



Eco-Link

Linking Social, Economic, and Ecological Issues

Volume 11, Number 1

Forest Health

An ecosystem is a natural system, which functions as a unit. It is an assemblage of living organisms reacting with each other and their non-living environment in a particular area. It can be anything from a rotten log to the entire planet. **A forest is simply an ecosystem dominated by trees,** with a unique combination of plants, animals, microbes, soil, and climate. Forests thrive on the natural chaos or disturbance in the ecosystem.

As a science, ecology makes no value judgments. It is society that places expectations on forests for goods and services. Social and economic benefits are based on healthy forests with fully functioning ecological processes, diversity and resiliency. Forests are also essential for clean air and water.

Disturbance is common and important in all ecosystems. Forests have evolved in response to disturbance-response regimes that have recurred over millions of years. Disturbance caused by drought, disease, fire, insects, and wind is very common in forests. Recurrence of these disturbances and recovery within forest ecosystems is an important mechanism for: energy flow; nutrient cycling; and for maintaining age, species, genetic, and structural diversity. *Dynamic, diverse, productive, and resilient (ability to recover quickly to conditions*

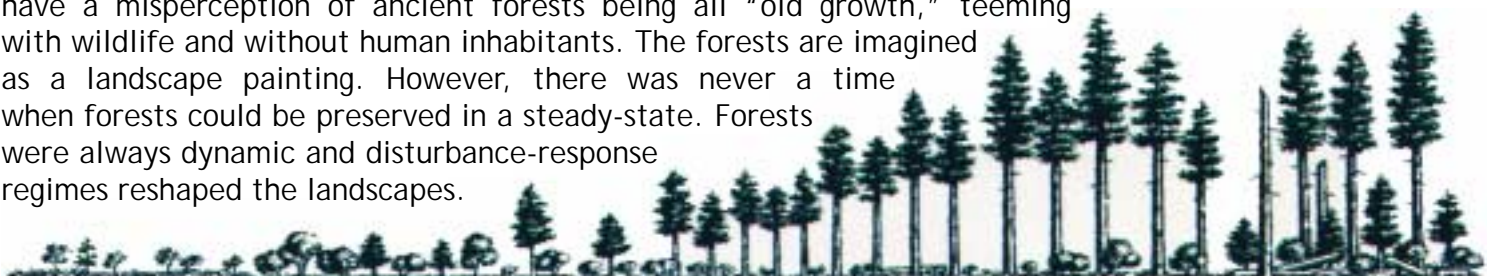


The results of disturbance are both short and long-term. *and relationships existing prior to the disturbance) forests are healthy forests.* In the short-term, social and economic impacts may dominate and then decrease as other goods, services and amenities replace ones that were lost. In the long-term, biological impacts may dominate (e.g. one species replaces another that was lost or diminished due to disturbance). Although disturbances have social and economic impacts, they can release: nutrients, light, water, and space, and make those available to remaining or new species. Many plants become marginal producers as they experience competition and stress, yet they continue to consume resources. Disease, insects and fire eventually kill weakened plants, creating the conditions for colonization by other vegetation.



An understanding of disturbance in ecosystem dynamics is essential to sustainable management. It increases the predictability of occurrence and socioeconomic impacts.

The “ancient forests” which the Europeans found were forests that had been shaped by natural disturbances including the aggressive use of fire by the Native American peoples. The ancient forest landscapes were diverse mosaics caused by disturbances, the harvesting of timber, and the conversion of forestlands for agriculture. Certainly, “old growth” forest stands were a component of those landscapes. People have a misperception of ancient forests being all “old growth,” teeming with wildlife and without human inhabitants. The forests are imagined as a landscape painting. However, there was never a time when forests could be preserved in a steady-state. Forests were always dynamic and disturbance-response regimes reshaped the landscapes.



A Historical Perspective - There is no way to overstate the importance of Native Americans in shaping our native forest landscapes. The historical record indicates that Native Americans were responsible for up to 50% of the fires that burned in our native forests. In addition, they were responsible for most of the fires that burned in Pacific Douglas-fir forests. They are the reason that fires burned nearly every year in the 90 million acres of longleaf pine forest that originally spread across the Southeast. Similarly, their fires maintain the oak savannas in the Midwest, California, Oregon, and Washington. They also played a significant role in sustaining eastern white pine forests and oak-chestnut forests, as well as many other forests. Native American burning and subsistence practices are even more important in the Southeast, where Native Americans helped to make longleaf pine forests the most diverse native forests in North America. These examples do not include their effects on forests from logging, agriculture, hunting, etc.

Forest Health is a condition wherein a forest has the capacity across the landscape for renewal, for recovery from a wide range of disturbances, and for retention of its ecological resiliency while meeting current and future needs of people for desired levels of values, uses, products, and services. US Forest Service

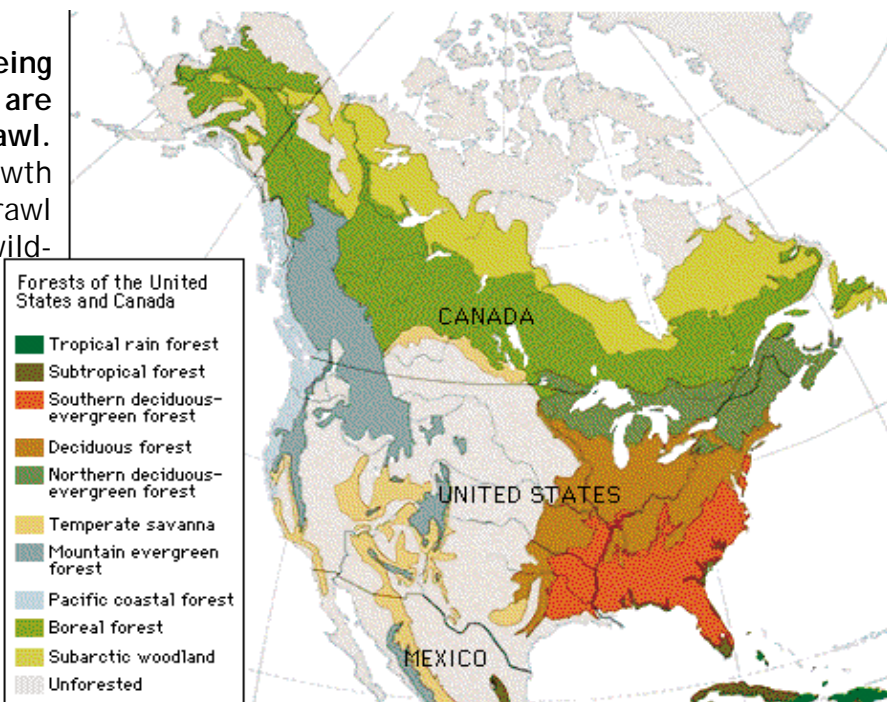
Dr. Tom Bonnicksen, a forestry professor at Texas A&M University, says that many of today's public forests are "unhealthy remnants" of the true pre-European forests. Dr. Bonnicksen is a pioneer in Restoration Forestry, which would use surgical forestry techniques such as harvesting, thinning and prescribed burning to mimic disturbances which shaped the pre-European forests. He points out that the ancient forests were diverse mosaics. Dr Bonnicksen says that in our efforts to eliminate wildfire in National Forests and National Parks, we have allowed them to grow thicker and more hazardous. Today, fires are larger and more destructive than the periodic low-intensity fires, which kept forests open and clear of debris. Thickets of trees compete for water, sunlight and nutrients while diseases and insects are on the rise. Dr. Bonnicksen feels that the urban public can understand and accept restoration forestry. Like any restoration process, it implies some chaos and the involvement of people.

It's important to monitor and manage forest ecosystems to maintain the balance of growth, mortality, and regeneration; appropriate biological diversity; and the ability to withstand or recover from internal and external impacts.

Health Update - Many of North America's forests are healthy. Since 1920 our forestland base is holding steady. We are also growing far more wood than we are harvesting and the biomass (i.e. weight of living things) is increasing. However, some areas have excessive mortality due to insects, disease, wind and wildfire. Many stands are overstocked and there is an excessive buildup of dead trees, woody debris on the forest floor, flammable brush and dense understories which can carry fire into the crowns of larger trees. It has become increasingly difficult to salvage dead and dying trees; setting up conditions for disease, insects and wildfire.

While many agricultural lands are being returned to forest, many forestlands are being lost to development and urban-sprawl.

This is a direct result of population growth and our ability to live anywhere. Urban-sprawl fragments landscapes, destroys fish and wildlife habitat, fouls air and water, and creates many urban/wildland conflicts. In 1900 we had 76 million people in the United States. Today we have 281 million. In 1900 our population was 60% rural. Today we are 80% urban. Rural dwellers support "conservation" while urban dwellers favor "preservation." Generally, the preservation viewpoint is based on a misperception of an idealized forest, which: never changes, is teeming with wildlife and has no people living in it. It's equivalent of some characterizations of the western landscape on canvas.



America's National Forests produce social benefits, environmental services and economic wealth, valued at over \$300 billion annually.

In its 1999 Health Update the US Forest Service lists seven key issues.

1. Wildfire Threat (fuel and vegetation-buildups)
2. Invasion of Exotic (non-native) Species
3. Urban-Wildland Interface
4. Degraded Riparian (streamside) Zones
5. Loss of Biodiversity
6. Air pollution (acid rain, ozone)
7. Changed Ecological Conditions

1. Wildfires - Fire is a major disturbance factor in the majority of forest ecosystems. Forest fire is part of natural ecological processes in which the forests have functioned for thousands of years. In addition to the lightning fires, native peoples used fire extensively to manage vegetation, drive game and improve transportation.

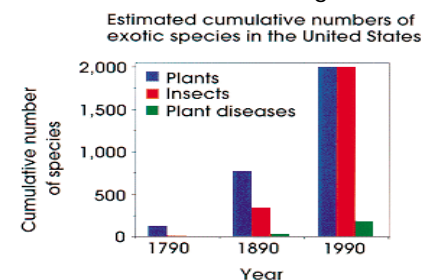


In 2000, a total of 92,250 wildfires burned 7.4 million acres of the US public land, compared to an average of 3 million acres for the previous 10-years. Source: National Interagency Fire Center

Almost a century of fire control has led to a forest that is, in many places, substantially overstocked with old, dead, and dying trees. Small natural fires have not been allowed to fulfill their function of removing ground litter and fuel buildup, and helping to thin overly dense stands. Prescribed burns, designed to mimic the impact of small natural fires, are often applied on forests that have excessive buildup of flammable materials. They can easily get out of control, as they did at Los Alamos where more than 400 families were left without homes.

Prescribed burns are useful, cost effective, and environmentally safe in areas with less fuel buildup. Areas with excessive fuel buildup should be treated to reduce the density of forest stands and to provide fuel breaks in critical areas, such as near human populations. Due to the value of harvested materials, such projects can easily cover some, if not all, of the management cost.

2. Exotics (non-native & invasive) - Exotics refer to species primarily of European or Asian origin that have been accidentally or intentionally introduced to North America. Some of these species are invasive meaning they have the ability to spread, dominate, and out-compete native communities. Therefore, these species thrive since they were introduced without the insects' diseases and organisms that kept them in check in their homelands. When brought into new ecosystems, exotic species often have no natural enemies and can therefore cause extensive damage.



The U.S. Forest Service estimates that between 1989 and 1998, efforts to control the European gypsy moth cost state and federal governments in excess of \$114 million. Source: GM Digest

Exotics may include members of all kingdoms including fungi, plants, and animals. They can cause major economic and ecological damage. For example: Gypsy moth (*Lymantria dispar*) is one of North America's most devastating forest pests. It was intentionally introduced from France in 1869 to produce silk. Today, it continues to spread, and at least 15 States are considered infested. Defoliation in the East increased from 363,300 acres in 1998 to 524,800 in 1999. The Gypsy moth feeds on the foliage of hundreds of species, but its favorites are oak and aspen.

"What makes these species so dominant is their ability to move quickly into an area. They lack natural biological control measures (like predators) allowing them to expend almost all of their energy in reproduction." Quita Sheehan, a US Forest Service plant ecologist.

The US Animal and Plant Health Inspections Service (APHIS) implements quick eradication efforts for exotic pests that are not well established, such as the Asian longhorn beetle. For well-established pests such as the gypsy moth and white pine blister

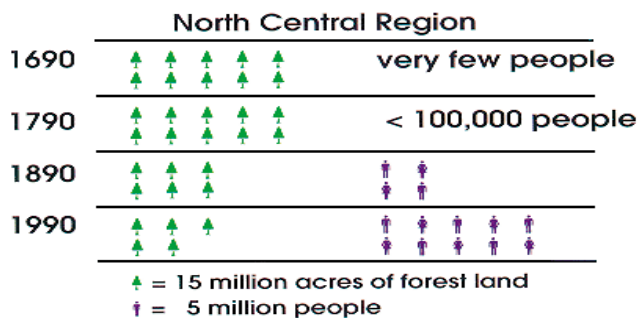
rust, the USDA Forest Service has established some programs to protect and restore affected tree species. Details may be found on the Forest Service website.



3. Urban-Wildland Interface - Urban areas are pressing-up against “wildlands” and managed forests. This creates some unique challenges in monitoring and managing forest health while protecting human health, safety, and property. One of the most serious issues is fire. Many homes are built in, or adjacent to, fire dependent ecosystems, which need to be burned using prescribed fire. Urban dwellers don’t like to breath in the smoke and consider smoke a hazard on the highway. Yet trees like the longleaf pines in southern coastal plains need fire and so do the red-cockaded woodpeckers that live in these trees. The ponderosa pines of the west are also fire dependent. Yet homes and whole cities exist in this ecosystem. Fire fighting efforts often have to focus on saving homes as opposed to protecting the forest.



With the increase in population, the demand for forest products is increasing: In 1900 there were 76 million people in the US and the average person consumed 56 lbs of paper per year. The United States’ resident population on Census Day, April 1, 2000 was 281,421,906. Today the average person uses 80 cubic feet of wood and 750 lbs of paper, an equivalent of a 100’ tree with an 18” trunk, per year. With so much public forest land set aside from commercial harvesting, we will need to get more and more of our wood fiber from private lands and intensively managed plantations. If carefully managed, non-industrial private timberlands can significantly increase their contribution to meeting the nation’s sustainable needs for clean water, timber, fish and wildlife.



Today, the average home size is 2,120 sq. ft. compared to 1,520 sq. ft. in 1971. It takes 15,000 board feet to build a 2,000 sq. ft. house. A board foot is one foot wide, one foot long, and one inch thick.



The National Forests offer a great outdoor recreation opportunity. These forests contain 380,000 miles of roads that carry over 20 million vehicles per day. It is a tremendous challenge to meet the growing need for recreation while protecting the health, diversity, and productivity of the land. Sixty percent of National Forest roads are not maintained to the public safety and environmental standards for which they were built. A \$10 billion reconstruction backlog exists for highly traveled roads.



Urban trees have higher average value as individuals than forest trees do. Total value of these trees in the United States is \$250 billion.

4. Degraded Watersheds and Riparian Zones
Healthy watersheds are vital to ecosystem health. Watersheds absorb rain and recharge underground aquifers. They serve as habitat for thousands of species of fish, wildlife, and rare plants. They dissipate floods across floodplains, increasing soil fertility and minimizing damage to lives, property, and streams. Over 80 percent of the freshwater sources originate on forestland. Downstream communities depend on the clean water that flows from watersheds for consumption, food production, agricultural development, employment, power generation, and recreation.

Poorly maintained roads can promote erosion and landslides, degrading riparian and wetland habitat. Sedimentation causes changes in stream flow, water temperature and water quality.



High quality riparian (streamside) areas trap sediments; slow runoff; and provide cooling shade and excellent habitat for wildlife, fish and plants. Degraded riparian areas lose many of these functions. The US Forest Service estimates that 50 percent of the riparian areas in National Forests and National Grasslands need aggressive management.

A complete watershed analysis reveals where the most severe riparian damage has occurred. While the riparian areas in forests are a major concern, the riparian areas that have been converted to residential and commercial uses pose a greater threat. Urban dwellers are hesitant to address the most serious issue affecting riparian zones, which is their total elimination in many downstream urban areas.



The Willamette River in downtown Portland, Oregon is a Superfund site and also habitat to endangered species of anadromous fish.

5. Biodiversity Loss - Biodiversity means a variety of life forms. It can be considered at three levels: ecosystem, community, and individual species. All three levels are interconnected and hierarchical; species are dependent on communities, which are dependent on the larger ecosystems in which they reside. Biologically diverse ecosystems tend to be more productive and resilient than those with less diversity.

Ecosystems can be lost or impoverished in basically two ways. The most obvious kind of loss is quantitative, the conversion of a native prairie to a corn field or to a parking lot. The second kind of loss is qualitative and involves a change or degradation in the structure, function, or composition of an ecosystem. Source: Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation, U.S. Geological Survey.

Biological diversity is important at all levels, not only for consideration of individual species, but also for the integrity of communities and ecosystems. Diverse forests can be maintained nearer to their ecological potential and can recover more readily from disturbances. Past management practices and white pine blister rust have led to substantial losses of western white pine, ponderosa pine and larch (tamarack). Today, the forest contains almost twice as much Douglas fir as was historically present. As a result, insects such as the Douglas fir bark beetle and root rot diseases are flourishing beyond historical levels. On the contrary, the number of western white pine trees is 93 percent less than 40 years ago.

Across a forest landscape, structural diversity is the key to all the other kinds of diversity. Biodiversity declines, as stands become dense, instead of having the openings and grassy areas of pre-settlement forests. Loss of species can affect higher levels of organization. For example, loss of the once common American chestnut in the Eastern United States has affected many floral and faunal components of oak-hickory forests.



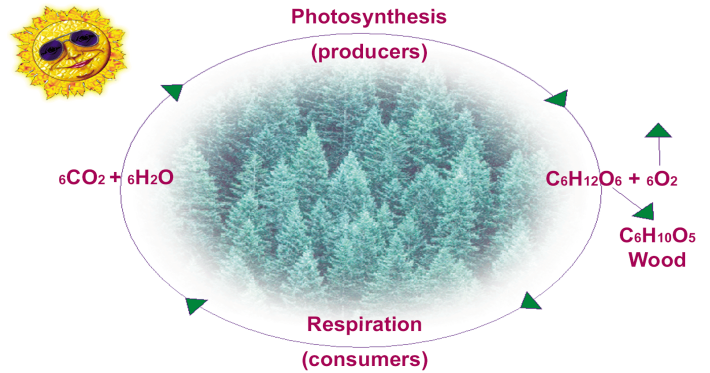
The fire-dependent longleaf pine based ecosystem is recognized by ecologists as one of the most biologically diverse ecosystems found anywhere outside the tropics, supporting hundreds of plant and animal species including over 30 threatened or endangered species. Previously spread across 92 million acres in the Southeastern United States, longleaf pine forests now cover less than 3 million acres. Source: USDA, Forest Service, Southern Research Center, June 2, 2000.

Tree plantations fit into larger landscapes as very important components for sustainable forestry. Most plantations are far more diverse than the single-aged monocultures which are commonly pictured. They contain diverse streamside riparian-zones, often stocked with hardwoods. Many tree plantations replaced far less diverse and less sustainable agricultural crops such as cotton and tobacco. Plantations are held in the early stages of ecological succession, but usually contain several age classes. They absorb carbon dioxide, pump out oxygen, and prevent urban-sprawl. Most importantly, plantations maximize wood yield from a given acre of land, and that keeps the developers at bay.



Loss of biodiversity at the ecosystem level, which occurs when distinct habitats, species assemblages, and natural processes are diminished or degraded in quality, is least recognized.

6. Air Pollution - Air pollution, particularly acid rain and ground-level ozone, impacts forest ecosystems. Pollutant emissions associated with increased industrialization, resource consumption, and other human activities are expected to continue to increase nationally and globally. This change in atmosphere affects the function, productivity and health of forest ecosystems. The capability to understand and to predict the consequences of the long-range transport of air pollutants on forests, and to pinpoint the sources of air pollutants, is essential for achieving the sustainable-management of forests.



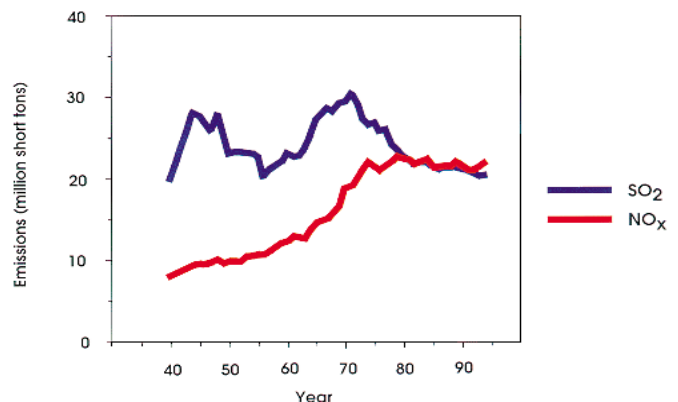
A vigorous forest acts as a sink, or a fixer of carbon, whereas deteriorating forests give up carbon, or become sources of atmospheric carbon dioxide as they decay.

Ozone is toxic (plant-killing) to sensitive plant species. It has been shown to alter forest ecosystems in areas of high deposition in the mountains of southern and central California. Ponderosa pine and Jeffrey pine in southern and central California show needle injury from ozone.

Ozone injury symptoms on blue elderberry following controlled exposure to 39 parts per million ozone over 28 days. Source: USDA, Monitoring for Ozone Injury in West Coast (Oregon, Washington, California) Forests in 1998.



Nitrogen is the primary growth-limiting nutrient, yet it is also a pollutant when in excess. As nitrate levels increase, tree growth rates decrease because nutrients are lost. Dr. Gene Likens, Director of the Institute of Ecosystem Studies at Hubbard Brook in New Hampshire, noted that nitrous oxide emissions from vehicles have been increasing and are expected to overtake sulfur emissions by 2010. His work shows that forest soils at Hubbard Brook have lost 50 percent of their calcium since 1950.



"Nitrate leaches through soils, taking calcium, potassium, and phosphorus, all critical to plants, with it." Dr. John Aber of Complex Systems, University of New Hampshire



The global carbon cycle is out of balance. Atmospheric CO₂ levels are rising rapidly, currently, they are 25 percent above where they stood before the industrial revolution. Earth's atmosphere now contains some 200 gigatons more carbon than it did two centuries ago. Climate Change, World Resources Institute.

Some forms of global change, such as urbanization, deforestation, and loss of wetlands, can happen within months or years. Others, such as changes in climate and the thinning of the atmosphere's stratospheric ozone layer, are measurable over a span of decades or centuries.



Today, there are two major pollutant types threatening forest ecosystems: photochemical oxidants, of which ozone is the primary compound, and nitrogen pollutants.

7. Changed Ecological Conditions - Each agent in an ecosystem acts in an environment produced by its interactions with other agents in the system. Therefore, every agent is constantly acting and reacting to what the other agents are doing. For example: "Insect outbreaks frequently are associated with drought, which, in turn, can exacerbate the adverse effects of insect activity. Drought also can enhance the ignitability of fuel and create a greater potential for fire, especially in ecosystems rarely affected by fire. Root diseases can predispose some trees to attack by insects such as bark beetles, which can subsequently be triggered to outbreak levels by other agents. Trees affected by root disease also are more prone to wind-throw. Loss of root-diseased trees by wind-throw increases the risk of adjacent trees to wind-throw during the same or future wind events. Increased tree mortality can enhance the amount of ignitable fuel and increases the chances of fire and its intensity when it occurs." Therefore, **change is constant** and the process, which regulates forests, is continually changing.



In 1990, USDA Forest Service began a major program aimed at understanding forest health called the Forest Health Monitoring Program. The program goal is to monitor, assess, and report on the status, changes, and long-term trends in the health of our nation's forests.

Example - Western White Pine

Due to fire suppression, western red cedar, western hemlock, or grand fir-species most tolerant of shade would eventually dominate many western forests. Prior to fire suppression, these species were rare, except on the wettest areas because of their susceptibility to fire. Even though mountain pine beetle outbreaks, fire suppression, and harvesting all have their impact on the change, the root cause is the white pine blister rust. Blister rust is a disease of white pines which was accidentally introduced into Vancouver Island, British Columbia in about 1910. By the 1940s, the disease was epidemic in Idaho. Today, a combination of blister rust, mountain pine beetle and harvesting has nearly eliminated mature western white pine stands. Remaining large western white pines now exist mostly as scattered individuals.



White Pine Blister Rust, Early Attack

Example - Eastern Hardwoods

Native insects and diseases, and other ecological disturbances impact forests or specific tree species, yet they do not cause species extinction. In contrast, exotic pests can threaten the continued existence of a species. Often host species have not evolved genetic resistance to exotic pests, as co-evolutionary processes have not occurred. For example, three North American tree species, American chestnut (Castanea dentata), butternut (Juglans cinerea), and American elm (Ulmus americana), have been devastated by exotic fungal diseases over the last century. American chestnut was eliminated from eastern forests as a dominant species by chestnut blight (Cryphonectria parasitica). Butternut is presently being extirpated, as butternut canker disease (Sirococcus clavigigenti-juglandacearum) spreads into northern populations. Urban and forest American elm populations have been decimated by Dutch elm disease (Ophiostoma ulmi and O. nova-ulmi).



Cracking and fruiting bodies on chestnut.

Source: USDA, Three American Tragedies: Chestnut Blight, Butternut Canker, and Dutch Elm Disease.

Fire Plan Budget - FY 2001 (Dollars in thousands)	
Fire Preparedness	\$574,890
Fire Workforce Development and Maintenance	\$17,000
New Technology Development, including the JFSP	\$20,600
Emergency Fire Contingency	\$426,000
Suppression	\$320,029
Reconstruction and Repair of Air Tanker Bases	\$12,000
Reconstruction and Repair of Fire Facilities	\$32,000
Fuels Management:	\$194,110
Analysis, monitoring, and planning for NEPA	\$11,500
Research and Development	\$16,000
Rehabilitation and Restoration	\$142,000
State Fire Assistance:	\$35,004
Firewise 4,000	\$4,000
Cost-share Incentives	\$28,990
Kenai Peninsula Borough	\$7,500
Volunteer Fire Assistance	\$13,280
Forest Health Management	\$75,944
Emergency Priority Pest Contingency	\$12,500
Economic Action Programs	\$42,836
Community and Private Land Fire Assistance	\$26,000
Fence Reconstruction	\$9,000
Total	\$2,021,183

The 2001 appropriations bill for the Forest Service includes \$1.1 billion in additional Forest Service funds for projects and activities identified in the National Fire Plan, which will:

- Ensure sufficient fire fighting resources for the future*
- Restore ecosystems damaged by the recent fires*
- Rebuild community economics*
- Reduce future fire risk through fuel reduction efforts*



Due to the cumulative-effect of the concerns discussed, North America's forests contain many examples of habitat change. Past management practices such as fire suppression, combined with native and non-native invasive species, have created landscapes that experience more frequent or intense disturbances. These landscapes are more costly



to manage, less able to provide the values humans desire and are less ecologically sustainable. There is an estimated backlog of \$40 billion in forest health work to be done on the US National Forests alone.

Forests need active management. In order to have diverse, productive and resilient forests, we need to learn how to mimic some of yesterday's disturbances, and utilize the safest and most effective tools available. We must learn to restore the real ancient forest, but on smaller landscapes. Which means that the uncontrolled disturbances of the past are unacceptable and nature cannot just take its course. These forests



must have mechanical thinning and harvesting as well as prescribed fire. They can contain some old growth mixed with stands in all stages of ecological succession. We must also have intensively managed plantations to meet our need for wood. These forests can be healthy, diverse productive and resilient ecosystems.



Glossary

Conservation: The sustainable use of forest resources in a manner that doesn't degrade the collective resource values of a region over the long term. **Eco:** This prefix comes from the Greek "Oikos" which means house. In the original context, ecology refers to the house we live in and economy refers to how we manage that house. **Ecological Sustainability:** Maintaining the composition, structure and processes of an ecosystem. **Ecology:** The study of ecosystems. As a science ecology makes no value judgements. **Forest:** An ecosystem dominated by trees, with a unique combination of plants, animals, microbes, soil, and climate. **Foresters:** Foresters manage forests for the maintenance and reoccurrence of desirable conditions. What is desirable is determined by social, biological, and economic considerations. **Forestry:** The art, science, and practice of managing forest landscapes to provide a sustained production of a variety of goods and services for society. **Silviculture:** The art and science of managing stands of trees to achieve desired outcomes relative to species composition and stand structure. **Fire regime:** The combination of fire frequency, predictability, intensity, seasonality, and extent of fire in an ecosystem. **Prescribed fire:** A fire ignited under known conditions of fuel, weather, and topography to achieve specific objectives. **Wildfire:** An uncontrolled fire, lightning or humans caused, that is not meeting land management objectives.

Links & Resources

America's Ancient Forests, From the Ice Age to the Age of Discovery
 Thomas M. Bonnicksen, John Wiley & Sons, Inc., www.oldforest.com
 USDA Forest Service: www.fs.fed.us. World Resource Institute: www.wri.org. U.S. Geological Survey: www.usgs.gov. Environmental News Network: www.enn.com.
 Bark Beetles: www.barkbeetles.org. National Interagency Fire Center: www.nifc.gov. Forestry at UBC: www.forestry.ubc.ca. The National Council for Science and the Environment: www.cnies.org. Plant Disease Control: plant-disease.orst.edu. National Invasive Species Council: www.invasivespecies.gov. National Wildlife Federation: www.nwf.org. Conservation Science: consci.tnc.org. Exotic Forest Pest Information System for North America: www.exoticforestpests.org. National Forest Foundation: www.nffweb.org. U.S. House of Representatives: resourcescommittee.house.gov. The State of the Nation's Ecosystems: www.us-ecosystems.org



Chairman, Dr. Robert G. Lee
 President & CEO, Robert F. Legg
 Vice President, Dr. John H. Baldwin
 CIO, Mohammad N. Khan
 CFO, Renee K. King
 14780 SW Osprey Drive, Suite 355
 Beaverton, OR 97007
 Tel: (503) 579-6762 Fax: (503) 579-0300
 E-mail: info@forestinfo.org
www.forestinfo.org

