BEYOND OLD GROWTH

Older Forests in a Changing World

A synthesis of findings from five regional workshops
sponsored by the

National Commission on Science for Sustainable Forestry (NCSSF)

A Program Conducted by the
National Council for Science and the Environment
"Improving the scientific basis for environmental decision making"

COMMISSION MEMBERS

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THE COMMISSION'S ROLE: REACHING OUT TO STAKEHOLDERS

The National Commission on Science for Sustainable Forestry (NCSSF) was created in 2001 to improve the scientific basis for sustainable forestry practices in the United States. NCSSF sponsors work of the highest technical quality that is relevant to the urgent needs of forest managers, practitioners and policymakers. Since it began its work, NCSSF has interacted with these primary target audiences to identify work that will improve the scientific basis for sustainable forestry and biodiversity.

The Commission also has received extensive external input from stakeholders—people in government, industry, academia, and environmental organizations that influence decisions about the future of sustainable forestry or will be affected by the consequences of those decisions. The Commissioners have responded by hosting meetings to help these stakeholders identify areas of consensus and divergence. One premise that has emerged is that sustainable forestry should recognize the unique role and value of older trees and forests.

In 2005, NCSSF held five regional workshops designed to define characteristics, functions, and strategies for protecting and perpetuating older forests, including mature stands of smaller trees with less complexity than similar old-growth stands as well as old growth itself.

The workshops were held in major forested regions across the United States—the Northeast, the Great Lakes, the Southeast, the Pacific Northwest, and the Southwest. Workshop participants examined the state of knowledge of older forests and addressed the questions:

- What is the status and extent of older forests in the region?
- What, if any, old-growth enhancement activities are desirable and possible?
- What action steps/plans are appropriate on public and private lands?
- How do forest certification systems treat older forests and how can the science base for this be strengthened?
- What thresholds exist that might set boundaries on the desired extent of older forests?

The workshops were conducted in 2005-06, and final reports were submitted to NCSSF. In October 2006, the project leaders met with Commission members and staff for a workshop to discuss how to integrate the findings that came out of the regional workshops. This publication is the result of those discussions.

The following pages synthesize some overarching commonalities and significant differences among the five regions that emerged from the workshops. They are highlights and examples, not a compilation or comprehensive overview of all of the workshop findings. More detailed information can be found in the individual workshop reports. These reports are available on the NCSSF web site at <http://www.NCSSF.org>.

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BIODIVERSITY
The Keystone of Sustainable Forestry

If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.

—Aldo Leopold, 1953

Biological diversity—or biodiversity— is the term given to the variety of life on Earth and the natural patterns it forms. The biodiversity we see today is the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. It forms the web of life of which we are an integral part and upon which we so fully depend. . . .

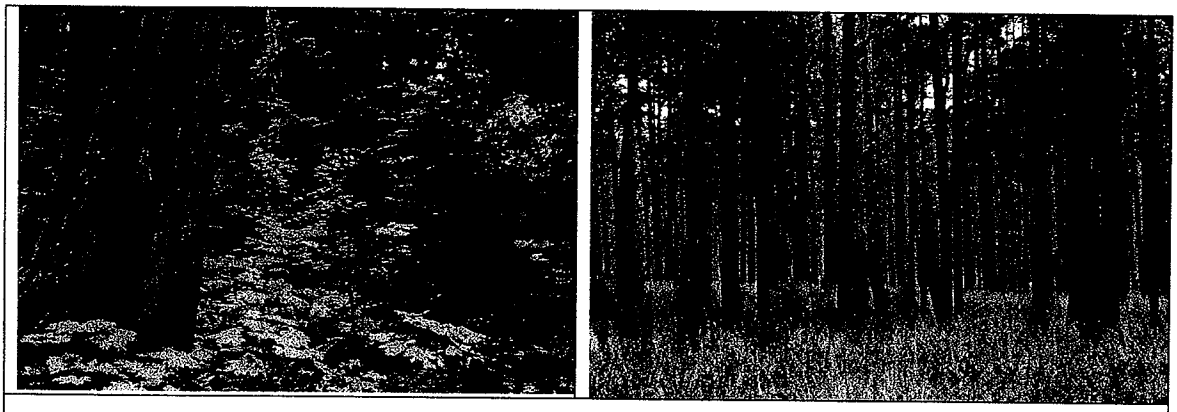
Protecting biodiversity is in our self-interest. Biological resources are the pillars upon which we build civilizations. Nature's products support such diverse industries as agriculture, cosmetics, pharmaceuticals, pulp and paper, horticulture, construction and waste treatment. The loss of biodiversity threatens our food supplies, opportunities for recreation and tourism, and sources of wood, medicines and energy. It also interferes with essential ecological functions.

—Convention on Biodiversity, United Nations Environment Programme, 2007

WHAT IS OLD GROWTH?

What image comes to mind when you hear the term "old growth"? To many it describes a forest that has grown for centuries without human disturbance and now is a stand of massive, towering trees with jumbles of large decaying tree trunks; deep shade pierced by shafts of sunlight; and dense patches of herbs, shrubs, and saplings that may conceal rare species. Such a forest is as awe-inspiring as it is biologically rich. It may contain the largest trees, the oldest trees, the most at-risk forest species, and the largest accumulation of carbon per acre of any forest type on earth. Given this picture, it's not difficult to understand why old-growth forests have become charismatic ecosystems in the debate about forest biodiversity.

This image accurately depicts many old-growth forests, but it doesn't fit all or even most of them. The basic definition of old growth is simply a forest that is dominated by big, old trees, both live and dead, standing and fallen, and that usually contains many other smaller trees. The individual trees are irregularly distributed over the land, and their diverse sizes give rise to a layered appearance. Most true old-growth forests give an overwhelming impression of diversity instead of uniformity.



Older forests can be very diverse. The left photo shows a forest in the Cascade Range in northern Washington. Fire is rare or absent in this landscape. Shade-tolerant trees regenerate in small gaps created by wind and disease. In the absence of catastrophic fire or windstorm, small patches of old, young, and maturing trees create a nearly continuous old-growth forest. The right photo shows a stand of old-growth longleaf pine in southwestern Georgia, with standing dead trees, regenerating saplings and wiregrass ground cover. Frequent low-intensity fire is a key element in maintaining this longleaf pine/wiregrass ecosystem. (left photo: USDA Forest Service, right photo: Jones Research Center) [OG 35 and OG 47]

Policymakers and forest managers are struggling to respond to various definitions of these complex ecosystems. What is certain is that older forests are reservoirs of species that are often rare or absent in younger forests and that they themselves are an important element in the biological legacies and continuity of our terrestrial environment.

If this crucial element of biological diversity is to be preserved, old-growth policy and management must be based on sound ecological concepts and principles, so that intelligent decisions can be made about where to focus our limited resources.

WHY GO "BEYOND OLD GROWTH"?

Human values, such as aesthetic and spiritual qualities, drive many public debates about old growth—ecology and biodiversity are secondary for many people. Although social values and issues lie at the heart of many old-growth controversies, ecological perspectives are needed if new policies are to lead to successful management.

Even if consensus is never reached on a broad ecological definition of old growth, managers need specific working definitions to conserve biodiversity effectively. Old-growth forests share many attributes, but they also differ in many ways. Efforts to conserve biodiversity must be sensitive to these differences and must consider forests of all developmental stages, not just the oldest ones. Forest policies and management practices may need to be as diverse as the forests they address. Unless some younger forests become older forests, one day in the future there will be no "old growth."

This publication is the product of an effort to synthesize some overarching commonalities and significant differences in the findings of five NCSSF-sponsored workshops. Its purpose isn't to debate definitions of old growth, but to go beyond them. This is why the Commission has chosen to use the neutral term "older forests" wherever possible instead of old-growth forests, ancient forests, virgin forests, or any of a myriad of other widely used terms. "Older forests" acknowledges that many of today's forests on land that was cleared or logged over the past couple of centuries have key ecological characteristics that traditionally have defined old-growth forests. With effective management, these forests can acquire the values that make what we know as old growth such a precious resource.

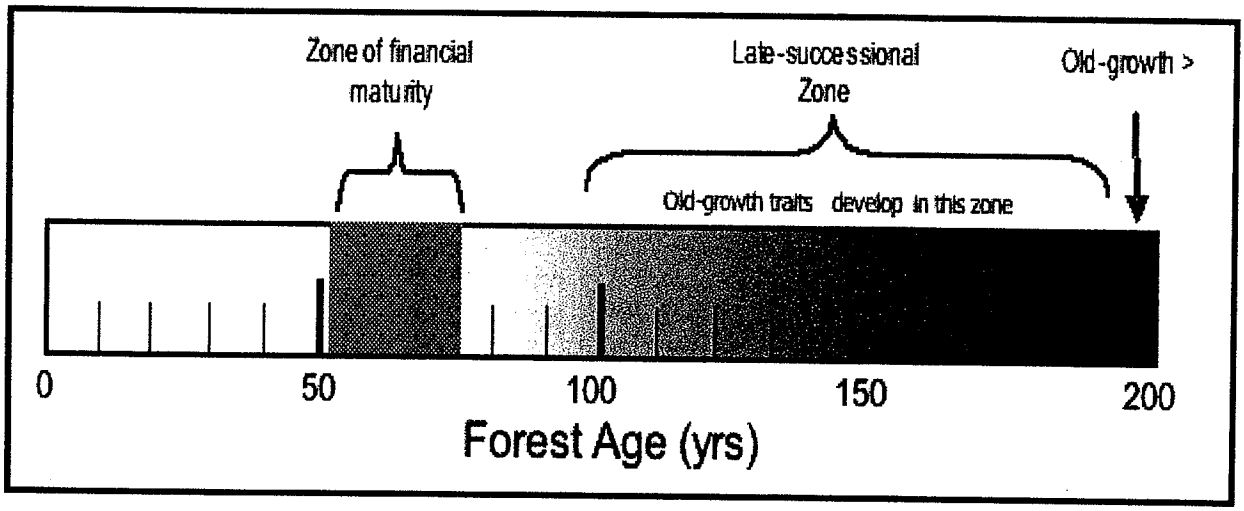
Unless some younger forests become older forests, one day in the future there will be no "old growth."

For example, it is not widely appreciated that even commercially managed timberland in northern New England still has a biologically significant component of older forest—stands in which there is a cohort (a group of trees in the same age class) 100 to 200+ years old. Such older stands have been virtually "invisible" as either a conservation problem or a conservation opportunity for several reasons.

First, ecologists and the environmental community have tended to focus on conserving "true" old growth, of which there is very little. Most remaining old growth has already been protected. But forests develop along a continuum via complex pathways. Old-growth characteristics don't develop instantaneously at some magical age; they accrue over time (Fig. 1). Thus even stands with a history of timber harvesting can have old-growth characteristics. Effective conservation of forest biodiversity requires us to see the forest as plants and animals experience it, not as black or white (e.g., pristine old-growth vs. everything else). Many older-forest species don't

understand the word "pristine" and occur in stands with old-growth characteristics. Forests in this stage and species that use them often slip through the coarse filter of conservation.

Second, because we haven't adequately appreciated the ecological significance of forests with harvest histories, we haven't built an understanding of biodiversity in older forests that are not accepted as "true" old growth. We are relatively uninformed about what species might be lost if this age class disappears from the landscape. However, scientists are beginning to realize that the abundance of older forest in managed landscapes will likely make or break the conservation of biodiversity in forest-dominated regions.



In northern hardwood (maple-birch) or softwood (spruce) stands, true old growth develops at around 200(+/-) years. Although stands can take many development pathways, old-growth characteristics begin to emerge when some trees in the stand reach about 100 years of age. Forest stands in the late-successional zone are rapidly disappearing because they are beyond the age of maximum commercial value. (John Hagan and Andrew Whitman). [OG 62]

The ultimate goal of this effort is to provide useful information that will contribute to policies and practices that keep older forests a biologically functional part of our nation's forestlands

WHY ARE OLDER FORESTS IMPORTANT?

Although the older forests of the five regions addressed by the NCSSF-sponsored workshops are very different from each other in composition, character, and other respects, they share many common values that make them important. Two values that clearly emerged from all five workshops were the essential role of older forests in maintaining biodiversity and some less tangible but important aesthetic and spiritual benefits that they provide to society.

Biodiversity

The findings of all five workshops emphasized the importance of older forests in maintaining biodiversity. Here are some examples:

- In the **Northeast**, some lichens, mosses, fungi, invertebrates (animals without backbones), and other species that depend on older forest are threatened by climate change because they disperse poorly. As their habitats shift northward in response to a warming climate, a system of corridors and stepping-stones (patches of favorable habitat in a fragmented forest landscape) of older forest could conserve forest biodiversity by providing migration routes for these species.

Old-growth forest of white pine, yellow birch, and hemlock, Sylvania Wilderness Area, Michigan. (Craig Lorimer) [OG 11]

- Although the older forests of the **Great Lakes** region are very different from those that were there before the region was intensively cut over in the late 19th and early 20th centuries, the findings of the Great Lakes workshop defined the ultimate goal of forest conservation as sustaining ecologically complex older forests with a broad range of habitat types across the region.
- The longleaf pine woodlands of the **Southeast** clearly illustrate the importance of older forests in sustaining native species. Mature longleaf pine forests that have been frequently burned over long periods are the preferred habitat of many species of concern (in danger of extinction, threatened with endangerment, or rare in the landscape) in the southeastern coastal plains. Bottomland hardwood forests also are important.
- In the **Pacific Northwest**, older forests provide habitat for many organisms, some of which show a preference for old-growth conditions compared with other stand development stages, the most famous of which is the northern spotted owl.
- In the **Southwest**, older forest helps to sustain the ponderosa pine ecosystem—its structure, processes, composition, and food-chain interactions—at a variety of scales. Older trees may be particularly important because they have survived centuries of environmental and biotic fluctuations, and their seeds and pollen may make critical contributions to genetic diversity. Under natural conditions, a biologically rich understory (the community of smaller plants that grows in the shade of the crowns of large trees) develops in diverse habitats in many older ponderosa forests—near clumps of big trees, in small openings

This ponderosa pine forest near Flagstaff, Arizona, photographed in 1903, is typical of the open forest structure of older ponderosa forests in the Southwest. (Northern Arizona University) [OG 15]

between clumps, and in open meadows and parks. Frequent low-intensity fire is a key element in maintaining this ecosystem.

Societal values

Societal values drive many public debates about old growth. Ecological and biodiversity concerns are secondary for many people who just don't want large, old trees to be cut down.

Surveys conducted in the **Northeast** indicate that the general public values older forests and wilderness areas and wants them maintained. Older forests of the **Southeast** offer many benefits to the people of the region beyond sustaining much of the diversity of plant and animal species. They also provide a link to the region's history through the piney woods and bottomland forests that provided resources to sustain the first European settlers. The aesthetic qualities of large "cathedral-like" stands of trees connect today's residents of the **Southeast** to their past.

Societal values drive many public debates about old growth. Ecological and biodiversity concerns are secondary for many people who just don't want large, old trees to be cut down.

Northern spotted owl fledgling in an Oregon forest. This species is an icon of old-growth conservation in the Pacific Northwest. (Dan Schafer) [OG 56]

The **Pacific Northwest** has a greater area of older forest than any other temperate-zone region on earth, and it has seen many heated policy and public debates about old growth over the past 25 years. The economic and social value of older forests in the region was clearly demonstrated when President Clinton convened a Forest Summit in 1993 to find solutions to controversies over logging old-growth timber on public lands. This summit led to the Northwest Forest Plan, designed to protect millions of acres of old growth on federal lands from logging. The high social value placed on older forests in this region grows from recognition of the recreational and aesthetic opportunities that they offer as well as their ecological importance.

Research on people's views of forests in the **Southwest** has affirmed the aesthetic value of older forests. One study concluded that many people prefer open, park-like old-growth ponderosa pine forests similar to those of pre-European settlement to denser forests with smaller trees. Another study recommended that large, mature trees should be retained in forest thinning projects because they are an important part of scenic beauty.

Carbon sequestration and other ecological services

In all five regions, healthy forests in general and older forests in particular provide many useful ecological services to society—benefits to households, communities, and economies such as maintaining clean air and water and enriching soils.

Forests play an important role in global climate change by absorbing atmospheric carbon dioxide and sequestering, or storing, carbon. Older forests contain large quantities of organic matter in living and dead trees, other vegetation, and soils and are thus larger reservoirs of sequestered carbon than younger forests. This is an ecological service that is a special attribute of older forests.

Older forests improve soil quality. As they decay, fallen trees slowly release nutrients that continually enrich soils, allowing them to support more diverse ecological communities. Some large, dead trees fall into streams, creating pools and cascades that provide favorable habitats for many aquatic plant and animal species. These logs also release nutrients into the water, help keep the stream water clean by capturing debris, and reduce the impacts of floods. Water that runs off from older forests is of high quality and is valuable for wildlife and human consumption.

CURRENT STATUS

How much older forest does each region have?

There aren't any comprehensive and compatible inventories of older forest for the five regions examined by the NCSSF-sponsored workshops, or for any other forested regions of the United States for that matter, primarily because there are no generally accepted definitions of old growth, older forest, ancient forest, or any of the other names that have been used.

Even when there is agreement on a definition, differences in methodology can produce major discrepancies in inventory results. For example, in 1991 the USDA Forest Service and the Wilderness Society released results of inventories of old-growth forests in the **Pacific Northwest** and northern California that each organization had performed. They both used a definition of old growth developed in 1986 at the USDA Forest Service Pacific Northwest Research Station. It was based on the number, age, and density of large trees per acre; the characteristics of the forest canopy (the upper layer formed by the crowns of the trees); the number of dead standing trees and fallen logs; the mix of species; and several other criteria. However, the two organizations used different remote-sensing techniques for assessing these characteristics in the forestlands that they surveyed. The Forest Service concluded that there were 4.3 million acres of old-growth forest in the study area, while the Wilderness Society reported 2.0 million acres.

There are no generally accepted definitions of old growth, older forest, ancient forest, or any of the other names that have been used.

In spite of the difficulty of assessing the amount of older forest in any of the five regions with any precision, it's possible to offer some broad generalizations about commonalities and differences among them.

It's clear that older forests are scarce and their future is precarious across the eastern United States. Less than 1 percent of forestland in the **Northeast** is considered to be old growth. Mature forests with the potential for becoming older forest in a few decades are slightly more abundant, but they are rapidly disappearing. The northern end of the region has more older forest

today than southern New England because the land was never farmed and the continuity of forest cover was never broken. However, timber harvesting currently threatens much of this remaining older forest.

The **Southeast** has even less older forest, according to a 1993 grassroots effort that culminated in the first inventory of old-growth forests in the eastern United States. This inventory identified approximately 425 old-growth sites in southeastern states, ranging from 21 in Mississippi to 67 in Florida. The total area of the identified sites comprises about 0.5 percent of the total forest area in the **Southeast**.

The percentage is even lower in the **Great Lakes** region, where no good inventories of older forests have been made, even for public lands, mainly because no consistent definitions of old-growth forests based on habitat or ecosystem type have been developed and accepted. State and federal agencies have worked for years to develop definitions, and a great deal of progress has been made within individual agencies, but the definitions aren't consistent across the region.

Given those conditions, it's not surprising that the conservation strategies that came out of the NCSSF-sponsored workshops in the **Northeast, Southeast,** and **Great Lakes** regions emphasized growing more older forests.

Older forests are more abundant in the West. As of the mid-1990s, older forest in the **Pacific Northwest** dominated by trees more than 30 inches in diameter with complex forest canopies was estimated to comprise approximately 6 percent of forestland on all ownerships in western Washington, Oregon, and northern California — 3.5 million acres out of a total of 56.8 million. If the definition is broadened to include older forest with a mix of medium- and large-diameter trees and simple as well as complex canopies, that figure increases to about 21 percent. Because of this relative abundance, forest policy in the **Pacific Northwest** has focused on protecting existing reserves and deciding how to manage them.

Logging camp south of Flagstaff, Arizona, 1904. At that time, it was considered good forest management to replace older, "decadent" trees as quickly as possible with young, "vigorous" forests. (Northern Arizona University, Cline Library, Unidentified Collection) [OG 39]

Information about the amount of old growth in the **Southwest** is sketchy, partly because there's no generally accepted definition of what constitutes old growth, but it's clear that there's not much of it. The area of old-growth ponderosa pine in the intermountain **Southwest** declined by 85 to 90 percent during the last century, mainly from logging. Less than 5 percent of ponderosa pine stands in southern Colorado and New Mexico are classified as old growth, and other parts of the Southwest also lack old trees. Old-growth conservation efforts in the Southwest are focused on how to manage older forests in frequent-fire landscapes.

In spite of the scarcity of older forests across much of our country and the many challenges that face efforts to preserve and restore them, long-term strategies are being developed in all five regions to ensure that these sanctuaries of biodiversity and providers of many other bene-

fits to our society continue to survive in spite of wildfire, fire suppression, invasive species, residential and commercial development, and other threats.

What is each region's capacity to preserve and/or restore older forest?

The optimum preservation and restoration strategy for older forests is likely to differ by regions and even localities because each region has a different mix of land ownership and because government decision-makers and the public have different goals. However, it seems safe to say that a truly comprehensive strategy will always include a mix of public and private lands and a mix of regulation and incentives.

Even in the **Northeast** and **Southeast**, where public land is relatively scarce, public lands can provide an important "backbone" of preserved older forests. Perhaps the best example of how this might work is the "Wildlands and Woodlands" plan for Massachusetts discussed in the "Conservation Tools And Strategies" section of this report.

In general, it's easier to establish long-term preservation areas and practice long-rotation forestry on public land (rotation length is the number of years between timber harvests). However, incentives should be considered to encourage private forestland owners to apply these strategies, particularly where they can be coupled with ecological services such as watershed protection and carbon sequestration. Other important elements of any old-forest strategy are public involvement that provides mutual education and information exchange among all those affected by the strategy. This should include city dwellers, as they must provide much of the political will and cash to support any strategy.

In the **Northeast** and **Southeast**, older forest strategies will depend heavily on private lands and incentive programs, with an important but relatively slight backbone of older forest on public land. In the **Great Lakes** region, where cooperative effort has a long and relatively successful history, there likely will be a mix of public and private actions. In the **Northwest** and **Southwest**, federal lands, and state forests to a lesser but important extent, will provide a robust backbone of older forests with big trees. Important contributions such as restoration of older forests in lowlands and flood plains on private land can be encouraged by carefully crafted incentives and appeals to landowners. The most important element in designing strategies will be to recognize both the dynamic nature of older forests and the extent to which regional culture and society dictate what is possible.

Public lands in the **Northeast** provide a good opportunity to preserve or restore older forest. Various public lands have diverse mandates, however, and not all of them have the same capacity. Though the 800,000-acre White Mountain National Forest has a long logging history, about 38% of the area is classified as "old." About 53% of this national forest is off limits to harvesting, and about 25% is in lower elevation forest that will become older forest and old-growth over time.

State-owned forest in Maine administered by the Bureau of Parks and Lands has a multiple-use mandate, but harvesting is much less than growth. These public lands have the capacity to extend rotation length to maintain and restore older forest. Baxter State Park in northern

Maine is mostly 60- to 80-year-old second-growth forest, but it will grow into older forest in the next several decades. Because it never went through a grazing/farming phase, the continuity of forest cover was never broken.

The willingness of state land managers to maintain older forest varies tremendously, and nearly all states lack an explicit process for conserving it (Pennsylvania is a notable exception). In summary, public lands offer the best opportunities to preserve and restore older forest in the Northeast, but there will be a near-term net loss because of trends on private lands.

The first step in a **Great Lakes** regional old growth conservation framework must be for a regional team to develop consistent definitions for old-growth forests by habitat or ecosystem type. The second step must be to inventory and assess old growth. Setting goals and management plans isn't possible without knowing what's there. Ideally, these inventories would include private lands where possible, because much old growth on private lands isn't protected. Starting with a broad-scale assessment on private lands might encourage a finer scale assessment that could help landowners recognize old-growth opportunities.

To have old growth in the future, it's necessary to identify and protect or restore older forests that are nearing old-growth conditions and to sustain a resilient forest landscape by encouraging a wide range of forest types and ages.

Assessments need to consider older forests with the potential for becoming old growth, not just forests that are in ideal old-growth condition now. Inventories and management plans that exclude stands that do not meet exact definitions of old growth will reduce resiliency to catastrophic disturbances. To have old growth in the future, it's necessary to identify and protect or restore older forests that are nearing old-growth conditions and to sustain a resilient forest landscape by encouraging a wide range of forest types and ages.

In the **Southeast**, older forests are best sustained by thinking of them as perpetual, with part of the forest being born and part dying (or being harvested) but the forest as a whole never ending. This concept allows for management, including timber harvesting, and allows stands of trees to age with time. Guidelines based on this approach have great potential for conserving older forest in the region.

Two firefighters rake litter away from an older tree to help protect it from a low-intensity prescribed burn in Northern Arizona in 2003. (Northern Arizona University) [OG 16]

Given the predominance of federal land and its occurrence in large blocks in the **Pacific Northwest**, the potential for conserving and restoring old growth in that region is relatively good. However, the story varies by forest type, and it is clear that one-size-fits-all approaches to old growth won't work.

The capacity to restore old growth in the **Southwest** depends on two factors: the ability to restore the structure and composition of the ponderosa pine ecosystem by returning fire to it (often preceded by thinning) and the ability to produce old growth from existing stock once it is thinned and exposed to

low-intensity fires. This capacity is presently buoyed by fuel-reduction efforts by the federal and state governments and local groups. Public support for forest restoration and fuel-reduction treatments in the **Southwest** is reasonably high. Residents don't support old-growth logging, but they generally accept removal of some larger trees as part of restoration and/or fuel-reduction efforts. Most of them have moved beyond the kinds of legal battles that surround old-growth forests in the Pacific Northwest and elsewhere. On the negative side, there is insufficient capacity and financial resources to restore older forests at the pace and scale needed to solve the problem.

KEY ECOLOGICAL AND SOCIETAL FACTORS AND ISSUES

The five regional workshops identified a number of key ecological and economic/social/political factors and issues that must be considered in developing an effective conservation and management strategy for older forests.

Land-use history and status

One of the most important determinants of the current state of older forests is the way that humans have used the land over past decades and centuries. Each of the five regions has a distinctive land-use history. Examining and comparing these differences can tell us a great deal about the influences that shaped today's older forests in each region as well as revealing some qualities that they share.

The history of present forest ecosystems in the **Northeast**, **Great Lakes**, and **Northwest** regions began at the end of the last ice age about 12,000 years ago. These three regions had no forests for thousands of years before that time. The **Northeast** and **Great Lakes** regions were covered by the southernmost part of the great North American ice sheet, and much of the **Northwest** had glaciers at higher elevations and barren tundra or semi-desert in the lowlands. When the glaciers retreated northward toward the Arctic and upward to higher elevations, forests gradually reclaimed the ground that they had lost to cold and aridity.

By contrast, forest ecosystems in the **Southeast** and **Southwest** are much more ancient, although at the time of the glacial retreat they were dominated by species that are now found in more northerly regions.

Human land use in all five regions began with Native Americans. Although their impacts on the natural environment were minor compared to those of later European settlers, they altered the landscape by using fire for numerous purposes, including clearing land for agriculture.

European settlement brought dramatic changes to the forests of the **Northeast.** Grazing and farming nearly deforested the region between 1750 and 1850, although most of northern Maine wasn't cleared for agriculture because of its poor soils and lingering territorial disputes with the French and British. Logging has been the primary land use in northern New England since the late 1600s, and the Adirondacks and slopes of the central Appalachian Mountains also were heavily logged.

Deforestation and agriculture peaked around 1850, then grazing and farming gradually disappeared from New England as the western U.S. frontier opened up. Much cleared land in New England reverted to forest cover in the 20th century, and the Northeast is more heavily forested today than it was in 1850.

Great Lakes forests are still recovering from the lumber era, a period of extremely rapid and intensive logging in the late 19th and early 20th centuries that largely denuded regional forest cover and degraded the quality of watersheds and fisheries. So little old growth remained after the cutover that recovery and restoration, rather than preservation, are the central challenges for **Great Lakes** older-forest management.

Stumpland and soil erosion in Wisconsin where a forest was destroyed during the lumber era by logging followed by fire. (Wisconsin Historical Society, Image ID # 3991) [OG7]

The **Great Lakes** region is now more heavily forested than at any time since the lumber era, but the forests are very different places than they once were. Less than 1% of pre-cutover old growth remains, with particularly sharp declines in hemlock, yellow birch, and white pine.

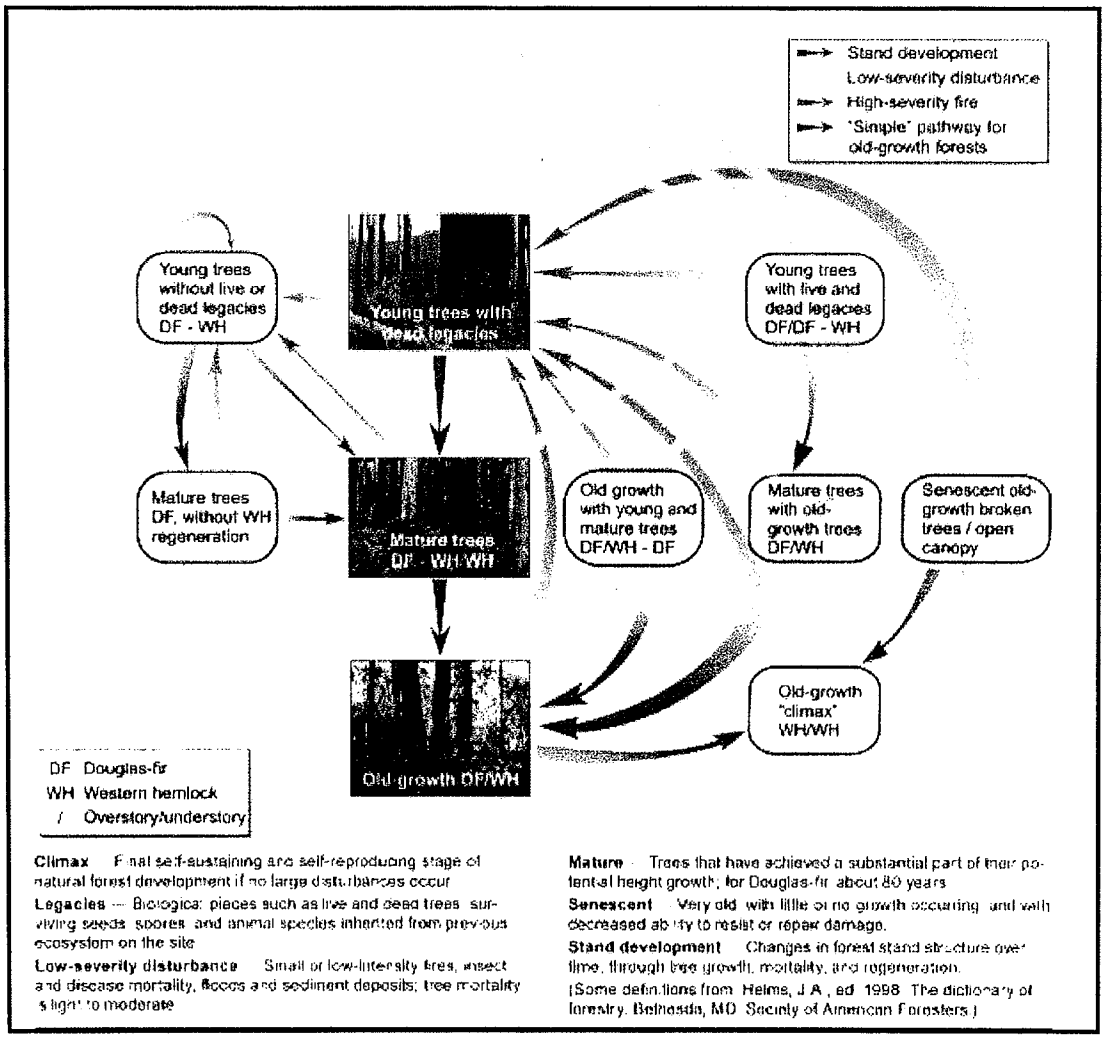
The forests of the **Southeast** have a long history of interaction with humans. Thousands of years of human activities shaped them, and they strongly influenced human societies. These biologically rich older forests provided food, shelter, and clothing for relatively large populations of Native Americans who used fire and simple tools to produce crops in the rich bottomlands for thousands of years. Europeans brought more powerful tools and used them to harvest high-quality timber and to extract naval stores such as pitch and tar from pine resin.

After the railroads came, the forest was almost completely cleared. Much of this cleared land was farmed or grazed. The first forests were harvested with little thought of re-growing them, and the long history of agricultural clearing has nearly eliminated older forests throughout the **Southeast**. While older forests are extremely rare—less than one half of one percent of the original range—isolated remnants can be found that resemble the forests that existed before European settlement. Given the rapidly changing ownership of industrial forests and the steady influx of people into the region, the southeastern states—some more than others—present opportunities for conservation through active management, preservation, and restoration of older forests.

Pacific Northwest forests have changed continually in composition and structure since the end of the last ice age. People have influenced forests over most or all of that time. For example, Native Americans set fires in the Willamette Valley in Oregon, keeping much of the valley as prairie or savanna ecosystems. Lightning fires also occurred.

Extensive fires didn't occur at an even pace. In western Oregon and Washington, extensive fire episodes occurred 8,000 to 10,000 years ago, 1,000 years ago, and 500 years ago. Many of today's old-growth Douglas-fir trees appeared after large fires burned during a period of warm, dry climate around 1400 to 1650.

In the 1880s European-American settlers cleared many old-growth forests or set wildfires that destroyed them. Scientists estimate that about half of the old-growth forests that existed in the western part of the **Pacific Northwest** at the beginning of the 20th century have since been logged. Most remaining Pacific coastal old-growth forests are on federal lands.



This diagram shows some pathways along which old-growth Douglas-fir forests developed in the Cascade Range of the Pacific Northwest. The most straightforward pathway, from young forest to old growth, is shown from top to bottom in the center. Low-severity fires, shown by yellow arrows, take a forest back to an earlier stage of forest development, although not always back to young forest. High-severity fires, shown by red arrows, take a forest back to one of two young forest types. Forest management often creates dense plantations without legacies. (Frank Vanni, USDA Forest Service) [OG 36]

Native Americans in the **Southwest** occupied and interacted with ponderosa pine ecosystems for centuries before Europeans arrived. They used ponderosa pine for building material, survival food, medicine, and ceremonies and used other plants and animals of the ecosystem in a typically sustainable manner. They also used fire to work with various aspects of the ponderosa pine system. While the extent of their burning practices remains controversial, it's clear that once Native Americans were forced onto reservations, the low-intensity fires on which the ecosystem depends decreased dramatically.

Low-intensity fires, whether ignited by lightning or by Native Americans, historically occurred at intervals ranging from 2 to 35 years in southwestern ponderosa pine ecosystems. Stand-replacing fires were rare or nonexistent, though they occurred periodically in dry forests in other parts of the **Southwest**. These fires limited the scope and severity of insect outbreaks and kept dwarf mistletoe (a parasitic plant that can cause major damage to ponderosa pines) in check by maintaining an open stand structure.

Threats

A major threat to older forests today is the view that the main task is simply to preserve those that now exist. All older forests began as young forests. Healthy forests contain groups of trees of many age classes over large areas. Thus effective protection of older forests must begin with the recognition that they are part of a long cycle and that all parts of that cycle must be protected or restored. In this section, individual categories of threats to older forests are considered, but effective older-forest protection and enhancement efforts must integrate those categories to produce and maintain older forests at a steady or increasing rate. For example, management regimes that include only short rotations will never produce older forests.

A major threat to older forests today is the view that the main task is simply to preserve those that now exist. Older forests are part of a long cycle, and all parts of that cycle must be protected or restored.

Invasive species, pests, and pathogens

Non-native invasive species are species whose introduction threatens or harms natural ecosystems, human health, economic values, or all three. They are a serious threat to older forests in all five regions.

Forest ecosystems can adapt to the slow, natural movement of species. Over the last 200 years, however, human travel between continents has increased dramatically, and people have carried plants, animals, and pathogens (microscopic organisms that cause disease) to places they would never have reached by natural dispersal. Once there, away from parasites and other ecological controls that limited their environmental and socioeconomic impacts on their home continents, some of these non-native species have become invasive.

Over the past century, invasives in the United States have impacted forest biodiversity, health, and productivity; water and soil quality; and socioeconomic values. The loss is more than $2 billion annually just in terms of forest products.

In the mid-1900s chestnut blight eliminated American chestnut as a co-dominant species in oak-hickory forests throughout the **Northeast**. Beech bark disease, introduced in the 1930s, has spread throughout the region, killing mature trees but not affecting regeneration, leaving some northern hardwood stands dominated by a beech understory. The hemlock wooly adelgid, an insect introduced from Asia in 1924, is killing eastern hemlocks throughout the eastern United States. Eastern hemlock is a common long-lived species in older forests in the region. Thus

three keystone old-growth tree species are vulnerable to these human-caused stresses. The over-abundance of deer that browse on seedlings and saplings prevents regeneration in older forests in New York and Pennsylvania, challenging efforts to maintain existing older forest. Thus a diversity of stressors is affecting older forest conservation, and they vary in different parts of the region

Exotic diseases and insects also threaten older forests in the **Great Lakes** region. They have the potential to impact all forests significantly and could seriously damage surviving and restored older forests. A multi-state approach involving regulations, research, and control may be the only way to prevent or reduce the impact of these species on native ecosystems.

A potential influx of exotic insects and diseases is one of an array of stresses on forest ecosystems in the **Great Lakes** region, including high deer populations, drier soil conditions due to European earthworms, and warming temperatures. These stresses could remove many tree species from the forests. Although scientists don't know how to predict the consequences of such multiple stresses, they are concerned that, even in the absence of climate warming, older forests could be devastated within the next 20-50 years. Just two pests—hemlock woolly adelgid and Asian long-horned beetle—could virtually destroy old-growth hemlock-hardwood forests in wilderness areas, creating an abundance of fuel and coarse woody debris. What will be left? In the short term, red maple, white spruce, balsam fir, and northern white cedar might persist if no new invasives take over. Some species may persist as seedlings and saplings (as chestnut has done in the East), but some of the more devastating invasive pests kill large saplings as well as older trees. They threaten the ecological structure and function of all regional forests, not just old growth.

Tree species in the **Great Lakes** region are at special risk because nearly all of them have close relatives (with associated pests and pathogens) in Asia and western Europe. Yet not all species present the same risk, and control efforts should focus on pests and pathogens that have the potential to devastate the forests. Although agencies are trying to shift their focus, much of the current control effort goes to species that don't present the greatest threats. Social acceptance plays a large role—for example, the public hates gypsy moths and wants them controlled, and their elected representatives in the legislature can overrule the foresters. Such social constraints affect what can be done.

Invasive species threaten to change the character and dynamics of native older forests in the **Southeast** by altering patterns of herbivory (grazing on plants), predation, habitat, competition, and disease. They also threaten the preservation and restoration of old-growth ponderosa pine in the **Southwest**.

Fragmentation and parcelization

Fragmentation occurs when large expanses of forestland are broken up into smaller forest tracts surrounded by other land uses. It often results from residential or commercial development. Parcelization refers to changes in ownership that divide large forested tracts into smaller parcels that may or may not remain contiguous forest. It often occurs when a large tract of family forest is passed on from a single owner to multiple heirs. Older forests in all five regions face both of these threats.

Development that converts forestland to non-forest uses is the primary threat to older forests in the part of the **Northeast** region outside the northernmost commercial forests. In many ways the restoration of abandoned agricultural land in the **Northeast** to older forest condition is a race against urban sprawl and development. Many old fields that would become older forest in the next couple of decades will probably succumb to development before that time. In fact, post-agricultural reforestation in the eastern United States appears to be coming to an end. Development pressure is reducing forest cover, reversing the forest-recovery trend of the last 100 years. This threat is compounded by increased parcelization as land ownership passes from one generation to the next. Thus, although the small amount of existing true old growth is protected both in the northern and southern sections of the region, the amount of older forest will decline.

Development is a major threat to older forests in the **Great Lakes** region, especially second-home development that fragments forestland into small parcels. Recreational demands are changing land use in the north, with human populations increasing in recent decades after nearly a century of decline. This is particularly serious on the valuable lakeshores, removing habitat and affecting water quality and lake ecosystems.

Gopher tortoise on Ichauway Plantation, an ecological research area in southwestern Georgia. This tortoise digs deep burrows that also provide shelter for frogs, snakes, small mammals and other species. Much of its habitat in older longleaf pine forests is threatened by urban development. (Jones Research Center) [OG 65]

Urban development is a serious threat to older forest in the **Southeast**, as this region is rapidly changing from a largely rural society to a highly urbanized one. Urban growth in the **Southeast** has generally been unconstrained by zoning or planning, resulting in highly fragmented landscapes molded by short-term economic gain rather than long-term collective value to the region. Older forests rarely win the struggle with this type of growth. Urbanization also makes forest management more difficult, bringing restrictions and regulations (on smoke from burning, for example) and elevated land prices that preclude economic forest management.

Logging has fragmented many areas of old growth in the **Pacific Northwest** in the 20th century. Recent policies have addressed this problem, but it will be many decades before that influence diminishes. For example, most of the old growth in the reserves is fragmented by 20- to 50-year-old forest plantations that cover as much as 40% of the reserve area.

Fire suppression and catastrophic wildfires

Fire has always been an important element of North American forest ecology. As noted earlier, Native Americans cleared forestland with fire in all of the regions examined by the NCSSF-sponsored workshops, and natural wildfires also played a significant role in the ecological evolution of forests.

Gifford Pinchot, the founder of the United States Forest Service, led a fire suppression movement that began in the late 1890s. The science of ecology was in its infancy, and this movement was based on the simplistic rationale that fire destroys forests and keeping fire out of forests conserves them just as keeping fire out of cornfields conserves corn. Many foresters and timber, pulp, and paper companies supported the movement. The Forest Service adopted fire

control as its principle job, and fire suppression became an important mission for other federal land-management agencies.

A lightning strike started this wildfire in Kaibab National Forest in Arizona in May 2000. (Northern Arizona University, Cline Library, The Eliot Pickett Collection) [OG 41]

But after several decades, unwelcome changes started to appear in forests and grasslands where fire had been systematically suppressed. Dangerous levels of fuel for wildfires accumulated in forests where prescribed burning had been discontinued, and the threat of catastrophic wildfires increased. Undesirable plant species began to dominate some areas. It became increasingly clear to many forest managers and policy-makers that fire is an important element of natural forest ecosystems and that its exclusion threatens their integrity.

Fire exclusion has reduced the pine and oak components of forests in the **Great Lakes** region. Fire is needed to maintain pine and oak and increase their resilience to change, but managers face serious constraints on the use of fire. Some resistance is due to lack of ecological and silvicultural understanding about the roles of fire in various forest types. Systematic experiments comparing the effects of fire on various sites could help resolve these questions. But the largest limits on fire as a tool are social and economic.

Fire suppression and high severity wildfire may be a serious threat to old growth in dry provinces of the Pacific **Northwest**. Fire suppression has transformed open stands of old-growth species such as ponderosa pine to dense stands with understories of small-diameter conifers. These dense forests in dry landscapes are susceptible to high severity wildfire that can kill old-growth pines and Douglas-firs that may have survived lower intensity fires in the past. Insect and disease outbreaks that can kill old trees may be more common in these dense stands.

Fire suppression has threatened the preservation and restoration of old-growth ponderosa pine in the **Southwest** by allowing shade- and fire-intolerant species to encroach on the ponderosa pine ecosystem, probably causing the death of old trees. Invasion by shade-tolerant species occurs at higher elevations where ponderosa pine is in transition to the mixed conifer type.

Climate change

Climate change is a threat to older forests in all five regions. Two of its most serious potential impacts may be pressure for species to migrate and an increase in the frequency and severity of large-scale weather disturbances, particularly severe storms, droughts and fires.

If the global climate warms over the next century, the environment for most existing tree species will shift northward. In the **Northeast** and **Great Lakes** regions, for example, most forest vertebrates (animals with backbones) probably will be able to move as their habitats move north because they readily disperse and only require mature (60-80 years old) or younger forest. However, species that depend on old growth, such as some lichens, mosses, fungi, and invertebrates, disperse slowly and may be at risk. One strategy for conserving biodiversity in the face of climate change could be a system of "stepping stones" and corridors of older forest that permit such slow-moving species to keep up. This is an important reason for identifying existing old growth in each region and planning to develop future old growth in strategic locations.

If the global climate warms over the next century, the environment for most existing tree species will shift northward.

Forests of the **Southeast** have been molded by hurricanes and fire. Some scientists believe that rising ocean temperatures will result in more storms or more intense storm activity. The small footprint of older forests on the southeastern landscape makes this threat more serious. Several hundred years ago, a large storm could affect only a small segment of older forest, but now a stand of older trees may be completely exposed to catastrophic storm damage.

The preservation and restoration of old-growth ponderosa pine in the **Southwest** are threatened by climate change that probably will continue to alter fire regimes, affecting the types, size, and severity of fire in ways that will bring undesirable consequences for old growth and potential old growth in many ponderosa pine forests.

Socioeconomic values

Unless enough people want older forests and have the political will to foster actions that will maintain and increase them, they will continue to decline in most regions. Thus public apathy toward older forests may constitute the most serious threat to their continuation. Data are scarce on the feelings most people have about older forests, and contact between the average citizen and older forests is decreasing with increasing urbanization. It will be important to understand people's attitudes toward older forests and to make a factual and compelling case for retaining and restoring them.

More than 70 million people live within a day's drive of the 26-million-acre Northern Forest of the **Northeast** region. However, the Northern Forest itself has a paradoxically low human population density, given its proximity to the densely populated Boston-New York City corridor. Surveys indicate that the general public in the region values forests and wilderness areas and wants them maintained; "baby boomers" born between 1946 and 1964 expressed the strongest support for wilderness. However, it's not clear *how much* the public wants older forest and wilderness areas and how it wants them distributed across the landscape.

In the **Great Lakes region,** the transformation from sustained-yield management of a few commercial tree species to the protection and management of entire ecosystems is changing many basic premises of forest management. Forest managers often fail to understand why local communities don't trust them. Many local residents fear that foresters are going to reduce access to forest resources, while urban environmental advocates believe that foresters will do just the opposite. When different groups face conflicts over resources, it can be useful for each group to see themselves as part of the same community, at odds on certain issues, but drawing from a common history and headed toward common goals. Human and ecological histories intertwine in the Great Lakes region, and both shape future management possibilities. Ecological history can be helpful for restoration, but it's not a template that tells us what to do; consensual goals must emerge from broader social conversations about the values of older forests.

Unless enough people want older forests and have the political will to foster actions that will maintain and increase them, they will continue to decline.

Older forests represent significant cultural and economic values for the **Southeast**. Older trees produce high quality wood, and the market value of timber from these forests is two to ten times that of younger trees. This economic value has resulted in extensive timber harvesting in both public and private older forests in the region.

Great horned owl on a longleaf pine, Ichauway Plantation, southwestern Georgia. Mature great horned owls have wingspans of five to six feet and move with ease through the open pine forests of the southeastern uplands. (Matt Greene) [OG 50]

As southeastern older forests decline, appreciation of their cultural and esthetic values is increasing. In the past, the rural nature of the **Southeast** linked people to forests in fundamental ways. Today, the aesthetics of these old "cathedral" stands of woods often connect people with the cultural heritage of the forests.

Older forests of the **Pacific Northwest** have many social values, ranging from timber to recreation and aesthetics. The large volume of wood in an old-growth stand makes it quite valuable. For example, one acre of old-growth timber could be worth $25,000 (assuming 50,000 board feet per acre and a market value of $500 per thousand board feet), and a single 50-acre clearcut could be worth $1.2 million. At one time, large-diameter logs commanded a premium at the mill, but now large logs are actually less in demand than small ones. Today, few mills can process logs more than 20 inches in diameter, and new technologies allow large beams to be constructed from small-diameter logs.

The social values of older forests remain high in the **Pacific Northwest**. Old growth has become an icon for the environmental movement in the that region. For many people, it symbolizes wild and awe-inspiring places that are rich in diverse life forms. It may also be perceived as an environment unaltered by humans, where nature is in a perpetual state of perfect balance. This perception isn't consistent with our increased understanding of the role of natural disturbances in old growth, especially in fire-dependent ecosystems.

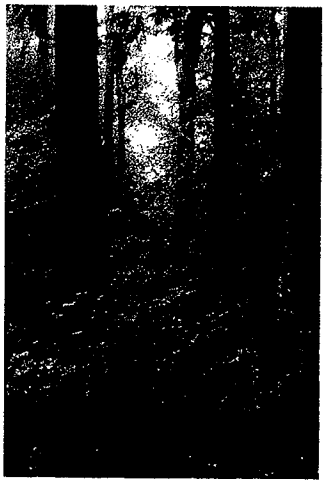
Urban development in forested ecosystems of the **Southwest** has increased risks related to fire. Many residents of the Southwest understand the ecological role of fire in frequent-fire forests but remain uncomfortable with allowing wildfires to burn.

Scenic and recreation values and expectations are often in conflict with activities such as mining and timber management.

Residents of the **Southwest** are solidly opposed to logging old growth, although they are not consistently opposed to removing some larger trees during thinning operations. They generally support mechanical thinning to reduce forest fuels and restore forest structure.

Ownership

There are striking differences in the ratio of private and public forest ownership in the three eastern regions and the two western ones. Because different owners have different attitudes toward older forests and different capacities to conserve them, it is important to know more about how owners see the role of older forests in the landscape. In general, older forests are more prevalent and tolerated on public land than on private holdings. Many private owners are motivated primarily by economic considerations and use short timber production cycles to optimize profit, reducing the potential development of older forests. However, some private owners manage forests on long rotations, and some private land harbors significant amounts of older forest.



Old-growth hemlock-hardwood forest in the 60,000-acre Porcupine Mountains Wilderness State Park, Michigan, one of the few remaining large wilderness areas in the Great Lakes region. (Craig Lorimer) [OG5]

Compared to the western United States, the **Northeast** has little public land, and private forest ownership predominates. All northeastern states have less than 15% in public ownership. Maine has the lowest percentage of public ownership (only about 6%), but the highest percentage of large (more than 5000 acres) private forests managed for timber (about 50% of the state). .

Private, non-industrial owners dominate timberland ownership in the **Great Lakes** region. In 2000, according to the USDA Forest Service, approximately 69% of the 72.8 million acres of timberland in the Minnesota, Wisconsin, Michigan, Ohio, Illinois, Indiana, and Iowa was privately owned, with 82.6% of this in private non-industrial ownership. Although most large blocks of remaining old growth are on public lands, many smaller fragments of old growth and older forest are in private hands, often with little or no protection.

The landscape of the **Southeast** is largely a matrix of predominately private land with scattered islands of public land. A large proportion of older forest is on military reservations where forest conservation has a lower priority than military missions. Thus the **Southeast** must consider how both public and private land strategies can work with some synergy.

Most remaining old growth in the **Pacific Northwest** is on federal and state lands. There is relatively little older forest on private lands, where a good economic return on investment typically is a primary management goal. Management goals for most public lands include biological diversity and recreation, making them the easiest places to develop old-growth conservation strategies. Since public lands cover more than 50% of the region, the opportunities for conserving old-growth in the region are generally good by national and global standards.

Although ponderosa pine of the **Southwest** exists in parts of southern Colorado, southern Utah, southeastern Nevada, western Texas, and northern Mexico, the best available data on ownership come from two states—New Mexico and Arizona. The USDA Forest Service oversees 1.8 million acres or 64% of all the ponderosa pine in New Mexico. Other public agencies manage

172,000 acres, and non-industrial private owners (including Native American tribes) handle 798,000 acres. The majority of this acreage, 2.4 million acres, is in non-reserved status, which means that it has not been legally removed from management for wood production.

Arizona has slightly more than 3 million acres of ponderosa pine, with slightly more than 2 million of those acres managed by the USDA Forest Service. Other public agencies oversee 122,000 acres, and private owners (including Native American tribes) manage 851,000 acres. Only 6% of the total acreage of ponderosa pine in Arizona is protected from harvesting for commercial wood production.

Climate change and the dynamics of ecosystems

Climate change has always affected the amount of older forest through its influence on fire frequency, winter hardiness, and drought tolerance. These factors have shaped the forest cycle and existing and potential older forest in each region. As human-caused climate change accelerates changes in temperature and weather, it will be particularly important to understand the effects on older forests and older forest potential. The best, though imperfect, route to this understanding is through knowledge of past climate changes and their effects.

In the **Northeast** during the last ice age, the present-day New England states were covered by ice that extended into Pennsylvania. As a consequence, forest cover in this region is relatively young geologically. Current tree species have only existed there for about 2,000 to 3,000 years, and natural forest communities have only occupied particular sites for 1,000 to 2,000 years.

Four major forest types dominate the region. They are:

- spruce-fir in northern New England and on mountaintops south along the spine of the Appalachian Mountains
- northern hardwoods (beech, yellow birch, and maple) in central New England, northern New York and upper elevations extending to West Virginia
- oak-pine in southern New England
- oak-hickory south of New England.

Despite the geological youth of northeastern forests, the dominant tree species have changed frequently since the last ice age, and the abundances and distributions of various species have fluctuated in response to natural climate change and European colonization.

Climate change has always affected the amount of older forest through its influence on fire frequency, winter hardiness, and drought tolerance

Disturbance processes at various scales control ecosystem dynamics and diversity in the **Great Lakes** region. The glaciers of the last ice age shaped the physical geography of the soils

that still serve as key templates for today's forests. The glacial history of the region means that forest communities are relatively young, having appeared only after the glaciers retreated.

Various species with very different ecological characteristics moved in one by one at different rates from different locations and directions. Whole, complete communities didn't move together; individual species migrated at rates that depended on their effectiveness in dispersing seeds, their ability to thrive in the changing post-glacial climate, and their competitive ability.

As the climate moderated about 6,000 years ago, pines and oaks moved into the region. About 3,000 years ago pine and oak began to decline on the better, moister loamy soils. Hemlock thrived in these areas and came to dominate the landscape along with yellow birch and sugar maple. Gradual climate changes probably occurred at this time, helping hemlock invade and perhaps lowering the frequency of fires, favoring hemlock over the more fire-dependent pine.

Felling white pine in Wisconsin during the lumber era. (Wisconsin Historical Society image ID # 2413) [OG 13]

Nearly all of northern Wisconsin was dominated by pine for several thousand years before hemlock arrived. From about 3,000 to 1,000 years ago, white pine and hemlock coexisted, but hemlock became dominant on loamy soils while pine, aspen, and birch remained on sandier soils. In recent history, northern Wisconsin was dominated by extensive pine forests on sandy outwash soils and hemlock and maple on heavier soils.

Growing evidence from pollen and charcoal studies shows that this general distribution of forest types in the **Great Lakes** region, with hemlock and hardwoods on the better soils and mixtures of pines with some aspen and oak on sands, generally persisted from 3,000 years ago to the period of logging and settlement of the 1800s. This makes the northern Wisconsin landscape of the mid-1800s the best available benchmark of natural processes with a fairly constant climate.

This pattern from pollen and charcoal data is corroborated by historical data describing the forest and trees. Does this provide a template for restoring the landscape? Much has changed since then. But the relative stability of the period leading up to that historical time does provide a good benchmark, indicating the general natural dynamics and ecosystems that existed prior to the industrial period and providing important information about regional potentials. Ultimately, choices of activities and management approaches for this landscape will be based on social decisions. Historical and ecological knowledge will be part of this decision-making process.

The full potential diversity of southeastern forests exists only in native older forests where a frequent-fire regime has been maintained.

Older forests of the **Southeast** are among the most biologically diverse temperate-zone forests. In addition to their richness of plant species and reptiles and amphibians, these forests are home to many rare native species. The most commonly recognized are two woodpeckers that emphatically illustrate the ecological importance of these forests. The declining population of red-cockaded woodpeckers has long been connected with the demise of old upland pine forests,

and the nearly complete liquidation of the bottomland hardwood forest was thought to be the primary factor that drove the ivory-billed woodpecker to extinction. However, recent sightings of this species reported in Louisiana and Florida provide both hope for the species and a sense of urgency for conservation.

The diversity of forests in the **Southeast** results mainly from disturbance regimes that prevailed as they evolved. Upland forests flourished on coarse-textured, low-fertility soils that encouraged development of fire-driven ecosystems. In fact, southeastern pine savannas have the most frequent fire return interval of any natural fire regime on earth. The full potential diversity of southeastern forests exists only in native older forests where a frequent-fire regime has been maintained. Hurricanes interacted with fire to create the complex forest structure of the pre-European settlement forest and the variation in bottomland forest that allowed renewal and regeneration.

Red-cockaded woodpecker, southwestern Georgia. This endangered species makes its home in open pine forests, nesting in cavities that it excavates in the trunks of mature trees. It prefers longleaf pines from 70 to 100 years old. (Richard Bryant) [OG 63]

Older forests have developed in a wide range of forest types and disturbance dynamics in the **Pacific Northwest**. For example, old-growth ponderosa pine on dry sites is characterized by relatively open understories that were maintained historically by relatively frequent low to moderate intensity fires at intervals of less than 20 years. Old growth in wetter forest types, such as western hemlock and Sitka spruce near the coast, typically has large accumulations of live and dead wood in the understories and experiences stand-replacing disturbances at intervals of one to several centuries. Forests between these extreme are subject to "mixed severity" fire regimes, with fires that range from low to high severity. Fire suppression can alter the dynamics of some of these forest types, and moderate to high severity fire may be needed to maintain a patchwork of older and younger forest stages at landscape levels. The mixed severity regimes are particularly challenging to forest managers seeking to conserve old growth. High severity fire was a natural component of these landscapes and isn't readily replaced by prescribed burning, which normally occurs at low intensity.

Ponderosa pine ecosystems in the **Southwest** merge into pinyon-juniper, chaparral mountain shrubland, or grasslands at lower elevations and into mixed conifers at higher elevations. For example, ponderosa pine is found in southern Colorado between lower-elevation grassland or pinyon-juniper and higher-elevation Douglas fir, while in southern Utah ponderosa borders shrubland or Colorado pinyon-Utah juniper woodland.

The dynamics of healthy ponderosa pine ecosystems are inextricably tied to low-intensity, patch-size fires that occur fairly regularly. There are also occasional mixed-severity fires and rare stand-replacement fires. The regular, low-intensity fires historically produced open ponderosa pine stands dominated by clumps of old, fire-resistant trees and a highly diverse understory on fine-textured, basalt-clay soils. On sites with coarse-textured soils, the forest was denser and less clumpy, although nowhere near the density of today's ponderosa pine forests in those same areas.

As described elsewhere, during the last century the ponderosa pine forests of the **Southwest** have undergone significant changes in structure, composition, fire frequency, fire intensity and severity, and overall landscape patterns. These changes have resulted in a new ecosystem dynamic in which severe fires threaten to destroy, rather than renew, the ponderosa pine ecosystem.

KNOWLEDGE GAPS AND RESEARCH NEEDS

Old-growth ponderosa pine in Winema National Forest in south-central Oregon on the dry eastern slopes of the Cascade Mountain Range. (K. Norman Johnson) [OG 54]

There have been few scientific studies of older forests outside the Pacific Northwest, and there is still much to learn even in that region. Early notions held that older forests were "decadent" and produced little of human value. It was considered good management to replace them as quickly as possible with young, "vigorous" forests. Now that pioneering research has shown that older forests have important roles to play in biodiversity, aesthetics, and carbon sequestration, as well as serving as spiritual exemplars of the majesty of nature, it's time to examine them in detail from the perspectives of all who benefit from them. We need to know more about their physiological and ecological processes and their interactions with humans. We need to know how to conserve the entire forest cycle that produces and maintains older forests. We need to know what kinds and levels of disturbance by human and natural sources older forests need and can tolerate. The most urgent research need is to get a better picture of the state and quantity of older forests in each region. The next most urgent task is to produce integrated management protocols to ameliorate the threats to older forests and to insure their continuity on the landscape.

CONSERVATION TOOLS AND STRATEGIES

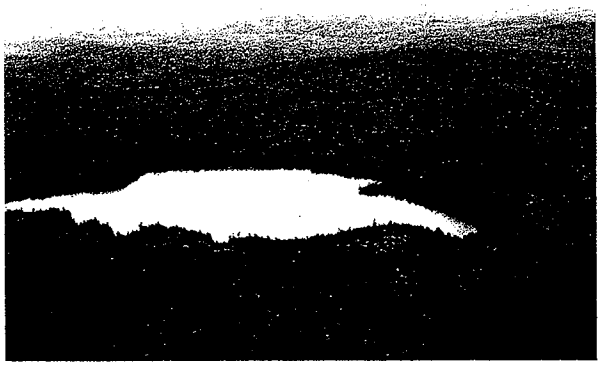
Reserves

Society's most familiar approach to forest conservation has been to set aside no-harvest reserves. Even on private commercial forestlands, forests of exceptional conservation value are sometimes set aside, but they usually represent only a fraction of a percent of the land base. Strict reserves are much more common on public lands. Reserves where a high density of older forest attributes is maintained by limited harvesting probably have the widest appeal for public and private land managers.

Forests are dynamic living organisms, and even a set-aside reserve can't preserve an older forest intact like a prehistoric fly in amber.

Set-aside reserves can be integrated with other management approaches. In the **Northeast**, an ambitious forest conservation proposal for Massachusetts is known as "Wildlands and Woodlands." It would put about 50% of Massachusetts' 5 million acres into either "wildlands"—

reserves with no harvesting—or working forest "woodlands" with sustainable harvesting. Forestry would be promoted and enhanced in the working forest areas and throughout local communities. About 10% of the 2.5 million acres in the program (about 5% of the state) would be allocated to wildlands destined to grow into older forest. This long-term vision won't become reality overnight. It will be expensive because many landowners will require fair compensation, through the purchase of no-development easements on their land, to give up their future rights to convert their forestland into some other more lucrative land use. Nevertheless, this may be the scale of vision that our society needs to achieve true forest sustainability.



The Nature Conservancy's 5,000-acre Big Reed Old-Growth Reserve in north-central Maine is the largest remnant of old-growth forest in New England, where very little old growth exists today. (John Hagan) [OG 18]

Remnant "old-growth-like" stands can still be found in Maine's commercial forests like this one. However, changes in wood markets and financial demands are causing a systematic and rapid loss of these remnants. (V. Brunelle) [OG 24]

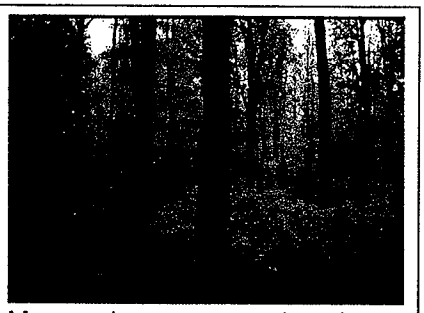
But forests are dynamic living organisms, and even a set-aside reserve can't preserve an older forest intact like a prehistoric fly in amber. In the **Pacific Northwest**, for example, where current federal policies emphasize protecting older forests, about 80% of federal land is in reserves where existing old growth is protected from logging. These forests are constantly changing, and natural disturbances, fire suppression, invasive species, insect and disease outbreaks, forest succession, and global warming will continue to bring change. Even though the forests are protected, managers face many decisions about the compatibility of changes with their long-term goals and the need to take action when undesirable ones appear.

Restoration, retention, and rotation length

In addition to reserves, potential conservation tools for older forests include restoration, retention, and rotation length. These tools are applicable primarily to lands where owners also seek some level of financial return from wood production.

Restoration provides the opportunity to promote long-lived tree species and to accelerate growth rates to produce older forest conditions sooner than they would have developed without management intervention. In most situations, restoration will cost the landowner in terms of lost revenue, as trees more than 100 years old generally are beyond the age of maximum commercial value. Moreover, promotion of large dead standing trees and fallen wood, which are more abundant in older forest, is not a typical goal for timber managers. Nevertheless, restoration is a tool

that is an option for interested forest managers, and it may be of special interest to conservation forest owners such as the Nature Conservancy and the Appalachian Mountain Club.



Managed, uneven-aged northern hardwood forest, dominated by sugar maple with some basswood and white ash, Nicolet National Forest, Wisconsin. (Craig Lorimer) [OG 8]

Retention refers to leaving some trees standing during harvesting and allowing them to mature beyond the age of maximum commercial value. They can be selected to retain older-forest features such as large trees and old trees that host particular epiphytes (plants that grow upon another plant but don't derive any nourishment from it). Retaining decadent or inferior quality trees often represents only a small opportunity cost to the landowner. Foresters and loggers must be knowledgeable about which trees make the best candidates for retention. Retention has become an increasingly popular management strategy for commercial forest landowners, but it's not clear that old trees are always being targeted for retention or that retention represents a long-term strategy for providing older-forest features on commercially managed forests.

Extending rotation length is problematic for commercial forest owners. For example, the commercial value of a tree in the **Northeast** peaks at an age of 50 to 80 years for many forest products, and older forest conditions start to emerge at 90+ years of age, depending on forest type and latitude. However, it may be realistic for some private forest managers to place part of the harvestable acreage, for example 10 percent, in a long-rotation management regime. "Rotation easements" similar to conservation easements that purchase development rights could be used to "buy" rotation length—that is, pay landowners the opportunity cost of longer rotation periods. Extending rotation length is more common on public lands where forest products represent one of many values to be sustained.

Economic incentives

Proposed strategies for protecting older forest on private lands include tax incentives and forest conservation easements (voluntary legal agreements by property owners to restrict development on their land, usually in return for financial compensation).

Another potential incentive may be forest-based carbon credits—tradable credits that represent the amount of carbon sequestered by a tract of forestland. These credits are sold to organizations such as utility companies that operate coal-burning electric-generating plants to offset the carbon dioxide emissions that they generate. Forest-based and other carbon credits are now traded independently as well as through the Chicago Climate Exchange, a voluntary but legally binding emissions-trading market. Growing forests over longer times allows them to absorb and retain more carbon, providing more potential for carbon credits. Some organizations, such as the Pacific Forest Trust, have established programs that provide revenue to private forestland owners from carbon credit sale. Larger forestland owners have sold carbon credits on the open market. In addition to finding a buyer, the seller must demonstrate that the forestland will actually sequester additional carbon and define the amount and method.

The cost of keeping timber past its maximum economic value and investing in restoration can be partly offset by the value of high-quality timber products and the potential of older forests for wildlife management and recreation. Comprehensive economic models that explicitly evaluate such tradeoffs and incentives are needed, especially for protection, restoration, and development of older forests on private land.

In the **Great Lakes** region, many of the few existing old-growth stands on public and private lands have no protection. The region has so few stands with trees more than 120 years old that many people feel that all of them should be protected without question, on private as well as public lands. Mature stands that are nearly old growth also deserve protection. The next step after protecting existing stands of older forest should be to select second-growth areas that can be managed for extended rotation in even-aged forest or older cohorts (groups of trees of similar age) in multi-aged forest. In many of these stands, thinning and fire may hasten the development of older forest characteristics. The percentage of the forest that is managed for extended rotation needs to be determined by a public process with scientific input. Active restoration is useful and necessary for restoring old growth conditions faster on certain sites, but simulations suggest that such efforts should be focused on even-aged stands, uneven-aged stands with few large trees, or former plantations. Heavy thinning may actually delay the onset of old-growth structure in older uneven-aged stands with numerous legacy trees (old trees that have been spared during harvest or have survived stand-replacing natural disturbances).

In the **Southwest**, ecological restoration appears to be the best strategy for conserving old-growth forests. It aims to restore forest structure, processes, and composition within their natural range of variability. The basic strategy is first to facilitate the partial recovery of the ecosystem structure through thinning and then to return the key ecosystem process—low-intensity fire—to set the stage for more natural rates of decomposition, nutrient cycling, and net primary productivity while at the same time helping to reestablish the system's plant and animal communities. In some cases it may be necessary to reseed or transplant missing plant species, rake around old trees before burning to prevent damage, control invasive plants, and defer or regulate grazing. Monitoring is required to make sure that the restoration is meeting the project's goals and objectives. It will be important to interact with people who are affected by the restoration.

DETERRENTS AND OBSTACLES

Lack of national and regional policy

The **Northeast** could benefit from comprehensive, integrated national, regional, and state policies that help inform the general public and private landowners about the value of older forest and that support voluntary approaches to older forest conservation. Such integration is lacking at present.

In the **Great Lakes** region, a lack of national and regional policy is a challenge to achieving a coherent conservation framework for older forests. Public agencies need to recognize that they have a unique opportunity to provide leadership in managing old growth, managing older forests on public lands, and demonstrating silvicultural techniques. States and other public entities have a lot of experience to share about old growth, but state and county jurisdictional

boundaries limit the opportunity to facilitate regional discussions. Public agencies must work with private forest landowners to encourage regional old-growth restoration and conservation.

The **Southeast** needs policies that recognize regional benefits of older forests and encourage conservation to maximize those benefits. Although public agencies have subsidized reforestation of cutover private land in the Southeast for many years, there has been little or no effort to help private landowners sustain older forests. Policymakers must consider economic tradeoffs as they develop strategies for conserving older forests.

The **Pacific Northwest** currently has no national or regional policy that protects all of the current old growth and produces sustainable levels of timber to support the economies of local communities. The Northwest Forest Plan allows cutting of old growth, but relatively little has been cut since the Plan was implemented. Consequently, timber production has been well below expected levels, and much timber is currently produced from thinning in plantations, not from cutting older forest. Once these plantations become too old (80 yrs) in about 30 years, the level of timber production will fall unless some older forest is cut or another strategy is used that meets the multiple demands on the federal forests more effectively.

National and regional policies are in place to support restoration of the ponderosa pine ecosystem of the **Southwest**, but they haven't been tested, and they exist in a context of previous policies, decisions, and agency cultural traditions. The obstacles are the implementation and monitoring of projects. To address what it perceived as environmental review processes that slow and obstruct action, Congress and the agencies have changed the environmental review processes. Congressional hearings in the summer of 2006 revealed that those authorities are just beginning to be applied, and it is unclear how well the changes have achieved their objectives of reducing appeals and accelerating action. Congress should monitor application of the environmental review process to see if the anticipated goals are being achieved. Congress should provide funding for public outreach and planning to rebuild trust in federal agencies by interest groups.

Lack of social agreement

This 150-year-old sugar maple in western Maine is covered with mosses and lichens that are typical of old forests, although it's in a stand that isn't considered to be old growth because of its harvest history. (John Hagan) [OG 27]

In the **Northeast**, a major challenge is how to balance public values associated with older forests across a region with such a diverse land-use history and ownership pattern. A question that hasn't been answered or even proposed is whether, as a society, the people of the region want older forest relegated only to public lands, or whether they want private forest owners to help keep it well distributed throughout the region. As things stand now, they can expect to look increasingly to public lands for maintaining older forest and are relying on a few progressive private landowners willing to make modest financial sacrifices to contribute to the public good. Other landowners may follow suit if they see that such strategies are economically feasible, but for this to happen, there must be a

strong consensus across society that it's important.

In the **Great Lakes** region, the need to reintroduce fire into forests provides a good example of the need for social agreement. Reintroduction of fire is necessary to maintain pine and oak forests and help make those forests more resilient to change. Yet managers face severe constraints on the use of fire as a tool. Some of this is due to lack of ecological and silvicultural understanding about the roles of fire in various forest types, but lack of public acceptance is a serious constraint.

Many people have a deeply ingrained conviction that forest fires are always a bad thing, and some fear that they may get out of control and destroy houses and other property. These beliefs have a historical basis in the **Great Lakes** region, where the worst recorded wildfire in U.S. history, the Peshtigo fire of 1871, consumed 1,800 square miles of forest, destroyed twelve towns, and killed an estimated 1,500 people in Michigan and Wisconsin.

Many people have a deeply ingrained conviction that forest fires are always a bad thing. There must be social agreement about the value of fire as a forest management tool before it can be used effectively.

In the **Southeast**, apathy is first and foremost among many obstacles that stand in the way of conserving older forests. For society to commit to conserving older forests, the public must recognize and agree that they have value. But as older forests have declined in the region, fewer people understand what they are and why they are valuable. Because the southeastern landscape is so highly fragmented and there is so little public land, conservation of older forests from a regional or landscape perspective will require multi-ownership cooperation and coordination. Managers of public and private lands must develop synergistic approaches that integrate the small remaining remnants of older forests with younger forests that surround them and stands that have some older forest. This kind of comprehensive and integrated effort will require a level of social agreement that doesn't exist in the region today.

The **Pacific Northwest** is relatively rich in older forests, but there are opportunities for improvement. On federal lands, they could include:

- protecting all remaining old growth
- increasing efforts to reduce risk of loss of remaining old growth from fire
- increasing the area of forests treated to restore old-growth structures and processes; developing more effective long-term strategies to provide for old growth as well as other forest types and forest values, i.e. more sustainable approaches.

On state lands, improvements could include developing old-growth conservation goals and strategies. On private lands, they could involve protecting or restoring old-growth types that aren't well represented on public lands, such as oak woodlands, and developing management strategies that include long rotations or higher retention levels of older forest elements.

A serious barrier to these improvements is lack of social agreement on how much old growth is desirable and where it should occur. Landowners in the **Pacific Northwest** have very

diverse goals and, given the predominance of federal lands, it's not clear how much they should contribute to old growth conservation.

Related social barriers include:

- lack of understanding of what's needed to maintain and restore old-growth diversity and processes in disturbance-prone landscapes that limits the willingness of the public and some managers to develop more effective long-term strategies
- lack of trust in agencies that seek to manage actively in new ways to meet diverse goals
- lack of public dialogue because debates often haven't been civil nor really designed to reach agreement on how to manage forests.

A member of a fire crew sets ground fuels afire during a prescribed fire in the Coconino National Forest in Arizona in 2001. (Northern Arizona University, Cline Library, The Eliot Pickett Collection) [OG 40]

In the **Southwest**, hands-off preservationist strategies that originated in the 1960s were effective when logging was the biggest threat to old growth in frequent-fire forests. However, this isn't an effective approach to conserving older forests today—active restoration is needed. Agreement must be reached about such key questions as whether such active restoration will involve a one-time intervention or repetition over prescribed time frames and whether wildfire will be allowed to burn or prescribed burning will be used. This will require social agreement.

Public understanding of issues and proposed solutions is a necessary prerequisite for social agreement. A definition of old growth in the frequent-fire ecosystems of the **Southwest** is critical to such an understanding. Attempts to transfer definitions developed from experience with the lush forests of the **Pacific Northwest** to the semiarid ponderosa forests of the **Southwest** have confused forest managers, policymakers, and the public. This confusion must be dispelled to achieve the kind of social agreement that is needed for effective conservation and restoration of the region's older forests.

WHAT IS THE FUTURE OF OLDER FORESTS?

The NCSSF-sponsored workshops clearly demonstrated that older forests are scarce in the United States. The **Pacific Northwest** is the region with the most preserved older forests, but even there the area is less than adequate by biodiversity criteria. If the nation is serious about preserving biodiversity, older forest area must be increased. Such efforts must begin with the existing base of older forests, but it ultimately will be necessary to go well beyond this base to effectively meet biodiversity and human values goals. In every region, the full forest growth and development cycle needs to be integrated into old-growth restoration plans.

Fire and its management will play an important role in the preservation and creation of older forests.

Each region is different, and there are major differences among and within them about the most useful definition of older forests, the major threats to existing older forests, public perceptions of what is important about them, and land ownership and use patterns. Thus restoration plans for older forests must be intensely local in construction and effect. But they must also create bridges among landowners and publics to establish an effective pattern of older forests on the landscape. Even in the **Pacific Northwest**, low-elevation and flood-plain older forests are extremely rare.

Fire and its management will play an important role in the preservation and creation of older forests. In the **Southeast**, the ability of forest managers to continue to use fire in spite of air-quality regulations is crucial to reestablishing old longleaf pine stands. In the dry west, the ability to harvest trees to "fire-proof" remaining old ponderosa pine forests is critical. The larger picture that emerges from the NCSSF-sponsored workshops is that creativity and flexibility, not rigid rules, will be the path to increasing older forests.

Prescribed burn in a stand of longleaf pine in southwestern Georgia. The longleaf pine ecosystem depends on frequent fire for sustainability and forest health. (Jones Research Center) [OG 44}

The role of urban populations in the older forest drama will become even more important as city dwellers continue to move into the country and as their political sway over rural areas grows with increasing urbanization. Unless city dwellers view older forests as a high conservation priority, it will be difficult to make progress. The relatively static view that many urban people have of forests and the countryside in general will have to give way to a more dynamic sense of how forests grow and exist. Clearly, preserving all the older forests of the **Northeast** and **Great Lakes** regions by buying them and creating reserves, even if that were possible, wouldn't meet the biodiversity need for older forests in the region.

Older forests are an important part of the "evolutionary anvil" upon which biodiversity is hammered out by natural selection. If we drive species to extinction through our artificial, often unwitting human-imposed selection processes, we will be harming the biological potential of the land far more than by the removal of individual species. We will be striking a devastating blow to the wellspring of our biological and social future.

We must have a coherent national forest policy that takes into account what we now know about older forests. We still lack the information to produce a clear, quantitative picture of the benefits of preserving and enhancing older forests. Creating this picture should be a primary goal of renewed forest policy action. As the NCSSF workshops made clear, we have a knowledge base as a starting point, but it's urgent to move forward now, before urbanization, climate change, new pathogens, and fire rob us of our priceless legacy of older forests.