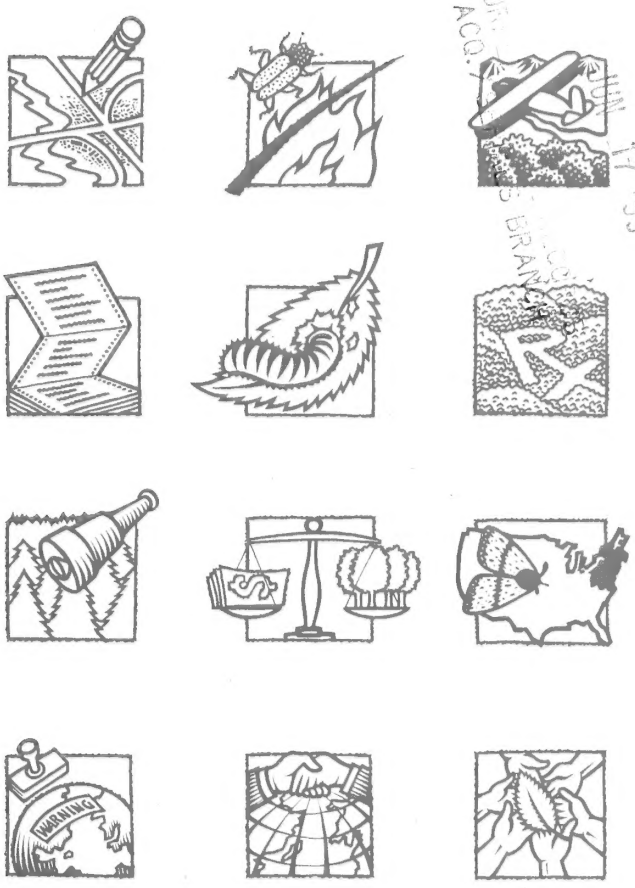
HEALTHY FORESTS FOR AMERICA'S FUTURE

A Strategic Plan



United States
Department of
Agriculture

Forest Service

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A land ethic, then, reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity.

In general, the trend of the evidence indicates that in land, just as in the human body, the symptoms may lie in one organ and the cause in another. The practices we now call conservation are, to a large extent, local alleviations of biotic pain. They are necessary but they must not be confused with cures. The art of land doctoring is being practiced with vigor, but the science of land health is yet to be born.

Aldo Leopold, in "Sand County Almanac and Sketches Here and There," 1949

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EXECUTIVE SUMMARY

Purpose

THIS PLAN SETS FORTH THE USDA FOREST SERVICE'S STRATEGIC GOALS TO PROTECT THE HEALTH OF AMERICA'S FORESTS. IT UPDATES AND SUPERSEDES THE 1988 PLAN ENTITLED *FOREST HEALTH THROUGH SILVICULTURE AND INTEGRATED PEST MANAGEMENT—A STRATEGIC PLAN.*

THIS PLAN WILL FURTHER STRENGTHEN FOREST SERVICE POLICIES AND DIRECTION FOR RESPONDING TO FOREST HEALTH PROBLEMS. OF MAJOR CONCERN ARE THE FORESTS IN WHICH ECOLOGICAL CONDITIONS HAVE BEEN ALTERED, RESULTING IN INCREASED SUSCEPTIBILITY TO DROUGHT, PEST EPIDEMICS, AND WILDFIRE. OTHER IMPORTANT CONCERNS ARE INTRODUCED FOREST PESTS AND FOREST PEST AND WILDFIRE PROBLEMS IN THE URBAN–WILDLAND INTERFACE.

Discussion

During the past few years, pest epidemics and wildfire have increased, particularly in western forests that have been altered over several decades by past harvesting practices, successful fire control, and other factors. Other areas in the West with the same conditions are susceptible to damage. In the East, the southern pine beetle, European gypsy moth, and hardwood declines continue to be damaging. Introduced pests have become an increasing concern. Three new introduced forest pests were discovered in North America in the past 2 years. Some challenging forest health problems are occurring in the urban–wildland interface.

This plan, like the 1988 plan, responds to concerns of members of Congress. Several congressional hearings were held in 1992 on forest health or related issues. During the hearings, members of Congress asked how the forests recently damaged by drought, pest epidemics, and wildfires will be restored and how similar damage will be prevented elsewhere.

The strategic goals and actions in this plan support the new emphasis on ecosystem management in the National Forest System. On national forests, forest health is integrated with other ecosystem management considerations through the Forest Service's formal land management planning process. In this 1993 plan, a desired state of forest health is a condition where biotic and abiotic influences on the forest (that is, pests, silvicultural treatments, harvesting practices) do not threaten resource management objectives now or in the future.

The Forest Service provides assistance to the States for forest fire control, forest management, and forest health protection. The strategic goals and actions in this plan will help strengthen Forest Service cooperative programs and provide for better coordination and assistance on forest health problems.

This plan outlines procedural actions that will lead to better integration of forest health considerations into agency planning and decision making. It does not establish resource management policy, goals, or objectives, or make resource management decisions. Other concerns closely related to forest health, for example, in protection of grasslands or wetlands, are not addressed in this plan. These concerns are either being addressed through existing policies or require separate analysis.

Strategic Goals

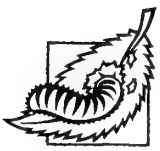
Twelve strategic goals are identified: four are new and eight are restatements and continuations from the original plan, with new actions added.

PLANNING
The ecological significance of pests and wildfire is considered in all forest resource management planning processes.

PREVENTION
Susceptibility to pests is decreased by applying available forest management options.

SUPPRESSION
Pest suppression and fire control options and funding are available to meet resource management objectives.

ENVIRONMENTAL ANALYSIS
Program-level National Environmental Policy Act documents are available prior to outbreaks of major pests.



PESTICIDES
Environmentally acceptable pesticides are available to protect forest values and achieve resource management objectives.

FOREST PROTECTION TECHNOLOGY
Effective, economical, and environmentally acceptable forest protection technologies are available to meet forest resource management objectives.

FOREST HEALTH MONITORING
A Forest Health Monitoring Program is eventually established nationwide, and provides information on forest condition and trends for formulation of national policy.

FOREST HEALTH RESTORATION
Those forests that have suffered recent severe mortality from drought, pests, and wildfire are eventually restored to sustainable and productive condition, and other forests highly susceptible to this same kind of event are treated to avert similar damage.

MANAGEMENT OF INTRODUCED FOREST PESTS
Plans and capabilities exist to limit spread or eradicate newly introduced forest pests, and to minimize ecosystem disruption from pests that have already been introduced or may be introduced in the future.

EXCLUSION OF EXOTIC FOREST PESTS
Plans and policies are developed and applied to prevent additional forest pest introductions into the United States.

INTERNATIONAL COOPERATION IN FOREST HEALTH PROTECTION
Forest health protection is recognized as a problem requiring international cooperation, common interests are identified with other countries, and long-term relationships are developed to maintain and protect forest health worldwide.

PUBLIC INVOLVEMENT
The public is informed about current forest health conditions and the role of pests and wildfire in forest ecosystems, and accepts and supports measures needed to restore and protect forests.

Implementation

Actions in this plan will be carried out by the Forest Service. The participation of several Washington Office staffs will be needed. Where appropriate, actions will be carried out in partnership with other agencies.

Year 1909

INTRODUCTION

Purpose

This plan sets forth the Forest Service's strategic goals to protect the health of America's forests. It updates and supersedes the 1988 plan entitled *Forest Health Through Silviculture and Integrated Pest Management—A Strategic Plan.*

This current plan will further strengthen Forest Service policies and direction for responding to forest health problems. Of major concern are the forests in which ecological conditions have been altered resulting in increased susceptibility to drought, pest epidemics, and wildfire. Other significant concerns are introduced forest pests, and forest pest and wildfire problems in the urban–wildland interface.

This plan also represents the Forest Service response to congressional and public interest in forest health, incorporates new Forest Service emphasis on ecosystem management and an expanded international forestry role, and renews the longstanding Forest Service commitment to protect and restore forest health.

Background

Like the 1988 plan, this plan was developed in part because of congressional concern about the health of forests. During the 1987 congressional appropriations hearings, members of Congress were concerned about gypsy moth, southern pine beetle, western spruce budworm, mountain pine beetle, root diseases, and atmospheric deposition. Questions were raised about whether a proper balance was being maintained between short-term commodity-oriented pest suppression projects and long-term investments in prevention and research.

In 1990, due to congressional interest, the Cooperative Forestry Assistance Act of 1978 was amended to strengthen Forest Service programs concerned with forest health. The authorizing section in the act for the Forest Health Protection program was amended specifically to include forest health monitoring, technology development, and promotion of management measures to protect forest health. Protection of the health of forests and trees was also authorized as part of the new Forest Stewardship and Urban and Community Forestry Assistance Programs.

In the last few years, damage due to drought, pest epidemics, and wildfire has increased in some forest areas, particularly in the

West. The major problem areas in the West are in California, Idaho, Nevada, Oregon, and Washington. Damage has been greatest in overstocked and overmature stands and in stands where past harvesting practices and successful fire control have encouraged the growth of tree species susceptible to pests, drought, and fire. In the East, southern pine beetle, gypsy moth, and hardwood declines continued as concerns.

Because of the several forest health problems, particularly in the West, Congress held five hearings during 1992 on forest health and related issues. Questions were asked about how forests that are already damaged will be restored and how similar damage will be prevented elsewhere.

One of the areas frequently discussed during the hearings was the Blue Mountains of Northeastern Oregon and Southeastern Washington. Epidemic insect infestations and several consecutive years of drought have combined to cause serious damage to the forests of the Blue Mountains. Factors that contributed to the problem include past harvesting practices and successful fire control that altered the species composition of the forests. In 1992, the Forest Service began a new initiative in the Blue Mountains to mitigate the damage and begin restoring the forests to a healthy

Combined effects of drought and pests caused extensive defoliation and death of Douglas-fir and true firs in areas of the Blue Mountains of Oregon.

condition. Measures being used include thinning, prescribed fire, salvage of dead trees, increased preparedness for suppression of wildfire, and suppression of major pest outbreaks. Research and development have been accelerated in support of the restoration effort. Thousands of acres in the Blue Mountains and elsewhere are affected and even more disturbing are the other areas in the Intermountain West that are rapidly developing similar unhealthy conditions. Plans to expand the initiative to address these other areas are being considered during the fiscal year 1994 and 1995 Forest Service budget processes. A long-term protection, prevention, and restoration effort will be required.

Concerns about the introduction and establishment of exotic pests have increased, starting in 1990 with an industry proposal to import larch logs from Russia. A pest risk analysis done by the Forest Service for the USDA Animal and Plant Health Inspection Service (APHIS) showed that potential damage could occur from introduction of forest pests from Russia, leading to regulatory action by APHIS. Meanwhile, three new exotic forest pests (unrelated to log shipments) were detected in 1991 and 1992: the Asian gypsy moth, common European pine shoot beetle, and Eurasian poplar leaf rust. Previously introduced exotic pests such as the European gypsy moth and white pine blister rust continue to spread and cause damage to new forest areas of the United States.

Scope

This plan responds to forest health concerns that require national emphasis and strengthening of program policies or direction. Concerns emphasized in this plan are forests where ecological conditions have been altered resulting in increased susceptibility to drought, pests, and wildfire; problems with introduced forest pests; and forest pest and wildfire problems in the urban–wildland interface. Concerns closely related to forest health, for example, those related to protection of grasslands and wetlands, are not addressed in this plan. These other concerns will require separate analysis.

This plan outlines procedural actions that will lead to better integration of forest health into agency planning and decision making. It does not establish resource management policy, goals, or objectives, or make resource management decisions. It does not take the place of regional programs, plans, or policies, or land

management and stewardship plans. In the Forest Service, National Forest System field units are responsible for establishing resource management objectives for the lands they administer. National Environmental Policy Act and National Forest Management Act requirements will be met as appropriate at the level where resource decisions are made. Private landowners and State land management agencies each develop their own policies and objectives, set their own management objectives, and determine the management and protection actions they will take to meet their objectives.

Many of the actions in this plan will benefit the States and private landowners. States, local governments, individuals, and forest industry own 519 million acres or 71 percent of the 731 million acres of forest in the United States. The Forest Service provides assistance to the States for forest fire control, forest management, and forest health protection. This plan will help strengthen Forest Service cooperative programs and provide for better coordination and assistance on forest health problems. States or private landowners will not be required to implement actions in this plan.

This plan continues the emphasis in the 1988 plan on strengthening integrated pest management and providing environmentally acceptable, biologically sound, and economically efficient pest management systems. Actions taken under this plan will, for example, improve understanding of the positive and negative effects of pests in forests, assess possible negative impacts of management actions on organisms other than pests, and lead to new alternative pest management methods.

Forest Health and Ecosystem Management

For this plan, a desired state of forest health is a condition where biotic and abiotic influences on the forest (for example, pests, atmospheric deposition, silvicultural treatments, and harvesting practices) do not threaten resource management objectives now or in the future. This description links forest health to the formal land management planning process for the National Forest System. Likewise, this description of forest health would also reflect a private landowner's resource management objectives. Furthermore, this description of forest health recognizes that human influence on forests is, to some degree, inevitable. Resource management objectives do not necessarily mean

commercial products; objectives reflect the many uses and values of forests, including recreation, wildlife, wilderness, timber, grazing, and water. A desired state of health does not necessarily imply that the forest can or should be totally free of damaging pests or dead and dying trees at all times.

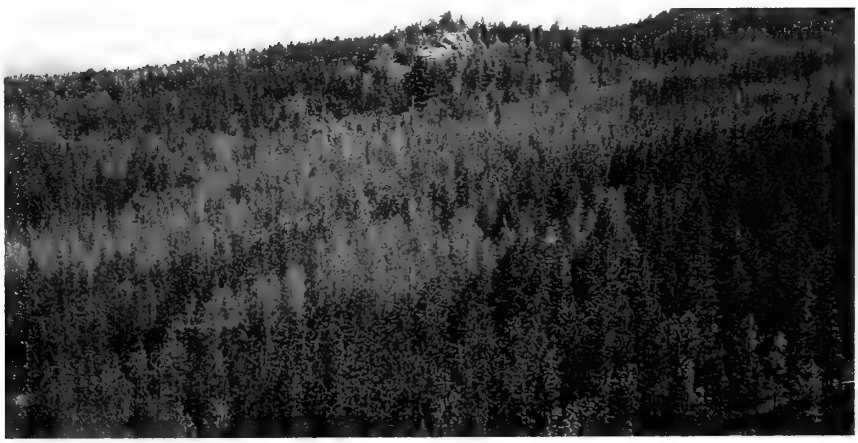
The National Forest Management Act requires that a management plan be developed for each unit of the National Forest System. Through the land management planning process, resource management objectives are set that reflect the capacity of the land and desired future conditions. Forest plans are subject to changes in implementation schedules and to periodic amendment and revision. This process provides forest supervisors with the opportunity to change implementation of the forest plan in response to monitoring of forest ecosystems; to examine alternatives and tradeoffs through amendment or revision; to address emerging forest health issues; and to consider the long-range forest health implications of management alternatives.

Recent, unusually severe pest epidemics and wildfires in some forests have been associated with objectives or practices applied over the past several decades that did not fully consider ecological processes or ecosystem limitations. For this reason, Monnig and Byler (1992) have recommended that criteria for judging forest health focus not only on management objectives, but also on ecosystem function and patterns of change. Monnig and Byler summarize criteria for judging forest health based on ecosystem function by the statements that "a forest in good health is a fully functioning community of plants and animals and their physical environment," and "a healthy forest is an ecosystem in balance." They also suggest using patterns and rates of change compared to historical patterns as criteria for judging forest health. This approach recognizes the link between forest health and forest succession, a link that was recognized by Leopold (1949) in his statement that "health is the capacity of the land for self-renewal." In suggesting the use of multiple, complementary criteria for judging forest health, Monnig and Byler emphasize the importance of setting management objectives that reflect ecosystem limitations. Richard Wilson has stated that "in the broadest sense, a healthy forest is a description of a productive, resilient, and diverse forest ecosystem; a forest with a future" (Wilson 1991). These several definitions or criteria are useful in the continued integration of forest health along with other ecosystem management considerations into the Forest Service's formal land management planning process.

Pests are almost always present and remain at endemic levels until forest, weather or other factors are right for development of epidemics. When epidemics do occur, management objectives can be threatened. Some of the most important forest pests native to North America include bark beetles (for example, mountain pine beetle, western pine beetle, and southern pine beetle), defoliators (for example, Douglas-fir tussock moth and western spruce budworm), the dwarf mistletoes (for example, lodgepole pine dwarf mistletoe and Douglas-fir dwarf mistletoe), rust pathogens (for example, the fungi that cause fusiform rust and western gall rust), and root pathogens (for example, the fungi that cause armillaria root disease, laminated root rot, and annosus root disease). Important introduced pests include the European gypsy moth and balsam woolly adelgid, and the fungi that cause chestnut blight, white pine blister rust, Dutch elm disease, and dogwood anthracnose. Abiotic factors such as poor soil conditions, flooding, and air pollution also cause tree diseases. In one of the most notable examples, Jeffrey and ponderosa pines in the San Bernardino and San Gabriel mountains near Los Angeles have shown ozone injury since the 1960's (Miller 1973), and many of these ozone-injured trees have died due to drought or bark beetle attack (Cobb and Stark 1970).

Ecosystem management on the national forests in part involves applying our understanding of the historical roles of wildfire and native pests in ecosystems. Wildfire and native pests have been significant factors in ecosystems. For example, Heinselman (1978) states that the presettlement forests of northern North

Forests in the Bear Mountain Basin (South Dakota) are infested with mountain pine beetle.



America were strongly fire dependent. Harvey (1985) states that certain budworms (*Choristoneura* spp.) have been a part of the ecology of spruce-fir and pine forests of North America for centuries, suggesting that outbreaks are a part of the natural condition. Historical records and research show that outbreaks of spruce budworm have occurred over the past 200 to 300 years at many locations (Blais 1985, Fleming 1985). Several bark beetles play a major role in forest ecosystems.

The ecological roles of the more aggressive bark beetles are associated with disturbances (drought, windthrow, etc.) and conditions of the host trees. Populations of these beetles can increase very rapidly and develop into widespread outbreaks (Berryman 1982) covering very large areas, particularly where large stands of even-aged host trees are involved, for example, mountain pine beetle in lodgepole pine. Outbreaks of the southern pine beetle were recorded as early as the 1750's (Nettleton 1988). Dwarf mistletoes, the most damaging disease agents of conifers in many parts of the West, have evolved along with their hosts over thousands of years (Hawksworth and Weins 1972). Decline diseases of hardwoods in the East have an extensive history (Houston 1987, Millers et al. 1989).

Epidemics of some native pests are now exceeding historic levels, largely due to past management activities that created forest conditions favoring pests. Management activities that have led to increased epidemics were discussed in the 1988 Forest Health Strategic Plan:

Management activities influencing forest pest outbreaks include activities that, by design or accident, produce forest conditions favorable to survival or growth of forest pests. There are many examples of management activities on forested lands of the United States that are responsible for some of the more destructive pest outbreaks. Specific examples that frequently occurred in the past include off-site planting; harvest schedules beyond the entomological or pathological rotations for the species and area; planting susceptible varieties (or relying on natural vegetation) in areas of known disease occurrence; increasing stand densities; planting or encouraging the natural establishment of extensive monocultures; failure to remove infested overstory trees during harvest; and failure to provide a cultural substitute for the mosiac-creating effects of fire. Stand management plans that do not address potential pest problems set up conditions for pest outbreaks . . . Silvicultural practices that manipulate vegetation in such a way as to maintain the vigor of the forest could play a major role in achieving healthy forests. Sound management practices can greatly reduce a forest's susceptibility to insects and diseases.


Year 1927

Although many of America's forests are healthy, there are forests where long-term forest health is threatened and management objectives may not be met. Of major concern are forests where ecological conditions have been altered resulting in increased susceptibility to drought, pest epidemics, and wildfire. Other important concerns are introduced forest pests and forest pest and wildfire problems in the urban–wildland interface. The forest health concerns used as examples in this plan represent the major concerns that require national emphasis at this time. The forest cover types in the examples that follow are only a few of the cover types in the United States. Eyre (1980) identifies 144 forest cover types in the United States, 89 in the East and 55 in the West. Forest health problems can vary between and within forest cover types.

Altered Ecological Conditions

Forest health problems of greatest immediate concern are in ecosystems where conditions have been most altered over the past several decades by management practices and successful fire control. The most dramatic changes are in the short-interval fire-adapted ecosystems containing mainly long-needled pines. In the West, these are primarily the interior ponderosa pine and western white pine types and in the South the longleaf–slash and loblolly–shortleaf types. Problems also exist in the long-interval fire-adapted ecosystems, for example, the lodgepole pine type in the interior West and the Pacific Douglas-fir type in Oregon and Washington.

INTERIOR PONDEROSA PINE TYPE

In the Blue Mountains of Oregon and Washington (and elsewhere) past harvesting practices, fire control, and lack of thinning have favored reproduction and growth of true firs and Douglas-fir—species that are particularly susceptible to drought and pests on these sites (Monnig and Byler 1992, Wickman 1992). In the past, periodic low-intensity wildfires kept these species in check while sparing the fire-adapted ponderosa pine and larch (Mutch 1992). Fire control has been highly successful, and harvesting has removed much of the ponderosa pine. The resulting altered ecological conditions have contributed to recent serious forest health problems in the Blue Mountains as true firs and Douglas-fir are damaged and killed by drought, western spruce budworm, Douglas-fir tussock moth, Douglas-fir beetle,

fir engraver, spruce beetle, and root diseases. Fire problems have increased due to the many dead trees. The probability of high-intensity catastrophic fires, which would be extremely difficult to prevent or control, has greatly increased. Increased wildfire suppression costs have occurred and will likely continue, and suppression of western spruce budworm outbreaks has been necessary in some high-value areas.

In this forest type, as well as many other forest types in the West, past harvesting practices and successful fire control have also led to increased dwarf mistletoe problems. Harvesting practices that left infected trees have led to perpetuation and intensification of this disease problem (Hawksworth 1958 and 1961). Wildfires were a primary factor in determining the abundance and intensity of the dwarf mistletoes and tended to keep them in check. With successful fire control, the area affected and intensity of infection have increased (Alexander and Hawksworth 1975).

Many younger ponderosa pine stands in Oregon, Idaho, and elsewhere are overstocked and susceptible to drought and bark beetles. Many of these stands have been badly damaged during the recent drought.

WESTERN WHITE PINE TYPE

White pine blister rust, an introduced disease, has destroyed much of the valuable western white pine resource. In many places, western white pine has been replaced with true firs and Douglas-fir, which are susceptible to drought, pests, and wildfire (Monnig and Byler 1992). Serious root disease problems are occurring in many of the areas where true firs and Douglas-fir replaced western white pine, and these problems are expected to continue.

LODGEPOLE PINE TYPE

Some lodgepole pine is dependent on fires to heat and open its cones so that seeds are released. Historically, mountain pine beetle outbreaks were followed by large high-intensity wildfires that released the seeds to start a new stand. In recent decades, large areas of the lodgepole pine type reached a size and condition vulnerable to the mountain pine beetle and were attacked and killed. Because of fire control, lodgepole has had difficulty perpetuating itself on some sites and in some cases is being replaced by the true firs and Douglas-fir, which are highly susceptible to drought, pests, and wildfire (Monnig and Byler 1992).

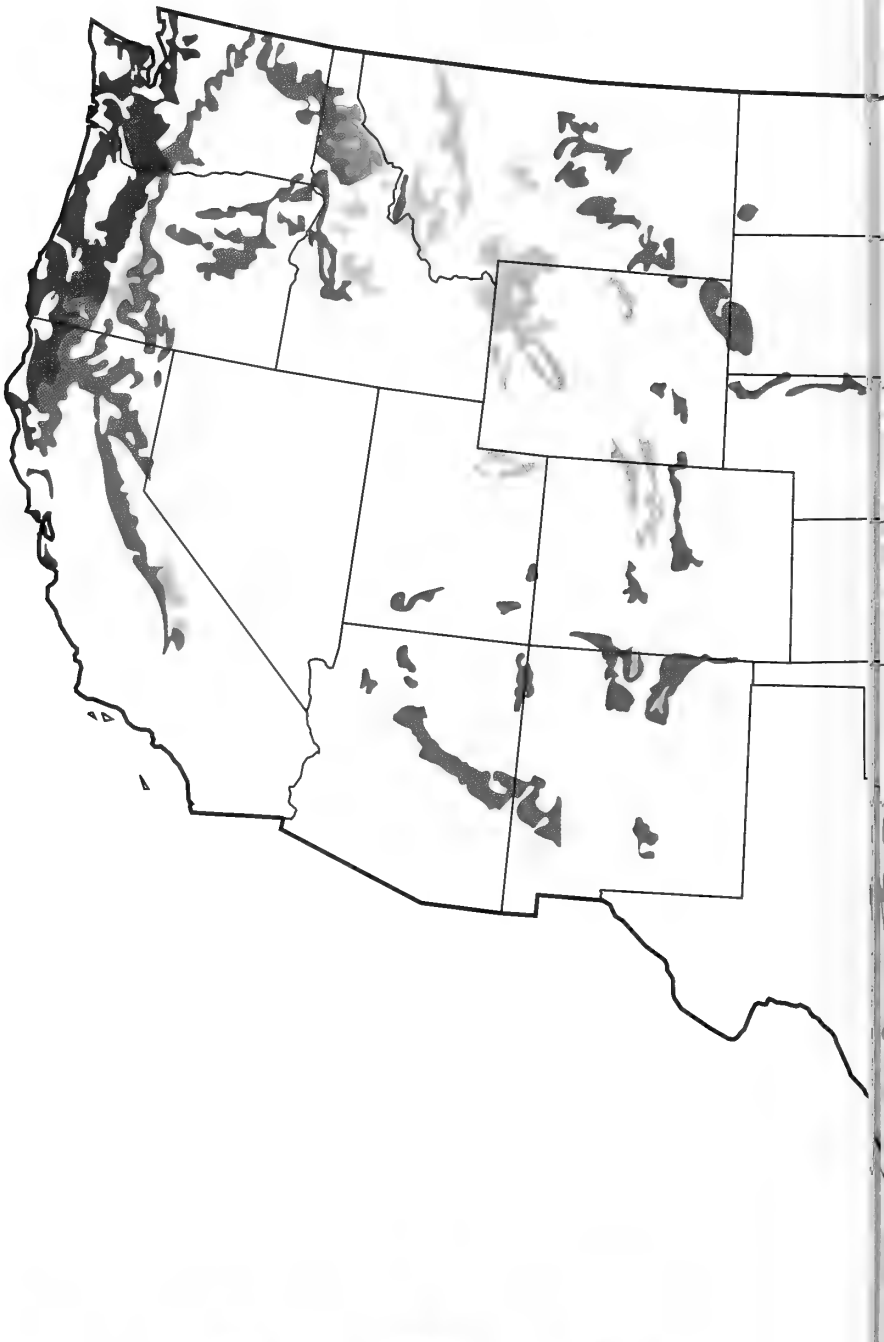
THE ROLE OF FIRE IN FOREST SUCCESSION

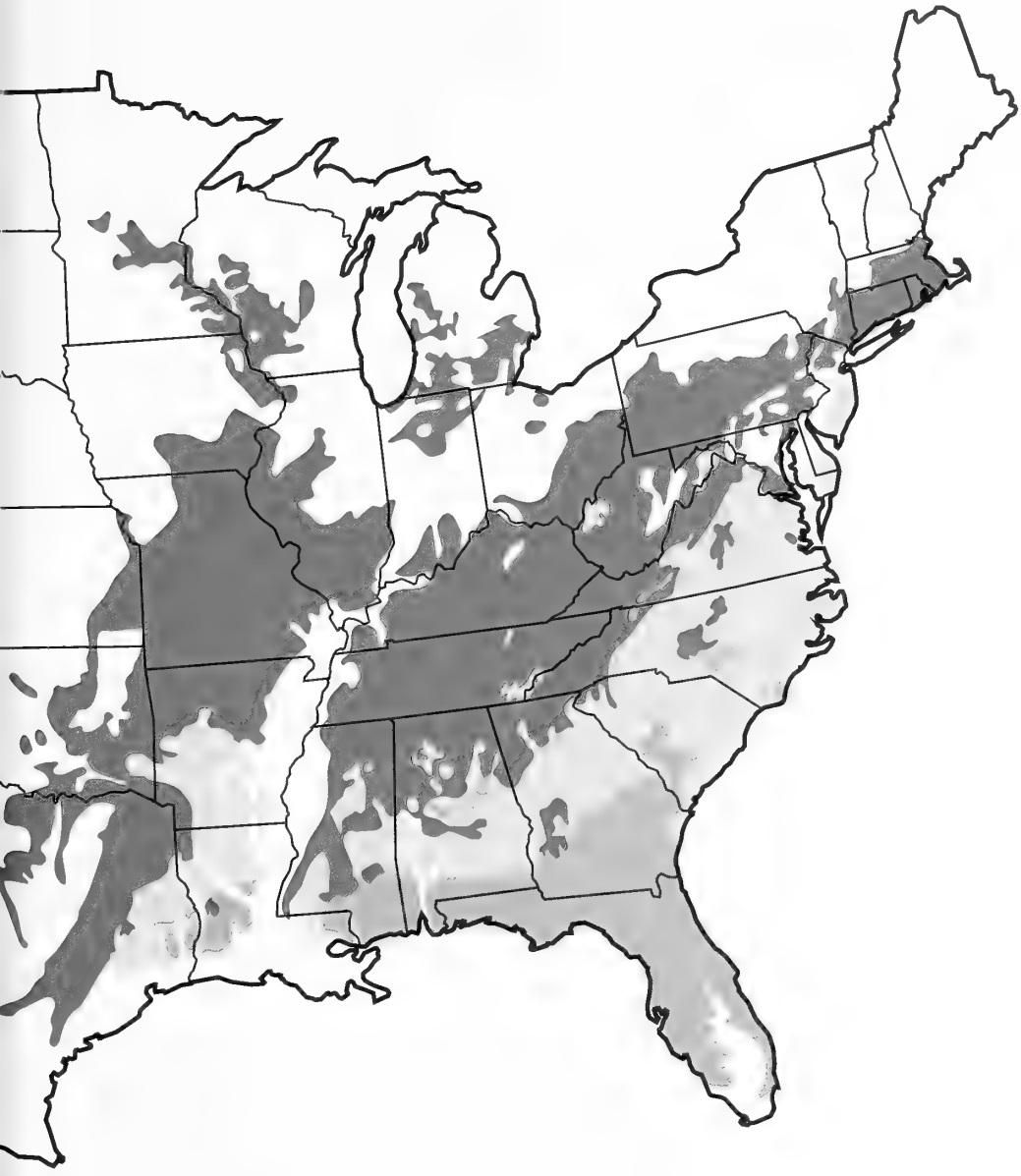
Frequent low-intensity fires maintain open-grown pine ecosystems by limiting the establishment and growth of shade-tolerant species (inner cycle). With fire removed from the ecosystem, dense stands of shade-tolerant firs develop that are highlly susceptible to insect and disease epidemics and high-intensity stand replacement fires (outer cycle).

PACIFIC DOUGLAS-FIR TYPE

Douglas-fir forests of the Pacific slope (the westward side of the Cascade Range) are long-lived and extremely productive. Stands of Douglas-fir were typically regenerated about every 300 years by high-intensity stand-replacement wildfire. Harvesting on short rotations, intermediate cutting, continuous cropping of Douglas-fir on the same sites, and widespread planting of Douglas-fir on sites formerly occupied by other species are some of the factors associated with a significant increase in root disease damage in this type (Byler 1988). Tree mortality is severe on some sites, and productivity of stands is greatly reduced. Douglas-firs replanted immediately in areas with root disease problems are quickly infected, and tree losses begin early in the rotation.

MAJOR FOREST COVER TYPES



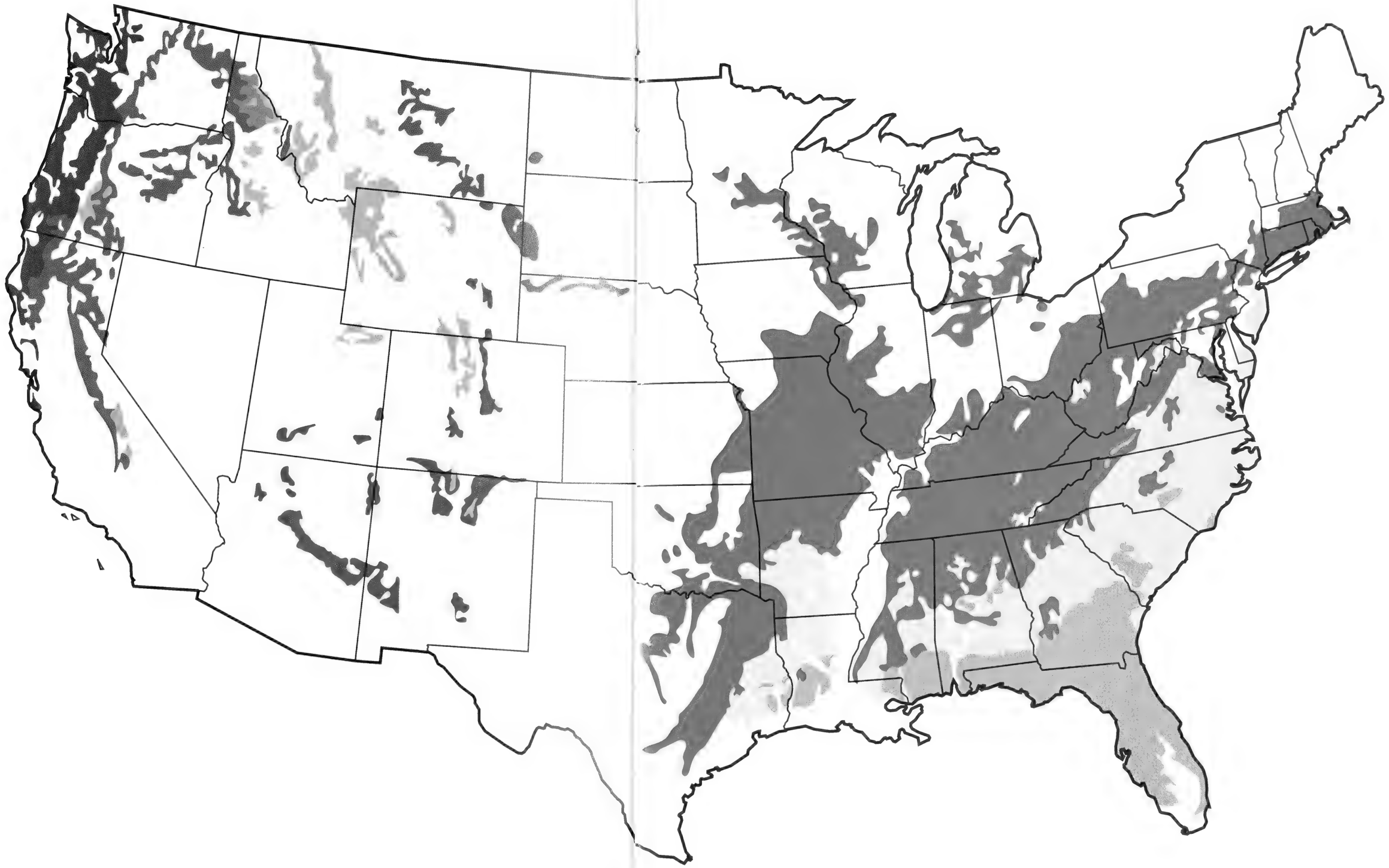


Longleaf–Slash Pine

Loblolly–Shortleaf Pine

Upland Oaks and Oak–Pine Types

MAJOR FOREST COVER TYPES



Pacific Douglas-fir

Interior Ponderosa Pine

Western White Pine

Lodgepole Pine

Longleaf–Slash Pine

Loblolly–Shortleaf Pine

Upland Oaks and Oak–Pine Types

LOBLOLLY–SHORTLEAF AND LONGLEAF–SLASH PINE TYPES

Starting with planting programs in the 1930's, major changes have taken place in the distribution of pine species in the South. Loblolly and slash pines became established naturally on abandoned farms. The two species were also extensively planted on marginal sites outside their natural range, including many sites formerly occupied by longleaf pine.

Southern pine beetle, the most important forest insect pest in the South, was favored by the shift from the more resistant longleaf pine to loblolly and slash pines, by the overall increase in susceptible host types and, in recent years, by older stand age and high stocking levels (Nettleton 1988). During recent years, southern pine beetle outbreaks have become more severe and damage has increased. The need for suppression to control spot infestations and minimize timber and other losses has increased.

Wildernesses in some of the southern national forests have stands of older pine that are particularly susceptible to southern pine beetle. Some of these wildernesses provide habitat for the red-cockaded woodpecker, an endangered species. Suppression of southern pine beetle has been necessary to protect the pines on which this woodpecker depends.

Pine forest in Four Notch (Texas) infested with southern pine beetles (photo © R. Billings, Texas Forest Service).

Fusiform rust disease was also favored by the shift to the more susceptible loblolly and slash pines and the increase in area of susceptible host type (Dinus 1974). Spread of the rust was accelerated by nursery and reforestation practices and by fire control, which increased the growth of oaks, the alternate host for this rust fungus. Before widespread planting of pines in the 1930's, fusiform rust was a relatively unimportant part of loblolly and slash pine ecosystems. Today, it is the most costly disease in southern forests. Removal of rust-infected trees during thinning and planting operations has had some limited benefit in reducing losses, and screening for rust resistance has shown promise.

Impacts of southern pine beetle may continue to increase due to the abundance of host type, increasing stand age, and high stocking levels. Impacts of fusiform rust will probably continue to be serious for the foreseeable future.

UPLAND OAKS AND OAK–PINE TYPES

Successful fire control, chestnut blight, land use patterns, and past harvesting practices have greatly altered the composition and structure of the upland oak and oak-pine forest types. In addition, drought and pest epidemics have resulted in widespread and sometimes severe decline of oaks. Much of the problem is occurring in stands where harvest or regeneration cuts are not planned for some time, or where recreation and wildlife objectives predominate. Concern about the future status of these stands is widespread among both forest managers and the public.

Introduced Pests

Introduced pests are a serious concern. Unlike native pests, introduced pests usually have few natural regulating factors in North American forest ecosystems. Some introduced pests have caused permanent, irreversible changes in forest ecosystems and continue to spread and cause damage in new areas. Introduced pests have proven to be difficult and expensive to manage. As global trade and travel increase, the potential for new introductions of forest pests also increases. Preventing additional introductions of exotic pests to North America is a continuing concern for the governments of Canada, the United States, and Mexico. The strategies for dealing with introduced pests have to be very different from the strategies for native pests.

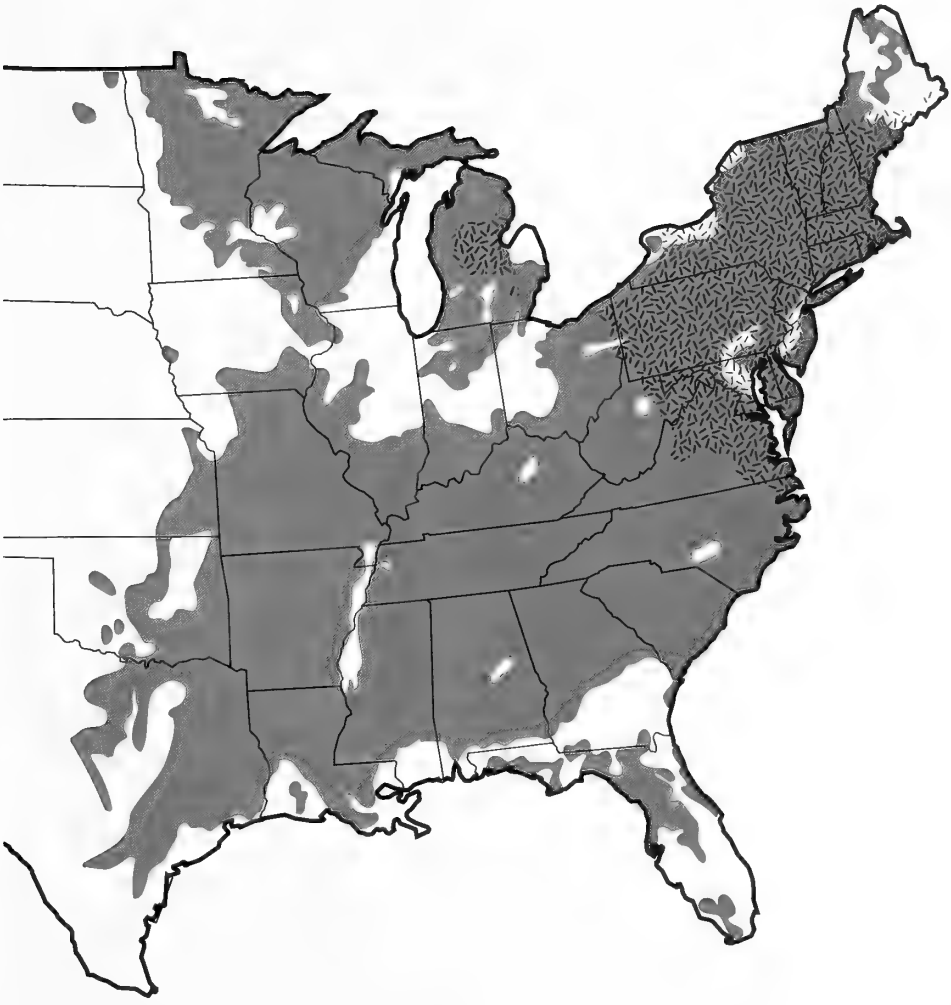
INTRODUCED PESTS THAT ARE WELL ESTABLISHED

Examples of introduced forest pests that have become established in the United States are the European gypsy moth, balsam woolly adelgid, and the fungi causing white pine blister rust, Dutch elm disease, beech bark disease, and chestnut blight.

European gypsy moth, the most serious pest of oak forest types, was introduced into Massachusetts in 1869. Favored by the large expanses of oaks and other host species in the Eastern United States and a relative lack of natural enemies, it has since spread and become established in all or portions of 16 Northern and Mid-Atlantic States. The infestation has now reached into Michigan, North Carolina, Ohio, Virginia, and West Virginia and continues expanding westward and southward at a rate of about 10 to 15 miles per year. Landowners and forest managers in the path of the expanding infestation are experiencing its effects for the first time. In areas infested for the first time, outbreaks tend to persist longer and cause defoliation in several consecutive years. As a result, tree mortality can be heavy. Loss of trees affects wildlife habitat, aesthetics, wilderness, recreation, and timber productivity. The European gypsy moth feeds on more than 300 tree and other plant species, so its impact extends beyond oaks, which are one of its favorite foods. Suppression of outbreak populations is often necessary to protect high-value forests. Vast

Oaks around this house in Pennsylvania were defoliated by the European gypsy moth (photo © 1992 Nate Bacon).

GYPSY MOTH INFESTATION



Susceptible forests

Extent of general infestation (1990)

acreages of forest susceptible to European gypsy moth in the South, Midwest, Lake States, and West are not yet infested. Despite quarantine measures, isolated infestations are frequently found in these areas, the result of movement of infested outdoor equipment or other articles from infested areas. Eradication treatments are applied wherever isolated infestations are found, for example in Georgia, Oregon, Utah, Washington, and Wisconsin.

The ***balsam woolly adelgid,*** first discovered in Maine in 1908, now occurs widely in Canada and the United States. In recent decades, it has killed large numbers of Fraser fir in North Carolina (Witter and Ragenovich 1986).

White pine blister rust, an introduced disease of pines, has severely affected most of the valuable western white pine and, to a lesser extent, the sugar pine resource. This disease was first discovered in 1906 in New York State, and it subsequently spread through the range of eastern white pine, causing significant damage in some stands. The disease was found in western North America for the first time in 1921 at Vancouver, British Columbia, and subsequently spread widely in the Western United States. White pine blister rust continues to spread to new areas. In 1990 the disease was found for the first time in New Mexico, where it now poses a serious threat to southwestern white pine.

Dutch elm disease was first found in 1930 in Ohio. This disease now occurs throughout the United States. Large numbers of the valuable American elm have been killed, significantly altering many urban landscapes, and the disease continues to kill trees.

Beech bark disease, first discovered in Canada, has spread from Maine through the Northeast since the 1930's and has now reached as far south as West Virginia (Houston 1987). The disease results when bark attacked and altered by the introduced beech scale insect is invaded and killed by fungi. As the disease has spread, it has killed large numbers of American beech trees.

Chestnut blight virtually eliminated the American chestnut as a dominant tree species in the eastern forests during the early 1900's. American chestnuts were large, upper-canopy trees over 100 feet in height. When the chestnuts were killed, they were replaced by other species, often oaks. Small chestnut trees still grow from living root systems, but the sprouts are usually destroyed within a short time by the blight.

RECENTLY INTRODUCED PESTS

Three new exotic forest pests have been discovered in North America during the past 2 years. ***Asian gypsy moth,*** a serious pest of conifers and hardwoods in Asia, was discovered in Oregon, Washington, and British Columbia in 1991. This gypsy moth laid its eggs on the superstructure of cargo vessels while these vessels were in Russian ports. When the vessels reached North America the eggs hatched and larvae were carried by the wind into nearby forests. The successful eradication and survey effort cost the Federal and State governments $19 million in 1992. Additional funds were spent by public agencies in Canada to eradicate the pest there.

The ***common European pine shoot beetle,*** an important pest of trees in Europe and Asia, was discovered in Ohio in 1992 and subsequently in Indiana, Illinois, Michigan, New York, Ohio, and Pennsylvania. A Federal quarantine was placed on infested counties to regulate movement of logs, lumber, nursery stock, and Christmas trees into other areas of the United States. The ***Eurasian poplar leaf rust*** was discovered in California, Oregon, and Washington in 1992.

RISK OF NEW INTRODUCTIONS

Many forest pests that might adversely affect forests in this country are known to occur in other parts of the world and have not been introduced into North America. With increasing international trade, including the possible importation of logs as well as wood products, the risk of additional introductions will increase. Keeping these pests out is critical to protecting forest ecosystems in North America.

Concerns about the potential for new introductions have greatly increased since 1990, when commercial interests proposed importing larch logs from Siberia. In 1991, at the request of the USDA Animal and Plant Health Inspection Service (APHIS), the Forest Service completed a pest risk assessment of importing Russian larch logs (USDA Forest Service 1991). The assessment found that any one of several forest pests in Russia could cause serious damage if introduced into the United States. Similar proposals were later received for log importations from New Zealand and Chile. The pest risk assessment completed for New Zealand logs also found pests of concern if Monterey pine logs were to be imported without appropriate quarantine measures (USDA Forest Service 1992). A pest risk assessment is underway for log importations from Chile.

The Urban–Wildland Interface

In recent decades many people have chosen to build homes within forested lands, in what is termed the ***urban–wildland interface.*** This trend has occurred throughout the country and significant amounts of forest land have been affected. Both pest and wildfire problems have increased as a result, and many of these forests can be maintained in a healthy condition only with great difficulty.

Construction of roads and houses and installation of utilities often results in direct injury to tree roots, crowns, and boles. Changed water drainage patterns and soil compaction place additional stress on trees. Trees often die as a direct result of injury or are weakened and succumb to drought or attack by pests.

In developed forests, individual trees take on added value and pest problems that might not be important in a typical forest situation demand attention. Where homes are at risk, the potential losses from forest fires are vastly increased and fire control takes on added importance.

Oak wilt disease in Texas and Minnesota is an example of a pest problem in developed areas. When forested lands in these two States (where the problem is most critical) are developed for homesites, oak wilt disease is already present or becomes established when trees are wounded during construction. Thus, a disease that otherwise would be of relatively minor significance becomes very important because of the high value attached to the native oaks left on house lots. Control efforts are required because of the high value of the trees.

In the last few years, drought and bark beetles have combined to kill large numbers of trees in Jeffrey pine stands in the Lake Tahoe Basin of California and Nevada. The dead trees add to the fire hazard and present difficulty in protecting properties.

Year 1918

This section of the plan sets forth the Forest Service's strategic goals to protect forest health. Twelve strategic goals have been identified, along with appropriate actions. Each goal is a statement of the ultimate desired condition. Each goal is supported by rationale statements that explain the basis for the goal and actions.

The 12 strategic goals address planning, prevention, suppression, environmental analysis, pesticides, forest protection technology, forest health monitoring, forest health restoration, management of introduced forest pests, exclusion of exotic forest pests, international cooperation in forest health protection, and public involvement. The first eight goals are continued from the 1988 Forest Health Strategic Plan. These goals, identified as "issues" in the 1988 plan, are restated as goals, and rationale statements and actions for these goals have been revised. The strategic goals were developed by reviewing forest health concerns, the new and existing threats of introduced pests, and new Forest Service emphasis on ecosystem management and an expanded international forestry role. Actions are identified to achieve each goal. Some of the actions require further analysis and the consideration of alternative procedures before they will be ready for implementation.

Planning

GOAL
The ecological significance of pests and wildfire is considered in all forest resource management planning processes.

RATIONALE
Failure to consider the ecological significance of pests and wildfire can result in resource management objectives (including timber, wildlife, recreation, wilderness, and water) not being met and problems that are difficult and expensive to correct. Not considering pests and wildfire in forest planning processes will result in overly optimistic assumptions about forest health and in the use of emergency measures that are usually expensive and do not provide a long-term solution. In the past, forest resource planning processes have focused on what will be done after a pest epidemic occurs, rather than on changing or avoiding ecosystem conditions that favor pest epidemics.

Ecological conditions favoring development of pest epidemics and increased wildfire hazard are best examined and addressed on an ecosystem scale; fragmented approaches will be less effective. In many cases, forest pest epidemics and wildfire overlap ownership boundaries, and management actions such as prescribed fire to restore and protect forest health may require coordinated action among adjoining landowners. Forest pest and wildfire damage becomes more important as demands on public and private forest lands increase.

ACTIONS

The following actions should be taken to ensure that forest resource management planning processes consider the ecological significance of pests and wildfire:

- ***Consider forest health in the 1995 Forest Service Resources Planning Act (RPA) Assessment and Program.*** During the RPA process consider the ecological significance of native and introduced forest pests and wildfire, and their effects on forest health.

- ***Consider the ecological significance of forest pests and wildfire, and their effects on forest health in developing Forest Service land management planning regulations and directives.*** During the revision process consider the ecological significance of native and introduced pests and wildfire, and their effects on forest health.

- ***Develop pest modeling and decision support systems to assist land managers in making ecosystem management decisions.*** Complete development of pest damage models for major pests and pest complexes, and develop the capability to predict pest behavior in key ecosystems under various ecological conditions and to integrate this information with other considerations during forest resource planning processes.

- ***Ensure input by pest specialists to interdisciplinary planning teams during the next round of forest plan revisions.*** Strengthen Forest Pest Management's capability to provide necessary input to the next round of plan revisions.

- ***During planning processes, make greater use of historical data and case studies on the roles of drought, pests, and wildfire in ecosystems.*** Develop and implement mecha-

nisms for making information available to forest resource managers on the historical roles of drought, pests, and wildfire.

- ***Give appropriate consideration to forest health conditions and pests and wildfire in forest plan monitoring.*** Review forest plan monitoring guidelines and make any needed changes.

- ***Help ensure that native and introduced pests and wildfire are considered on private forest lands, urban areas, and the urban–wildland interface.*** Incorporate forest health considerations into the planning process for State forest resource plans, forest stewardship plans, and urban forestry plans.

Prevention

GOAL
Susceptibility to pests is decreased by applying available forest management options.

RATIONALE
Many stands are at risk to pest damage because of high stocking density, wrong species composition for the site, or failure to use available management measures. Many losses could be prevented and suppression costs reduced if management treatments to reduce stocking could be directed to immediately threatened stands. Much of this activity will require additional funding and collective action across resources, jurisdictions, and ownerships. Pest and wildfire problems in the urban–wildland interface are a significant example of this need.

ACTIONS
The following actions should be taken to facilitate application of prevention measures:

- ***Include funding needs for pest risk rating and prevention planning in future budget requests.*** Determine funding needs to risk-rate stands for bark beetles, European gypsy moth, western spruce budworm, Douglas-fir tussock moth, root diseases, and fusiform rust. The

regions would use the results of risk rating to prioritize stands and plan silvicultural treatments in those areas at immediate risk.

- ***Encourage use of resource management practices that prevent pest losses.*** Review current prevention needs and technology for major pests, conduct an economic analysis to prioritize possible prevention activities, and develop and implement a strategy for optimizing use of existing programs for prevention to meet resource management objectives.

- ***Assist States and private landowners in preventing pest damage and wildfire in the urban-wildland interface.*** With the State Foresters, develop and implement a joint strategy to optimize use of the Cooperative Forest Health, Cooperative Fire Protection, and Cooperative Forestry Programs to meet needs in the urban–wildland interface.

Experimental restoration plot on the Starkey Forest in the Blue Mountains of Oregon. Douglas-fir and true firs dead from drought stress and 11 years of spruce worm infestations have been removed from the area on the right. Western larches remain and will serve as seed trees. Ponderosa pines are being replanted. Douglas-fir and other trees in the riparian area to the left remain because they are not stressed as severely by the drought.

Suppression

GOAL
Pest suppression and fire control options and funding continue to be available to meet resource management objectives.

RATIONALE
Large areas of forests that are susceptible to pests and wildfire will continue to require a substantial suppression effort for the foreseeable future. Need for suppression of pests to protect nontimber values, especially habitat for threatened and endangered species, probably will increase. Pest suppression in western ecosystems that have current or potential damage from drought, certain pests, and wildfire can save surviving trees and extend the time available for orderly implementation of silvicultural measures to restore these forests.

Suppression of western spruce budworm on National Forest System lands should decrease over the next several decades as ecosystem management is emphasized and forest plans and resource management decisions give more consideration to the underlying ecological conditions that lead to outbreaks of native pests. Suppression needs for the European gypsy moth will probably increase.

Pest suppression decisions will continue to be strongly influenced by political considerations and land managers' perception of public acceptance. Credibility with congressional appropriation committees and the careful administration of pest suppression funding require accurate long-term estimates of suppression funding needs.

ACTIONS
The following actions should be taken to ensure the continued availability of suppression options and funding:

- ***Improve accuracy of long-term pest suppression need projections.*** Assess alternatives and implement appropriate procedures for making long-term projections of pest suppression needs. One alternative should be similar to the method used for projecting fire control needs. This activity should include State and other Federal cooperators.

- ***Maintain a reliable way of meeting emergency pest suppression funding needs.*** Work with the Department of Agriculture, the Office of Management and Budget (OMB), and the Congress to ensure that all parties are kept informed about the administration and status of suppression funding, including the Emergency Pest Suppression Fund, and that a reliable way of meeting suppression needs is maintained.

- ***Increase research and development of pest suppression options.*** Prepare and implement a plan for increased research and development of alternative methods for pest suppression.

Environmental Analysis

GOAL
Program-level National Environmental Policy Act (NEPA) documents are available prior to major pest outbreaks.

RATIONALE
Forest pest suppression activities require supporting environmental analyses. Conducting NEPA analyses on a planned basis avoids the higher costs incurred when these analyses are done on an emergency basis and would allow for rapid responses (suppression) against low-level, but increasing populations of a threatening pest. Preparation of program-level or broad-scale NEPA documents also facilitates early communications with the public.

ACTION
The following actions should be taken to make program-level NEPA documents available and keep them current:

- ***Prepare program-level or broad-scale NEPA documentation in advance for potentially controversial pest management activities.*** Prepare and update programmatic environmental impact statements (EIS's) for major multiregional pests, which can be used as a basis or reference for preparation of site-specific EIS's, environmental assessments, and forest plans. This activity should include State and other Federal cooperators.

Pesticides

GOAL
Environmentally acceptable pesticides are available to protect forest values and achieve resource management objectives.

RATIONALE
Because the demand for forestry pesticides is small in relation to the overall market, commercial producers of pesticides are reluctant to address forest protection needs for development and registration of additional environmentally acceptable pesticides and behavioral chemicals. Further potential exists to improve the accuracy of pesticide applications and the dependability and effectiveness of biological pesticides.

Use of pesticides will continue to be challenged, particularly when information on environmental impacts is lacking, or substantial environmental risks exist. A lack of studies on environmental impacts could threaten the continued use of the biological insecticide ***Bacillus thuringiensis,*** the most widely used insecticide for protecting forests from defoliators. There is a continuing need to develop new, safer pesticides for forest nursery soils. Methyl bromide, the most widely used soil fumigant, will soon be unavailable because of environmental concerns. Few pheromones and other behavioral chemicals have been used operationally because of a lack of data necessary to satisfy U.S. Environmental Protection Agency's registration requirements. The mountain pine beetle pheromone, which is used operationally to attract the insect to stands scheduled for harvest, is a successful exception.

ACTIONS
The following actions should be taken to ensure that environmentally acceptable pesticides are available to meet resource management objectives.

- ***Ensure that necessary data are available to assess environmental impacts of* Bacillus thuringiensis *and other key pesticides.*** Develop and implement a national plan to fill the environmental data gaps on ***Bacillus thuringiensis*** and other key pesticides, including effects on nontarget insects.

- ***Obtain registration of pheromones and other behavioral chemicals.*** Develop and implement a national strategy to complete research and testing needed to satisfy registration requirements for pheromones and other behavioral chemicals.

- ***Increase the availability and effectiveness of microbial pesticides and pheromones.*** Develop and implement a national plan to increase research, development, and application of microbial pesticides and pheromones and continue to encourage commercial production of GYPCHEK.

- ***Find alternatives to methyl bromide for fumigating forest nursery soils.*** Develop and implement a national strategy to find alternatives to methyl bromide.

Forest Protection Technology

GOAL
Effective, economical, and environmentally acceptable forest protection technologies are available to meet forest resource management objectives.

RATIONALE
A significant time lag sometimes exists for movement of new technologies from research to operational use. There is a continuing need for development and evaluation of new, more environmentally acceptable integrated pest management technologies, such as classic biological control methods.

The beneficial effects of insects and diseases in forest ecosystems and the implications of new uses of forest management methods (particularly reduced use of clearcutting and wider use of other silvicultural regeneration methods in ecosystem management) need further study. Development of the ability to make long-range forecasts of large-scale pest epidemics would improve planning and preparation.

ACTIONS

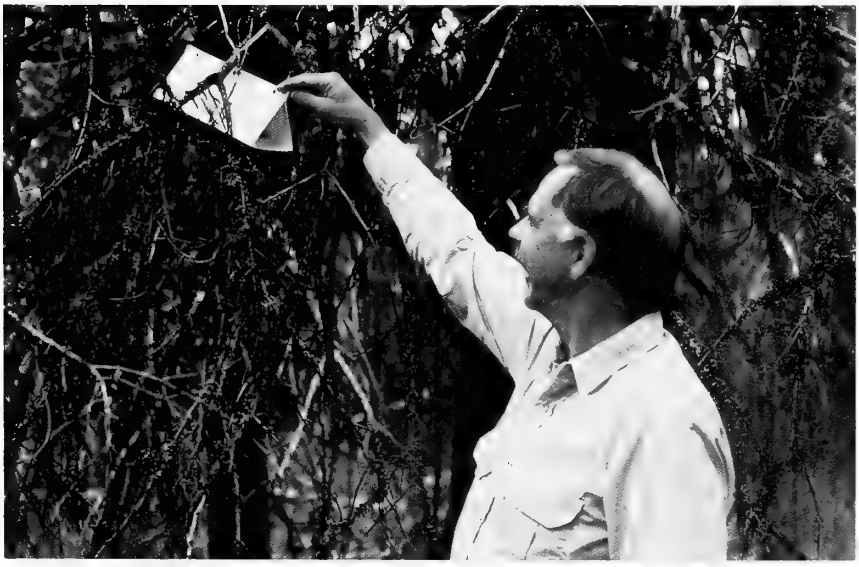
The following actions should be taken to enhance scientific understanding, development, and application of forest protection technologies:

- ***Ensure that the latest integrated pest management technology is made available to forest managers.*** Assess whether the latest technology is reaching forest managers and make appropriate recommendations. Develop and implement appropriate mechanisms for implementation of technology, where mechanisms are lacking.

- ***Accelerate the development and application of new integrated pest management technologies for major pests.*** Plan and implement projects to accelerate development and application of new technologies for major pests, for example, gypsy moth, western spruce budworm, Douglas-fir tussock moth, mountain pine beetle, fungi causing root diseases, and other major pests.

- ***Make increased use of environmentally benign pest management technologies including classic biological control, conservation, and augmentation of native natural***

Pheromone traps are used to detect, monitor, and assess insect populations. This trap attracts western spruce budworm.



controls, and use of resistant varieties of trees. Develop and implement appropriate plans and projects to increase research, development, and application of biologically based pest management strategies. Cooperation with other countries and other USDA agencies, and participation in the USDA Interagency Biological Control Initiative will be explored.

- ***Develop technology to evaluate the impacts of vegetation management practices and pests on forest health and resource values.*** Explore opportunities to increase research to develop procedures for evaluating the impacts of management practices and pests on forest health and resource management objectives. Research will include the impacts of uneven-aged stands on forest management and the evaluation of impacts on nontimber resources. An interdisciplinary approach will be used.

- ***Increase knowledge of the role of forest insect pests, other arthropods, and microorganisms in ecosystems in relation to forest health.*** Expand research programs to include the ecological role of forest insect pests, other arthropods, and microorganisms and their beneficial influences on forest health.

- ***Evaluate alternative silvicultural methods and harvesting systems for ecosystem management that reduce the impacts of drought, pests, and wildfire and promote forest health.*** Support research and development of harvesting technologies and silvicultural regeneration methods and intermediate treatments such as thinning for reducing drought, pest, and wildfire impacts. An interdisciplinary approach will be used.

- ***Provide long-range forecasting of pest epidemics.*** Support development of a long-range forecasting capability for large-scale pest epidemics in the major forest ecosystems. The technology would be based on the history of large-scale pest epidemics and on past, current, and expected future ecosystem conditions. Long-range forecasts will improve national planning and preparation.

Forest Health Monitoring

GOAL
A Forest Health Monitoring Program is eventually established nationwide, and provides information on forest condition and trends for formulation of national policy.

RATIONALE
Large-scale, subtle changes in forests, such as those that might be caused by atmospheric deposition, soil nutrient loss, global warming, and some pests, are difficult to detect and could easily be overlooked until serious or irreversible. Monitoring of forests to describe their condition and identify changes that are occurring provides a factual basis for public policy and private ownership decisions.

The Forest Service, in partnership with the U.S. Environmental Protection Agency (EPA) and the State Foresters, has implemented the Forest Health Monitoring Program in 12 Eastern States and 2 Western States since 1990. The program participants are technically capable of expanding the program nationwide over the next few years. This program has already produced data showing that a much-feared regional decline of sugar maples is not occurring. Similar national monitoring programs are well established in Canada and over 30 European countries, offering the opportunity to compare forest health trends across the Northern Hemisphere.

ACTIONS
The following actions should be taken to continue implementation of the Forest Health Monitoring Program:

- ***Continue joint implementation of the Forest Health Monitoring Program.*** In cooperation with the State Foresters, other Federal land management agencies, and the EPA's Environmental Monitoring and Assessment Program (EMAP), continue joint implementation of the Forest Health Monitoring Program as funds become available, with the goal of full implementation nationwide. Establish a national steering committee for the Forest Health Monitoring Program and carry out the other recommendations resulting from the national review conducted in 1992.

- ***Make appropriate improvements in forest health monitoring and increase coordination with Canada, Mexico, and European countries.*** In cooperation with the State Foresters, continue to enhance the monitoring program as new indicators are developed. Coordinate with existing Canadian and European monitoring programs and work to develop others.

Forest Health Restoration

GOAL

Those forests that have suffered recent severe mortality from drought, pests, and wildfire are eventually restored to sustainable and productive condition, and other forests highly susceptible to this same kind of event are treated to avert similar damage.

RATIONALE

Fire control and other management practices in the past have greatly altered the character of the Nation's forests and in many cases have created conditions highly susceptible to drought, pests, and wildfire. A combination of an extended drought, pest epidemics, and wildfire has recently brought attention to the fragility of western forest ecosystems and the need for future management to be more sensitive to the ecology of these forests. Even though the same or similar conditions exist throughout much of the Intermountain West and California, restoration strategies have not been developed except for a few limited areas, and it has not been possible to formulate a well-coordinated budget proposal. There will be a strong tendency to focus restoration efforts only on those forests where damage has already occurred, rather than on similar forests where the same underlying conditions exist and actions taken now could avert future damage.

Many forests probably will not restore themselves in a timely manner and thus would benefit from active management. However, active restoration still would require several decades. Where economically justified, pest suppression can be an appropriate measure to save stands until silvicultural practices can be applied.

Because restoration strategies will involve manipulation of vegetation as well as other management measures, they may be contro-

versial and require strong public involvement efforts. Forest health problems overlap ownership boundaries, and coordinated action will be most effective. Constraints on use of appropriations have slowed restoration efforts. Budget support for restoration will be difficult to sustain if the serious tree mortality in the West subsides.

ACTIONS
The following actions should be taken to meet forest health restoration needs:

- ***Include funding needs for restoration in future budget requests.*** Formulate a long-term restoration budget including establishment of priorities to ensure action is taken to achieve the most good. Outline long-term restoration strategies on which budget estimates would be based, with priorities based on resource condition, management objectives, resource values, and economic efficiency.

- ***Seek legislative or administrative relief to allow flexibility in use of appropriations to meet restoration needs.*** Prepare legislative proposals for consideration.

Management of Introduced Forest Pests

GOAL
Plans and capabilities exist to limit spread or eradicate new introductions of exotic forest pests and to minimize ecosystem disruption from pests that have already been introduced or may be introduced in the future.

RATIONALE
Large numbers of exotic forest pests have been introduced to North America, and new species continue to arrive. Three new serious exotic forest pests were discovered in the United States in the last 2 years. Additional introductions are likely, and little prior national planning has gone into appropriate survey and eradication strategies for response to introductions of new forest pests. By the time they are discovered, many newly introduced pests have spread too widely for successful eradication (for exam-

ple, the common European pine shoot beetle had already spread to six States before it was discovered in 1992). Often, technology to respond to exotic pests has not been available, so that extraordinary research and technology development efforts are usually necessary for new pests.

Introduced pests are usually more difficult and expensive to control than native pests because they lack natural enemies. They often are much more damaging here than in their places of origin and they can disrupt ecosystems to such an extent that reversal of the process or restoring the ecosystem to its previous condition may be impossible.

Pests that are already established continue to require management efforts. Eradication of isolated infestations of the European gypsy moth and slowing the advancing front saves the long-term costs of suppression and allows forest managers more time to plan appropriate responses.

ACTIONS

The following actions will be taken to respond to the threat of introduced forest pests:

- ***Provide resource managers with information on the impacts that introduced pests have had on our forest ecosystems.*** Review the behavior and effects of introduced pests in our forest ecosystems, and identify any appropriate restoration or mitigation measures available for forest managers.

- ***Develop a database on introduced pests and look for historical patterns of introductions of pests into the United States.*** Review the frequency, origin, and pathways for historical introductions to the United States, and subsequent rates of spread through forests in this country for clues to use in developing strategies for response when new introductions occur. In cooperation with the USDA Animal and Plant Health Inspection Service (APHIS), use this database to plan responses to new introductions.

- ***Work with APHIS to develop a national strategy for response to forest pest introductions.*** With APHIS, develop a national strategy that outlines approaches and capacities to detect and respond to new introductions. This will involve a review of the most

dangerous exotic forest pests, including the biology and ecology of the pests and their natural enemies in their native countries, possible modes of introduction, risk of establishment in the United States, available information on survey and control, research and technology development needs, and need for enhanced surveys in the United States for early detection. The successful cooperative project led by APHIS in 1992 to eradicate Asian gypsy moth in Oregon and Washington is an excellent model on which to base a national strategy.

- ***Serve on APHIS emergency management teams for forest pests.*** When a new pest introduction is discovered, APHIS convenes a team to plan for surveys, impact assessments, control options, and quarantine requirements. The Forest Service will continue to provide technical support on emergency teams.

- ***In cooperation with APHIS, continue measures to slow the establishment of European gypsy moth in new areas, and take appropriate action against any additional infestations of the Asian gypsy moth.*** Continue support for eradication of isolated infestations of the European gypsy moth in the Midwest, South, and West, and for a large-scale, multiyear pilot project in North Carolina, Virginia, West Virginia, and Michigan to evaluate the operational and technical feasibility of slowing the spread of European gypsy moth along its advancing front.

- ***Cooperate with APHIS on survey and impact evaluation of the recently discovered common European pine shoot beetle.*** Continue support for efforts led by APHIS to determine the nationwide extent of the infestation, host preferences, biology, control options, and damage potential.

- ***Continue to support pilot tests and impact assessments for introduced pests.*** Continue support for pilot control tests and special management initiatives for introduced pests, for example, hemlock woolly adelgid and the fungi causing dogwood anthracnose and Port-Orford-cedar root disease. Continue to support white pine blister rust screening programs.

Exclusion of Exotic Forest Pests

GOAL
Plans and policies are developed and applied to prevent additional forest pest introductions into the United States.

RATIONALE
The best defense against exotic pests is exclusion. There are many potentially serious forest pests in other temperate and boreal forest ecosystems of the world that have not yet reached North America. However, with increasing international commerce, the potential for new introductions increases.

The USDA Animal and Plant Health Inspection Service (APHIS), which is responsible for enforcing Federal plant quarantine laws, frequently intercepts exotic forest pests at ports of entry. However, at present, the United States is one of the few major countries in the world without general quarantine regulations for unprocessed wood and U.S. business concerns have recently proposed importing whole logs. As a basis for APHIS quarantine action, the Forest Service has completed pest risk assessments for the importation of logs from Russia and New Zealand and is preparing an assessment for Chilean logs. APHIS is preparing general regulations for the importation of all unprocessed wood products. Although quarantine regulations and enforcement against forest pests are being strengthened, the potential for new introductions will always exist.

ACTIONS
The following actions will be taken to prevent additional introduction of exotic pests:

- ***Develop and implement with APHIS a strategy to work with foreign countries to control pest out breaks around areas of storage or loading of goods in international trade to reduce potential for movement of exotic forest pests to the United States.*** With APHIS, Agriculture Canada, Forestry Canada, and Sanidad Forestal (Mexico), develop and implement a strategy for ensuring that commodities, ships, and containers bound for North America are not infested with exotic forest pests before leaving the port of origin. Starting in Russia at the ports infested by the Asian gypsy moth, Forest Service, APHIS, and Canadian specialists work with foreign countries to establish survey and control procedures at the point of pest origin.

- ***Develop pest risk assessments.*** Continue to support APHIS regulatory actions by preparing pest risk assessments for unprocessed wood imports. Prepare other risk assessments as appropriate, for example, a risk assessment for shipping containers used in international trade that could be a means of exotic pest transfer.

- ***Participate on APHIS's interagency advisory group to develop general quarantine regulations for wood and wood products.*** Support the APHIS effort to establish prohibitions or restrictions on the importation of logs and other unprocessed wood, hitherto unregulated.

- ***Together with APHIS work with Canada and Mexico to harmonize North American quarantine measures against exotic forest pests.*** With APHIS, Forestry Canada, Agriculture Canada, and Sanidad Forestal (Mexico), work to ensure that quarantine regulations of the three countries are equivalent and provide adequate protection from forest pests exotic to North America. Through the Working Group on Forest Insects and Diseases of the North American Forestry Commission, Food and Agriculture Organization of the United Nations (FAO), assist Mexico to develop adequate safeguards against exotic pests.

International Cooperation in Forest Health Protection

GOAL

Forest health is recognized as a problem requiring international cooperation, common interests are identified with other countries, and long-term relationships are developed to maintain and protect forest health worldwide.

RATIONALE

Protecting and restoring forest health is a common interest of all nations and cooperation and exchanges are mutually beneficial. International coalitions to address mutual problems in forest health are forming. The threat of exotic forest pests to the United States and, similarly, the threat forest pests native to the United States pose for other countries, are of mutual concern.

Cooperative working relationships have already been established with Brazil, Canada, Chile, China, Kenya, Mexico, New Zealand, and Russia.

The United States has integrated pest management technologies that could be useful in other countries, particularly technologies in remote sensing, pest modeling, and decision support systems. Other countries are advanced beyond the United States in some integrated pest management technologies, particularly in classical biological control. Some developing countries need help in establishing basic survey and control programs.

ACTIONS

The following actions will be taken to improve international cooperation in forest health:

- ***Strengthen international cooperation in operational technologies for management of insects and diseases.*** With international agencies such as the Food and Agriculture Organization of the United Nations (FAO) continue to encourage long-term relationships with other countries.

- ***Provide technical assistance to developing countries to strengthen their program capabilities.*** With international agencies such as the FAO, work with developing countries to strengthen their operational survey and control capabilities.

- ***Strengthen international cooperation and scientific exchanges to enhance research capabilities for protecting forest health.*** Continue to promote long-term relationships with other countries.

- ***Increase cooperative interactions with other countries to develop a knowledge base on foreign pests that are likely to be introduced to North America.*** Establish cooperative relationships with other countries to develop a database of foreign pests that might be introduced to this country.

Public Involvement

GOAL
The public is informed about current forest health conditions and the role of pests and wildfire in forest ecosystems, and accepts and supports measures needed to restore and protect forests.

RATIONALE
Pest epidemics, wildfire, and other disturbances are among the most significant ecological factors affecting forest ecosystems, yet their roles in forest ecosystem dynamics usually receive little attention until after serious problems exist. Then, harvesting, prescribed fire, and other management practices necessary to correct or prevent conditions favorable to pest outbreaks and wildfire often elicit strong negative public reactions. Public involvement is highly desirable and needs to be fostered.

The Forest Service has been in a reactive mode with respect to providing information on forest health conditions and issues. In the absence of information provided by the Forest Service, various media sources have, at times, provided incomplete information to the public on forest health conditions and issues.

ACTIONS
The following actions will be taken to increase the involvement of the public in forest health issues:

- ***Encourage an active role by the public in considering resource management alternatives for forests threatened by pests and wildfire.*** Develop and implement measures to facilitate greater public involvement in planning processes. These measures should emphasize that the Forest Service intends to make forest health considerations an integral part of considering alternatives for resource management and that the public has an active role in this planning process.

- ***Provide timely and accurate information on forest health issues and conditions to the public.*** Develop a forest health communications plan to facilitate early, accurate information dissemination on forest health issues and conditions, and encourage public involvement.

- ***Initiate an annual forest health report.*** Prepare an annual national report on effects of pests and wildfire on achieving resource management objectives, and what corrective measures are being carried out.

Year 1948

IMPLEMENTATION

These actions require national leadership and coordination by the Forest Service. They will meet national responsibilities, strengthen program capabilities, and enable Forest Service field units and others to meet resource management responsibilities.

Implementation of some of the actions in this plan will require coordination with other Federal agencies. Necessary coordination mechanisms are in place. Forest Pest Management and Fire and Aviation Management have established coordination mechanisms with other Federal agencies for forest health protection and forest fire protection. Mechanisms are also established for cooperation with APHIS for strengthening pest quarantine measures. The Forest Health Monitoring Program is a cooperative effort with the U.S. Environmental Protection Agency.

The actions to be taken under this plan will benefit the States and private landowners through existing Forest Service partnerships and cooperative programs. The Forest Service, through partnerships and cooperative programs, provides technical and financial assistance to States. Cooperative programs include the Cooperative Forest Health Program, Cooperative Fire Protection Program, Forest Health Monitoring Program, Forest Stewardship Program, and Urban and Community Forestry Assistance Program. State Foresters have staffs of specialists in each of these programs who work with and assist private landowners.

The Forest Service will develop an implementation plan to carry out the actions in this plan. State and Private Forestry, Forest Service Research, National Forest System, Administration, Programs and Legislation, and Public Affairs Office staffs will participate in developing the plan and carrying out the actions.

LITERATURE CITED

Alexander, M.E.; Hawksworth, F.G. 1975. Wildland fires and dwarf mistletoes: A literature review of ecology and prescribed burning. Gen. Tech. Rep. RM-14. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.

Berryman, A.A. 1982. Population dynamics of bark beetles. In: Mitton, J.B.; Sturgeon, K.B., eds. Bark beetles in North American conifers. Austin, TX: University of Texas Press: 264-314.

Blais, J.R. 1985. The spruce budworm and the forest. In: Saunders, C.J.; Stark, R.W.; Mullins, E.J.; Murphy, J., eds. Recent advances in spruce budworms research. Proceedings, CANUSA Spruce Budworms Research Symposium; 1984 Sept. 16-20; Bangor, ME. Ottawa, ON: Canadian Forestry Service: 135-136.

Byler, J.W. 1988. Root diseases in western forests. In: Forest health through silviculture and integrated pest management: supporting appendies. Washington, DC: U.S. Department of Agriculture, Forest Service: E1-E17.

Cobb, F.W.; Stark, R.W. 1970. Decline and mortality of smog-injured ponderosa pine. Journal of Forestry 68:147-149.

Dinus, R.J. 1974. Knowledge about natural ecosystems as a guide to disease control in managed forests. In: Proceedings, 66th annual meeting of the American Phytopathological Society; 1974 August 12; Vancouver, BC. St. Paul, MN: The American Phytopathological Society: 186-190.

Eyre, F.H., ed. 1980. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters. 148 p.

Fleming, R.A. 1985. How should one view the historical role of spruce budworm outbreaks? In: Saunders, C.J.; Stark, R.W.; Mullins, E.J.; Murphy, J., eds. Recent advances in spruce budworms research. Proceedings, CANUSA Spruce Budworms Research Symposium; 1984 Sept. 16-20; Bangor, ME. Ottawa, ON: Canadian Forestry Service: 136-137.

Harvey, G.T. 1985. The taxonomy of the coniferophagous *Choristoneura* (Lepidoptera: Tortricidae): a review. In: Saunders, C.J.; Stark, R.W.; Mullins, E.J.; Murphy, J., eds. Recent advances in spruce budworms research. Proceedings, CANUSA Spruce Budworms Research Symposium; 1984 Sept. 16-20; Bangor, ME. Ottawa, ON: Canadian Forestry Service: 16-48.

Hawksworth, F.G. 1958. Rate of spread and intensification of dwarf mistletoe in young lodgepole pine stands. Journal of Forestry 56:404-407.

Hawksworth, F.G. 1961. Dwarf mistletoes of ponderosa pine. In: Recent advances in botany. University of Toronto Press: 1537-1541.

Hawksworth, F.G; Weins, D. 1972. Biology and classification of the dwarf mistletoes (Arceuthobium). Agric. Handbk. 401. Washington, DC: U.S. Department of Agriculture, Forest Service. 234 p.

Heinselman, M.L. 1978. Fire intensity and frequency as factors in the distribution and structure of northern ecosystems. In: Proceedings of conference on fire regimes and ecosystem properties. Gen. Tech. Rep. WO-26. Washington, DC: U.S. Department of Agriculture, Forest Service: 7-57.

Houston, D.R. 1987. Forest tree declines of past and present: current understanding. Canadian Journal of Plant Pathology 9: 349-360.

Leopold, A. 1949. A Sand County almanac and sketches here and there. New York: Oxford University Press. 226 p.

Miller, P.L. 1973. Oxidant-induced community change in a mixed conifer forest. In: Advances in Chemistry Series 122, Air pollution damage to vegetation. Washington, DC: American Chemical Society: 101-117.

Millers, I.; Shriner, D.S.; Rizzo, D. 1989. History of hardwood decline in the eastern United States. Gen. Tech. Rep. NE-126. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 75 p.

Monnig, E.; Byler, J. 1992. Forest health and ecological integrity in the Northern Rockies. FPM Report 92-7. R1-92-32. Missoula, MT: U.S. Department of Agriculture, Forest Service, Northern Region. 18 p.

Mutch, R.W. 1992. Sustaining forest health to benefit people, property, and natural resources. Paper presented at the Fire Working Group Technical Session, Society of American Foresters' National Convention. 1992 October 25-28.

Nettleton, W.A. 1988. Southern pine beetle. In: Forest health through silviculture and integrated pest management: supporting apppendices. Washington, DC: U.S. Department of Agriculture, Forest Service: D1-D20.

U. S. Department of Agriculture, Forest Service. 1991. Pest risk assessment of the importation of larch from Siberia and the Soviet Far East. Misc. Publ. 1495. Washington, DC.

U. S. Department of Agriculture, Forest Service. 1992. Pest risk assessment of the importation of *Pinus radiata* and Douglas-fir logs from New Zealand. Misc. Publ. 1508. Washington, DC.

Wickman, B.E. 1992. Forest health in the Blue Mountains: the influence of insects and disease. Gen. Tech. Rep. PNW-GTR-295. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 15 p.

Wilson, R. 1991. Opening remarks. Proceedings, California Pest Council Annual Meeting: 2-4.

Witter, J.A.; Ragenovich, I.R. 1986. Regeneration of Fraser fir at Mt. Mitchell, North Carolina, after depredations by the balsam woolly adelgid. Forest Science 32:585-594.

APPENDIX ONE

Glossary

ABIOTIC DISEASES
Diseases caused by environmental conditions or factors such as atmospheric deposition and pollution, nutrient imbalance, adverse temperatures, lightning, soil compaction, and flooding.

BIOTIC DISEASES
Diseases caused by pathogens.

ECOSYSTEM MANAGEMENT
Ecosystem management is the operating philosophy of the Forest Service for stewardship of lands and resources to achieve environmentally sound multiple-use management of the National Forest System. Ecosystem management means using an ecological approach to achieve the multiple-use management of national forests and grasslands by blending the needs of people and environmental values in such a way that these lands represent diverse, healthy, productive, and sustainable ecosystems.

EXOTIC FOREST PESTS
Those forest pests not native to the North American continent.

FOREST PESTS
Insects and related organisms and pathogens that damage trees and have the potential to be detrimental to ecosystem integrity or to achievement of resource management objectives. Many organisms, though detrimental to individual trees, do not necessarily have serious effects on the health of the forest.

INTEGRATED PEST MANAGEMENT
Decision-making and action process incorporating biological, economic, and environmental evaluation of pest–host systems to manage pest populations.

INTRODUCED FOREST PESTS
Exotic pests that have become established on the North American continent.

PATHOGENS
Biotic agents capable of causing disease, usually parasitic fungi, bacteria, viruses, and other microorganisms, and parasitic seed plants (e.g., mistletoes) but not insects and related organisms.

APPENDIX TWO

Additional Reading

Those who would like to read further on forest health and related topics may want to start with some of the following sources:

Baskerville, G.L. 1975. Spruce budworm: super silviculturist. Forestry Chronicle 51:138-140.

Byler, J.W.; Zimmer-Grove, S. 1991. A forest health perspective on interior Douglas-fir management. In: Proceedings of symposium on interior Douglas-fir the species and its management. Spokane, WA: Pullman, WA: Washington State University, Department of Natural Resource Sciences and Cooperative Extension: 103-108

Dubos, R. 1987. Mirage of health: utopias, progress, and biological change. New Brunswick, NJ: Rutgers University Press. 282 p.

Hepting, G.H. 1963. Climate and forest diseases. Annual Review of Phytopathology 1:31-50.

Hepting, G.H. 1964. Damage to forests from air pollution. Journal of Forestry 62: 630-634.

Holling, C.S., ed. 1978. Adaptive environmental assessment and management. New York: John Wiley & Sons. 377 p.

Houston, D.R. 1981. Stress triggered tree diseases: the diebacks and declines. NE-INF-41-81. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 36 p.

Houston, D.R. 1986. Recognizing and managing diebacks/declines. In: Proceedings of integrated pest management symposium for northern forests; 1986 March 24-27; Madison, WI. Madison, WI: University of Wisconsin Cooperative Extension Service: 153-166.

McGregor, M.D.; Cole, D.M. 1985. Integrating management strategies for the mountain pine beetle with multiple-resource management of lodgepole pine forests. Gen. Tech. Rep. INT-174. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 68 p.

Smith, D.M. 1976. Changes in eastern forests since 1600 and possible effects. In: Anderson, J.F.; Kaya, H.K., eds. Perspectives in forest entomology. New York: Academic Press: 3-20.

Smith, W.H. 1974. Air pollution-effects on the structure and function of the temperate forest ecosystem. Environmental Pollution 6:111-129.

Smith, W.H. 1985. Forest quality and air quality. Journal of Forestry 83:82-92.

Swaine, J.M. 1933. The relation of insect activity to forest development as exemplified in the forests of eastern North America. Scientific Agriculture 14: 8-31.

APPENDIX THREE

Development of This Plan

This strategic plan was developed under the direction of the Forest Health Steering Committee and the Ecosystem Management Task Team on Forest Health.

FOREST HEALTH STEERING COMMITTEE

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Jim Howard
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USDA Forest Service, Legislative Affairs

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Jerry Williams
USDA Forest Service, Fire and Aviation Management

Thomas A. Dupree, John H. Cashwell, and ***Dave Struble*** represented the National Association of State Foresters during development of this strategic plan.

APPENDIX FOUR

Accomplishments Under the 1988 Forest Health Strategic Plan

Eight strategic issues were identified in the 1988 Forest Health Strategic Plan. Some of the most significant accomplishments since 1988 addressing these issues are described below:

PLANNING

Tree mortality and growth loss caused by pests are now considered within growth and yield models for several forest areas. This capability is available for use during the next National Forest System land management planning cycle.

Forest Pest Management regional offices were decentralized and additional staff members were added as part of a national effort to make Forest Pest Management specialists more available to resource managers and strengthen pest prevention through involvement in forest plan development and implementation. Between the end of 1987 and end of 1990, the number of Forest Pest Management field offices was increased from 8 to 18, and 27 new permanent positions were established nationwide. The additional staff members, combined with moving existing regional office staff to field offices, resulted in a shift from a majority of pest management specialists being located in headquarters offices to a majority being located in field offices. Regional staffs report that the decentralization and addition of staff has led to significantly greater input by pest management specialists to interdisciplinary resource planning teams.

A Forest Pest Management and Land Management Planning Workshop provided recommendations for strengthening consideration of forest health during forest plan implementation and monitoring.

PUBLIC INVOLVEMENT

A 1-hour documentary video was developed to inform the public on the dynamics of forest ecosystems, including subjects such as atmospheric deposition, southern pine beetle, mountain pine beetle, wildfire, and wilderness. The documentary, entitled "Are We Killing America's Forests," has been shown on PBS.

Forest Service public involvement policy on pest suppression was clarified. A public participation plan is now required for all forest pest suppression projects on national forests.

Forest Service Northern Region prepared *Forest Health and Ecological Integrity in the Northern Rockies.* Written in popular format, this publication has been distributed widely beyond the

Northern Region. The publication discusses the ecology of ponderosa pine, lodgepole pine, and western white pine, particularly the role of forest pests and wildfire and influence of management practices.

RESOURCE MANAGEMENT

Decision support systems for integrated pest management were developed and are being demonstrated on several national forests.

An economic analysis conducted in 1988 examined the efficiency of incremental additions to Forest Pest Management program activities. The results led to the addition of Forest Pest Management staff to support resource managers. A second economic analysis was completed in 1992. It examined the efficiency of the overall program and identified opportunities to enhance efficiency by shifting expenditures among program activities.

PEST SUPPRESSION

Starting in fiscal year 1993, Congress has provided an Emergency Pest Suppression Fund similar to the Forest Service Emergency Firefighting Fund. The new fund could enable rapid response to unforeseen circumstances such as those associated with pest infestations and drought, or introduced pests.

Suppression continued to provide protection of high-value resources where management objectives are threatened. All suppression projects met the Forest Service's criteria of being biologically sound, economically efficient, and environmentally acceptable.

ENVIRONMENTAL ANALYSIS

Programmatic NEPA documents have been completed, or are in progress, for pest management in most National Forest System seed orchards and nurseries.

An interdisciplinary team has been established to prepare a new Environmental Impact Statement for national gypsy moth management and eradication programs. The Forest Service and the USDA Animal and Plant Health Inspection Service are jointly conducting the environmental analysis.

PESTICIDES

Significant progress was made in development of pheromones and other behavioral chemicals. These materials show strong promise for managing populations of bark beetles, low-level gypsy moth populations, and other pests.

Application technology was significantly improved with application rates and volumes reduced; this significantly reduced suppression costs and lessened environmental impacts.

Production of GYPCHEK, a biological insecticide used against the gypsy moth, was continued by the Forest Service pending commercial production.

PEST CONTROL TECHNOLOGY

Pest management technology development was significantly expanded. National pest technology development steering committees were established to review progress and recommend priorities. About 30 technology development projects are being carried out by Regional forest pest management staffs each year. Many of the projects are done jointly with Forest Service Research and provide for rapid movement of new research findings into application.

The National Center of Forest Health Management was established in West Virginia. The new center will facilitate development and application of integrated pest management technologies for problems of national importance such as gypsy moth, western spruce budworm, and southern pine beetle.

FOREST HEALTH MONITORING

A Forest Health Monitoring Program was initiated in 1990 in the 6 New England States and has now been implemented in 14 States. The program is a cooperative effort between the Forest Service, the State Foresters, and the U.S Environmental Protection Agency.

The Growth Story

These historical photographs document forest succession when fire is controlled and pines are cut selectively (see the fire cycle on page 11). They were taken from the same place near Lick Creek on the Bitterroot National Forest in Montana, looking southward.

Year 1909 *—Introduction (page x)*
The Lick Creek area was covered by an open ponderosa pine stand that was cut selectively in 1907 or 1908. The pines are scarred by fire and Douglas-fir are scarce.

Year 1927 *—Forest Health Concerns (page 8)*
Douglas-firs have regenerated, markedly changing the understory. Grasses and forbs persist on the ground, but are being replaced by bitterbrush and snowberry.

Year 1938 *—Strategic Goals & Actions (page 22)*
Douglas-fir understory continues to increase in size and density. Overstory trees continue to die.

Year 1948 *—Implementation (page 42)*
Original view now obstructed by young Douglas-fir. Snowberry predominates in ground cover.

Photographs from the National Agricultural Library, Forest Service Photographic Collection.