversity, and the loss of ecosystem processes that contribute to forest productivity (e.g., fire suppression, flood control, nutrient cycling) are cited as threats to the forest ecosystem health in many parts of the world . The consequences of many of these stresses are difficult to predict. But as our understanding of them improves, pressures to respond by adjusting policy and forest management practices will mount. Already, controlling environmental stresses -- from insect control and fire management to restoring fisheries and wildlife habitat -- has become a major activity on every National Forest in the country and represents a growing slice of the agency's budget.

Third, countries are beginning to respond through *international negotiations and voluntary agreements* to real or perceived international environmental problems. For example, most countries have become members of international treaties on climate change and biodiversity and many countries have agreed to implement criteria and indicators of sustainable forest management under the Helsinki Process (European countries), the Montreal Process (non-European temperate and countries), and the Tarapoto Agreement (Amazon Basin countries). This category of global trends will likely expand in coming decades as international cooperation is sought to address problems that cannot be contained within national borders. These trends can

also shape debate about policies and practices on the U.S. National Forest system in a number of ways (e.g., are we practicing what we preach to other countries?; are management practices in line with international agreements?).

Finally, and fourth, *policy and market experimentation* are likely to become more common as governments around the world respond to widespread dissatisfaction with centralized governance and inequitable distribution of forest benefits. From reforming forest tenure systems and concession policies in developing countries to the use of more participatory approaches for planning in the United States and Canada, new policy approaches are being tested in a growing number of countries. For example, the National Forest system is being tugged both by the “wise use” movement and grassroots environmental groups that want more say in forest planning and management -- demands that are changing the way the U.S. Forest Service interacts with local communities. On the other hand, new market mechanisms and producer agreements -- such as the fledgling independent certification movement and the International Tropical Timber Agreement -- are designed to assure increasingly knowledgeable consumers around the world that forest products are being produced using “sustainable” and “socially equitable” practices. Again, these trends are evident in the United States. For example, the American Forest and Paper Association has launched a program of forest management principles -- the Sustainable Forestry Initiative -- that its members are required to adopt, and a small but growing number of forest producers in the United States are applying for independent certification under the auspices of the international Forest Stewardship Council.

In each of these categories, a number of uncertainties are prominent and make future projections risky, difficult, or impossible. For example, what is the likelihood that new electronic communications and data storage technologies will reduce per capita paper use during the next decade? What does biotechnology hold for forestry before the middle of the next century? The only certain thing about these trends is that they all have the potential to affect forests and forest policy in the United States. Policies affecting the National Forest system will continue to be developed primarily in response to domestic interests and trends, but international developments

will increasingly shape those interests and occasionally tip the balance in favor of a particular policy option.

Although imperfect in many ways, the RPA and the NFMA -- our most recent forest policy landmarks -- set in motion long-range planning processes designed at least in part to anticipate and shape future conditions by considering current and projected trends. Should the public decide to revise these policies, they would be wise to insist that new policies ensure accessible information and provide opportunities to participate meaningfully in the planning and selection of forest management options. Without long-range planning open to all interested parties and informed by the best information, we risk losing opportunities to choose the kind of forests we'd like our children to inherit.

## II. Domestic Demand and Supply for Forest Resources

A. U.S. demand for wood products has increased steadily on a per capita basis for decades.

1. In 1990, Americans consumed an average of 81 cubic feet of raw wood per capita -- an increase of 33% since 1970 (U.S. Bureau of Census 1993).
2. Consumption has increased steadily for all major categories of wood products. For example, per capita consumption of paper and paperboard doubled between 1960 and 1995 (EDF 1996) while consumption of lumber grew by nearly 30% and wood-based panel consumption jumped by 163% between 1962 and 1991 (Haynes et al. 1995).
3. With average timber productivity of 44 cubic feet/acre, it now takes approximately 1.8 acres of U.S. timberland managed on a sustained timber-yield basis to supply domestic demand. With 490 million acres of timberland (forest land productive enough to justify harvesting and not legally protected in national parks, wilderness areas, etc.), the U.S. can now just barely meet domestic demand for wood products on a sustained-



yield basis (Johnson and Ditz, *unpublished manuscript*).

4. The U.S. Forest Service projects continued steady growth in per capita domestic wood products consumption -- by approximately 26% between now and 2020 and over 40% by 2040 (Haynes et al. 1995).
- B. Forest area is expected to remain stable, but timber productivity shows signs of stagnation.
1. Overall forest area has remained basically stable -- fluctuating between 730 and 760 million acres -- since 1920 (Powell et al. 1993) despite population growth of 150 million during that period.
  2. The U.S. Forest Service projects a small decline (less than 5%) in forest area during the next 30 years (Haynes et al. 1995) while the U.S. population increases by an estimated 70 million (WRI/IUCN/UNEP, 1996).
  3. Between 1952 and 1991, net annual growth for timber increased approximately 54% and available timber volume nearly doubled to over 22 billion cubic feet (Powell et al. 1993).
  4. The U.S. Forest Service, however, projects dramatically slower net annual timber growth in coming decades averaging -- as low as 0.3% annually between now and 2040 compared to 2.7% between 1952 and 1991 (Haynes et al. 1995).
  5. These projections are supported by the most recent data produced under the RPA inventory that indicate timber productivity has begun to stagnate. Between 1986 and net growth levels declined by 2% at the national level -- the first decline since the U.S. Forest Service began tracking timber productivity in 1952 (Powell et al. 1993). In fact, net annual growth on a national basis has not increased significantly since the late 1970s.
  6. In 1976, timber growth rates exceeded harvest rates by 54% -- a figure that slipped to approximately 30% in 1991. On forest industry lands, harvests exceeded growth by 21% in 1991, and harvests on private non-industrial

lands are expected to exceed growth soon after 2000 (Haynes et al. 1995). Public lands show an increase in growth over harvests as they are increasingly managed for non-timber objectives.

7. The excess of harvests over growth does not mean that the United States will lose forest area or run out of wood supplies any time soon. It does, however, mean that the average size of trees being harvested and the average age of timberlands is steadily declining. It also means the U.S. is likely to join the ranks of countries moving from net wood exporters to net wood importers.

C. Domestic Demands for Non-timber Products and Services are Also Growing.

1. The number of recreational visitor days registered in the National Forest system is ten times higher today than it was in 1950 (Barber et al. 1994). Nationwide, the economic value of outdoor recreation is estimated at over \$6.6 billion -- or a little over \$20/per person for each of the nearly 300 million visitor days in 1995 (O'Toole 1995).
2. U.S. Forest Service projections for recreational demand show dramatic increases for many activities over the next five decades -- 193 percent for day hiking, 155% for backpacking, 77% for developed campgrounds, 74% for wildlife observation and photography, etc. (USDA 1989).
3. Although small in comparison to the forest products industry, the harvesting of non-timber forest products (e.g., mushrooms, medicinal plants, craft materials, wild floral greens, wild berries, etc.) is growing rapidly. Although difficult to estimate precisely, the annual value of these products totals hundreds of millions of dollars annually on a national basis -- with markets growing by as much as 15-20 annually in recent years (Johnson and Ditz *in press*).
4. While some species, such as whitetail deer, pronghorn antelope, elk, and wild turkey, have increased dramatically in recent decades (MaCleery 1992), a growing number of species -- most of them requiring specialized

habitat conditions -- are showing signs of population decline. For example, a review of the conservation status of 20,500 species in the United States by the Nature Conservancy finds that approximately one third are of conservation concern based on current population levels and habitat conditions (TNC 1996). Flather et al. (1994) found that over half of the species currently listed as threatened and endangered are associated with forest ecosystems.

D. Domestic Projections Alone Suggest Emerging Challenges to Sustainability in the U.S. Forest Sector.

1. Steadily rising domestic demands alone for both timber and non-timber forest products and benefits will force Americans to confront choices about what they wish their forests to provide.
2. As part of the World Resources Institute's U.S. Sustainability Project, Johnson and Ditz (*in press*) identified five issues -- based primarily on analysis of domestic trends -- that will be the most important determinants of sustainability in the U.S. forest sector in coming decades. These include: *forest health and timber productivity, biological diversity, climate change, persistent acute toxic pollutants, and managing demand within supply constraints.*
3. Nevertheless, in contrast to many countries, the U.S. has the luxury of time, a history of innovation, and a set of robust market and policy processes -- factors that can help the U.S. forest sector stay ahead of the most serious problems. But, growing international demands coupled with domestic demands could overwhelm some forest resources if we define forest policies and practices only on the basis of what we see in the U.S. today.

III. Global Trends Affecting Demand and Supply for Forest Resources.

A. Trends Driving Global Demand for Forest Resources.

1. In 1995, the world population stood at 5.7 billion with a 1.6% annual

- growth rate. Most of this growth is in developing countries in Africa (2.8%), Latin America (1.7%), and Asia (1.6%) where nearly 75 percent of the world's people now live (WRI/UNEP/UNDP/World Bank 1996).
2. Although global population growth rates are projected to decline moderately in coming decades, middle range projections place the world's population at 8.3 billion in 2025 and just over 10 billion in 2050.
  3. Between 1970 and 1990, roundwood consumption on a per capita basis worldwide increased only slightly. Virtually all of that growth has been in developed countries, especially the United States, Canada, Germany, and Japan where growth rates have been in excess of 1% annually (UNFAO 1993). Per capita consumption (much of it in the form of fuelwood) in developing countries has remained relatively stable at 0.5 cubic meters (or about one third per capita consumption -- which is mostly in the form of manufactured wood products -- in developed countries ).
  4. More than population, growth in per capita GDP will be a major driver of global demand for forest resources. For example, the United States, with a 1993 per capita GDP of \$24,279, consumes 700 pounds of paper per capita. By contrast, per capita paper consumption averages 66 pounds in Latin where per capita GDP is typically less than \$2,000 and 50 pounds in Asia where per capita GDP outside Japan, Korea, and Taiwan is typically less than \$1,000.
  5. Global demand for paper and wood-based panels (the two fastest growing wood products sectors) are projected to grow steadily at 3% annually over the next decade (UNFAO, 1993). Most of this growth is expected to come from emerging economies in Asia, and to a lesser extent in Latin America and Eastern Europe, as economic gains increase per capita GDP. In China, for example, paper consumption has been growing at 10% annually since 1980 (Jones 1995).
  6. Still, it's important to keep in mind that growth coming from emerging

economies is starting from a very low base per capita consumption level. The vast majority of internationally traded forest products are consumed in developed countries. It is the appetite of developed countries that drives the global search for fiber -- a search that is now expanding to new parts of the world such as the natural forests of the Amazon Basin and Guyana Shield in South America, Central Africa, the Russian Far East, and Canada, the plantations of Chile, New Zealand, and Brazil, and maturing secondary forests in parts of the United States.

7. Finally, it's worth noting that international demand is also growing for non-timber forest products and services. For example, the majority of wild mushrooms and floral display materials (e.g., ferns, moss) collected in the Pacific Northwest are exported to restaurants and markets in Europe and Japan (Cohn 1995). Tourism has become one of the largest industries in the world. Nature-based tourism or ecotourism is now estimated to be worth as much as \$50 billion world wide, increasing at a rate of 7% annually (Filion et al., 1992). Forests are often the focus of such tourism. Indonesia, for example, recently issued a 100,000 hectare forest concession to a firm for the express purpose of nature-based tourism development rather than for logging.

#### B. Trends Affecting the Global Supply of Forest Resources

1. About 40% of the Earth's land area (5.1 billion acres) was covered by forest and other wooded land in 1990 (WRI/UNEP/UNDP/WORLD BANK 1996). Of this, 3.4 billion hectares is closed canopy forest or plantation -- the rest is savanna, scrubland, or areas under shifting cultivation. Just over half the world's forest and other woodlands are found in the tropics, the remainder in temperate and boreal zones. The six countries with the largest forest area -- Russia, Canada, Brazil, the United States, Zaire, and Indonesia -- have just over half of the world's forest and woodland area.

2. Deforestation and forest degradation -- most of it in the tropics -- have taken a noticeable toll on the world's forest resources in recent decades. Between 1980 and 1990, the world's forest area declined by 100 million hectares or approximately 2% (WRI/UNEP/UNDP/WORLD BANK 1996). In the tropics, forest and wooded land declined by 3.6%.
3. The 2% net global loss of forest and other wooded land area masks more significant declines in natural forest area alone. In developing countries, natural forest cover declined just over 8% during the 1980s. No estimates are available for the loss of natural forest area in temperate and boreal zones of developed countries (WRI/UNEP/UNDP/WORLD BANK 1996).
4. Deforestation rates are higher in some regions and countries than others. For example, deforestation claimed 11% of Asia's forests between 1980 and 1990, while deforestation claimed just over 7% of Africa's forests, and 8% of Latin America's (WRI/UNEP/UNDP/WORLD BANK 1996).
5. The most important factor with respect to deforestation rates is that they have been increasing steadily since global inventories started in the 1960s. Tropical deforestation rates climbed from an average of 0.60% annually in the 1960s to 0.75% in the 1970s and to 0.82% in the 1980s.
6. Deforestation is the result of complex forces. Agricultural expansion -- both for subsistence and plantations and ranches developed for export commodities -- is widely recognized as the leading cause of deforestation, followed by destructive logging, and infrastructure development (Sharma 1992). However, the root causes of deforestation are extremely complex and synergistic -- lack of tenure, widespread corruption, population growth and migration, tax and economic development policies, subsidies for agricultural development and logging concessions, inadequate investment in forest management, etc. (Johnson and Cabarle 1993).
6. While large blocks of natural tropical forest remain in the Amazon Basin, Central Africa, and isolated areas in Southeast Asia, a growing number of

countries have moved from the ranks of timber exporting to timber importing countries as they convert or degrade their natural forest resources. For example, the Philippines, Thailand, Sri Lanka, Nigeria, Togo, El Salvador, Haiti -- all once extensively forested -- now have virtually no natural forest and must import wood. Many other countries, particularly in Southeast Asia (traditionally the source of most internationally traded tropical timber) and Central America have logged or allocated concessions on all non-protected natural forest areas.

7. Partially offsetting the loss of natural tropical forests is the expansion of tree plantations. According to the FAO 1990 Forest Assessment, plantation cover in developing countries increased by 88% between 1980 and 1990. Still, the area planted was only one fifth of the total area of natural forest lost to other uses. Moreover, plantations are less biologically diverse and tend to be less resistant to natural forests to pests, fire, and other natural disturbances (Hansen et al. 1991).
8. Properly managed plantations have promise to produce considerably more fiber on much less land. For example, using data from existing examples of highly productive plantations such Eucalyptus plantations in Brazil, a recent study by the International Institute for Environment estimates that the world's total current demand for pulp and paper products could be produced on 40 million hectares (IIED/WBCSD 1996). This area, roughly the size of Paraguay or Sweden, is less than 1% of the world's total forest area and about one quarter the forest area intensively managed for fiber production today. If they are established without converting natural forest areas (e.g., on marginal agricultural lands), plantations may become an important strategy for meeting fiber needs while increasing the emphasis on sustaining non-timber benefits from natural forest areas. potentially relieve harvesting pressures on natural forest areas.

9. Non-wood sources of fiber could become more important substitutes for wood fiber, especially in paper products, in coming decades. A wide variety of fibers -- including rice and other small grain straw, corn stalks, kenaf, and industrial hemp -- can be substituted for wood (IIED/WBCSD 1996). The majority of paper products in India and China are made with agricultural residues, and pilot efforts in the U.S. and Canada demonstrate that kenaf and hemp can produce extremely high quality fiber for many applications (Johnson and Ditz, *in press*). Still, uncertainties about cost, pollution, fiber storage, processing technology and other issues (e.g., huge investments in trees) have limited interest on the part of pulp and paper companies in alternative fibers (EDF 1996).

#### IV. Other Relevant Global Trends

##### A. Environmental Stresses on Forest Ecosystems Are Growing Worldwide

1. **Climate Change.** The most recent assessment of the Intergovernmental Panel on Climate Change (IPCC 1996) indicates growing scientific consensus that the world will warm within a range of 0.8 - 3.5 degrees C. over the next century. The IPCC suggests warming due to human activities has already begun. Forests are sensitive to climate change -- average temperature changes of as little as 1 degree C. can affect the reproduction and growth of many trees species (IPCC 1996). There is significant risk that climate warming, as projected by the IPCC, will adversely impact forest ecosystem through changes in species composition, increased prevalence of insect pests and microbial pathogens, and more frequent and severe fires in some areas and more severe storms and flooding in others (IPCC 1996). While temperate forests are expected to be less impacted by climate warming than boreal and tropical forest regions, U.S. forests during the next century could be expected to undergo significant changes in species composition, pest and disease outbreaks, and fire frequency and severity -- changes that could



substantially alter the mix of forest fiber available to industry and irreversibly deplete forest biodiversity.

2. **Biodiversity Loss.** Biodiversity -- the variety and variability among organisms at the genetic and species level and the ecological complexes in which they occur -- has rapidly become one of the most visible and complex issues in forest management. Evidence suggests that biodiversity losses are mounting in many of the world's ecosystems, including the temperate forests of North America (UNEP 1995). Globally, there are estimated to be between 7 and 20 million species -- most of them invertebrates (only 1.75 million species have been identified). The Global Biodiversity Assessment, conducted by a team of several hundred scientists from around the world, estimates that current extinction rates are approximately 100 times greater than the natural background rates experienced in the absence of human activities (UNEP 1995). The United States is home to more species (approximately 100,000) than all but a few tropical countries such as Brazil, Colombia, Indonesia, and Mexico (Eisner et al. 1995). Forest ecosystems are an important reservoir of this biodiversity and may be home to at least half of the terrestrial species in the United States. Flather et al. (1994) indicate 10 hotspot regions of species endangerment in the U.S., several of which are extensively forested. These include the Southern Appalachians, Peninsular Florida, the eastern Gulf Coast, northern coastal California, and the Pacific Northwest. Species endangerment in forested regions is the result of multiple causes, of which forest clearing and logging practices are but one factor. Agricultural practices, grazing, water pollution, road building, residential and commercial development, and the spread of exotic species are also significant factors in forested areas (Flather et al. 1994).
3. **Air Pollution.** Air pollution has long been linked to acute tree injuries around smelters and other industrial facilities. More recently, lower levels

of air pollution have been firmly linked to widespread forest declines in Europe (approximately 25% of European forest area exhibited moderate or severe defoliation linked to pollution in 1994 according to the Economic Commission for Europe), Asia, and more limited declines in high elevation areas in the eastern U.S (WRI/UNEP/UNDP/World Bank 1996; MacKenzie and El-Ashry, 1989). Acid rain was the subject of heated controversies in the U.S. during the 1980s. An extensive research effort in the U.S. during the 1980s -- the National Acid Precipitation Assessment Program (NAPAP) -- failed to conclude that acid precipitation was responsible for the observed forest declines on the summits of Mt. Mitchell in North Carolina and Camel's Hump in Vermont. More recent research findings strongly implicate pollution levels in increased tree mortality in New England. For example, Likens et al. (1996) found that SO<sub>2</sub> and NO<sub>x</sub> leach calcium -- a critical buffer that neutralizes acid and an important nutrient -- out of forest soils leaving them vulnerable to even relatively low levels of acidic deposition in New Hampshire. In West Virginia, research shows NO<sub>x</sub> from car exhaust -- a major component in the region's acidic deposition -- is clearly linked to increased tree mortality and growth declines (Gilliam et al. 1996).

4. **Wildfire.** Concerns about fire consuming forest resources have been a major focus of forest management in the U.S. for more than a century. Between 1920 and 1990, the average annual area burned by wildfire decreased by 90% (MacCleery 1992). Fire suppression efforts have been so effective that large forest areas, particularly in the intermountain West, are heavily loaded with highly flammable dead wood and young firs that pose potential risks of catastrophic fires (Clark and Sampson 1995). Many local communities and timber companies believe the potential risk of large and severe wildfires justify immediate and large scale salvage logging efforts that reduce risks and simultaneously generate economic benefits.

Many ecologists and conservationists, on the other hand, believe the threat to sustainability is not fire *per se*, but forest management practices that have created the potential for fire. They advocate more use of prescriptive fires, a halt to logging large fire resistant trees in vulnerable areas, judicious thinning of flammable young trees, and salvage logging only when fire poses an imminent risk to human life or extensive property loss.

5. **Insects and Disease.** Insect pests and disease have always been part of forest ecosystems and can be important factors in the successional transitions of some forest ecosystems. However, the incidence and severity of pest and disease outbreaks have probably increased in many parts of the world for two reasons. First, increasing trade has introduced many new insects and diseases that affect trees, many of them with greater impact than native insects and disease because native trees have not evolved defenses against the new pathogens. For example, American chestnuts -- one of the most widespread, ecologically dominant, and economically valuable species in eastern hardwood forests until chestnut blight was introduced from Asia -- have disappeared from forests over their entire range. Second, intensive forest management practices have altered insect predator/prey relationships and tree farms have concentrated one or two tree species over large areas making them more vulnerable to pests and disease than natural forests with more dispersed or clumped distributions of tree species. Climate change could substantially increase the vulnerability of U.S. forests to pest and disease outbreaks in coming decades (IPCC 1996).

- B. **International Policy Responses to Environmental Problems.** The 1992 Earth Summit -- or the United Nations Conference on Environment and Development (UNCED) -- raised international discussions on forests to a new level. Although no comprehensive binding agreement exists on the loss and degradation of forest cover, general international consensus has been reached on several important

issues. These include the role of forests in maintaining biological diversity and climate, the criteria and indicators for sustainable forest management, and the need for cross-sectoral policy frameworks to confront deforestation.

1. **Convention on Biological Diversity and the Framework Convention on Climate Change.** These two major agreements negotiated for UNCED recognize the broad role that forests play in the maintenance of global ecosystems. At the Third Conference of the Parties (November 1996), countries will determine whether and how the Convention will specifically address the sustainable use and conservation of forest biodiversity. The U.S. is one of only a few countries that has not yet ratified the Convention (it was signed in June 1993), but it has been an active supporter of the Convention's basic objectives and participates actively in negotiations and discussions related to implementing the Convention. Under the Framework Convention on Climate Change, however, forests have become a major factor in "joint implementation" agreements to offset or reduce emissions of greenhouse gases. When two countries enter into a joint implementation agreement, the United States funding tree planting or forest conservation in Costa Rica for example, both countries can receive "credit" for the absorption of CO<sub>2</sub> emissions by the agreed upon forest conservation or tree planting. Thus far, there are only a few pilot carbon sequestration projects between U.S. and European utility companies and governments or non-governmental development agencies in Russia, Guatemala, Ecuador, and Costa Rica and no joint implementation agreements have yet been negotiated. Still, nations are likely to continue to develop forest conservation mechanisms under both Conventions over the next decade (WRI/UNEP/UNDP/World Bank 1996).
2. **Criteria and Indicators for Sustainable Forest Management.** Perhaps the most significant areas of agreement on forests since the Earth Summit has been on the definition of criteria and indicators for sustainable forest

management (WRI/UNEP/UNDP/World Bank 1996). In 1990, the International Tropical Timber Organization became the first intergovernmental body to develop criteria and indicators for sustainable forest management, with producer countries agreeing that all internationally traded tropical forest products should come from sustainably managed forests. In 1994, the tropical countries belonging to ITTO were able to extract an agreement from temperate forest countries to develop similar criteria and indicators. Three separate processes emerged including the European Helsinki Process, the non-European Montreal Process (which includes the U.S.) the Tarapoto agreement between Amazon Basin Countries. Each covers a broad range of criteria and indicators that constitute general guidelines for sustainable forest management. The U.S. and other countries are now in the early stages of applying these criteria and indicators. It remains to be seen how seriously these criteria and indicators will be applied since each country has enormous differences in available information and varying levels of political opposition to developing internationally comparable data.

3. **The World Commission on Sustainable Development and the International Panel on Forests.** The World Commission on Sustainable Development (CSD) was established at UNCED to follow-up on the agreements and issues raised in Rio. The CSD created the International Panel on Forests (IPF) as a working group to generate consensus on major forest issues of international concern and propose potential agreements related to sustainable forest management. The issues being addressed by the IPF include trade, monitoring of forest condition, scientific and technological cooperation between countries, and specific roles for inter-governmental organizations such as the UN Food and Agriculture Organization and multilateral institutions such as the World Bank. The IPF is addressing an enormously complex set of issues and is working on a

tight deadline (it reports in April 1997). Still, as the highest international body ever to address forest issues, IPF's recommendations are likely to set the agenda for forest policy and development cooperation for the next several years.

C. **Market and Policy Innovations.**

1. **Forest Stewardship Council.** Given the frustrations and erratic performance of intergovernmental agreements, several non-governmental organizations and private sector groups have launched voluntary efforts to harness market forces to promote trade in forest products from well-managed sources. One prominent example is the Forest Stewardship Council (FSC). The FSC's main functions are to evaluate, accredit, and monitor timber certification organizations that inspect forest operations. To date, the FSC has certified 21 forests covering 9 million acres. Several Swedish forestry companies -- representing 38% of the country's 58 million acres of forest -- announced in February 1996 their intention to adopt the FSC criteria. A growing number of independent forest-certification groups are based in the U.S. and several small and medium-sized forest companies, including Collins Pine in California and Seven Islands in Maine, have been certified. Still, some industry associations and governments criticize independent certification as being too inflexible and too expensive to implement. Industry initiatives such as the Sustainable Forestry Initiative of the American Forest and Paper Association which rely on self-certification are emerging as a response.
2. **Innovative Policy Efforts.** Innovative and new approaches to forest policy are emerging around the world -- far too many to enumerate here -- but many of them will provide ideas that influence forest policy and management in the U.S.

## REFERENCES

- AFPA, 1995. *Sustainable Forestry*. Brochure on the Sustainable Forestry Initiative. American Forest and Paper Association, Washington, D.C.
- Aplet, G.H., N. Johnson, J.T. Olson and V.A. Sample, 1993. *Defining Sustainable Forestry*. Island Press, Washington, D.C.
- Barber, C.V., N.C. Johnson and E. Hafild, 1994. *Breaking the Logjam: Obstacles to Forest Policy Reform in Indonesia and the United States*. World Resources Institute, Washington, D.C.
- Clark, L.R., and R.N. Sampson, 1995. *Forest Ecosystem Health: A Science and Policy Reader*. American Forests, Washington, D.C.
- Cohn, L, 1995. The Growing Market for Special Forest Products: an Opportunity and Challenge. *Forest Perspectives* 4(4): 4-9.
- Dudley, N., 1992. *Forests in Trouble: A Review of the Status of Temperate Forests Worldwide*. WWF-World Wide Fund For Nature, Gland, Switzerland.
- EDF. 1995. *Paper Task Force Recommendations for Purchasing and Using Environmentally Preferable Paper*, The Paper Task Force: Duke University, Environmental Defense Fund, Johnson & Johnson, McDonald's, The Prudential Insurance Company of America, Time Inc., New York.
- FAO, 1993. *The Challenge of Sustainable Forest Management: What Future for The World's Forests?* United Nations Food and Agriculture Organization, Rome.
- FAO, 1995. *FAO Yearbook: Forest Products, 1982-1993* United Nations Food and Agriculture Organization, Rome.
- Flather, C.H., L.A. Joyce, and C.A. Bloomgarden, 1994. *Species Endangerment Patterns in the United States*. General Technical Report RM-241, U.S. Department of Agriculture Forest Service, Fort Collins, CO.
- Frederick, K.D. and R.A. Sedjo, 1991. *America's Renewable Resources: Historical Trends and Current Challenges*. Resources for the Future, Washington, D.C.
- Gilliam, F.S., M.B. Adams, and B.M. Yurish, 1996. Ecosystem Nutrient Responses to Chronic Nitrogen Inputs at Fernow Experimental Forest, West Virginia. *Canadian Journal of Forest Research*. 26(2): 196-204

- Greenwire, 1996. "Ecolabeling: Swedish Firms Seek Forest Certification." *Greenwire* 5 (202): February 29.
- Haynes, R.W., D.M. Adams, and J.R. Mills, 1995. *The 1993 RPA Timber Assessment Update*, U.S.D.A. Forest Service General Technical Report RM-259, Fort Collins, CO: USDA, March.
- IIED/WBCSD, 1996. *Towards a Sustainable Paper Cycle: Final Report*. International Institute for Environment and Development, London, and World Business Council for Sustainable Development, Geneva.
- IPCC, 1996. *IPCC Working Group II Second Assessment Report*. International Panel on Climate Change, Geneva, Switzerland.
- ITTO, 1990. *ITTO Guidelines for the Sustainable Management of Natural Tropical Forests*. International Tropical Timber Organization, Yokohama, Japan.
- Johnson, N. and D. Ditz. *In press. Forest Future: Sustainability Challenges in the United States*. World Resources Institute, Washington, DC.
- Johnson, N. and B. Cabarle, 1993. *Surviving the Cut: Natural Forest Management in the Humid Tropics*. World Resources Institute, Washington, D.C.
- Likens, G.E., C.T. Driscoll, and D.C. Buso, 1996. "Long-term Effects of Acid Rain: Response and Recovery of a Forest Ecosystem." *Science* 272: 244-246.
- Lyden, F.J., B.W. Twight, and E.T. Tuchmann, 1990. "Citizen Participation in Long-range Planning: the RPA Experience." *Natural Resources Journal*. 30: 123-138.
- MacCleery, D.W., 1992. *American Forests: A History of Resilience and Recovery*. U.S. Department of Agriculture Forest Service and Forest History Society, Durham, NC.
- MacKenzie, J.J. and M.T. El-Ashry, 1989. *Air Pollution's Toll on Forests and Crops*. Yale University Press, New Haven, CT.
- Noss, R.F. and A.Y. Cooperrider, 1994. *Saving Nature's Legacy: Protecting and Restoring Biodiversity*. Island Press, Washington, D.C.
- O'Toole, R., 1996. Recreation values on the National Forests. *Different Drummer*. 5: 5-8.
- Powell, D.S., J.L. Faulkner, D.R. Darr, Z. Zhu, and D.W. MacCleery, 1993. *Forest Resources of the United States, 1992*. U.S. Forest Service General Technical Report RM-234, U.S. Department of Agriculture, Fort Collins, CO.



- Sharma, N.P. 1992. *Managing the World's Forests*. Kendall/Hunt Publishers, Dubuque, Iowa.
- Santiago Declaration, 1995. *Criteria and Indicators for the Sustainable Management of Temperate and Boreal Forests*. Canadian Forest Service, Hull, Quebec.
- TNC, 1996. *Priorities for Conservation: 1996 Annual Report Card for U.S. Plant and Animal Species*. The Nature Conservancy, Arlington, VA
- UNEP. 1995. *Global Biodiversity Assessment*. United Nations Environment Programme. Cambridge University Press, Cambridge, UK.
- U.S. Bureau of the Census. 1993. *Statistical Abstract of the United States 1993*. U.S. Government Printing Office, Washington, D.C.
- USDA. 1989. *RPA Assessment of the Forest and Rangeland Situation in the United States -- 1989*. U.S. Department of Agriculture Forest Service, Washington, D.C.
- WRI/UNEP/UNDP/World Bank. 1996. *World Resources 1996-97: A Guide to the Global Environment*. World Resources Institute, U.N. Environment Programme, UN Development Program, and the World Bank. Oxford University Press, New York.