Forest Service

Forestry Research West

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A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture.

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Cover

Research Plant Pathologist Ray Brown checks a climatological station at a mine site on the Gallatin National Forest in Montana. He is part of an Intermountain Station team of scientists investigating ways of healing wounds caused by mining, recreation, etc. in alpine ecosystems. Details begin on page 1.

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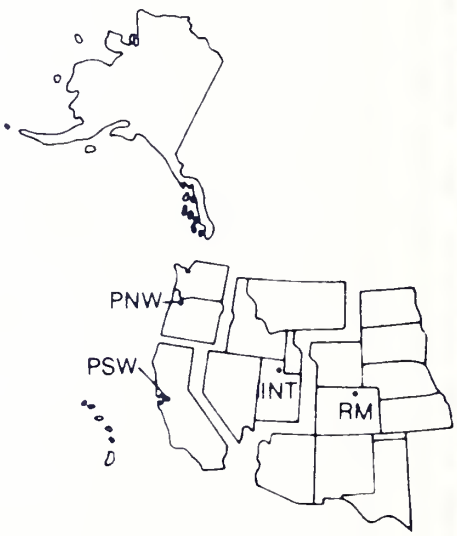


Healing the high country

by David Tippets
Intermountain Station

Extreme growing conditions in the alpine zone, too harsh for trees, challenge revegetation efforts.

Whether combating the havoc wreaked by giant bulldozers or the pounding of hundreds of boot-shod human feet, land managers must understand and apply basic ecology to successfully revegetate fragile alpine land.

"Approximately 7.5 million acres or nearly 12 percent of the alpine tundra in the Western United States has been disturbed," reports Research Plant Physiologist Ray Brown. Brown and Research Plant Ecologist Jeanne Chambers, of the Intermountain Research Station's Logan, Utah, Forestry Sciences Laboratory combine forces to investigate alpine ecology and revegetation. Their research helps provide land managers with the information needed to heal wounds in the alpine zone that many thought would endure for centuries as ugly scars.

Disturbances range from miners stripping off all plants and topsoil for open-pit mining, to the more subtle changes induced by a hundred years of domestic sheep trailing to their high summer range, or more recently, by the growing thongs of hikers trampling fragile alpine vegetation as they seek solitude along high-mountain lake shores.

"Our major challenge in the face of expanding development, however, is not to withdraw all these areas from reasonable use, but to develop the technology and skills necessary to return these unique ecosystems to a natural, self-sustaining state," Brown says.

Keeping alpine ecosystems healthy is essential, not an optional element in welfare of humankind. The high mountains trap and store water for thousands of lowland farmers and city dwellers.

History has proven that when alpine watersheds deteriorate, the whole hydrologic system below them can come unraveled.

Against the odds

No matter what the disturbance in alpine lands, once vegetation dies, and once topsoil is gone, nature alone may never heal the raw sores within the time measured on human calendars. In mountain-top environments with almost no frost-free days but with intense solar radiation, and with hurricane force winds that suck the moisture from young seedlings and abrade old plants with blowing ice particles, the odds of survival are stacked against every seed that sprouts. So adverse are growing conditions that European biologists have nicknamed the alpine environment the "kampfzone," or zone of struggle.

Confronted with the challenges to survival at high elevations, and with concern for increasing disturbances to alpine vegetation, Intermountain Research Station scientists began studying alpine revegetation at the McLaren gold mine, just northeast of Yellowstone National Park, in 1972. The Beartooth Plateau area between Cooke City and Big Timber, Montana, is loaded with precious metals including one of the world's richest known platinum and chromium deposits. Gold miners began scarring the plateau before the turn of the century. When scientists investigate natural succession on Beartooth mine spoils they have disturbances up to over 100 years old to study and monitor nature's progress.

At the old Copper King Mine near Goose Lake in the Absaroka-Beartooth Wilderness, technicians install experimental revegetation plots, using only materials and tools that they backpacked to the site.

Extreme alpine conditions kill more tree seedlings than they nourish, and the few that survive on the edge of their range grow as deformed bushes called krummholz. In the treeless land above timberline, grasses and forbs are better adapted to survive the harsh climate.

"Seedling survival is surprisingly good," Chambers says, "as long as the seeds of alpine species fall in "safe spots'." But in the barren pavement and soil of disturbed areas few seeds find these microsite safe spots that provide protection and conditions for germination.

Cold is the insidious grim reaper of the alpine zone, in many years aborting progeny by robbing parent plants of the warm hours needed to reproduce. Succulent seedlings that aren't frozen outright are often severed from their roots and pushed from the ground by needle ice and left to shrivel unprotected on the soil surface.

But it is the lack of warmth rather than the extreme low temperatures that challenges plant survival in the alpine zone. "Almost no annual plants exist in the alpine zone," Chambers says, "because there isn't enough time for plants to grow and reproduce in the same season." Chambers knows of only two naturally occurring annuals on the Beartooth Plateau and only three species in the alpine zones of Colorado.

Plants need a minimum of warm hours each day for enough days during the growing season to manufacture and store plant energy through photosynthesis in order to complete their growth cycle and reproduce. Even in summer it's often too cool for

plants to capture the sun's energy. In addition to the cold, mountains create their own climate with frequent cloud cover that blocks the sun's rays and further reduces photosynthesis.

The problem compounds by the fact that respiration—the burning of stored plant energy—the opposite process of photosynthesis—occurs at temperatures too low for photosynthesis. When plants spend more energy than they save they soon become bankrupt. Destitute plants can't even hold down their own piece of topsoil, let alone expand to colonize the barren mineral soil of damaged alpine watersheds.

Yin and yang

Like opposing but balancing opposite forces, intense solar radiation and wind challenge plant survival from the opposite extremes of cold and ice, demanding that alpine plants make many of the same adaptations to survive as desert plants.

"Many plants in the alpine zone have the same adaptation as plants in the desert," Brown says, "but they don't have to use those adaptations for such long periods." During a short period of the summer the sun's rays, unfiltered in the thin atmosphere of high elevation, cause high temperature on the soil surface. The same seedlings frozen before dawn might be scorched before dusk. And the same seedlings torn by needle ice and then drenched by melting frost might be blown dry in the wind—and likely desiccated to death.

Next to cold, desiccation is the greatest scourge of the alpine zone. It's not limited to the summer; krummholz and dwarf shrubs can be dried out in mid winter. After the ground is frozen and transport of water and nutrients to the leaves shut off at the roots, wind and solar radiation go to work on the leaves. On warm winter days respiration kicks into gear but photosynthesis is impossible. Before long, both nutrients and water are gone from the leaves producing the red top called "winter kill" often seen in krummholz.

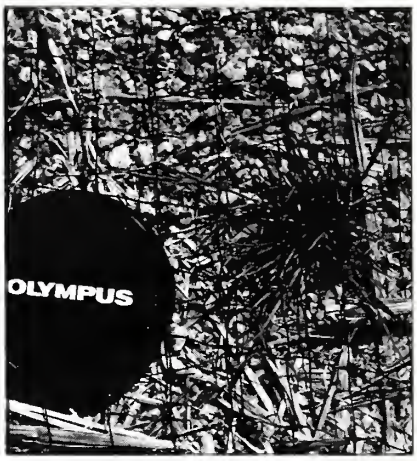
"Extreme ecosystems are amazingly similar." Chambers says, describing how desert and alpine winds play similar roles. "Wind is the most important mechanism of seed transport," she says, but also explains that wind blows the fine soil particles away from disturbed areas leaving the soil surface less favorable for seedling establishment. And the same wind that transports seed to the bare soil is likely to blow it off the bare soil to a place where the seed will be trapped in existing vegetation or litter.

Granivores (feeds on grains and seeds) prey on the seeds that aren't blown off alpine wounds. Chambers observed one Beartooth study site where beetles collect a heavy toll on seed production.

Using only hand labor, technicians complete an experimental revegeation treatment as they spread mulch over a remote backcountry mining disturbance at the head of Peru Creek in Horseshoe Basin in the White River National Forest in Colorado.

Chamber's study on an abandoned gravel pit in the alpine zone above the Beartooth Highway, National Scenic Byway, showed that, with appropriate revegetation methods, alpine vegetation can become established on extremely disturbed sites: Before treatment.

After treatment.



Hairgrass seedlings.

She learned that birds and rodents don't consume nearly as much seed in the alpine zone as in the desert.

Getting seeds and seedlings to run the gauntlet of cold, ice, solar radiation, wind, and predators, and then to survive to a second growing season is a critical step in alpine revegetation. Once a seedling completes its first year of growth to be "hardened" by fall's frosts and then covered by a protective blanket of snow, the battle for survival is almost won.

Imitate nature's path

"Imitate nature," Brown advises managers seeking the best reclamation practices for their own alpine zones. All of the recommendations derived from Brown's and Chamber's research come from observing nature's own adaptations for survival in the alpine zone. They have devoted much of their time to observing natural plant succession on disturbed areas.

"Studies indicate that an understanding of the basic processes that determine succession is necessary to restore an acceptable level of ecosystem functioning," Chambers reports.

Early in their studies of succession they observed that only a few native species are adapted to colonize bare ground in the alpine zone. All attempts to use the introduced species valuable for reclamation at lower elevations failed. Once, a district ranger refused to accept Brown's findings and insisted that a miner use a standard accepted Forest Service seed mix to reclaim his spoils. The site, adjacent to one of Brown's study plots, now stands vacant of the introduced species while the native plants thrive nearby on his plot.

"After studying natural colonization on disturbances in the area, managers may discover fewer than five successful species, some of which may be difficult to collect seed for. Hairgrass (*Deschampsia caespitosa*) is the one real champion of alpine revegetation," Chambers reports. It is the one species present in all seral stages and relatively easy to collect seed from.

"Huge quantities of grass seed can be collected by several people in a couple of hours," Brown says, instructing workers to strip off the whole inflorescence between their thumb and fingers. He explains that most alpine species will produce 1 to 2.5 million seeds per pound, and only 50 to 100 seeds per square foot of ground are needed for successful revegetation.

"Get a mixture of as many different species and life forms as possible," he recommends, "but target those species observed to be successful."

Fall is best

"We recommend collecting and seeding in fall at the same time nature's seed begins to fall," Brown says. "There is no mystery—nature seeds in fall because it optimizes the chances for survival. Spring seeding can set you up for massive failure."

September is a good time to work in the alpine zone because access is good and the seeds won't germinate until the next spring. A period of cold wet seed storage, like nature provides during the winter, "breaks dormancy" and increases the percentage of seeds that germinate. Seed that germinates in the spring is less likely to die than summer plantings because it has the most days to mature before winter.

Many managers have learned the wisdom of collecting some native seed ahead of time to be prepared for unplanned disturbances. If seed is available, they can plant larger areas in the fall, prior to the first spring snowmelt, and try to stabilize the topsoil before it is washed away.

Magnificent mulch

"Mulch is critical," Chambers says, summarizing one of the scientists' most significant findings about how managers can create safe spots for seed germination and assist seedling survival.

"Jeanne really drove the nail in the coffin," Brown says, telling about how her work supported the hypothesis that mulch and fertilizer are essential ingredients in revegetating alpine disturbances.

For extreme disturbances where all of the native soil has been lost, some kind of supplemental nutrient is essential to help seedlings mature fast and start a natural nutrient cycling process. But for lesser disturbances fertilizer is often not essential. In wilderness, workers may find animal manure nearby in sufficient amounts to supplement the soil nutrients for that critical first year of growth.

Jeanne Chambers shows seed collected in the bottom of a "seed rain trap" at her study area on the Beartooth Plateau above Redlodge, Montana.

The material and technologies for mined-land reclamation where roads and motorized equipment can be used are abundant and well documented, but much less has been published about how to accomplish the same work in wilderness while observing wilderness legislation. Almost any place modern humans have opened wounds in the wilderness, managers are committed to finding the best way to heal those wounds. Brown has studied low-impact hand methods of reclamation for wilderness in Colorado alpine zones, on wind-blown tops of the La Sal Mountains of Utah, and on the Beartooth Plateau.

This work shows conclusively that successful revegetation can be accomplished on small scales entirely with local materials and hand labor.

For example, Brown suggests that the only tool needed in the wilderness for revegetation work is a rake with the handle sawn in half to make it easier to pack. The rake is used to roughen up the soil surface. Next, after local native seed is collected and sown on the site, the rake is used to collect plant litter from the area near the site. This litter is the mulch that will improve success dramatically.

On sites that need fast revegetation, Brown recommends the extra effort of mixing the litter in with the upper layer of soil. Mixing will increase the rate of decay and help hold the litter on site.

Although mulch can be packed into the backcountry outside of wilderness, Brown suggests staying with locally collected material because it will contain the specific microorganisms essential to recreating a healthy ecosystem on the disturbed area.

Brown and Chambers use a nylon net to hold down mulch in the ferocious winds that whip across this alpine ridge on the Beartooth Plateau.

Because of the high winds common in alpine zones, keeping litter on the disturbed area is a significant challenge. Scattering rocks, logs, and clumps of sod on top of the litter help break the wind and hold the mulch down. In addition, large objects help retain snow on the site and create microclimates often favorable for seed germination and survival.

In areas with extremely high winds, a commercially made woven mulch matte is available that can be staked down on the site.

After mulching Brown suggests that snow retention on the site is important. Bare knobs and barren ridges, known as "balds," are common in the alpine zone. Snow blows off of balds, severely reducing the amount of water available for plant growth. Temporary snow fence can be installed until vegetation is established. Short of snow fence, roughening the soil surface and placing large objects on the site helps. Once vegetation starts to thrive in the shadow of the snow fence, it will help trap snow, making balds more hospitable to other plants.

"Revegetation is like baking a pie," Brown says, "everyone has a favorite recipe. The common ingredient to all good alpine recipes is an understanding of how alpine plants and alpine ecosystems function."

"If the pie burns," Brown says, "and revegetation efforts fail, think back to basics of how plants survive in the alpine environment. Use a recipe with the right alpine species adapted to the location. Create a seed bed with safe spots for seeds that favor germination. Use a surface mulch similar to natural plant litter. Imitate nature and sow your seeds in the fall."

A perspective on agroforestry

by Bill Rietveld and
Rick Fletcher
Rocky Mountain Station

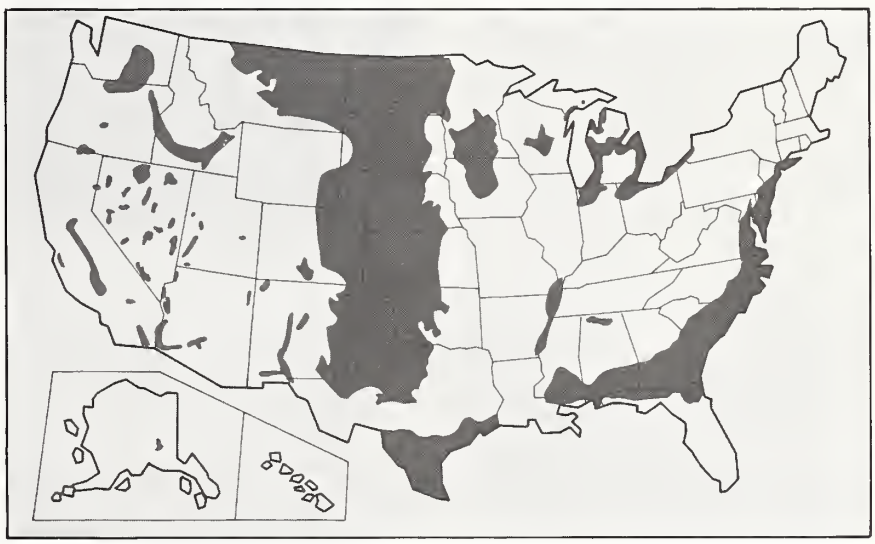
Agroforestry in the semiarid Great Plains is broadly defined as trees in support of agriculture, environmental conservation, and people. On semiarid agricultural lands, conservation trees are "working" trees. They protect crops, livestock, wildlife, soil, water, homes, and roads. However, trees have generally not fared well in the path of "efficient" agricultural production. Ironically, modern agriculture is now in trouble due to an array of environmental problems, in part because of neglect of soil and water conservation—key roles of trees!

Scientists with the Rocky Mountain Station's Forestry Sciences Laboratory in Lincoln, Nebraska, are focusing their efforts on agroforestry in the Great Plains. They are endeavoring to integrate state-of-the-art technology for planting and nuturing trees—especially windbreaks—with the most up-to-date agricultural practices.

The following are excerpts from a paper presented at the recent "Mid-south Conference on Agroforestry Practices and Policies" in West Memphis, Tennessee. It is authored by Rocky Mountain Station Director Hank Montrey and Supervisory Research Plant Pathologist Willis J. (Bill) Rietveld. The paper focuses on the numerous vital roles and opportunities for tree planting and agroforestry in the Great Plains.

Agroforestry (agriculture + forestry) is the application of conservation forestry practices on agricultural lands. The introduction of trees and shrubs into agricultural environments that lack trees can have enormous impacts on wildlife and other amenities. "However", says Montrey "we must not lose sight of the fact that we are planting trees in support of agriculture, not the reverse. Our goal should be to sustain and enhance agriculture, to attain a harmony between agricultural production and resource conservation. Agroforestry is not just 'tree planting'!"

The existing one million acres of field and farmstead windbreaks in the Great Plains yield at least $700 million per year in benefits. These include decreased topsoil loss and wind and water erosion, increased crop and livestock production, increased hunting of game species, reduced home heating and cooling costs, and important wood products.



This map shows cropland areas of the United States that have the highest potential for wind erosion.

A failure to communicate

The use of trees to augment agriculture has been slow to take hold in the United States. There is a sound body of research to support the incorporation of trees into agricultural systems. However, trees are often reluctantly tolerated as a conservation measure, and are not generally recognized as an income producer by much of the agricultural community.

"There are several rationalizations for the slow progress made in the acceptance of trees by the agricultural community", says Rietveld, "including: (1) older tree plantings require too much land relative to the amount of protection provided; (2) economic pressures act to physically restrict the area available for trees; (3) there

is a lack of quantitative data on the effects of windbreaks on crops and livestock; (4) many windbreaks have been poorly managed and are in poor condition and unsightly; and (5) many farmers have little appreciation for the intrinsic values of the trees themselves.

"The agricultural community needs to be convinced that conservation forestry practices have a lot to contribute toward the solution of serious environmental and sustainability problems," says Rietveld. "The real challenge facing foresters is not technological barriers, but the need to penetrate communication barriers. We need to change the way we think and present our issues. Our focus should be on emphasizing the many vital roles of trees in sustaining agriculture on semiarid lands—to conserve valuable topsoil, maintain water quality, increase landscape and biological diversity, provide harborage for natural enemies of crop pests, increase carbon dioxide fixation, increase preparedness for climate change, improve environmental quality and quality of human environments, increase energy efficiency, and protect wildlife."

Field windbreaks

Soil erosion by wind is a major problem in semiarid environments. The Great Plains holds nearly three-fourths of the highly wind-erodible lands in the United States. Trees have been planted in semiarid regions throughout the world to halt or slow the process of desertification. A striking example of resource recovery occurred in the United States during and immediately following the dust bowl years in the 1930's. Two hundred twenty-three million trees established in 18,600 miles of windbreaks from 1935–1942 dramatically changed the landscape of the region and helped to make the land productive again.

Scientists at Lincoln, NE, in cooperation with Iowa State University, have genetically engineered poplar trees with a proteinase inhibitor gene that retards insect development and reproduction. Current research will focus on the effects of environmental stresses on plant defense gene systems.

Although trees have served to restore damaged lands during crisis periods, they can serve equally well in preventing such damage if they are included as an integral part of agricultural systems. "Tragically, that is not always the case," says Rietveld. "Miles of existing windbreaks are being ripped out in modern agricultural systems. Crop residue management (leaving some of the dead residue of the previous crop on top of the soil to hold it in place) is now a recommended method for controlling wind erosion. But crop residue management can't control wind erosion when protection is needed the most—during a drought when shriveled crops mean insufficient residues." Due to recent years of drought, soil erosion (based on acres damaged) has been 130 percent worse than during the dust bowl days of the 1930's. Shelterbelts can do the job when the rains fail, says Rietveld. "Instead of removing windbreaks, we should be planting thousands of miles of new ones, both to hold the soil and to maintain sustainable, profitable farming operations," he said.

Rietveld and Montrey advocate legislation that includes strong incentives for the planting and management of field windbreaks. And they concur that there is a continuing need to develop stress-resistant and pest-resistant trees, install demonstration plantings, train conservation specialists on shelterbelt design and establishment, and develop and aggressively promote conservation forestry.

Filter strips

The sustainable agriculture concept emphasizes judicious use of fertilizers, pesticides and crop rotation practices to increase farming efficiency. "This is a sound concept," Rietveld explains, "but the reality for several years to come is that agriculture will continue to be the largest source of groundwater contamination and non-point water pollution in the United States."

Researchers at the Forestry Sciences Lab note that the planting of trees and shrubs along waterways to filter out excess fertilizers and pesticides, to reduce sediment loads reaching waterways, and to provide wildlife cover, is another vital role of trees in sustainable agricultural systems. Present practices include grassed waterways in the fields, and wooded riparian zones. However, the in-between waterways (fields, and the network of various ditches, gullys, intermittent creeks, and small streams) are almost completely neglected. Filter strips of specialized trees placed along waterways have a substantial capacity to filter out excess farm chemicals and sediments, and are a good source for fuelwood.

Biological diversity

The efficiency and productivity of modern agriculture in the United States is largely dependent upon the use of synthetic pesticides to control pests. Reliance on this single control strategy, however, has created formidable problems and broad societal concerns, such as: (1) pest resistance to chemicals has diminished their efficacy; (2) chemical pesticides kill or disrupt natural enemies of crop pests; (3) concerns over pesticide toxicity to non-target species, wildlife, and people; (4) negative effects on groundwater; (5) food contamination; and (6) the removal of effective pesticides and the difficulty in getting new pesticides registered. The bottomline is that pesticides are becoming less effective and their use will likely be more restricted in the future.

An important component of the sustainable agriculture concept is the use of biological controls to manage crop pests. Biological control is pest and disease suppression utilizing natural predators, pathogens, antagonists, and parasites. Organisms used in biological control are almost always environmentally safe, non-polluting, and usually affect only the targeted pest or disease organism. Trees and shrubs can play a key role in supporting biological controls by providing harborage and habitat for natural enemies of crop pests. "The result," says Rietveld, "will be more biologically diverse agricultural ecosystems with healthy pest-predator relationships, rather than simplified ecosystems dependent on chemical controls."

Adapting to climate change

Climate change models predict that the Great Plains will become warmer and drier in the next 40 years. The expected impacts on agriculture are increased wind erosion and pest problems, and decreased crop productivity. Station scientists believe that trees can play a vital role in the changing climates of this region. Field windbreaks provide continuous protection of crops, soil, and water that crop residue management practices alone do not provide. Studies show that crop growth is reduced when winds exceed seven miles per hour. Because windbreaks reduce wind speeds, sand blasting of young tender plants is prevented, less water is lost to evapotranspiration, and crops use available water more efficiently. Windbreaks can prevent desertification of the Great Plains, and can be the backbone of future sustainable agricultural systems, buffering crops and livestock from cumulative effects as well as severe weather.

Integrated conservation systems

"The best approach to achieve the soil and water conservation and biodiversity goals of sustainable agriculture is one that considers all options," says Rietveld. "This approach integrates the most appropriate conservation farming and conservation forestry practices into flexible, adaptable whole-farm systems. For example, the combination of windbreaks, conservation tillage, terraces, contour planting, grassed waterways, and filter strips will minimize soil losses and water contamination. The systems approach incorporates the best combinations of practices that will most effectively minimize both wind and water erosion, provide year-round and long-term protection, and provide the desired conservation and amenity benefits a particular farm or ranch operation is striving to achieve," he says.

The Center for Semiarid Agroforestry

In the 1990 Farm Bill, Congress authorized the establishment of a Center for Semiarid Agroforestry, in conjunction with the Rocky Mountain Station's Forestry Sciences Laboratory in Lincoln, Nebraska. Funding for the Center is yet to be appropriated. The Center's mission is to initiate, stimulate, and support research, development, demonstration, technology transfer, and education leading to more sustainable land use through the appropriate integration of trees into semiarid agricultural systems. It will achieve its mission through in-house research and technology transfer, and through collaborations and partnerships with other USDA agencies, state forestry agencies and universities, and the National Arbor Day Foundation.

Enhancing the quality of life

Station Director Montrey explains that if shown side-by-side photographs of two farms, one with conservation trees, and one with open fields, few people would select the latter as the more desirable place to live. "Trees break up the monotony of crop land, soften the microclimate around farmsteads, attract wildlife, and reduce dust and noise levels from busy roads or agricultural activities," he said. "In addition, the many benefits of trees and windbreaks listed earlier also directly relate to the quality of life on the farm."

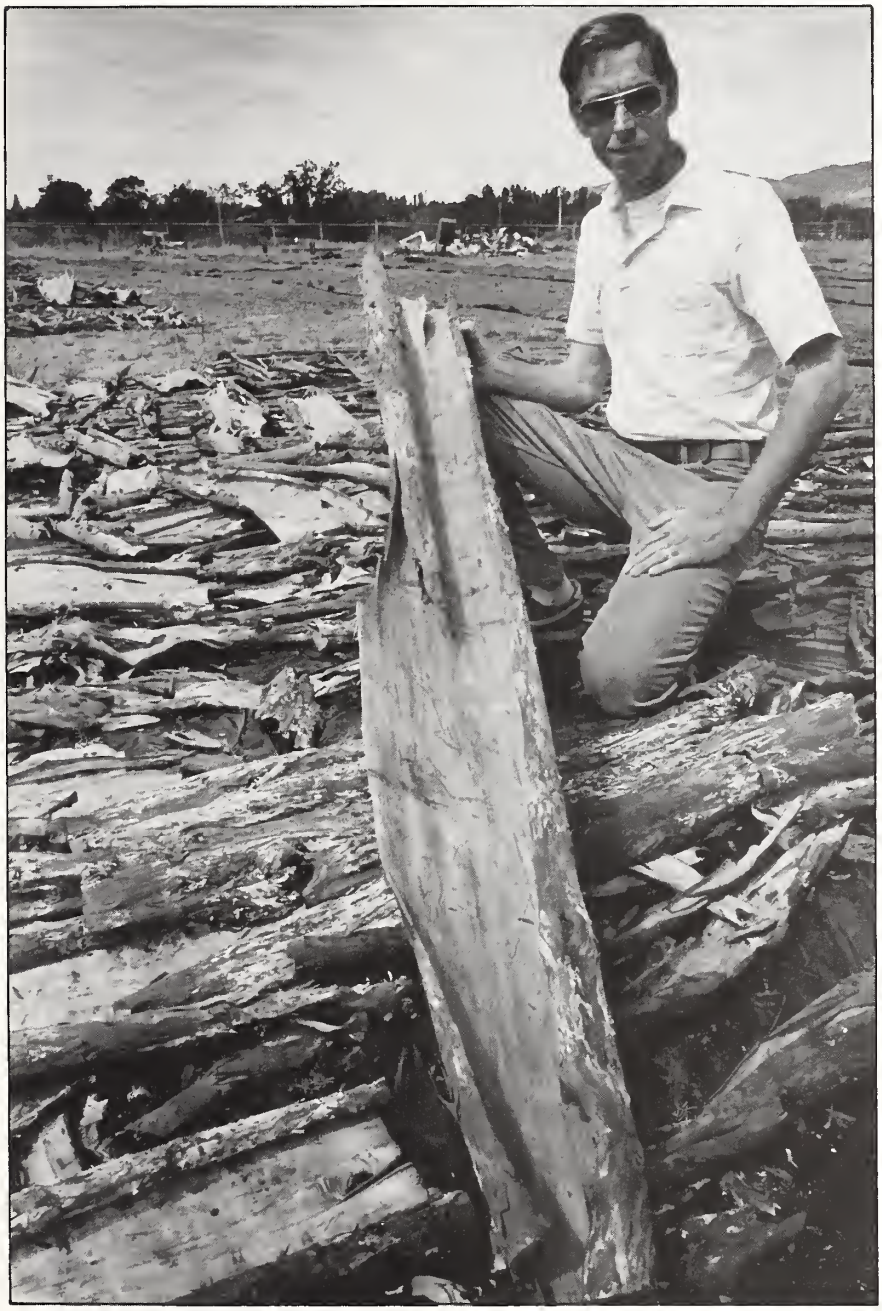
Research on biological controls being conducted at Lincoln will focus on identifying natural enemies of tree insect pests and characterizing their role in agroforestry ecosystems.

"For all of their conservation benefits, windbreaks should be viewed as more than just big wind screens," says Montrey. "They are green, living biological systems and, with planning and foresight, can be a source of countless amenities. Windbreaks can include nut trees or fine hardwoods, and can shelter fruit orchards, a garden, or a picnic area. Properly managed windbreaks can be a continuous source of firewood, and they will increase the abundance of wildlife. Windbreaks can spread the soft touch of nature's beauty throughout the countryside."

If you would like additional information on the potential for, and future of, agroforestry in the Great Plains, contact Bill Rietveld at the Forestry Sciences Laboratory, University of Nebraska – East Campus, Lincoln, Nebraska 68583, (402) 471–5178, FTS-541–5178. Rietveld, who heads the Lab's Protection and Improvement of Trees in the Great Plains project can also provide information on related research endeavors which include: (1) identifying and developing superior trees that are resistant to insects and diseases, and adapted to the Great Plains environment; and (2) developing methods for reducing the impacts of major tree diseases and insect pests in the Great Plains.

Pacific yew: a miracle cancer cure?

by Sherri Richardson
Pacific Northwest Station



Floyd Ehrheart of Medford, Oregon, is examining drying yew bark. Ehrheart, a former firewood cutter, collects the bark, twigs, and needles of yew trees and grinds them up for shipment to a chemical company. (Photo courtesy of the Medford Mail Tribune)

The yew tree has been the subject of folklore, history, myths, and legends for centuries. Many stories have associated the tree with death. The Victorians believed the roots of yew trees in churchyards grew into the throats of the dead. The ancient Greeks, Egyptians, and Romans incorporated the yew into funeral ceremonies, according to Hal Hartzell and Jerry Rust, coauthors of the book *Yew*. Today, the Pacific yew (*Taxus brevifolia*) is identified as the source of a life-saving drug, taxol. Experiments conducted at the National Cancer Institute (NCI) for the past 10 years have proven that taxol, a drug extracted from the bark of the Pacific yew, is effective in treating cancer.

"The institute has been looking at natural products for more than 30 years," explains Dr. Gordon Cragg, a chemist and chief of the natural products branch of NCI, "and we have found taxol to be the most effective product in curing ovarian cancer. So far, 30 percent of our patients have had a total remission or cure. We are, however, still in the preliminary stages with the drug as far as treating breast and lung cancer." In 1988, Cragg presented a seminar at the Pacific Northwest Research Station (PNW) about a worldwide search the institute was conducting to find plant compounds useful in curing cancer.

More than 120,000 plant compounds were tested, and taxol was one of the most promising of those tested. "Because 60,000 pounds of bark is needed to produce 9 pounds of taxol," Cragg says, "enough to treat only 100 to 200 patients, we needed statistics on bark availability before continuing our experiments."

Chuck Bolsinger, principal resource analyst with the PNW Station, attended that presentation and soon after began work on a chapter on the Pacific yew for the latest edition of a silviculture manual for trees in North America. "Not much has been known about the tree in the past, and it had not been included in previous silviculture manuals because it wasn't considered commercially. important," Bolsinger says — a situation that may change with the current interest in the yew tree and its properties.

Characteristics of the Pacific yew

One of the major problems encountered with the Pacific yew as a source for taxol is the fact that the tree grows relatively slowly. "It takes about the same time to grow to 12 inches in d.b.h. as other conifers in the same stand take to grow to several times that size," Bolsinger says. "Trees larger than 20 inches in d.b.h. and taller than 40 feet are rare within most of the species' range; they account for less than 2 percent of the yew trees tallied on inventory plots on non-Federal lands in California, Oregon, and Washington,"

The Pacific or western yew is a coniferous tree associated with several conifer and hardwood tree species on various sites. It is found along the Pacific Ocean from southern Alaska to central California, and in the Rocky Mountains from southeastern British Columbia to central Idaho and western Montana. In Idaho, Montana, Washington, Oregon, and California, the yew occupies 1.2 million acres. The tree survives best on deep, moist, rich, rocky or gravelly soil and is found from sea level to timberline in areas with 20–120 inches of annual precipitation. The growing season ranges from 60 to 300 days.

"The yew is an understory species found in several forest cover types. It is a major component in some stands, but in most it is minor to rare," Bolsinger adds. "Sometimes it is shrublike and forms dense thickets like those commonly found in the western part of Montana, parts of Idaho, and northeastern California. The limbs are sometimes as long as the tree is tall. Young trees often have an umbrella-shaped crown of flat branches, while old trees have long drooping spraylike branches." The bark of the yew is purplish, papery thin, and scalelike. The wood is the heaviest of U.S. conifers.

Supply and demand

Although the Pacific yew has never been in demand by the forest products industry, it has many uses. Japan was a major purchaser of the yew in the mid-1980s. Japanese buyers used it for wood carvings and ceremonial "Toko" poles placed next to entrances of their homes. The resistance of the yew to decay made it popular for fenceposts. It has also been used for archery bows, canoe paddles, tool handles, gunstocks, boat decking, furniture, musical instruments, and miscellaneous novelty items.

The interest generated in the bark for taxol production has changed the future for the yew. Chris Lewis, forest products officer for the Rogue River National Forest in Oregon, says the tree is in such demand now that theft of the tree is common and hard to detect. "People cut the yew, put it on the back of a pickup, and cover it up," Lewis says. "I think we need to get a handle on how many yew trees are being used—we need some accountability. We make bark available for research, but the only trees used now are those cut in the course of logging operations that otherwise would go to waste." Dealers pay 5 cents a pound for yew bark. Lewis says the NCI purchased 10,000 pounds of the bark in 1987, compared to 31,000 pounds in 1990. "We are now collecting cuttings and looking towards putting them in the ground in about 2 years to keep up with the demand."

Of the 85 million acres of forest land surveyed and estimated in Idaho, Montana, Washington, Oregon, and California, Pacific yew was found on about 1.2 million acres. "In the past yew was considered a 'trash' tree, and it got the same treatment as manzanita or vine maple in logging operations, but that seems to be changing," Bolsinger says. "An unknown, but large proportion of the yew trees that existed at the turn of the century, have been destroyed in logging operations, land clearing, and fires."

Commercial and community interest

Several companies, like Weyerhauser, have taken an interest in marketing the yew. "For the past 3 years we have been looking at marketing and producing the yew," says Nicholas Wheeler, a geneticist with Weyerhauser. "We are still determining if it makes sense to pursue commercial production of this tree. We are concerned with producing sustainable quantities of the tree so we don't destroy the stands already thriving."

Interest in the tree continues to grow and has caused an Oregon county commissioner, Jerry Rust, to push for national legislation to protect the yew from logging operations that he believes destroys the tree. The Pacific Yew Conservation Group has a growing national membership and seeks to have the tree designated as a "strategic national resource."

Jim Driscoll is using a sharp knife to peel bark from a yew tree in the Butte Falls Ranger District, Rogue River National Forest. (Photo courtesy of the Medford Mail Tribune)

"I decided we needed to get together and do something about this situation," Rust says. "So we are launching an action to propulgate this resource."

Pacific yew on Federal and private land

Trees cut down in southwestern Oregon provided NCI with 60,000 pounds of dried Pacific yew bark in 1988. In 1989, the institute ordered another 60,000 pounds of the bark. The combined order was the equivalent of 6,000 to 7,000 trees. One tree, on the average, provides 40 pounds of green bark that, when dried, weighs 19 pounds. The 60,000 pounds of dried bark produces about 9 pounds of taxol. According to Bolsinger, clinicians in several locations across the country asked for increased supplies of taxol.

Yew has not been inventoried on National Forest land in Oregon and Washington, but it is expected that inventory projects will soon be started. The inventories have been conducted on private, State, and Bureau of Land Management (BLM) land. On private land, the tree is present on about 500,000 acres of young-growth stands, most less than 50 years old. Included are yew trees that regenerate by sprouting (yew is one of two coniferous species in Oregon that readily sprout from the stump when cut—the other is redwood) and from seedlings. In old-growth stands on BLM land, which is intermingled with private land in a checkerboard pattern in western Oregon, Bolsinger found yew to be present on about 4 percent of the area—the same proportion found in young-growth stands in private ownership. The number of yew trees per acre in old-growth stands averaged twice the number found in young growth—considerably fewer large yew trees were found in the young-growth stands.

Although yew trees are appearing in many young-growth stands—often as sprouts from stumps—long-term viability of the species may still be a problem, especially where extensive areas of forest are managed on a short-rotation and harvested by clearcutting. Bolsinger doubts that yew trees will attain sexual maturity in the 30 to 50 years that stands are allowed to grow under short rotation management. Yew trees rarely would exceed 3 to 4 inches in d.b.h. in that time period.

"In the long term, sexual reproduction is essential for survival," Bolsinger says. "In parks, wilderness, and other protected areas, the yew's future seems assured. There is the concern, however, that unique genetic strains of the species, including perhaps genotypes that produce unusually large amounts of taxol, may disappear before their unusual properties are known."

Synthesis of taxol

The demand for taxol production probably will increase and substantially decrease a resource that already has been taxed. Bolsinger explains that attempts to synthesize taxol in the laboratory have not been successful and many people believe that it will not be possible. Although taxol has been found in other species of *Taxus*, the Pacific yew is considered the only source for quantities suitable for clinical use. One private organization, however, has begun to experiment and examine alternate ways of producing taxol through tissue culture and growing vegetatively propagated trees in a controlled environment.

The USDA is also in the process of filing a patent to produce taxol from laboratory tissue culture. Neil Jans, director of business development for Hauser Chemical Research in Boulder, Colorado, expects the demand for yew trees to fall in about 5 years. He believes that researchers will have found a substitute for taxol by that time.

Yew trees are usually small in diameter. Chuck Bolsinger is standing next to an exceptionally large yew near Ripplebrook, Oregon.

Yew update

The interest in the Pacific Yew is growing as public and private organizations take positions on the future of the tree. In September, several environmental groups met in Washington, DC, and submitted a petition to Secretary of the Interior Manuel Lujan to declare the Pacific yew a threatened species. Some of the groups represented were the Environmental Defense Fund, National Wildlife Federation, The Wilderness Society, and Friends of Ancient Forests. Two leading taxol researchers and the American Cancer Society, which has 2.5 million members were also represented.

Meanwhile, the NCI is seeking research proposals from the public and private sectors that have a high probability of increasing the supply of taxol. A team of scientists from PNW and Oregon State University are currently preparing a proposal for such a research project.

For more information on the Pacific yew, contact Chuck Bolsinger at the Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208. For more information on taxol, contact Gordon Cragg, Natural Products Branch, National Cancer Institute, Frederick Cancer Research and Development Center, Building 1052, Room 109, P.O. Box B, Frederick, MD 21701.

A G.I.S. for fire

by J. Louise Mastrantonio
for Pacific Southwest
Station

Some time in 1991, the U. S. Forest Service hopes to implement a national computer-based Geographic Information System (GIS). When that happens, the agency—which adopted the Data General system for administrative functions in the mid 1980's—will be drawn irretrievably into the computer age. Dozens of different data bases will be merged and many more land management activities—from planning to analysis and reporting—will be assisted by computer.

The GIS has many applications in fire management. At the Intermountain Station in Missoula, for example, researchers are working on a GIS for fire behavior modeling. And at the Pacific Southwest Station's Forest Fire Laboratory in Riverside, California, Research Forester Lucy A. Salazar has developed a prototype of a Fire GIS for the San Jacinto Ranger District of the San Bernardio National Forest.

Site is important

Salazar began working on computer applications in fire economics modeling about ten years ago. At that time the work was nonspatial, that is, the data could not be "attached" to specific locations. That turned out to be a drawback in fire management where location is especially important. Managers need to know where the fire is...what the vegetation types are...where crews are located. "Site is everything," according to Salazar.

A GIS integrates mapped data of different themes, locations, and sources to provide information for analysis and decisionmaking.

About four years ago, the research unit began working with geographic information systems—computer data bases that amass large amounts of resource data and fit it—like a glove—to a given site. That became possible because the U. S. Geological Survey had prepared computerized elevation data, called "digital elevation model data," for the entire United States. Now, for the first time, managers could construct three-dimensional computer views of a landscape—including contour lines, slope, and aspect. About that time, also, the data storage capability of computers increased and the cost began to go down. Thus, it became possible—and practical—to develop and manipulate the large data bases required for a GIS.

A GIS is essentially geographic information that is "layered" onto an existing map base which might contain data on vegetation type or elevation. Other information—such as roads and trails, crew locations, wildlife habitat—may be added as needed and can either be printed out in different colors and studied visually or layered on in a computer display.

A pilot study

The San Jacinto Ranger District was selected for the pilot study because of its proximity to the Riverside Fire Laboratory, its diversity of topography and vegetation type, and a history of prescribed burning. In addition, the District has a potentially serious fire problem caused by a growing wildland-urban interface. Home building in and around the Forest boundary is adding to the fire hazard. "We wanted to look at some of these problems before there is a real crisis," Salazar says.

Construction of the data base is a first—and large—step in developing a GIS. The San Jacinto data was compiled by students at the University of California, Riverside, under the direction of Rich Minnich, Professor of Earth Science at UCR and Michael Hamilton, professor of biology and director of the James San Jacinto Mountain Reserve. The "finished" data base (Salazar says they are never really finished) includes elevation data on a 30 minute grid (USGS), vegetation type, mean June temperature and precipitation data, roads and trails, administrative boundaries, watersheds, streams, campgrounds, power lines, buildings, lookout towers, fire management zones, and fire history.

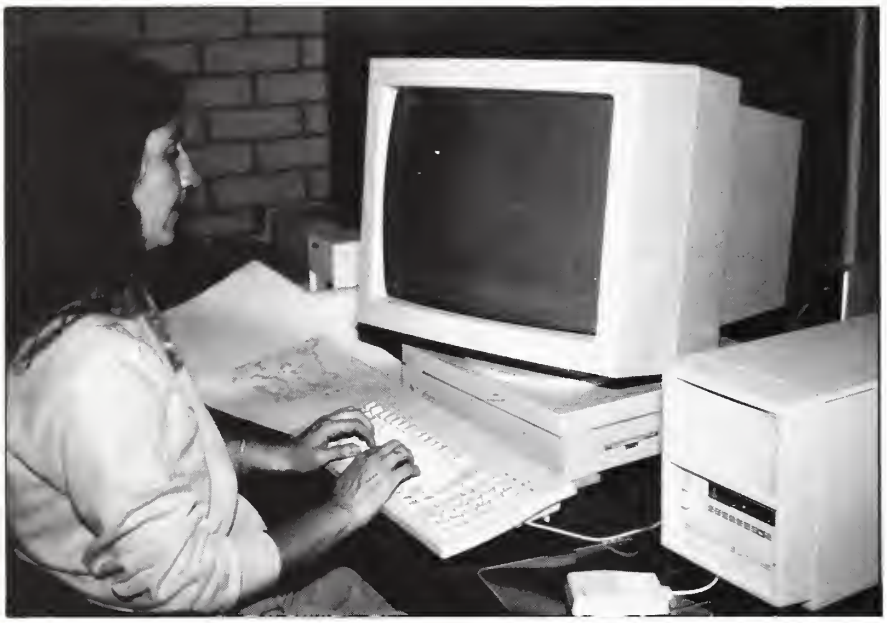
In a sense, the GIS does not provide new information. Rather, it combines existing data - from maps, aerial photographs, reports, on-the-ground observation - into a central data base that can be used by staff members in different disciplines. It will save both time and money and will enable managers to do many kinds of analyses not possible now.

Construction of the data base took longer than expected—about two years. Delays were caused by the need to maintain accuracy, and because the data base finally had to be transferred from the VAX computer at UC, Riverside, to a new SUN SPARC station acquired by researchers at the Forest Fire Laboratory. "It is very important," Salazar says, "to make sure the data is correct before putting it into the system." It is also important to document what was done so that future users can work with or change the data base without introducing error or inconsistencies.

Potential uses

Already the Ranger District has begun to use parts of the data base—in hard copy—as an aid in planning prescribed burns. And Fire Control Officer Clark Harvey is looking forward to the time when it can be used more extensively. Last summer, Harvey attended a three-day Forest-wide seminar on GIS. That conference, together with his knowledge of Salazar's work, has made him a convert. "I am just amazed at the capabilities," he said.

Salazar has also used the data base to analyze the District's fire management zones. That work is summarized in a paper she gave in November at the International Conference on Forest Fire Research at the University of Coimbra in Portugal.



The analysis capabilities of a GIS facilitate computer modeling of fire spread, spotting, smoke dispersal, and crew routing.

The researcher has also spent considerable time identifying potential applications. Eventually, such a data base may be used to:

- Identify vegetation types and delineate areas for fuel treatment such as prescribed burning.
- Delineate vegetation types—such as chamise—that are particularly fire-prone.
- Locate roads, trails, other improvements, high hazard areas, and water sources as an aid in deploying fire crews.
- Identify special features—sites of historical interest or unique wildlife habitat.
- Define fire management zones—areas of similar vegetation or fire hazard—as an aid in fire planning and budgeting.
- Model fire behavior including rate of spread and spotting potential.
- Train new fire personnel or crews brought in from other regions.

A changing technology

The GIS technology is "definitely coming," Salazar says. "Everyone is getting into it. Within a few years, it will be possible to have a terminal on your dash...in your car or fire vehicle."

In the future GIS may be even more useful because of innovations that are now just around the corner. Global positioning satellites will make it possible to determine locations on the ground within centimeters. From a helicopter flying over a fire, an observer could "map" the fire line and send that information back to the incident commander. "Interactive video" could supplement the GIS data base with historical photographs, tabular data or other imagery. And expert systems could be used in documenting and tracking decision making.

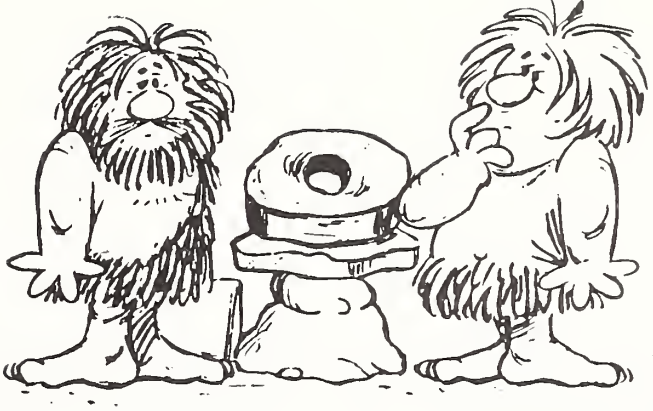
Fire experience useful

Salazar has a bachelor's degree in mathematics from the University of California at Irvine, and a master's in forestry from Humboldt State University, CA. She was raised in San Bernardino, in the heart of southern California's "fire country," and has had practical field experience working on fire and timber crews.

In fact, her first Forest Service job was on a fire crew in Idaho's Clearwater National Forest. One experience especially sticks in her mind. There was a fire at the top of the hill. The fire boss didn't know if the road they were on went all the way to the top so he sent the crew hiking up the hill to the fire. "Most of the brush was over my head," Salazar recalls. "But what really threw me off was when we finally got up to the top here came the driver who had let us off." That incident provided an idea for her master's thesis—to use remote sensing to identify vegetation type and roads in preattack planning.

In August 1990, Salazar transferred to Eureka as vegetation management specialist with the Fire Staff of the Six Rivers National Forest. There she expects to continue to be involved in using GIS in fire management.

New from research



Stability and change in minerotrophic peatlands, Sierra Nevada of California and Nevada

Minerotrophic peatlands or fens are small wet meadows surrounded by mixed conifer forests. Sierran meadows are important habitats and recreational resources. Plant succession has a strong impact on the quality of meadows. Concern has been expressed particularly about changes caused by pine invasions. The seral sequences and factors governing plant cover changes and timing are largely unknown for many Sierran meadows. Hence, decisions about management for preservation or restoration are severely hampered. Wet meadows, because of their clear dependence on hydrologic regimes, may provide a simpler system for analysis than other types. Their sensitivity to hydrologic changes makes them particularly sensitive to natural or human perturbation.

Management of pine invasions is not needed for preservation of Sierran fen ecosystems. Fens are persistent features in the landscape. They are not fragile, disappearing vestiges of an ancient glacial event. This type of wet meadow is so persistent that the establishment of pines anywhere on them should be considered a temporary natural fluctuation. Actions which change their water supply will affect the persistence, spatial distribution and size of fens.

For more information on fens request Research Paper PSW-198, available from the Pacific Southwest Station.

The value of recreation on our National Forests

A new report outlines a special study designed to give advice on the economic value of recreation, for use in the 1990 RPA Program Analysis. This study was the first of its kind to consistently analyze several Forest Service Regions, and the wide array of recreational activities they provide.

The Public Area Recreation Visitors Survey (PARVS) was used to estimate demand models, from the site operator's point of view, for twelve types of activity trips in all nine Regions. By using the same model for each Region, scientists were able to easily compare all nine.

For a copy of *The Net Economic Value of Recreation on the National Forests: Twelve Types of Primary Activity Trips Across Nine Forest Service Regions*, write the Rocky Mountain Station and request Research Paper RM-289.

Forest nursery management in the Northwest

The Intermountain Forest Nursery Association recently met to discuss various forest nursery management techniques and to honor the organization's 30 year anniversary.

Twenty-three papers were offered on such topics as "Seedbed Mulching with Stabilized Sawdust", and "Causes and Control of Overwintering Damage in Nursery Stock." All papers presented at the symposium appear in a recently published proceedings. Special sections are devoted to fumigation in forest nurseries, and articles addressing Great Plains nurseries.

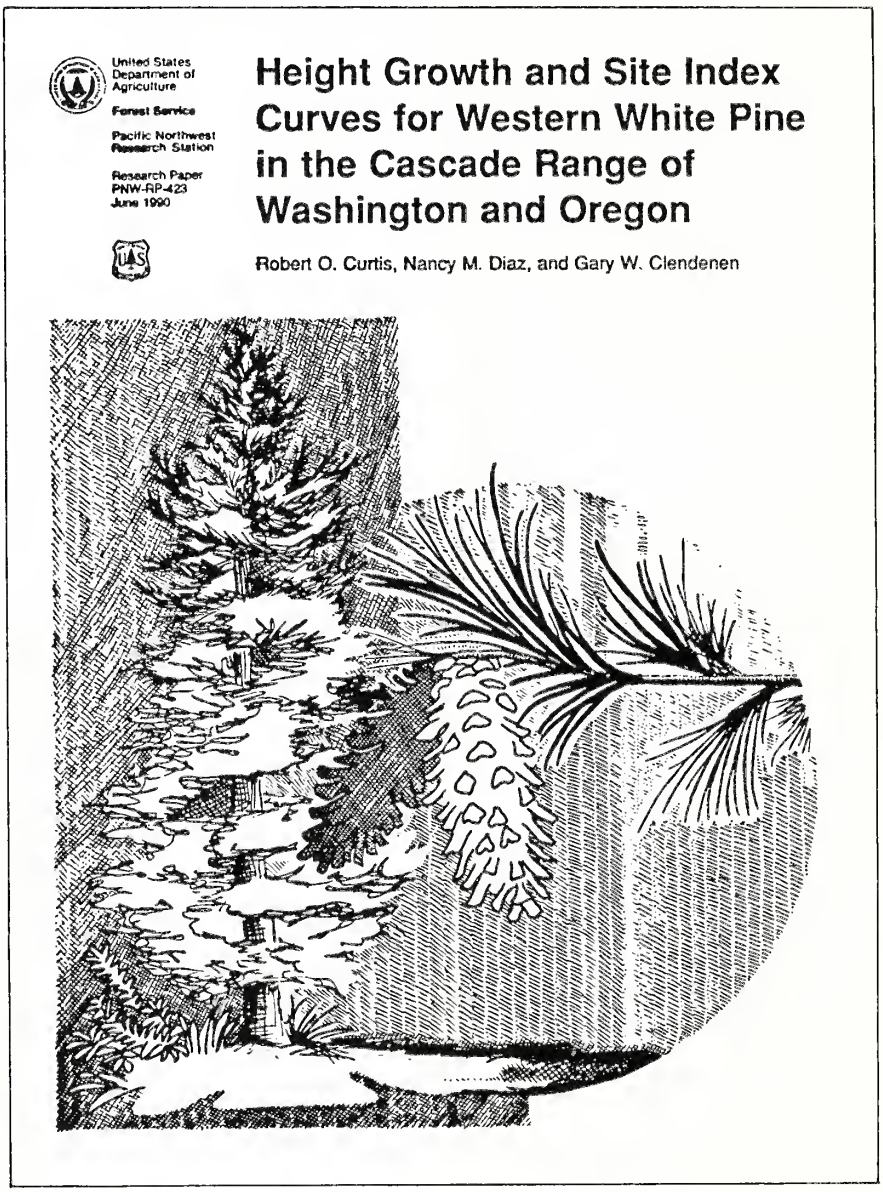
For a copy of *Proceedings, Intermountain Forest Nursery Association*, request General Technical Report RM-184 from the Rocky Mountain Station.

Western white pine: site index and growth

With the introduction of blister rust-resistant planting stock, interest in western white pine has been renewed. For instance, the species can serve as an alternative to Douglas-fir on poor sites or areas susceptible to frost damage. Limited planting is being done, and managers need to classify sites for growth potential and to estimate yields.

This publication provides height growth and site index curves based on data from National Forest lands in the central and northern Cascade Range. Although the original intent of the authors was to sample throughout the area where white pine is being planted, the occurrence of white pine is so limited (partly from salvage cutting) that sampling could only be done in undisturbed upper elevation stands. Use of these curves, therefore, will mostly require extrapolations. Nonetheless, these curves represent the best tools for estimating potential growth and yield that are available.

For a copy, request *Height Growth and Site Index Curves for Western White Pine in the Cascade Range of Washington and Oregon*, Research Paper PNW-423.



Wilderness choices provide hints to managers

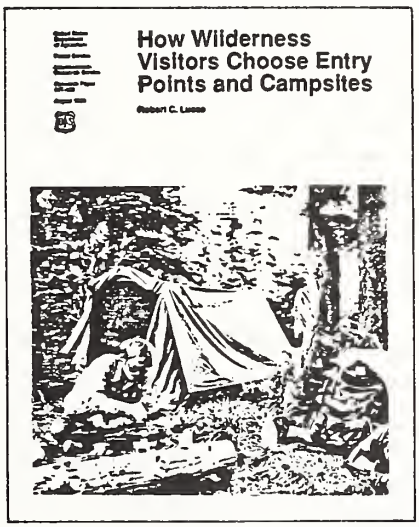
A study about the behavior of visitors to the Bob Marshall Wilderness provides insights to managers about how they might influence the distribution of use, reducing impacts in wilderness and improving the quality of wilderness experience.

Social scientist Robert C. Lucas of the Intermountain Station's Wilderness Management research unit in Missoula, Montana, investigated the criteria different types of visitors use to select campsites and trailheads. He explored the attributes of sites important to visitors, and he related those attributes selected to the different kinds of visitors.

"Horse users and hunters have different, less-demanding ideas about acceptable wilderness campsite conditions," Lucas reported. "They pass up campsites more often, primarily for reasons related to functional, utilitarian aspects, not minimum impact." He also learned that this is the group least likely to contact the Forest Service for information prior to a visit, and when they do contact the Forest Service it is almost always in person.

On the other hand, he learned that avoiding horse manure is a major reason that backpackers reject campsites, indicating the need for emphasis on keeping livestock away from campsites and scattering "meadow muffins."

Contrary to what he expected, Lucas found that visitors seeking solitude were less likely to plan their trips far in advance. "It appears that those who say solitude is very important to them do not do much more than other visitors to try to find solitude." he wrote.

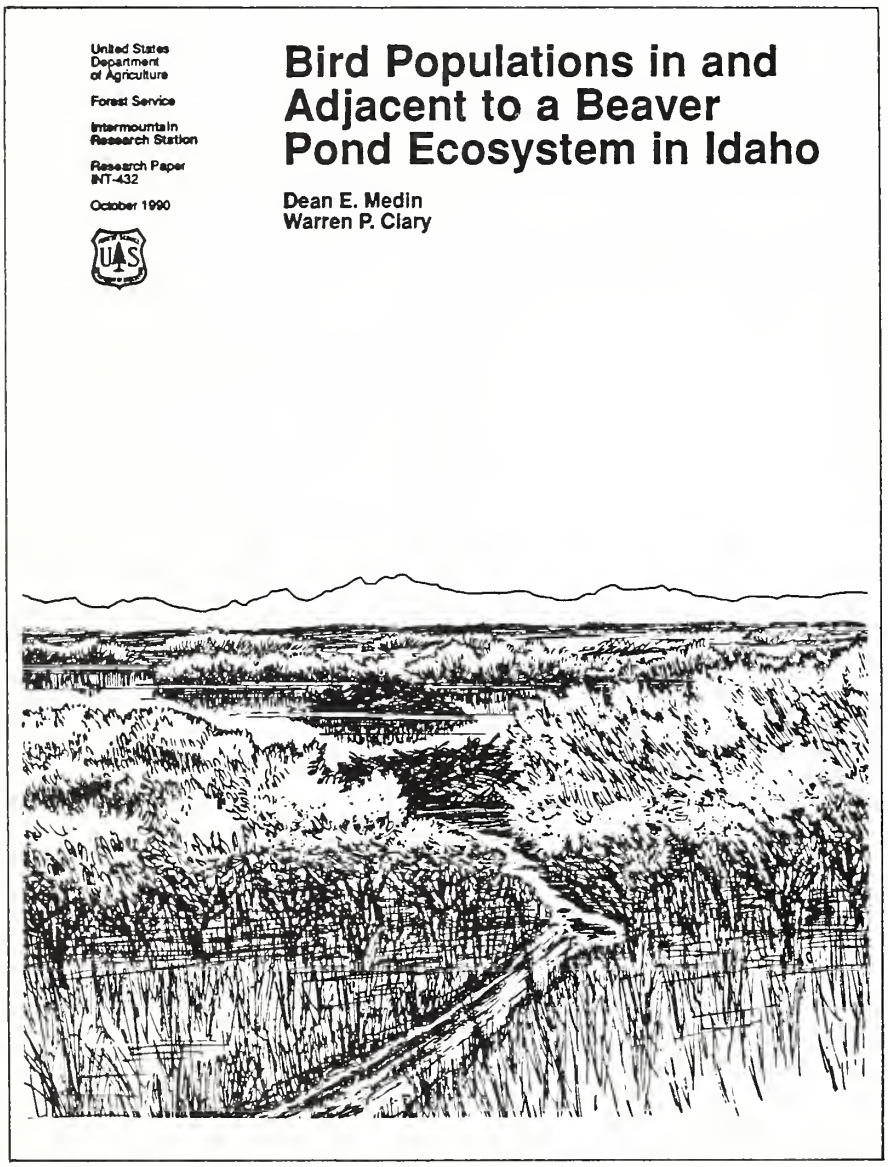


Most visitors, with hunters and horse users being the exceptions, look for new places to visit. They use maps as their main source of information to choose locations and plan their trips. The management implication of this is that "the agency needs to have good maps available, with all key information on them, and use maps as a major information and education tool."

So few visitors have Forest Service contact that every contact is "too rare to squander," Lucas said, suggesting that low-impact camping methods be taught at every opportunity.

His research also indicates that inflexible systems requiring advanced registration for a specific campsite so conflict with natural behavior that those systems are likely to fail most of the time.

Request *How Wilderness Visitors Choose Entry Points and Campsites*, Research Paper INT-428, available from the Intermountain Station.



Beaver beneficial to breeding birds

Beaver pond ecosystems with willows provided habitat for three times the bird density as nearby non-willow riparian ecosystems, in a study reported by the Intermountain Station's Wildlife Biologist Dean Medin and Project Leader Warren Clary in east-central Idaho.

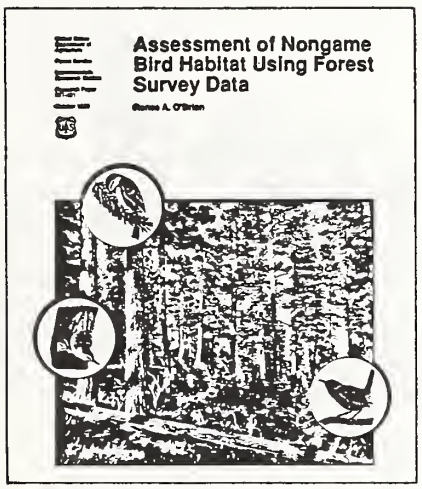
Clary and Medin, scientists with the Riparian-Stream Ecosystem Research Work Unit, also determined that species richness, diversity, and total breeding biomass were all significantly greater in the beaver pond community. More foraging and nesting guilds are also represented in the beaver pond complex. The higher productivity results mostly from the structural habitat provided by the willow canopy. Both ecosystems studied are protected from domestic grazing.

The study findings suggest that beaver pond ecosystems are important habitat for nongame breeding birds in the Western United States.

Request *Bird Populations in, and Adjacent to, a Beaver Pond Ecosystem in Idaho*, INT-432, available from the Intermountain Research Station.

Monitoring nongame bird habitat over a large area

Forest Survey data collected for lands of mixed ownership may provide a way to monitor structural habitat trends for highly mobile and migrating species of nongame birds.



Intermountain Station's survey unit assesses renewable resources on lands of all ownerships in the eight Rocky Mountain States, west Texas, and the Oklahoma panhandle. The multiresource data that field crews collect is unique because it includes private land and is summarized for states and large regions. For highly mobile and often migrating kinds of wildlife such as songbirds, this kind of broad data is essential to identifying habitat trends.

Ecologist Renee O'Brien studied two species of nuthatch, the Mountain chickadee, and the House wren, learning that, although the correlation between bird numbers and the survey data is variable, some correlation is possible. The broad-based data may be useful in identifying concerns for gross habitat trend, and identifying opportunities for habitat improvement through changes in timber management.

Request Research Paper, INT-431, available from the Intermountain Research Station.

Bird identification by song

Birds call and sing differently from region to region and some birds emit a variety of sounds. Existing guides have been inadequate as means for accurate identification for detailed surveys. To train observers for such surveys of bird communities, the authors developed a guide that summarizes existing guides and adds observations they and colleagues have made as they have participated in extensive surveys.

The guide provides written descriptions of bird calls only and is intended to be used in conjunction with field guides and recordings of bird calls and songs, recordings specific to the region when possible. About 120 bird species are listed by common name including the marbled murrelet (KEER-KEER) and Rufous hummingbird (V-V-V-V-VVRIP). For a copy, request *Training Guide for Bird Identification in Pacific Northwest Douglas-Fir Forests*, General Technical Report PNW-260.

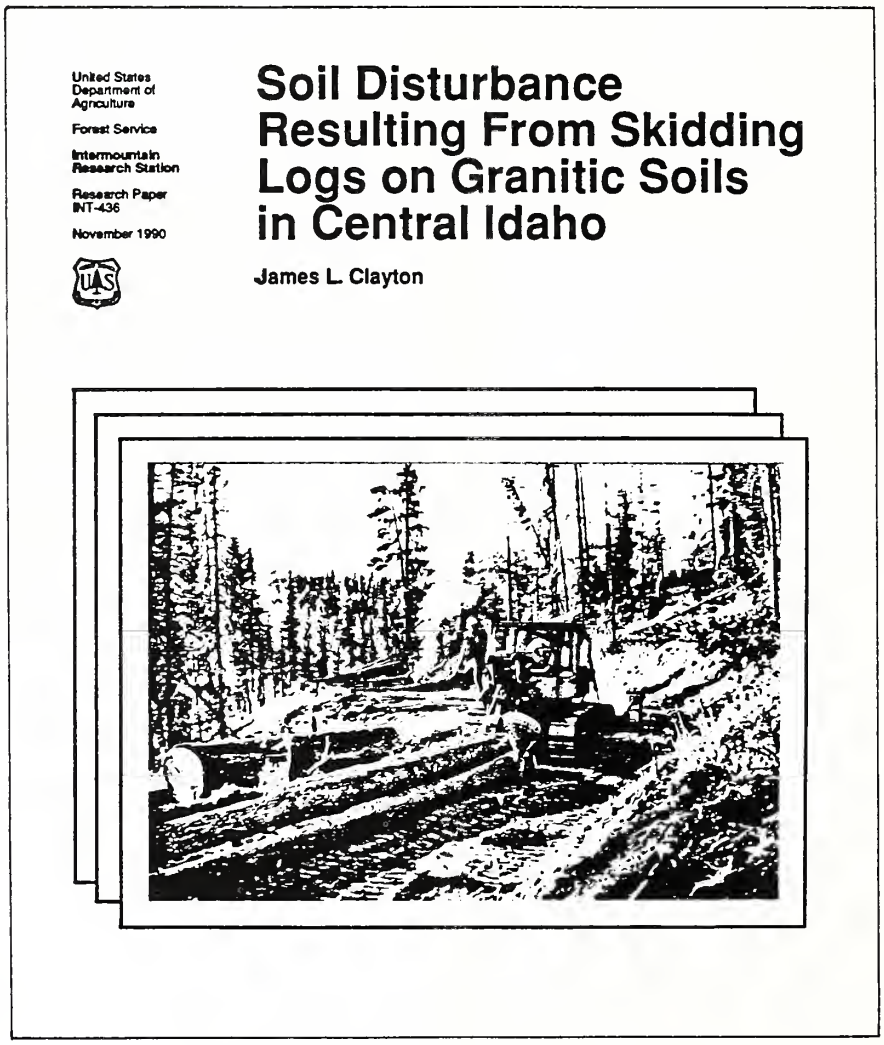
Tractor skidding reduces soil productivity

Evidence collected from three study areas in Central Idaho shows that when crawler tractor or rubber-tired skidders make several trips over the same area soil is significantly disturbed and compacted.

Soil Scientist James Clayton of the Intermountain Research Station's Boise Forestry Sciences Laboratory measured the bulk density of soils in areas with different kinds and intensities of skidding to measure soil compaction. Compaction increased with the number of passes that the machine made over the site. Crawler tractors disturbed and compacted the soil more than rubber-tired skidders. Compaction reduced productivity the most in sandy soils because the normal annual freeze-thaw process or shrinking and swelling did not reverse the compaction process as fast as in finer textured soils.

Clayton's recommendations to reduce loss in productivity from skidding compaction are: (1) restrict skidding to marked trails; (2) require directional felling; and (3) encourage operators to string cables to logs instead of driving to them.

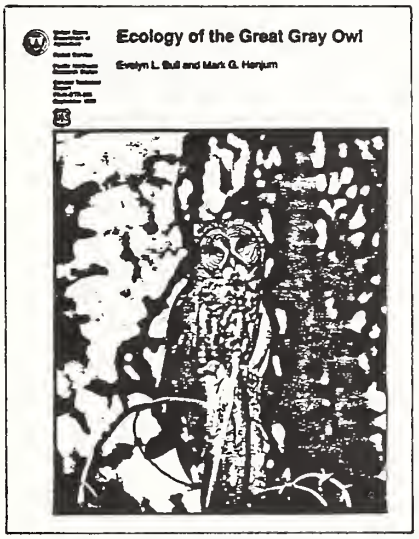
Request *Soil Disturbance Resulting from Skidding Logs on Granitic Soils in Central Idaho*, Research Paper INT-436, available from the Intermountain Station.



Ecology of the Great Gray Owl

Although the great gray owl has a range across Canada and into Alaska and down into the Midwest States and the Northwest, the bird is not easily observed because of its low numbers, nocturnal habits, and secretive nature. This publication brings together scientific information on the ecology of this bird and puts it into a guide that provides the basics from size of home range to influence of prey on nesting. The guide is particularly interesting reading.

Information existed about the bird in other parts of the world but Evelyn Bull and Mark G. Henjum found great gaps in what was known about the bird in northeastern Oregon. They began their study of the elusive owl in 1982, examining nesting biology, diet, habitat, movements, and mortality.



Their recommendations for managing habitat very briefly include putting up nest platforms (these owls use them very readily) and providing large diameter dead trees with broken tops; dead, down, and leaning material; dense stands near nest trees; and open areas for foraging that include perches.

For a copy, request *Ecology of the Great Gray Owl*, General Technical Report PNW-265.

Wilderness use promotes wellness

Throughout thousands of years and in many cultures, wilderness has promoted balance and harmony in people's lives. How important is it to maintain natural areas for people's mental health? Should this be something we care about? A recent symposium held in Estes Park, Colorado addressed these questions and others on this intriguing topic.

A new publication titled *The Use of Wilderness for Personal Growth, Therapy and Education* outlines papers discussed at the symposium, such as: "Wilderness Education: A Holistic Approach"; "Reducing Levels of Trait Anxiety through the Application of Wilderness-based Activities"; and "Changes in Self-Efficacy Through Outdoor Skills Instruction."

For a copy, request General Technical Report RM-193, available from the Rocky Mountain Station.

Small-diameter trees: new technology

Trees harvested for wood products increasingly get smaller as old-growth supply diminishes and rotations decrease. An integrated harvesting and processing system has been operating in dense stands of small-diameter western hemlock on the Olympic Peninsula of western Washington. This paper describes the system and examines its productivity and cost. With six pieces of woodland equipment, three separate products are produced simultaneously from a stagnated stand of small trees where single-product extraction had not previously been profitable. For a copy, request *Cost and Productivity of New Technology for Harvesting and In-Woods Processing Small-Diameter Trees*, Research Paper PNW-430.

The latest in inventory methods

The methods used for inventory of forest have been changing at a very rapid pace. This publication has 86 papers presented at a summer 1989 inventory symposium in Syracuse, New York. Topics for the papers include special analysis of inventory data, updating methods for forest inventories, and accessing USDA Forest Service inventory and analysis data. For a copy, request *State-of-the-Art Methodology of Forest Inventory: A Symposium Proceedings*, General Technical Report PNW-263.

Ponderosa pine seedlings and competing vegetation: ecology, growth, and cost

When foresters contemplate releasing young conifer plantations, they often ask: What is the most effective treatment and how cost effective is it? A related question usually follows: When is the best time to apply the treatment? The central theme of the study reported here, which is one of many in a National Forest Service Administrative Study on vegetation management, addresses these questions.

Spraying with Velpar was the least expensive and most cost-effective treatment. Grubbing small radii around ponderosa pine seedlings did not appear to be effective biologically and was expensive. New plants, sprouts, and "edge" plants apparently usurped critical resources in the cleared area, and lowered the productivity of pine seedlings. Applying treatments at an early age led to statistically significant differences among treatments earlier than in other studies, and suggested the worth of treating competing vegetation as soon as possible.

For more information regarding vegetation management for Ponderosa Pines, request Research Paper PSW-199, available from the Pacific Southwest Station.

To order any of the publications listed in this issue of *Forestry Research West*, use the order cards below. All cards require postage. Please remember to use your Zip Code on the return address.

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2. (89-114) *Height Growth and Site Index Curves for Western White Pine in the Cascade Range of Washington and Oregon*, Research Paper PNW-423.
3. (89-145) *Training Guide for Bird Identification in Pacific Northwest Douglas-fir Forests*, General Technical Report PNW-260.
4. (89-212) *An Analysis of the Timber Situation in Alaska: 1970-2010*, General Technical Report PNW-264.
5. (90-061) *State-of-the-Art Methodology of Forest Inventory: A Symposium Proceedings*, General Technical Report PNW-263.
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3. *Monitoring Nongame Bird Habitat Over a Large Area*, Research Paper INT-431.
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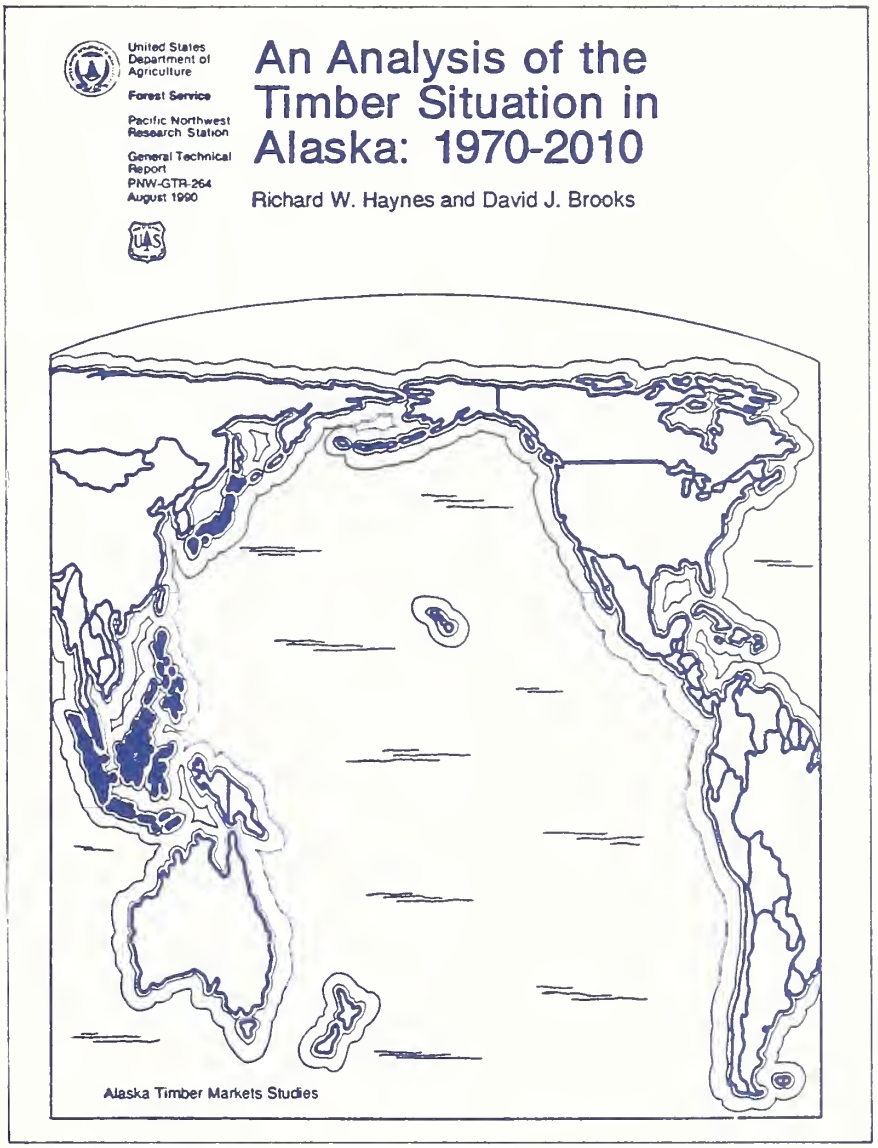
Timber in Alaska: 1970 – 2010

The demand for National Forest timber in Alaska, mostly harvested from the Tongass, declined from 1979 until 1986. Declining timber harvests, despite higher quantities offered for sale, prompted questions about markets for Alaska timber products. At the same time the emergence of a new owner—Native Corporations—with management objectives and market opportunities differing from those of the National Forest changed the pattern of Alaska timber harvests.

This paper looks at this and other factors in the harvest trends in Alaska as the authors consider prospective changes in markets, and formulate an outlook for Alaska timber harvests to 2010. They examine recent studies to develop projections of Alaska timber products output, timber harvest, and timber harvest by owner. For a copy, request *An Analysis of the Timber Situation in Alaska: 1970–2010*, General Technical Report PNW-264.



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