Communicating the Role of Silviculture in Managing the National Forests

Proceedings of the National Silviculture Workshop

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Warren, Pennsylvania

Foreword

The 1997 National Silviculture Workshop was held in Warren, Pennsylvania, and hosted by the Allegheny National Forest, Region 9, and the Northeastern Forest Experiment Station. This was the latest in a series of biennial workshops started in 1973, in Marquette, Michigan. The theme of this workshop was "Communicating the Role of Silviculture in Managing the National Forests."

The communication theme is especially timely and critical for several reasons. First, the Forest Service has been practicing good silviculture for several decades, but we have not done a good job of communicating that fact to our publics and customers. Second, the skills and capabilities of our silviculturists have often been overlooked both internally and externally. And finally, we need to communicate the importance of developing and following scientifically sound silvicultural practices as we move toward an ecological approach to the management of the national forests.

An excellent field trip to the Allegheny National Forest and the Kane Experimental Forest was hosted by Allegheny National Forest and Northeastern Station personnel. The field trip gave the participants an opportunity to observe and discuss forest research and management activities and how they might be used to demonstrate how silviculture can be used to achieve a variety of desired forest conditions.

The need for silviculturists to communicate their role and the role of silviculture in the current management of national forests is critical. This was discussed in an open forum at the workshop and a team of NFS (National Forest System) and Research people was assigned to address this need and develop a strategy to deal with it.

The Washington Office Forest Management (WO-FM) and the Forest Management Research (WO-FMR) staffs appreciate the efforts of our hosts in Pennsylvania. Special acknowledgment is made to Chris Nowak, Jim Redding, Susan Stout, Wendy Jo Snavley, and Kathy Sweeney, Northeastern Station; Robert White, Steve Wingate, and Lois Demarco, Allegheny National Forest; and Monty Maldonado, Eastern Region, for their leadership and support in planning, arranging, and hosting the workshop. Also commended are the speakers for their excellent presentations; the poster presenters; the moderators who led the sessions; the 130 participants from Research and NFS from all over the country; and the special guests who participated in the workshop.

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Communicating the Story of Silviculture on the Allegheny National Forest

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Abstract.—To communicate the story of silviculture on the Allegheny National Forest, we need to distinguish silviculture—the art and science of manipulating forest vegetation to achieve management objectives—from forest management. During the field trip for the National Silviculture Workshop we visited five sites that demonstrate how inventory and monitoring, resource management, research, education, demonstration, and partnerships help communicate the role of silviculture. They also demonstrate communication to practitioners, policy makers, and members of the public who participate in setting management direction for national forests. On the Allegheny National Forest, our close association with our partners in Research and State and Private Forestry increases our effectiveness as communicators about the role of silviculture in managing this National Forest.

INTRODUCTION

For years, many of us thought of ourselves as both silviculturists and forest managers - as though these roles were one and the same. And for years, this was an accepted association. In recent years, it has become more and more apparent that these are truly separate roles. Management choices are made in concert with public participation. Silviculturists then identify and implement the silvicultural practices needed to achieve the desired management conditions. The joint silviculturist/manager role may have been effective in the past. Today, with increased public participation in our management decision-making process, there are some very good reasons to separate the roles of silviculturist and manager more distinctly.

Stepping away from center stage of the management debate strengthens our ability to show how silviculture can be used to achieve ecosystem objectives. It helps us show that silviculture is focused more on growing forests and helping vegetation develop to the desired condition than it is on making stumps. Silviculture is much more than maximizing volume or value production in an Allegheny hardwood stand. However if volume production is the selected management objective, we know a variety of techniques to employ to meet that goal. The management debate draws on the expertise of silviculturists and other specialists to assess management options. Management decisions then reflect a wide range of concerns.

Communication Themes

Silviculture is an integral component of the varied functions served by the Forest Service. We communicate the role of silviculture, both internally and externally, through policy making, inventory and monitoring, resource management, research, education, demonstration, and partnerships. We must effectively communicate what silviculture is, how it contributes to the management of the National Forests, and how we can use it to create the vegetative conditions that enhance ALL resources managed on the Forest.

Background

An understanding of the history and origin of the forests and vegetation found today on the Allegheny National Forest (ANF) is the foundation for today's silvicultural practices (Marquis 1975). The turn of the century timber industry made an indelible mark on the landscape - in terms of vegetation, structure of local communities and economies, and on people's perceptions of what kinds of wood products can be produced here. There are several other equally important developmental influences on this forest.

The oil and gas industry had its origin in nearby Titusville, PA where Francis Drake successfully drilled the first well in 1859. There was a period of exploration and development that peaked in 1883 and continued into the 1890's. Things remained relatively static until the 1920's when the development of new extraction techniques resulted in a resurgence of more intensive development (Ross 1996). Mineral development is a permanent feature on the Forest, as 93 percent of the mineral rights are owned by private interests.

The Forest provides a range of recreation opportunities, as well. By the 1920's, deer populations had recovered from near extirpation at the turn of the twentieth century sufficiently to begin attracting hunters from nearby urban areas and adjoining states. Fishing opportunities also attracted many visitors. The sporting traditions established several generations ago influence the expectations of today's hunters and anglers.

The Civilian Conservation Corps ran thirteen resident camps on or near the Forest during the 1930's. The men participated in a wide range of activities, many of which were geared toward restoring renewable forest resources or the development of recreation sites. Recreation sites developed by the CCCs increased popular use of the ANF for picnicking, swimming, and camping, and many CCC facilities are still in use today.

The national interest in the development of Forest Service recreation resources and facilities in the 1950's and 60's resulted in the construction of many developed campgrounds and recreation facilities along the Allegheny Reservoir shoreline. More diverse recreation development occurred in the last 10-15 years, including all terrain vehicle and motorbike trails, snowmobile trails, and the designation of the Hickory Creek and Allegheny Island Wildernesses

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and the Allegheny National Recreation Area. Recreation is big business; it provides more than twice as many jobs in the local economy as does the timber industry. Given that the Forest is located within a half day drive of one-third of the US population and half of the Canadian population, we expect that recreation demands will continue to increase over time.

The Forest Service established the Kane Experimental Forest in 1932, following the initiation of forest management research in 1927. This marked the beginning of what has become a very productive and supportive relationship between the Northeastern Forest Experiment Station Laboratory in Warren, PA (the Lab) and the ANF. Early studies focused on the growth and development of the young Allegheny hardwood stands, although researchers recognized problematic changes in herbaceous, seedling and shrub vegetation caused by the rapidly expanding deer populations of the 1930's and 40's.

A major silvicultural shift occurred in the east during the 1960's from uneven-aged to even-aged management philosophies. On the ANF and at the Lab, this shift focused attention on the establishment, survival and development of tree seedlings. In 1970, the Lab began an intensive effort to develop guidelines to ensure successful regeneration through silviculture. Today, managers on the ANF rely upon the research findings of the past 27 years as we implement prescriptions that support our management decisions.

There is intense interest in virtually every acre of this forest, usually by more than one user group, often with divergent points of view. Management debates are interesting - often intense and filled with emotion. As silviculturists, we can contribute information about the capabilities of the forest ecosystem to achieve different management objectives. Within these limits, we can suggest actions that will take us in the directions that our public wants us to pursue - all we need to know is the desired direction. To fulfill these dual roles for silviculturists—helping members of the public understand the capabilities of the forested ecosystem, and achieving management objectives—we must communicate effectively about the role of silviculture. The sites selected for the 1997 National Silviculture Workshop Field Tour represent our use of many different techniques to communicate the story of silviculture on the Allegheny National Forest.

FIVE SITES ON THE ALLEGHENY NATIONAL FOREST

We visited five sites as part of the field tour conducted during the National Silviculture Workshop (Warren, PA, May 19-22, 1997). Each exemplifies one or more strategies for communicating the role of silviculture in the management of the ANF. While the communication technique and silvicultural messages differ from site to site, there is one element common to all five. This is the strong partnership between the ANF and the Northeastern Forest Experiment Station Lab. Because of this partnership, researchers share information promptly with managers. Managers apply the information quickly and monitor its effectiveness in operational use. Monitoring information provides feedback for planning new research.

Hearts Content -- Communicating the Role of Silviculture through Demonstration and Education

One challenge we face in communicating the role of silviculture in National Forest management is developing a baseline understanding of ecological processes. A 120-acre remnant of the presettlement forest, Hearts Content Scenic Area has long been a favored site for forest visitors (Lutz 1930). Its importance as an ecological remnant is recognized by its designation as a National Natural Landmark. Managers from the ANF worked with scientists from the Lab and cooperators from the University of Indiana to select key messages and develop an interpretive plan. The interpretation includes multisensory (visual and tactile) signs and a self-guided tour tape. These help visitors understand ecological processes associated with the old-growth ecosystem, the history of the ANF, and the key role that deer play in this forest region.

Hearts Content vividly displays the interaction of natural factors that affect the development of an old growth forest. The impacts of years of over-browsing by white-tailed deer on understory vegetation (Whitney 1984), and the more recent, rapid impact of beech-bark disease on 200-300 year old beech trees are quite evident. The public can see and understand how browsing by white-tailed deer has prevented the establishment of any new age classes for the last 60 years. In the growing space vacated by deer browsing, resistant and resilient species like fern and beech have become dominant. Even as deer densities go down, these plants shade out seedlings of other species. Since 1985, the exotic beech scale-nectria complex has affected overstory beech in this area. Beech represented 40 percent of the trees in the original old-growth on the Allegheny plateau, but the beech bark disease complex is altering the structure and composition of the forest over time.

The messages are complex and raise several important questions for even the casual visitor. What does the future hold for our old-growth forests when key species are threatened with disease? What are the implications of this for overall forest health? If we can effectively explain the important ecological processes that are occurring on the "neutral ground" of an undamaged, old growth forest, then perhaps people will understand these challenges separately from the management decisions and silvicultural options available in managed forests. A well-thought out interpretive plan can communicate the role of silviculture in some surprising places.

Intensive Oak Reforestation Site - Communicating the Role of Silviculture through Resource Management

Our management activities themselves can be important tools for communicating the role of silviculture in National Forest management. In the ANF Land and Resource Management Plan (Forest Plan), approved in 1986, managers made a commitment to maintain the oak forest type. When 18,000 acres of overstory oak mortality developed in 1988 in response to the first wave of gypsy moth defoliation and a severe drought, managers were forced to address two major issues. Should forest managers use pesticides during periods of insect outbreak and could forest managers overcome the historical difficulties associated with regenerating oak?

Public interest in maintaining the oak type resulted in a series of treatments in response to gypsy moth outbreak and subsequent tree mortality. The Forest treated 137,000 acres with an aerial application of dimilin and Bt from 1984 to 1993. Public reaction to this program was mixed, but pesticide use to maintain the oak seed source during insect outbreak has been accepted by most of the public. The high visibility of both gypsy moth defoliation and the resultant mortality helped build public acceptance.

Public support for maintaining the oak type continued, though mortality occurred. We explained the difficulties encountered in stand regeneration so that people would understand the intensive reforestation treatments we proposed. These included browsing by white-tailed deer, eliminating both acorns and seedlings, and understories dominated by species like fern, grass, beech and striped maple that prevented the establishment of oak species. The Forest carried out many reforestation treatments, including herbicide application, area fencing, tree planting, and individual seedling protection with tree tubes. Many of these treatments were in highly visible areas, along main roads and recreation and river corridors. We use these sites frequently for field tours to communicate with internal and external audiences.

Interpretive signing, readily accessible and observable sites that display the range of oak regeneration treatments, and field tours communicate our commitment to meeting the wishes of the public. A partnership with State and Private Forestry to inventory the scope of the oak mortality has been important, as are ongoing research and monitoring efforts by the NEFES labs in Morgantown and Parsons, WV.

Thinning Research - Communicating the Importance of Silviculture through Partnerships and to Policy Makers

Silvicultural research can create visually striking changes in forests. These differences can help policy makers and practitioners understand the role of silviculture in managing National Forests and other forests as well. This is especially true in the complex, stratified species mixtures that characterize the eastern hardwood forest. Species of widely different commercial, aesthetic, and wildlife values grow together at different rates. On the Kane Experimental Forest, researchers have installed and followed thirty-two two-acre research plots for this study. These show the separate and combined effects of residual stand density and residual stand structure on growth and development of even-aged cherry-maple forests since 1973 (Marquis and Ernst 1991; Nowak 1996). The contrasts created by these treatments have been invaluable during training sessions for practitioners, for loggers, and tours for policy makers. These contrasts demonstrate otherwise abstract ideas about the effect of intermediate treatments on stand value, structure, volume, habitat, and regeneration over time. These training sessions are sponsored by the Lab and Penn State Cooperative Extension, acting in partnership.

At the policy level, results from the research conducted on these sites forms the official basis for intermediate treatments on all public land and some large industrial holdings in Pennsylvania. The growth and yield model used for development of the ANF Forest Plan was developed using data from these plots, as was the widely used SILVAH decision support system (Marquis and Ernst 1992; Marquis and others 1992).

In 1992, the Lab/Penn State partnership organized the first logger training sessions in Pennsylvania using the Kane Experimental Forest research plots as key demonstration areas. These plots were so effective at communicating the role of silviculture that a new partnership was formed to install similar plots at seven other locations across the State. Penn State and the Lab worked with many other partners to find funding and to identify sites, install the treatments, design monitoring protocols, and interpret the new installations to users (Harmon and others 1997).

Allegheny Highlands Diversity Study - Communicating the Importance of Silviculture through Research

New research can also be an important tool to communicate the role of silviculture and the commitment of the Forest Service to expanded understanding of forest ecosystems. The silvicultural guidelines included in the Forest Plan are based largely on research completed on the Kane Experimental Forest, the ANF, State Forest lands, and nearby private industrial forest lands. The desired future condition described in the Forest Plan includes a more balanced age-class distribution and stands that continue to produce high-quality sawtimber. Realizing both these conditions requires successful regeneration of desired species after harvest. Effective herbicide treatments are essential tools for achieving regeneration success in the face of decades of deer browsing and the thousands of acres of fern, grass, beech and striped maple understories that interfere with the regeneration of other species.

The guidelines for herbicide-shelterwood treatments are based on nearly 20 years of research that focused on target plants and commercial tree species (Horsley 1992, 1994). In 1991, the Forest prepared an Environmental Impact Statement to amend the Forest Plan to include the use of sulfometuron methyl (in addition to glyphosate) in our herbicide program. The process involved an intensive public involvement effort that included field tours, correspondence, and several public meetings, some held as far away as Pittsburgh, PA. At the public meetings, we found that coordinated presentations were extremely effective for communicating our message. Resource managers presented the need for the reforestation treatment, while the scientist who had conducted the experiments offered detailed explanations of the chemicals and their effects.

Through the public involvement process, we learned of the public's concerns regarding the impact of these herbicides on non-target organisms. The public gained an increased understanding and acceptance of the use of herbicides in our reforestation program. The Allegheny Highland Diversity Study is a direct outgrowth of the public meetings, promised in the final Environmental Impact Statement as a mitigation measure. This study will extend our knowledge by testing the impacts of operational herbicide-shelterwood treatments on songbirds, small mammals, reptiles, amphibians, and herbaceous plants at ten locations across the ANF (Ristau 1995, 1997). It is a formal research study conducted by the Lab.

Red Bridge Sugar Maple Mortality Monitoring - Communicating the Importance of Silviculture through Inventory and Monitoring, and Partnerships

Inventory and monitoring can communicate the importance of silviculture by providing evidence of the scale of problems that require silvicultural solutions. When ANF managers realized in 1994 that sugar maple decline affected nearly 90,000 acres of the 500,000-acre Forest, silvicultural intervention was an immediate consideration. Allegheny Forest Plan objectives include maintaining continuous forest cover and producing high quality sawtimber. Of the 90,000 acres of mortality, about 11,000 have >50 percent mortality/decline, 30,000 have 20-49 percent, and 49,000 have 5-19 percent. Management options have been analyzed on about 76,000 acres. Based on a 1991 inventory conducted by the ANF, we know that on 70 percent of the ANF, plants that interfere with tree seedling development dominate the forest floor. This field trip site is a prime example, where even the seed source has been lost. The combination of overstory mortality and historic regeneration problems creates "forest decline." Reforestation is a key activity, but with such drastic forest change, managers are forced to work at the edge of their comfort zone with familiar silvicultural treatments. Adaptive management and monitoring become the norm.

Changing conditions, such as these, require ecological research to understand the reasons for change and research or adaptive management to develop or adapt silvicultural strategies to address changed conditions. The mortality is associated with many environmental stressors, and there is an aggressive multiagency interdisciplinary research program designed to assess the causes (Long and others in press) and develop appropriate long-term management responses. Stressors include three droughts within the last decade, defoliation of more than 70 percent of the ANF by one or more native and exotic pests, pollution stress (the Allegheny region receives some of the highest levels of nitrogen and sulfate deposition in the country), and nutrient poor, unglaciated soils. Sugar maple in the second growth forest is about twice as abundant as it was in the presettlement forest, and it appears on different landscape positions.

SUMMARY

Forest managers have relied upon the expertise of silviculturists and other specialists for treatment options in the day to day decision making of the management of our National Forests. One of our professional strengths is our ability to clearly define what impact silvicultural treatments can have on ecosystems, and how these actions can support the implementation of Forest Plans. Communicating the silvicultural message internally and externally can be challenging, but the rewards of doing so are great.

Communication can be strengthened by partnerships in our working environment. The Allegheny is fortunate to have a close working relationship with both the Northeastern Station and with State and Private Forestry in Morgantown, WV. The benefits of these partnerhsips show in the forest around us today and in the forest we are growing for the future.

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Bent Creek Demonstration Program

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Abstract.—Bent Creek Research and Demonstration Forest scientists have transferred the results of research on the ecology and management of Southern Appalachian hardwoods since 1925. Since 1989, a full-time technology transfer specialist has led demonstration efforts. The demonstration program was designed to quickly transfer research results to interested users, and free-up scientists to conduct research. Tours of the experimental forest, a large photo point program, customized demonstration publications, short course offerings, and publications are the focal points of the Bent Creek program.

INTRODUCTION

Technology transfer is an essential task of any U.S. Forest Service Research work unit. Projects vary widely in their approach to the demonstration task. Most units prefer to assign technology transfer responsibilities to individual panelled scientists. Since the scientist is intimately familiar with his or her research, little is lost translating research findings to interested groups. A few research work units have filled technology transfer specialist positions; enabling scientists to spend more time conducting research.

Bent Creek Research and Demonstration Forest scientists found themselves spending vast amounts of time transferring research results in the late 1980's. Since the experimental forest is located less than a 30 minute drive from Southern Station Headquarters, visiting scientists frequently took time to tour the Bent Creek Experimental Forest. School groups, managers, and the general public were frequent guests.

The project leader decided to fill a full-time technology transfer specialist in 1989, to help meet the growing demonstration need. Bent Creek scientists have remained active in transferring information, but the day- to- day tasks are now performed by a specialist.

DEMONSTRATION PROGRAM COMPONENTS

There is nothing unique about the way information is passed along to users at Bent Creek. However, the research work unit enjoys an unusually strong emphasis on technology transfer. Specific activities include:

- tours
- demonstration cuttings
- photo points
- slide shows
- training
- custom literature searches
- personal contacts
- publications

[1]Forester, Bent Creek Research and Demonstration Forest, Southern Research Station

Tours

About 800-1000 people per year tour Bent Creek as part of 30-40 groups. Target user groups include a wide array of students. Most of the forestry schools in the southeastern U.S. send both graduate and undergraduate students to Bent Creek annually. State forestry groups and industrial foresters use Bent Creek as an outdoor classroom for their personnel. Scientists and managers from eastern Europe and Asia have been visiting frequently since the late 1980's. Virtually all major research and forest management organizations in the southeastern United States have sent personnel to take the Bent Creek tour.

Visitors are drawn by the side-by-side array of demonstration forest cuttings. Since Southern Appalachian hardwoods respond quickly to disturbance, keeping the demonstrations fresh is a challenge. We are constantly planning for the next round of cuttings at Bent Creek.

Photo Points

We have installed photo points in all of the Bent Creek demonstration cuttings, taking fresh photos once every 3 years. We also maintain long-term photo points, dating back to the late 1800's. An example of this is the photo series of the Carl Schenk white pine orchard, located on the Biltmore estate. Photos taken in the 1880's clearly show severely eroded soils, typical of western North Carolina a century ago. Bent Creek scientists periodically took photographs of the 1899 eastern white pine plantation located on these eroded side hills. Photographs have chronicled the progress of this stand, the oldest white pine plantation in the southeastern United States.

Training

Bent Creek sponsors a wide variety of forest management and science training sessions, including two major offerings: environmental sciences training targeted at middle school teachers, and a hardwood silviculture shortcourse, designed for state and industrial foresters.

Teacher Training: Bent Creek personnel cooperate with Asheville-Buncombe Technical College and Western Carolina University staff to offer a two week long intensive shortcourse in environmental sciences. Our hope is that newly trained teachers will approach environmental education objectively, passing along sound science to their students.

Hardwood Silviculture Shortcourse: Every Bent Creek scientist, plus several outside speakers, focus their efforts on this annual training session. The shortcourse is designed to provide essential tools for silvicultural prescription development, including:

- disturbance history
- site classification
- forest health
- economics
- wildlife
- stand dynamics
- hardwood autecology and synecology
- hardwood regeneration
- intermediate stand treatments

Future Training Efforts: We are planning to offer an advanced hardwood silviculture shortcourse. This new offering will be a hands-on, week-long series of exercises enabling participants to prepare sound prescriptions at both the stand and forest level.

Publications

The Bent Creek staff has created a variety of brochures, mostly targeted at the general public. A more recent endeavor is the development of focused literature reviews, which will provide the background information needed for topical brochures.

Evaluating and Communicating Options for Harvesting Young-growth Douglas-fir Forests

Dean S. DeBell, Jeffrey D. DeBell, Robert O. Curtis, and Nancy K. Allison[1]

Abstract.—A cooperative project, developed by Washington State Department of Natural Resources (DNR) and the Pacific Northwest Research Station (PNW), provides a framework for managers and scientists to (1) obtain experience with a range of silvicultural options; (2) develop information about public response to visual appearance, economic performance, and biological aspects associated with each option; and (3) demonstrate and communicate the consequences of applying the options (singly or mixes thereof) over the landscape to lay and technical audiences. The project is being installed as part of DNR's timber sale program on a 90,000-acre "working forest."

INTRODUCTION

Silviculturists at the Pacific Northwest Research Station's (PNW) Olympia Forestry Sciences Laboratory have joined with foresters of the Washington State Department of Natural Resources (DNR) to establish a comparison of options for harvesting and regenerating young-growth Douglas-fir forests. This project is an integrated research and development effort with elements of adaptive management and demonstration. It will provide a vehicle for communicating with policy makers and other parties interested in or concerned about silvicultural practices. It has been designed and laid out, and the first replicate block will be harvested in summer 1998. Many scientists from PNW laboratories, technical specialists from DNR, and faculty from the University of Washington and the University of Idaho are currently involved with the project and will participate in evaluation of the options. We expect others to join us in the future.

In this paper, we describe briefly the general setting of forestry in Washington State today and the concerns that stimulated DNR and PNW to work together on this project. We discuss some considerations that shaped our approach to the project design and describe the harvesting options to be compared. We then describe the general nature of evaluations, including use of computer-generated visual images of stand development. Finally, we summarize benefits expected from the project.

FORESTRY IN WASHINGTON STATE

Our project is concerned with forests west of the Cascades. This area, commonly referred to as the Douglas-fir region, contains some of the most productive forest land in the nation. Seventy-five percent of the land is capable of growing more than 120 ft^3 per acre per year (Note: only 13% of forest land in the nation and only 17% of land in the southeast has such high production potential). Of 9.5 million acres of timberland west of the Cascades, 56% is in State or industrial ownership, 21% is in non-industrial, private ownership; the remaining 23% are federal lands, primarily National Forests. Historically, forest products have dominated the region's economy, and they still are very important.

During the past 25 years, human populations have boomed, particularly in and around Puget Sound. Most people are urban and suburban residents; they appreciate the scenic beauty and other values provided in our forests. Many, probably most, of these residents are opposed to clearcutting. Wood supplies contributed by National Forests have diminished substantially during the past decade, but timber harvests and silvicultural issues associated with them are more important than ever—for harvests have accelerated on other lands.

Despite many well-publicized conflicts and legal battles over forest management, we believe that most forest users, managers, and owners are interested in the multiple benefits that forests of our region can provide. And these include wood products and the financial returns derived from timber harvests, which, in most instances, directly or indirectly finance the provision of other values.

CONCERNS OF DNR

DNR is one of the largest forestry organizations in the Pacific Northwest, managing more than 2 million acres of forest land in the State. Management objectives—as defined by law—are to generate income in perpetuity for trust beneficiaries. These beneficiaries consist of educational and other state and county institutions. DNR foresters must manage responsibly, and they must consider financial trade-offs and long-term productivity of the forest resources when they make decisions about harvest options and silvicultural practices. As a government agency, DNR must retain broad citizen support. Public concerns about visual effects of harvesting activities have become major considerations in DNR management decisions, especially along major travel routes. Such concerns have led to limited application of a wide variety of practices, particularly alternatives to conventional clearcutting, for which little management or research experience exists. Even when conflicts over visual appearance are avoided, DNR foresters question whether they are selecting the best approaches. Thus, they want to develop a tool kit of reasonable harvesting alternatives, with sound, quantitative information about public response to visual appearance, economic performance, and biological/ecological aspects associated with each alternative.

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CONCERNS OF PNW SILVICULTURISTS

Silviculturists at PNW Station have long recognized a need to develop and evaluate a range of harvest options (or silvicultural systems) to meet multiple objectives in managed forests. This long-term need has become more urgent because many organizations are now trying different approaches in attempts to satisfy various combinations of owner objectives, societal expectations, and regulatory requirements. In most instances, there is no opportunity to determine what is gained or lost in comparison with conventional clearcutting or even whether the desired objectives are attained. A few experimental projects exist but options tested are limited and, in most cases, do not permit evaluation of all major elements or considerations that are important in assessing trade-offs and making decisions. Although this topic is now a top Station priority, we lack the staffing and funding to carry out a large-scale, long-term effort alone, especially if done as a conventional research study. The need for harvest options and sound information about them is also important for National Forests, but constraints associated with the Northwest Forest Plan and fears of appeals currently limit effective participation of west-side National Forests as partners, especially for projects that require timber sales in the age classes and at the scale needed to evaluate options for managing multi-purpose forests.

OBJECTIVES AND PROJECT AREA

Given the above concerns, an excellent opportunity existed to design an operational-scale project to develop and compare options for harvest and regeneration on Capitol Forest, a State-owned forest managed by DNR. This forest is adjacent to PNW's Olympia Forestry Sciences Laboratory and contains 90,000 acres of highly productive land. Douglas-fir is the predominant species, but smaller amounts of western hemlock, western redcedar, and red alder are present. Most of the stands are 60 to 70 years old and would normally be considered ready for regeneration harvest. But DNR plans to defer regeneration of some stands until they are considerably older, and thus develop a more balanced age class distribution. The forest contains and abuts many scenic areas, is adjoined by many residences, and portions are visible from major travel routes. Much of the forest is surrounded by industrial lands where extensive recent cutting indirectly limits DNR options in many viewsheds. Thus, a specific objective of the project is to provide options that will ease conflicts between aesthetic values and timber harvesting.

STRATEGIES IN PLANNING AND IMPLEMENTING THE PROJECT

Early in the project, we agreed upon several principles that would guide its development. We believe these have contributed to its success to date and have strengthened relationships among participating individuals and organizations. These are:

Joint Design by Managers and Scientists.—Local managers and field foresters identified the driving issue—develop harvesting options that reconcile aesthetic values with economic return and sustained wood production in visually sensitive areas. Research scientists provided guidance in experimental design. Together, we developed (a) rational options (silvicultural systems), (b) ways to implement and test them, and (3) methods to obtain the quantitative data needed for useful comparisons.

Operational and Adaptive in Nature.—We believed that operational scale and feasibility were essential if the project was to provide useful information to managers and was to be effective as a demonstration area. We also agreed that our goal would be developing as well as comparing a range of silvicultural options. This means that some options will receive some silvicultural practices during a rotation that are essential for their success—even though the practices are unneeded and may not be applied in others. Weed control may be an example. The additional costs and complications will become a part of the evaluation.

Financial and Staffing Resources.—This project was not initiated in association with an increase in resources available to either organization, but we were committed to making it happen. It is part of DNR's timber sale program on the Forest; planting and other treatments will be done as components of on-going operational efforts. Similarly, evaluation procedures are planned so that those data which are absolutely essential can be collected within expected funding levels of our silviculture team and within the framework of DNR monitoring efforts. We hope to attract additional partners and funds, but these are not critical to the project's success.

Stand- and Landscape-level Considerations.—Because a major objective of the project was to obtain information for managing in visually sensitive areas, it was essential to design the project so that interpretations could be applied to forest landscapes as well as stands.

FEATURES TO FAVOR LONG-TERM CONTINUITY

Any project installed to compare silvicultural systems must continue beyond the careers of the initial participants. Over the years, we have formed opinions about factors that favor survival of long-term efforts, and have kept them in mind as the project developed:

Wide Range of Options.—Treatments were selected to cover a range that extends beyond that deemed optimum today. Social needs and desires change as do forest conditions. Even in multi-purpose forests, the relative importance of different values in the mix will no doubt differ 10 or 20 years hence.

Large Treatment Areas and Adequate Replication.—Size and the number of treatment areas must be sufficient to accommodate the "environmental insults"—damage and mortality of various kinds—and still provide useful information. Larger areas are generally required for assessments pertaining to nontimber values such as wildlife habitat than for timber values alone.

Applicability to Major Portions of the Forest Land Base.—Project must be installed in an area representative of major portions of the land base—in this case, land that will be available for multi-purpose forestry.

Minimum Essential Expenses.—We wanted to minimize essential expenses so that the project can survive during the lows of financial cycles and when political interest declines. But we wanted to provide flexibility within the layout and basic data collection to accommodate additional work when resources permit.

Multiple Disciplines and Organizations.—Multiple disciplines and cooperating organizations increase cost-efficiency and permit more comprehensive evaluations. And such diversity in partners also will help buffer the project from the cycles of support that occur within and among disciplines and organizations.

Foster Support and Visibility Throughout the Organization.—Although this project was a grass-roots effort in the truest sense, efforts have been made and continue to be made to build support throughout the hierarchy of the two major cooperating agencies. These efforts have included visits to the site and discussion of the project with top administrators, and preparation of a formal project plan for approval and signature by DNR and PNW managers.

EXPERIMENTAL DESIGN AND OPTIONS

Given the foregoing considerations with overall strategy, including features to foster support and continuity, we decided to implement and evaluate six harvesting options (Figure 1). Each option will be imposed on areas of 35 to 80 acres in size, and will be replicated three times on Capitol Forest. We believe all options are biologically and operationally reasonable. We expect differences among them in public response as well as economic and crop productivity, but none would be ruled out at current stumpage prices. Four treatments are regeneration harvests; the other two extend the rotation age of the present stand (one with thinning; the other, without thinning; the latter "do-nothing" option could be a reasonable short-term solution in certain situations and it also serves as an "experimental" control for some kinds of assessments). The options will lead to even-aged, two-aged, and multi-aged stands, thus creating a wide range of stand conditions, habitat values, and visual appearances.

TECHNOLOGY FOR STAND AND LANDSCAPE VISUALIZATION

Because visual appearance of harvest cuts was a big consideration in the project, we needed an approach to evaluate public response that would be transferable to other situations. Reactions of people to harvesting are influenced by personal factors and by several on-site matters. Some of these on-site considerations include post-harvest appearance, changes over time (stand dynamics), and surrounding conditions, including the nature and extent of harvesting on the landscape.

Except for post-harvest appearance, it is difficult to provide designed comparisons of these considerations in real time and space. Recently, researchers at PNW's Seattle lab developed software to provide images of stands and landscapes from topographic and stand inventory data (McGaughey 1997). This visualization software has been linked with existing growth models (Oliver and McCarter 1996) to provide approximations of stand development over time.

The stand and landscape images shown in Figures 2, 3, and 4 demonstrate the capability of this technology. Topographic and inventory data from the first block (replicate) of our project, coupled with an existing growth model, were used to depict the initial stand conditions, the landscape after the initial harvest (all options) in 1998, and stand development over the next 60 years for the two-aged and group selection options. The software continues to be refined, both for general use and specific application to this project. We believe the technology—even in its present state—is valuable for demonstration and public interaction.

STAND AND LANDSCAPE EVALUATIONS

Tree Growth and Stand Development.—We have already established permanent sample plots to assess damage, survival, growth, and development of the residual stand components and regeneration. A substudy will compare performance of genetically selected stock vs. standard planting stock in some options.

Economics.—DNR foresters are keeping track of planning, sale preparation, and administration costs by harvesting options. Data on quantity and grade of products removed, production rates, and costs of harvest will be collected. This information in combination with other appropriate data and knowledge will be used in an overall economic assessment.

Visual Quality and Public Response.—Landscape architects and sociologists will use photographs, on-site visits, and computer-generated images to assess and understand public reaction to the various harvest options.

Other values.—We are currently examining the opportunities and costs for evaluation of wildlife habitat, fungi, and long-term soil productivity.

EXPECTED BENEFITS

Over the long term, the information and experience gained from the project will permit sound and defensible decisions about harvesting options, and should lead to improved multi-

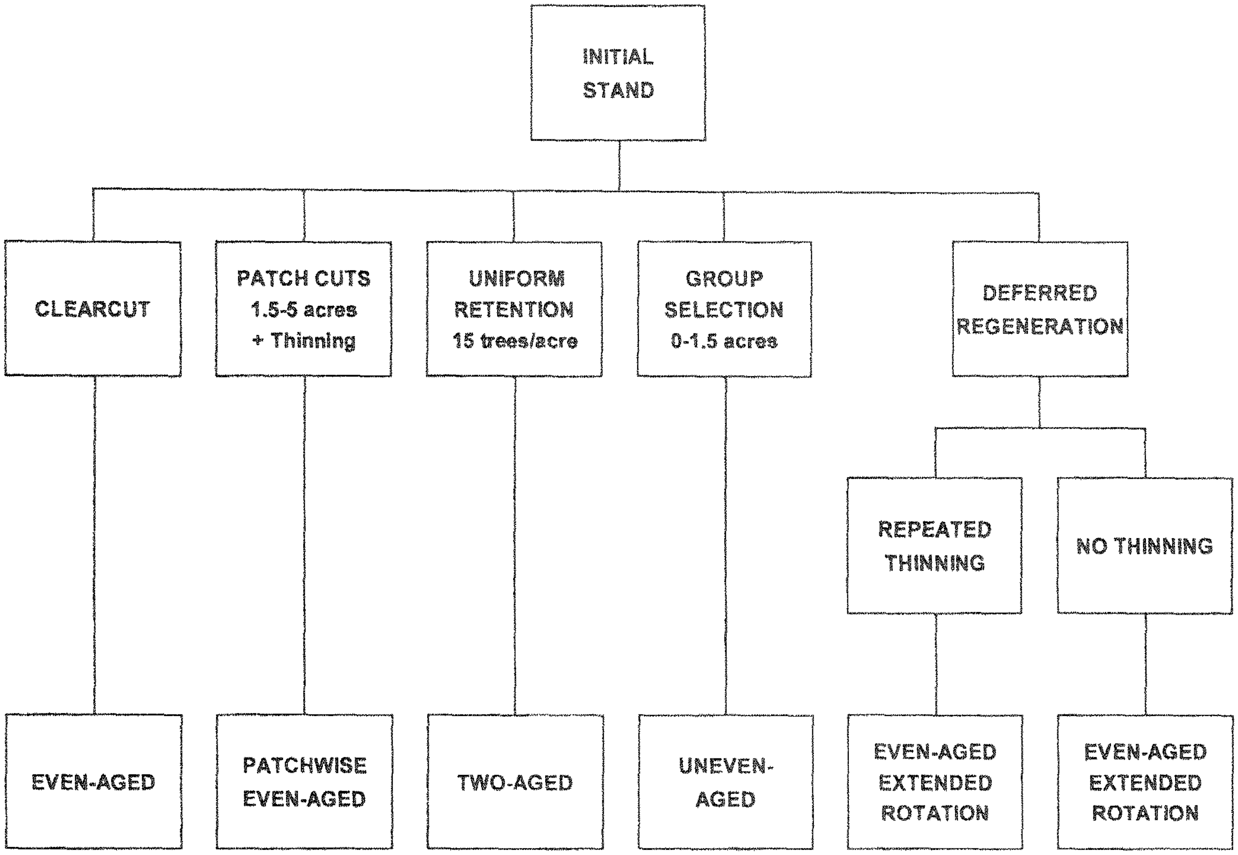
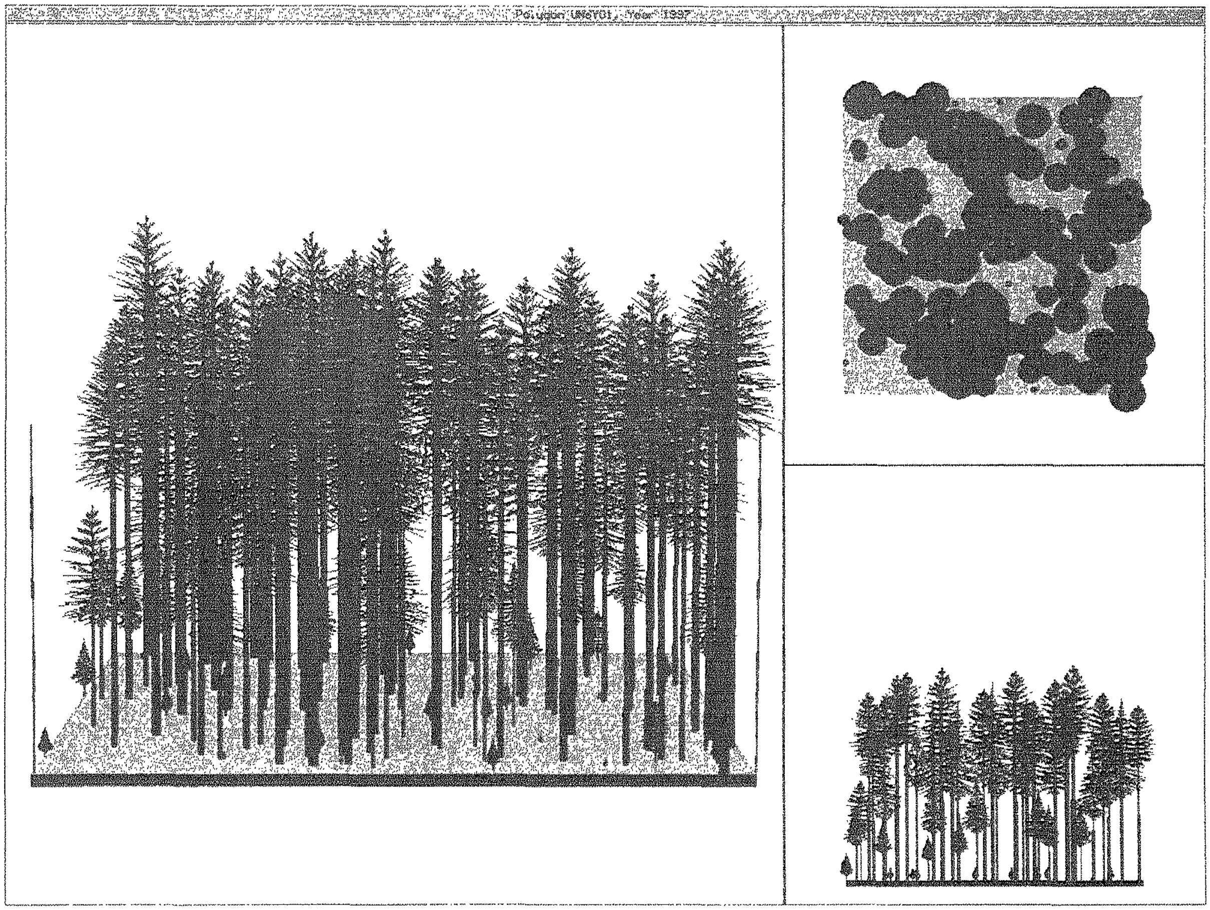
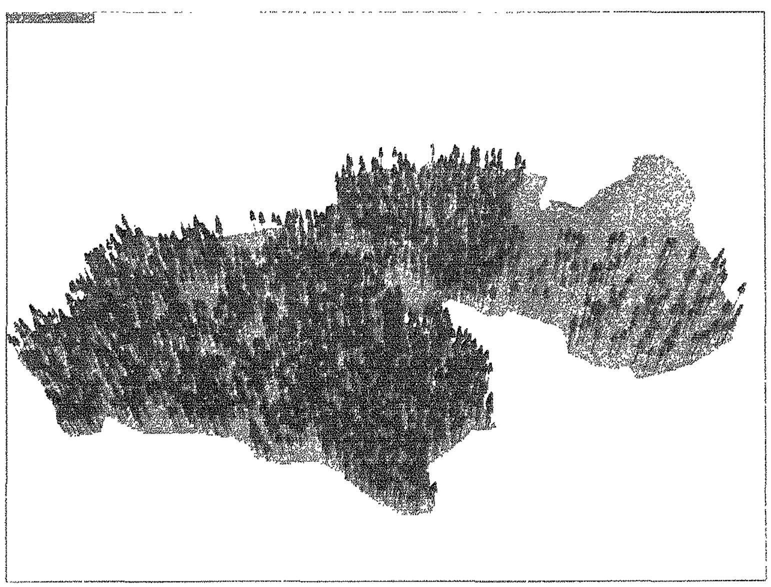


Figure 1.—Harvesting options compared in the projects.



(A)



(B)

Figure 2.—View of forest conditions in the first block of the project: initial within stand conditions (A), and landscape view of all options after initial 1998 harvest (B).

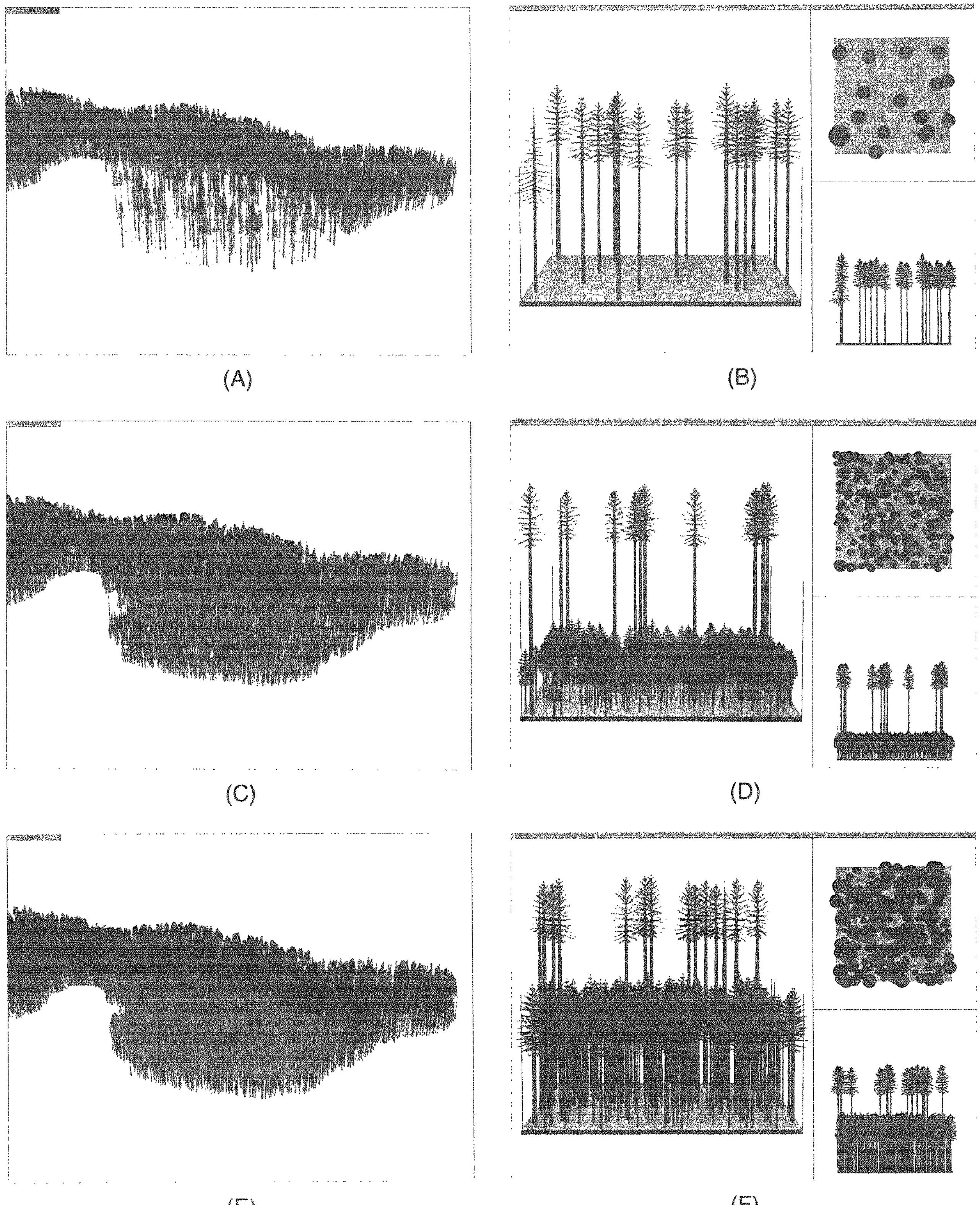
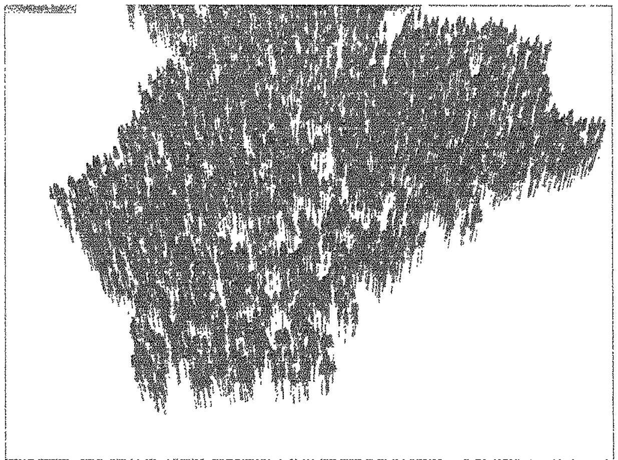
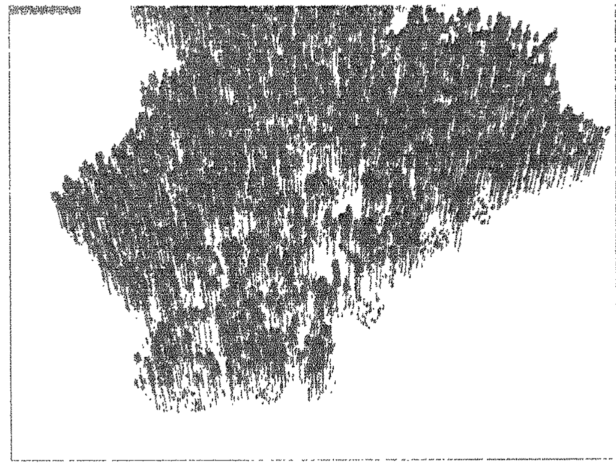


Figure 3.—Views of forest conditions over time for the two-age option: landscape and within stand views (A) and (B), respectively, after 1998 harvest; in 2028, (C) and (D); and in 2058 (E) and (F).



(A)



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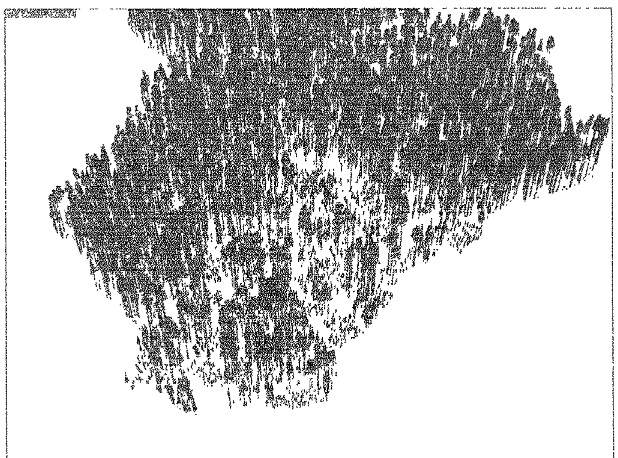

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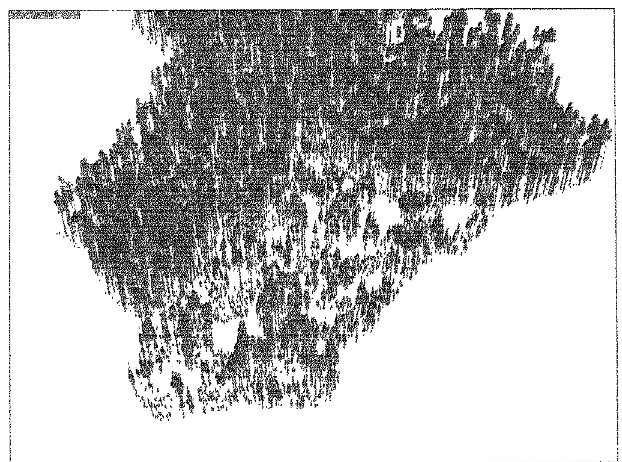

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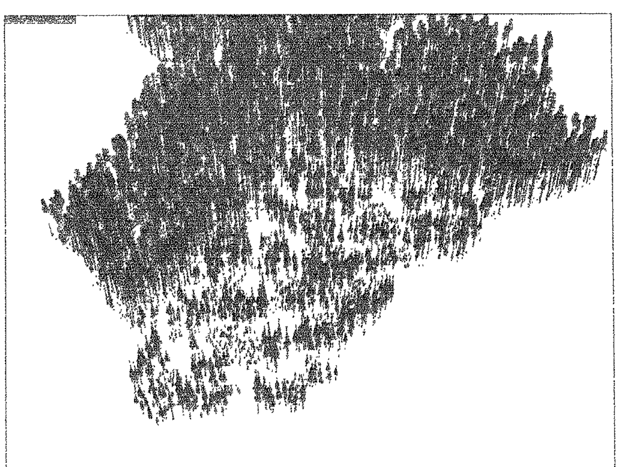
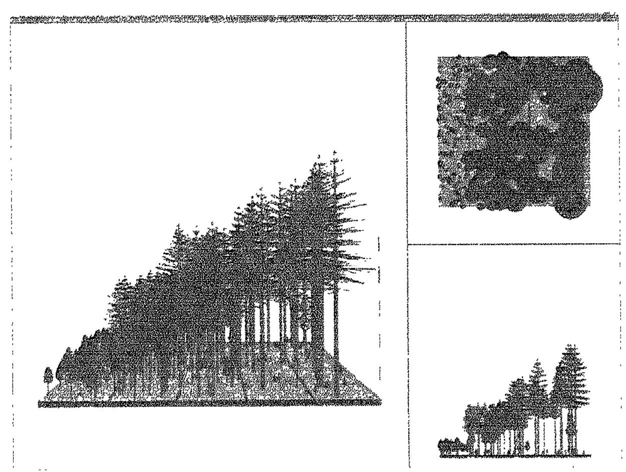


(E)



(F)

Figure 4.—Views of forest conditions over time for the group selection option; landscape view after harvest in 1998 (A), in 2013 (B), in 2028 (C), in 2043 (D), and in 2058 (E); within stand view illustrating size of reproduction expected in various groups in 2058 (F).

purpose forest management. There are also some near-term benefits:

- Managers and scientists have already obtained experience with adaptive management; that is, we have developed a design—to be implemented as a part of operations—that will provide useful information for modifying and developing harvesting practices.
- By next summer, we will have experience with planning, layout, and harvesting of timber sales, using the different practices. The problems and situations encountered will aid operational foresters and researchers in future work.
- The collaboration of sociologists, landscape architects, visualization modellers, and silviculturists will provide some information even before the area is cut. The visualization technology should be helpful not only in assessing public response, but also in fostering understanding about growth and development of stands and forests—their dynamic nature—and how silvicultural practice may affect them. And the real-life trials will provide a check on use of the simulated scenes, and will indicate changes needed to improve the visualization technology.
- Demonstration—This designed network of harvest units will provide a highly accessible showcase of the options and—with time—information on the costs and benefits associated with each and the trade-offs among them. We also hope to communicate and reinforce the idea that there is no one best approach or option to multi-purpose forest management. The initial emphasis of this project on visual characteristics should help to foster this broad outlook. It seems obvious that even for visual objectives alone, approaches must differ greatly in various situations. The availability of the visualization technology should also stimulate consideration of a wide range of options, and help us see how they can be mixed and matched on the forest landscape to provide the conditions and values desired in our forests.

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Seeing is Believing

Steve Wingate and David Wolf[1]

Abstract.—When people view forest management activities there is usually nobody present to explain or interpret what is actually taking place. They judge what has happened by what they can see. In the short term, many long-term, beneficial activities such as clearcuts or herbicide applications appear to the average person as destruction, and they often only view an activity at one point in time.

Photographing, typical management activities from the same location and with the same equipment over a period of years (photo point photography) demonstrates in a short period of time what has taken place over a long period of time. Growth of a new forest from seedlings to trees can be shown visually in a matter of minutes. Another benefit of photo point photography is the ability to record changes which can be studied at a later date.

People believe what they see. Their judgement of what they see is based on whatever information they have at hand at one moment in time. Rarely is there anyone on the scene who can explain or interpret silvicultural activities.

To the average forest visitor, a recent final harvest of cut stumps, horizontal tops, ruts, and muddy landings represent destruction. They cannot distinguish new tree seedlings from other ground vegetation. Whether viewed in person, on video or in a picture, a recent final harvest makes a negative, lasting impression which is frozen in time. Even when interpreted by a forester, the visual image is so powerful that it can defeat his or her credibility. Published in the media, this image can negatively effect the opinions of millions of citizens.

Changes in the forest environment usually occur over long periods of time and happen seemingly without notice.

Repeat or photo point photography is a way of credibly documenting change which has taken place over a longer period of time. This method of documenting change has been used by researchers and historians almost since photography was invented. A series of photos taken at Little Arnot Creek on the Allegheny National Forest beginning in 1927 shows the amazing transformation of an old-growth stand to a seedling stand, and its subsequent growth into the mature Allegheny Hardwood stand it is today.

Photo points can be used to follow the progress of any type of management or natural change. Later, the pictures can be displayed in minutes to explain what has actually taken place over a number years. The fact that the location can be identified in each picture lends credibility to the demonstration.

[1]USDA Forest Service, Allegheny National Forest

Subject matter on the Allegheny National Forest can vary widely and can include clearcuts, beaver ponds, oil and gas operations, fish structures, wildlife planting, road closures, landing rehabilitation, roadside activities, trail rehabilitation, scenic vistas, or dispersed camping spots. The most common subject matter is silvicultural activities such as shelterwoods, thinnings and selection cuts but also includes herbiciding, patch clearcutting, TSI, and many replications of other final harvest cuts. Other sequuences cover the long-term effects of different logging systems and rehabilitation techniques. There is also extensive coverage of a large tornado which occurred in 1985.

One of the most dramatic series shows a stand before and after clearcutting followed by the steady growth of seedling into a sapling stand. This series was used on the television show "Pennsylvania Outdoors" to illustrate how forests are regenerated. The producer blended each successive slide so that on video the stand seemed to actually grown in front of the viewers eyes.

On the Allegheny National Forest, the photopoint program is actually accomplished by a Dave Wolf, a volunteer. He keeps track of over 150 photo points. Each point is periodically reviewed and re-photographed at one, five or ten year intervals. Dave has kept the program going for over 14 years. He recieves help from Forest Service personnel in locating the subjects, modest compensation for his out of pocket expenses, and a place to store his materials.

To be credible, photo point photography must be properly done. It is important to use the same type of camera, lens, and film speed. The points should be photographed at about the same time of day, time of year and, in similar light conditions.

When the subject matter is chosen it is very important to pick the right place from which to take the photograph. The photographer should select a long-lasting object such as a rock or stump to use as a reference point in each picture. The lens and focal length should be planned to insure that what is being observed will always remain in the scene as trees grow, roads get wider and vegetation spreads. We have many slides of regeneration cuts that began as panoramic views of slash and distant tree lines, and that now appear as a wall of vegetation which fills the photograph.

To accomplish these things, a record of each photo point must be carefully maintained. Many of the points have a permanent reference stake installed in a safe location. The photo point form has an attached map to show the general and detailed location. The actual point is measured from the reference stake or object by distance and azimith. The scene and the reference object is recorded on the form as well as the dates and times of previous photos. Dave finds it helpful to bring along the most recent slide when going to take a repeat picture. He then compares the slide with image in his view finder to fine-tune the current picture.

The slides are filed in indexed plastic slide holders. When slides are needed to explain a treatment to the public, the appropriate subject can be located from a master list. The slide holder is then retrieved and can be quickly viewed on a light table or displayed with a slide projector.

It is time consuming to do this work well, and the benefits are often intangible and long-term. It is the kind of work that usually suffers when budgets are cut. Volunteers can be an effective way to keep the program going in lean years.

Conclusion: Repeat photography can be an important and credible way to demonstrate the long-term effects of forest management to the public. A series of pictures can show that the unattractive image of timber harvesting is temporary and actually results in the rebirth or growth of the forest. It can also be used to show the results of many other types of management.

To be credible, photo point photography must be carefully done. The observer should be able to see that the image is of the same spot each time even though the size and the shape of the vegetation changes. When variation is minimized, these photos are readily adaptable to video presentations.

As we learn to communicate with changing technology, being able to display convincing positive visual images is essential. Photo points can offer a believable picture, video or digital display of change in the forest.

Reference: MacCleery, Doug. 08/23/85. Repeat photography for Assessing Ecosystem Change: A Partial Listing of References. USDA/Forest Service.

An Historical Overview of Forest Service Silvicultural Activities in Puerto Rico and the Caribbean Islands

Peter L. Weaver[1]

Abstract.—Forestry has a long history in the Caribbean Islands, in particular, in Puerto Rico. This experience, implemented in recent years through numerous partnerships, involves research, inventory and monitoring, and resource management, and has been communicated through demonstration and educational activities. Much of this history is documented in the 24 volumes of the Caribbean Forester, in 58 years of Annual Reports or Annual Letters written by the U.S. Forest Service's International Institute of Tropical Forestry (IITF), in forestry bibliographies, and numerous publications in scientific journals as well as the proceedings of seminars, meetings and conferences. Forest managers and researchers, not only in the United States, but also in the international arena, have been the recipients of information on tropical forestry through the IITF's library and its program in international cooperation. The purpose of this paper is to briefly summarize Forest Service activities in Puerto Rico and the Caribbean.

INTRODUCTION

Silvics and silviculture were defined many years ago (Baker 1950) but have become more complex with time. Silvics is the knowledge of forests and forest trees—how they grow, reproduce, and respond to changes in their environment. Biological information, however, has blossomed since that definition was proposed. Silviculture, in turn, was defined as the handling of the forest in view of its silvics—a practice modified by economic factors. Silviculture is also modified by environmental concerns and is formulated in different cultures in response to human needs and influenced through varying degrees of local, national and international involvement, and politics. Deforestation, biodiversity, neo-tropical migratory birds, biomass plantations, sustainable management, ecosystem management, urban forestry, timber certification, and global climate change have become major silvicultural topics at home and abroad.

Much of the IITF's program involves neotropical countries where the common languages are Spanish and Portuguese, and the culture, working environment, and way of doing business contrast with those at home. Moreover, forestry operations are characterized by selective harvest of prime species and poor extraction techniques. Limited budgets and inadequate staffing make control over forest lands, many distant from the central offices, virtually impossible. A complex forest planning process is absent or perfunctory and many key forest administrators are only casually familiar with forestry.

The purpose of this paper is to review IITF's involvement in communicating silvicultural information for managing neotropical forests including those of Puerto Rico and the U. S. Virgin Islands. Special emphasis is given to educational approaches although the other topics considered in this conference (eg., forest inventory and monitoring, research, resource management, demonstration, and partnerships) are an integral part of the IITF program. Without them, the educational aspect would be greatly diminished. This review, intended to be comprehensive but not exhaustive, touches on the more important activities and references only a fraction of IITF's publications. Throughout the text, the following acronyms are used:

CEER ... Center for Energy and Environmental Research (Univ. of Puerto Rico)
CITES ... Convention on International Trade in Endangered Species
CNF ... Caribbean National Forest (management designation)
DNER ... Commonwealth Department of Natural and Environmental Resources
FAO ... Food and Agricultural Organization of the United Nations
ITF (IITF) ... International Institute of Tropical Forestry (research)
ITTO ... International Timber Trade Organization
IUFRO ... International Union of Forestry Research Organizations
LEF ... Luquillo Experiment Forest (research designation)
LTER ... Long Term Ecological Research (National Science Foundation)
MAB ... Man and the Biosphere Program (UNESCO)
UNESCO ... United Nations Educational and Scientific Organization
USAID ... United States Agency for International Development
YCC ... Youth Conservation Corps
YACC ... Young Adult Conservation Corps

HISTORICAL PERSPECTIVE OF FORESTRY ACTIVITIES

The history of forestry in Puerto Rico and the U. S. Virgin Islands is briefly summarized in four documents that outline institutional programs, research and publications (Brown et al. 1983; Mosquera and Feheley 1984; Wadsworth 1970, 1995). Highlights extracted from these documents follow.

In 1876, the Spanish government proclaimed forest reserves in Puerto Rico including nearly 5,000 ha of the Luquillo Forest in the northeastern part of the island (later additions increased the land area to 11,300 ha). In 1898, after the Spanish-American War, ownership of crown lands in Puerto Rico were transferred to the United States. In 1903, the United States proclaimed the Luquillo Forest as a reserve and in 1907, as a national forest. Boundary surveys were conducted in 1916, mahogany was first planted in 1931, and the first forest inventory was completed in 1937.

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An Act of Congress (McSweeney-McNary Forest Research Act of 1928) designated a nation-wide system of forest experiment stations which included one in the West Indies. In 1939, the Tropical Forest Experiment Station was designated and funded in Río Piedras, Puerto Rico (in 1961, it became the ITF, and in 1992, the IITF). In 1940, the CNF staff was transferred to the station where it published the first of its annual reports and the first of its 24 volumes of the Caribbean Forester. Subsequent research concentrated on the tropical forest environment, regeneration, silviculture of secondary forests and plantations, mensuration, management, and the economic value of forests. Species trials began throughout the island and today more than 100 native species and 350 introduced species have been tested. Long-term monitoring of permanent plots began in 1943 and the first timber management plan was completed in 1949, the same year that the Baño de Oro research natural area was set aside in the LEF.

In 1953, the ITF began the first of its international tropical forestry short courses. In 1956, the CNF was also administratively designated as the LEF to recognize the importance of research. From 1956 through 1970, about 2,800 hectares of lower montane forest were thinned. In 1959, Caribbean Pine was successfully introduced in Puerto Rico and in the early 1960's, ecological research was initiated in the LEF in collaboration with the Atomic Energy Commission. In 1965, the ITF's Annual Letter replaced the Caribbean Forester as the instrument to inform readers about ITF activities. In 1968, formal research efforts to save the endangered Puerto Rican Parrot, now confined to the Luquillo Forest, were started. In 1976, the Luquillo Forest was designated as a Biosphere Reserve. In 1980, the ITF, in conjunction with the Southern Experiment Station, initiated a continuous inventory of the island's secondary forests. In 1982, the ITF began biennial meetings of the Caribbean Foresters to discuss and publish forestry topics of regional interest. In 1986, LTER research was initiated in the Bisley watersheds of the Luquillo Forest, and in 1996, the El Portal Tropical Forest Center, Puerto Rico's gateway to the tropics, was opened to the public.

CURRENT PROGRAMS

A comprehensive program aimed at communicating the role of silviculture in managing national forests through educational means would be impossible without a full complement of other activities. Currently, the IITF (research designation) and the CNF (management designation) implement their programs on the same 11,300 ha forest in northeastern Puerto Rico with a combined staff of 17 professionals, 21 technicians, and 26 persons in administrative, clerical and support positions. Numerous cooperative agreements, grants, and volunteers extend the program's effectiveness.

Research

The IITF's research program is divided into four areas of emphasis: forest management, ecosystem management, wildlife management, and social ecology (Weaver 1996). The research unit description, approved in 1994 and scheduled to cover the next 5 years, concerns four research problem areas and involves 60 studies:

- Problem 1: Insufficient knowledge to effectively manage primary forests, or secondary forests following tropical disturbance and land use changes;
- Problem 2: Insufficient knowledge and predictive methods regarding the internal dynamics and external influences that affect atmospheric and hydrologic characteristics of forested tropical watersheds;
- Problem 3: Need to identify and characterize threatened, endangered, or sensitive tropical wildlife and to determine habitat characteristics and requirements for overwintering migrant birds in the Caribbean to develop ameliorative practices; and
- Problem 4: Need to quantify the economic and social values of American tropical forests.

The IITF also cooperates with the Forest Products Laboratory focusing on the utilization of tropical forest products and tropical mycology. Moreover, occasionally it sponsors or co-sponsors special projects or activities such as symposia or training programs.

The IITF research library subscribes to more than 100 journals and receives almost the same number of complementary serial publications through exchange with other institutions. The library also owns about 7,000 books on forestry and forest-related resources, houses a geographic section with about 20,000 brochures and reports, and contains numerous historical documents and maps. The library also posseses the "Silver Platter" CD-ROM on forestry literature and just inaugerated a WEB site to facilitate communication. The IITF research laboratory contains modern facilities and equipment for the analysis of soil and vegetation samples, and GIS work.

Resource Management

The CNF staff is responsible for the daily management of the Luquillo Forest which involves four major activities: customer service; property management; planning and design; and ecosystems programs. Special use permits, management of the El Portal Tropical Forest Center, grants and agreements, recreational programs (eg. Rent a Ranger, interpretation), trail maintenance and cleaning, environmental education, and the development of the forest management plan are included in the first three groups of activities. Ecosystems programs deal with visual and heritage resources, soil, water and air resources, wildlife, botany, threatened and endangered species, and timber stand improvement.

The CNF and IITF staffs, through a program of public involvement, developed a revised land and resource management plan for the Luquillo Forest along with its accompanying environmental impact statement (U. S. Forest Service 1994). Recently, the CNF assumed the management of the El Portal tropical forest center within the Luquillo Forest.

In 1995, the IITF State and Private forestry program managed 25 grants working closely with natural resource agencies in Puerto Rico and the U. S. Virgin Islands. Among the programs being implemented are: urban and community forestry; forest stewardship and stewardship incentive; economic recovery; rural conservation and development; wood in transportation; forest products conservation and recycling; nursery and tree improvement; forest resources management; forest legacy; forestry incentives; agricultural conservation; forest health management on cooperative and federal lands; rural fire prevention and control; state resource planning; and natural resource conservation and education.

Inventory and Monitoring

The IITF has several inventory and/or monitoring programs:

◆ Natural forest: monitoring natural regeneration and succession of key tree species on several sites in Puerto Rico and the U. S. Virgin Islands. Specifically, since 1943, on 20 permanent plots in different forest types in the Luquillo Mountains (Crow and Weaver 1977; Weaver, in press); from 1946 to the mid-1970's, on numerous sites throughout Puerto Rico (Weaver 1983); since 1983, on 16 plots in the Cinnamon Bay watershed of St. John, U.S. Virgin Islands (Weaver and Chinea-Rivera 1987); and since 1984, in the dry Guanica forest in southestern Puerto Rico (Murphy and Lugo 1986);

◆ Plantations: since the 1940's, periodic measurement of numerous species including several provenance trials throughout Puerto Rico and the U. S. Virgin Islands (Francis 1995);

◆ Arboretum: since 1960, the establishment and maintenance of an arboretum with more than 100 species, many with multiple subspecies and provenances, in forest conditions at 400 to 550 m in elevation in the Luquillo Mountains (Francis 1989);

◆ Parrots: since 1968, habitat research, and long-term monitoring of Puerto Rican Parrots (Snyder et al. 1987) and for shorter periods, other species including neotropical migrants (Wunderle and Waide 1994) and rare, endangered, or sensitive species;

◆ Secondary forest: since 1980, an island-wide inventory of secondary forest resources, updated in 1985 and 1990, and subsequently planned for re-measurement at 10-year intervals (Birdsey and Weaver 1982, 1987; Weaver and Birdsey 1990;

◆ LTER: since 1986, a long-term ecological research program dealing with flora and fauna in the Bisley watersheds of the Luquillo Mountains (Scatena 1989); and

◆ Big tree registry: since 1987, the maintenance of a registry of Puerto Rico's record trees to increase local appreciation for forest resources (Francis and Alemañy 1996).

The inventory and monitoring programs have provided valuable baseline information regarding forest structure, species composition, tree growth rates, and dynamics, especially in response to past human intervention and major climatic events such as hurricanes (Walker et al. 1991).

Wildlife monitoring within the Caribbean has indicated the proportions of local bird populations that are migratory and noted declines in neo-tropical migrants during the past quarter of a century. Continued monitoring may provide valuable comparative data for questions relating to human impacts on forests and wildlife as well as possible changes in global climate.

Demonstration

The Forest Service's organization and way of doing business (eg., research, management, state and private functions, and program administration) serve as a model for most visitors. Other demonstrations include:

◆ the IITF's continuous record system of 2550 studies;

◆ the maintenance and monitoring of numerous plantations (including mahogany line plantings) varying by species (or provenences), planting technique, age, and site;

◆ the maintenance of inventory and monitoring in primary and secondary forests, and restoration plots on abandoned lands;

◆ the CNF land management planning for multiple benefits;

◆ the El Portal tropical forest center; and

◆ the State and Private program with its complement of activities.

Partnerships

In 1995, the IITF had 63 active research grants and agreements with numerous institutions located in Puerto Rico, the U.S. Virgin Islands, the United States, and in foreign countries. The grants and agreements focus on a wide variety of tropical forestry issues including forest management, neotropical migratory birds, biodiversity, ecotourism, reforestation, wetlands, and the effects of deforestation on regional and global atmospheric composition.

Many scientists, managers, and students visit the island to conduct cooperative studies or observe activities on the national forest. Moreover, many of the IITF/CNF staff, working through the IITF's International Cooperation Program, participate on assignments in forest research, management or administrative activities throughout the neotropics. This frequently involves cooperation with foreign governments, international entities, Federal and Commonwealth agencies, private institutions, domestic and foreign universities, and non-government organizations whose influence may span regions or groups of countries. Among the more salient IITF cooperative activities during the past several years are:

◆ participation in overseas consultancies with the Forest Service, USAID, FAO, the World Bank, UNESCO, and other international entities to advance the interests of the United States at home and abroad;

◆ international cooperation with the World Bank in forest restoration of degraded lands throughout the tropics, activities aimed at the improvement of site productivity and increasing timber and commodity production (Parrotta and Kanashiro 1995);

◆ cooperation with Brazil including global carbon and trace gas emission studies in Brazilian Amazon forests, activities aimed at the development of land management technologies that mitigate global climate change, water quality deterioration, soil erosion, and the loss of timber and non-timber species, and wildlife; and additional studies such as an English-Portuguese list of forestry terminology (Francis 1994) and a photographic guide to the trees of the Tapajos Forest (Parrotta et al. 1995);

◆ cooperative funding of forest inventories in the Maya zone of Mexico;

◆ assistance in the development of technical guidelines in support of the interests of the United States in the international arena including trade, migratory wildlife, and endangered species agreements (eg., CITES);

◆ cooperation with the Forest Department of Antigua-Barbuda in the development of a woody species list (Antigua: 286 species, 153 natives; Barbuda: 127 species, 65 natives) (Francis et al. 1994);

◆ cooperative funding of silviculture in mountain forests with the Forestry Department of Dominica;

◆ Peace Corps and host country collaboration through formal technology transfer plans (eg., Antigua, Dominican Republic, Grenada and Montserrat) in the design and development of nature trails and reforestation projects;

◆ Cooperation with the Park Service on the island of St. John, U. S. Virgin Islands, in forestry and wildlife research, and long-term monitoring;

◆ local cooperative research and management activities with the Puerto Rico Conservation Trust and other conservation groups;

◆ Collaboration with U. S. national forests as facilitators (shepherds) for six Sister Forest programs (pairings of U.S. National Forests and select national forests in neotropical countries); and

◆ numerous local, national and international advisory committes, among them: student thesis and university committees (eg., CEER), and interagency committees of the Commonwealth and Federal governments; national committees (eg. LTER); and international committees such as MAB, IUFRO, and the North Amerian and Latin American Forestry Commissions of the FAO. The staff also reviews proposals for ITTO and locally cooperates with the local DNER on reviews of management plans and legislation, and with Puerto Rican Conservation Trust on research and management programs on their properties scattered throughout the island.

Education

The IITF/CNF's educational program and clientele are diverse. The program includes research and publications, library activities, training and technology transfer, conferences and workshops, and other related activities. The clientele includes local, national and international forestry researchers, managers and administrators.

Publications. During recent years, the IITF research staff has published more than 50 scientific articles annually on forest management, ecology, wildlife, and social ecology. Staff members have also served on several journal editorial boards and reviewed numerous scientific articles for publication at home and abroad. Among the major efforts since the establishment of the IITF in 1939 are the following:

◆ 1939-1964: edit, publish and distribute to 2,000 collaborators, in Spanish and English, articles on forestry and related environmental topics in 24 quarterly volumes of the Caribbean Forester;

◆ 1939 to present: write an annual report (later called annual letter). Early editions were placed in the Caribbean Forester in both Spanish and English, but after 1964, the Annual Letter was published independently;

◆ 1949 to present: study and publish information on forest gradients, long-term growth, phenology, and fauna (eg., the Puerto Rican Parrot and other avifauna) in the Baño de Oro Research Natural Area (Weaver 1994);

◆ 1949-1993: publish the results of tree seed studies for more than 300 native and exotic species including collection, treatments, germination, and storage (Marrero 1949; Francis and Rodriguez 1993);

◆ 1950: publish the results of tree plantings on degraded lands (Marrero 1950a) and tree species adaptability on lands ranging from sea level to 1,000 m in elevation with rainfalls between 800 and 2,500 mm/yr (Marrero 1950b);

◆ 1949-1952: forest descriptions and the formulation of a land management plan based on climate, soil, topography, faunal requirements, scenic values, and past land uses and designating areas to be used for wildlife habitat, recreation, comparative research, timber production, and for the protection of primary forest ecosystems (Wadsworth 1949; 1951, 1952a, 1952b);

◆ 1963 to present: establish 1,275 ha of line planted mahogany at the management level (Weaver and Bauer 1986);

◆ 1964 and 1974: publish 2 volumes with dendrological and taxonomical descriptions, natural occurrence, uses, and common names for 750 native and exotic tree species of Puerto Rico and the U.S. Virgin Islands (Little and Wadsworth 1964; Little et al. 1974);

◆ 1966: summarize the results of eight herbicides for weed control in plantations (Hadley and Briscoe 1966);

◆ since 1968: investigate avifauna in Puerto Rico and elsewhere in the West Indies to determine population trends and the status of critical species (Snyder et al. 1987; Wunderle and Waide 1994) and their response to hurricanes Wunderle 1995);

◆ 1971-1973: map the ecological life zones of Puerto Rico and the U. S. Virgin Islands (Ewel and Whitmore 1973);

◆ 1972: summarize the results of fence post longevity based on four preservatives and two treatments for 6700 treated and non-treated control posts representing 70 tree species (Chudnoff and Goytía 1972);

◆ 1972: publish a summary of growth studies involving 15 conifer and 16 hardwood species for use in 60,000 ha of Puerto Rico's granitic uplands (Geary and Briscoe 1972);

◆ since 1975: publish 20 papers on long-term forest monitoring in the LEF and the Virgin Islands, some with records spanning more than 50 years (Crow and Weaver 1977; Weaver 1988, 1991; Weaver and Murphy 1990);

◆ 1979: publish a bulletin in English and Spanish on the use of 46 tree species in urban settings for Puerto Rico and the U. S. Virgin Islands (Schubert 1979);

◆ since 1981: edit the quarterly newsletter of International Society of Tropical Foresters for 2,000 subscribors in 128 countries;

◆ since 1981: draft 100 papers on indigeneous and exotic tree species in Puerto Rico and the U. S. Virgin Islands for the IITF's tropical silvics manual (including 8 species placed in the U. S. Silvics Manual) with information on habitat, life history, special uses, and genetics (Francis et al., in prep.; Burns and Honkala 1990);

◆ 1982: describe the storage and production of organic matter in tropical forests and their role in the carbon cycle (Brown and Lugo 1982);

◆ since 1982: publish several papers on the occurrence of tree species, forest structure and dynamics, and hurricane impacts for the forests of St. John, U. S. Virgin Islands (Woodbury and Weaver 1987; Park Science 1992);

◆ 1985: publish a volume on 150 vine species that grow in Puerto Rico (Acevedo-Rodríguez and Woodbury 1985);

◆ since 1987: edit and publish Acta Cientifica, a scientific journal for Puerto Rican science teachers;

◆ 1987 and 1991: publish a technical guide for nursery management (Liegel and Venator 1987) and growth and site relationships of Caribbean Pine in the Caribbean Basin (Liegel 1991);

◆ since 1988: maintain a registry of big trees in Puerto Rico;

◆ since 1988: research and publish about 200 papers on LTER in the LEF's Bisley watersheds beginning with a description of the watersheds (Scatena1989); and

◆ 1991: publish a list of 118 naturalized exotic tree species in Puerto Rico including information on where they are common, their environmental requirements (eg., rainfall and soil properties), and their estimated rates of spread (Francis and Liogier 1991);

Moreover, the IITF has collaborated with numerous other scientists in the publication of such works as:

◆ Puerto Rican woods (Longwood 1961) and Commercial timbers of the Caribbean (Longwood 1962), two volumes containing the physical and machining properties of 60 Puerto Rican timbers and 68 Caribbean timbers with commercial potential, cooperative research with the Forest Products Laboratory in Madison, Wisconsin;

◆ A tropical rain forest: a description of research beginning in the early 1960's and culminating in 1970 with a compendium of information in 111 research papers totaling 1644 pages (Odum and Pigeon 1970);

◆ Journal of the Arnold Arboretum: the introduction by Howard (1968) was the first of 17 articles published from 1968-77 on the climate, soils, forest resources, and related topics in the LEF's dwarf forest; and

◆ The parrots of Luquillo: a history of 20 years of parrot research in the LEF published in 1987 (Snyder et al. 1987).

Library. The library staff hosts from 600 to 700 international and local visitors annually. Most library users are from Federal and Commonwealth government agencies or students and teachers from local universities and highschools. The library also answers an average of 16,000 information requests annually, half of which are from Puerto Rico. The IITF's Annual Letter is interchanged for research reports with about 200 research units worldwide.

Training and Technology Transfer. Since 1939, the IITF staff has hosted innumerable visitors and interns from all over the tropics. Recently, volunteers have worked with the research staff for periods ranging from a few weeks to a year. Formal training programs have been presented for several groups or individuals, among them the following:

◆ from 1953 to 1983, the presentation of 20 bilingual international forestry short courses with some of the attendees later being promoted to leadership positions within their respective governments;

◆ 1962-63, formal 3-month programs of graduate study in tropical forestry and silviculture for 30 forestry students from all over the United States;

◆ from 1975 to the present, the occasional development of short training programs for Peace Corps volunteers, mainly in Caribbean Basin countries; and

◆ from 1980 to the present, participation on student theses comittees and as lecturers in university courses locally, in the U. S., and internationally.

In addition to the formal training programs mentioned above, the CNF staff hosts 700,000 visitors annually within the Luquillo Forest. Among the major attractions are wildlife, mountainous scenery, riparian areas, and several trails with interpretative signs. Tours are available on request.

Recently, the El Portal tropical forest center opened to the public. The 930 square meters of floor space is divided into classrooms, conference rooms, laboratories, and three large exhibition rooms. The staff of the Portal offers educational programs for students and holds workshops for school teachers. Training modules highlighting Puerto Rican tree species and forests, human benefits derived from forests,

Table 1.—Symposia and conferences held in Puerto Rico and sponsored by or in collaboration with the International Institute of Tropical Forestry

Date	Topic
1986	Conference on the Management of the Forests of Tropical America[1]
1987	Workshop on Caribbean Wetlands
1988	USAID Mangrove Workshop
1989	IITF Golden Anniversary Symposium[2]
1991	Seed Workshop for Nursery Managers
1991	USFS-NASA-FAO Workshop on Remote Sensing[3]
1993	30th Anniversary of the Association for Tropical Biology (ATB)
1993	International Symposium on Tropical Montane Forests[4]
1996	Horticulture Conference
1996	Big-leaf Mahogany: ecology, genetic resources, and management[5]

[1]Figueroa Colon et al. 1986.
[2]Lugo and Lowe 1995.
[3]Gillespie 1991.
[4]Hamilton et al. 1993.
[5]Proceedings in preparation.

Table 2.—Host countries and topics for the Biennial Caribbean Foresters' Meetings

Host country location Dates	Conference themes[1]
Castries, St. Lucia May 24-28, 1982	Forestry in the Caribbean
Kingstown, St. Vincent March 19-23, 1984	Watershed management in the Caribbean
Pointe-a-Pitre, Guadeloupe May 19-23, 1986	Forest recreation in the Caribbean Islands
Roseau, Dominica April 5-9, 1988	Wildlife management in the Caribbean Islands
Port-of-Spain, Trinidad May 21-26, 1990	Wetlands management in the Caribbean and the role of forestry in the economy
Fort de France, Martinique July 20-22, 1992	Towards sustainable forest resource management in the Caribbean
Kingston, Jamaica July 20-24, 1994	Economics of Caribbean Forestry
St. Georges, Grenada June 2-6, 1996	Protected areas management

[1]All conferences have been published as proceedings except the last which is in press.

and conservation issues have been developed to serve an estimated 30,000 students per year. A training program aimed at improving forest management capabilities will also be offered for forest managers from the Caribbean and Latin America.

The CNF also hosts the YACC and YCC programs during the summer months. Occasionally, it sponsors an open house on the forest or exhibits at shopping malls where up to 20,000 visitors may become familiar with Forest Service programs. Other activities include judging at local science fairs, participation in highschool career day activities, and presentations on local radio and television programs.

Conferences and Workshops. The IITF has hosted several different activities both locally (Table 1) and internationally (Table 2). Attendance at these meetings ranges from 25 to 300 or more with representation from numerous countries throughout the world. Proceedings of locally sponsored meetings are always published.

SUMMARY

The IITF has a 58-year history of serving its forestry clientele—the domestic interests of the peoples of Puerto Rico, the U.S. Virgin Islands, and the United States, and the foreign concerns of the peoples elsewhere in the Caribbean Basin and Latin America. Research, resource management, forest inventories and monitoring, demonstration, partnerships, and educational activities have been an integral part of its domestic and international programs.

Program diversity has been one critical element in program success. Currently, this diversity includes research, management, international cooperation, and state and private forestry. Another important element has been the long term coordination of forest research and management objectives within Puerto Rico and the U.S. Virgin Islands. These program attributes, diversity and coordination, along with the library and the recently completed El Portal tropical forest center, have contributed to a viable forestry program and have facilitated the communication of silvicultural benefits to domestic and international audiences.

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Communicating the Value and Benefits of Silviculture through Partnerships and Collaborative Stewardship

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Abstract.—Opening comments to this session share observations on the current management climate within the USDA Forest Service. Partnerships and collaborative stewardship as agency philosophy are discussed. Silviculturists roles, as scientists and managers are compared, and the need for internal and external cooperation stressed as we strive to meet forest stewardship goals.

INTRODUCTION

The current management climate affecting the Forest Service is one of great challenge and opportunities. The Forest Service is striving to implement a major shift in management approach towards sustainable resource management. It is doing so under scrutiny of Congressional appropriations committees that are struggling to understand what this change will mean in terms of an agency budget formed largely of timber management funds. The April, 1997 Government Account Office Report "Forest Service Decision-making: A Framework for Improving Performance" reveals an agency wide lack of accountability for decision-making and associated low return on investment of planning dollars. This problem, also known as "analysis paralysis" has created an agency "debt" caused by investment of dollars and expertise without return in the form of positive management action on the ground. Clint Carlson, Team Leader for the Bitterroot Ecosystem Management Research Project, describes this debt as "forests susceptible to fire, disease and insects" that affect both amenity and commodity benefits, and "over 3 billion dollars annually to run an agency whose productivity is declining dramatically." Add to this the increasing demands being placed on limited forest resources worldwide(Carlson, 1997).

It is important to note that although Congressional interest is intense, many members of Congress have very limited awareness of the mission of the Forest Service, which reflects a limited awareness among the Americans they serve.

Meanwhile, Forest Service resource managers are working harder than ever, applying their professional expertise to define and achieve the agency's land stewardship and public service mission. The Forest Service continues to expand its contributions in International Forestry, State and Private Forestry programs, Research, and in National Forest Systems. However, the agency faces difficult times as an agency, with many of us experiencing challenges in forming ecosystem based plans and projects, and equal difficulty in implementing them on the ground. Polarized interests, prolonged analysis, changing techniques, and funding uncertainties all contribute to today's management climate. There is a maxim that states "there is opportunity in chaos." Applying agency energy to building a stronger constituency and support base for sustainable resource management is one such opportunity to speed achievement of sustainable management goals.

PARTNERSHIPS AND COLLABORATIVE STEWARDSHIP

Webster's II defines a partnership as "an association with another or others in a common activity or interest." If one collaborates, one is "working together in a joint intellectual effort. Stewardship is defined as "the state of managing an others' property, finances, or other affairs." Critically examining these definitions is important to understanding what is meant when Chief Dombeck calls the agency to "Collaborative Stewardship." Collaborative stewardship gives contextual meaning to our responsibility for managing America's forests and supporting sound stewardship throughout the world. Chief Dombeck adds additional context in his definitions of collaborative stewardship as our agency resource management philosophy. It is achieved by "listening to all our constituents and by living within the limits of the land" and through a "commitment to healthy ecosystems and working with people on the land (Dombeck, 1997).

There is no cookbook for collaborative stewardship. It requires scientist and managers to purposefully seek ways to work together with each other, and with the public, in defining limits to the land and defining sustainable uses of the land. This happens most effectively with people getting together on the land in communities where programs are implemented.

ROLES OF SCIENTISTS AND MANAGERS

Effective collaboration begins with an understanding of what each can contribute to developing management objectives for the land. Individuals and interest groups bring their needs, concerns, and expertise. All, regardless of what draws them to the table, have something to contribute. So, too, with scientists and managers. It is important for scientists and managers to know their respective roles. Tom Mills, Pacific Northwest Station Director, lists the following characteristics of **scientists** as they do their jobs in support of managers and decision makers:

- retain independence
- quantify risk
- do not define appropriate levels of risk
- accomplish quality control
- conduct consistency checks between decisions and scientific information considered - was science interpreted correctly? were risks associated with decision understood, considered, and revealed?
- do not take positions

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He also describes the primary roles of **decision makers and managers:**

- clarify management goals
- clarify management questions
- determine levels of risk tolerance
- understand science findings and their implications for management
- challenge scientific logic, if faulty
- do not challenge science because the results are uncomfortable
- do not ask scientist to take or to support a position (Mills, 1997)

Collaboration based on an understanding of these roles can result in highly effective application of science in decision making. Both scientists and managers need to periodically scrutinize their work processes to determine if their interactions with the "other" are contributing to effective application of science in land management decision-making. It is important for members of the public to understand these ascribed roles to enable them to better work with local Forest Service officials.

CHALLENGES AND OPPORTUNITIES

The Silviculturist as Integrator. In collaborative stewardship, all agency professionals must serve as teachers before they can guide and contribute as scientists and managers. Silviculturists have many challenges and opportunities to conquer during this transitional period in the Forest Service. As experts of the dominating feature of forested landscapes, silviculturists are in a powerful position to be leaders in building internal partnerships and external support. The job of the silviculturist must, now more than ever, go beyond an exclusive interest in growing and harvesting trees. Silviculturists can champion biodiversity and sustainability and define ways to achieve it through their role in managing the structural backbone of these ecosystems. To do this, silviculturists need a understanding of the relationships between vegetative cover and soil stability, water quantity and quality, species diversity, fire risk and air quality. When silviculturists speak beyond the trees, they can demonstrate to the public how vegetation management can positively affect individual ecological components as well as the whole. As public understanding grows, so does increased support for on the ground management.

Aiming for the Middle. About 10 percent of those involved in natural resource management issues are controlling 90 percent of the debate. While it is important to understand the positions and desires of polarized interests it is prudent to quickly realize how impossible it is to satisfy opposite poles. Line officers with support from interdisciplinary teams, must develop public involvement goals that capture the interest of the community members who fill the space between the polar opposites. As more local citizens become aware of the Forest Service mission and how it relates to their communities and lives, there is a greater chance for management choices and decisions to receive broader support, and greater success in of implementation.

Dealing with Uncertainty and Risk. "We don't know enough." This is a statement frequently heard both inside and outside of the agency. As we manage landscapes for biological diversity and long-term sustainability of ecosystems, we do so without the extensive benefit of past experience. Forestry and silviculture have a long history of on the ground management and research, when compared with other resource areas. Once again, silviculturists have an opportunity to ease uncertainty and risk by examining past activities in the context of landscapes and other resource effects.

The antidote to uncertainty lies in identifying acceptable levels of risk with existing information and developing monitoring processes to closely track effects of implementation over time. Through the relationships developed with collaborative stewardship, Forest Service scientists and decision-makers can describe uncertainty and commit to monitoring after decisions are made. We then can demonstrate to the public that conscientious thought has gone into decisions, and that risks are not ignored. This approach must become standardized because it, too, will lead to increased understanding and support of management decisions and result in implementation. The unfavorable alternative is an extended analysis process that consumes resources with delayed or non-existent results.

Measuring Results

Here are a few indicators for identifying goals for and evaluating collaborative relationships:

- **Attentive listening** - is everyone involved given the chance to be heard?
- **Shared values** - have individuals identified shared values enable them to commit to the relationship?
- **Responsiveness** - have participants made adjustments and trade-offs to accommodate shared values and important requirements?
- **Celebrate accomplishments** - are there issues that were successfully resolved or activities successfully accomplished?

Collaborative stewardship provides an important opportunity for promoting the values and benefits of silviculture. Scientists and managers can use it as the basis for effective working relationships with each other, decision-makers, interdisciplinary teams, and communities. Just as there is no cookbook for designing collaborative stewardship, there is set process for measuring results. It is a journey, it is about relationships, and it is about action on the ground. Collaborative stewardship is not a quick-fix management initiative. It takes time to develop, as with any lasting relationship.

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Demonstrating Appropriate Silviculture for Sustainable Forestry in Central Siberia: A Russian - American Partnership

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Abstract.—A joint Northeastern Forest Experiment Station - Eastern Region team is working with Russian counterparts on a Forests for the Future Initiative in the Krasnoyarsk region of central Siberia. Russian team members include scientists from the Sukachev Institute of the Russian Academy of Sciences, managers from a number of units of the Federal Forest Service of Russia, and the directors of a logging and sawmilling enterprise. The goal is to establish a pilot project demonstrating principals of forest conservation and sustainable development. Applying silvicultural treatments appropriate for the forests of the region is a key element of the program.

INTRODUCTION

In 1993, a team of scientists and managers from the USDA Forest Service's Northeastern Forest Experiment Station and the Eastern Region was established to work with Russian counterparts on a Forests for the Future Initiative (FFI) in the Krasnoyarsk Krai (Region) of central Siberia. The goal of the FFI program is to establish pilot projects to demonstrate the principles of forest conservation and sustainable development. The first phase of the project in Krasnoyarsk was to provide geographic information system (GIS) capability at the field level in Siberia. Begun in 1995, the second phase was to establish demonstrations of sustainable forestry practices in areas scheduled for harvesting. This paper will present background, progress, and plans for Phase Two.

Currently, members of the American team include scientists from the Northeastern Forest Experiment Station, and managers from Region 9, Region 1, and the Washington Office of the Forest Service. Russian team members include scientists of the Sukachev Institute of the Russian Academy of Sciences, managers from a number of units of the Federal Forest Service of Russia, and the directors of a state-owned logging and sawmilling enterprise.

In preparation for Phase Two, the American team visited Siberia in 1995 to become familiar with the ecology of the region and the state of research in the area. We returned to Siberia in 1996 to witness harvest operations in the area. Also in 1995 and 1996, several delegations of Russian researchers, managers, and industrialists visited northern New England and the Lake States to view our long-term research and operations on national forest and industrial forest lands, and visited California and Montana to learn about prescribed burning.

AN OVERVIEW OF KRASNOYARSK KRAI

Krasnoyarsk Krai is in the Asian part of the Russian Federation and occupies 233 million ha or 13.6 percent of the country's territory. The krai lies between 51° and 81° N, and 78° and 113° E, and includes the geographic center of Russia. Its southern boundary is the Sayan Mountains and its northern, the Arctic Ocean. Elevation ranges from 100 to 3,000 m above sea level. In the past, many political exiles, including Lenin, were sent to the region; today its population is about 3 million people, most living in cities. The first democratic elections in the krai were held in 1993.

The Yenisei River, one of the world's largest with a total length of more than 4,000 km, flows through Krasnoyarsk Krai. It starts in the Sayan Mountains and flows north to the Kara Sea, dividing east and west Siberia. The two largest hydro-electric stations in Eurasia are on the Yenisei. With its many tributaries, the Yenisei forms an important transportation network for goods and passengers. One of its tributaries, the Angara, is the outlet of Lake Baikal. Although the rivers are extremely important for transportation within the region, they are of limited value for exporting goods because the outlet is to the Arctic Ocean. The Trans-Siberian Railway crosses the Krai; however, distances to commercial centers are vast. In a direct line it is 3,200 km west to Moscow and 3,000 km east to Vladivostok.

The Krasnoyarsk Krai takes its name from its capital city. Located on the Yenisei, the city of Krasnoyarsk, which loosely means "beautiful red riverbank," was founded in 1628 by a nobleman from Moscow and some 300 Cossacks. It is an industrial, cultural, and educational center with a population of nearly 1 million people.

The area within Krasnoyarsk Krai chosen for demonstrating sustainable forestry is in the Predivinsk lespromkhoz (a timber enterprise) within Bolshoya Murta leskhoz (equivalent to a national forest in the United States). Bolshoya Murta is also the name of a village and the surrounding administrative district, similar to a county. Predivinsk is a village of about 5,000 people on the east bank of the Yenisei River, east-northeast of Bolshoya Murta. The people who live in the village are entirely dependent on the timber enterprise for their livelihoods. They work either in the sawmill, as loggers, or in support of those activities.

THE FORESTS OF BOLSHOYA MURTA

The Bolshoya Murta leskhoz (approximately 57° N, 93° E) is about 450,000 ha in size and 93 percent forested. The climate is continental with a mean annual temperature of 1.0° C, and maximum and minimum temperatures of 36.9°

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and -48.0° C, respectively (E. Vaganov, personal communication). Precipitation averages 406 mm per year, the growing season averages 146 days, and soils typically freeze to a depth of 172 cm. The area was not covered by the last continental glacier.

The leskhoz is divided by the Yenisei River. The western part of Bolshoya Murta is southern taiga and subtaiga forest-steppe transition. These sites are quite flat. Soils are Podzolic (Alfisol and Spodosol) and Chernozem (Mollisol). The eastern part is mountain taiga forest. The mountains are not large and only moderate slopes are encountered. Soils there are also Podzolic. The area is south of the permafrost zone.

The southern taiga and mountain taiga forests are comprised of "dark coniferous", "light coniferous", and hardwood stands. Except for scattered trees occasionally harvested for local use, these stands have never been logged. However, because of natural disturbance, average stand age is only about 91 years (E. Vaganov, personal communication). Nevertheless, coring of individual trees when we were there indicated some more than 200 years old. Furthermore, many of the stands we visited had the appearance of being uneven-aged. Trees of the forest-steppe transition are mostly birch, *Betula*, and pine, *Pinus*.

Although they are at higher latitude, dark coniferous stands found in Bolshoya Murta are strikingly similar to spruce-fir, *Picea-Abies*, forests of eastern North America. Siberian spruce, *P. obovata*, is similar to red spruce, *P. rubens* Sarg., so common in Maine and Atlantic Canada, and to white spruce, *P. glauca* (Moench) Voss, which is common across the northern United States and Canada. Siberian fir, *A. sibirica*, is similar to balsam fir, *A. balsamea* (L.) Mill. Although it is a stone pine (i.e., 5-needle fascicles, short-winged or wingless seeds), Siberian pine, *P. sibirica*, (called cedar by the local people) seems to have an ecological niche much like eastern white pine, *P. strobus* L., in mixed conifer forests of eastern North America. These are all relatively tolerant species and the stands tend to have multiple cohorts. Natural disturbances include insect epidemics, wind, and fire. After stand-replacing disturbance, dark coniferous stands are followed by the region's only large hardwoods, birch, *B. pendula*, and aspen, *Populus tremula*.

Light coniferous stands of Scotch pine, *Pinus sylvestris* L., are usually even-aged and appear similar to natural stands of red pine, *P. resinosa* Ait., in the Lake States. With increasing latitude, Siberian larch, *Larix sibirica*, progressively replaces pine in light coniferous stands. However, in the area where we are working, pine is much more common than larch.

Essentially all land in Russia is owned by the state. Forests are classified into three groups according to function. Group I forests are protected. Degree of protection varies by sub-group but, in general, only light partial salvage and sanitary cuts are allowed. Protection is provided to ensure a presence of Siberian pine in the forest, for riparian zones, shelter belts along roads, and at forest-town interfaces. In Bolshoya Murta, 11.7 percent of the forest area is Group I (E. Vaganov, personal communication). Wood from Group II forests can be harvested for local use, but these forests also have defined protective functions. Only 3.2 percent of the forest area of Bolshoya Murta is Group II. Forests in Group III are subject to industrial wood harvesting and the wood can be exported outside the region. These forests are supposed to be protected from fire and regenerated after harvesting. In Bolshoya Murta, 85.1 percent of the forest area is Group III, and thus available for industrial management.

Various elements of the Federal Forest Service of Russia are responsible for inventory, protection, and management of the forests. Under Soviet rule, state-controlled industrial enterprises harvested and processed timber. Since then, many of the enterprises have been privatized. The enterprise located in Predivinsk, however, remains state-owed, under the direction of an appointed official. Like the few other state-owned enterprises in non-strategic industries, the Predivinsk Lespromkhoz operates as an independent unit.

Because of the current state of the economy in Russia, operating funds for federal agencies are extremely scarce. To maintain a viable organization, the Federal Forest Service resorts to innovative methods to raise revenue. While harvesting and processing are generally performed by industry, the Federal Forest Service is responsible for thinning and salvage operations, the income from which they can keep. The organization also keeps some of the money collected in fines levied for violating forest statutes.

CURRENT SITUATION

Silvicultural treatments in the Soviet Union were mandated based on forest type, stand structure, slope, and whether the site had sufficient advanced regeneration of valuable species. The same or similar rules still apply. However, since the breakup of the Soviet Union, these rules are not strictly enforced for a number of reasons, both economic and political in nature.

Russian partners in this project include ecologists, silviculturists, and fire behavior scientists from the Sukachev Institute, and managers from the Federal Forest Service at levels equivalent to Region, Forest, and District in the USDA Forest Service. We also work with members of the aerial fire suppression branch, which is separate from forest management. The director of the Predivinsk lespromkhoz and key members of his staff are also active participants. These Russians are all well trained and highly professional. They understand the ecology of their forests and how they should be managed. However, our Russian partners face severe economic and cultural barriers to implementing appropriate silviculture. Markets within the krai are limited and access to export markets is poor owing to the vast distances involved. The agencies represented by the partners in this project do not encourage dialogue between their personnel, probably a legacy of strict centralized control. That culture may also explain why silvicultural treatments are mandated and not prescribed on a site-specific basis.

Dark Coniferous Forest

In the Predivinsk lespromkhoz, tracts of dark coniferous forest are clearcut with little concern for regeneration. Harvesting is in 50-ha units using tracked feller-skidders. See Folkema and Holowacz (1985) for detailed descriptions of Russian logging equipment and practices. This equipment has several limitations: the operator can only harvest trees to the left; the boom reach is only 5 m; and trees cannot be lifted once cut—so tops are dragged across the site before the butt of the tree is placed in a bunk at the back of the machine. Furthermore, skidding progresses in 5-m wide strips across the harvest unit with each skid trail being the previously felled strip. Thus, the whole unit is covered by skidding and all advanced regeneration is destroyed. If artificial regeneration was an option, such harvesting might be acceptable. However, there is neither nursery capacity nor infrastructure to ensure that all harvest units get planted, and there is no funding available to release established conifer seedlings from hardwood competition.

Before mechanized harvesters were available, trees were felled by hand crews using chainsaws and moved to landings by cable skidders. That operation protected advanced regeneration. Paradoxically, even though the economy is poor, loggers in the area are no longer willing to fell trees by hand. The reason given for this anomaly was an unacceptably bad safety record for hand-felling operations. Yet, this is a concern that could be overcome with proper training. Perhaps the view that technology is a panacea for the current production slump and the possibility (however remote) to garner state funds for technological modernization are additional factors. Regardless, the director of the lespromkhoz feels compelled to continue mechanical harvesting and its resulting destruction of the regeneration.

In 1996, an experimental prescribed fire was used to reduce slash in a recent clearcut and to prepare the site for planting. That successful experiment was innovative. In Russia, fire is routinely considered destructive, and prescribed fire is a radical idea and virtually untested management tool. Only time will tell when, or if, prescribed burning will become an accepted practice.

Light Coniferous Forest

In Bolshoya Murta, most Scotch pine stands are in riparian zones or on slopes and, therefore, clearcutting is not permitted. However, we did visit one unit where pines had been harvested and strips of seed trees were left to regenerate the site. Pine stands are characterized by large volumes of high-quality, high-value sawtimber. In the only active operation we saw in such stands, individual trees were selectively cut (i.e., high graded) using a feller-buncher. Because it was considered a thinning operation, the logs were milled and sold by the local unit of the Federal Forest Service (equivalent to a Ranger District on a national forest in the United States). Although the best stems were removed, the cut was light and the residual stand retained a high density of quality trees. Furthermore, the feller-buncher operator did an excellent job of protecting the residual stand from damage while cutting and maneuvering harvested trees.

We saw a number of pine stands with evidence of low intensity, understory wild fires. In each case, good stocking of seedling and sapling pines existed in the burned areas, suggesting that fire might be an effective way to establish advanced regeneration before harvesting the overstory. As in the dark coniferous forest, however, prescribed fire has not been considered a method for achieving silvicultural goals. Nevertheless, prescribed fire could have significant implications for regeneration and maintenance of pine stands.

ACCOMPLISHMENTS AND PLANS

Since its beginning in 1993, this project can claim a number of accomplishments. Communications among all the partners are improving, and there is a strong sense that what we are trying to accomplish is extremely important. Undoubtedly, the greatest accomplishment has been bringing together the various agencies responsible for inventorying, protecting, managing, and utilizing the forests to work toward a common goal. Phase One, developing local capacity to build, maintain, and use GIS technology is operational and nearly complete. Managers of the forests around Bolshoya Murta have been authorized to experiment with treatments other than those normally prescribed by rule; the prescribed burn in 1996 is the first attempt at such innovation. Exchange visits between Russian and American partners have improved our understanding of each other and of our respective forests. These exchanges have shaped our annual work plans, infusing this project with a high degree of flexibility.

We have a number of objectives for the future. Within the next year, GIS technology should become available to the lespromkhoz, thus completing Phase One. Under Phase Two, we have two immediate objectives. One is to plan and conduct a site preparation underburn in a light coniferous stand to demonstrate the potential of fire to enhance natural regeneration of pine. The other is to conduct a trial harvest designed to protect some advanced regeneration in a dark coniferous stand using existing mechanical harvesting equipment.

The proposed harvest will cut 5-m wide skid trails in the conventional way, alternated with 5-m strips where trees will be cut and removed while providing some protection for advanced regeneration. Regeneration will be lost on the skid trails and not fully protected on the adjacent strips, but any regeneration saved is an improvement over present practice. This logging method is technically feasible using existing equipment, but is somewhat more difficult operationally. The director of the lespromkhoz is skeptical about the economics of the method but willing to try it as a demonstration. Over the longer term, we hope to encourage harvesting equipment manufacturers to demonstrate their machines in the region. Under similar terrain and forest conditions in the industrial spruce-fir forest of Maine and elsewhere, state-of-the-art feller-bunchers operating on designated skid trails do a good job of protecting advanced regeneration.

To its credit, this project has succeeded in generating a series of quick accomplishments. We hope that continued successful demonstrations of silvicultural techniques will lead to a willingness to consider a longer term approach and integrated planning. We would like to identify some areas well before they are scheduled for harvest and prepare a thorough prescription. The evaluation would consider the state of advanced regeneration and recommend appropriate prescribed fire and cutting methods to control the composition and density of the future stand. In conclusion, the Russian-American partnership has tangible accomplishments and the vision needed to develop appropriate silvicultural prescriptions to help sustain the forests of Siberia for the future.

ACKNOWLEDGMENTS

We thank our Russian colleagues for willingness to share their forests and for their patience with our language difficulties. We have met many wonderful Russians on our travels and unfortunately cannot mention them all by name here. However, some people deserve special credit for making this project successful. They include: R. Babintseva, A. Buzykin, V. Cherkashin, V. Ivanov, N. Kovalov, A. Laletin, V. Malkevich, E. Petrenko, T. Shvetsova, E. Vaganov, E. Valendik and V. Vekshin. We also thank L. Kenefic of the Northeastern Forest Experiment Station for translating Russian silvicultural terms and rules regarding practices. Finally we thank P. Owston, J. Senick, and J. Zasada for helpful review comments about an earlier draft of this paper.

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The Blue Mountains Natural Resources Institute: Partnerships that Demonstrate the Role of Silviculture in Forest Management

James McIver[1], Andrew Youngblood[2]

Abstract.—The research program of the Blue Mountains Natural Resources Institute (BMNRI) aims to understand the ecological effects of current management practices. In forest systems, this amounts to silvicultural research. We describe how the BMNRI fosters partnerships to carry out and showcase silvicultural research leading to information that allows assessment of economic/environmental tradeoffs. We also describe how partnerships are fostered not only to undertake research, but to encourage adaptive management. The BMNRI plays a unique role as a facilitator of relationships among managers, scientists, and the public, and has a structure ideal for demonstrating the role of silviculture in forest management.

INTRODUCTION

Although silviculuture has evolved into a multidisciplinary practice, to much of the public it still implies a focus on tree growth and timber production (O'Hara et al. 1994). While wildlife biologists have acknowledged the central role of silviculture in maintaining habitat (Thomas et al. 1979), reflecting the view that silviculture is the primary tool for objectives that require active management, many professionals in the Forest Service and elsewhere remain suspicious of a tree-focused agenda of silviculturists when it comes to making forest management decisions. The best way to change these perceptions is to demonstrate on the ground the role played by silviculture for implementation of a variety of management objectives. With an agenda to research the effect of management practices on ecological processes, the Blue Mountains Natural Resources Institute (BMNRI) is ideally poised to demonstrate this role.

The BMNRI was chartered in 1991 with a mission to "enhance the social and economic benefits derived from natural resources in the Blue Mountains in an ecologically sustainable manner." A small professional staff employed by the U.S.D.A. Forest Service is given advice by an approved Federal Advisory Committee, consisting of 24 members representing local, state, and federal government, academia, industry, environmental groups, and private citizens/landowners. The BMNRI carries out its mission by brokering natural resources information through research, demonstration, and education. The staff relies heavily on its 80 partner organizations to accomplish its objectives—partners participate in planning or carrying out projects, circulating information, or conducting research. It is assumed that better scientific information has considerable value in dispelling myth and in providing a more solid foundation from which natural resources decisions are made. Issues that have information needs are first identified by the advisory committee and then are classified by the staff as needs that: 1) are a question of perceptions and/or values; 2) can be met by pulling together existing information; or 3) require new research. Value issues are best met by bringing people with opposing views together into forums, conferences, seminars, or workshops that illustrate the causes of people's perceptions. Information issues can in some cases be resolved by gathering information that already exists into syntheses or by simply making that information more available to the public and to land managers. If little or no information on a given issue can be obtained from the current literature, new research is fostered to fill the knowledge gap. This paper describes how partnerships are used to facilitate interaction among scientists and managers in undertaking operational research. The primary audience for BMNRI research is land managers, although the same information is made available to any interested group.

Once a knowledge gap is identified, research is planned that seeks information gathered in a management context, and that is integrated well enough to provide managers with the opportunity to explore tradeoffs. A strong technology transfer element completes the formula, because it is argued that for many contentious issues, managers require information in a more timely manner than is typical for most scientific publications. The BMNRI is currently involved in three main lines of research: relations between forest management and bird population viability, improved cattle distribution practices, and forest fuel reduction. We will illustrate the style and process of BMNRI research by focusing on how partnerships are fostered to facilitate research on fuel reduction. We hope to make it clear that not only is silvicultural expertise central to our fuel reduction research, but that the style the BMNRI uses to carry out the research is ideal for illustrating the role and value of silviculture.

THE FUEL REDUCTION ISSUE

Forest fuel reduction is currently a key objective for Forest Service managers in the inland West, primarily because fuel has increased due to 90 years of fire suppression (Everett 1993; Agee 1996). The concept is that if fuel of intermediate size classes (3-20 inches in diameter) can be reduced, the spread of wildfire and its intensity on any given site will also be reduced. Furthermore, because fuel levels are considered to be a problem for large areas of public land in the inland West (Gast et al. 1991; Quigley et al. 1997), fuel reduction needs to be accomplished at landscape scales, and this can realistically be done only with landscape prescribed fire (underburning) and by mechanical means (single-grip harvesters and their like). Although considerable research has focused on ecological effects of both of these practices (U.S.D.A. 1979; Kellogg et al. 1992; Monleon & Cromack 1996), and their relative costs are generally understood (Rich 1989; Kellogg et al. 1992),

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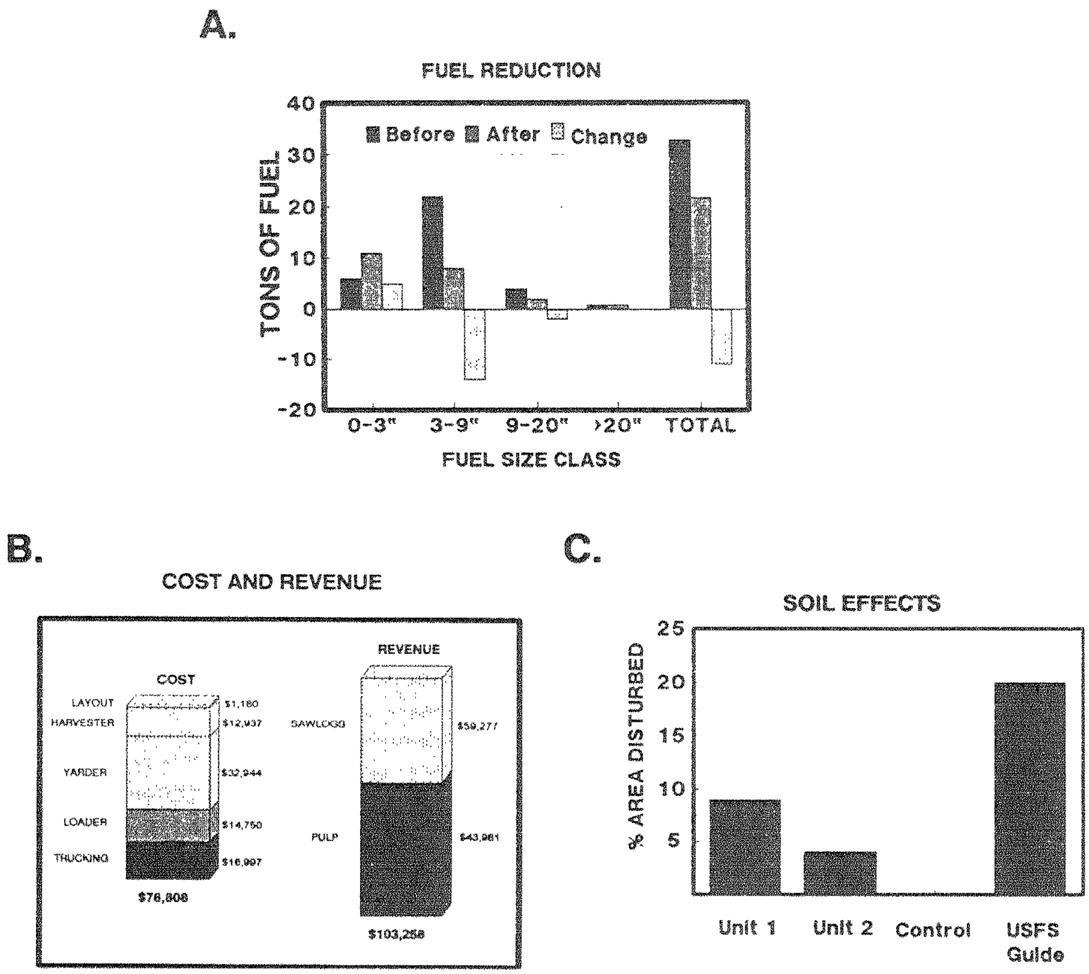

Figure 1.—Extent of fuel reduction, logging costs and revenue, and soil effects of the Deerhorn Harvest, July- August 1994.

few studies have measured both economics and environmental effects simultaneously under the same stand conditions. Only studies that are integrated in this way can provide information allowing assessment of economic/ environmental tradeoffs associated with either method, or that allows direct comparison of the two methods. The fuel reduction research program of the Blue Mountains Institute is designed to provide this kind of integrated information on comparative tradeoffs, such that managers will be able to better assess the relative benefits of alternative fuel reduction methods. In this essay, we will discuss a sequence of three fuel reduction projects that illustrate not only the style of integrated research used by the BMNRI, but the role of silviculture as well.

Integrated Research

The value of integrated research is well illustrated by the Deerhorn case study, which explored the economics and soil effects of implementing a fuel reduction prescription in a lodgepole pine stand growing on flat ground. Coordinated by the BMNRI, Deerhorn was a collaborative effort involving the La Grande Ranger District (prescription), Louisiana-Pacific (owners of the land), Eagle Trucking (yarding equipment), McClaren Logging Co., Oregon State University (operations and research), and the Forest Service PNW Station (fuel research). The prescription was designed to maintain overstory stand structure, significantly reduce fuel (down wood) in the 3-15 inch size classes, and still allow sufficient removal of material to keep the project economically feasible. A further constraint was that to adequately protect sensitive soils, a skyline yarder was used to retrieve material cut by a single-grip harvester. The flat ground at the Deerhorn site, coupled with the fuel reduction objective, placed considerable pressure on the silviculturist for a prescription that balanced all the needs. Undertaken over a 2-month period in summer 1994, the project resulted in significant fuel reduction in the 3-9 inch size class (Figure 1a), was economically viable (Figure 1b), and caused soil impacts well within the standards imposed by the Forest Service

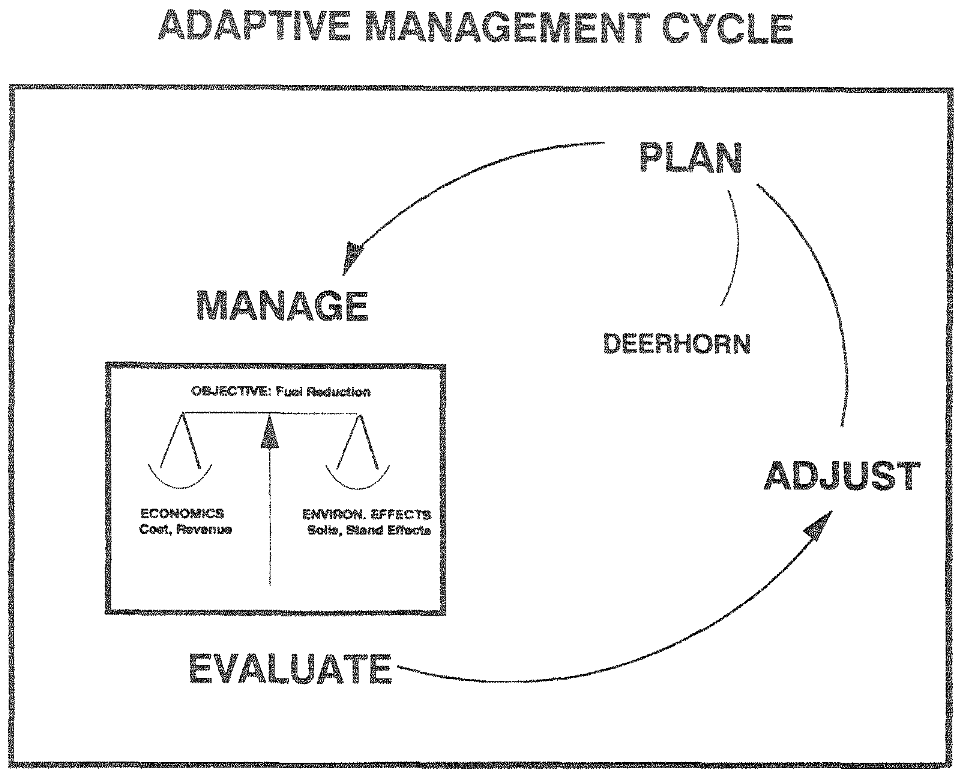

Figure 2.—Adaptive management cycle using an integrated management experiment as example of new information.

(Figure 1c) (McIver 1995). Results also indicated that fuel reduction of intermediate size classes may typically be associated with increases in the small diameter "flashy" fuel (< 3 inch) due to logging activity, thus increasing fire risk in the short term. Heavy soil impacts were all associated with gouging in the yarding corridors, due to inadequate log suspension during retrieval. Additional intermediate supports would be required to mitigate this type of damage. Finally, economic viability in this project was clearly associated with the percentage of the more valuable sawlog material removed, thus making the silvicultural prescription a critical link in the planning process (Brown & Kellogg 1996). This last point makes it clear that in order to implement a management objective that involves removal of low-value material, the role of the silviculturist is fundamental, especially under circumstances where both economics and environmental effects are of concern.

Adaptive Management

Results at the 50-acre Deerhorn site encouraged the La Grande Ranger District to move forward with plans to conduct fuel reduction at a larger scale. Deerhorn thus contributed to a cycle of adaptive management (Figure 2) in which lessons learned from one operation were used directly to plan the next operation. Because there is so much uncertainty surrounding the fuel reduction issue, and because many of the lands upon which fuel reduction is needed lie within municipal watersheds, information on how best to reduce fuels is at a premium. These are the kinds of circumstances within which adaptive management can best function. Decisions facing the La Grande Ranger District serve as a case in point. It has been estimated that in 1997 over 40,000 acres of the District required immediate treatment of low-value material to reduce the intensity and spread of wildfire. The highest-priority project turned out to be on Limber Jim ridge, a string of mixed-conifer/lodgepole pine stands on the divide between the Upper Grande Ronde River to the southwest and the Beaver Creek Drainage on the northeast, the latter being the principal watershed for the city of La Grande, Oregon. The idea was to create a "shaded fuel break," centered on the logging road that split the two watersheds, that could serve as an anchor point to station fire fighters in the event of a wildfire in the area. The fuel break would be about 7 miles long and 1000 ft. wide on either side of the road, with non-treated corridors in the draws to allow movement of forest-dependent wildlife. The challenge was to reduce fuel to less than half of the observed loadings by removing both standing and down dead wood, and to remove some of the smaller-diameter green trees to create growing space for the residual stand. Fuel reduction had to be accomplished economically, and without damaging the residual soils or stand, because the District wanted to demonstrate sensitive and feasible logging practices for fuel reduction on a larger scale.

Previous findings at Deerhorn and elsewhere had indicated that while the skyline retrieval system was ideal for protecting sensitive soils, it was expensive compared to more commonly used ground-based systems, especially on flat ground. Hence the BMNRI, working with the La Grande Ranger District, and a group of scientists at Oregon State University, the University of California, and the PNW Research Station, designed a fully replicated study to compare skyline retrieval of the low-value material at Limber Jim with an articulated, rubber-tired forwarder. The challenge for the silviculturist was to create a prescription that adequately balanced needs for wildlife and for fuel reduction, while providing enough sawlogs and pulp material to make the project economically feasible as a timber sale. Moreover, because stands differed substantially in species composition and structure, prescriptions had to be uniquely crafted to meet the fuel reduction objectives. The general guideline was that the only material removed would be down and standing dead material less than 15 inches in diameter, leaving at least 40 pieces per acre of residual down woody material.

Fuel reduction prescriptions were first implemented with a single-grip harvester in each of three stands at Limber Jim. Logs were cut to 16-foot lengths and stacked at regular intervals along corridors spaced 60 feet apart (the single-grip could reach 30 feet into the stand on either side of each corridor). Each unit was paired such that logs on one side were retrieved by skyline yarding, and on the other side by rubber-tired forwarding; efficiency (tons of logs retrieved per unit time) was compared for the two techniques. Fuel loads and soil bulk densities were measured both pre- and post-treatment; soil biota and residual stand damage were measured post-treatment. Although results are still preliminary, it is clear that fuel was reduced by between 50 and 80 percent, and forwarding appears to be the most economically feasible and environmentally attractive means to reduce fuel.

Although a primary objective of research at Limber Jim was to provide better information to managers on the efficacy of various logging systems for fuel reduction, it was equally important to demonstrate environmentally sensitive logging to the concerned public. Hence while operations and research were being carried out at Limber Jim, the BMNRI conducted several tours to demonstrate the efficacy of mechanical means to reduce excess fuel. Audiences included the general public; local, state, and national officials; environmental and industry groups; and land managers from the state agencies, BLM and the Forest Service. Additionally, a video illustrating the process of fuel reduction at Limber Jim, and the relationships among scientists, managers, and the public is currently being prepared.

The inclusion of a replicated scientific design within the Limber Jim project is one way in which adaptive management can be applied to accelerate learning. However, the kind of information needed to improve methods of fuel reduction is not only technical, but social as well. If the public is not confident of both the need for fuel reduction on federal lands, or the means to accomplish it, land managers will find it much more difficult explain and carry out their plans. Hence the BMNRI commissioned a study to survey the citizens of the Blue Mountains about fuel reduction needs and methods. Results indicated that of 560 citizens surveyed, most citizens felt that excess fuel needed to be treated, and the great majority were comfortable with the Forest Service using prescribed fire or thinning/removal to accomplish fuel reduction objectives (Shindler 1997).

Coordinated Silvicultural Research

The high degree of confidence expressed by the public for fuel reduction work motivated the BMNRI to acquire funds to carry out an ecological and economic comparison of prescribed fire and mechanical thinning/removal. The "Hungry Bob" project is designed to measure and illustrate how reduction of fuel by fire differs in quality and quantity from reduction by thinning and removal. The study will be carried out in ponderosa pine-dominated dry forest, where managers could conceivably use either method in any given situation. The project will require close interaction among several partners, including the Wallowa Valley Ranger District (which manages the site), scientists at Oregon State University and the PNW Station (labs in Corvallis, La Grande, and Seattle), and the contractor who buys the timber sale. At Hungry Bob, the challenge for the silviculturist will be to develop prescriptions for the thinning units that result in approximately the same levels of fuel as units that are underburned. This requires a close working relationship between the project silviculturist and the fire specialist. Measured variables include fuel levels, economics, soil effects (biology, chemistry, physics), and residual stand damage.

As for previous fuel reduction studies, the BMNRI will coordinate research, and serve as the liaison between research, management, and the public. Coordination of the players involved requires a substantial commitment of time and energy. Although coordination involves several activities conducted at key stages during the planning, undertaking, and reporting of a project (Table 1), the most important activities are raising funds to measure variables, and serving as the liaison between science and management. By taking over these two roles, the BMNRI can attract scientists to large-scale operational studies, which require substantial interaction with management and significant funding. By definition, research conducted within a management context will almost always generate information more useful to the manager, and thus the BMNRI plays an important role in applied silviculture research and adaptive management.

The approach described in this essay, in which relationships between managers, scientists, and the public are improved and tightened, is used for each project fostered by the BMNRI. Whenever managers and/or the public are allowed to identify and prioritize knowledge gaps themselves, and whenever scientists are encouraged to apply their expertise within a management context, the result will generally be that more useful information will be generated. Adaptive management in its more rigorous form can then become a reality, with its quicker turnaround of more reliable information.

Table 1.—Principal functions of BMNRI in coordinating integrated silvicultural research

FUNCTION	PLAYERS INVOLVED
Recognize information need	Managers, Partners, Public
Determine treatments/variables	Managers, Scientists, Public
Establish QA/QC measures	Scientists
Obtain funding to measure response variables	Scientists
Incorporate experimental design within timber sale contract	Managers
Liaison between managers and scientists	Managers, Scientists
Liaison between contractor and scientists	Contractor, Managers, Scientists
Oversee technology transfer, public relations	Management, Scientists, Public
Organize tours	Managers, Scientists, Partners, Public

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Monitoring the Mighty Duck Timber Sale: a National Forest - Conservation Organization - Research Partnership

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Abstract.—Resource managers are seeking silvicultural solutions to a variety of ecological, economic, and social issues. These issues include maintaining healthy and aesthetically pleasing forests, and sustaining or increasing ecological diversity. To reestablish a conifer component, and thereby increase species diversity, the LaCroix Ranger District of the Superior National Forest planned to apply a reserve tree method (RTM) to reduce the density of aspen suckers and increase survival and growth of planted conifers. The Ruffed Grouse Society questioned widespread application of the treatment because of its potential impacts on early successional forest communities, and offered to help finance a study to monitor results of the RTM. Communication and cooperation among the LaCroix District, the North Central Station, and the Ruffed Grouse Society led to a three-way partnership and a study to monitor and evaluate the results in six stands for 10 years. This long-term partnership will provide mutually beneficial silvicultural information to all parties.

INTRODUCTION

At the 1993 National Silviculture Workshop, Bill Shands (Shands 1994) called for new, stronger relations between Forest Service Research, the National Forest System, and the public in implementing the complicated business of ecosystem management. He also listed, among his seven points of ecosystem management, the need for Forest Service silviculturists and others to help forge these new cooperative relationships. The only change we would suggest today would be to rephrase his last item to read: "No matter what your position description you have an **opportunity** to help forge these new, cooperative relationships!" This paper reports a case study that illustrates his points and shows how communication and cooperation led to a three-way partnership between the LaCroix Ranger District on the Superior National Forest, the Ruffed Grouse Society, and the Silviculture of Northern Great Lakes Forests Research Work Unit of the North Central Forest Experiment Station.

HISTORICAL BACKGROUND

The LaCroix District is typical of much of the public forest land of the northern Great Lakes region. Ecologically, most of the forest types are far different from those of a century ago. Depending on location, the pre-settlement species growing on medium to fine-textured soils of Minnesota, Michigan, and Wisconsin were predominantly shade-tolerant conifers including white pine, eastern hemlock, and northern white-cedar; and tolerant hardwoods dominated by sugar maple, red maple, yellow birch, and basswood (Albert 1995; Braun 1950; Coffman et al. 1983; Kotar et al. 1988). White spruce, balsam fir, white ash, and American elm were common associates. Without stand-replacing disturbances, the aspens occurred as minor associates (Braun 1950).

During the late 19th century, exploitative logging, initially of conifer species, created conditions for slash-fueled wildfires that swept over large areas of the region, destroyed advanced regeneration of the former species, and resulted in "brushlands" comprised predominantly of aspen suckers and stump sprouts of associated hardwood species (Graham *et al.* 1963). Effective fire control beginning in the 1920's permitted these stands to develop into the present-day second-growth forests dominated by aspen.

ECOLOGY AND MANAGEMENT

The aspens are intolerant, rapidly growing, short-lived species that regenerate by root suckers following removal of the parent stand (Perala and Russell 1983). Suckers exhibit more rapid early height growth than seedlings or sprouts of associated species, so they typically form the dominant overstory during the early and mid-stages of stand development. On medium and fine-textured soils, pure aspen stands are rare; most include a component of more tolerant, longer lived species typical of these sites in the absence of disturbance. Until the 1960's, aspen was considered a "weed" species and little was harvested, resulting in an unbalanced age class distribution. Over much of the region, a relatively small portion of the type is less than 30 years old and a much larger proportion is older than 60 years. On most land, aspen is managed for wood products or for a combination of fiber and wildlife habitat. Where wood production is a primary objective, the stands normally are harvested by a silvicultural clearcut of all species and the aspen is regenerated from root suckers. Presumably, the procedure can be repeated and the aspen maintained indefinitely (Perala and Russell 1983).

THE PROBLEM

Clearcutting at frequent (40- to 50-year) intervals to maintain single or dual-species stands in an early successional state conflicts with several of the objectives of ecosystem management (*e.g.*, Irland 1994). Ecologically, this interrupts natural successional processes and "resets the successional clock" (Mladnoff and Pastor 1993). Additionally, the extensive loss of the conifer component from much of the forest area of the Lake States region has caused concerns about ecosystem structure and function and the diversity and quality of wildlife habitat (Green 1995; Mladenoff and Pastor 1993). In this context, members of the Timber Management staff and the Wildlife Biologist on the LaCroix District had discussions about Desired Future Conditions on the District

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and possible ways to reestablish a component of native conifer species. Establishing these species on suitable sites was considered a first step toward increasing species diversity at the stand level. Moreover, total yields of mixed-species stands may well exceed those of aspen alone (Navratil et al. 1994; Perala 1977). Natural regeneration of most conifers on these sites usually is limited by lack of available seed sources. Development of planted seedlings frequently is hampered by competition from dense stands of aspen suckers, stump sprouts, hazel, mountain maple, and herbaceous species. Research on use of prescribed fire for conifer regeneration has begun, but results are not yet available.

APPROACH TO SOLUTION

Ruark (1990) proposed a reserve shelterwood system to convert 30- to 35-year-old, even-aged aspen stands to two-aged stands and concentrate limited site resources (sunlight, nutrients, water, and growing space) on fewer stems per unit area. The method has not been tested or validated, but offers several potential advantages at different spatial scales. At the stand management level, the additional growth of the residual trees would be concentrated on a few quality stems producing high-value sawlogs and veneer bolts rather than pulpwood. Likewise, inhibition of dense suckering could channel the carbohydrate and nutrient reserves in the parent root systems to fewer suckers and increase their early growth.

From a landscape perspective, the resulting two-storied stands are aesthetically more appealing to many people than are clearcuts. Maintaining partial stocking of the site may be less disruptive to normal hydrologic and nutrient cycling processes. Two-storied stands provide structural diversity that benefits some wildlife species (Green 1995; Ruark 1990). The portion of the timber volume retained will reduce the sale volume per unit area, but the Allowable Sale Quantity can be distributed over a larger area. This will accelerate development of a more balanced age class distribution and reduce the eminent "breakup" of overmature stands. From a silvicultural and forest health viewpoint, this is especially important to those Districts that are losing net volume from mortality due to stem decay.

THE MIGHTY DUCK SALE

The sale area is in the northern portion of the District, near Voyageurs National Park along the Canadian border. It includes about 70,000 cords of predominantly mature and overmature aspen in 38 stands, totaling 1,050 ha (2,600 ac) distributed over a 4,740-ha (11,700 ac) area. The Mighty Duck sale is the first of four within the sale area; it included 19,000 cords in 14 stands and was scheduled to be sold in fiscal year 1996. The original intent was to apply the RTM on about 40 percent of the sale area, or 420 ha (1,030 ac). This involved leaving about 25 to 40 dominant, vigorous aspen per hectare (10 to 15 per ac), at a spacing of 15 to 20 m (50 to 66 ft). The objective of the RTM was to reduce the overall density of aspen suckers per unit area. It was assumed that the reserve trees will inhibit suckering to a degree (Ruark 1990). The remainder of each stand will be clearcut, with natural sucker development.

The conventional logging practice in the area is mechanical felling using feller-bunchers, limbing at the stump to a 10-cm (4 in) top diameter, and tree-length skidding with grapple skidders. Except for a penalty for damage to reserve trees, no restrictions on skidding routes were specified. This normally results in skidder traffic over most of the site and helps to control the typically dense understories of hazel and mountain maple. Depending on soil texture and internal drainage, either white pine, red pine, white spruce, or a mixture of white pine and red pine seedlings will be planted between the reserve trees at about 900 to 1,200 seedlings per hectare (400 to 500 per ac). At typical survival rates of 70 to 80 percent, this will provide stands of predominantly aspen with a mixture of conifers adapted to the sites.

During the public comment period on the Environmental Assessment in April and May 1996, concerns were raised by several participants about: (1) the uncertainties surrounding application of the RTM treatment to a 420-ha (1,030 ac) area without prior experience to predict the results; (2) the loss of merchantable volume left in the reserved trees; (3) a potential reduction in the long-term volume of aspen; and (4) a perceived degradation of habitat quality for wildlife species dependent upon early successional vegetation. To address these concerns, the District reduced the area to 220 ha (535 ac) in the Decision Notice and Finding of No Significant Impact issued in June.

In July, the Ruffed Grouse Society further questioned application of the RTM on the grounds that it was unlikely to yield the desired results and that it conflicted with the Forest Plan, which specifies clearcutting and group selection for the aspen type. The District agreed to reduce the area to 60 ha (140 ac) in six stands selected to include both summer and winter logging and a range of soil characteristics and stand conditions. The Ruffed Grouse Society agreed to this proposal and offered to help finance a designed study to monitor and evaluate the results. A condition of the agreement was that an approved study plan would be in effect before the sale was offered. In mid-August the District contacted the Silviculture of Northern Great Lakes Forests Research Unit at the North Central Station to design and conduct a study to evaluate the results of the RTM.

THE RTM STUDY

The District gave our research work unit copies of Environmental Assessment documents, sale area maps, stand and site information, and land type phase descriptions and maps. We used the information to outline a preliminary study plan, and met with District staff in mid-September for an on-site examination of the stands. We then designed a study and prepared a study plan to document initial overstory and understory conditions; evaluate effects of summer *vs.* winter logging; assess logging impacts on site disturbance and soil physical properties; and to monitor the condition and vigor of the reserve trees, density and growth of aspen suckers and competing vegetation, and survival and growth of the planted conifers. The study will provide data on effects of season of logging; overstory density; site disturbance; distribution and depth of logging slash; competing woody and herbaceous vegetation; and physical soil properties, sufficient to assess development of the regeneration. This information will enable us to evaluate the RTM, and perhaps, to develop preliminary management recommendations for establishment of mixed-species stands on similar sites. Study installation began in late September, and the Mighty Duck Sale was sold on schedule.

DISCUSSION

In our experience, communication and cooperation between the National Forests and silviculture research units in the Lake States have been excellent. However, implementing ecosystem management is changing silvicultural objectives, practices, inquiries and questions. Resource managers are seeking silvicultural solutions to a variety of ecological, economic, and social issues that include sustaining or increasing ecological diversity, maintaining healthy and aesthetically pleasing forests, and restoring fish and wildlife habitat (Kaufmann *et al.* 1994; Baumgras and Skog 1996). Silvicultural research has a long record of providing scientific information and guidelines for maintaining and sustaining productive forests; however our research has emphasized the production aspects of forest management (Loftus and Aune 1995). The complexity of ecosystem management challenges us to change the way we approach and carry out our silvicultural tasks; this means renewed responsibilities for silvicultural research (Loftus and Aune 1995). Research units may not have answers to all of your questions, but we are willing to work with you to find satisfactory answers, or at least to develop "first approximation" solutions.

The Mighty Duck sale and the RTM study illustrate the role of communication, cooperation, and partnerships in implementing ecosystem management. The District was seeking a silvicultural approach to increase species and structural diversity by reestablishing a component of native conifers. The philosophy of ecosystem management says that we can manage forest lands for their full array of values and uses, but this calls for changes in the traditional ways of managing resources (Loftus and Aune 1995). To meet its multiple use objectives, the District was willing to take an adaptive management approach and try a modification of a method that had not been tested nor validated. The Ruffed Grouse Society helped to place the uncertainties of the RTM in perspective, pointed out the need for monitoring and evaluation, and committed to share the associated costs. The partnership provided the Station an opportunity to initiate a study on establishment of mixed-species stands that is likely to require some on-the-ground adaptive management. Adaptive management provides an opportunity for silvicultural research to contribute to the implementation of ecosystem management (Loftus and Aune 1995). It also gives us reason to monitor results and evaluate outcomes of our guidelines and prescriptions. This will improve resource management activities incrementally as managers and scientists learn from experience and new scientific findings.

Although the study is still being installed, and logging has not yet begun, it illustrates how ranger districts, partners, and research units can work together for mutual benefit. The results will give the District information on whether or not the RTM applied to 60- to 70-year-old aspen stands is effective in decreasing sucker density and in facilitating establishment of native conifers. It will provide the Ruffed Grouse Society with data about treatment effects on development of aspen suckers and on wildlife habitat characteristics. The study results will enable us to evaluate the RTM in mature stands harvested in summer and winter, and depending on the outcome, to either develop preliminary management recommendations for similar stands and sites, or design a study to evaluate the RTM under a range of overstory densities in younger age classes. Either way, this partnership illustrates a "win-win-win" situation.

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APPENDIX

Common and scientific names of trees and shrubs.

Balsam fir (*Abies balsamea* (L.) Mill.)
Red maple (*Acer rubrum* L.)
Sugar maple (*Acer saccharum* Marsh.)
Yellow birch (*Betula alleghaniensis* Britt.)
Paper birch (*Betula papyrifera* Marsh.)
White ash (*Fraxinus americana* L.)
White spruce (*Picea glauca* (Moench) Voss)
Eastern white pine (*Pinus strobus* L.)
Bigtooth aspen (*Populus grandidentata* Michx.)
Trembling aspen (*Populus tremuloides* Michx.)
Northern white-cedar (*Thuja occidentalis* L.)
Basswood (*Tilia americana* L.)
Eastern hemlock (*Tsuga canadensis* (L.) Carr.)
American elm (*Ulmus americana* L.)

Mountain maple (*Acer spicatum* Lam.)
Beaked hazel (*Corylus cornuta* Marsh.)

The role of silviculture in the active management of riparian zone vegetation in the Oregon Coast Range: a partnership between researchers and managers

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Abstract. —Riparian plant communities are extremely diverse. Their structure and composition can affect fish and wildlife habitat, while trees and associated vegetation can provide sustainable sources of forest products. Management of riparian vegetation can greatly affect these values. Little information exists however, about the consequences of actively managing riparians to develop desirable habitat characteristics and enhance function versus setting aside areas as passively managed reserves. Management options are limited in riparian areas because of concerns for the protection of values provided by these sensitive areas.

Researchers and managers from multiple disciplines and agencies in partnership through the COPE (Coastal Oregon Productivity Enhancement) program are testing a variety of silvicultural treatment alternatives for active management of riparian areas. The partners collaborate to define needs, identify knowledge gaps, design and implement studies, and facilitate technology transfer. We are learning about the ecological consequences of active management within riparian reserve scenarios by developing and studying a range of active management and reserve options.

The studies provide a reference for managers, researchers, and the interested public to evaluate silvicultural alternatives in riparian areas. We have found in our studies that active management practices such as thinning, vegetation management, and tree regeneration are needed to establish conifers in hardwood and shrub-dominated riparian areas of the Oregon Coast Range. The establishment of conifers along with hardwoods is expected to maintain and enhance riparian structure, function, and productivity. Thinning to create canopy openings that allow 40% or more of full sunlight to penetrate through the overstory and reducing the competition from understory shrubs is necessary to successfully regenerate trees in the hardwood dominated-riparian areas of the Oregon Coast Range. Managers have adapted the findings into both demonstration and on-going operational riparian restoration projects. Cooperation through this partnership has resulted in adaptive learning and better understanding of the options and opportunities for riparian vegetation management, enhancement, and restoration.

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INTRODUCTION

Riparian areas in the Pacific Northwest have traditionally been used for sources of natural resources, settlement, agriculture, transportation corridors and energy (Malanson 1993). Current perspectives of riparian areas focus on the biological and physical functions and processes in riparian areas along with the traditional utilitarian uses. Examples of these functions and processes include habitat for wildlife; nutrient capture; filtering and cycling; the input of woody debris and sediments; provision of favorable microsite and microclimate conditions; and high quality water (Gregory 1997).

Riparian areas are critically important transition zones between the aquatic and upland terrestrial landscape. Frequent disturbances from flooding, landslides, and debris flows have created physically complex environments that are highly productive and capable of supporting a diversity of species. Healthy riparian areas and streams serve as reservoirs of biodiversity, animal habitat, corridors, clean water, wood products, food, special forest products, energy, and recreation. The diversity of riparian outputs often results in conflicts between different interest groups over the use of riparian areas. The biophysical complexity of the riparian landscape and the interactions between the aquatic, streamside, and upslope communities poses a significant management challenge for resource managers (Hayes et al. 1996). The influence of past management practices on aquatic dependent species (especially anadromous fish) have surfaced as one of the most significant challenges currently facing land managers in the Pacific Northwest.

The Northwest Forest Plan (Record of Decision, 1994) amended the Land and Resource Management Plans of federally managed forest lands situated within the range of the northern spotted owl (*Strix occidentalis*) in Washington, Oregon, and northern California. An important component of the Northwest Forest Plan was the Aquatic Conservation Strategy and its emphasis on the importance of riparian areas across this landscape. Riparian Reserves were established to: 1) protect riparian-dependent and aquatic ecosystems and 2) to provide habitat for upslope communities of fauna and flora. Interim widths of the Riparian Reserves designated in the Northwest Forest Plan are determined by "site-potential tree heights". Reserve widths are designated as either one (perennial, nonfish-bearing or intermittent streams) or two (perennial fish-bearing streams) site-potential tree heights. A site-potential tree height is the average maximum tree height that can be attained on a given site at age 200 or older.

Riparian Reserves can encompass over 80% of the coastal forests of the Pacific Northwest. Characteristics that contribute to these extensive reserves include a landscape that is highly dissected by streams, relatively short and steep topography, environmental conditions favorable for the

Figure 1.—Riparian zones are amongst the most ecologically diverse and productive components of the forested landscape in the Pacific Northwest. Diverse riparian vegetation and large woody debris contribute to the habitat and complex functions provided by this coastal Oregon stream.

growth of large and tall tree species and diverse species composition. The Aquatic Conservation Strategy of the Northwest Forest Plan stressed that management activities in Riparian Reserves maintain or improve current riparian habitat conditions, functions, and processes. A watershed analysis process established under the Northwest Forest Plan and variations employed by state agencies and private timber companies are now used for assessing the state of current conditions, the historic conditions, identifying issues and knowledge gaps, and developing management options in riparian areas.

WATERSHED ANALYSIS

A planning process known as watershed analysis is conducted on watersheds to determine current condition of the biotic, abiotic, and social elements within the watersheds (EPA and others, 1995). The watershed analysis process is an important collaboration between land managers, researchers, and private landowners. Analysis of historical conditions and the frequency and impact of natural and human caused disturbances help to establish reference conditions for a watershed. Landscape conditions that influence the function and ability of the watershed to provide the ecosystem values and meet the health and productivity goals are identified. Perhaps most important in the watershed analysis process is determining what is known and unknown about the functions and processes at work. This helps to identify data gaps and define research needs. A listing of the management opportunities that assist in changing the watershed toward a desired future condition is often included at the conclusion of the watershed analysis.

The information from watershed analysis can be used to validate or modify riparian reserve boundaries (widths). Following watershed analysis, management practices on federal lands are designed and implemented to attain the goals of the Northwest Forest Plan's Aquatic Conservation Strategy. These Practices often include silvicultural and instream treatments to enhance terrestrial and aquatic habitat. The outcomes of these practices are monitored for efficacy through an adaptive management learning process.

Land managers need to understand the processes at work within riparian areas and the interrelationship to aquatic and terrestrial species and functions (Figure 1). An understanding of riparian areas begins with an awareness of the geomorphology of the landscape, hence the type and longevity of material within the stream, and mechanisms at work for distributing woody debris, rock, cobble, and sediment throughout the course of the stream. Classifying the width and gradient of the stream reaches assists in identifying various processes at work within the system.

With this information, managers can then determine if the current vegetative composition is appropriate, within the

Figure 2.—Past management practices adjacent and within this coastal Oregon stream has contributed to bank erosion, scouring to bedrock, lack of large woody debris, and the dominance of red alder and salmonberry.

context of the entire stream system being considered. Silviculture is often the most appropriate long-term and cost-effective method for enhancing or restoring healthy conditions in riparian areas (Newton et al. 1996). With specific objectives clearly defined, the silviculturist can develop prescriptions that can shift the current riparian forest to a desired future condition.

Silvicultural practices can help grow large conifers within riparian areas that provide shade and wood to streams over long periods of time. Large conifers in the stream (standing or down) are important structural components. When standing, large conifers provide habitat to a wide variety of birds, mammals, insects, and invertebrates. When fallen, large conifers in riparian areas continue to provide habitat to terrestrial wildlife species and often benefit aquatic species as well (Maser and Sedell 1994).

THE HARDWOOD- AND SHRUB-DOMINATED RIPARIAN LANDSCAPE

Previous land-use and harvesting practices have produced a fragmented landscape with isolated patches of older coniferous forests and extensive areas of hardwood-dominated stream reaches. Historic clearing for homesteads, logging, and changes in fire patterns have altered the nature of streamside vegetation. In pre-settlement coastal forests, riparian vegetation often consisted of a mix of deciduous tress such as bigleaf maple (*Acre macrophyllum*) and red alder (*Alnus rubra*) with conifers such as western redcedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziessii*), Sitka spruce (*Picea sichensis*), grand fir (*Abies grandis*), or western hemlock (*Tsuga heterophylla*). Due to human influences, many streams (Figure 2) have been degraded and an overstory of red alder and an understory of salmonberry (*Rubus spectabilis*) now heavily dominates these riparian areas.

Riparian areas in the coastal mountains of the Pacific Northwest are physically complex. Microsite variations in soil, drainage, light, geomorphology, and edge occur within short distances. The variations in riparian microsites result in a range of plant growing conditions capable of supporting diverse plant communities. The dense canopies associated with red alder and shrub-dominated riparian areas often mask these complex site characteristics. Large woody debris on the forest floor is often sparse or absent in hardwood- and shrub-dominated riparian areas in the coastal mountains of the Pacific Northwest.

Forest managers, especially fisheries biologists are concerned about the state of vegetation and habitat in these riparian areas. Natural regeneration of both conifer and hardwood trees in red alder- and shrub-dominated riparian areas are extremely sparse (Minore and Weatherly 1994; Hibbs and Giordano 1997). Establishing conifers in these hardwood- and shrub-dominated areas is desirable both for fish and wildlife habitat and for future sources of timber and special forest products. However, restoring or converting these areas to conifer-dominated or mixed stands is often unsuccessful under the heavy shade of red alder. Competition from salmonberry and damage from beaver and animal browsing add to the difficulty. Salmonberry is an extremely aggressive and persistent shrub that occupies highly productive riparian and upslope sites in the Coast Ranges of the Pacific Northwest. The ability of salmonberry to reproduce effectively from rhizomes, seeds, and layering allow it to persist, grow, and invade sites following disturbance (Tappeiner et al. 1991). The multiple mechanisms for salmonberry reproduction often allow it to rapidly occupy sites and effectively exclude tree regeneration.

Red alder is a fast growing, nitrogen-fixing, relatively short-lived, shade-intolerant deciduous tree mainly found on moist, well-drained sites (Harrington et al. 1994, Harrington 1996). At maturity red alder is small in diameter and produces much less wood volume when compared to most conifers (Hibbs 1996). Alder logs decay rapidly and often cannot provide the long-term function of providing large woody debris input into the stream. Large, long lasting logs are an important component of stream channels in the Pacific Northwest (Maser and Sedell 1994). They help create pools and substrate habitat for fish and other aquatic-dependent vertebrates and invertebrates (Bilby and Ward 1991). Many salmon restoration projects have focused on installing logs in stream channels to improve habitat for fish in streams. While this may be a successful short-term solution, these restoration efforts are costly and not self-sustaining. Managing riparian areas for recruitment of large trees from riparian and upslope areas provide a long term and sustainable option for developing and maintaining productive stream and riparian habitat.

A STUDY ON GROWING CONDITIONS, STAND DYNAMICS, AND TREE REGENERATION IN HARDWOOD- AND SHRUB-DOMINATED RIPARIAN AREAS

Opportunities for enhancing riparian habitats desirable for fish and wildlife and tree regeneration in areas dominated by red alder may be forfeited if riparian buffers are not actively managed. Red alder and salmonberry form plant communities that are biologically quite stable and resilient. Understory shrub cover often increases with overstory age. These plant communities create conditions that often exclude tree regeneration, crucial for producing future sources of large wood for fish, wildlife, and timber (Hibbs and Giordano 1996; Nirenburg 1996).

Numerous factors can affect tree regeneration in the Oregon Coast Range. Light availability; soil moisture, rooting substrate; seed source availability; disturbance type, intensity, timing, and frequency; and animals are some the factors that affect tree regeneration. We have found that one of the key elements limiting tree regeneration in the Oregon Coast Range is light (Chan 1990). Light levels under the shade of a red alder canopy are very low. Alder also responds quickly to thinning or gap creation through epicormic and main canopy branch growth. Salmonberry and other associated understory shrubs also compete with tree seedlings for light and water. Competitions from either or both red alder and understory shrubs are major limiting factors for tree regeneration in the Oregon Coast Range.

Scientists and managers of different disciplines from the USDA Forest Service, USDI Bureau of Land Management, Oregon State University , Oregon State Department of Forestry, forest industry, and counties in partnership through the Coastal Oregon Productivity Enhancement Program (COPE) have established studies on the ecology and silviculture of riparian areas in coastal mountains of Oregon. The objectives from one of the studies is to examine: 1) the environmental causes for the scarcity of tree regeneration, and 2) a variety of silvicultural approaches for tree regeneration in hardwood- and shrub-dominated riparian areas. The study focuses on the effects of riparian growing conditions (e.g., light and soil moisture levels and understory shrub and overstory hardwood density and dynamics) on the regeneration of six tree species (Douglas-fir, western redcedar, Sitka spruce, western hemlock, grand fir, and red alder) in the Oregon Coast Range.

Results from the study indicate that growth of the underplanted trees (except red alder and Douglas-fir) in partially thinned riparian alder stands (40-60% of full light penetrating through the canopy) are similar to trees growing in large openings where the canopy was completely removed. However, rapid regrowth of the thinned alder canopy at 8-12% annually may again lead to closed canopy and light-limiting conditions.

Light levels are often low (less than 10% of open conditions) in alder- and shrub- dominated riparian areas (Figure 3a). Light availability is highly correlated with tree regeneration in riparian areas. Light levels above 10-20% of open conditions are necessary for moderate (>60%) long-term survival of six commonly planted conifers and hardwoods. Canopy openings where between 30-70% of full sunlight penetrates are necessary for promoting good tree growth. Between 50-90% of the alder trees in a stand (depending on size, age, and vigor) may have to be thinned to achieve canopy openings of 30-70% (Figure 3b).

Thinning the overstory also favors understory shrub and herb development (Figure 3c). Repeated annual cutting of the understory during the active growing season is effective in preventing the increase in cover and height of most shrubs, and is most effective under a partially or unthinned overstory. Tree regeneration for each of the six tested tree species was enhanced when the understory vegetation was cut at least once a year. However, cutting the understory vegetation more than once a year did not increase the survival and growth of tree regeneration over a single annual cutting. Cutting the understory twice a year shifted the understory composition from a shrub-dominated plant community to an herb- and grass-dominated community. Left undisturbed, the understory shrubs and herbs can have a strong competitive effect on tree regeneration.

Riparian areas are variable: a range of silvicultural treatment options, including choice of planted species can be applied to reach specific goals for fish and amphibian habitat, timber, clean water, and special forest products. Active riparian vegetation management in hardwood- and shrub-dominated riparian areas is often necessary to create growing conditions (i.e., increased light) that favor tree

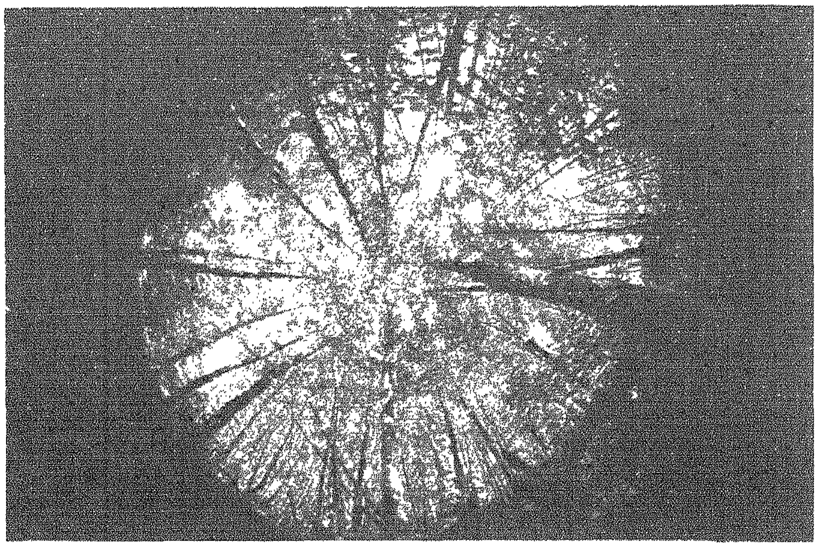

Figure 3a.—Dense plant canopies in riparian areas dominated by red alder and salmonberry effectively exclude tree regeneration. Light levels in this stand are approximately 3 percent of open conditions.

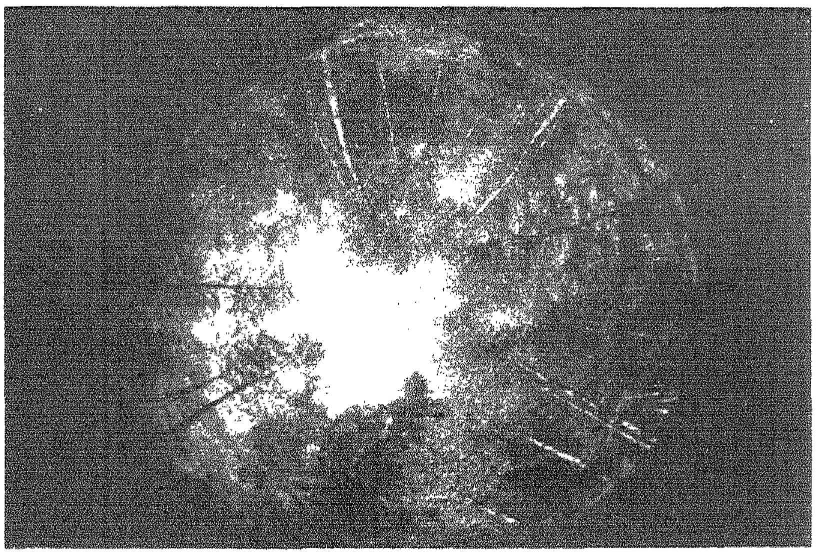

Figure 3b.—A substantial portion of the overstory canopy of red alder must be thinned to create conditions favorable for tree regeneration in riparian areas. The canopy of this thinned 46 year old red alder stand has closed almost 50% five years after thinning.

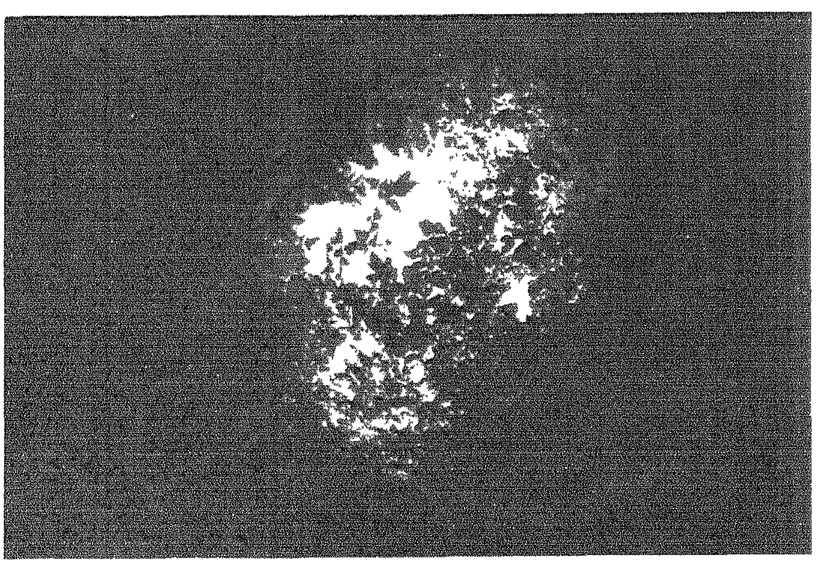

Figure 3c.—Understory shrubs such as salmonberry can quickly fill gaps created in the overstory and exclude tree regeneration.

Figure. 4.—Successful tree regeneration can occur in hardwood and shrub dominated riparian areas of the Oregon Coast Range through active management of riparian vegetation.

regeneration and understory development (Figure 4). Managers should focus on treatments that create adequate tree growing conditions (e.g., light availability) for a particular site versus targeting for a blanket prescription to fit all riparian areas.

Adequate tree regeneration and understory development can serve as the basic structural units for building, sustaining, and optimizing the composition and function of riparian plant communities. Short-term disturbances that promote tree regeneration in previously degraded riparian sites currently dominated by hardwoods and shrubs, are likely necessary to achieve long-term goals for restoring riparian processes and functions.

Emphasis on technology transfer by both researchers and managers through workshops, field trips, publications, and consultations have accelerated adoption of new knowledge and improved techniques for larger scale riparian projects. Ongoing visits and evaluations of the research and demonstration sites by managers, researchers, interested publics, and policy makers have further enhanced the value of this partnership between research and management.

CONCLUSIONS

The application of active management in riparian areas to promote tree regeneration for habitat complexity on a landscape basis should be based on a program of learning through adaptive management (Hayes et al. 1996). We have learned much about silviculture in riparian areas (especially tree regeneration) since our partnership began seven years ago. We realize that there is more to learn, since successful regeneration of trees in riparian areas merely establishes part of the foundation from which managers can build riparian stands and landscapes. We have little information on what is, and how to achieve, the optimal range of riparian disturbances and stand composition and structures. We also lack knowledge on appropriate mixes and distributions of hardwoods and conifers in a watershed. Historical conditions can provide some clues, but do not provide actual evidence of proper function. We continue to learn about how different silvicultural approaches drive stand dynamics and structure, species interactions, and succession in riparian areas. The long-term role and consequences of establishing extensive riparian buffers and their management will also need to be examined. The effects and interactions of riparian silviculture on animal populations remain largely unknown. The role of animals such as beavers on tree regeneration and stand dynamics will need to need to be closely monitored.

The role of silviculture in the active management of riparian areas will continue to gain importance as a long-term solution for enhancing and restoring degraded riparian areas. The effectiveness of silvicultural options in riparian areas will depend on continuing and building the partnership between researchers and managers. Active involvement of specialists (e.g., fisheries and wildlife biologists, botanists, soil scientists, engineers, hydrologists, scientists) in defining objectives and issues with silviculturists is critical.

Elements for Successful Partnerships between Research and Management: a Commentary

The complexity of land management issues has increased, but resources available for addressing these issues have actually decreased for most public agencies. Partnerships between land managers and researchers can be an efficient mechanism for leveraging resources and expertise to focus on important issues. A successful partnership between researchers and resource managers focuses on common issues, problems, and goals. Successful partnerships are especially valuable in studies that are designed for long-term value.

Researchers may propose activities that may be at odds with current best management practices (e.g., cutting all the trees along a section of a stream). Likewise, managers realize that some of our current assumptions might have to be challenged to gain insight on their effectiveness. Thus, a successful partnership may require that managers and researchers assume both traditional and non-traditional approaches.

The traditional roles of land managers in research projects are to: 1) identify issues and problems, 2) work with researchers and stakeholders to implement projects, and 3) alert researchers to potential problems that may affect implementation. Questions that managers might ask researchers include: Is the study pertinent to my needs? What solutions or new knowledge will the study provide? Will the study be well utilized? Is the study visible and supported by stakeholders? A researcher's traditional role is to conduct good science that leads towards a solution or better information. The researcher: 1) develops a problem analysis, 2) packages issues into testable hypotheses, 3) develops an appropriate experimental design, and 4) designs realistic studies that consider site constraints, management concerns, and limitations of resources.

A successful partnership between managers and researchers often dictates procedures that go beyond traditional experimental protocol. A common issue cited by managers is that researchers are often not familiar with the operational details of: 1) environmental laws such as the National Environmental Protection Act and Threatened and Endangered Species Act and the associated consultation and public comment process, 2) project scheduling (it might take two or more years to fully implement a field study), 3) the requirements of the Northwest Forest Plan including watershed analyses, and permitted practices under different land-use designations. Researchers also need to be aware of the manager's funding process and concerns about public perceptions. Researchers can address the needs of land managers by facilitating district and forest involvement in the study. Managers should be provided with progress updates and findings in a timely manner. Researchers should work with managers to interpret and extend research results into operational activities.

Managers must understand a study before they can fully appreciate its value. Understanding a study will often require that managers be aware of the factors that lead to good research such as problem analysis, hypotheses testing, and methods. Managers should work with the researchers in fine-tuning the design and implementation of the study. Managers should be aware of the study design and methods including: the treatments applied, concepts of replication, procedures that may lead to bias, and consistency in which procedures are applied. Managers will likely encounter some procedures in a study that might be contrary to or in addition to what would be done at an operational level. Hopefully, managers will perceive the studies as providing important information leading towards adaptive management. Finally, managers and researchers need to realize the limitations of current and new knowledge and use the information with good common sense. Our partnership has demonstrated an important role for silviculture in the active management of riparian vegetation in the Oregon Coast Range.

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Raccoon Ecological Management Area: Partnership between Forest Service Research and Mead Corporation

Daniel A. Yaussy, Wayne Lashbrook, and Walt Smith[1]

Abstract.—The Chief of the Forest Service and the Chief Executive Officer of Mead Corporation signed a Memorandum of Understating (MOU) that created the Raccoon Ecological Management Area (REMA). This MOU designated nearly 17,000 acres as a special area to be co-managed by Mead and the Forest Service. The REMA is a working forest that continues to produce timber and pulpwood for Mead. Current Forest Service research within the REMA consists of two sites of a large, oak ecosystem restoration research project, and one site of a long-term oak stand density study. Facilities provide a place for researchers to stay while collecting data, and classrooms for the educational workshops presented for the public. The REMA will provide new sites for silvicultural and other demonstrations.

INTRODUCTION

On June 29, 1995, a Memorandum of Understanding (MOU) was signed that created the Raccoon Ecological Management Area (REMA) in southeastern Ohio (Fig. 1). This MOU was signed in the U.S. Congressional Office building by Jack Ward Thomas, then Chief of the Forest Service, and Steven C. Mason, Chairman of the Board and Chief Executive Officer of Mead Corporation.

Mead has operations in 30 countries around the world and is recognized as a leading producer and supplier of paper and paperboard products. Mead has designated their Woodlands Division in Chillicothe, Ohio, as their liaison in this endeavor.

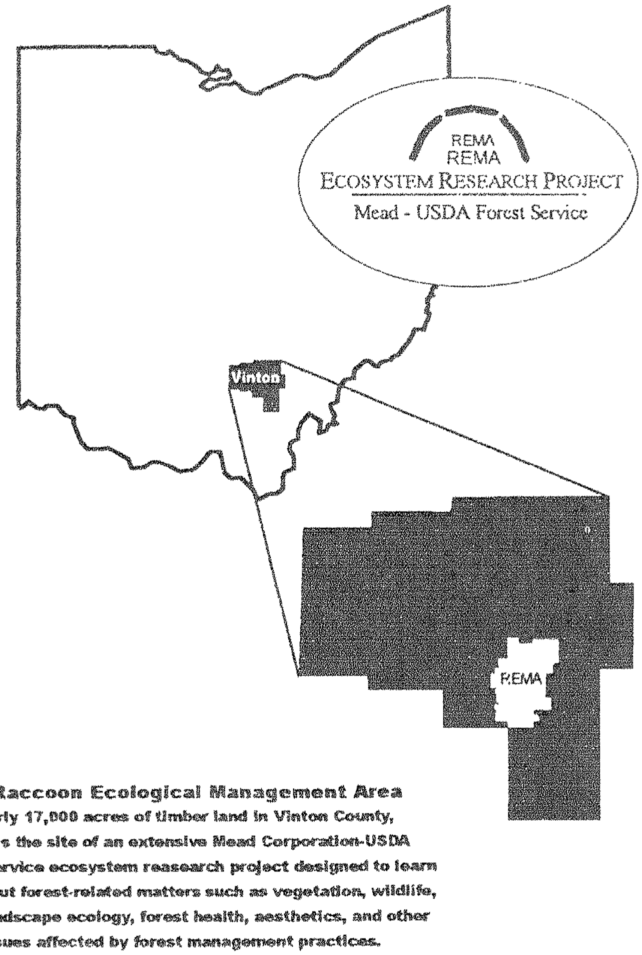

Figure 1.—Location of the Raccoon Ecological Management Area that is jointly managed by the Mead Corporation and the USDA Forest Service.

The Forest Service representative for this MOU is the Forest Ecosystem Modeling project located in Delaware, Ohio. The full project title is: Quantitative Methods for Modeling Response of Northeastern Forest Ecosystems to Management and Environmental Stresses. The scientists are involved with studies funded by the Forest Service's Global Change program and Ecosystem Management research grants.

The Forest Service and Mead will cooperatively manage the nearly 17,000 acres of contiguous mixed-oak forest designated as the REMA. The REMA was created to develop and test various forest ecosystem management practices at the stand and landscape scale. This is a working forest rather than an experimental forest and Mead retains all rights to manage the tract as needed. The cooperators are developing a management plan for the area that will identify near-term and long-term opportunities for research.

HISTORY

The REMA is the largest area of contiguous forest in Ohio under private ownership. It is located in the Hanging Rock region, which was a large producer of iron ore before and during the Civil War. The area had two iron furnaces that operated between 1850 and 1890 (Hutchinson[2]). The

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[2]Hutchinson, Todd. In preparation. History of the mixed oak forests and land-use in Southern Ohio.

surrounding hillsides were cleared, repeatedly, to produce charcoal used to smelt the iron ore. After the furnaces closed, the land reverted to forest with some limited farming and grazing activities. There is evidence that low intensity wildfires burned through the area every 2 to 3 years (Sutherland 1997). Disturbance history (clear cutting, ample stump sprouts, frequent fires, and possible grazing) determined the species composition of the resulting forest. The overstory of the existing forest is 100 to 150 years old, consisting mostly of white, chestnut, scarlet, and black oak (*Quercus alba, Q. prinus, Q. coccinea, Q. velutina*). In 1952, Baker Wood Preserving Company bought land in Vinton County, Ohio, and set 1,200 acres aside for use by the Forest Service as the Vinton Furnace Experimental Forest (VFEF). A decade later, Mead purchased the tract and maintained the relationship with the Forest Service.

Many of the studies and demonstrations on the VFEF date from the mid to late fifties and include the comparison of different cutting practices on timber production and species composition, the effect of the size of canopy opening on composition of regeneration, conversion of dry sites to pine, and the effect of understory removal on the growth of the overstory. Like many of the experimental forests in the East, we claim that Ben Roach, a well-known research silviculturalist, performed much of his research on complete clearcutting and stand density on our forest.

FACILITIES AND EDUCATION

The headquarters area of the VFEF consists of an equipment shed, fuel shed, an office and lodging for overnight stays, and an education/workshop building. In 1996, Mead and the Forest Service conducted 33 tours and training exercises on the VFEF and REMA involving 812 people. Many of the tours are presented by Mead to wholesale purchasers of their products. These "Paper Knowledge Tours" start in Mead's Chillicothe paper mill and end at the VFEF with visits to some of the demonstration areas. We also have provided tours for college classes from The Ohio State University, Hocking College, and the University of Kentucky. Last year we even had a group from Sweden. Other tours have been given to the local Sierra Club, state legislators, and the Farm Bureau.

Hocking College and Mead also use the facilities to conduct courses in Best Management Practices, Clear Water, Chainsaw Safety, Logger Training, and Sustainable Forestry. The VFEF was also a site for the Society of American Foresters Central States Forest Soils Workshop in 1995.

With the intense use of the area for tours, workshops, and education, Mead is planning to replace the vintage World War II Quonset hut used as a classroom, with a new training/workshop building.

CURRENT RESEARCH

Current research on the REMA includes a study on the effects different thinning levels have on residual trees, development of a computer based ecosystem classification system, a study of the effects of prescribed burning on the ecosystem, and a case study to regenerate shortleaf pine under a shelterwood system. The thinning-level study was installed in 1959 as one of two sites on Mead land in Ohio. Two other replications were located on the Daniel Boone National Forest in Kentucky. The original goal of this study was to develop recommended levels of thinning for management of even-aged upland oak stands. The information has been incorporated into the GROAK and OAKSIM growth and yield simulators. Although most of the information on the effects of thinning have been reported, we are continuing to remeasure the plots every 5 years. We are currently using the control plots for a drought/mortality study to determine which soil and climatic factors are related to differential mortality of species.

In 1993, Mead planned to harvest a mixed shortleaf pine-oak stand and allow it to regenerate to hardwoods. When Forest Service scientists were asked if they had any suggestions, the idea of a shortleaf shelterwood cut was proposed. So far the results have not been favorable. Our plans are to conduct a prescribed burn through part of the site to improve conditions for seeding.

Using the information available from a Geographical Information System (GIS), Iverson and others (1996) developed an integrated moisture index for the REMA. The index uses information from the county soil survey and a digitized topography map to compute the influence of slope, aspect, water flow, curvature, and water-holding capacity on the amount of moisture available to the trees. This computer generated index can predict species composition and site index. It is now used as a variable in any study being planned by our project.

The largest field study in which our partnership is involved is the "Effectiveness of prescribed burning in the ecological restoration of mixed-oak forest ecosystems in southern Ohio". Two study areas (250 acres each) are located on the REMA, with an additional two areas on the Ironton District of the Wayne National Forest. The premise of this study is that prescribed burning will remove much of the understory competition to oak seedlings (red maple (*Acer rubrum*), sugar maple (*A. saccharum*), dogwood (*Cornus florida*), and blackgum (*Nyssa sylvatica*) saplings) and allow them to advance to the sapling stage, thereby providing advanced reproduction to replace overstory oaks lost to mortality or harvesting. Various aspects of the ecosystem are being studied by many partners. Scientists from The Ohio State University are studying the effects of prescribed burning on neo-tropical migratory birds, soil microbiology and nutrients, and insects. The Ohio Department of Natural Resources, Division of Natural Areas and Preserves is cooperating with The Nature Conservancy in studying the effects of the fires on herbaceous plants. Ohio University is investigating the effect of burning on the amount of light reaching the forest floor. Forest Service scientists are monitoring the species composition, mortality, and quality changes of the woody species.

With the efforts of so many scientists concentrated on these areas, interesting offshoot studies have emerged concerning threatened and endangered (T&E) species. One of the largest populations of timber rattle snakes, on Ohio's T&E list, has been located and tracked. Individual snakes have been captured and implanted with radio transmitters so that their movements could be followed throughout the year. The larger males can roam up to 5 miles before returning to the den.

A former candidate for the federal T&E species list is Bentley's bent reed grass *(Calamagrostis porteri var. insperata)*. This species has been found in large patches on both of the study areas of the REMA, but is found in only a few locations in Missouri, Arkansas, and Illinois (Schneider 1995). Potentially the largest populations in the world are on the REMA. This plant rarely flowers and viable seeds have never been found.

CURRENT MANAGEMENT

As a member of the American Forest and Paper Association (AF&PA), Mead subscribes to the principles of the Sustainable Forestry Initiative (SFI). These principles focus on 1) sustainable forestry, 2) responsible economic and environmental practices, 3) forest health and productivity, 4) protection of sites with special significance, and 5) continuous improvement of forestry practices. During the past 2 years, some 2 dozen companies have resigned their membership from AF&PA, and another 15 companies have been suspended from membership for failure to confirm their participation in the SFI. Even with the loss of these companies from the program, the 150 association members own or control 52.7 million acres of the 70 million acres of industrial forest land in the nation.

Currently, Mead is in the process of removing veneer-quality stems from the REMA tract and plans to complete this by the year 2000. This management is in response to two different pressures: forest age and gypsy moth. In the 100- to 150-year old forest, many of the scarlet and black oaks have died or are dying and the older stems are being recovered before the value is lost. The other major threat is the gypsy moth (*Lymantria dispar*) which should have an impact within the next 5 to 10 years. The gypsy moths' preferred food is oak leaves which jeopardizes the REMA. Removal of oaks from the overstory is one of the silvicultural methods of reducing the risk of mortality due to gypsy moth (Gottschalk 1993). These removals are being conducted with an advanced forwarder designed to reduce the impacts on the soils and are not occurring on sites where there is current or planned research.

Mead does not own the mineral rights under some of the REMA surface. Strip mining for coal is occurring in the southwestern corner of the tract and there are threats to the northern portion. In areas in which stripping is imminent, Mead is recovering all the wood resource possible. These areas do not lend themselves to the establishment of long-term forest management research.

FUTURE RESEARCH

Mead and the Forest Service are in the planning stages of implementing a landscape-scale inventory and monitoring scheme, which is needed to develop a long-term management plan for the REMA. This will involve the use of permanent plots with collection of data from ecosystem components other than just the timber resource. These methods, when developed, could be used in National Forest Systems (NFS) landscapes as well as those of industrial forest lands to provide estimates for any portion of the area.

Areas are being located for an extension of the prescribed burning study. In the new areas, we will use herbicides to remove larger poles and saplings as recommended by Loftis (1990). With the exclusion of fire in the recent past, many stems of maple, dogwood, blackgum, and other shade tolerant species, have grown into the understory of the oak dominated overstory. This understory can contain up to 30 percent of the stocking in a stand. We are proposing to remove this shade tolerant understory with the injection of herbicides. Prescribed burning will be used on half of the sites to promote the establishment of oak seedlings and sprouts. This study will be installed on relatively moist sites, where advanced regeneration of oak seedlings and saplings is seldom present.

With Mead's commitment to the Sustainable Forest Initiative, they are quite interested in evaluating the effects of short rotations on the productivity of the soils. With the deposition of atmospheric nitrogen reducing the amount of calcium available to the trees, they are looking for strategies to mitigate the effect with the use of mill sludge and stack ash.

CONCLUSION

The creation of the REMA and the partnership between the Forest Service and Mead are beneficial to both entities and the communities within Ohio. The long-term and cutting-edge research in the area involves and benefits Forest Service scientists, Mead, the NFS, universities and state agencies. The educational programs and tours improve logging and forestry practices within Ohio and inform the public what forestry is and what it can be.

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