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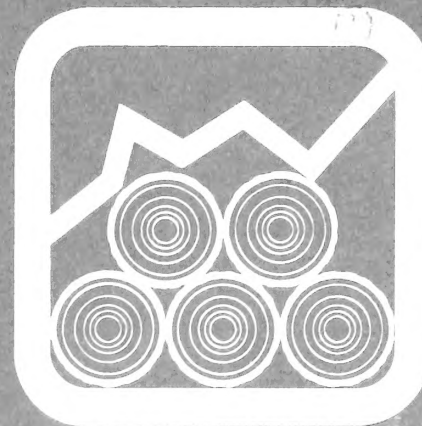
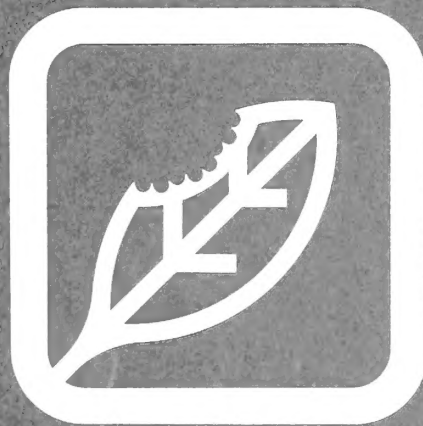
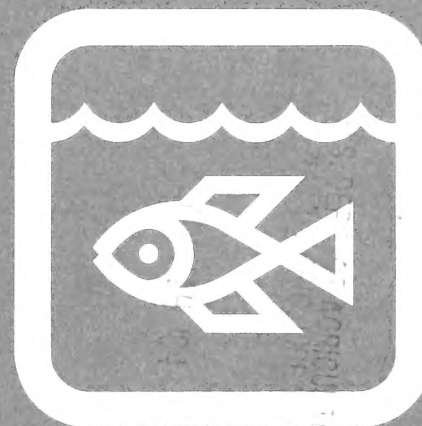
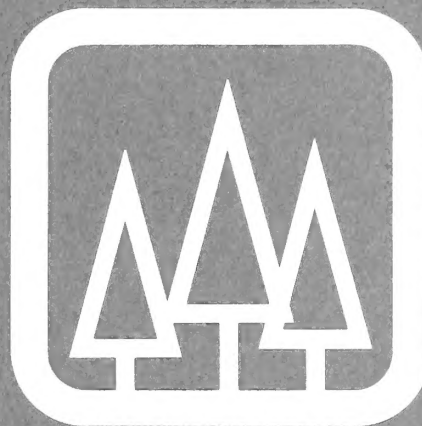
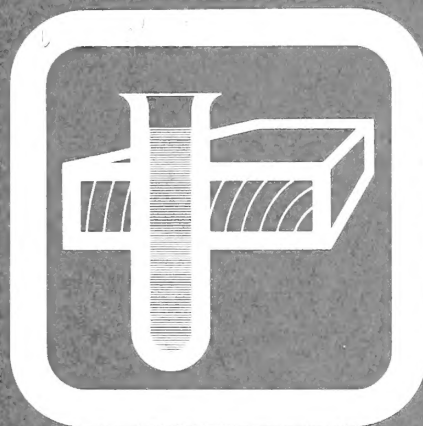
Forest
Service

General
Technical
Report
WO-41



Research for Tomorrow's Forests

1983 Research Accomplishments



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United States
Department of
Agriculture

Forest Service

General Technical
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July 1984

Research for Tomorrow's Forests

1983 Research Accomplishments

Foreword

In this booklet you will find more than 50 highlights of our research projects. They are samples of the studies that our scientists and cooperators are doing to ensure a better job of resource management in the future. The listing of our research publications beginning on page 54 will give you an even more comprehensive look at the extent and depth of Forest Service research carried on in our eight regional Experiment Stations and in the Forest Products Laboratory. (A map of principal Research headquarters and field offices is on page 235.)

Our research takes several approaches in solving the problems of future management. Most often we undertake original research by analyzing the problem, experimenting carefully, then testing and applying the findings. Or, in cases where much research has already been done on parts of problems, we may gather and synthesize earlier findings that have yet to be applied. Our research has uncovered new ways to stretch limited management dollars, such as in appraising wildfire effects and making wildlife and recreation management more cost effective.

Basic research--because it can open whole new areas in the use of natural resources--continues to be an indispensable part of our program. Research in basic biotechnology, for example, may provide us with several ways to use the enzyme that degrades the lignin in wood--an enzyme that has been newly discovered by our scientists and that shows promise for many industrial applications.






The increasing demands on our renewable resources will make innovative research like this more important than ever in managing tomorrow's forests.



R. Max Peterson

Chief

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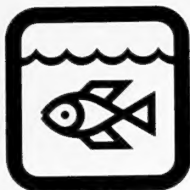
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Acknowledgment

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Environment

Predicting Winter Survival of Hawks and Owls

Forest Service managers must ensure viable populations of wildlife species, as required by the National Forest Management Act. However, they are hampered by how little is known about habitat and energy needs of raptors, or birds of prey. Forest managers who contemplate changing the habitat need to know whether a raptor will use the new habitat and whether there is sufficient prey for the raptor to survive during winter, an especially crucial period.

Scientists at the North Central Station and the University of Missouri have determined the energy requirements and habitat preferences of Missouri raptors. They found that each species meets its winter energy demands in a different way. The red-tailed hawk, for example, migrates farther south in the winter than the great horned owl. Although they are ecological counterparts (both live in forests and hunt in openings), the red-tail lacks the energy-saving adaptations of the great horned owl--better thermal insulation and a sit-and-wait hunting technique.

The research by Station and University scientists on raptor energy requirements and on the abundance of prey in various habitats formed the foundation for a model to predict whether a raptor can survive the winter in a given habitat. Armed with this new tool, Forest Service managers are able to modify their management practices to ensure enough of the right habitat for the birds to survive during winter.



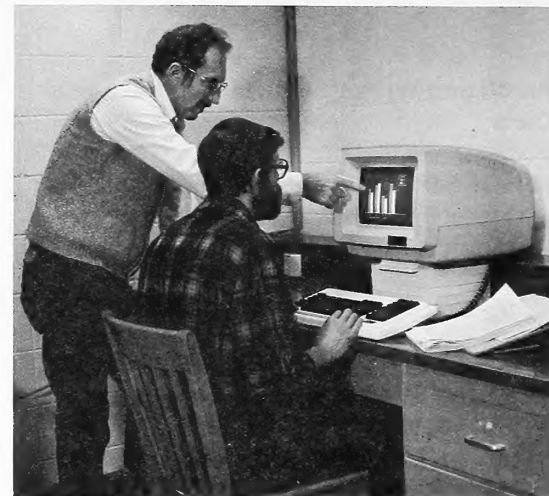
The radio pack on this red-shouldered hawk will help researchers study what habitats the bird prefers.

Variations on the Acid Rain Theme

Before ways to control acid rain are developed by the United States and Canada, its sources and cause must be better understood. The chemicals that fall from the atmosphere in rain and snow vary greatly, depending on their sources and the type of storm. Researchers at the North Central and Northeastern Stations are learning that there are important regional differences in the cause of acid rain.

In north central Minnesota, alkaline dust from the arid West sometimes neutralizes the acid (hydrogen ions) in the rain. Scientists in the North Central Station have developed a method to separate "dusty" rain samples from "clean" ones. (The dusty ones contain only 10 percent of the hydrogen ions falling so that most of the acid is in the clean samples.) These clean samples of acid rain in Minnesota reveal that the acidity is caused primarily by nitrates and not by sulfates. Nitrates in acid rain are derived chiefly from the burning of gasoline and natural gas, while sulfates come mainly from the burning of high-sulfur coal. Acid rain caused by sulfate can acidify lakes, while nitrates (a common fertilizer) are quickly utilized by vegetation without the water becoming acid.

In New England, alkaline dust has less influence on rainfall than in Minnesota. More important for acid rain are the type of storm and direction it comes from, as studies in central New Hampshire show. Precipitation from the north-northwest through northeast was "cleanest" (pH 4.4), while storms from the south (between Boston and New York City) and south-southwest (through New York City) were most acid (pH 4.0). Rain from short thunderstorms was usually more acid than rain from long-lasting frontal storms; in fact, sulfate concentrations were four times greater in thunderstorms. Acid rain is greatest in summer in the Northeastern United States because thunderstorms prevail then, atmospheric sulfates are high, and stormwinds are most often southerly to westerly.



Evaluating the impact of acid rain is easier now that scientists have found precise ways to compute the amount of acidifying chemicals in rain samples.

Revegetating Bentonite Mine Spoils: A New Lead

Bentonite mine spoils in the northern Great Plains are difficult to revegetate and reclaim. Although the spoils are not deficient in nutrients, their physical and chemical properties are poor. Plant succession is slow on them for other reasons too: topsoil is scarce, rainfall is low, and there is livestock grazing. Steep spoils mined 30 years ago remain barren and eroded.

Reclamation efforts (contouring, top soil spreading, seeding) by researchers in the Rocky Mountain Station have shown promise of overcoming low pH, soil salinity, high sodium and sulfur concentrations, and soil compaction. But none of the plants that were intentionally seeded by scientists on the reclaimed spoils survived better or was more productive than rillscale, a native broadleaved herb that seeded in on its own.

The success of rillscale, regardless of the age of the spoil or reclamation treatment, shows that revegetation is possible in this harsh environment. However, more than 75 years may be required to restore these disturbed sites to productive sagebrush grasslands once again.



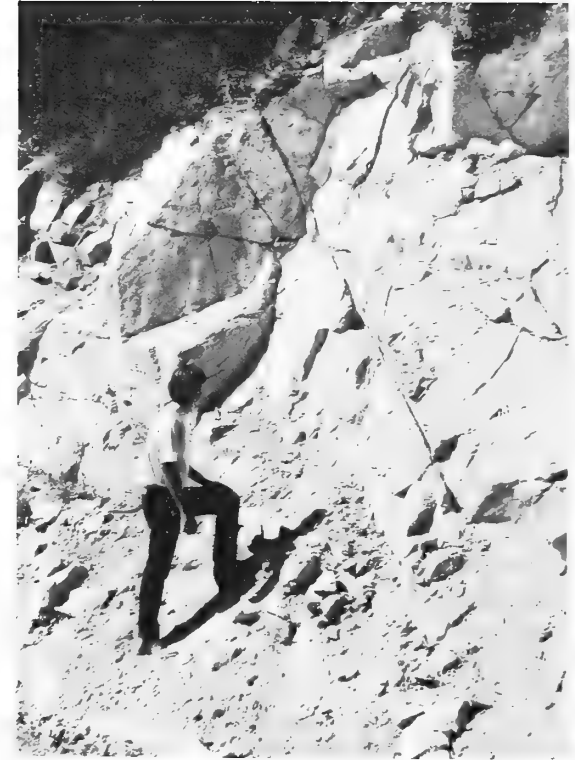
Native plant rillscale is the most successful colonizer on the bentonite mine spoils.

Geophysical Exploration: How Firm a Foundation?

On steep, unstable, granitic slopes in central Idaho, locating and designing roads to minimize erosion and sediment production is extremely important. One crucial but largely neglected factor has been subsurface rock properties on these slopes. Underground rocks that have weathered or altered enough to contain sufficient clay can become "plastic" and collapse after a disturbance such as roadbuilding.

Researchers at the Intermountain Station found that a combination of seismic and resistivity surveys can predict zones of weathered rock and provide information about its strength and the subsurface water content. Previously, geophysical surveys using only one technique had not proved particularly valuable for predicting the degree of rock weathering or zones of subsurface water flow requiring drainage. By combining the two survey techniques, scientists allow the strengths of one to compensate for the weaknesses of the other and improve the interpretation of results.

These research findings cut the cost of road repairs substantially, particularly in areas where engineers have little experience or prior knowledge about subsurface conditions. In addition, engineers can now predict accurately (without preconstruction data) where to locate underground drains.



Two geophysical survey techniques can predict the properties of subsurface rocks and cut the costs of road repair.

Getting More Water From Rocky Mountain Forests

Harvesting timber increases water yield by reducing evapotranspiration and altering soil moisture patterns. Especially in the West, this spinoff from timber harvesting is a major resource. Rocky Mountain Station scientists have pioneered the research on integrating high-elevation timber harvests with other resource uses, including water and wildlife.

A pilot-scale application of research findings on a 41-hectare watershed on the Fraser Experimental Forest in Colorado now has verified the performance of the Subalpine Water Balance Model for predicting water yield increases after timber harvest. Trees were harvested in small, circular patches covering 36 percent of the watershed area. Diameter of the patches was about five times the height of the trees. These small holes in the canopy create turbulence and trap snow blowing over the forest. When these snowdrifts melt in the late spring, they feed streams rather than trees.

The Subalpine Water Balance Model had predicted a 4.3-centimeter increase in water yield in an average year; for the 4 years since treatment, the flow increase has averaged 4.6 centimeters, with no effect on peak flow. Significantly more snow accumulated in the cut opening, but mean peak water equivalent on the watershed was not altered, substantiating research understanding of snow redistribution processes.



Small openings cut in mountain forests trap blowing winter snows in deep drifts to prolong snow melt into summer.

New System of Monitoring Bird Populations and Habitat

The National Forest Management Act requires that wildlife on National Forests be monitored to ensure that no species are endangered by forest management and to verify that wildlife species respond to planned activities. However, it is prohibitively expensive to monitor populations of many species of wildlife over an area as large as a National Forest with usual census methods. The Pacific Southwest Station has developed a new approach which, if applied nationwide, could reduce costs of monitoring birds by 50 to 75 percent.

The idea is to group together all bird species that use similar parts of the habitat for the same purposes (either feeding or nesting) and then count all individuals (no matter what species) in the group. Such groupings are called guilds, examples of which include birds that primarily use either the ground, shrubs, tree trunks, or foliage.

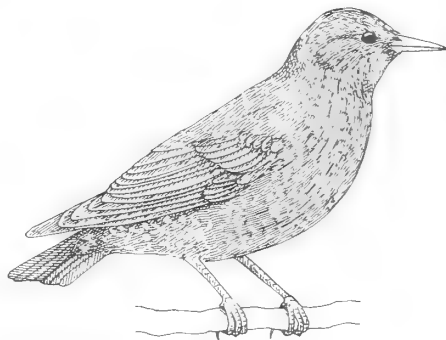
Monitoring trends in guilds provides important information on the ability of individual zones of a habitat to support the birds that inhabit that zone. In addition, because all birds are counted during field sampling (which costs no more than counting only one species), Forest Service managers may be able to evaluate evidence of declines in individual species as well.



American Kestrel



Screech Owl



Starling



Common Flicker

This group of birds, or "guild," includes those that feed on the ground and nest in tree boles and limbs.

Applying What We Already Know About Rangelands

Managing the rangelands of the Great Basin has been hampered because we do not know enough about them and because what we do know has not been fully applied. As a result, range quality and the range's ability to produce livestock and wildlife have declined. In recent years the public has been displeased over the condition and use of publicly owned rangelands and concerned about protecting and increasing all rangeland values.

In an effort to make useful what is already known about rangelands, the Intermountain Station has published a summary paper "Managing Intermountain Rangelands--Sagebrush-Grass Ranges," GTR-INT-134. Sagebrush-grass vegetation makes up one of the largest ecosystems in the Great Basin and has been the subject of considerable research during the past half century. Much of this ecosystem was abused during early settlement; and much is still far below its potential in forage production, wildlife habitat, and environmental quality.

This summary distills for rangeland managers and users the most important information already available. Besides summarizing methods of rehabilitating, converting, and managing sagebrush, it also serves as a manager's reference and guide to research results. Included, for example, is the latest on sagebrush taxonomy and classification of sagebrush ecosystems.

This first-in-a-series of summary publications on managing Great Basin rangelands does for users and managers what they do not have the time or inclination to do for themselves--digest the most useful knowledge from over 1,250 earlier papers.



Sagebrush vegetation can provide excellent forage. Here, sheep eat seed stalks of black sagebrush in Utah.

New Plants Will Help To Improve Intermountain Ranges

Three range plants have been given to commercial growers so they can produce and distribute certified seed in the Intermountain West. Adapted to arid sites (10 to 15 inches of rainfall), the three plants will serve as forage for livestock and wildlife and help to control erosion.

The Intermountain Station, USDA Soil Conservation Service, the Utah Division of Wildlife Resources, and other agencies released the plants after 15 to 20 years of tests that determined the best varieties for certain purposes. All three are widely adapted to conditions in the Intermountain area.

"Ephraim" crested wheatgrass was selected over other crested wheatgrasses because of its ability to produce rhizomes. It is particularly valuable for stabilizing disturbed sites. "Paiute" orchardgrass is adapted to drier conditions than other orchardgrasses and provides a longer period of green forage and better fall greenup on dry sites than the crested wheatgrasses. "Rincon" fourwing saltbush was selected for its sustained biomass production, wide adaptation, and forage quality.



Seeds are plentiful on a 3-year-old "Rincon" fourwing saltbush plant, useful for its forage quality and sustained production.

Acid Mine Drainage Not a Major Problem in Appalachian Watersheds

An analysis of streams from surface-mined watersheds throughout the Appalachian coal mining region has shown that streams are less acid than commonly believed. Research reports from the Northeastern Station show that at least two-thirds of streams draining both mined and unmined watersheds have pH values exceeding 6 (mildly acid). Values averaged 6.3 on pre-1972 mined watersheds, 6.7 on watersheds mined from 1972 on, and 7.0 (neutral) on unmined watersheds. In general, streams from watersheds mined after January 1972 are more favorable for aquatic life (less acid) than those from watersheds mined earlier. The pH values of streams in all categories also tend to be grouped in accordance with geologic boundaries.

The reports are being used as baseline information by miners, consultants, environmentalists, regulatory agencies, and others. Also, the data are useful as a basis for future water quality studies. Some States are trying to obtain permission from the U.S. Office of Surface

Mining to use these data in lieu of some of the pre-mining water sampling now required as part of mining permit applications. Besides the published reports, this information has been disseminated in training sessions to mining operators and regulatory personnel in Kentucky and West Virginia, and sessions are planned for other States in Appalachia.



At least two-thirds of streams draining mined and unmined watersheds are above pH 6 (only mildly acid).

What Makes an Urban Park or Forest Visitor Feel Safe?

Fear of crime and antisocial behavior in urban parks and forests is a serious barrier that prevents many people from using the parks and detracts from the enjoyment of those who do. Urban forest managers could encourage more enjoyable use of parks and forests if they could relate the park environment to how safe people feel.

The North Central and Southeastern Stations jointly studied how people reacted when they were shown color slides of urban parks and forests. Analysis showed, for example, that dense vegetation increases fear for most people, but some feel safest in heavily wooded, undeveloped forest. Most people feel safer when there are buildings, cars, or other people nearby, as long as the park and nearby structures are well maintained and free of graffiti.

The results of this research will provide guidelines for managers seeking to improve park safety (both real and perceived) while maintaining esthetically pleasing landscapes. Trees and other vegetation are essential for esthetic quality; and if they are properly placed and trimmed, they need not interfere with the visibility that most people need in order to feel safe in a park.



A park can be experienced as both safe and beautiful if trees are placed and trimmed so they do not interfere with visibility.

Report Fosters Cooperation Among Wilderness Managers

The National Wilderness Preservation System, encompassing about 80 million acres, contains diverse ecosystems and supports many uses. Each of the four agencies that manage wilderness areas imposes its own mandates and policies. This results in a decentralized system loosely united through the general provisions of the Wilderness Act.

To understand how individual wilderness areas fit into the national system, researchers at the Intermountain Station surveyed managers of all wilderness units. The managers answered questions about their management situations, problems, and techniques.

The survey shows that most wilderness units share common problems. Resource degradation and loss of solitude are troublesome in most areas. Despite similar problems, however, managers responded differently because of differing philosophies among agencies. The National Park Service manages most restrictively; its philosophy emphasizes resource protection. The Forest Service emphasizes freedom of choice for the user, so is less restrictive, while the Fish and Wildlife Service emphasizes preservation of wildlife on its lands.

The survey suggests that managers should share their common experiences in managing wilderness. More communication and cooperation between areas with similar problems would improve management. The survey helps managers to identify areas with similar problems and areas where various management techniques have been tried. This allows managers to profit from each other's experiences and should ultimately lead to a more consistently and efficiently managed wilderness system.



Even though wilderness areas are physically diverse and are managed according to different philosophies, they have many problems in common.

Growing Timber and Protecting Water Quality—Are They Compatible?

The southern coastal plain of the United States extends far up the Mississippi Valley to southern Illinois; it includes, for example, most of the State of Mississippi. The hardwoods that originally covered the area were cleared for agriculture. Poor farming practices often led to severe erosion and eventual abandonment. Since the 1930's and 1940's large areas of this eroded land have been planted to pines. Now that pine management is an important contributor to the local economy, forest managers need to know what impact managing pine has on water quality and site productivity of the coastal plain.

To begin answering this question, scientists at the Southern Station have gathered baseline data on nutrient and sediment yields from streamflow on five undisturbed pine plantation watersheds. These are being compared with yields from sites disturbed by management activities such as timber cutting and site preparation. Results so far show that careful harvesting methods do not reduce water quality, but that site preparation methods necessary to maintain water quality have yet to be worked out.

Regarding nutrients, the concentration of nitrogen and the biological oxygen demand of streamflow from the undisturbed watersheds were well within the limits recommended for protection of aquatic life. Concentration of phosphorus, however, approached these limits. Most phosphorus, half the nitrogen, and a third of the organic carbon were lost in the sediment, showing that soil disturbance must be minimized during management. Researchers developed an equation that can be used to predict sediment-related losses of nutrients, even in watersheds differing in soils and hydrology. This is currently being used by regulatory agencies that establish water quality standards in Coastal Plain States.



By sampling nutrients in streams researchers found that careful timber harvesting does not reduce water quality.

The Forest Floor: A Home for Many Species

Knowing the habitat needs of wildlife is essential to meet the requirements of the National Forest Management Act, which states that we must maintain viable populations of native species. The role of amphibians and reptiles in the forest ecosystem is not yet well understood, but we do know they are an important food for wildlife such as raccoons, wading birds, and thrushes. A species such as the red-shouldered hawk feeds largely on frogs and salamanders. To learn more about the kinds of habitat used by different reptile and amphibian species, the Northeastern Station is studying these animals in the major forest types of the Northeast.

In a 125-acre study area in New Hampshire, scientists counted over 2,000 individuals of 11 different species; the most common species included the wood frog, American toad, and red-back salamander. The different species differed greatly with respect to the number of individuals inhabiting different forest types. Most species, for example, were found more frequently in hardwood types. Litter depth seems to be more related to the abundance of amphibians than other features of habitat, but research is continuing to determine the habitat requirements of these lesser known species. Could a forest management practice such as whole-tree

harvesting have a serious impact on salamanders that breed in rotten, fallen logs, for example? Researchers will eventually be able to answer these questions for forest managers.



Trapping is one step in determining the habitat requirements of amphibians and reptiles.

Mountain Meadows in the Sierra Nevada of California

The vegetation and diverse habitats of mountain meadows in the Sierra Nevada make them concentration points for people and animals. Abundant forage attracts livestock and wildlife, while the scenery attracts hikers and campers. Pack trippers and their animals are also drawn to them. As a result, many meadows have deteriorated and some suffer from overuse.

Since the early 1960's, Pacific Southwest Station scientists have been involved in research to improve meadow management. A comprehensive work, "Mountain Meadows in the Sierra Nevada of California," will soon be published to summarize knowledge about meadows for land managers. A portion of the guide will deal with techniques that land managers can use to help restore deteriorated meadows. Some meadows have been so trampled by livestock and people that sod and soil are seriously affected. Erosion has moved nutrients from place to place and eventually altered the kinds of plants that grow there. Other meadows are being invaded by lodgepole pine seedlings, whose establishment is favored by low snowpacks and early melting. Restoration can be a slow process because the higher mountain meadows lie, the lower their productivity and the longer it takes land managers to restore them to reasonable use.

In addition to helping land managers in the Sierra Nevada ensure the future productivity of meadows, the new guide will classify meadows according to soil and vegetation characteristics and describe how biologically and geologically stable they are. It will also categorize more than 200 plants into "decreasers," "increasers," and "invaders." Land managers can tell how "healthy" a meadow is by the relative sizes of these three groups of plants.



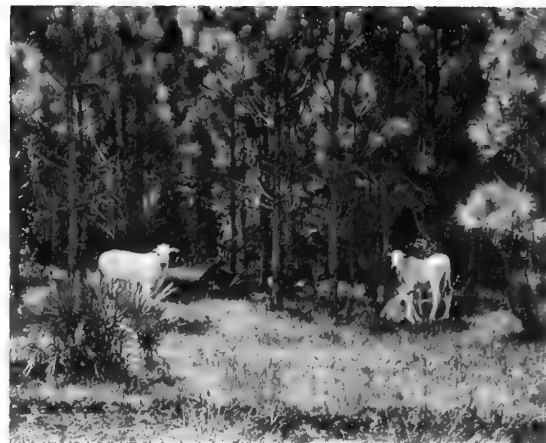
How frequently certain plants are found tells a lot about meadow conditions.

Prescribed Burning Improves Range Forage and Growth of Longleaf Pine Seedlings

On the coastal plain of the Southern United States, large amounts of cattle forage can be produced beneath young pine stands or under older stands in which the trees are widely spaced. To keep forage quality high, however, pine pastures must be burned every 1 to 3 years. Prescribed burning removes old vegetation and pine litter so livestock can more readily graze the new green growth. Winter burning increases forage yields, while summer burning boosts forage quality. Continuous moderate grazing after periodic burning helps keep forage plants producing new growth. It also aids cattle in maintaining their weight throughout the summer without supplements on what appears to be protein-deficient forage.

People considering joint production of pine and cattle in the region have raised the question--what about the effects of repeated burning and grazing on the productivity of the soil? Long-term studies by the Southeastern Station indicate that productivity is not lost. Even though frequent burning greatly reduces the amount of organic matter in the forest floor, a 40-year study shows that burning followed by grazing has no detrimental effects on nutrient budgets or on pine growth. In fact, burning may improve pine growth by mineralizing nutrients that would otherwise be tied up in the forest floor.

Scientists at the Southern Station also learned that longleaf pine seedlings in the "grass" stage on the range responded better in both survival and height growth to May burning than to the commonly practiced March burning. Moreover, scientists have found that two or three annual fires in May, followed by fires at 2-year intervals, may be adequate and better than a series of annual fires over many years. As a result of these findings, scientists are now recommending May burning for longleaf pine sites on the National Forests of the coastal plain.



Burning at the right time removes litter and encourages growth of forage for cattle. It also gives a boost to longleaf pine seedlings.

Access to Recreation for All

Most visitors to recreation areas seek recreation, refreshment of spirit, and enjoyment of natural resources. In this respect, handicapped individuals are no different from nonhandicapped visitors. Unfortunately, there are barriers to access for the handicapped in many areas and facilities, and handicapped citizens may find they are unable to avail themselves of the recreation opportunities nonhandicapped persons take for granted.

With this in mind, the Northeastern Station, along with the University of New Hampshire and several other State, private, and Federal agencies, studied the problem of accessibility by handicapped people to recreational resources in New Hampshire. They came up with recommendations on how to remove barriers and provide aids for the handicapped. They also published a guide for handicapped visitors to the New Hampshire State Parks and to areas in the White Mountain National Forest. The guide has been widely disseminated. The study procedures could be duplicated elsewhere in order to help improve accessibility for the handicapped, not only in New Hampshire but regionally and nationally as well.



A new guide for handicapped users of recreation areas recommends ways to remove barriers and provide aids.

Keeping the "Wild" in Wilderness Campsites

One of the wilderness manager's most vexing problems is deciding what to do about overused campsites. Without action, the goal of preserving natural conditions in wilderness areas cannot be achieved.

Researchers at the Intermountain Station have conducted studies in the northern Rockies to develop guidelines on how managers can control campsite impacts. The results show that just a little use can cause considerable damage, and that beyond this threshold a lot more use causes only a little additional damage. For example, in the Eagle Cap Wilderness, campsites used only a few times a year had a 9-percent vegetation cover, while campsites used up to 50 times more frequently still retained a vegetation cover of 4-percent.

This suggests that managers can minimize ecological change in heavily used parts of backcountry areas by limiting use to a few sites. If they do not take this action, campers will begin to camp everywhere at popular destinations. In one study, 221 campsites were found in a 325-acre area around two Eagle Cap Wilderness lakes, even though typical use was fewer than 10 parties per night. Dispersing use among a large number of sites seems appropriate only where use

is low, ecosystems are resistant, and campers are familiar with low-impact camping techniques.

Parties using pack animals are particularly hard on campsites. This was demonstrated in a study in the Bob Marshall Wilderness, where sites used by stock parties were unusually large and had numerous damaged trees. Researchers have found that the most effective way to minimize these impacts is to educate users, particularly about the damage caused by felling trees and tying stock to trees. While there is much more to learn about what deteriorates campsites, managers in the northern Rockies are already putting these research results to use in their campsite management plans.



By concentrating use at a few campsites, managers can minimize ecological change in heavily used backcountry of the northern Rockies.



Insects and Disease

Sawfly Virus Is Registered With EPA

The European pine sawfly has been a minor, but recurring, pest of red and Scotch pines in the Northern United States. Christmas tree and municipal plantings have been a frequent target of this insect. It can be controlled by a nucleopolyhedrosis virus (NPV), a naturally occurring disease organism that spreads rapidly through sawfly populations.

Research at the Northeastern Station, in cooperation with several universities, State and Private Forestry, and Canada, culminated in registration of the virus product by the Environmental Protection Agency in 1983 for use by the Forest Service. The registered product has been given the name "Neochek-S."

The virus is highly virulent in sawflies and environmentally safe--one reason why it is in demand by watershed managers. It is highly effective at very low dosages and inexpensive to produce and use. Unlike a chemical insecticide, it has the advantage of spreading through the sawfly population after it is applied. Conventional ground or aerial equipment can be used to apply the virus in

formulations that do not require special protectants or additives other than "stickers"-- commonly used substances that keep the virus from washing off tree needles in the rain.



NEOCHEK - S

**BIOLOGICAL INSECTICIDE FOR
THE EUROPEAN PINE SAWFLY,
NEODIPRION SERTIFER**



Newly registered Neochek-S equals trouble for the European pine sawfly, but good news for forest trees.

Beetle and Decay Protection in Log-Kit Homes

Log-kit construction of homes is a new and growing billion-dollar industry. However, studies of recently constructed homes turned up frequent cases of wood-infesting beetles and decay, even including fungus fruiting bodies, on major structural components. Following up, scientists at the Southern Station and Mississippi State University undertook extensive research on how to prevent beetle and decay attacks.

The researchers came up with guidelines prescribing measures that owners should take to guard against insects and decay. These measures begin with choosing building designs and log shapes that do not trap moisture. Manufacturers should debark logs immediately after harvest and then use a three-step system that includes log drying and application of preservatives to protect against beetles and mold or mildew fungi. The guidelines end with maintenance measures that log-kit owners themselves can take at 4- to 5-year intervals to protect their investment in a home.



Fungus fruiting bodies on several logs and in the corner indicate advanced decay in a 5-year-old log house. Roof runoff onto log ends encourages decay.

Reducing Impacts of the Western Spruce Budworm

The western spruce budworm is the most widely distributed and destructive defoliating insect of true fir, Douglas-fir, and spruce forests in the West. In the northern Rockies alone, it has persisted for 3 1/2 decades on more than 10 million acres, substantially reducing the region's ability to meet demands for timber and other resources. Past use of insecticides has temporarily reduced budworm populations, but has not changed the course of the regional outbreak, or significantly reduced the problem.

In addition to evaluating past suppression efforts with chemical insecticides, Intermountain Station scientists have investigated the biology and ecology of the budworm and have appraised the alternatives to the use of insecticides. They have better defined insect-host-stand relationships and have developed equations predicting topkill, mortality, height growth, and regeneration vigor.

The findings indicate that the best long-term approach to reduce the impact of the budworm is through intensive silviculture--to create tree and stand conditions less favorable to the budworm and more favorable to the establishment and early development of vigorous young stands. Guidelines developed by Station scientists are being used

by managers to select silvicultural prescriptions that integrate the management of the budworm with sound forest practices.



Even-aged silvicultural systems, such as this seed tree cut in Montana, reduce susceptibility to western spruce budworm.

New and Cheaper Ways To Control Walnut Root Rots

Root rot boosts the cost of producing walnut seedlings by more than \$4 per thousand, or 17 percent of total production costs. For States that grow large numbers of walnut seedlings, these additional costs are significant.

Cooperating researchers at the North Central Forest Experiment Station, Purdue University, and Virginia Polytechnic Institute and State University have found that five different fungi are responsible for walnut seedling root rots. Scientists at these institutions have developed a guide for nursery managers that describes walnut root rot symptoms and shows managers how to identify the fungi that cause the diseases.

The guide also recommends cultural, biological, and integrated controls that could be less expensive than chemical controls. One example is the use of raised seedling beds. These promote good drainage after irrigation and avoid conditions that favor root rots. This and other recommendations in the guide are already being used by nursery managers in the Midwest to increase walnut production and reduce costs.



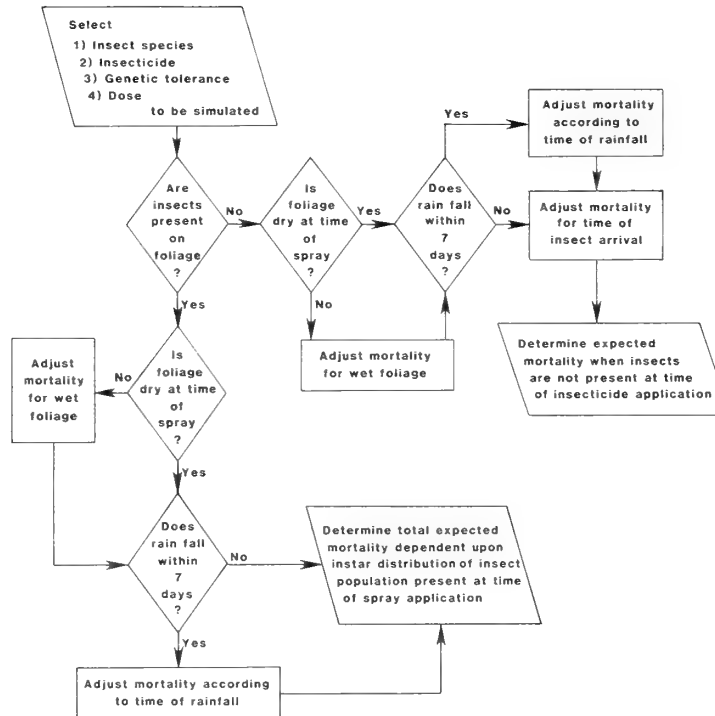
Preventing root rot in the nursery bed can mean substantial savings for States that grow many black walnut seedlings.

New Model Predicts Field Effectiveness of Insecticides

Many attempts based solely on laboratory test results have been made to predict the effectiveness of chemical insecticides on forest defoliators. Laboratory tests are considerably less expensive than field trials and, if well designed, could be used to plan and predict the results of field trials and ensure that desired insect mortality is attained at minimum cost.

Scientists at the Pacific Southwest Station and the University of Idaho, Moscow, have developed a probability model that predicts how efficient insecticides will be against western spruce budworm and Douglas-fir tussock moth populations during their seasonal development. The model is flexible and interactive. It can also be used to predict the effect of a chemical insecticide for any specified distribution of the immature larval stages.

This model will be useful both as a research tool and as an aid for forest managers specifically concerned with managing western spruce budworm or Douglas-fir tussock moth. The model predicts the results of actual field applications with 73- to 95-percent accuracy. The logic that this model uses should be adaptable to other forest defoliators, once comprehensive laboratory data bases have been developed for them.



To choose an insecticide for western spruce budworm or Douglas-fir tussock moth, foresters will be using this model.

Insects of Eastern Forests

When insect damage to trees is noticed, identification of the insect is the first step toward possible management. After the insect has been identified, information is needed to decide how serious the problem is and how to reduce or prevent further damage.

For this type of problem, an up-to-date reference book is invaluable. It should contain descriptions of pest species and their damage, their life histories, and general information on their control. The first comprehensive reference on forest insect pests in the Eastern United States was published in 1950 by F. C. Craighead as a USDA Miscellaneous Publication, "Insect Enemies of Eastern Forests." It was updated in 1972 by W. L. Baker and published under the title "Eastern Forest Insects."

Since then, a great deal more has been learned about forest insects, and the book has again been updated, this time by A. T. Drooz of the Southeastern Forest Experiment Station. The new volume, which contains an additional decade of research findings, will be available soon from the U.S. Government Printing Office under the title "Insects of Eastern Forests."



This tiny parasitic wasp, stinging the cocoon of an introduced pine sawfly, is important in biologic control.

Ferretting Out Information To Manage the Southern Pine Beetle

Recent infestations of the southern pine beetle prompted scientists in the Forest Service to develop a series of computer-based mathematical models that describe beetle population dynamics, stand growth, and utilization of beetle-killed timber. The models also rated stand hazard and evaluated the impact of the infestation. Access to these models was limited to research scientists because of the manner in which they were originally developed. To overcome this problem and make the models accessible to forest managers, Southern Station scientists and researchers at Texas A & M University developed a computer program called FERRET.

FERRET is an interactive system of questions and answers that leads users to the most appropriate model or models for their needs. At the present time, 28 models are available for use. Through FERRET, users have access to information for decisionmaking based on pest population dynamics, host dynamics, impact, overall management objectives, ownership, land use patterns, and user capabilities.

FERRET is useful for long-term resource planning as well as for crises. Likewise, it provides a means of evaluating management strategies and treatment tactics. Organizations currently using FERRET include forest industry, State forestry organizations, the Forest Service, and other Federal agencies.



A user interacts with the computer by punching in answers to questions about his timber stand and its beetle infestation.

Beetle-Killed White Spruce Retains Value for Pulp and Paper

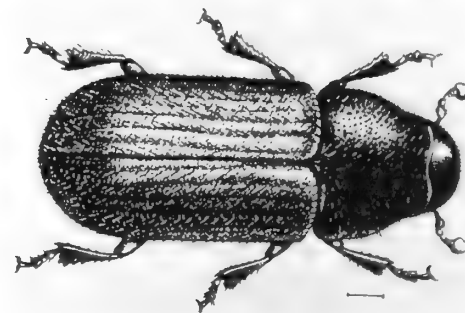
White spruce killed by spruce bark beetle infestations in south-central Alaska retain their value for making pulp and paper even after the trees have been dead for 50 years. Researchers for the Pacific Northwest Station have found no difference in pulp yields between trees dead for 1 year and those dead for as long as 50 years.

This finding is important because extensive stands of these dead white spruce are not accessible for logging at present, and there are currently no local paper mills or out-of-State markets for this material. However, forest managers will have time to work out these problems. White spruce is the most important commercial species of timber in Alaska. Insect losses annually amount to 100,000 cubic meters (3,531,467 cubic feet).

The research was conducted throughout south-central Alaska and in the Yukon Territory of Canada. Cooperating in the study were the Yukon Forest Service and the Alaska Region of the USDA Forest Service. These agencies were concerned about whether harvest of dead spruce could be postponed until it becomes economically feasible.



White spruce killed by bark beetles is salvaged near Tyonek, Alaska.



Significance of "Natural" Smog

Organic hydrocarbons (such as monoterpenes and isoprene) that are emitted from trees, brush, and other vegetation are the forerunners of "natural" smog. To determine the significance of these emissions in the Los Angeles Basin, scientists from the Pacific Southwest Station, the Statewide Air Pollution Research Center, and the University of California, Riverside, determined vegetation composition and measured the hydrocarbons emitted from this vegetation.

They found native and urban plant species to be minor sources of reactive organic hydrocarbons while human sources were major. No more than 10 percent (and probably much less) of the photochemically formed ozone in the Los Angeles Basin can be traced to emissions from foliage.

Below the 3,600-foot level, native vegetation covered 33 percent of the land area in the Los Angeles Basin. The estimate for the upper limit of emissions from native vegetation in the summer was 52 tons per day; an additional 41 tons per day were estimated for urban vegetation.

This information was generated by a multiagency, multidisciplinary research team funded by the California Air Resources Board, and the results were made available immediately to State and local pollution control authorities.



At most, 10 percent of the photochemically formed ozone recorded on this instrument results from hydrocarbons given off by trees and plants.

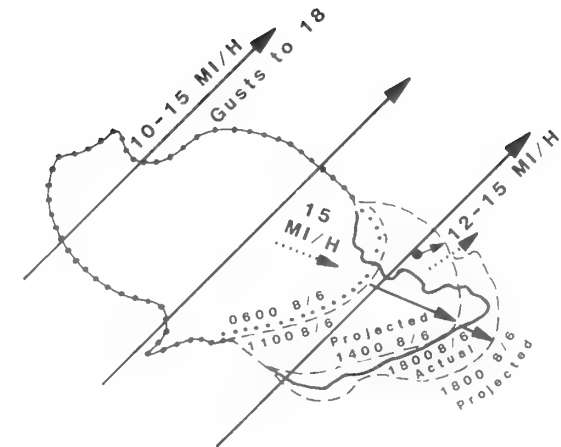


Predicting Fire Behavior

Can wildland fire behavior really be predicted? According to fire behavior scientists at the Intermountain Station, it depends on how accurate you expect the answer to be. The minute-by-minute movement of a fire will probably never be predictable—certainly not from weather conditions forecast many hours before the fire. Nevertheless, they say, practice and experienced judgment in assessing the fire environment, coupled with a systematic method of calculating fire behavior, yields surprisingly good results.

The Intermountain Station has published a manual, "How to Predict the Spread and Intensity of Forest and Range Fires," which is the result of many years of fundamental and applied research. It includes methods of assessing the major factors influencing fires and simplified methods of calculating rate of spread, fire intensity, fire size, and spotting distance. It contains maps of fire growth and guides for interpreting and informing others about expected fire behavior.

Information in the manual has been used for training fire behavior officers in all of the Nation's land management agencies, including those of many States.



BLACKFOOT FIRE

- constructed handline
- open line
- projected fireline
- actual fireline

Forest and range fire behavior can be predicted within limits. A new Intermountain Station manual gives the procedures.

After the Fire Is Out

Funds could be allocated more efficiently in a fire management budget if managers could measure the economic impact of wildfires more comprehensively than in the past. Because fires have different impacts on each product and amenity of wildlands, it has been difficult for fire managers to put a prefire value on these resources. North Central Station scientists, in cooperation with Michigan State University and the Wisconsin Department of Natural Resources, have now developed a system of appraising wildfire effects on private land that strikes a balance between comprehensiveness and ease of use.

The system incorporates positive, as well as negative, economic impacts of fires on timber, wildlife, recreation, ornamental trees, crops, equipment, and improvements. In addition, esthetic and environmental values are rated on a relative scale. Although the system incorporates many variables, only a few field measurements are required. Many complex factors such as stumpage prices, wildlife loss or benefit, and recreation values are precalculated for each county. So, although the system is comprehensive, it takes a manager less than 30 minutes to complete the appraisal for an average fire.

The system is operational in Wisconsin and is currently being evaluated for possible use throughout the Northeast. Because it is correct in theory, consistent in appraisal, and easy to use, the system is a step toward cheaper and more effective fire management.



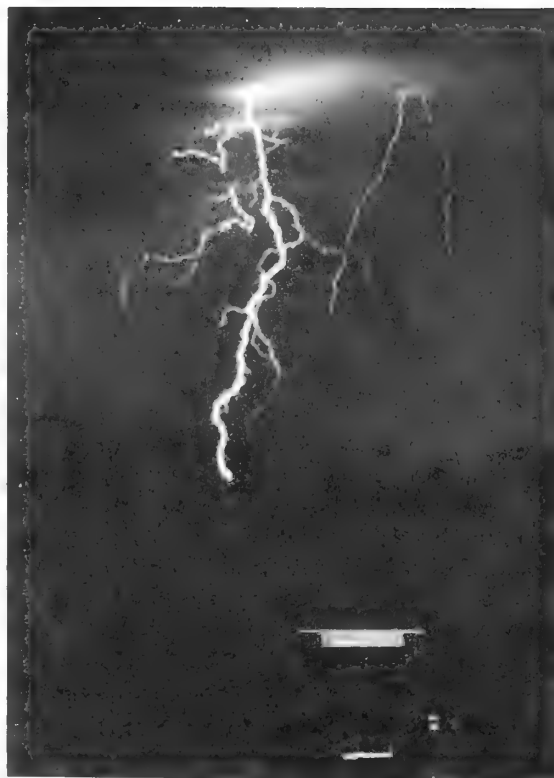
After wildfires are under control, the next step is to appraise fire damage to trees and other resources. A new system allows this to be done simply.

Lightning Location and Fire Forecasting

To detect lightning fires in the West, spotter aircraft presently fly a fixed pattern over forested areas at a considerable cost. Recently, the Intermountain Station developed a computer system called Lightning Location and Fire Forecasting (LLAFFS), which indicates the probable locations of fires after lightning storms. The system will save considerable money by narrowing the search zone and reducing the time flown by spotter aircraft after a storm.

The system goes into action as the lightning strikes are occurring, sorts data from thousands of lightning strikes, and calculates the condition of the forest fuels in the path of the storm. Results are displayed on a computer printout. Using the printout and a transparent map overlay, fire dispatchers can determine areas where fires are most likely to start and send spotter aircraft right to them.

LLAFFS has already been tested by the Forest Service and the Bureau of Land Management and is expected to be in operation by the summer of 1984.



Scientists have developed a computer system to indicate the probable location of fires started by lightning.

Determining the Economic Costs of Fire Management Programs

Researchers at the Pacific Southwest Station have developed a procedure for estimating the economic or "opportunity" costs of fire management programs. The procedure enables fire control managers to combine the direct and indirect costs for fire management and convert them to per-hour costs for various levels of deployment.

The procedure is a major improvement over earlier attempts at cost estimation because it incorporates costs that are not typically included in accounting data. It is also flexible enough to be applied by different fire control organizations in their fire planning. The procedure divides costs among five basic fire management activities: fire prevention, detection, fuel treatment, initial attack, and suppression. So far, the procedure has been applied only to initial attack and suppression costs, but it is being developed for the other three activities. The technique is computerized and has been used to evaluate costs in three Forest Service Regions and in the State Forestry Departments of California, Oregon, and Montana.



Fire control organizations are using a new way of estimating the costs of initial attack and suppression.

Fire History Shows Prescribed Burning Can Be Useful

The recent discovery that fire has played a prominent historical role in the development of mixed conifer stands in the Southwestern United States opens up new prospects for using fire as a management tool in this productive ecosystem. Prescribed fire is commonly used to reduce fuels and alter plant succession in ponderosa pine forests, but is not widely used in the protection and management of mixed conifers. Fire history information developed by Rocky Mountain Station scientists on a 460-acre watershed in the White Mountains of Arizona now shows that prescribed fire can also be used in the management of the mixed conifer type.

Researchers counted tree rings to date fire scars on cross sections of 35 trees. The resulting composite history indicated that major fires burned over the area at roughly 22-year intervals for the 200-year period before 1900. Frequent small fires apparently burned on parts of the area between the major fire years. Now that land managers know that fire can be used in mixed conifer forests without doing more harm than good, they can go on to test the technique.



Fire-scarred trees provide historical data so forest managers can use prescribed fire effectively.



Timber Management

Prospect Good for Increasing Loblolly Pine Growth Through Seed Selection

The potential for increased plantation yield through seed source selection in loblolly pine is clearly demonstrated by research reported in two Southern Station publications. Forest managers generally use local seed sources of loblolly pine for planting in most areas of the South. Two large seed source studies in southern Arkansas, established by the Southern Station and industrial cooperators in the 1950's, now show that trees from most nonlocal seed sources grow faster than those from the local source. Maladaptation of nonlocal sources is possible, but after 25 years there is no evidence of poor adaptation in any but the most southern Gulf Coastal sources. Loblolly from the Atlantic Coastal Plain look particularly good in southern Arkansas, averaging 8 feet taller than the local source, and the yield is about 25 percent greater.

Forest managers in southern Arkansas and northern Louisiana now must carefully weigh this prospective gain against the possibility of future maladaptation locally. The Weyerhaeuser

Company has been the first to announce a decision to use nonlocal loblolly pine seed from the North Carolina coastal plain on their Arkansas-Oklahoma land holdings. If they obtain a similar 25-percent growth increase, it will amount to a gain of about 1.5 billion cubic feet of wood over a 35-year rotation.



Trees from the South Carolina coastal plain (on the right) grow taller (70 feet) than more local Oklahoma trees (63 feet) after 25 years in southern Arkansas.

New Guides Improve Thinning of Shortleaf Pine

Immature shortleaf pine stands must be thinned to grow large-diameter trees quickly. Traditionally, how much you thin depends on basal area (the total cross-sectional area of all trees on an acre). Basal area alone, though, is not a good indicator of stand stocking (number of trees in a stand), and thinnings controlled by basal area may often leave a stand understocked. When crop tree thinnings are made, the number and spacing of crop trees are often selected without regard for future stand stocking.

Thinning guides for shortleaf pine, recently developed by North Central Station scientists, provide managers with a new and effective tool to control thinnings. The guides are in the form of stocking charts that graphically define the relationships among basal area, number of trees, and the diameter of the tree of average basal area. The guides are based on research that defined the growing space requirements of shortleaf pine and are independent of stand age and site quality. The format used for the background chart was previously described in Agriculture Handbook 355, "Even-Aged Silviculture for Upland Central Hardwoods," and has recently been adopted for use throughout the National Forest System.



This 30-year-old stand was thinned according to the growing space it needs and will grow about a cord per acre per year in the next decade.

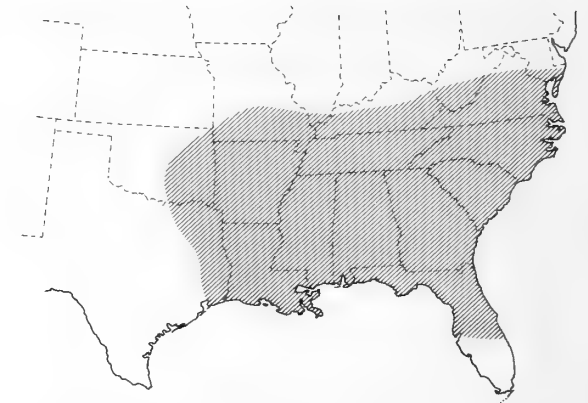
Cheaper Kudzu Control and Eradication

Kudzu is an imported vine that has spread over millions of acres in the South. First established on depleted farmland for erosion control and cattle grazing, this rapidly spreading pest now grows in forests, halting most wood production on infested lands. Kudzu is one of the few plants in the world that can stop natural plant succession and forest development. The commonly used method of eradication costs about \$150 per acre, which has discouraged any concentrated control programs except on large industrial forests.

Cooperative research by the Southern and Southeastern Stations, State forestry agencies, Auburn University, and forest industry has come up with new herbicide treatments and application procedures that cost less--from \$75 to \$120 per acre. To get these results, over 25 herbicides were tested at seven locations. The new procedures developed by Forest Service scientists recommended liquid herbicides that can be applied by nonindustrial, private forest landowners using farm-tractor sprayers. Special application procedures are still being studied, but many recommendations are already available. Kudzu is exceedingly difficult to control because of its large, woody

root. Older plants with 200- to 400-pound roots may require several herbicide applications over a 4- to 10-year period. But unless these procedures are followed and the vine is controlled, kudzu will continue to hamper tree growth on more and more potentially productive forest lands.

To spread word about the new treatments, signs giving treatment, number of applications, and costs have been placed at study areas along major highways. Field days have been held in Georgia and Alabama counties to show landowners how to control this pest. Response has been good because the new treatments are both cheap and environmentally acceptable.



Kudzu has invaded 2 million acres of farm and forest in the Southeast, where it can climb and kill trees 100 feet tall in a few years.

Conifer Yields Increase After Weeds Are Controlled

Dramatic gains in stem volume of Douglas-fir and ponderosa pine following use of chemicals to control weeds at the time of planting are reported by scientists at the Pacific Northwest Station. Seven herbicides and two combinations of herbicides were sprayed, using a backpack sprayer, on grasses and forbs competing with trees.

Benefits just discernible at 3 years after planting were increasing rapidly by the end of the sixth year. Volume increases on sprayed areas ranged from 349 to 650 percent higher than on areas that did not have the one-time application of chemicals. Especially effective for reducing competition from weeds were hexazinone and a mixture of dalapon and atrazine.

The research was conducted in the Wenatchee National Forest in eastern Washington. Young conifers in that area must compete successfully with established herbaceous plants that rapidly deplete available soil moisture to critical levels when summer drought starts. Control of grasses and forbs, either before or during planting, is usually essential for survival and growth of trees.

Few herbicides are registered in forestry for controlling grasses and forbs, however, and fewer still are really effective. Demonstration and publication of the research showing the effectiveness of the two herbicides have led to widespread interest by forest managers. They plan to use these herbicides for preparing planting sites to get better conifer growth and reduce mortality from competition and moisture stress.



Unless these dense grasses and weeds are controlled, they will use up the soil moisture needed by young conifers to survive on this logged area.



Resource Economics

Legumes Stimulate Growth of Southern Pines

Nitrogen fertilization is rapidly gaining a following in southern forestry, and its use in pine plantations on poor soils might become routine if the costs could be reduced. In agriculture, supplies of soil nitrogen for succeeding crops are often increased by growing a crop of legumes--peanuts or clover or lespedeza. Scientists at the Southeastern Station hope they can adapt this practice to forestry. In the South, legumes must be able to survive hot, dry summers and fit into management schemes for southern pine plantations.

More than 50 species of highly promising nitrogen-fixing plants were tested in Virginia and the Carolinas. Of these, *Sericea lespedeza*, a perennial, survived well and competed successfully with native weed species--a requirement for legumes planted on forest sites. The species thrived with the application of phosphorus. Subterranean clover, an annual, reseeded itself and competed well with weeds for 3 or more years under favorable conditions.

When the crowns of planted pines come together at age 5 to 10 in a typical plantation, legumes die. If all goes as expected, however, the nitrogen they have fixed in the soil early in the life of the plantation is slowly taken up by the trees and stimulates their growth for many years.



Legumes, such as this *Sericea lespedeza* plant, take nitrogen from the air and turn it into compounds that stimulate pines to grow for years after the legumes have died.

Home Stoves Have Increased the Value of U.S. Wood Resources

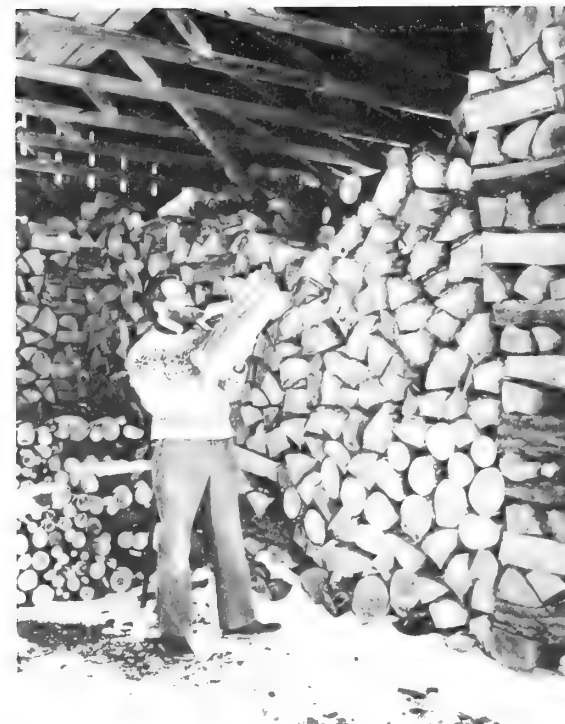
A Forest Service survey confirms that woodburning in home stoves and fireplaces is now greater than at any time since World War II. In 1981, Americans burned four or five times more fuelwood than 10 years ago.

The Forest Products Laboratory, aided by the University of Wisconsin Survey Laboratory, surveyed U.S. households to learn about residential woodburning and about sources of fuelwood. They found that fuelwood use increased to 42 million cords or 3 to 4 billion cubic feet in 1981. This was one-fourth the amount used for all other wood products. In the East, 95 percent of fuelwood was from relatively abundant hardwoods. In the West, 42 percent was hardwood.

About one-fourth of all U.S. households burned fuelwood. In rural areas, one-half of households burned wood. Half of all woodburners use fireplaces and burned one-fourth of all fuelwood. The other half of all woodburners burned wood in stoves or furnaces and consumed three-fourths of all fuelwood.

Most of the fuelwood was cut by household members. They said 30 percent of the fuelwood they cut was from non-woodland areas. Fuelwood cut from

woodlands was salvaged mostly from dead or down trees and logging residue. Only 28 percent of the fuelwood came from standing live trees. The estimated value of wood sold commercially to household woodburners was \$620 million during 1981.



Most fuelwood is cut at its source by household members; only a quarter of it is sold by vendors.

Bigger Bucks From Hardwoods in Piedmont Woodlands

The high cost of converting hardwood stands to pine in the South is causing foresters to reconsider hardwood management--especially on forests owned by nonindustrial, private landowners. Income from their woodlands typically comes only from stumpage or sales of cut products. They do not get the additional income that industrial landowners get from value added in primary processing. So given the obstacles, is better hardwood management feasible?

Researchers at the Southeastern Station analyzed forest survey plot information collected on the hardwood lands of woodland owners in the Piedmont Region stretching from Virginia to Georgia. The analysis covered more than 28 million acres of hardwoods. The researchers looked at size classes as well as opportunities for both silvicultural treatments and marketing the timber regionally.

The analysis showed that hardwood stands in the Piedmont can be managed by methods that are neither expensive nor intensive. By using guidelines from this analysis, Piedmont woodland owners can minimize out-of-pocket treatment costs, increase incomes from timber

harvest, and upgrade the future stand. The guidelines should also prove valuable to State forestry agencies, extension foresters, and others who are concerned with forestry programs in the Southeastern Piedmont Region.



Piedmont woodland owners can upgrade the future stand by felling the cull trees and noncommercial saplings pictured here.

Huge Resource Inventory Underway in Alaska

A new inventory system is being used in Alaska to survey the natural resources on 32 million acres of the Tanana River Basin in interior Alaska, an area as large as Alabama. The four-phase system was developed by the Pacific Northwest Station.

The system uses imagery from satellites, small-scale and large-scale aerial photography plots, and a newly developed field plot system. In addition to the usual data on timber volume, growth, and mortality, the survey will gather information on vegetation composition, density, production, and biomass; wildlife habitat; fuels for fire management; and soils. A general vegetation and soils map for the Tanana Basin is being produced by the Soil Conservation Service working in cooperation with the Forest Service.

The 14-million-acre western Tanana Basin was surveyed in 1982, and interest in the data already is being expressed by Federal, State, and private agencies in Alaska. The data will help the Forest Service meet the requirements of the Resource Planning Act for a national inventory of renewable natural resources.



A crewmember takes a vegetation sample as part of an inventory of natural resources in interior Alaska.

The Economic Impacts of Increasing Timber Supply

A supply impact model developed by the Pacific Northwest Station will assist forest economists in assessing the significance of changes in the availability of resources needed to produce goods and services in a forest-dependent area.

Researchers adapted a conventional economic model to provide a convenient means to analyze changes in the import of primary inputs, such as logs or investment capital, into an area. Using data from Douglas County, Oreg., the research contrasted the effects of importing logs versus increasing local timber supply from National Forests. They found, for example, that the economic impacts on Douglas County from increasing the supply of local Forest Service timber far surpassed the economic benefits of importing logs from other areas. They also compared the effects of capital funds flowing into or out of the area.

This economic model can provide a more thorough analysis of the consequences of existing or proposed public forest management policies than is ordinarily done.



The impact on housing is only one of several economic impacts expected from increasing the supply of local Forest Service timber.

Assessing the Costs of Wildlife and Recreation

When budgets shrink and markets for forest outputs are poor, land managers must manage more cost effectively. This is especially true for protecting or improving nontimber resources such as wildlife and recreation. The first step in judging cost effectiveness is being able to assess or predict the costs of wildlife and recreation practices accurately.

Researchers from the Intermountain Station developed estimates and models to predict what wildlife management practices cost, especially those for improving habitat in the Forest Service's Northern Region. They found, for example, that costs ranged from as low as 5 cents per acre for fence maintenance to over \$400 per acre for structures to help maintain fish spawning beds. Prescribed burning, the most common wildlife practice, cost \$9.12 per acre (in 1972 dollars). To predict costs of prescribed burning, the researchers made a model based on such variables as acres burned, amount of fireline, and ignition technique.

To obtain recreation costs, researchers sampled more than half the recreation sites existing in the Northern Region in 1980. They put the costs of a whole range of recreation sites on an annual

basis. Then they worked out models that will predict the annualized costs of different sized facilities. With a better idea of how to assess the cost of these wildlife and recreation activities, forest managers in the Northern Region can get the most out of their budget dollars.



Working out the annual costs of recreation sites like this is a must for tight, cost-effective management.

The Outlook for Renewable Resources

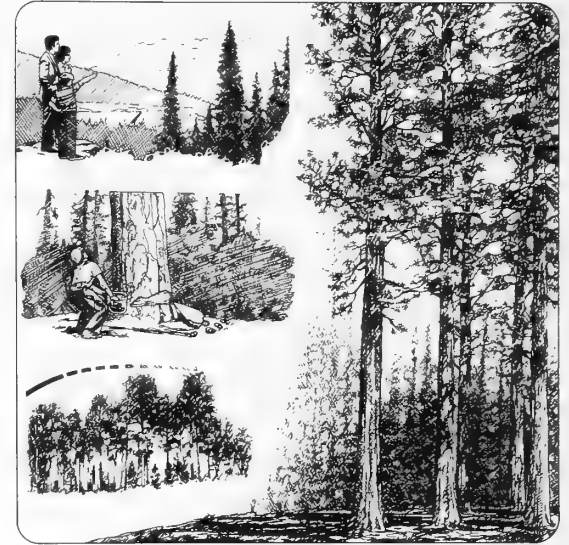
A new review of the Nation's renewable resource situation, completed as a part of the work underway to prepare a Forest Service program for submission to Congress in 1985, shows that the basic outlook continues much the same. The Nation is faced with the prospect of a growing imbalance between the supply of forest, range, and water products and the quantities that people would like to consume.

For timber, this means continuing increases in the prices of standing timber and timber products and the associated adverse impacts on the economy, the environment, and society. The outlook for water and range forage is similar in many respects. For users of wildlife, fish, and outdoor recreation resources, it will mean intensifying competition for the available resources.

This may well lead to shrinking populations of wildlife and fish; fewer and less satisfying outdoor recreation experiences; and overall, a gradual reduction in the quality of life that people have come to appreciate and expect.

The new review shows that this outlook is not inevitable. There is a very large forest, range, and water base that can supply demands for nearly all products, if it is more intensively managed and better utilized.

For example, these lands and waters have the physical capacity to supply sites for most types of outdoor recreation well in excess of expected increases in demands and to support much larger wildlife and fish populations. Under intensive management, rangelands have the capacity to produce nearly three times more forage, and forest lands more than twice the volume of the timber grown today.



A continuing supply of renewable resources will depend on intensive management and better utilization.

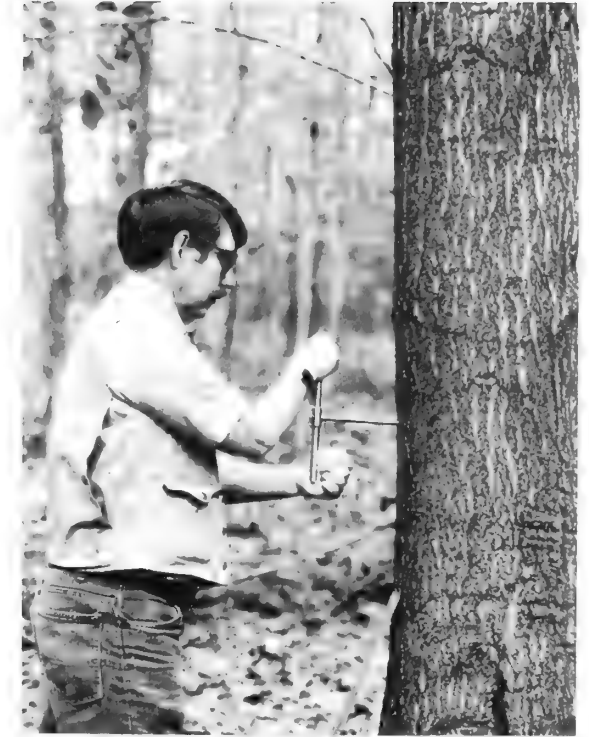
Predicting Forest Stand Losses to Gypsy Moth

The gypsy moth is one of the most challenging problems facing forest managers in the Northeast today. People attempting to cope with the pest need help in predicting and evaluating its impacts so they can decide whether to attempt control efforts and where to concentrate them.

Some techniques for predicting forest stand losses to gypsy moth have already been developed by the Northeastern Station in cooperation with State and Private Forestry, Northeastern Area. These include the use of easy-to-measure stand characteristics. Typical of the models used for prediction is an equation for estimating the rate of change in timber value for forest stands exposed to an outbreak. The important stand measurements in this equation are ones easily taken by a forest manager--basal area per acre in tree species that the gypsy moth tends to avoid, percentage of stand basal area in trees 3.0 to 4.9 inches in diameter, and percentage of stand basal area in trees with poor crowns.

Impacts could become more serious as the pest spreads south and west into forests where oaks are more common and timber quality is better. In an

attempt to measure impacts in advance of gypsy moth infestation, scientists have installed some 600 field plots in the heart of Pennsylvania's oak country. Besides learning whether these stands have a greater potential for economic loss, researchers will be able to refine existing models for better prediction of the insect's impact.



Gypsy moth infested forest plots are remeasured twice a year to gather data on growth, mortality, and stand changes.

The Forest Resources of Puerto Rico

Forest inventory scientists from the Southern Forest Experiment Station cooperatively completed the first inventory of Puerto Rico's forests. The island is one-third forested; half of the forest land protects watersheds and provides recreation opportunities and wildlife habitat, and half can produce timber. Despite wide diversity in species and site, more than half of the young forests contain sufficient stocking of good sapling and poletimber trees to produce manageable stands.

The inventory provides information for natural resource administrators and planners in government and private industry and helps identify research needs for secondary forest management in Puerto Rico. The analysis will help stimulate forestry development, which could in turn reduce the island's dependence on timber imports.

The inventory project has developed and refined techniques and procedures for conducting secondary forest assessments in tropical areas. The techniques have been used in inventory projects in a Commonwealth forest in Puerto Rico and an inventory of Hawaii and U.S. Trust Territories in the Pacific region and will be used in a forthcoming survey of St. Vincent Island in the Lesser Antilles.



A timber cruiser making estimates on a sample plot in a Puerto Rican forest.

State Income Taxes Mean Less Incentive for Forestry

Provisions in the Federal income tax law help to encourage forest management by the nonindustrial, private forest owner. These provisions encourage capital formation and reforestation and help compensate for the income lag and risk that timber growers must take. But what about State income taxes? What effect do they have on forest management by woodland owners in the South?

No studies had ever been made to assess the impact of State income taxes on forestry before economists at the Southern Station and Virginia Polytechnic Institute and State University began cooperative research on the subject in 1981. When the researchers analyzed State income tax provisions in the South, they found wide variations among States. The conventional wisdom was that State income taxes were so low that they did not make much difference either way. The researchers found differently--in many cases State income taxes tended to discourage timber investments.

To illustrate, the scientists computed the 1981 total tax liability (Federal plus State) for hypothetical forest owners with medium and high incomes and for managed and unmanaged forest land.

The State portion of the total tax burden ranged higher (up to 31 percent) for medium income forest owners who managed their forests than for owners who did not (up to 25 percent). The same trend was true for high-income forest owners--up to 19 percent for those who managed forests, but only up to 17 percent for those who did not. In short, the tax burden in most of the 12 States studied was greater for owners who managed their forests than for those who did not.

As a result of these findings, the Forest Service and Council of State Governments are recommending that States change their income tax laws, if necessary, to encourage better forest management by woodland owners in the South.

A Program To Analyze Forestry Investment

How profitable are investments in forestry? Landowners, foresters, and investors want to know about payoffs from growing timber and how these investments compare with other opportunities. Each tract of timberland, each landowner, and each market is different, and general guidelines are often not very useful. Also, these computations are complex and time consuming, especially when income taxes are considered. Each timber production option should be considered separately on its own merits. Now, a new model developed by the Southeastern Station and several universities makes it easy to figure the profitability of many forestry investments. This new method is a computer program, which can be run on a variety of readily available and inexpensive microcomputers.

The new program finds the present net value, benefit-cost ratio, and rate of return for timber investments with or without calculating the effects of Federal income tax. The model even figures complicated timber depletion and amortization amounts automatically. Investments as long as a century can be analyzed as easily as those lasting only a few years. No computer experience is necessary. The user must

know when timber management activities will be done and how much they cost. Also, the user must supply timber harvest volume, current market price, and expected rates of change. Costs and benefits for nontimber aspects of forest production can also be included.

Foresters have discovered how easily it can be used to solve on-the-ground problems such as: How much can I pay for timberland and still make a profit? Does fertilization pay? Are past management activities cost effective? Government foresters are using the program to select the best management options on public land. Industrial foresters are using the model to analyze intensive forestry to boost yield and profits. University professors are even using it to teach students the fundamentals of forestry.



"Plugged in" for future timber dollars, a forester illustrates the ease of using the new investment program in a microcomputer.



Products and Engineering

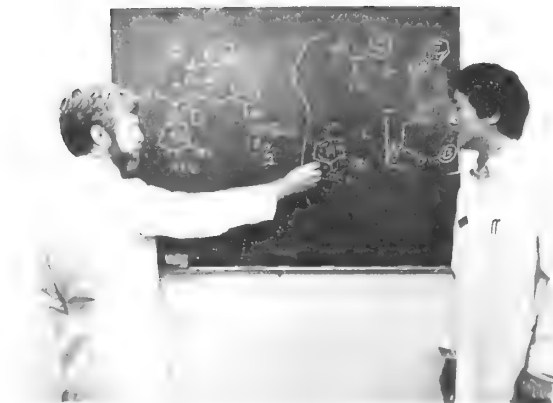
First Lignin-Degrading Enzyme Discovered

Lignin is the complex natural plastic that cements and stiffens wood fibers. It comprises about 25 percent of wood and, next to cellulose, is the most abundant organic compound on earth. Until now, the biochemical mechanisms involved in its natural degradation during wood decay were essentially unknown.

Researchers at the Forest Products Laboratory, after years of painstaking basic research, have discovered a lignin-degrading enzyme. This enzyme is secreted by a fungus, Phanerochaete chrysosporium, one of the organisms causing white-rot decay in wood. During degradation, the enzyme causes oxygen from the air to be combined with lignin, and the result is a partial biological oxidation and subsequent breakdown of the lignin.

Discovery of this enzyme opens up possibilities for many applications of biotechnology in wood processing, such as pulping, bleaching pulps, converting lignin to useful chemicals, and cleaning up noxious lignin wastes from pulp mills

and papermills. The increased knowledge of the decay process gained by this research may also lead to biological methods for controlling wood decay.



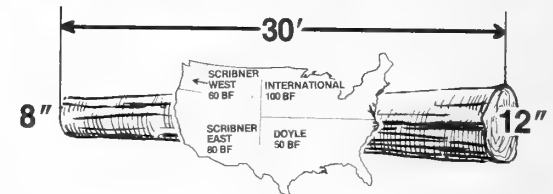
The discovery of the enzyme that breaks down the lignin in wood will have many applications.

Application of Cubic Scale Has Merits

Use of cubic scale, a means of measuring the volume of logs, is the best way to improve measurement systems in forestry and forest products. Pacific Northwest Station researchers concluded this after they developed techniques to evaluate the effectiveness of some 95 log rules currently used in the United States and Canada.

Basing their evaluation on recovery studies in mills where precise data on volume and value are available, the researchers became convinced that cubic scale gives the most accurate measure. They subsequently have developed cubic measurement techniques to derive log scale deductions for dead timber and to predict product volume and value from log scale. The techniques developed at the Pacific Northwest Station are being reviewed by a national committee, sponsored by the National Forest Products Association and the Forest Service, to choose the best of several possible measurement systems. The committee is currently developing a user's guide to apply cubic scale in all aspects of forestry and forest products.

The researchers conducted a workshop on using cubic scale in forestry in Portland, Oreg. in the spring of 1983. The high interest in this subject attracted 300 people from all over the United States, indicating the recognized need for a better measurement system in forestry and forest products.



One benefit of a cubic scale system is that the volume of a log would measure the same in every part of the country. At present, there are 95 log rules in use.

New Ways To Test the Strength of Light-Frame Floors and Walls

Wood-frame construction accounts for the use of about half of the lumber and panel products in the United States. Improved building techniques and more efficient types of materials are continually being proposed to offset the increasing cost of labor and materials.

One roadblock to using new materials and techniques is that building code representatives do not know how to determine the effect of these changes on the structural safety of the building. To provide this information, the industry needs structural analysis methods for new light-frame components.

Researchers at the Forest Products Laboratory, in cooperation with researchers from several universities, have devised new ways to analyze floors and walls and have verified these methods by testing. In addition, scientists have developed a revised computer program for truss analysis. The new structural analysis methods can accurately predict both the stiffness and strength of components under the types of loads that occupants and winds would put on a building in service.

The new methods will provide ways for builders to determine the effect of new types of framing, sheathing, or fastening materials on the strength of a building without the extensive testing of full-size components once required. Both suppliers and users will easily be able to determine how changes in materials or construction practices will affect both the serviceability and the safety of light-frame floors and walls.



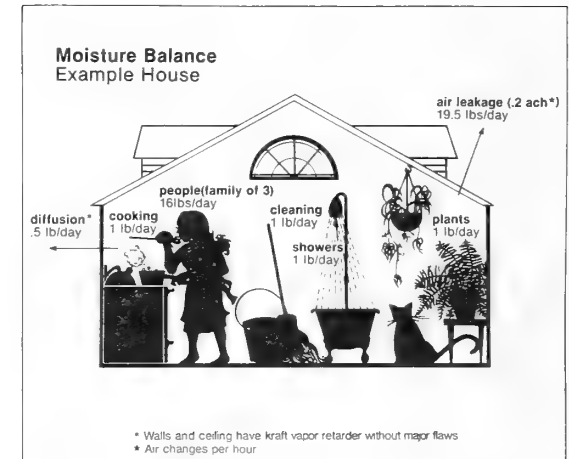
A computer program analyzes and predicts the strength of floor and wall components made of new material.

Managing Moisture in Wood-Frame Buildings

Over the past 10 years, rising energy costs have changed building construction practices. Buildings are better insulated and air leakage has been greatly reduced. These factors can combine to create moisture problems within walls, floors, and roofs of our wood-frame homes. To prevent damage to these structures, indoor humidity levels must be controlled. The moisture that results primarily from breathing, cooking, and bathing can be managed by ventilating the living space and using proper construction techniques.

Researchers at the Forest Products Laboratory are taking several approaches to ensure that moisture in our homes does not become a construction problem on a national scale. These include analytic studies and laboratory experiments along with field experiments under both controlled and natural conditions. A theoretical model, which includes the effect of air leakage, has been developed to analyze moisture movement through walls. A field study of moisture in attics indicates that present ventilation criteria, which were developed in the 1940's, may not be suitable for today's construction. Controlled field experiments describe the seasonal moisture changes in walls of several different types of houses in both a cold climate and a moist summer climate.

Manufacturers are using results of these studies of siding and insulation materials in their recommendations of construction techniques to help the homeowner avoid moisture problems.



Breathing, cooking, and bathing give off a surprising amount of moisture. New venting techniques may be needed to avoid problems.

Thinking Small: Harvesting Systems for the Interior West

Small softwood trees makes up a large part of the potentially available wood in the interior West. (Lodgepole pine alone occupies more than 12 million acres). Two kinds of small-timber stands prevail -- second growth, pole-sized trees, which are usually overstocked, and mature or overmature stagnated trees, which are grossly overstocked. Severe insect and disease infestations are widespread; many of these stands are a mixture of live and dead timber. The danger of catastrophic wildfire is on the increase in these stands.

In both kinds of stands, management objectives--whether of timber, water, wildlife habitat, or esthetics--depend upon some sort of harvesting. An efficient harvesting system could extend the wood resource as well as improve the management and protection of other resources.

Knowing that the costs of harvesting and handling small stems are often the main barrier to effective utilization, researchers at the Intermountain Station field-tested and evaluated several harvesting systems that handle small trees more efficiently than conventional harvesting and recover a mix of products.

The researchers found that the most effective systems incorporated feller-bunchers, grapple skidders (or farm tractors with grapples), and whole-tree chippers, with equipment to load and transport logs and chips.

The benefits are a clean logging site with no residue, utilization of all material harvested, and recovery of both logs and chips to obtain maximum value.



Grapple skidders, whole-tree processors, and chippers are the most efficient way to harvest small timber.

Having Our Roads and Our Fishing Too

The National Forests of central Idaho have salmon and steelhead streams with steep, erodable mountain slopes separating them. In building forest roads on these slopes, forest engineers must ensure that sediment from the roads does not destroy fish habitat in nearby streams and that rising construction costs are kept as low as possible. In other words, there are stringent water quality standards to be met by the Forest Service in the most cost-efficient manner.

Engineering researchers at the Intermountain Station have begun to deal with erosion and cost reduction in several ways. By developing techniques for predicting surface erosion (given certain soils, vegetation, geologic conditions, road specifications, and climatic events), the cheapest alternative for reducing it can be worked out before construction. Also, determining what part of the disturbed area yields most of the sediment will help engineers reduce control costs. Studies on the Silver Creek Experimental Watershed, Boise National Forest, and the Nezperce National Forest showed that in some areas more sediment eroded from the cutslope and ditch, over the long term, than from the road surface. Knowing this, engineers can

avoid the very high cost of rock surfacing the road and turn their attention to cheaper ways of reducing erosion from the cuts and ditches.

As this knowledge becomes available from research, the Nezperce National Forest and others in the Northern Region are putting it to work to help protect the fine fishing resource of the Columbia River system.

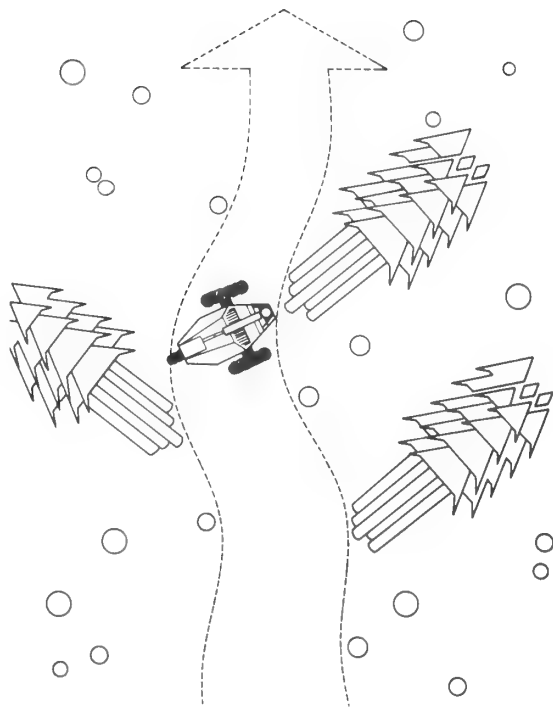


Simulated rainfall on a test section of forest road helps engineers find ways to reduce surface erosion.

Thinning Southern Pines

Every year, thousands of acres of southern pine forests reach the age where some form of thinning is desirable. But increased labor costs and fewer woods workers discourage this important forest management operation. This creates a substantial demand for thinning equipment that has high production capabilities, low costs, and does the job with minimal impact to the environment.

Southern Station research engineers have evaluated several recently developed machines. The results of these studies provide information on production rates, costs, and physical impacts to the soil and residual trees. The machines tested represent the current state-of-the-art in thinning equipment. The tests involve standardized procedures that provide information needed for direct comparisons of alternative equipment. The information can be used to evaluate and implement forest management plans that include either selective or systematic pattern methods of thinning. Several southern forest products companies are using the information in trials of plantation thinnings.



A small feller-buncher can remove trees selectively from both sides of a corridor less than 10 feet wide.

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