

United States
Department of
Agriculture

PROCEEDINGS OF THE NATIONAL SILVICULTURE WORKSHOP
SUCCESES IN SILVICULTURE

Forest
Service

Rapid City, South Dakota
May 13-16, 1985

Timber
Management
Washington, D.C.

Acknowledgement

The 1985 National Silviculture Workshop was held in Rapid City, South Dakota, and the Black Hills National Forest. The purpose of the workshop was to discuss, review, and share information and experiences regarding successful silvicultural treatment that may have application in other Regions.

The Washington Office Silviculture Group appreciates the efforts of our hosts from the Black Hills National Forest, Rocky Mountain Research Station, and the Rocky Mountain Regional Staff. We also extend our thanks to all who made presentations and participated during the session. A special thanks goes to Dr. T. W. Daniel, Professor Emeritus, Utah State University, for his attendance and participation during the entire session.

Silviculture Group
Timber Management Staff
Washington, D.C.

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Theme: Successes in Silviculture

Division of Timber Management
USDA, Forest Service
Washington, D.C.

TABLE OF CONTENTS

	<u>Page</u>
Workshop Agenda	1
Names of Attendees	6
<u>Proceedings</u>	
<u>Current Events</u>	
Gary L. McCoy	Welcoming Address 8
Larry Gross	Regulations, Litigation, and The Forest Service Program 15
Henry Lachowski	Aerial Photography in the Forest Service 26
<u>Examination and Prescriptions</u>	
Jim Chew	Matrix for Determining Type of Stand Examination 35
John W. Joy	Silvicultural Prescription Process 59
Jerry Henderson	Silvicultural Prescriptions With New Land Management Plans 74
Mike Murphy	Silviculture at the District Level 87
Nelson S. Loftus	Innovative Silvicultural Research in the 1980's 98
<u>Regeneration</u>	
Glenn Jacobsen	Rehabilitation of Old Partial Cut Failures 104
Richard L. Kracht	Site Preparation - The Light Touch 109
Lloyd A. Musser	The Forest Cultivator: A Soil Restoration and Site Preparation Tool 125
Brian H. Avery	Artificial Regeneration Practices on the North Kaibab Ranger District in Arizona 133

		<u>Page</u>
David F. Thomas	The Use of Sheep to Control Competing Vegetation in Conifer Plantations on the Downieville Ranger District, Tahoe National Forest: 1981 - 1984	140
Max Williamson	Equipment for Hand and Other Ground Application of Herbicides	147
<u>Pest Management</u>		
Mike Znerold	Management of Lodgepole Pine Under Catastrophic Conditions	151
Roger Belanger	Integrated Pest Management in Southern Forests	167
<u>Timber Stand Improvement</u>		
John Nesbitt	The Fremont Fuels Appraisal Process	173
Tom Beckman	Elements of a Successful Fertilization Program	183
<u>Harvesting - Timber Sales - Immunization</u>		
James B. Baker	Uneven-Aged Management on The Crossett Experimental Forest	208
John B. Amundson	Reforestation with Firewood Sales	223
Gary O. Fiddler & Robert J. Laacke	Overstory Removal: An Assessment	230
<u>Other Resources</u>		
Mike Rauscher, Hrish Saha & Pierre Robert	CHAMPS: A Computerized Habitat Analysis and Multiple-Use Prescription System	238
David Winn	Elk Thermal Cover: A Dilemma for the Forest Planner	256
Darwin L. Richards & Marianne Burke	Improving Bald Eagle Habitat With Silvicultural Manipulation in Northeastern California	277
<u>Genetics and Tree Improvement</u>		
Bobby Kitchens	One-Quarter Century of Tree Improvement in the Southern Region	284
John Murphy & Hyun-Chung Kang	The Role of Genetic Models for Silvicultural Systems: A Proposal	289

FINAL AGENDA
1985 NATIONAL SILVICULTURE WORKSHOP
RAPID CITY, SOUTH DAKOTA
MAY 13-16, 1985

THEME: SUCCESSES IN SILVICULTURE

PURPOSE: Discuss current silvicultural issues affecting all Regions. Representative of Regions and Stations will discuss and share information and experiences regarding successful silvicultural treatments that may have application in other Regions.

MONDAY - May 13 (Indoors)

Moderator - Bob Naumann, R-1 (a.m.)

8:00 a.m.	Call to Order & Introduction of Participants	Dick Fitzgerald, W0
	Welcome and Background on Black Hills NF and Region 2	Gary McCoy, Resource Staff, Black Hills NF & Bill Gee, TM, R-2
	House Rules and Announcements	Willy Wisler, Black Hills NF, & Carl Puuri, W0
	Purpose and Objectives of Meeting	Dick Fitzgerald, W0
9:00 a.m.	National TM Issues	David Jolly, Deputy Director TM, W0
9:45 a.m.	Break	
10:00 a.m.	Growth and Yield Update and TM Newsletter	Dick Fitzgerald, W0
10:45 a.m.	Silviculturist Certification	Carl Puuri, W0
11:15 a.m.	Regeneration Committee Update and Equipment Development Seedling Survival & Planting Survival Word	Dick Miller, W0
11:45 a.m.	National Economics Handbook	Linda Hagen, W0
12:00	Lunch	

Moderator - Bill Beaufait, R-5 (p.m.)

1:00 p.m.	Backlog Investigative Committee	Dick Fitzgerald, W0
1:30 p.m.	Regulations, Litigation, and The Forest Service Program	Larry Gross, W0
3:15 p.m.	Aerial Photograpy in the Forest Service	Henry Lachowshi, W0
4:00 p.m.	Task Force on Below Cost Timber Sales Finding on Black Hills NF as Case Study	Dave Jolly, W0 & TM Staff Officer, Black Hills NF

Tuesday - May 14 (Indoors)

Moderator - Ralph Jaszowski, R-6 (a.m.)

Technical Session - Silvicultural Successes

Examination & Prescriptions

8:00 a.m.	Matrix for Determining Type of Stand Examination	Jim Chew, R-1
8:30 a.m.	Silvicultural Prescription Process	John W. Joy, R-1
9:00 a.m.	Silviculture at the District Level	Mike Murphy
9:45 a.m.	Break	
10:00 a.m.	Innovative Silvicultural Research in the 1980's	Nelson Loftus, W0

Regeneration

10:30 a.m.	Rehabilitation of Old Partial Cut Failures	Glenn Jacobsen, R-4
11:15 a.m.	Site Preparation - The Light Touch	Dick Kracht, R-1
11:45 a.m.	Lunch	

Moderator - Bob Blomquist, R-9 (p.m.)

12:45 p.m.	The Forest Cultivator: A Soil Restoration and Site Preparation Tool	Lloyd Musser, R-6
1:15 p.m.	Artificial Regeneration Practices on the North Kaibab Ranger District in Arizona	Brian Avery, R-3
1:45 p.m.	The Use of Sheep to Control Competing Vegetation in Conifer Plantations on the Downieville Ranger District, Tahoe National Forest: 1981-1984	Dave Thomas, R-5
2:15 p.m.	Equipment for Hand and Other Ground Application of Herbicides	Max Williamson, R-8
2:45 p.m.	Break	

Pest Management

3:00 p.m.	Management of Lodgepole Pine Under Catastrophic Conditions	Mike Znerold, R-6
3:30 p.m.	Integrated Pest Management in Southern Forests	Roger Belanger, SE
4:15 p.m.	Open Discussion	
4:30 p.m.	Discussion of Field Trip	Black Hills NF Staff & R.M. Station

Wednesday, May 15 (Outdoors)

8:00 a.m. - 5:00 p.m. Day will be spent on the Black Hills National Forest. The group will see results of silvicultural treatments being conducted on the Forest and will also become acquainted with several research projects conducted locally by RM Station. The Region, Regional Silviculturist, and the Black Hills National Forest Timber Staff will lead the tour and serve as moderators.

Evening - Banquet

Speaker - Dr. Ted Daniel - Retired, Utah State University
"Forest Management in the Peoples Republic of China"

Thursday, May 16 (Indoors)

Moderator - Milo Larson, R-3 (a.m.)

Timber Stand Improvement

8:00 a.m. The Fremont Fuels Appraisal Process John Nesbitt, R-6

8:45 a.m. Elements of a Successful Fertilization Program Tom Beckman, R-6

Harvesting - Timber Sales - Utilization

9:15 a.m. Uneven-Aged Stand Management on the Crossett Experimental Forest Jim Baker, S0

9:45 a.m. Reforesting with Firewood Sales Jack Amundson, R-4

10:15 a.m. Break

10:30 a.m. Overstory Removal: An Assessment Gary Fiddler, R-5
& Robert Laacke, R-5

Other Resources

11:15 a.m. CHAMPS: A Computerized Habitat Analysis and Multiple-Use Prescription System Mike Rauscher, NC,
Hrishi Saha, Alabama A&M U.,
& Pierre Robert, Minnesota U

12:00 noon Lunch

Moderator - Dennis Murphy, R-10 (p.m.)

1:00 p.m. Elk Thermal Cover: A Dilemma for the Forest Planner David Winn, R-4

1:30 p.m. Improving Bald Eagle Nesting Habitat with Silvicultural Manipulation in Northeastern California Darwin Richards, R-5

Genetics and Tree Improvement

2:00 p.m. One-Quarter Century of Tree Improvement in the Southern Region Bobby Kitchens, R-8

2:45 p.m. Break

3:00 p.m. The Role of Genetic Models for Silvicultural Systems John Murphy, R-9
& Hyun-Chung Kang, NCFES

3:30 p.m. Open Discussion

4:00 p.m. Summary & Wrap-up

Dick Fitzgerald, WO

4:30 p.m. Adjourn

NATIONAL SILVICULTURE WORKSHOP

WORKSHOP ATTENDEES

R-1

P Jim Chew, R.O.
P Dick Kracht, Gallatin NF
P John Joy, Deerlodge NF
Sue Rainville, Idaho Panhandle NF
Al Underwood, Helena NF
Bob Naumann, R.O.

R-5

John Fiske, R.O.
P Dave Thomas, Eldorado NF
P Darwin Richards, Lassen NF
P Gary Fiddler, SDU
Will Charter, R.O.
Bill Beaufait, R.O.

R-2

Bill Gee, R.O.
P* Mike Murphy, Black Hills NF
* Edward Johnson, Black Hills NF
* Bill Nightingale, Black Hills NF
* Willy Wisler, Black Hills NF
* George Foley, Black Hills NF
Reese Pope, Medicine Bow NF
* Jim Allen, Black Hills NF
* Jerry Gaither, Black Hills NF
* Gary McCoy, Black Hills NF
* Dick Kessler, Black Hills NF
* Kathy Atkinson, Black Hills NF
Sally Edwards, Routt NF
Phil Anderson, Rio Grande NF
Bob Damson, Big Horn NF
Jim Krugman, GM-UNC-GUN NFs
Dave Powell, Pike & San Isabel NF
Fred Winkler, Araphaho &
Roosevelt NFs

R-6

Lee Boeckstiegel,
Mt. Baker-Snoqualmie NF
Frank Johnson, R.O.
P Mike Znerold, Deschutes NF
P John Nesbitt, Fremont NF
P Lloyd Musser, Mt. Hood NF
P Tom Beckman, Gifford
Pinchot NF
Ralph Jaszowski, R.O.

R-8

Lee Cromley
P Bobby Kitchens, R.O.
Karl Stoneking, R.O.
P Jerry Henderson, R.O.
P Max Williamson, R.O.

R-3

Milo Larson, R.O.
Dick Bassett, R.O.
Susan Gray, Cibola NF
Dave Wahlfield, Kaibab NF
P Brian Avery, Kaibab NF

R-9

Bob Blomquist, R.O.
P John Murphy, R.O.

R-4

Orville Engelby, R.O.
Jerry Hamilton, R.O.
Ron Hamilton, R.O.
P David Winn, R.O.
P Glenn Jacobsen, Payette NF
P Jack Amundson, Targhee NF

WORKSHOP ATTENDEES cont'd

R-10

Dennis Murphy, R.O.
Jim McFarland, Tongass NF
John Standerwick, RO

SE

P Roger Belanger
Don Beck
William Harms

WO

P David Jolly, TM
P Dick Fitzgerald, TM
P Dick Miller, TM
Carl Puuri, TM
Linda Hagen, TM
P Larry Gross, FPM
P Nelson Loftus, TMR
Henry Lachowski, E
Dan Schroeder, TM
Hugh Black, F & WL
Kermit Larson, WS & A
Ed Gryczan, TM

SO

P Jim Baker

RM

* Michele Girard, Rapid City
* Carolyn Sieg, Rapid City
Carl Edminster
Wayne Shepperd

PSW

K. Leroy Dolph

NE

Don Hilt

PNW

Ken Seidel

NC

P Mike Rauscher

Guest of Honor

Dr. T.W. Daniel,
Professor Emeritus,
Utah State University

P - On Program
* - Local Person

NATIONAL SILVICULTURAL CONVENTION

WELCOMING ADDRESS

GARY L. McCOY, STAFF OFFICER, RESOURCES

BLACK HILLS NATIONAL FOREST

MAY 13, 1985

GOOD MORNING AND WELCOME TO THE BLACK
HILLS NATIONAL FOREST.

I THINK YOU WILL FIND THE BLACK HILLS AN
APPROPRIATE PLACE FOR YOUR SILVICULTURE
WORKSHOP AND THE THEME "SUCCESSSES IN
SILVICULTURE". I BELIEVE WE HAVE SOME
EXCELLENT EXAMPLES OF GOOD SILVICULTURAL
PRACTICES.

THE BLACK HILLS HAS HAD A LONG HISTORY OF
TIMBER CUTTING STARTING AS FAR BACK AS
THE 1880's. IN THOSE EARLY DAYS THE
TIMBER WAS HIGHGRADED AND ONLY THE BEST
TREES WERE REMOVED FOR SUCH ITEMS AS MINE
TIMBERS, LUMBER, TIES, AND CORDWOOD. WE
ESTIMATE THAT IN THE PERIOD BEFORE THE
BLACK HILLS WAS SET ASIDE AS A FOREST
RESERVE, AS MUCH AS 1.5 BILLION BOARD
FEET WAS CUT. CURRENTLY, WE ARE WELL ON
OUR WAY TO HARVESTING THE 6TH BILLION
BOARD FOOT FROM THE BLACK HILLS.

IN 1897, PRESIDENT CLEVELAND SET ASIDE
THE BLACK HILLS AS A FOREST RESERVE.
LATER THAT SAME YEAR, AS PROVIDED IN THE
ORGANIC ACT, AN APPLICATION WAS MADE TO
PURCHASE TIMBER FROM THE RESERVE. THIS
APPLICATION WAS MADE BY THE HOMESTAKE
MINING CO., IT READ, "TO PURCHASE ALL OF
THE TIMBER OF A DIAMETER OF EIGHT INCHES
AND OVER" ON THE AREA NOW KNOWN AS CASE
#1. THIS WAS THE FIRST TIMBER SALE IN
THE NATION FROM NATIONAL FOREST SYSTEM
LANDS AND THE FIRST "SILVICULTURAL
PRESCRIPTION" ON THE BLACKHILLS.
CUTTING ON THE SALE BEGAN ABOUT CHRISTMAS

OF 1899 AND AFTER FOUR EXTENSIONS OF TIME
THE SALE WAS FINALLY CLOSED IN APRIL OF
1903.

THIS TREND CONTINUES TODAY WITH SEVERAL
SALES OVER 10 YEARS OLD AND APPROXIMATELY
380 MMBF UNDER CONTRACT ON THE BLACK
HILLS NATIONAL FOREST.

MARKING POLICY WAS LACKING AT FIRST ON
CASE #1, BUT AS THE SALE PROGRESSED,
TREES WERE MARKED FOR CUTTING WITH AN AXE
AND "US" WRITTEN ON THE BLAZE WITH A
PENCIL. CASE 100, WHICH JOINS CASE 1,
SAW THE FIRST USE OF A MARKING HAMMER
WITH THE "US" ON THE BACK.

THE LATEST ACREAGE FIGURES SHOW THAT
THERE ARE ABOUT 1.5 MM ACRES OF NATIONAL
FOREST SYSTEM LAND OF WHICH 1.1 MM ACRES
ARE PRODUCTIVE FOREST LAND. NINETY FOUR
PERCENT OF THIS PRODUCTIVE FOREST LAND IS
AVAILABLE FOR TIMBER PRODUCTION.

IT IS IMPORTANT TO UNDERSTAND THAT EVEN
THOUGH TIMBER HARVEST IS A CONSUMPTIVE
USE, THE MANAGING OF TIMBER FOR OTHER

RESOURCE VALUES IS VERY IMPORTANT ON THE BLACK HILLS. THIS IS SHOWN QUITE CLEARLY IN OUR APPROVED LAND AND RESOURCE MANAGEMENT PLAN, WHICH I MIGHT ADD, WAS THE FIRST IN THE NATION.

THE PLAN SHOWS THE TIMBER OUTPUT AS 148.3 MMBF IN SALE OFFERINGS PER YEAR. THIS INCLUDES 29.9 MMBF OF ROUNDWOOD OR PRODUCTS OTHER THAN LOGS. YOU WILL HEAR MORE ABOUT POL WHEN DAVE AND I DISCUSS "BELOW-COST TIMBER SALES" LATER TODAY. THE PRESENT CUT IS ABOUT 132 MMBF YEARLY.

AT PRESENT THE FOREST HAS ELEVEN CERTIFIED SILVICULTURISTS WRITING PRESCRIPTIONS ON SEVEN RANGER DISTRICTS. EVEN THOUGH THE HILLS HAS ONLY TWO COMMERCIAL SPECIES, PONDEROSA PINE AND WHITE SPRUCE, THE FOREST PLAN ALLOWS FOR THE USE OF A FULL MULTITUDE OF SILVICULTURAL SYSTEMS. THE REASONS FOR HAVING THESE OPTIONS AT OUR DISPOSAL IS QUITE SIMPLE. ALL THE PRESCRIPTIONS WRITTEN ON THE HILLS ARE MULTI-RESOURCE PRESCRIPTIONS NOT STRICTLY TIMBER PRESCRIPTIONS.

THE BASIC SILVICULTURAL SYSTEM USED ON THE BLACK HILLS IS A TWO STEP SHELTERWOOD SYSTEM. IT INCLUDES A 100 YEAR ROTATION, WITH ONE PRECOMMERCIAL THINNING AND FIVE COMMERCIAL ENTRIES DURING THE ROTATION. PERCENT STOCKING AND BASAL AREAS VARY DUE TO SITE AND MANAGEMENT AREA.

THE BLACK HILLS IS BLESSED WITH THE ABILITY TO REGENERATE ITSELF NATURALLY. THE MAJORITY OF THE PRECIP IN THE AREA COMES DURING THE MONTHS OF APRIL THROUGH JULY, OR PRECISELY WHEN NEEDED TO GERMINATE TREE SEED AND KEEP THE NEWLY GENERATED TREES GROWING DURING THEIR FIRST YEAR. DUE TO THE ABILITY TO REGENERATE, PINE REGENERATION IS FREQUENTLY A PROBLEM. MEADOW INVASION BY PINE IS JUST ONE EXAMPLE.

ON WEDNESDAY DURING THE FIELD TRIP, NOTICE HOW THE FOREST HAS A MANAGED APPEARANCE. NEARLY ALL THE HILLS HAS

BEEN CUT AT ONE TIME OR ANOTHER. HOWEVER, THIS CUTTING CREATES VERY LITTLE CRITICISM FROM THE PUBLIC. MILLIONS OF TOURISTS FREQUENT THE BLACK HILLS EVERY YEAR. ACCEPTANCE OF TIMBER CUTTING BY THE PUBLIC IS AN ACCOMPLISHED FACT.

IN SOME WAYS THE MOUNTAIN PINE BEETLE HAS AIDED IN THIS ACCEPTANCE. WITH THE "BEETLE" EPIDEMIC OF THE MID 1970'S AND OUR CONCENTRATED PUBLIC RELATIONS PROGRAM, THE PUBLIC HAS BEEN MADE AWARE THAT TIMBER MANAGEMENT IS BENEFICIAL TO THE FOREST, ESPECIALLY WHERE CONTROL OF THE MOUNTAIN PINE BEETLE IS CONCERNED.

I BELIEVE THE AMERICAN PUBLIC CAN AND WILL ACCEPT TIMBER MANAGEMENT, AS LONG AS THEY ARE TOLD WHAT IS BEING DONE, WHY IT IS BEING DONE, AND MOST IMPORTANTLY THAT WE DO THE BEST JOB POSSIBLE. THIS IS WHERE OUR EMPLOYEES EARN THEIR KEEP. ONLY WITH A PROPER MULTI-RESOURCE PRESCRIPTION AND A PROPER JOB OF CONTRACT ADMINISTRATION AND CULTURAL TREATMENTS CAN WE HOPE TO ACHIEVE CONDITIONS ACCEPTABLE TO THE PUBLIC.

YOU WILL FIND SEVERAL OF THE FOREST
SILVICULTURISTS ATTENDING THE WORKSHOP
THROUGH THE WEEK. THEY ARE AVAILABLE FOR
ANY QUESTIONS YOU MIGHT HAVE ABOUT THE
BLACK HILLS. IN ORDER TO IDENTIFY THEM,
LOOK FOR THE PINK NAME TAGS.

I HOPE YOUR STAY HERE IN THE BLACK HILLS
WILL BE ENJOYABLE AND AGAIN, WELCOME.

Regulations, Litigation, and The Forest Service Program

A Presentation at the National Silviculture Workshop, May 13, 1985

By Larry Gross

The issue of worst case analysis, National Environmental Policy Act, appeals and lawsuits in our vegetation management and other pest management programs is complex and perplexing to you the silviculturist as well as the land manager and everyone else. What I hope to do is to lay out to you the current NEPA regulations and Council of Environmental Quality (CEQ) guidelines, the history of various lawsuits and the courts interpretation of the regulations and guidelines, and where we are today.

First the CEQ regulations for implementing NEPA. Five areas are causing concerns in developing environmental documents:

1. Section 1502.16 Environmental Consequences. "The discussion will include the environmental impacts of the alternatives including the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented. This section should not duplicate discussions in §1502.14. It shall include discussions of:

(a) Direct effects and their significance (§1508.8).

(b) Indirect effects and their significance (§1508.8)."

2. Section 1502.22 Incomplete or unavailable information. "When an agency is evaluating significant adverse effects on the human environment in an environmental impact statement and there are gaps in relevant information or scientific uncertainty, the agency shall always make clear that such information is lacking or that uncertainty exists.

(a) If the information relevant to adverse impacts is essential to a reasoned choice among alternatives and is not known and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement.

(b) If (1) the information relevant to adverse impacts is essential to a reasoned choice among alternatives and is not known and the overall costs of obtaining it are exorbitant or (2) the information relevant to adverse impacts is important to the decision and the means to obtain it are not known (e.g., the means for obtaining it are beyond the state of the art) the agency shall weigh the need for the action against the risk and severity of possible adverse impacts were the action to proceed in the face of uncertainty. If the agency proceeds, it shall include a worst case analysis and an indication of the probability or improbability of its occurrence."

3. §1502.8 Writing. Environmental impact statements shall be written in plain language and may use appropriate graphics so that decisionmakers and the public can readily understand them. Agencies should employ writers of clear prose or editors to write, review, or edit statements, which will be based upon the analysis and supporting data from the natural and social sciences and the environmental design arts.

4. §1508.7 Cumulative impact. "Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

5. Section 1508.8 Effects. Effects include: (a) Direct effects, are caused by the action and occur at the same time and place. (b) Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Effects and impacts as used in these regulations are synonymous. Effects includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial.

These five sections require us to discuss the indirect effects and their significance (including health) of each alternative, the cumulative impact of all actions, and where information relevant to adverse impacts is essential to a reasoned choice among alternatives but is not known or too costly to obtain, a risk analysis must be made and if the agency proceeds a worst case analysis is required in an EIS. Also the document must be written in plain, clear language.

Now that we have the information from the five sections of the CEQ regulations in front of us let's look at some court decisions and how they have interpreted NEPA and the CEQ regulations.

1. Southern Oregon Citizens Against Toxic Sprays, Inc., et al. (SOCATS) v. James Watt, et al. (Civil No. 79-1098FR, D.C. Oregon, opinion and order issued September 9, 1982, modified October 20, 1982 (Judge Helen Frye). Ninth Circuit Court of Appeals decision filed December 2, 1983. Petition for rehearing and rehearing en banc denied on March 21, 1984.)

The Bureau of Land Management (BLM) filed a programmatic environmental impact statement (EIS) in 1978, proposing use of 14 herbicides including silvex and 2,4-D. (Silvex use in forestry was later suspended by the U.S. Environmental Protection Agency (EPA)). The district court found scientific uncertainty existed about the carcinogenic and mutagenic potential of 2,4-D and whether there is a safe level of dosage. Therefore, the district court held that BLM must do a worst case analysis so that the Government can assess the probability of the worst case actually happening and evaluate the risks if the Government decides to proceed in spite of the uncertainty.

The Ninth Circuit Court of Appeals held that the Council on Environmental Quality (CEQ) regulations, 40 C.F.R. Section 1502.22, required BLM to prepare a worst case analysis when significant scientific uncertainty exists about the safety of a spraying program and further study cannot eliminate the uncertainty.

A petition for a writ of certiorari was filed with the Supreme Court in August. The Supreme Court announced on November 13, 1984 that it would not review this case. This leaves the lower courts ruling intact.

2. Oregon Environmental Council, et al. (OEC) v. Leonard Kunzman, et al. (Ninth Circuit No. 82-3232 (on appeal from District Court of Oregon, Judge Redden) oral argument held May 4, 1983. Decision filed August 30, affirmed in part, reversed in part, and remanded. Injunction issued January 26, 1984. District Court No. 82-504-RE. Temporary restraining order denied May 9, 1984.)

The USDA Animal and Plant Health Inspection Service (APHIS) agreed to provide funds to the State of Oregon Department of Agriculture, which planned a project to control gypsy moths using carbaryl (Sevin®) in Marion County, Oregon.

The district court held that the APHIS/Forest Service EIS was adequate and that plaintiffs did not have a private right of action under FIFRA or the Federal Aviation Act. Following an appeal to the ninth circuit, the district court again denied an injunction but held that the spraying program was subject to review under the Administrative Procedures Act (APA).

The ninth circuit panel held that the programmatic EIS and environmental analysis were inadequate, that the case was not moot, that the APA provided for review of the agency action, and that the spray program did not violate FIFRA.

The Oregon Environmental Council filed a request for \$132,000 in attorneys' fees, and the Government opposed.

On October 11, 1983, the Forest Service and APHIS published notice of plans to prepare a new programmatic EIS (48 Fed. Reg. 46089). On January 26, 1984, the district court granted an injunction barring aerial broadcast spraying of carbaryl in populated areas of Oregon until an adequate EIS was prepared. A draft EIS was prepared, and public comments were due February 25, 1984.

Public comment period on final EIS ended May 7, 1984. The final EIS was approved by the Forest Service and APHIS on May 8. OEC sought a nationwide temporary restraining order (TRO) and on May 9, 1984, Judge Redden denied TRO request. The court retained jurisdiction-set hearing for July 9 on EIS in the abstract. Except for a small area in Michigan (see Almeida v. Kindinger), all gypsy moth spraying was completed as planned.

The hearing date was extended to September 25. On August 17, the Forest Service and APHIS provided a notice to the Federal Register stating that a supplement to the EIS would be prepared and a draft completed about November 1. The Government then sought dismissal of the case. The plaintiffs filed a response objecting to the motion to dismiss.

Friends of the Earth and the National Coalition Against the Misuse of Pesticides filed a motion to intervene on behalf of the plaintiffs.

The judge held a telephone conference with the parties in the case on November 13. The case was not dismissed.

A supplement to the EIS including a risk analysis was prepared by the Forest Service and APHIS. This document was reviewed through the NEPA process.

The judge heard the case involving the FEIS supplement and risk analysis April 16. The court ruled that the worst case analysis was legally inadequate because it does not meet the regulatory mandate of clarity. On all other issues the document was adequate.

3. Paul E. Merrell v. John R. Block, Bureau of Land Management, and Environmental Protection Agency (EPA). (Civil No. 81-6138-E, District Court of Oregon (Judge Robert Belloni). Opinion issued April 14, 1983. Injunction issued May 20, 1983. On appeal: Adverse decision issued January 26, 1984. Petition for rehearing and rehearing en banc filed March 12, 1984.)

Although Judge Belloni ruled in favor of the Government on most issues, he held that the Forest Service and BLM violated NEPA procedures because they failed to do actual research on the health effects of using listed herbicides in the area described in their environmental assessments. The court ordered the Forest Service and BLM to conduct site-specific research. He also held that the Government cannot rely solely on EPA research done when EPA registered the chemicals under FIFRA. He enjoined the use of pesticides listed in the EIS and environmental assessment by the Federal Agencies in vegetation management programs.

The court granted a stay of the injunction, but the injunction was reinstated by the Ninth Circuit Court of Appeals. The final injunction barred aerial spraying of several herbicides in specified areas of BLM lands and the Siuslaw National Forest.

The Ninth Circuit Court of Appeals ruled that the agencies must comply with NEPA and CEQ regulations, which provide that when significant scientific uncertainty exists or data gaps occur, an agency must either do research to answer the uncertainty or fill the gaps. If the costs of doing so would be exorbitant or if no answer is possible under the state of the art, the agency must do a worst case analysis.

The circuit court overruled the district court denials of awards of attorneys' fees to plaintiffs in the Merrell and Save Our EcoSystems cases. The circuit court held that the Forest Service and BLM were notified that worst case analyses were required under NEPA when the Fifth Circuit Court of Appeals held in January 1983 that the Army Corps of Engineers must do a worst case analysis on the potential effect of oil tanker accidents.

The Ninth Circuit Court of Appeals also held that the Forest Service and BLM cannot rely on EPA registration. A worst case analysis must be issued for public review and comment under rules applying to EIS's (e.g., 45-day comment period). Further, the court held that the agencies (BLM, Forest Service, and EPA) were not required to do joint EIS's.

4. Save Our EcoSystems (SOES) and Citizens for Alternatives to Toxic Sprays (CATS) v. Clark. (Civil No. 83-6090-E, District Court of Oregon (Judge Robert Belloni). Opinion issued May 6, 1983. Injunction issued May 20, 1983. On appeal: Adverse decision issued January 26, 1984. Petition for rehearing and rehearing en banc filed March 9, 1984).

SOES and CATS filed a suit on March 4, 1983, seeking to halt use of herbicides by BLM in its Eugene district and review of a worst case analysis. The Eugene district prepared and released the worst case analysis on February 12, 1983, as part of their 1983 environmental assessment on vegetation management. The court held that BLM's worst case analysis was not adequate because it failed to assume that the named herbicides are carcinogens and mutagens. On May 12, the court granted a stay of the injunction, but the Ninth Circuit Court of Appeals reinstated the injunctive relief.

The circuit court held that the worst case analysis prepared by BLM was inadequate, too brief, and conclusory. The court also ruled that the 45-day comment period is applicable to the worst case analysis and indicated the scope of the injunction was not broad enough. (See Merrell case, herein, for summary of Ninth Circuit Court of Appeals decision in SOES case.)

5. Northwest Coalition for Alternatives to Pesticides et al. (NCAP) v. Block, Watt, Ruckelshaus, et al. (Civil No. 83-6273-E, District Court of Oregon (Judge James Burns). Trial held August 3-5, 1983. Injunction issued March 3, 1984.)

NCAP sought to enjoin the Forest Service from using herbicides in Region 6 and the BLM from using herbicides in districts in Oregon and Washington because the agencies failed to comply with NEPA and prepare worst case analyses. Lack of NEPA compliance was decided in the Merrell case (on site-specific research) and in the SOES case on inadequacy of worst case analysis by BLM.

On March 3, the court issued an injunction against use of herbicides based on the failure to do an adequate worst case analysis and ruled that NCAP was the prevailing party for Equal Access to Justice Act attorneys' fees.

The Chief of the Forest Service issued a letter on March 30, 1984, deferring all aerial application of herbicides pending review of this and related court decisions.

The court granted a limited exemption to the injunction in response to a request by Union County, Oregon. The exemption permitted the spraying of about 40 acres of Forest Service lands on July 6, 1984, to control yellowstar thistle.

6. Safe Alternatives for the Forest Environment (SAFE) et al. v. R. Max Peterson et al. (E.D. California Civil No. S-83-1115 MLS, E.D.C. California. Memorandum and order issued October 14, 1983 (Judge Milton L. Schwartz.)

The district court denied SAFE's request for a preliminary injunction to stop use of Roundup®. The Forest Service relied on a 1974 EIS on vegetative management, which discussed 2,4,5-T (since suspended by EPA) but did not discuss some newer chemicals. SAFE had not objected to use of specific chemicals during the public participation period or during administrative appeals. SAFE claimed that the Forest Service must do a new EIS and a worst case analysis, that the environmental assessment should have included a "meaningful" benefit-cost analysis (on manual release), and that the Forest Service failure to evaluate "all reasonable alternatives" violated NEPA. The court held that SAFE failed to demonstrate they had "at least a fair chance of success on the merits." The case is still pending.

7. The National Organization for the Reform of Marijuana Laws (NORML) v. U.S. Drug Enforcement Agency (DEA), Francis M. Mullen, R. Max Peterson, John R. Block, et al. (Civil No. 83-2595, District Court of the District of Columbia (Judge June L. Green), filed September 1, 1983.)

NORML sued to enjoin the defendants from assisting in any DEA marijuana eradication programs using paraquat until NEPA, the APA, and agency regulations and guidelines have been complied with by the Federal Government.

NORML also seeks damages for violations of civil rights laws and the Constitution and asks for compensatory and punitive damages of \$30,000,000 against the individual defendants. Judge Green granted a TRO on September 13, halting the spray program pending hearing. DEA prepared a draft EIS in May 1984, and a updated supplement in Spring of 1985.

8. Sierra Club, National Coalition Against the Misuse of Pesticides, and Friends of the Earth v. Francis M. Mullen, Jr., R. Max Peterson, John R. Block, and James G. Watt. (Civil No. 83-2592, District Court for the District of Columbia (Judge June L. Green), filed September 1, 1983.)

The plaintiffs asked for injunctive relief to stop aerial application by DEA of paraquat on public lands, including Forest Service lands. They allege violations of NEPA and FIFRA. Judge Green granted a TRO on September 13. Spraying is halted pending preparation of an EIS.

9. Almeida et al. v. Kindinger et al. (Civil No. 84-CV-8278-FL, U.S.D.C. E.C. Michigan.)

Suit filed requesting a TRO on May 11, 1984, against Michigan State officials and the Forest Service on a proposed spraying of carbaryl in a gypsy moth suppression project in Livingston County, Michigan. A hearing on the TRO was held May 14, 1984. The court took the request under advisement, but before ruling on the TRO, the State of Michigan decided not to spray in Livingston County. The remaining Forest Service suppression projects were canceled in Michigan. Two APHIS eradication projects went forward without challenge in Eaton and Menominee Counties, as well as 100 percent State funded projects in Kent and Ottawa Counties. The case was dismissed July 18. The judge denied plaintiffs motion for court costs in September, 1984.

10. Paul E. Merrell v. William E. Ruckelshaus, Administrator, U.S. Environmental Protection Agency. (Civil No. 84-6105-E, U.S.D.C. D. Oregon (plaintiff pro se.))

Plaintiff sues under NEPA to set aside EPA's pesticide registration of herbicides Garlon® 4, Krenite®, dicamba, simazine, diuron, bromacil, and Rodeo® for roadside vegetative maintenance. This suit involves NEPA and its regulations 40 C.F.R., Section 1500-1508. Plaintiff claims, among other things, that EPA has issued registrations for roadside uses of herbicides . . . (c) without examining the potential worst case situations involved in roadside herbicide use.

The court ruled in favor of EPA in this case

11. Committee for Integrated Pest Management v. John R. Block et al. (Civil No. 82-0570 JB, District Court of New Mexico (Judge Juan G. Burciaga). Plaintiffs' motion for preliminary injunction was denied on June 10, 1983.)

The Committee for Integrated Pest Management opposes the use of chemical pesticides for insect control. The Forest Service prepared and issued a final EIS on October 27, 1981, on planned projects for spraying lands in New Mexico to control the western spruce budworm using carbaryl, acephate, and Bacillus thuringiensis (B.t.). Spraying was completed for the 1982 programs. The Committee alleged that the EIS was inadequate and claimed that possible spraying in water could cause a public nuisance. Plaintiffs sought injunctive relief and declaratory judgment. The case was settled and dismissed in late March 1984.

The following is a summary of the important facts in the courts decisions in the above litigations.

1. If there is scientific uncertainty about the carcinogenic or mutagenic potential of a pesticide a worst case analysis is necessary.

2. The Forest Service and BLM must do site specific research on the herbicides they list in their environmental assessments. Site specific research has not been defined.

3. We can not rely solely on research done when EPA registered the pesticides.

4. We must comply with CEQ regulations on NEPA.

5. If scientific uncertainty exists or data gaps occur, the agency must either do research to answer the uncertainty or fill the gaps. If it costs too much or is impossible to do because of state of art the agency will do a worst case analysis.

6. We must assume a herbicide is a carcinogen and a mutagen if we do not have scientific information that proves it is not.

7. Worst case analysis must have a 45-day public review period if included in an EA or EIS.

With the court decisions as they are, what actions are the Forest Service taking to comply with the courts rulings? We have been proceeding very slowly as risk analysis procedures are being developed as we go. The gypsy moth risk assessment and WCA is the first one completed and has been tested in court.

As can be seen on the following list we are working on many pesticides in nurseries, seed orchards, and vegetation management for all resource areas. For each pesticide all available information pertaining to toxicology and environmental fate must be reviewed and a background document written. This is a time consuming task which as well as taking time is costly. We have committed over \$600,000.00 to this effort as of today. The risk assessment for Region 6 for vegetation management will cost over \$118,000.

Risk Assessment Preparation

I. Washington Office and Northeastern Area, Forest Pest Management

A. Gypsy moth suppression and eradication projects

1. Acephate (Orthene)
2. Carbaryl (Sevin)
3. Diflubenzuron (Dimilin)
4. Trichlorfon (Dylox)

Status: Final Environmental Statement with Risk Analysis filed with EPA 3/11/85

II. Region 5, Timber Management

A. Vegetation Management for Reforestation in the Pacific Southwest Region

1. Asulam
2. Atrazine
3. Dalapon (Dowpon)
4. Dicamba (Banvel)
5. Fosamine Ammonium (Krenite)
6. Glyphosate (Roundup)
7. Hexazinone (Velpar, Pronone)
8. MSMA/Cacodylic Acid
9. Picloram (Tordon)
10. Simazine
11. Triclopyr (Garlon)
12. 2,4-D

Status: Fifth draft of Risk Analysis under review. Risk Analysis contracted to Peer Consultants

III. Region 1, Forest Pest Management

A. Herbicides used in noxious weed control

1. Amitrole
2. Dicamba (Banvel)
3. Glyphosate (Roundup)
4. Picloram (Tordon)
5. 2,4-D

Status: Draft Risk Analysis being revised after review

IV. Region 8, Forest Pest Management

A. Pesticides used in seed orchards

1. Acephate (Orthene)
2. Azinphos-Methyl (Guthion)
3. Carbaryl (Sevin)
4. Carbofuran (Furadan)
5. Chlorpyrifos (Dursban)
6. Diazinon (Spectracide)

7. Dimethoate (Cygon)
 8. Fenvalerate (Pydrin)
 9. Lindane
 10. Malathion
 11. Oxydemeton-Methyl (Metasystox-R)
 12. Permethrin (Ambush)
 13. Glyphosate (Roundup)
 14. 2,4-D
 15. Simazine
 16. Sulfometuron Methyl (Oust)
- Status: Information for Risk Analysis being developed

V. Washington Office, Forest Pest Management

A. Pesticides used in nurseries

1. Bifenox (Modown)
 2. DCPA (Dacthal)
 3. Diphenamid (Enide)
 4. Napropamide (Devrinol)
 5. Oxyfluorfen (Goal)
 6. Sethoxydim (Poast)
 7. Benomyl (Benlate)
 8. Captan
 9. Chlorothalonil (Bravo)
 10. DCNA (Botran)
 11. Dichloropropene (Telone)
 12. Methyl Bromide-Chloropicrin
 13. Triadimefon (Bayleton)
 14. Vorlex
 15. Diazinon (Spectracide)
 16. Dimethoate (Cygon)
- Status: Background information and first draft of Risk Analysis being prepared

VI. Region 6, Forest Pest Management

A. Vegetation management in the Pacific Northwest Region

1. Amitrole
 2. Asulam
 3. Atrazine
 4. Bromacil (Hyvar)
 5. 2,4-D
 6. 2,4-DP
 7. Dalapon
 8. Dicamba (Banvel)
 9. Diuron (Karmex)
 10. Fosamine Ammonium (Krenite)
 11. Glyphosate (Roundup)
 12. Hexazinone (Velpar)
 13. Picloram (Tordon)
 14. Simazine
 15. Tebuthiuron (Graslan, Spike)
 16. Triclopyr (Garlon)
- Status: Risk Analysis contracted to Labat-Anderson Inc.

With this background of the NEPA and the CEQ regulations, the court history, and where we are today, I would like to spend the remainder of the time answering questions that you may have.

AERIAL PHOTOGRAPHY IN THE FOREST SERVICE

Henry M. Lachowski
USDA Forest Service
WO-Engineering
P.O. Box 2417
Washington, D.C. 20013
Telephone (703) 235-8184

WO-Engineering has been working with several Regions and Stations on ways to improve the utilization of aerial photography at the field level. This is a summary of several activities including the development of a utility guide, photo quality evaluation, and training.

An aerial photography awareness package, including samples of photography at different scales, has been distributed at the Workshop. Copies of the material are available from WO-Engineering.

UTILITY GUIDE

The Utility Guide for Aerial Photography is a tool to assist Forest Service personnel in aerial photography planning and evaluation. An important objective of the Guide is to promote planning of photography on a "prescription basis" as opposed to photographing an entire Forest at predetermined time intervals and scales. Prescription means considering the following questions:

1. What portions of the Forest need to be photographed?
2. What is the purpose of the photography (requirements) ? Who will use it and how?
3. When is the photography to be acquired--year and season?
4. What scale and what emulsion (color, color infrared, or black and white) is required?

The Guide contains a representative sample of information requirements, indicates the photographic scales of color photography required to satisfy these requirements, and gives typical costs for acquiring the photography (Attachment 1). It was evaluated by all Regions, Stations, and the Area during September-December 1984. Comments received from the field indicate the following: the Guide is a useful tool for photo selection and for training; the photo scale range and requirements are adequate for current uses of photography; the Guide layout is easy to understand and use; and it is helpful in communicating requirements for photography between Ranger Districts, Forest Supervisors' Offices, and Regional Offices.

Suggestions for enhancements were as follows:

1. Develop a worksheet that can be used with the Guide to list and analyze Forest-specific requirements.
2. Include infrared film.
3. Include examples of photography.

Use of the Guide is being implemented Service-wide. The existing version of the Guide and the worksheet should be used when planning new aerial photography (refer to FSM 7140, revised 1985). Distribution of the Guide to all Forests (including enhancements) will be made in the first quarter of FY 1986.

PHOTO QUALITY EVALUATION

Acquisition of all standard aerial photography for areas greater than 100 square miles must be through the Agricultural Stabilization and Conservation Service-Aerial Photography Field Office (ASCS-APFO) in Salt Lake City, Utah. ASCS-APFO performs flight line planning, contracting, inspection, and printing.

A periodic evaluation of photo quality is necessary to ensure that photography users are getting materials which meet their expectations. In order to accomplish this, we have reviewed procedures at ASCS-APFO and put together a questionnaire dealing with the quality and timeliness of photography. The questionnaire (see Attachment 2) will be included with all future photography shipments from APFO.

The purpose of the questionnaire is to obtain feedback from photography users, and to improve communications between users and APFO. Generally, problems with photography are minimized, or nonexistent at Forests and Stations that maintain close contact with APFO.

TRAINING IN PHOTOINTERPRETATION

Training in the use of aerial photography is available from the Nationwide Forestry Applications Program (NFAP) in Salt Lake City, Utah, collocated with ASCS-APFO. New training materials and manuals have been developed and tested. Currently, two types of training are available--basic and advanced.

The basic course deals with utilization of conventional photography available at each Forest. The advanced course covers non-standard photography acquired with the panoramic camera (Optical Bar) and Large Format camera. It also covers other advanced concepts in remote sensing. Both the basic and advanced courses include work on Forest-specific problems (i.e., problems identified by photography users at a given location) and a field exercise. For information concerning training, consult your Regional, Station, or Area Remote Sensing Contact.

NATIONAL HIGH ALTITUDE PHOTOGRAPHY (NHAP) PROGRAM

The NHAP program is a multiagency, cyclic photography program initiated in 1980. The photography is acquired at 40,000 feet altitude with two cameras resulting in color infrared at 1:58,000 scale, and black and white at 1:80,000 scale, both in 9 X 9 inch format. Flight lines are north-south along the centerlines of 7.5-minute quadrangle maps.

Cycle II of NHAP is starting in 1986, with planned coverage of the entire country (except Alaska) every 5 years.

United States
Department of
Agriculture

Forest
Service

Engineering
Staff

Washington, D.C.



June 1984

Utility Guide for 9x9 Inch Format Color Aerial Photography

AERIAL PHOTOGRAPHY UTILITY GUIDE

The purpose of this Guide is to assist Forest Service personnel in planning aerial photography, i.e. in selecting appropriate photographic scales for various uses on National Forests. The Guide contains a representative sample of information requirements selected by users of photography. It indicates the photographic scales needed to satisfy these requirements, and the costs for acquiring photography at these scales.

The guide was developed with the participation of more than 100 users of photography on six National Forests in Region 5. It is based on day-to-day use of photography by Timber Management, Land Management Planning, Engineering, Range, Wildlife, and other users at the Supervisor's Office and Ranger District level. This version of the Guide deals with the most common photographic product used in the field--9 X 9-inch color prints and equipment currently available (pocket and mirror stereoscopes). Expansion to other emulsions, formats, and viewing equipment will be based, in part, on feedback from National Forests (reference Section 3).

In the Guide, the information requirements are positioned along a guide index, a relative measure that was used to link the information requirements to the photographic scales. For each information requirement, the required photographic scale and the cost of acquiring photography at that scale are all located along a single horizontal line. Note that the photo scales relate to the minimum feature dimension (area, diameter, etc.) given with the information requirements.

The indicated scales should not be considered as hard and fast values. They are average values at which typical photointerpreters (PIs) feel comfortable and are confident in making their decisions. Variations among PIs can result from differing Forest practices, PI specializations, and experience. Consequently, individual users may disagree with the relative index location of the requirements. They are approximate; requirements located within 10 index units may not have different photoscale requirements. Depending upon circumstances, there may also be a wide range of scales within which partial, but sufficient satisfaction of the requirements is possible.

The cost of acquisition of photography is based on previous experience with the ASCS-Aerial Photography Field Office, and on estimates obtained during FY 1984 for several locations in Region 5. The cost shown in the Guide applies to large area coverage--over 100 square miles, with 60 percent end lap and 30 percent side lap. The cost for small area coverage at selected scales is shown in Table 1. This is based on estimates obtained for selected areas on the Klamath and Shasta-Trinity National Forests.

The cost includes acquisition, production of a spot index map, and one set of inspection prints. In addition to scale, many factors can affect the cost of photography. Some of these are: relative elevation changes forcing breaks in flightlines, shape of the project area, local weather conditions, restricted areas, proximity to the contractor's base of operations, etc. The costs displayed should be treated as estimates.

Table 2 provides some information used in flight planning for 9 X 9-inch photography. Of main interest is the number of flight lines and photos required at different scales.

COST- LARGE AREA LIN MILE/SQ MILE	PHOTO SCALE	GUIDE INDEX
\$80 / \$135	1: 6,000	100+
\$60 / \$75	1: 8,000	80+
\$25 / \$21	1:12,000	60+
\$20 / \$12	1:16,000	40+
\$17 / \$7	1:24,000	20+
\$15 / \$4	1:40,000	0+
\$30 / \$5	1:60,000	0+

INFORMATION REQUIREMENTS

- (A) Identify conifers with crown diameter 2 feet or larger, for plantation management.
- (B) Identify individual trees, bushes, and other features for project boundary location (crowns 3 feet or more in diameter, features 3 feet or more in size).
- (C) Identify existing snags, 20 inches or more in diameter, 20 feet or more in height.
- (D) Identify slope breaks for stream management zones.
- (E) Identify tree species (for groups of trees) based on crown form, texture and color (crown diam 20 feet or larger).
- (F) Determine wet areas 1/10 acre or larger in size by color, texture, species composition of surrounding vegetation.
- (G) Locate existing trails, ditches, and other linear features 3 feet or more in width, broken to open cover.
- (H) Detect erosion, large gullies, etc. (8 feet or more in width).
- (I) Identify rock outcroppings, obstructions, 30 feet or larger in size.
- (J) Determine crown density (areas 1 acre or larger).
- (K) Identify potential rock source location (areas 1 acre or larger).
- (L) Locate change in vegetation cover on areas 5 acres or larger, for fire rehabilitation planning.
- (M) Locate existing structures - buildings, water towers, etc. (20 feet or greater in width or diameter).
- (N) Locate existing landings (between 1/3 and 1/2 acre).
- (O) Locate windrows and large slash piles over an area of 5 acres or more.
- (P) Locate existing logging roads for transportation planning (broken to open cover).
- (Q) Stratify landform for land management planning.
- (R) Map vegetation on a broad scale (areas over 100 acres).

Table 1. COST ESTIMATES FOR ACQUISITION OF AERIAL PHOTOGRAPHY FOR SMALL AREAS (60% side lap, 30% end lap).

SCALE AREA	1:6,000	1:8,000	1:12,000	1:16,000	1:24,000	1:40,000	1:60,000
PROJECT/COMPARTMENT <10 SQ. MILES (6400 ACRES) (COST PER PROJECT)	\$2200		\$1600				NA
ADDITIONAL PROJECTS OR COMPARTMENTS SCATTERED WITHIN ONE OR MORE RD* (COST PER SQ. MILE)	\$160	\$100	\$35	\$25	\$15	\$8	NA

*Example: For 6 projects or compartments (total area 60 sq. miles) located within 3 Ranger Districts, the cost for acquisition of 1:12,000 photography is estimated at \$3350 (\$1600 for first project + 50 sq. miles X \$35/sq. mile). If the 6 projects are flown at different times, then the cost will be \$9600 (6 X \$1600).

Table 2. COMPARISON OF THE NUMBER OF FLIGHT LINES AND PHOTOGRAPHS REQUIRED AT VARIOUS SCALES TO COVER AN AREA OF A 7 1/2-MIN. QUAD (area--57 sq. miles, 60% end lap, 30% side lap).

Assumption: The quad is part of a larger area. Note that in order to obtain stereo coverage at all edges of the area, an extra flight line and extra photos at the beginning and the end of each flight line may be necessary.

SCALE	1:6,000	1:8,000	1:12,000	1:16,000	1:24,000	1:40,000	1:60,000
LINEAR MILES	96	71	47	36	24	14	9
NUMBER OF FLIGHT LINES*	11	8.3	5.5	4.2	2.8	1.7	1
PHOTOS PER FLIGHT LINE	26	19	13	10	7	4	3
TOTAL NUMBER OF PHOTOS	286	158	71	42	20	7	3
DISTANCE BETW. PHOTOS (MILES)	0.34	0.45	0.68	0.90	1.36	2.27	3.40
DISTANCE BETW. FLIGHT LINES (MILES)	0.59	0.79	1.19	1.57	2.38	3.97	5.96

*The number of flight lines is normally rounded up for estimating aerial photography.

ATTACHMENT 2

FS/ASCS AERIAL PHOTOGRAPHY QUESTIONNAIRE

The purpose of this questionnaire is to obtain feedback from Forest Service users of aerial photography contracted/purchased from the ASCS-Aerial Photography Field Office (APFO) in Salt Lake City. Your comments are important to maintain the quality and timeliness of the photography program administered by ASCS. Please return your comments to:

USDA Forest Service
Washington Office-Engineering Staff
P.O. Box 2417, Room 1109-RPE
Washington, D.C. 20013

If you have any questions, please call WO-E at FTS 235-8184 or ASCS-APFO at FTS 588-5294.

A. GENERAL INFORMATION

1. National Forest: _____ Date: _____

Person to Contact (at RD or SO): _____

2. Type of photography requested? B-W COLOR COLOR IR

Scale: _____ Prints: _____ Transparencies: _____

3. When was photography received? Date: _____

4. What is/are the purpose(s) of this photography? What groups at the Forest will use the photography?

B. CONTRACTING

1. Was photography completed within requested time? Y N If not, was partial order requested and received? Y N

2. Was request properly handled by RO, WO, ASCS? Y N

3. Did anyone from the Forest follow progress of contract with RO or ASCS?
Y N

4. Did you receive status reports from ASCS (contractor)? Y N

C. QUALITY ASSURANCE

1. Can you use the photography for the intended purpose? Y N
2. Does ASCS-APFO have sample prints from your Forest on file? Y N
If yes, how old are these samples? _____

3. Overall quality of photography--please rate on scale of 1 to 10:



4. Is color balance satisfactory? Y N
5. Is color/quality uniform throughout the 9 X 9-inch print? Y N
6. Is color/quality consistent between flightlines? Y N

When problems with quality are noted, please send us samples of photos with your observations marked; the samples will be returned.

D. COMMENTS

Please comment on quality and timeliness of products and/or services received from ASCS/APFO.

MATRIX FOR DETERMINING TYPE OF STAND EXAMINATION

Jimmie D. Chew

Timber Management
Northern Region
USDA Forest Service

Abstract.-- A matrix was developed that provides direction on when to apply different types of stand examinations. An analysis was made with data from 40 stands. Tree measurements were modified to represent four different combinations of measurement accuracies and with and without diameter growth calibration. Impacts on stand attributes of CCF, BA, QMD, and merchantable cubic volume were examined in terms of initial data compilation and projections with the prognosis model. Results of the analysis suggest that examination types other than our standard exam can be more widely used than was initially considered. In terms of using stand data to develop silvicultural prescriptions, the design of the sample and the confidence interval about mean values are often more limiting than measurement accuracy.

Forest Service Handbook 2409.7, Chapter 8, begins with the statement "Examining forest stands....". It is listed as "... some of the most important tasks connected with proper management of the National Forests".

For Region 1, in FY 1984 we examined 976,000 acres for a total cost of approximately \$3,900,000. For FY 1986 we have requested \$4,916,000 for stand examinations. For the diverse purposes for which stand examinations are to be taken as shown in the handbook, are we being cost effective? Approximately 5 years ago we initiated changes to reduce our stand examination costs. In FY 1978 we had an average examination cost of \$8.38 per acre. In FY 1981 this was reduced to \$6.46; in FY 1982, \$5.24; in FY 1983, \$5.09; in FY 1984, \$4.51.

The changes that were made to reduce these costs were associated with recognizing a variety of stand examination types. Since the initial emphasis on utilizing a variety of stand examination types we have had the need to further refine the direction for the types of examinations; identify minimum standards and appropriate use of each exam type. A way to provide this direction was to develop a matrix, Figure 1. The top of our matrix covers the four types of examinations in use. The photo interpretation is usually associated with our compartment inventory process and used to delineate strata to which attributes are assigned through regression estimators. The walk thrus are used to verify photo interpretation information or information from any other source. Quick plots evolved out of the need expressed by the field to take something less than our standard examination. The standard examination has been the predominate type taken throughout the Region. It provides maximum data for a specific site and stand. Figure 2 displays the data sheet for the standard

TYPE OF EXAMINATION

PURPOSE OF EXAM	PHOTO INTERP	WALK THRU	QUICK PLOTS	STANDARD EXAM
Project Activities:				
Immature Stand (less than rotation age)				
Origin & stand size unknown	NA	NA	Acpt.	Pref.
Origin known, less than merch. size	NA	NA	Pref.	Acpt.
merch. size, Origin known or unknown	NA	NA	Acpt.	Pref.
Mature Stand (greater than rotation age)				
Obviously decadent > 20" QMD high damage incidence understocked poor vigor	NA	Acpt.	Pref.	NA
All other situations 12"-20" QMD low damage incidence > minimum stocking good vigor	NA	NA	Acpt.	Pref.

Mature stands with a understory that may be manageable will be examined according to the criteria for immature stands

examination. Shaded fields represent the minimum fields for the Quick Plot exam.

The vertical axis of the matrix was generated by examining the types of decisions that are made within the silvicultural prescription process. Decisions can be put into two broad categories that correspond to immature vs. mature stands. The type of information that we perceive as needed to make these decisions, and what we may already know about the stands resulted in a further breakdown of the vertical axis. Intuitively we filled out the matrix with what we considered to be the "acceptable" or "preferred" type of stand examination.

Placing more emphasis on Quick Plots and identifying minimum standards for this type of examination involved a number of questions. What one could and could not use quick plot data for needed to be clarified. Did tree diameters and heights have to be measured or could they be estimated?. Does diameter growth have to be taken? Can prognosis be run using Quick Plot data? For the purpose of writing silvicultural prescriptions, exactly what data is needed?

To help answer these questions, we conducted an analysis that consisted of selecting 40 stands that had been examined with a standard examination. This data was modified to represent four different combinations of examination data (figure 3):

measured diameters and heights with dia growth measurements

measured diameters and heights without dia growth measurements

estimated diameters and heights with dia growth measurements

estimated diameters and heights without dia growth measurements

The modifications were achieved by using a program to randomly assign plus or minus 10% to the measurement and then rounding to the nearest inch or foot. An evaluation was made to insure that the random assignment did not "balance out" resulting in no difference in the mean attributes for the stands.

We examined how these different combinations affected stand attributes that are commonly used in developing stand prescriptions; CCF, BA, QMD, and merch. cubic volume. These attributes were examined from a initial data compilation and from decades 1, 5, and 10 of a prognosis projection. A comparison of these stand attributes was made by examining the differences between group means as compared to the measured group. Evaluations were made in a number of ways. Simple t and F tests for all attributes were made on the means of each group. The results were no significant difference for any group at the 95% level.

A stepwise regression analysis on just the merch. cubic volume was made. The interpretations of these results were that the estimation of tree dimensions as we simulated them would not lead to appreciably different, on the average, projected volumes from those of completely measured trees.

Failure to calibrate prognosis projections with a set of growth sample trees for a stand can lead to projections which are somewhat biased as compared to

Page _____ of _____

Crew _____ Date _____ Continued on Reverse R1-FS-2410-15 25 (1/83)

	w/ measured data	w/est data
		1" dia class
w/ growth calibration #	(1) *	(3) *
w/o growth calibration	(2) *	(4) *

* 3 runs each, each with a unique random number seeds

Trees with growth are measured

Runs will be made for 4 age groups, 10 stands each group, each stand will be run 4 different ways (see above table)

Total of: 40 stands X 4 ways X 3 runs = 480 prognosis runs

projections with calibration. Using estimated rather than measured tree dimensions will not bias growth calibrated prognosis projections, but error of the projections will be increased some.

The statistical tests and the regression analysis dealt with means and averages. To help better visualize the range of variation, we have provided scattergrams. These are typical of all the scattergrams made for each of the stand attributes examined. For the initial compilation of the data the first scattergram (figure #4) displays the difference between the measured with growth and the measured without growth. As expected for an initial compilation, growth makes no difference. The second (figure #5) and third (figure #6) diagrams display the difference between the measured with growth and the estimated with growth and estimated without growth. A slight difference does exist, not because of the growth, but if growth was measured on a tree, then the other tree attributes are also considered measured. The scattergrams show that estimating does not induce much of a difference in merch. cubic volume. The greatest difference is when the initial volume is around 4800 plus.

The next three scattergrams are for stand projection with the prognosis model. The first scattergram (figure #7) displays the difference of measured without growth. The second (figure #8) shows the difference of estimated without growth. The third (figure #9) shows estimated with growth measurements. The conclusion is the same as that resulting from the regression analysis: Growth calibration is more significant than measuring tree attributes of diameter and height.

As can be noticed from the scattergrams, there are individual stands that do have significant variation. Thus, a portion of our analysis deals with how these differences would influence our decisions made within the diagnosis step of the silvicultural prescription process. For this portion of the analysis we have used two stands from different age groups in our sample of forty stands.

The first stand is from our group that is less than 30 years old. Most trees are below the breakpoint for taking radial growth measurements (3"). Thus growth calibration is not a significant part of the analysis for this stand. Time spent in measuring diameters can still be significant, as our Regional Stand Exam Handbook calls for trees greater than .5 inches dbh to be measured to the nearest .1 inch. A comparison of the initial compilation of the data as actually measured and as estimated shows no difference. A target stand for a QMD of 2.0 inches can be described as a maximum of 400 trees per acre and a minimum of 275 trees per acre (figure 10). This comparison to the mean stand attribute of 440 trees per acre seems rather simple; in terms of QMD values we can judge the differences as insignificant. But let's go one step further. The original data came from ten plots, three of which were nonstocked. The statistics for the initial compilation of the data have a 95% confidence interval for trees per acre of 146 to 734. The difference between estimated vs. measured diameters and heights becomes even more insignificant considering that if we are at either end of the confidence interval we are outside of our target stand.

To be able to make a decision about the range of the confidence interval being large, we must identify some "threshold" values that help us to define when a difference is too great. For our example let's use 600 trees per acre as the

FILE NUNAME (CREATION DATE = 12/07/84)

SCATTERGRAM OF (DOWN) DIFF. MEA WITH GR. AND MEA MD GR. (ACROSS) STARTING VOLUME - MER CUBIC

INITIAL
COMPARISON

3000.00

2400.00

1800.00

1200.00

600.00

.00

-600.00

-1200.00

-1800.00

-2400.00

-3000.00

W/CIL

MERCH

0.00 688.00 1376.00 2064.00 2752.00 3440.00 4128.00 4816.00 5504.00 6192.00 6880.00

PLOTTED VALUES - 40 MISSING VALUES - EXCLUDED VALUES -

FILE	NUMNAME	(CREATION DATE = 12/07/84)	DIFF MEA WITH GR & EST MD GR -	(ACROSS) STARTING VOLUME - MER CUBIC
SCATTERGRAM OF	(DOWN) DIFF 3			
	344.00	1032.00	1720.00	2408.00
		3096.00	3784.00	4472.00
			5160.00	5848.00
				6536.00
	3000.00			
	2400.00			
	1800.00			
	1200.00			
	600.00			
	0.00			

MECH CUBIC

FILE NONAME (CREATION DATE = 12/07/84)

SCATTERGRAM OF	(DOWN) DIFF2	DIFF MEA WITH GR & EST WITH GR -	(ACROSS) STARTVOL	STARTING VOLUME -	PER CUBIC

344.00	1032.00	1720.00	2408.00	3096.00	3784.00	4472.00	5160.00	5848.00	6536.00

3000.00

2400,00

00-0081

1200.00

600.00

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-600.00

-1200.00

00-0081-

-2400.00

-3000.00

0.00	688.00	1376.00	2064.00	2752.00	3440.00	4128.00	4816.00	5504.00	6192.00	6880.00

PLOTTED VALUES -

40

EXCLUDED VALUES-

○

MISSING VALUES -

ANALYSIS OF DIFF. OF MEANS FOR MEASUREMENT ACC. & GROWTH CAL.

FILE NONAME (CREATION DATE = 12/07/84)

SCATTERGRAM OF (DOWN) DIFF1 MEA WITH GR AND MEA WD GR (ACROSS) DECADE

1.00	3.00	5.00	7.00	9.00	11.00	13.00	15.00	17.00	19.00

28

3000.00

2400.00

1800.00

1200.00

600.00

.00

-600.00

-1200.00

-1800.00

-2400.00

-3000.00

20.00

18.00

16.00

14.00

12.00

10.00

3.00

6.000

4.00,

2000

60

MISSING VALUES - 0

EXCLUDED VALUES-

48

PLOTTED VALUES -

MEET ALBIS

ANALYSIS OF DIFF. OF MEANS FOR MEASUREMENT ACC. & GROWTH CAL.

FILE NO NAME (CREATION DATE = 12/07/84)

SCATTERGRAM OF	(DOWN) DIFF3	DIFF MEA WITH GR & EST WO GR - M	(ACROSS) DECADE
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
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33	33	33	33
34	34	34	34
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52	52	52	52
53	53	53	53
54	54	54	54
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57	57	57	57
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59	59	59	59
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62	62	62	62
63	63	63	63
64	64	64	64
65	65	65	65
66	66	66	66
67	67	67	67
68	68	68	68
69	69	69	69
70	70	70	70
71	71	71	71
72	72	72	72
73	73	73	73
74	74	74	74
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90	90	90	90
91	91	91	91
92	92	92	92
93	93	93	93
94	94	94	94
95	95	95	95
96	96	96	96
97	97	97	97
98	98	98	98
99	99	99	99
100	100	100	100

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2400.00

-2400.00

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3000-00

7/8/77 M. R. J. W.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1990	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	

PLUTED VALUES -

48

EXCLUDED VALUES-

C

MISSING VALUES -

ANALYSIS OF DIFF. OF MEANS FOR MEASUREMENT ACC. & GROWTH CAL.

FILE	MUNAME	(CREATION DATE = 12/07/94)					
SCATTERGRAM OF	(DOWN) DIFF2	DIFF MFA WITH GR & EST WITH GR = (ACROSS) DECADE					
	1.00	3.00	5.00	7.00	9.00	11.00	13.00

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2400.00

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-600.00

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16.00

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12.00

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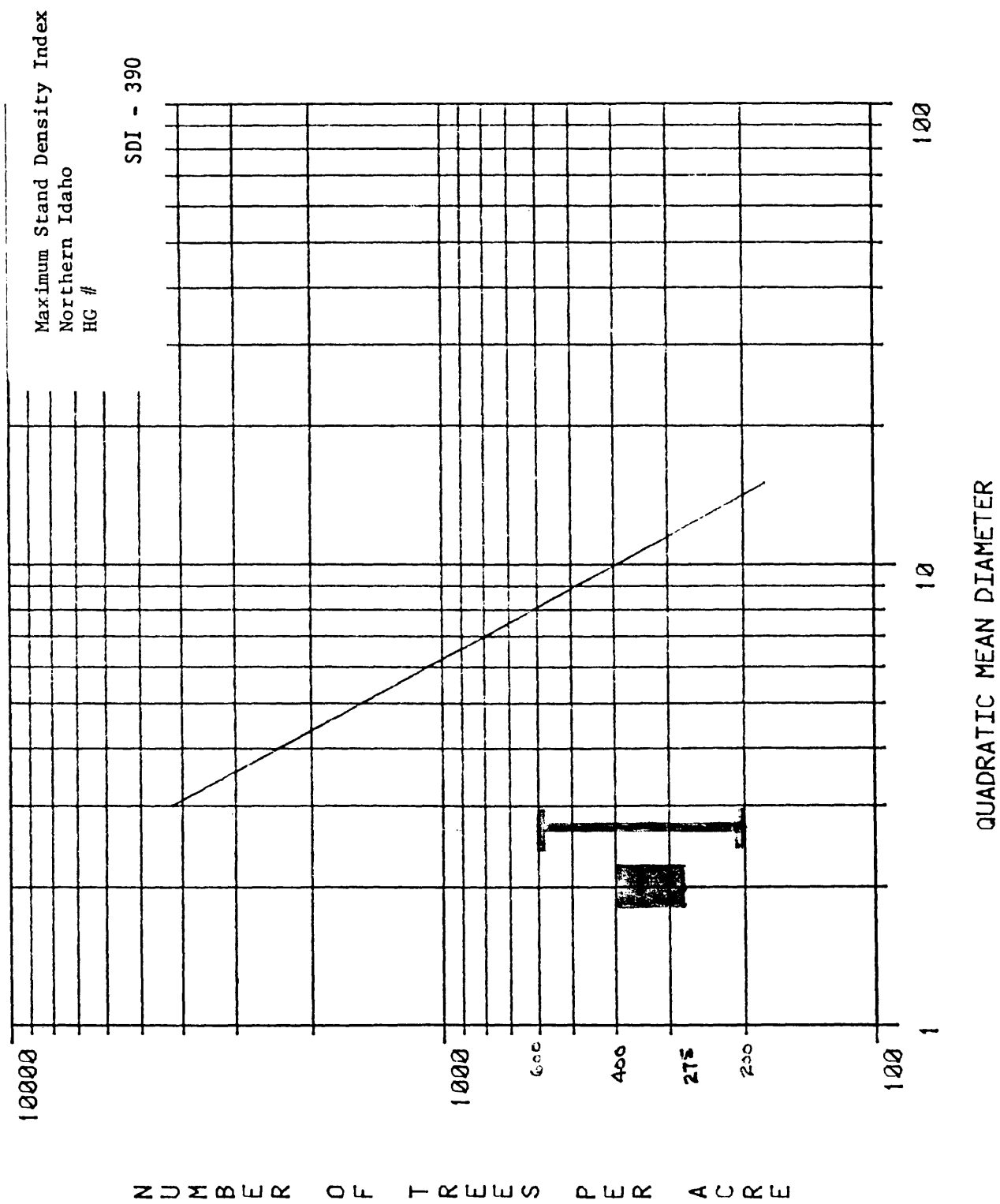
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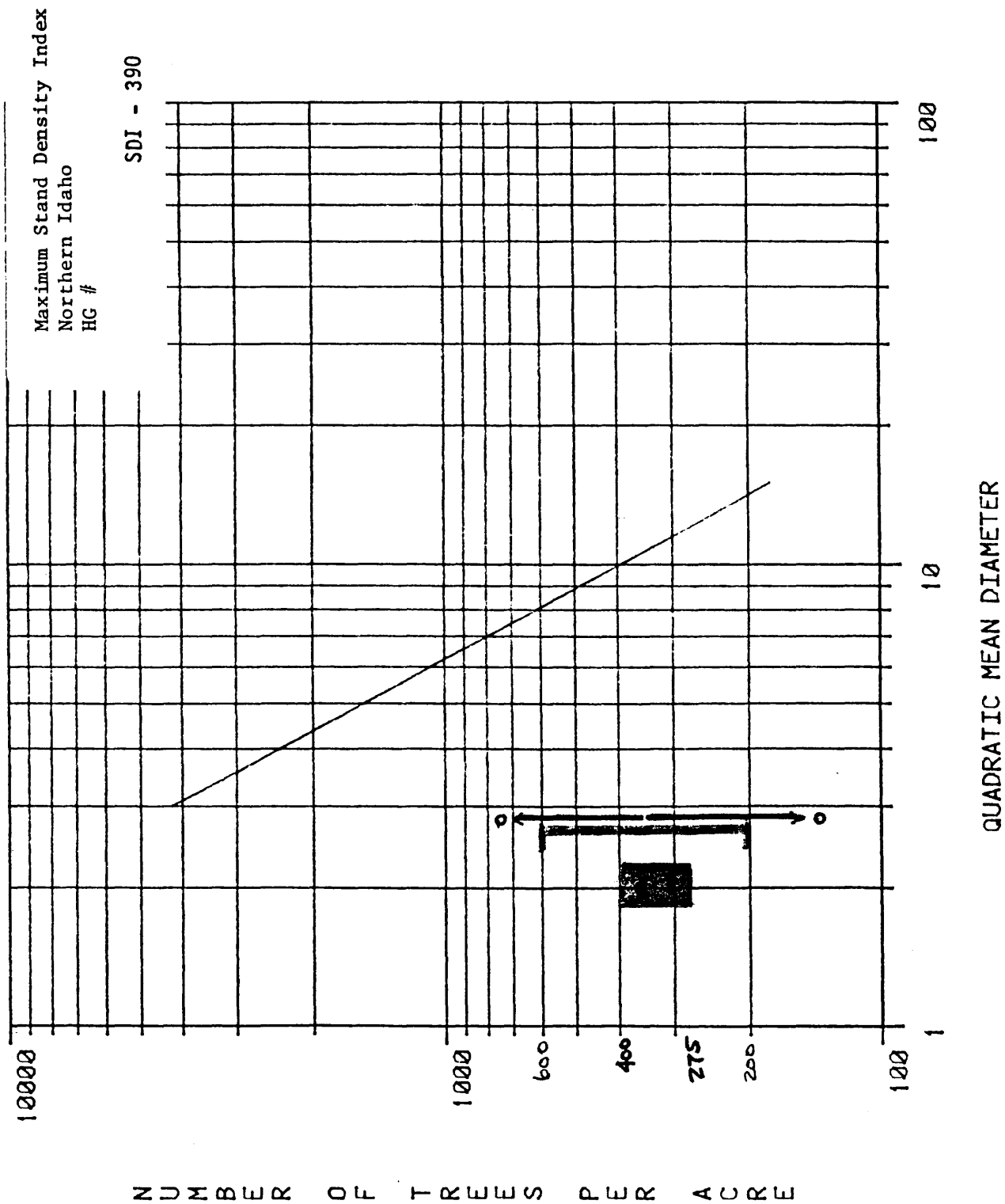
upper limit. If our stand is above 600 tree per acre, then we judge this difference between the actual and target as being too great and we need to take action (thinning) to meet our target stand. For a lower limit lets use 200 trees per acre. If our stand is below 200 trees per acre we need to take some action to get it up to the minimum we used in describing our target stand (275 trees per acre). Figure #11 compares our target stand, our threshold values, and the confidence interval for our data. Figure #12 displays the differences between the thresholds and the confidence interval as areas under a normal distribution. These areas can be represented as probabilities. These probabilities represent the condition of the stand falling outside of our target to the extent that it needs a treatment; a treatment that will not be prescribed if we make our decision using just the mean values from our stand examination (2% for lower end and 8% for upper).

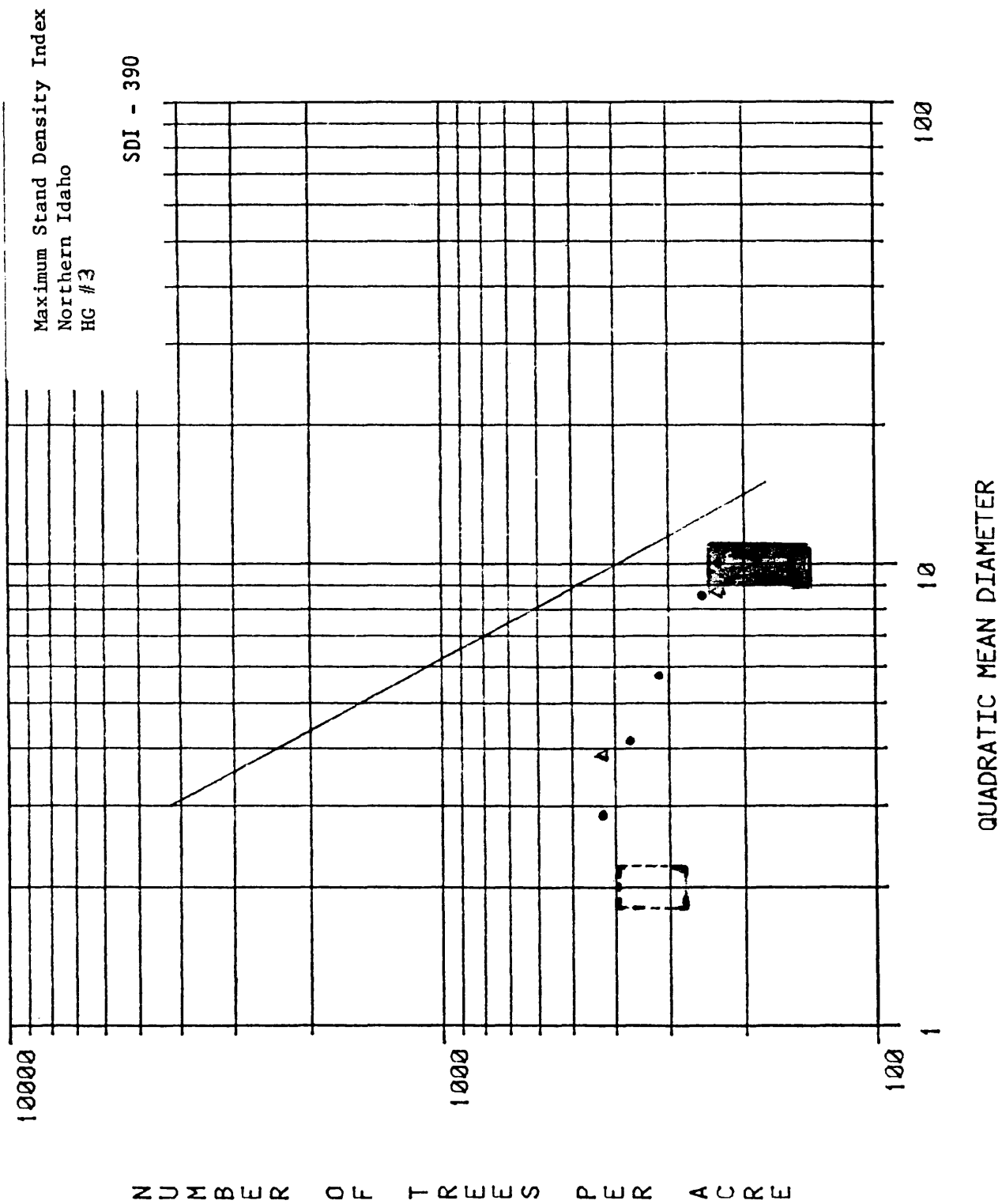
For considering the projection of the data, we define a future target stand that has a QMD of 10 inches with trees per acre varying from 240 to 150. Figure #13 displays our previously defined target stand, the projection of both the measured and estimated data, and the maximum difference points taken from the scattergram for average age 15 difference in QMD by decade. The same conclusion can be reached as with just the initial data compilation. The difference between measuring vs. estimating does not appear to make a significant difference in the decisions made for this stand. For this stand, the width of the confidence interval can contribute more to making a wrong decision in developing the silvicultural prescription. The more narrowly we define the range for our target stand and the smaller the difference between our target and our "thresholds", the more important the confidence interval width becomes.

The second stand represents an older one (50 years) in which calibration of diameter increment is a factor. A total of 78 tree records had diameter increment taken in the examination for this stand. For the initial compilation of the data no differences existed between the four types of stand data. A target stand was indentified as a QMD of 8.0 inches with basal area as a percent of the average maximum density for this particular habitat type group/geographic area. The range is 130 to 80 sq ft basal area. Figure #14 displays the mean basal area from the stand examination, the 95% confidence interval, and our target stand. The range of our target basal area 130 to 80 represents 60 and 40 percent of the maximum of 214. The confidence interval for the stand ranges from 124 to 214. Except for a minor amount (130 to 124) the confidence interval values are above the target stand. For our comparison we'll consider thinning to a basal area of 100 sq ft.

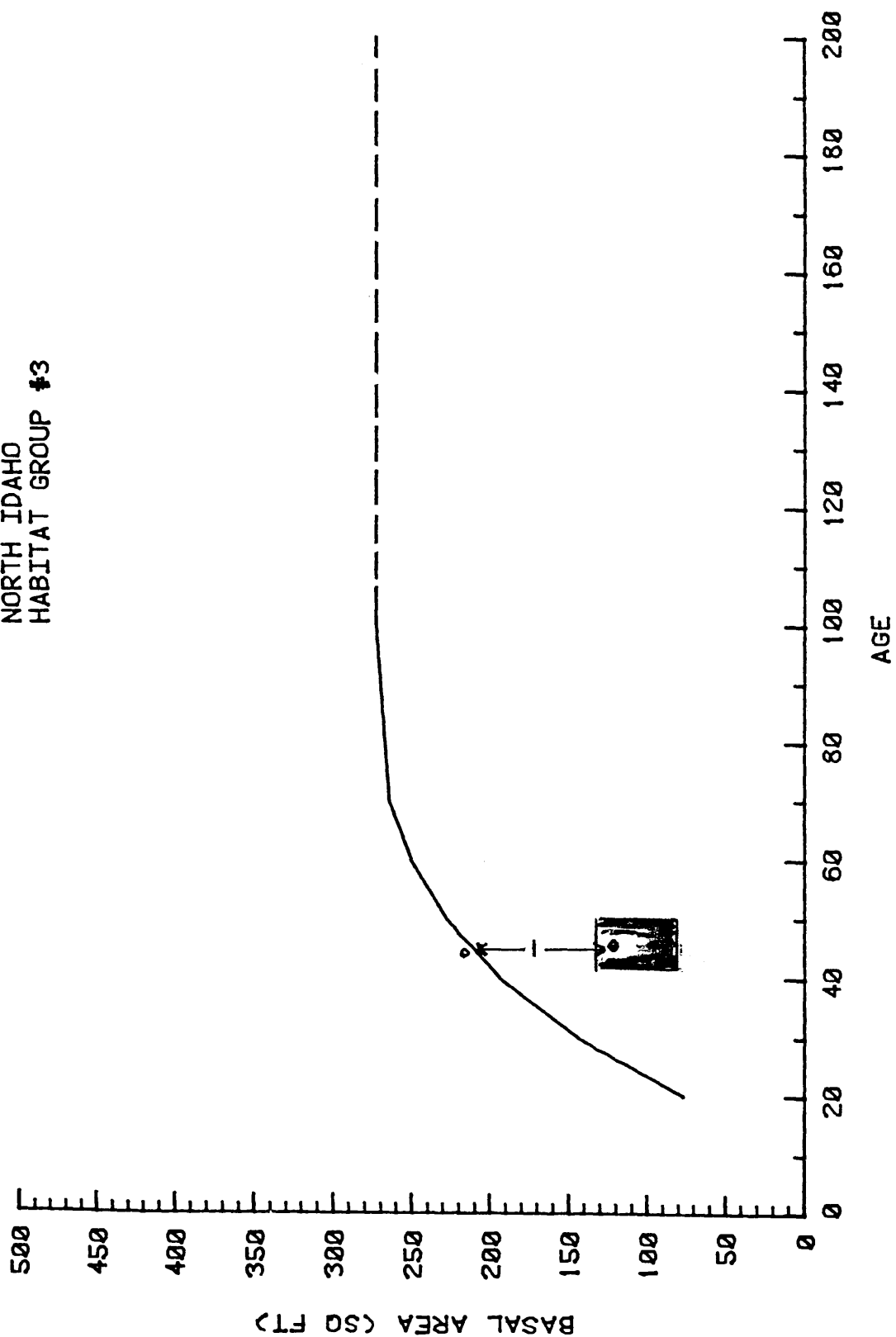
As with our previous stand, we need to identify "threshold" values. In this case it's an upper amount of basal area that if we tried to remove the volume it represents, unacceptable damage would probably result to the residual stand. For our analysis we have defined this as approximately 190 sq ft of basal area. For this stand, this level is so high ($100 + 190 = 290$) above the upper confidence interval we essentially have no upper limit. For the lower

limit we have identified removing about 40 sq ft of basal area which would be approximately 2000 board ft per acre. Figure #15 displays the relationship of these values to the confidence interval for the stand (2% probability). As with the initial compilation for the other stand using basal area instead of QMD gives the same results. In this situation it is not so much of a question





MAXIMUM BASAL AREA
NORTH IDAHO
HABITAT GROUP #3



of prescribing a treatment that may not be needed or not prescribing one when it is really needed, but a question of degree of need, or priority. The actual response of the stand may be different if we really are going from 214 to 100 sq ft as compared to going from 124 to 100. The priority of this stand to be thinned will vary if it really is closer to the maximum basal area value instead of 124 sq ft. The economic feasibility of the thinning (minimum volumes needed) will vary depending on where we really are within the confidence interval. The width of the 95% confidence interval is more significant than the differences resulting from the measured vs estimated and with and without growth for an analysis where all that is needed is initial data compilation.

Figure #16 displays the variation in the projection of the stand data using the prognosis model and our target stand. Our target is described in terms of a stand that at a rotation age of 110 years has a basal area ranging from 75 to 90% of the maximum basal area for that age. This shows that the projection of all data results in a stand above our target. After applying a thinning to the desired basal area of 100 sq ft, Figure #17 shows that two of the projections fall outside (below) our target stand; those without growth measurements. In using the data that represents no growth measurements, we would make a decision to thin to some level above the 100 sq ft level. With all variations of the data we would still make the same decision: to thin. However, the residual level would vary.

In comparing the variation in projected cubic volume the total variation at age 110 amounts to 3069 cubic feet (6714 to 9783). By comparing the original data to the estimated with growth, this difference is only 246 merch cubic feet (9537 to 9783). The initial 95% confidence interval for merch cubic feet from the measured stand data was 3184 to 5704, 2519 cubic feet.

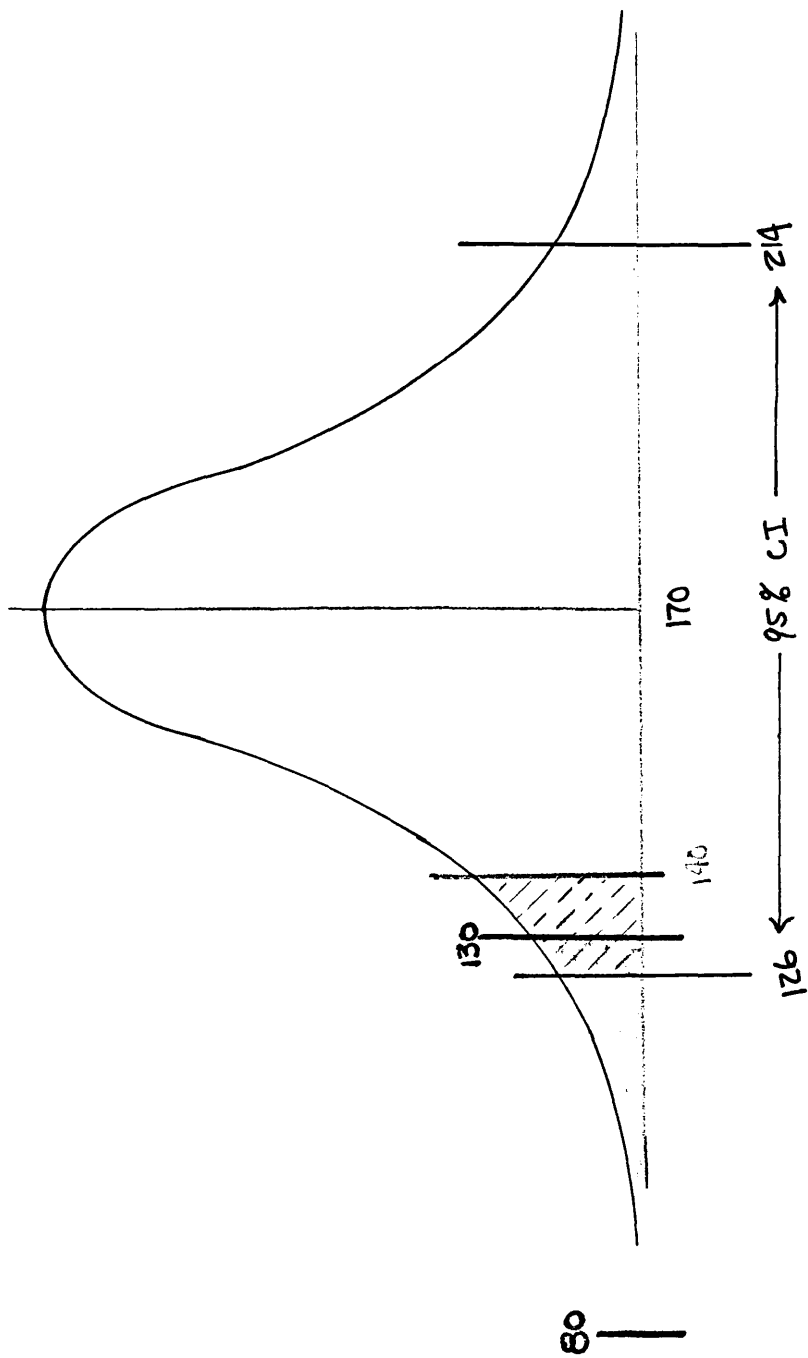
Summary and Conclusions

In arriving at conclusions one must keep in mind the manner and magnitude of the difference we made in the data and the basic assumption we made; that there is no bias in the estimating.

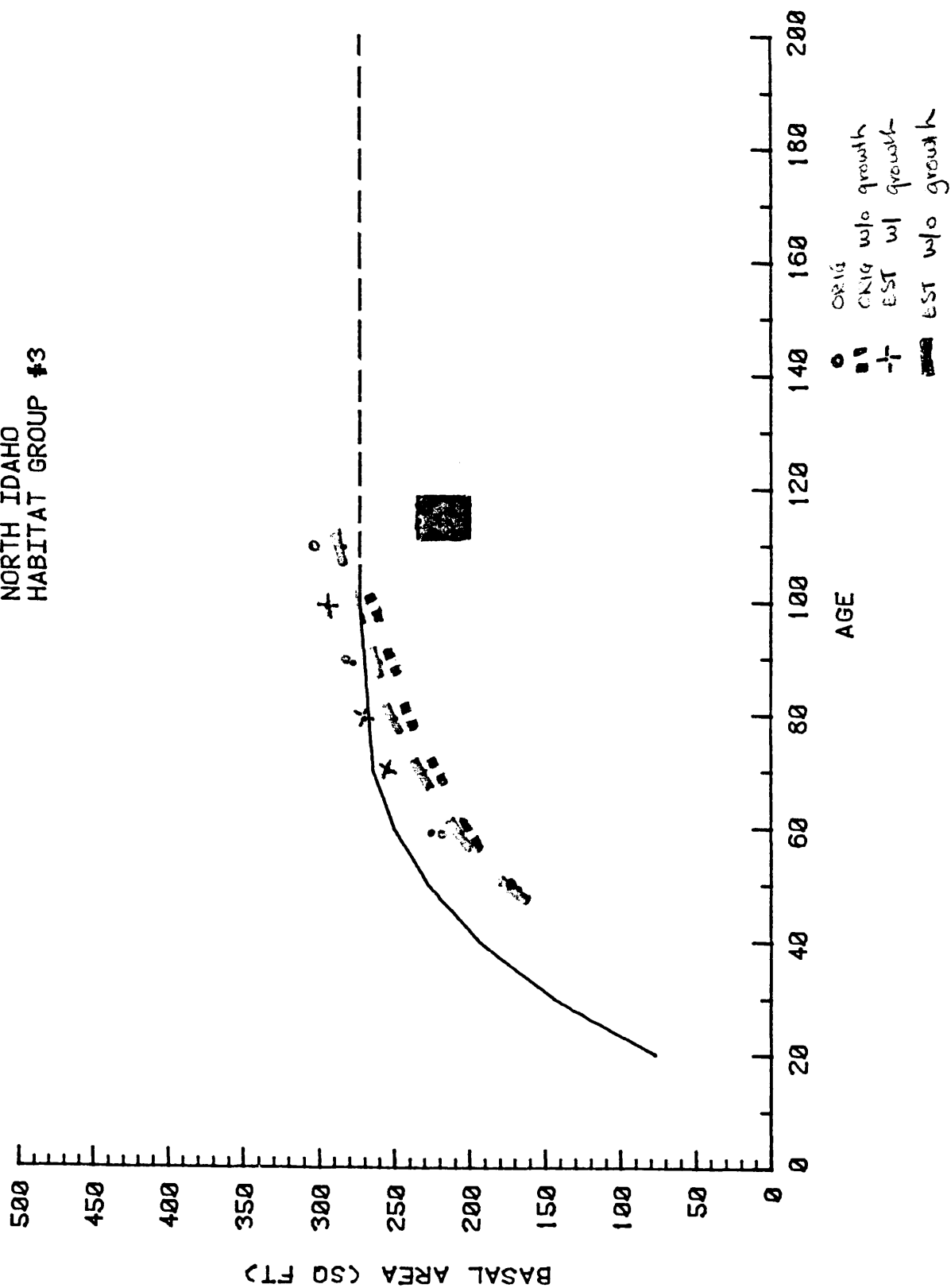
The differences resulting from measuring vs estimating and with and without diameter growth do not have a significant effect on the data resulting from an initial compilation. For projecting stand data with the prognosis model, taking diameter growth so that growth calibration can be made does become very significant; more so than whether the diameters and heights were measured or estimated. In terms of a large number of stands the measurement isn't significant, but for a given stand both the measurement accuracy and diameter growth calibration can be significant. However, the magnitude of the difference is often not a critical factor in the diagnosis step of the prescription process. More variation can be induced through taking a limited

number of plots (poorly designed sample), resulting in a large confidence interval.

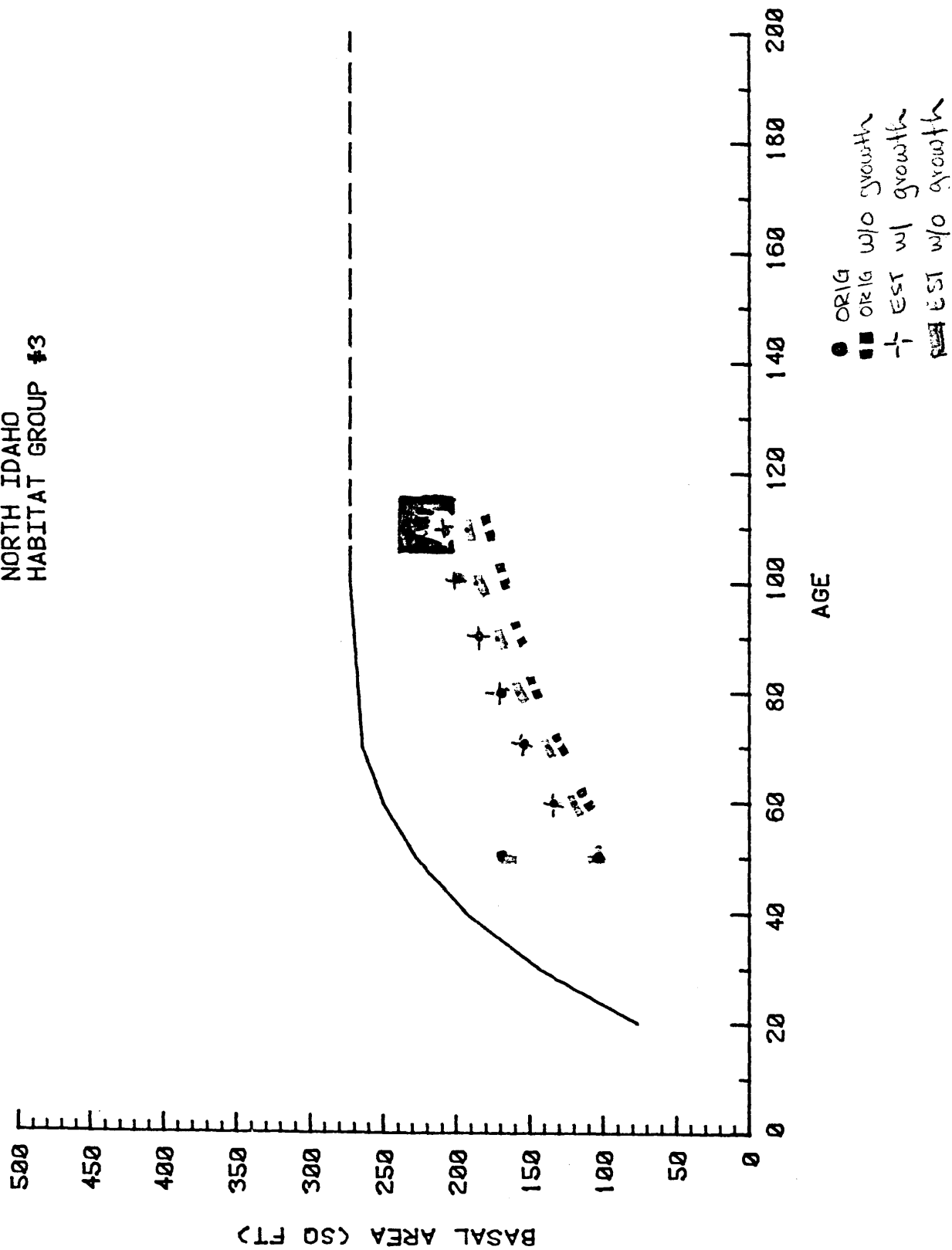
Another way to address what is significant involves looking at what the decisions are that have the potential to be costly if the wrong choice is



MAXIMUM BASAL AREA
NORTH IDAHO
HABITAT GROUP #3



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made. What does it cost to thin a stand that doesn't need it? What does it cost if the treatment timing is off by one decade? What does it cost if our stocking level is off by 20 sq ft basal area? The high costs of making wrong decisions are usually those associated with the wrong choice of silvicultural system, wrong choice of species for the site, wrong choice of type of regeneration. These latter decisions are not dependent upon whether tree diameters and heights are measured or estimated.

In terms of our matrix, if savings in time and dollars can be achieved by estimating tree attributes, then the role of our Quick Plots can be expanded. Quick Plots could become more of the "preferred" instead of the "acceptable" exam (figure #18). Additional plots can be taken providing a more acceptable confidence interval; growth can be taken when projections are desired, and other stand attributes such as the presence or absence of pathogens can still be obtained.

What seemed intuitively appropriate appears not to be analytically justifiable.

TYPE OF EXAMINATION

PURPOSE OF EXAM	PHOTO INTERP	WALK THRU	QUICK PLOTS	STANDARD EXAM
Project Activities:				
Immature Stand (less than rotation age)				
Origin & stand size unknown	NA	NA	~~Ref~~ Acpt.	~~Acpt~~ Pref.
Origin known, less than merch. size	NA	NA	Pref.	Acpt.
merch. size, Origin known or unknown	NA	NA	~~Ref~~ ~~Acpt.~~	~~Acpt~~ Pref.
Mature Stand (greater than rotation age)				
Obviously decadent > 20" QMD high damage incidence understocked poor vigor	NA	Acpt.	Pref.	NA
All other situations 12"-20" QMD low damage incidence > minimum stocking good vigor	NA	NA	~~Pref~~ Acpt.	~~Acpt~~ Pref.

Mature stands with a understory that may be manageable will be examined according to the criteria for immature stands

Silvicultural Prescription Process

Deerlodge National Forest

Northern Region

May 1985

**John W. Joy
Silviculturist**

My topic today is a discussion of an automated diagnosis and prescription process. The process uses the Data General equipment available at many offices.

I believe a bit of background information is necessary to explain how we came to this point. The original intent was to document small roundwood sales with silvicultural prescriptions and to do that documentation efficiently. Many of those treatments involved only small portions of a stand at any given time. But those treatments were being repeated in other parts of the same stand and in many other stands on a yearly basis. Long term objectives were not being identified nor were treated acres being reported. Thus this method to record both planned and accomplished treatments was developed.

Initially the prescription process was developed for only lodgepole pine stands with emphasis on removal of small roundwood products such as posts, rails, and prop poles. This was expanded to include other lodgepole pine stands where prescriptions are simple, straight forward, and repeated often. Further refinements in the process led to the addition of other species and other management objectives. The result was a 22 page written document.

From the outset my aim was to make the process usable to the forester and technician that were not silviculturists. Treatments are proposed for consideration rather than being dictatorial. The intent was to cause the user to think about his existing stand, compare it to a target stand, and then determine how best to treat his stand to meet the management objectives for that stand.

After a short period of use in the field our Regional Office experimented with a small portion of the process, putting it on the FLIPS system. Automating the process seemed to make it more usable and therefore the entire process was adapted to the computer program.

What I'm going to show you is what this process looks like on the Data General screen. Originally I had hoped to be able to display the program on a large screen TV but that was not possible. Another thought was to have a terminal here. That wasn't possible either. What I will use is the slide projector with slides taken of the process on the Data General.

To go along with the slides I am going to show you I've handed out copies of what the user will see when using this prescription process. The bold capitalized print is what appears on the screen. As you will see the program is very user friendly, prompting you at each step.

To begin the user must log on and call up the prescription process program. The present program is labeled SILV_PRESC4. The first full screen the user will see is the prescription needs page. Four choices are listed and the user must decide which choice best fits his stand.

THIS PROGRAM IS TO ASSIST IN THE DEVELOPMENT OF SILVICULTURAL PRESCRIPTIONS FOR CERTAIN TYPES OF STANDS. TO IDENTIFY A PRESCRIPTION CHOOSE ONE OF THE FOLLOWING:

1. -DOWN OR DEAD FIREWOOD

-IMPROVEMENT CUTTING IN AREAS WITH EXISTING PRESCRIPTION, E.G., REMOVAL OF POSTS AND POLES FROM AN AREA TO BE HARVESTED IN THE IMMEDIATE FUTURE AND WITH AN EXISTING PRESCRIPTION

-NONFORESTED AREAS (GRASSLAND) WHERE TREATED TO MAINTAIN OR ENHANCE FORAGE

2. -HIGHWAY RIGHT-OF-WAY

-POWERLINE RIGHT-OF-WAY

-ESSENTIALLY FOREST=GRASSLANDS WITH MINIMAL TREES WHERE BURN TREATMENT IS TO IMPROVE FORAGE, I.E., LANDS LESS THAN TEN PERCENT STOCKED WITH TREES

-SANITATION OR CLEANUP WITHIN EXISTING UNITS--DWARF MISTLETOE CONTROL IN RESIDUAL OVERSTORY

3. -POST AND POLE SALES (COMMERCIAL THIN)

-SIMPLE SAWLOG SALES

-GREEN HOUSE LOGS, POWER POLES (SILVICULTURIST MUST REVIEW ON-THE-GROUND, MARKING PLAN WILL BE NEEDED FOR THESE SALES)

-BACKLOG REFORESTATION OR REFORESTATION WITHOUT PREVIOUS PRESCRIPTION

-PRECOMMERCIAL THINNING STANDS

4. -MULTI-SPECIES STANDS

-STANDS IN RIPARIAN AREAS

-STANDS WITH RESORUCE CONCERNS NOT COVERED IN DEERLODGE PROCESS OR IN AREAS WITH CRITICAL WILDLIFE VALUES OR WITH VISUAL VALUES OR RETENTION

-MULTI-AGE STANDS

Depending upon the type of activity planned the program gives additional instructions:

If prescription needs number 1 is picked:

NO PRESCRIPTION IS NEEDED.

If prescription needs number 2 is picked:

A ONE OR TWO SENTENCE STATEMENT ON THE PRESCRIPTION FORM DESCRIBING THE TREATMENT IS ALL THAT IS NECESSARY.

If prescription needs number 4 is picked:

THE PROCESS IS NOT APPROPRIATE FOR THIS ALTERNATIVE. PRESCRIPTIONS MUST BE DEVELOPED BY A CERTIFIED SILVICULTURIST.

If prescription needs number 3 is picked:

ALTERNATIVE 3 REQUIRES THAT THE STAND HAS BEEN EXAMINED (IF NOT ENTER A 5). IF THE STAND HAS BEEN EXAMINED THEN FORM 21 MUST BE COMPLETED AND A MANAGEMENT OBJECTIVE IDENTIFIED. CHOOSE ONE OF THE FOLLOWING:

1. TIMBER MANAGEMENT
2. WILDLIFE AND TIMBER MANAGEMENT
3. VISUAL MANAGEMENT
4. DO NOT KNOW

A 5 terminates the program since an exam is necessary to complete the remaining steps.

Choosing management objective number 4 will direct you to:

GO BACK AND CHECK THE FOREST PLAN OR OTHER APPROPRIATE LAND USE PLANNING DOCUMENTS.

If either management objective 1 or 2 are picked you are directed to:

TO CHOOSE THE APPROPRIATE TARGET STAND SELECT ONE OF THE FOLLOWING

1. LODGEPOLE PINE (MORE THAN 75% LP)
2. DOUGLAS-FIR (MORE THAN 66% DF)
3. MIXED LODGEPOLE PINE AND DOUGLAS-FIR
4. OTHER SPECIES MIXTURES

If management objective 3 is picked a narrative on visual management is display.

This display is followed by the target stand format seen above.

VISUAL VALUE OBJECTIVES FOR THIS PROCESS RELATE BEST TO SITES WITH VQO OF MODIFICATION AND MOST CASES OF PARTIAL RETENTION. SOME STANDS WITH A VQO OF RETENTION MAY BE APPLICABLE. STANDS WITH VQO OF MAXIMUM MODIFICATIONS WILL NOT USUALLY BE TREATED DIFFERENTLY IN A FOREGROUND SITUATION THAN TIMBER VALUE LANDS.

TARGET STANDS WITH VISUAL CONCERNS HAVE BEEN GIVEN THE SAME NUMERICAL ATTRIBUTES AS TARGET STANDS WITH ONLY TIMBER CONCERNS. THE DIFFERENCE BETWEEN THEM IS NOT SO MUCH A FUNCTION OF THE ACTUAL NUMBER OF STEMS PER ACRE, BUT RATHER OF THE SPATIAL ARRANGEMENT OF THOSE STEMS WITHIN THE STAND. CREATION OF DIVERSITY THROUGH TREATMENT, OR AS A RESULT OF TREATMENT, IS THE WAY TO ACHIEVE THE VISUAL OBJECTIVE. THE EFFORT MUST BE PLANNED AND DOCUMENTED. BOTH HORIZONTAL AND VERTICAL DIVERSITY WITHIN THE STANDS NEEDS TO BE RECOGNIZED AS IMPORTANT AND PLANNED.

MANAGEMENT PRACTICES AND TREATMENTS ARE NEARLY THE SAME FOR ALL SPECIES IN THIS OBJECTIVE. THUS, NO DIFFERENCES HAVE BEEN DESCRIBED. DOUGLAS-FIR STANDS LEND THEMSELVES TO EASIER APPLICATION OF VISUAL PRINCIPLES BECAUSE LOWER BRANCHES ARE OFTEN LONGER LIVED.

THE FOLLOWING GUIDELINES, TAKEN FROM AGRICULTURAL HANDBOOK 559, WILL AID THE USER IN APPLYING VISUAL MANAGEMENT TO TREATED STANDS.

Selection of target stand number 4 terminates the program with the statement:

FOR OTHER SPECIES MIXTURES THIS PROCESS IS NOT APPROPRIATE.
SEE A SILVICULTURIST.

Selection target stand numbers 1, 2, or 3 will direct you to choose:

WHAT STAGE OF DEVELOPMENT FOR YOUR TARGET STAND

1. SEEDLINGS (1 INCH DBH)
2. SAPLINGS (1 INCH TO 4 INCHES DNH)
3. POLES (4 INCHES TO 6 INCHES DBH)
4. SAWLOGS (6 INCHES DBH)

Depending upon which stage of development is chosen the suggested target stand is displayed.

The program will now ask you to compare your existing stand to the target stand. The following information is needed:

8 DIGIT STAND-IDENTIFICATION NUMBER

DWARF MISTLETOE RATING

TYPE OF STAND EXAMINATION

TREES PER ACRE

STAND AGE TO THE NEAREST 10 YEARS

AVERAGE STAND HEIGHT IN FEET (THIS IS OF THE COMPONENT
YOU ARE TREATING)

STUMP DIAMETER GREATER THAN 3 INCHES - YES OR NO

PERCENT OF LODGEPOLE PINE OR DOUGLAS-FIR TREES

CROWN RATIO

SQUARE FEET OF BASAL AREA

AVERAGE STAND DIAMETER TO THE NEAREST INCH

If stump diameter is not an appropriate attribute, e.g. seedling, pole, and sawlog stands, just tab over and do not enter a value.

Next the program will list the values of the stand variables you selected:

FIELD DESCRIPTION VALUE

1. STAND-ID =
2. MISTLETOE RATING =
3. TYPE OF EXAM =
4. TREE/ACRE =
5. AVE. STAND AGE =
6. AVE. STAND HGT =
7. STUMP DIA GT 3 IN. =
8. % DF OR LP =
9. CROWN RATIO =
10. BASAL AREA =
11. AVE. STAND DIA. =

IF YOU WANT TO CHANGE ANY OF THE ABOVE VALUES ENTER FIELD NUMBER ELSE IF ALL VALUES OKAY, PRESS NEWLINE.

On lodgepole pine sawlog stands:

DOES THE STAND HAVE AN UNDERSTORY OF POLES? YES OR NO

On mixed species stands:

IS ADVANCE REGENERATION PRESENT? ENTER Y OR N.

Suggested treatment(s) is(are) displayed

The program now asks:

IF YOU WANT A SUMMARY OF THE OPTIONS YOU SELECTED
ENTER "Y" ELSE ENTER "N"?"

If No is selected the program terminates.

If Yes is selected a summary of your stand attributes are displayed.

You will then be asked:

IF YOU WANT A HARD COPY OF YOUR TARGET STAND AND THE
OPTIONS YOU SELECTED ENTER "Y"

If you select Y then the target stand, proposed treatments, and stand attributes will be printed. The process is now completed.

If you select N, or just tab through, then you now have the option of going back and changing management objectives, target stands, stage of development, different stand variables, starting over, or completing this program.

If finished:

YOU SHOULD COMPLETE THE STAND DIAGNOSIS AND PREPARE THE
DETAILED SILVICUTURAL PRESCRIPTION SUMMARY.

What is in the future for this process? I foresee additions to the system that could include other species, other management objectives, economics calculations, and a logical treatment sequence. I also envision ties or crossovers with the R-1 EDIT and TSMRS with perhaps an autoloading feature. Other possibilities could include compiling a summary of groups of stands and a photo series of target stands similar to the fuels photo series.

The following pages are appendix type material and include a Form 21 which is a data entry form for Region One's Timber Stand Management Record System. This form was mentioned previously. Also included is a sample detailed silvicultural prescription summary and three sample computer outputs from the Deerlodge prescription process.

R-1 TIMBER STAND DATA BASE
(Ref. FSH 2409.21e, R1)

FORM • 21

Forest _____

Name _____

Date _____

CARD 7

This stand originated from the
following parent stands on7 2
12 13 14 mo. day yr. 19

Stand Numbers

20

23

26

29

32

35

38

Comments:

CARD 1

FIELD NUMBER	CODE	DESCRIPTION	Stand ID
2	1	District	
3	2	Compartment	
4	3	Subcompartment	
5	4	Stand Number	
6	5	Region — Forest	
	6	Card Number	
	7	Action Code	
7	8	State	
8	9	Congressional District	
9	10	County	
10	11	Land Use Classification	
11	12	Stand Acres	
12	13	Forest Survey Type	
13	14	Land Form	
14	15	Soils	
15	16	Geology	
16	17	Slope Percent	
17	18	Aspect	
18	19	Elevation	
19	20	Habitat Type	
20	21	Productivity Class	
21	22	Site Index	
22	23	Index Species	
23	24	Operability	
24	25	Accessibility	
25	26	Capability Area	
26	27	Analysis Area	
27	28	Management Area	

*Fields are carried across from R1-Edit.

Action Codes: 2 = New Stand 4 = Update Existing Stand

R1-FS-2410-21(5/83)

DETAILED SILVICULTURAL PRESCRIPTION SUMMARY

Stand ID 204-3-02
Sale Unit 5Treatment Need Regeneration Cutting
ClearcutPrepared By John Vey Date 1-26-83
Approved By _____ Date _____

Activity	Activity Code	Year	Fund Code	Specifications
Regeneration Cutting Site preparation	4111 4984	0 1	12 11	Harvest will be by clearcut Upon completion of harvest, fuels treatment and site preparation will be by dozer piling and burning of the piles. Scarification should not exceed 50% and 10-15 tons/acre of large fuels should be left well distributed throughout the stand.
Reforestation Examination Reforestation	4317 4451 4432 or	1,3,5 5 3.5	03 12 03	Reforestation exams will be conducted to determine the stocking of natural regeneration. If after three years the stocking is not 300 trees per acre, plans should be instituted to plant to bring the stocking up to 436 trees per acre. Stocking exceeding 300 trees per acre evenly distributed, will be adequate to certify the stand as stocked. Regeneration will be 95% lodgepole pine. Stand exam will be conducted to determine the need for stocking reduction.
Stand Examination Stocking Reduction	4315 4521	18 20	37 02	If needed a "precommercial thinning" may be applied to bring the stand closer to optimum stocking. Target stand should be 425 to 450 trees per acre, favoring other species over lodgepole pine to enhance vegetative diversity.
Stand Examination Commercial Thinning	4316 4220	68 70	37 11	Examine stand to determine the need for an intermediate cutting. If necessary, apply an improvement cutting to enhance and maintain growth on residual stems. Thin from below so that residual basal area will be 80-110 sq. ft., and trees per acre will be 250-275. Continue to favor other species over lodgepole pine.
Stand Examination Regeneration Cutting	4316 4113	100 110-130	37 11	Stand examination to determine timing of regeneration cutting. Clearcut

THIS IS A SUMMARY OF THE OPTIONS YOU SELECTED FOR STAND 22406018

3: POST & POLE SALES(COMMERICAL THIN)--SIMPLE SAWLOG SALES
GREEN HOUSE LOGS,POWER POLES(MUST REVIEW, MARKING PLAN NEEDED)
BACKLOG REFOR OR REFOR WITHOUT PREVIOUS PRESC--PRECOMM THINNING STANDS

1: TIMBER MANAGEMENT
1: LODGEPOLE PINE(MORE THAN 75%LP)
4: SAWLOGS(6IN & GREATER DBH)
DWARF MISTLETOE RATING = 4
TYPE OF EXAM = 3
TREES/ACRE = 385
AVERAGE STAND AGE = 150
AVERAGE STAND HEIGHT = 60
STUMP DIAMETER IS GREATER THAN 3 IN.
% OF LODGE POLE TREES = 95
CROWN RATIO = 40%
SQ. FT. OF BASAL AREA = 140
AVE STAND DIAMETER = 9

THE PRESCRIPTION FOR YOUR STAND IS:

YOUR TARGET STAND IS 220 TREES/ACRE
LP GE 75%
BA IS 70 - 150 SQ FT
AGE IS GE 110 YEARS
MEAN DIAMETER GE TO 10 IN.

IN A TWO STORIED STAND OF SAWLOGS AND POLES CONSIDER THINNING
FROM BELOW TO REMOVE SMALL ROUND WOOD PRODUCTS. THE NEXT LOGICAL TREATMENT
WOULD BE A REGENERATION CUT.

CONSIDER A CLEARCUT.

IF SITE HAS MANAGEMENT CONSIDERATIONS OTHER THAN TIMBER, CONSIDER DEFERRED
OR NO TREATMENT.

THIS IS A SUMMARY OF THE OPTIONS YOU SELECTED FOR STAND 22406018

3: POST & POLE SALES(COMMERICAL THIN)--SIMPLE SAWLOG SALES

GREEN HOUSE LOGS, POWER POLES(MUST REVIEW, MARKING PLAN NEEDED)

BACKLOG REFOR OR REFOR WITHOUT PREVIOUS PRESC--PRECOMM THINNING STANDS

1: TIMBER MANAGEMENT

1: LODGEPOLE PINE(MORE THAN 75%LP)

1: SEEDLINGS(LT 1IN DBH)

DWARF MISTLETOE RATING = 1

TYPE OF EXAM = 3

TREES/ACRE = 200

AVERAGE STAND AGE = 3

AVERAGE STAND HEIGHT = 1

STUMP DIAMETER IS GREATER THAN 3 IN.

% OF LODGE POLE TREES = 95

CROWN RATIO = 90%

SQ. FT. OF BASAL AREA = 0

AVE STAND DIAMETER = 0

YOUR TARGET STAND IS 600 TREES/ACRE

LP GE 75%

CONSIDER FILL-IN PLANTING

THIS IS A SUMMARY OF THE OPTIONS YOU SELECTED FOR STAND 20402008

3: POST & POLE SALES(COMMERICAL THIN)---SIMPLE SAWLOG SALES
GREEN HOUSE LOGS,POWER POLES(MUST REVIEW, MARKING PLAN NEEDED)
BACKLOG REFOR OR REFOR WITHOUT PREVIOUS PRESC---PRECOMM THINNING STANDS
2: WILDLIFE AND TIMBER MANAGEMENT
3: MIXED LP-DF
4: SAWLOGS(6IN & GREATER DBH)
DWARF MISTLETOE RATING = 2
TYPE OF EXAM = 3
TREES/ACRE = 300
AVERAGE STAND AGE = 150
AVERAGE STAND HEIGHT = 50
STUMP DIAMETER IS GREATER THAN 3 IN.
% OF LODGE POLE TREES = 40
CROWN RATIO = 35%
SQ. FT. OF BASAL AREA = 150
AVE STAND DIAMETER = 12

THE PRESCRIPTION FOR YOUR STAND IS:

IF NO ADVANCE REGENERATION; CONSIDER REGENERATION HARVEST. THE MOST LOGICAL
OPTIONS TO CONSIDER ARE SEED CUT OF SHELTERWOOD, PREPARATORY CUT OF
SHELTERWOOD, OR CLEARCUT. CONSULTATION WITH WILDLIFE BIOLOGIST AND CERTIFIED
SILVICULTURIST IS ADVISED TO MAINTAIN COVER POTENTIAL.
GENERALLY HARVEST SYSTEMS WILL BE:
SHELTERWOOD ON DRIER HABITAT TYPES
2-STEP MOST SITES
3-STEP ON ESPECIALLY SENSITIVE SITES
CLEARCUT ONLY ON MOST MESIC HABITAT TYPES
CONSIDER SUPPLEMENTAL PLANTING(MORE THAN ONE SPECIES IF POSSIBLE) IF THE
POTENTIAL FOR NATURAL REGENERATION IS DOUBTFULL.

ADVANCED REGENERATION IS ESTABLISHED; CONSIDER REGENERATION HARVEST:

- A. OVERSTORY REMOVAL(REMOVAL CUT OF SHELTERWOOD)
IF REGENERATION HAS POTENTIAL FOR FUTURE CROP MANAGEMENT.
- B. CLEARCUT IF REGENERATION SHOULD NOT BE SAVED---I.E.,UNDESIRABLE SPECIES,
DISEASED, DAMAGED, LOW VIGOR ETC.,BEYOND REASONABLE RECOVERY.

SILVICULTURAL PRESCRIPTIONS WITH NEW LAND MANAGEMENT PLANS

NATIONAL SILVICULTURAL WORKSHOP

MAY 13-17, 1985

RAPID CITY, SOUTH DAKOTA

by: Jerry Henderson
Forester R-8
Timber Staff Unit

SILVICULTURAL PRESCRIPTIONS WITH NEW LAND MANAGEMENT PLANS

Most of our Forests have just completed or are nearing completion of the first round of planning under the National Forest Management Act. People are now looking at the document and asking themselves "Now that I have it, what do I do with it? How do I apply it on the ground?"

The silvicultural examination and prescription process is the stand level planning activity which implements the Land Management Plan objectives. The problem for the silviculturist is to be able to take the land management plan, which may contain many different management areas and analysis areas, and determine the management objectives, standards, and guidelines which are applicable to the particular stand or group of stands being examined.

Each Land Management Plan contains a section which provides Forest-wide management direction and goals, as well as Forest-wide standards and guidelines. In addition, each management area will be described, along with a set of standards and guidelines that apply only to that particular management area. The silviculturist should have no problem with Forest-wide direction or guidelines since they apply to the entire forest. However, in order to apply individual management area objectives, standards, and guidelines, the precise management area and analysis area of the stand under consideration must be identified. How easy or how difficult this becomes will depend somewhat on how the individual forest developed the FORPLAN model for their forest and/or the type of implementing instructions developed.

The proposed Land Management Plan for the National Forests in Mississippi is a document the silviculturist can easily apply to the ground, no matter where he or she is assigned on the Forest (Exhibit I).

Let us consider how I, if I were a silviculturist assigned to the Black Creek Ranger District on the National Forests in Mississippi, would implement the LMP through the silvicultural examination and prescription process.

I would first turn to the description of the Black Creek Management Area of the plan (Table 1). This gives a breakdown of total acres on the District by vegetative type. If I am considering a stand or compartment made up of the yellow pine type, it can easily be seen that there are 34,547 acres of yellow pine on the District. Further down the page is a breakdown of this acreage figure by beginning age classes. Then, turning to the FORPLAN allocation of cut for the yellow pine type (Table 2), the proposed regeneration can be determined.

As an example, if a stand of yellow pine between 50 and 60 years old is under consideration, I would turn to the description of the Black Creek Management Area (Table 1) and find there are 10,780 acres of this age class yellow pine on the District. Then the FORPLAN allocation (Table 2) shows that 7,708 acres of yellow pine between 50 and 60 years old were selected for artificial regeneration this plan period, or 72% of the total. This percentage figure is used as a guide in planning regeneration within the compartment.

Over the course of a year, about 72% of the 50-60 year old yellow pine examined would be prescribed for regeneration. A particular compartment might have more or less than 72%, but the overall average will be close. The total regenerated at the end of the 10 year plan period should be very close to the 10,780 acres selected by the FORPLAN model.

This same process is used to implement the Forest Plan Objectives for each regulated vegetative type on the District. A Regeneration Control Record is maintained for each vegetative type or working group to display regeneration goals by age class and to track accomplishments through the plan period (Exhibit II).

A page is also included in each silvicultural prescription, which list annual district objectives and gives the silviculturist an overall look at each compartment being entered in the current year in terms of existing conditions, FORPLAN or calculated regeneration, and how the acreage actually prescribed contributes to the LMP objectives. As silvicultural examinations and prescriptions are completed throughout the year, it is easy to track progress toward annual goals (Exhibit III).

This is one approach at making silvicultural examinations and prescriptions under the new Land Management Plans. It seems to work well under the circumstances described, allowing the silviculturist to identify Forest-wide objectives, district objectives, and then track progress toward those objectives.

Many of our proposed plans, however, will not be so simple to implement. Most Forests did not identify each district as a separate management area. FORPLAN solutions did not allocate by districts. When a District Silviculturist looks at the plan, he/she sees total acreage figures by management areas, which may include portions of several districts.

The proposed LMP for the Chattahoochee-Oconee National Forest is an example. The Forest is divided into 16 management areas. Some management areas are located entirely on one district, but most of them occur on more than one. Management Area 16, General Forest Area, occurs on all districts on the Forest.

The silviculturist on the District can turn to the description of Management Area 16 in the plan and determine the total forest acres, management goals, and Forest-wide standards and guidelines (Exhibit IV). The scheduled practices by management area (Table 3) displays the FORPLAN allocation for the management area in total. For example, there are 607,588 acres of Management Area 16 (Exhibit IV). Of this total, 10,205 acres of yellow pine, site class 2, age 61-100, is selected for regeneration by the clearcut method (Table 3).

Nowhere in the plan is the acreage of Management Area 16 displayed by District or how much of the 10,205 acres of selected regeneration is located on a particular district. The silviculturist must go to some other source to determine district goals.

This could be done by a process similar to what has previously been described. It would be necessary to go to the planning records and existing stand inventory data to determine acreages and percentage figures by districts. Another approach is to complete a Forest-wide 10-year stand selection process to allocate acreage objectives to individual Districts. Most of our Forests are still in the process of developing instructions for implementing their Land Management Plans.

The methods used in applying silvicultural prescriptions under the new Land Management Plans, may vary somewhat on different forests. Whatever method or approach is used, the silviculturist must assure that the prescription supports the overall objectives of the plan.

TABLE 1 -- Description of the Black Creek Ranger District
(Excerpt from Proposed LMP, NF's in Mississippi)

Vegetative Type	Suitable for Timber	Not Suitable for Timber
Yellow Pine	34,547	8,250
Hardwood	14,234	3,572
Longleaf	83,497	15,508
Slash	30,622	5,731
Pine-Hardwood	0	0
Moderate Hardwood	802	11,621
Moderate Slash	2,324	4,331
Water		546
Permanent Openings		17,268
TOTALS	232,853	66,827

Suitable Timber Analysis Areas
Working Group Acres

Beginning Age Class	YP	Hdwd.	Slash	LL	Mod. Slash	Mod. Hdwd.
1	4,869	509	11,482	8,294	352	208
2	1,698	526	2,708	5,673	297	57
3	3,691	429	3,191	2,371	212	10
4	9,281	968	3,426	12,105	749	28
5	10,780	5,338	7,942	36,812	212	140
6	2,090	3,716	1,343	16,896	152	249
7	1,730	1,695	466	1,195	61	61
8	273	493	62	62	32	49
9	134	82	--	--	257	--
10+	--	478	--	89	--	--

TABLE 2 -- FORPLAN Allocation of Cut Acres for First Decade
(Excerpt from Proposed LMP, NF's in Mississippi)

Land Suitable for Timber Production		
<u>Slash Working Group</u>		
<u>Practice</u>	<u>Beginning Age Class</u>	<u>Proposed Acres</u>
Artificial Regen.	6	
	7	73
Artificial Regen., Convert to Yellow Pine	4	2,421
	5	2,210
	6	1,153
	7	392
	8	62
Nat. Regen., Convert to Hardwood Intermediate Cut	5	2,000
	1	8,037
	2	1,896
	3	2,234

<u>Yellow Pine Working Group</u>		
<u>Practice</u>	<u>Beginning Age Class</u>	<u>Proposed Acres</u>
Artificial Regen.	4	
	5	7,708
	6	1,152
	7	1,450
	8	273
	9	134
Natural Regen. Intermediate Cut	6	638
	1	272
	3	272
	4	7,743
	5	2,004

<u>Longleaf Working Group</u>		
<u>Practice</u>	<u>Beginning Age Class</u>	<u>Proposed Acres</u>
Artificial Regen.	5	
	6	624
	7	635
	8	62
	10+	89
Natural Regen.	5	
	6	900
Intermediate Cut	1	
	2	3,971
	3	1,660
	4	8,474
	5	25,768
	6	

TABLE 3 -- Summary of Scheduled Practices by Management Areas for the First Decade

(Excerpt from the Chattahoochee-Oconee Proposed LMP)

Prescription	For. Type	Mgt. Type	Prod. Class	Age	Acres Allocated ^{1/}						Total
					MA 5	MA 11	MA 12	MA 14	MA 15	MA 16	
Shelterwood	White Pine	White Pine	1	61-100	112	2,489	66		710	12,082	15,459
Seedtree	Yellow Pine	Yellow Pine	2	61-100			157	141		10,030	10,328
Clearcut	Yellow Pine	Yellow Pine	2	61-100						10,205	10,205
Clearcut	Yellow Pine	White Pine	2	61-100					81	7,500	7,581
Thin	Cove	N/A	3	41-60				35	1,553	4,345	5,933
Thin	Cove	N/A	2	41-60	34				271	4,750	5,055
Clearcut	Yellow Pine	Yellow Pine	1	41-60				974		3,762	4,736
Clearcut	Yellow Pine	Yellow Pine	1	61-100				114		3,933	4,047
Thin	Pine	N/A	2	21-40				59		3,199	3,258
Clearcut	Yellow Pine	Yellow Pine	3	61-100						2,830	2,830
Seedtree	Yellow Pine	Yellow Pine	3	61-100						2,513	2,513
Thin	Cove	N/A	1	41-60						2,119	2,119
Selection	Upland White	Upland White	3	61-100	1,028	119	715				1,862
Clearcut	Yellow Pine	Cove White	1	61-100					140	1,628	1,768
Clearcut	White Pine	White Pine	2	100+						1,268	1,268
Clearcut	White Pine	Cove	1	61-100						935	935
Selection	Yellow Pine	Yellow Pine	2	61-100		255	361				616
Clearcut	Yellow Pine	Upland Yellow	1	61-100						554	554
Selection	Yellow Pine	Pine	1	41-60	25	338	138				501
Clearcut	Yellow Pine	Upland Yellow	2	61-100						465	465
Selection	Pine	Pine	2	41-60		113	37			265	415

^{1/} Management areas 1, 2, 3, 4, 6, 7, 8, 9, 10, and 13 are not available for timber harvesting except as specified under Standards and Guidelines for each Management area.

EXHIBIT I

(Excerpt from Proposed LMP, NF's in Mississippi)

MANAGEMENT AREAS

The Forest has been divided into twelve Management Areas (MA) comprised of Analysis Areas (AA). The AA's fall in two general groupings - those suitable for timber production and those allocated to other resource uses (lands not suitable for timber production). Management Areas coincide with Ranger Districts except the Tombigbee R.D. is divided into three MA's: the Yalobusha (part of the Holly Springs National Forest), the Trace and Ackerman which are separated units of the Tombigbee National Forest. The numbering scheme for the MA's matches the Forest Service accounting system for these units; the numbers are 1-11 and 17.

The use of administrative units for management areas facilitates scheduling, planning, implementing, and financing the Forest Plan. The National Forests in Mississippi are six widely separated proclaimed National Forests. Each MA is relatively uniform in timber productivity within itself (Table 4-6). However, between Management Areas, both productivity and timber value vary widely. The State has been divided into five market areas for timber appraisal purposes. The Forest Plan Economics and Yield tables were based on similar yields within a National Forest and the similar values within the market areas.

In most cases the same prescriptions will be used on similar AA's in each MA. For example, the thinning prescription for Yellow Pine Age Class 3 would be the same on all MA's. The application of constraints in the FORPLAN Model varied. Some were applied to all MA's, others to one or more proclaimed National Forest, and others varied in their application between MA's depending upon the purpose of the constraint. Standards and Guidelines unique to a specific MA are shown under the individual MA headings. Forest-wide standards and guidelines are applied to all MA's.

The following AA's occur on various MA's and have been identified on the maps accompanying this Plan. The applicable standards and guidelines are found under Forest-wide standards and guidelines, management prescriptions, and management areas.

- RCW Colonies and Recruitment Stands
- Trails
- Tank Maneuver Area
- Artillery Impact Area and Buffer
- Military Rifle Range
- Potential Botanical Areas
- Experimental Forests
- Utility Corridors
- Wild and Scenic River Study Area and Black Creek Float Trip
- Black Creek Wilderness
- Leaf Wilderness
- Ashe Forest Tree Nursery
- Erambert Forest Seed Orchard
- Gavin Plantation Auto Tour and Unmanaged "40"
- Research Natural Area
- USFS Hydrology Laboratory
- Archaeological Site
- SCS Plant Materials Center
- Other Agency Special Use
- State Park
- Botanical Area

EXHIBIT I (Cont'd)

- Scenic Area
- Developed Recreation Area
- Administrative Sites
- General Forest Grazed
- General Forest Non-Grazed

Additional acres of unsuitable forest land were not mapped. These were the areas classed as lands not physically suited for timber production due to lack of site preparation technology or an inability to restock within 5 years. Included in this category are limestone outcroppings, sterile river outwash, and waterlogged soils.

EXHIBIT II**Planned Regeneration Control Record**

_____ Working Group

_____ District

First Period Regeneration Goals Beginning Age Class									
	4	5	6	7	8	9	10+	Total	Av. An Regen
Regen Ac									
Total Ac									
% to Regen									

Beginning Age Class

Fiscal Year	4	5	6	7	8	9	10+	Total	Diff From Av. Annual Regen	
86 Regen Ac Cum Total										
87 Regen Ac Cum Total										
88 Regen Ac Cum Total										
89 Regen Ac Cum Total										
90 Regen Ac Cum Total										
91 Regen Ac Cum Total										
92 Regen Ac Cum Total										
93 Regen Ac Cum Total										
94 Regen Ac Cum Total										
95 Regen Ac Cum Total										

Instructions: Sum of given FY prescribed program from compartment prescriptions

EXHIBIT III

Ranger District

A. Regeneration Objectives

Working Group FY _____

Page ____ of ____

Annual District Regeneration Objectives

	4	5	6	7	8	9	10	11	12	13	14	Total
BAC												
Total Acres												
%Regeneration												
Regeneration Acres												

Compt. No.	Max Allow Regen	Beginning Age Class												
		4	5	6	7	8	9	10	11	12	13	14	Total	
		A												
		C												
		P												
		S												
		A												
		C												
		P												
		S												
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		C												
		P												
		S												

Key

BAC-Beginning Age Class (Base Year 1980 Age Class)
 A-Compartment Acres Available in Base Year
 C-Acres Computed for Regeneration
 P-Prescription Acres
 S-Acres Selected for Regeneration
 % Regen-From Planned Regeneration Control Record
 Regen Acres-Total Computed Acres for FY
 Total Acres-Totals for Compartments to be Entered

INSTRUCTIONS - FORM MS 2400-41A-1--Regeneration Objectives

This form is part of the Silvicultural Examination and Prescription Report. Using the order of entry prescribed in Appendix C, "10 Year Sales Plan" of the LMP, list the compartments to be entered in a given fiscal year. Using available total compartment acres calculate the maximum allowable regeneration based upon regenerating 25% of a compartment (LMP Standard and Guidelines) or when applicable, the maximum to be regenerated when constrained by the red-cockaded woodpecker.

Next, using available stand data, complete line A for each compartment. Total line A by each Beginning Age Class (BAC) for all compartments to be entered. These totals are entered on the line total acres by BAC, under District Regeneration Objective. Enter the appropriate % of regeneration by BAC, calculated from the LMP, on the line under annual District Regeneration objectives.

The regeneration acres line is completed by applying the appropriate percentage to the total acres by BAC.

Next, complete line C by BAC for each compartment by applying the % of regeneration by BAC found under "Annual District Regeneration Objective" to line A.

As prescriptions are completed, line P (acres by BAC as found by the Prescrip-tionist) and S (acres selected for regeneration) are completed for each compartment.

EXHIBIT IV

(Excerpt from Proposed Chattahoochee-Oconee LMP)

MANAGEMENT AREA 16 (607,583 acres)

<u>Description</u>	This management area consists of all Forest lands not included in the other management areas and is referred to as the <u>general forest area</u> . These lands are located in the following DBRU's-- <u>1/</u> --Blue Ridge DBRU - 463,088 acres --Upper Piedmont DBRU - 42,062 acres --Lower Piedmont DBRU - 89,048 acres --Ridge and Valley DBRU - 62,647 acres
<u>Management Goals</u>	To administer the area in compliance with the Multiple-Use Sustained Yield Act of 1960.
<u>Management Direction</u>	Emphasis placed on the maintenance in perpetuity of a high level annual or regular periodic output of the various renewable resources of the Forests without impairment of the productivity of the land.

1/ Blue Ridge DBRU (Districts - 02, 03, 04, 05, 06, 07), Upper Piedmont (District 06), Lower Piedmont DBRU (District 08), Ridge and Valley DBRU (District 01).

SILVICULTURE AT THE DISTRICT LEVEL

Presentation at the National Silvicultural Workshop

Rapid City, South Dakota

May 13-16, 1985

Michael B. Murphy

Elk Mountain Ranger District

Black Hills National Forest

I've been asked to talk on how silviculture is practiced and implemented at the District level. My background for this is that I am a Certified Silviculturist and am also the Timber Management Assistant on a District in the Black Hills.

Management on our District is generally planned for on what we call a Resource Management Area. The boundaries for these areas usually follow watershed lines and vary from 5,000 to 20,000 acres (and usually comprise three to five Data Base locations). Our goal is to bring the whole area under management as directed by the Forest Plan. All resources and functions are examined and their needs evaluated. An Implementation or Activity Plan is then prepared which coordinates all projects in the area for the next three - five years. One all-inclusive Environmental Assessment is prepared to cover all activities. It may sound like a lot of work, but we've found that in the long run it's easier than preparing separate plans for each resource or each year's activities. We also feel confident that by dealing with a large area, and including all resources, conflicts between resources are minimized. For example, range isn't eradicating unpalatable shrubs that wildlife previously planted for deer browse.

Our successes in these plans and in planning for specific projects involving silviculture are a result of following three principles:

1. Interdisciplinary Approach.
2. Field Verification.
3. Building Support.

Our failures have usually been a result of not following one or more of these guidelines.

The 1st principle is have an

INTERDISCIPLINARY APPROACH

In discussing an Interdisciplinary Approach we can look at it in two ways:

1. The role of the Silviculturist, and
2. The process used.

An Interdisciplinary Approach requires that, as Silviculturists, we have a broader view of our roles than a simple definition might imply. Silviculture has been defined as growing and tending a crop of trees. If we work at a nursery, that may be all that we do.

What we really do, however, is much more extensive. We help tend the whole forest ecosystem through our involvement with Forest Plans Environmental Assessments, KV Plans, Fuel Plans and the myriad opportunities we have to provide professional input on resource projects. We provide input on how the soil, water and vegetation found in a forest can be re-arranged or otherwise treated to provide outputs such as timber, aesthetic views, wildlife habitat, forage and recreation.

Frederick Baker, in an early edition of his textbook Principles of Silviculture defined forestry as "...the scientific management of forests for the continuous production of goods and services. "He also said that "...the forester should work for the good of the forest as an entity." (emphasis added)

Our Management Area Plans are an attempt to practice FORESTRY. Silviculture is used as a tool to manipulate the forest ecosystem to yield the products that the ID approach has determined to be needed in the area.

The process we use is an informal one. Usually only District personnel are involved and most people involved have dual roles. For example, range and wildlife are represented by the same individual, as is fuels and recreation. The important thing isn't having a specialist from every resource but to insure that there's enough people present to have a meaningful dialogue about the area's management needs.

The process itself starts with Scoping. This involves identifying the issues, concerns, and opportunities relevant to the area. Each resource specialist provides input on what he/she considers the most critical management problems are. From the input received, broad goals, and opportunities in the area are determined.

Once the goals are clearly established, each resource reviews its objectives for the area which will meet the goals decided upon. These objectives are commonly linked to specific projects that are proposed for the area. Next

comes the crucial step of producing a plan which will provide on the ground direction in the most efficient manner.

The first step is to have each specialist describe their proposed projects in terms of the following five factors:

1. Environmental Effects (effects on soil, vegetation, wildlife, etc.).
2. Sponsor (who wants the action and why).
3. Timing (deadlines, season of accessibility, etc.).
4. Technical details (methods and tools to be used).
5. Public interest (likelihood of controversy or special public relations needs).

This informs everyone involved of potential conflicts and potential areas of cooperation where it may be possible to combine or re-design projects to meet more than a single objective. For example, it may become apparent that a need for fuel reduction could be combined with a range project to provide increased forage. In other cases, however, it's obvious that there are mutually exclusive projects, such as the timber shop wanting to cut an area, wildlife wants to retain for cover.

When (not if) there are conflicts, the real challenge of the interdisciplinary

approach begins. The task is to decide which projects are implemented, which can be modified, and which have to be dropped from the program. An open forum type of meeting is held to resolve the conflict. It is important that each participant be aware of the pressures that the projects' spokesperson is facing. These pressures fall into the following five categories and are why they were first proposed:

1. OUTPUT NEEDS: Forest Plans and budget allocations call for the production of certain levels of outputs. (Targets) These influence the selection of projects.
2. POLITICAL REQUIREMENTS: This includes a review of Forest Plan direction, commitments to outside groups or organizations and NFMA requirements, such as the requirement for regeneration within six years of the regeneration cut.
3. SOCIAL FACTORS: This is a measure of the social benefits or public relations benefits that may accrue from a project. Examples of these would be meeting a personal use firewood demand, or accomodating extensive hunting season use.
4. ECONOMICS: For example, the availability of KV or appropriated funds may influence the timing or location of a project.
5. OWN NEEDS: Every individual has a slightly different opinion of what is most important for an area (hierarchary of needs). These personal values influence their support or opposition to a

project. The team usually ends up respecting this feeling as long as the overall goals are met.

The second principle that we try to follow is FIELD VERIFICATION:

This is a very important step. In order to discuss management for an area its vital that anyone who plays an important role in managing the area has personally visited the site. Personal "hands on" knowledge is needed for each resource specialist to represent their programs. In practice what we find is that if a specialist tells us we have a critical problem in the area based on only a map or a report, he/she may end up being ignored. For example, the Landscape Architect may mention that visual quality is an important objective, but unless he is willing to commit his energies to visit the site, either before the scoping meeting or during project planning, his input generally gets heavily discounted. Field Verification is a barometer of a person's interest or level of importance the person attaches to the project.

For the initial planning site visits can be somewhat limited. We find, for example, that the Fire Control Officer who has been on the District for twenty-two years has enough knowledge of most planning areas by virtue of his longevity on the District; also his input is of a more general nature concerning the planning unit as a whole.

For silvicultural prescriptions, on the other hand, it's necessary to visit or walk every stand to 1) determine what's on the ground now in terms of vegetation, and 2) make an estimate of the site's potential to determine if it's feasible to meet the objective on the ground. It is very important that

those planning the management of an area get out to visit; it is even more critical that the silviculturist writing the prescription that will meet the objectives decided upon for the area get out and visit every stand.

If lack of funds and/or manpower preclude individual site visits, it seems that on our District the probability of future problems is doubled or tripled.

Our third guideline we try to follow is getting the BUILDING SUPPORT. We do this by:

Involving other resources in the planning and execution of silvicultural projects.

and by,

Developing a well-trained enthusiastic pre-sale team through training, involvement, monitoring and feedback.

The best term for describing how all resources are involved in our process is as a team. That is a group of people who voluntarily get together to meet a common goal.

During the planning process, each resource specialist has the opportunity to provide input. Besides developing a multiple-use plan, it also develops support for our silvicultural activities because they have had a share in shaping them. Instead of having timber projects we end up with area management projects. From our own experience in trying to implement Forest Plan

direction, a single forester, timber manager, or silviculturist is apt to have too narrow a view.

The silviculturist teams up with the resource managers when he prescribes a specific treatment. The old saying "Two heads are better than one" is true. By having an open, non-critical relationship each is able to share their expertise.

I'd like to again quote Baker who said "...a sufficiently wise and flexible silvicultural art can be developed on the ground only by practitioners who understand the forest as a biological entity." (Emphasis added) Every resource has developed its' own specialized techniques and jargon to deal with the complexities of its management. If the Silviculturist doesn't communicate with other specialists he's apt to get lost in AUM's and ROS's, and VQO's.

For timber sales this team concept is also extended to our seasonal employees doing the actual sale marking. This means using good personnel management techniques in dealing with them. Recent books such as The Art of Japanese Management and In Search of Excellence include the basic theme that people are an organization's most important resource. One chapter in the later book is called "Man Waiting for Motivation". The title certainly says a lot for the opportunities we have to involve the pre-sale forester and the seasonal marking crew in accomplishing our silvicultural objectives.

Our marking crew is trained in the principles of ponderosa pine silviculture in addition to how to use a marking gun. The training program is an on-going one with frequent brush-up lessons in the field or 15 to 30 minute slide talks in the office.

There is constant checking and feedback on their work (on a daily basis at the start of the season). Each marker has their own individual paint mark so that when stands are critiqued recognition for a good job can be given to the right person.

Crew bosses and straw bosses are encouraged to ask questions and to discuss prescriptions that don't seem right. We've found that several times the original prescription wasn't as good as what the marking crew boss suggests. If the original silvicultural prescription is upheld, we see it as an opportunity to give further training in the how and why of our marking program.

This approach builds an esprit de corps which is vital to avoid mistakes in the field.

In conclusion, I'd like to review the three steps necessary to accomplish a silvicultural activity.

1. Diagnosis:

- a. Know objectives (use ID approach be open and flexible).
- b. Know site potential (inventory).

- c. Have a personal knowledge of the area.
-
- 2. Prescription:
 - a. Perform an on-site evaluation (be in the field).
 - b. Have a good level of silvicultural knowledge and knowledge of other resources.
-
- 3. Implementation:
 - a. Produce comprehensive marking guides or field directions.
 - b. Ensure that those who will implement the guides have the skills and ability needed, and that they understand objectives.
 - c. Monitor their execution (check marking against guides).
 - d. Provide quick feedback and motivation (don't let them work in a vacuum; get the most out of your people).

Following the three principles of 1) using an interdisciplinary approach, 2) having field verification and 3) building support for your program can produce the best results in silviculture.

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NATIONAL SILVICULTURE WORKSHOP
RAPID CITY, SOUTH DAKOTA
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INNOVATIVE SILVICULTURAL RESEARCH IN THE 1980'S

(Highlights from a Slide Presentation)

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Timber Management Research
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One-third of the Nation's total land area is covered by forests, and nearly two-thirds of this is capable of growing continuous crops of timber products. The full benefits from this renewable resource, however, cannot be realized without proper forest management supported by a dynamic research program. The mission of Forest Service research is to develop the scientific and technical base needed to manage this vast resource. The objective of timber management research is to develop the silvicultural alternatives and guidelines to: (1) increase the productivity and multiple-use benefits of forest lands; (2) enhance the growth and quality of forest trees and stands; and (3) maintain the productivity of the land as required in the National Forest Management Act of 1976.

Timber management research in the 1980's focuses on developing regeneration strategies to produce new stands adequately stocked with preferred species; cultural techniques to insure survival, optimum growth, and continuing stand development; growth and yield prediction systems and computer programs to provide quantitative information for management and investment decisions; effective and environmentally safe methods to control unwanted vegetation; systems to classify and evaluate site productivity and response to management; and genetic selections for increased growth, quality and resistance to forest pests. Basic research is conducted to enhance our understanding of the physical, biological, and genetic factors controlling development of individual trees and forest stands. This research is conducted by approximately 190 scientists located at over 60 Research Work Units throughout the United States. Following is a brief look at timber management research activities that are providing some of the scientific and technical information needed to manage the 190 million acres of land within the National Forest system.

Two Types of Two-age Management Being Tested for Allegheny Hardwoods-- One is the true two-age system designed to permit regeneration of shade intolerants such as black cherry without ever completely removing the overstory. This system falls between the traditional even-aged and uneven-aged schemes. The other is the retention of about 10 percent stocking of shade-tolerant residuals (older age class) at the time of final harvest to insure that faster growing black cherry (intolerant) and slower growing sugar maple (tolerant) develop together in an even-sized stand.

European "Aesthetic Clearcut" Applicable to Appalachians--Deferment cutting, a procedure which retains about 20 square feet of basal area per acre in 12 to 15 trees, is being tested as a modification of the standard shelterwood technique. Selected residual trees including red oak, white oak, yellow-poplar, and black cherry are retained as a component of the new stand. When fully developed this practice will assure preferred species in the new stand, respond to public criticism of clearcutting, and provide for a continuous forest habitat for wildlife.

SILVAH is Available--A complete stand analysis and prescription procedure has been developed for Allegheny hardwoods that provides a systematic way of measuring and evaluating critical stand conditions and using that data to arrive at a recommended treatment. Once a stand inventory has been made, a computer program called SILVAH does the entire job of analysis, prescription, and preparation of marking instructions based on principles established through research. Application of the SILVAH procedure is being expanded to include northern hardwoods, oak-hickory, and transition forest types in addition to Allegheny hardwoods.

Good Advance Oak Reproduction Under Shelterwood--The ability to control species composition in hardwood stands following timber harvest continues to be a high priority need of forest managers in the East. The need is particularly critical for the oaks which we know are difficult to regenerate in the absence of advanced reproduction. Research in the Allegheny, Appalachian, and Central hardwood regions suggests that the shelterwood system may provide the best opportunity to establish the size and quantity of advanced reproduction required for oak to be a major component of the new stand. Underplanting of large seedlings is an alternative to natural regeneration that is being tested on good sites. Early results indicate that planted northern red oaks grow well and compete successfully with other vegetation after removal of the shelterwood.

STEMS and TWIGS, Simulate Response to Management in the Central States--STEMS (Stand and Tree Evaluation and Modeling System) and TWIGS (microcomputer version of STEMS) use inventory data to forecast the growth and mortality of individual trees. Results can be used to forecast composite changes in uneven or even-aged, pure or mixed, hardwood or conifer stands, forests or entire regions.

Pine-Hardwood Mixtures in the Piedmont--Research and the National Forests in South Carolina have been successfully testing a mixture of loblolly pine and red oak or sweetgum to regenerate low quality sites in the upper Piedmont. The procedure calls for fall or winter harvest, control of competition in the spring with herbicides, late summer prescribed burn, and planting of improved loblolly pine seedlings in the fall. Total cost for this treatment is under \$75 per acre.

Look at the Hardwood Sprouts--Competition control or vegetative management is the subject of much research in the Forest Service. Due to the loss of 2,4,5-T, the premier herbicide for conifer release, there has been a concerted effort to identify effective substitutes and alternative methods. Mechanical removal of all hardwoods to promote the natural regeneration of southern pines is an alternative to the more costly injection treatment, however, this treatment usually results in proliferation of sprout growth. Modeling herbicide fate in the environment is necessary if we plan to use herbicides and effectively respond to public concerns. For example, research data on Tordon 101 collected on the Chattahoochee National Forest recently helped win dismissal of the "West Case" in Knoxville, Tennessee.

Predicting the Impact of Fusiform Rust on Yields--Fusiform rust continues as a major disease of the southern pines. However, researchers in genetics, pathology, and silviculture have developed a rust level parameter called "STEM 5" to predict the effects of rust on stand development and yield. By determining the proportion of living trees at age 5 with stem cankers, foresters can evaluate the cost and potential benefits of alternative rust management treatments.

Silviculture and Western Spruce Budworms--Research silviculturists have examined the relationships of western spruce budworms to their host tree species. The most shade tolerant species on a given site were found to be the preferred hosts. For most of this century, intensive fire suppression practices and "economic selection" cuttings have allowed true firs and Douglas-fir to succeed ponderosa pine in the northern Rockies, thereby, increasing the proportion of shade-tolerant trees; the preferred hosts of the

budworms. The Solution? Even-aged silviculture practices that reduce the layering of stand structure and the proportion of shade-tolerant trees, both of which are needed to sustain budworm populations.

Additions to the Stand PROGNOSIS Model--The Stand Prognosis Model is now being calibrated for many parts of the western United States and Canada. Extensions to the Model's application since it was introduced in 1973 include: (1) combination with the Douglas-fir Tussock Moth Outbreak Model; (2) addition of the Regeneration Establishment Model; and (3) release of the Shrub Dynamics Model. Addition of the Douglas-fir Tussock Moth Outbreak Model provides the capability to evaluate the effect of defoliation on expected timber harvest volumes and compare strategies for integrated pest management. The Regeneration Establishment Model is used to evaluate expected results of regeneration prescriptions and project stand development. The Shrub Dynamics Model ties silviculture to wildlife and watershed management through descriptions of understory cover species.

Habitat Type Classification Provides an Ecological Framework for Silviculture--Pioneering work by the Daubenmires in the western United States and its application and enhancement by Forest Service research set the stage for habitat type classification throughout much of the West. This research is providing forest managers with: (1) a classification of seral vegetation that serves as a communication base; (2) a measure of vegetal response to various disturbances such as site preparation treatments, fire, and grazing; (3) information of interrelations of planted tree survival, competing vegetation, and pocket gopher density; and (4) Relative forage values of seral community types to big game and livestock. Our plant succession research is revealing numerous disturbance-response interactions, such as the response of Ceanothus and other shrub species to prescribed fire, that are significant when planning land management activities.

Reforestation Systems Research in Southwestern Oregon--Over 200 thousand acres of Forest Service and BLM lands in southwestern Oregon have been removed from the timber base due to harvesting and regeneration problems arising from the lack of summer precipitation, severe competition, and adverse soil conditions. Silvicultural research is developing reforestation strategies to increase survival and growth of seedlings and minimize the development of brushfields in this hot and dry part of the Douglas-fir range. The need for

competition control has been well established and research is continuing to develop specific recommendations for site preparation, planting stock, animal-damage protection, and levels of release from competition.

Multidisciplinary Research in Southeastern Alaska--In southeastern Alaska the western hemlock-Sitka spruce forest type is capable of high timber production. Clearcutting is the principal silvicultural system for harvesting timber with successful natural regeneration of desired tree species on over 95 percent of the areas logged. Most of these second growth stands are overstocked and research is developing thinning guidelines to optimize stand growth and development. Growth and yield research in Alaska includes development of a variant of the Stand Prognosis Model for the old-growth and new growth simulation models for natural unthinned and thinned second growth stands. Timber management practices in coastal Alaska must include the associated resources of water, fish, wildlife, and recreational opportunities. SAMM (Southeastern Alaska Multi-resource simulation Model) was developed by a multidisciplinary team to quantify and display timber, hydrology, fisheries, and wildlife relationships and their interactions to management. A management utility test of SAMM is currently being conducted.

A Growth and Yield Model for Sierra Nevada Mixed Conifers--Much of the growth and yield research in the West centers on the development of "variants" of the Stand Prognosis Model. Using Prognosis as a framework, Forest Service researchers in California are developing a growth and yield model for the westside Sierra Nevada mixed-conifer type. The study area for this research includes six National Forests in California. The model is expected to be available in 1986. Research to develop a growth and yield model for the red fir type in California and southern Oregon is also in progress.

Shrub Competition Delays Ponderosa Pine Growth--Studies of the influence of competition on the growth of planted ponderosa pine show that shrubs significantly reduce mean tree volumes at spacings up to 9 feet between trees 18 years after planting. This could delay the first commercial entry into the stand by 10 to 12 years. As part of a national administrative study and in cooperation with Region 5, we are comparing manual, chemical, and animal alternatives for controlling competition in Douglas-fir and ponderosa pine plantations.

Cooperative Research in Forest Fertilization--Goals of the Region 5 and PSW Station cooperative program in forest fertilization are to: (1) develop the means to predict the occurrence of nitrogen deficiency; (2) estimate tree growth response to fertilization; and (3) study the environmental side-effects of fertilization especially the potential contamination of ground water with nitrate. Results from this continuing cooperative effort have been released in a series of research papers and a 30-minute slide tape program.

Basic Research in Biotechnology--The application of this technology to forest genetics permits the manipulation of genes into combinations not achievable through traditional breeding methods. The ability to create new gene combinations in trees provides a great potential for advances in forestry. With this new technology gene combinations exhibiting pest resistance or tolerance can be rapidly identified and isolated.

In conclusion, timber management research in the Forest Service encompasses all this and much more. To a very great extent, future improvements in silviculture and management efficiency on our National Forest lands will depend upon the imaginative use of new technologies developed by Forest Service research.

REHABILITATION OF OLD PARTIAL CUT FAILURES

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ABSTRACT

Through a new timber inventory, the Payette National Forest identified a strata of areas partially cut over since the early 1960's. An intensive survey of these areas (strata 21) indicated many stands were in need of further silviculture treatments.

A proposal was developed to rehabilitate those areas in need of treatment. The proposal was initiated on the Council Ranger District by establishing a forester position. Support has been generated for the program, and to date 1900 acres have been rehabilitated and are growing at their site potential.

REHABILITATION OF OLD PARTIAL CUT FAILURES

Introduction

The Payette National Forest is located in West Central Idaho approximately 100 miles north of Boise. Commercial forest land covers 804,000 acres or 35 percent of the net National Forest area, based on the 1976 Timber Management Plan. Eighty-three percent of the commercial forest area is in sawtimber stands. Douglas-fir is the predominant species followed by ponderosa pine, Engelmann spruce, sub alpine fir, grand fir, lodgepole pine, and western larch. Thirty-five percent of all stands are overmature with only 38 percent in the 1 to 100-year age group. Precipitation ranges from 15 to 40 inches within the commercial forest land. The annual allowable harvest is 75 million board feet.

Prior to the early 1960's the majority of the cutting on the Forest was "Risk" cutting in an attempt to reduce losses to insects and diseases. During the 1960's, clearcutting and overstory removal were the dominant methods used. During the summer of 1969 Forest personnel examined a sample of overstory removal and clearcut units to determine the regeneration success of each method. The sample showed good success with clearcutting and artificial regeneration and very poor success with overstory removal, primarily due to understories that were diseased, suppressed or scattered so that only clumps remained.

This was the same period that clearcutting gained bad publicity, and land managers were reluctant to clearcut. More emphasis was placed on partial cutting using shelterwood preparatory cuts and shelterwood removal cuts to leave standing green trees.

1978 TIMBER INVENTORY

In 1978 the Payette Forest initiated a new timber inventory using strata groupings which were sampled on a stand basis rather than a ten point cluster as previously used on the Forest. A strata was defined as areas of similar crown percent cover and stand age as identified on aerial photographs.

"Strata 21" identified partial cutting units which had 10 to 50 percent ~~residual stocking~~^{crown cover} after logging. This amounted to 40,000 acres delineated on the 1976 aerial photo flight. An additional 15,000 to 20,000 acres have been created since 1976.

Some of these acres are in satisfactory condition and no further silviculture treatments are necessary at this entry. Many of these acres have major problems which greatly influence the growth on these sites.

1980 SURVEY

In 1980 a project was undertaken by the Forest with financial assistance of Forest Pest Management to sample the conditions of the "21" strata areas. In cooperation with district personnel, priorities for sampling the cutover stands were identified on aerial photographs and strata maps for the Council and New Meadows Districts. The survey was a Region 4 Type 2 stocking survey based on a grid. 16,322 acres were sampled that were in need of an immediate treatment; 1392 acres were in good condition and adequately stocked.

	<u>SEEDLING /SAPLING</u>	<u>SEEDLING / SAPLING</u>	
	Stocked with Disease	Lightly or nonstocked with Disease	No immediate Treatment Necessary
Council RD	5158 AC	6687 AC	1082 AC
New Meadows RD	1536 AC	2941 AC	310 AC
Total	6694 AC	9628 AC	1392 AC

Major problems encountered in the survey were:

1. Need for removal of scattered overstory for insect and disease control. Especially where dwarf mistletoe (DM) infected overstory residual was underplanted with a susceptible understory.
2. Need for thinning of both understory and overstory for patch or group release and DM control.
3. Need for site preparation and planting on 30 to 40 percent of the area sampled to return the 21's to production.

Why was there a need for treatment? For following reasons:

1. These are some of the most highly productive sites on the Forest and in the Region. (Seventy-nine percent was on ground capable of 50+ cu.ft./Ac./yr.)
2. Access roads are in place or need very little treatment to reopen.
3. The 40 to 60 year old residual is growing at less than 50 percent of its potential in many instances.
4. The insect and disease control is necessary to protect investments already made in these areas.

IMPLEMENTATION

The next step was to determine how to proceed to meet the needs. We developed a short slide program explaining the "21" strata conditions and the need to rehabilitate the sites. It was shown to Forest Pest Management personnel and Regional Office personnel to gain their support. Then we reviewed it at a Forest Management Team meeting. The team agreed to continue the survey on more acres.

Rod Barker, Council District Ranger, was very enthusiastic about getting the "21" acres on his District back into production. With the assistance of Steve Donnelly, Council District Silviculturist, probable treatments were identified by priorities for the Council District.

The broad categories of treatment were:

1. Salvage sales to remove merchantable volume at appraised rates. These are generally areas having 2 MBF per acre or more.
2. Salvage sales at administrative use rate of \$.50 per MBF. This is generally areas having 1 to 2 MBF per acre.
3. Firewood sales of green and dead material.
4. Mistletoe control, thinning.
5. Push over residual, site preparation, and plant.
6. Girdle overstory and leave standing to protect residual stand.

Priorities for treatment of dwarf mistletoe control were established with the following criteria:

Priority 1: 1 to 5 years

Adequate stocking of seedling-sapling-overstory infecting and damaging seedlings and saplings.

Priority 2: 5 to 10 years

Adequate patchwork stocking seedling-saplings threatened from edges by existing clumps from insects and disease in residual.

Priority 3: 10 years +

Predominately 40 to 80 year old residual - no immediate threat to seedling-saplings.

Priority 4:

Area can wait until next sale entry.

An economic analysis was completed for 6330 acres of priority 1 and 2's showing a positive PNV of \$302,033 and a benefit cost ratio of 1.57. The potential loss without treatment on those acres amounted to 277 BF/ac/year for a total of 1,753 MBF per year.

The next step was to determine the best option to implement the rehabilitation of the "21" strata areas. The following options were developed; based on two groups within the district timber organization:

	<u>*Section</u>	<u>Acres/Yr.</u>	<u>Total Acres</u>	<u>Time to Complete</u>
Option 1	Salvage Group	250	6800	27 yrs
	Silvic. Group	300	3200	10 to 11 yrs

Based on existing district personnel under the assumption of good market conditions for sale of salvage material.

Option 2	Salvage Group	900 ac	6800 ac	7 to 8 yrs
	Silvic. group	Same as option 1		

Based on the addition of a full-time GS-9 Forester or Technician at 650 acres/year. Estimated on-the-ground cost of GS-9 plus temporary help = plus or minus \$30,000.

Option 3

Considered 2 or more permanent Foresters, but the district felt they could not handle the additional workload. Lack of markets, small loggers, lack of adequate seed sources, etc. are main reasons at this time.

Mr. Barker selected Option 2 and with support of the Supervisor's Timber Staff was able to create a GS-9 Forester position on the District. The position required skills in silviculture, sale layout, and sale administration. This was not a training type position, as he wanted a person who could get the program off the ground. The position was filled in May 1984 with a skilled individual.

ACCOMPLISHMENTS

Accomplishments to date on the Forest in our strata "21" areas needing treatment are:

Acres back into production	573 acres
Acres to be treated under timber sales sold in 1984	508 acres
Acres to be treated under timber sales sold in 1985	845 acres
TOTAL	1926 acres

We expect to see an increase in acres accomplished the next few years as increased emphasis is being placed on the strata 21 rehabilitation program by the remaining districts on the Forest in addition to the Council Ranger District. We were able to get a jump on the program in 1983 with the Job's Bill monies.

CONCLUSION

In conclusion, the Forest has initiated a rehabilitation program on cutover stands needing silviculture treatment to bring them back into production. This has been accomplished with commitment from a District Ranger and his staff plus support from Forest Pest Management and the Regional Silviculture group. Emphasis for the program is also included in the proposed land use plan to be released this summer.

SITE PREPARATION - THE LIGHT TOUCH

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ABSTRACT

Through the fifties, sixties and early seventies the objective of site preparation and hazard reduction was complete debris removal and maximum exposure of mineral soil ("potato patching"). In the past decade it has become apparent that one objective for all sites is not correct.

The Region has been aware of this problem since the mid-seventies. However, there has been a reluctance on the part of some land managers to change their methods; from those they are comfortable with, to something different.

In the early eighties the Gallatin National Forest embarked upon a project of determining the causes of reforestation failures, especially on harsh sites, and to develop recommendations for reforestation activities on these sites that would be acceptable.

Through intensive monitoring of several sites on the "Obsidian Sand Flats", just west of Yellowstone National Park we have determined that to protect new regeneration (natural and artificial) from cold, drought, and heat, it is critical to leave debris and to have minimum disturbance of the soil surface on harsh sites.

Through this effort the Gallatin National Forest has developed a goal for site preparation and fuel hazard reduction. The goal is to use techniques that minimize disturbance to the soil surface and minimize removal of forest residues to those which are necessary to meet the long-term land management objectives for the area.

This has have met with wide acceptance on the Forest and has provided successes in natural and artificial regeneration on harsh sites.

KEYWORDS: regeneration, site preparation, lodgepole pine, moisture stress, slash disposal, soil and water, microsite

I. REGIONAL PERSPECTIVE

Since the mid-seventies the Region has been concerned with the lack of success in the natural and artificial reforestation programs of the past. While there have been successes, it was felt that the Forests could improve their performance.

In the last decade the Region has provided emphasis for modifying site preparation techniques to achieve:

- (1) Seedling protection
 - insolation
 - wind
 - drought
- (2) Soil protection & long-term productivity
 - increased organic matter for increased cation exchange
 - soil moisture retention
 - mycorrhiza
 - soil erosion and compaction
- (3) Animal damage control
 - livestock
 - big game
 - gophers

Research in the past decade has provided much needed information concerning the above site amelioration factors. The Region has passed this information along to the Forests through guidelines in handbooks and manuals, service visits to Forests, meetings and training sessions, and correspondence.

A review of the Region's reforestation programs (natural and artificial) indicates that these techniques have paid off in terms of increased survival. This success can not be attributed to better site preparation techniques alone. Without proper site preparation the other techniques of improved stock quality, improved stock storage, improved stock handling would not have been as successful.

II. GALLATIN SITUATION

From the late fifties through the early seventies the Gallatin National Forest harvested several thousand acres on relatively harsh sites, generally through clearcutting. Little thought was given to reforestation of these areas until after harvest had occurred. Slash was left to naturally abate.

Several years following harvest it was decided that these sites "looked bad" and were a fire hazard. In accordance with existing practices, all slash (and any natural regeneration that may have been present) was pushed into piles and burned. Due to the topography (level to rolling) it was decided to machine plant these areas,

therefore most of the stumps were removed in the piling operation. Machine planting proceeded, with limited success. By the early eighties virtually all of this area was still under-stocked, even after several planting attempts.

At this point the Gallatin became concerned with the high failure rate of our natural and artificial reforestation efforts. The concerns centered on: the high cost of artificial reforestation, especially repeated plantings; slow vegetation recovery for visuals, watershed and wildlife cover; and continued mortality (due to the mountain pine beetle epidemic) adjacent to under-stocked stands.

Although the times and land management objectives had changed, many of our reforestation practices had not. Recommendations to decrease soil disturbance and to increase the amount of debris left on the sites following timber harvest were met with some resistance.

III. GALLATIN ACTION

The Forest's Soil Scientist and Silviculturist embarked upon the task of determining the causes of regeneration failures, especially on harsh sites, and to develop recommendations for reforestation activities that would be accepted.

Through a scoping process it was determined that:

- reforestation practices did not vary significantly across the forest
- backlog regeneration areas were a high priority
- site characteristics and conditions were the main factors in seedling survival
- funding and time would limit monitoring to a few sites

The "Obsidian Sand Flats", a 190 km² area near West Yellowstone, Montana, was chosen for review due to: the harsh environment; the large reforestation backlog; the large reforestation program in progress; and, the large amount of mortality (from MPB) requiring harvest and reforestation activities in the near future.

AREA DESCRIPTION

The area is part of a large, nearly flat glacial outwash plain dating from the Pleistocene (Witkind, 1969). The plain is composed of subangular and subrounded obsidian, vitrified tuff (welded ash), and quartz coarse sands and small gravels. The entire area has been covered with a thin layer of loess (wind blown silt). This loess is probably of volcanic origin (Klages, 1965).

Forests are pure, all aged lodgepole pine (Pinus contorta var. latifolia) (0-150 years old), averaging about 38 percent serotiny (Perry and Lotan, 1977). Average site index on a 100 year base is 40

(ibid). The forested areas are composed of open stands with a sparse understory of litter, a few grasses, and some bitterbrush (Purshia tridentata). There are many interspersed openings. Smaller openings (less than 0.04 ha) have about 50 percent ground cover, largely bitterbrush. Larger openings have a sagebrush (Artemesi tridentata) overstory with numerous forbs and grasses in the understory. Clear cuts have very few grasses and sedges, with over 80 percent bare ground. Lodgepole pine saplings and seedlings occur on the south side of these openings, because of increased shade and moisture provided by the adjacent stand. Fire occurs in the ecosystem, but it is not required for regeneration under natural conditions (Fischer and Clayton, 1983).

The habitat type is *Pinus contorta*/*Purshia tridentata* (lodgepole pine/bitterbrush) (Pfister et. al., 1977). This type is uncommon and represents an example of a true lodgepole pine climax situation. This is the only area in Region One where this habitat type occurs.

The area has a continental mountain climate. Winters are cold, with a high snowpack (up to 190 cm), and summers are warm and dry. Average annual temperature is 17 degrees C. Average annual precipitation is 58 cm, falling mostly as snow. Rainfall in the summer averages 2.5-5.0 cm per month (Environmental Data Service, 1970).

The soils are Typic Cryochrepts, loamy skeletal, mixed, or Typic Cryochrepts, sandy skeletal, mixed. Soil features are weakly expressed, because of the recent deposition, cool climate, and coarse textured parent material. The loess layer is probably the source of the silt and clay, because the gravels and sands are relatively unweathered (Klages and Southard, 1965). A representative soil profile is given in Figure 1. Almost all biological activity is in the upper 43 cm. There is about 28 percent silt and clay in these layers, and less than 13 percent below. In comparison, a "normal" soil in the area is about 66 percent silt and clay throughout.

These soils have low fertility and low water holding capacity. The dark colored sands are hot in the summer, increasing stress on plants, though heat is probably not a major cause of mortality (Lotan, 1964). Klages and Southard (1965) indicate the soils are subject to intense drought over the summer season. Lotan (1964) indicates up to 90 percent of lodgepole seedling deaths were attributable to drought. Most mortality occurred in the early summer when rainfall was low. Angular sands and gravels are difficult for roots to penetrate, increasing the energy plants need to grow, and reducing the effective area they can access for water.

METHODS

Soils were field characterized at nine sites. Field soil moisture was measured with a "Speedy" moisture meter. Field pH was measured with a Hellige Truog field kit. Undisturbed soil cores were taken with a 5 cm core sampler. Laboratory tests were for organic matter (modified Walkely Black), cation exchange capacity or CEC (NH₄OAc, pH 7.0), exchangeable cations, coarse fragment content, soil texture (modified

Day), and water holding capacity using a pressure plate (Montana State University Soil Testing Laboratory). Because of the large gravel and sand fraction, all calculations are on a whole soil basis. This represents the actual seedling environment better than if the fragments greater than two millimeters in diameter are excluded.

Saturated and unsaturated hydraulic conductivity, porosity, and water contents were run at the Montana State University Soil Physics Laboratory (Melton, 1983). On site weather was measured with a "Climatronix" remote weather station. Young trees were excavated with a shovel, knife, and by hand. Roots were excavated to a minimum diameter of 1/2 mm, then cut off, to provide a relatively consistent representation of root length.

RESULTS and DISCUSSION

Site Properties

Four sites were selected as representative of the area. Table 1 gives characteristics of the sites. CC,DIST (Clear Cut, Disturbed) represents an obsidian soil that has been manipulated harshly by skidding, slash disposal, and site preparation practices. CC,UNDIST (Clear Cut, Undisturbed) represents a clear cut site that was low impact logged. FS,UNDIST (Forested, Undisturbed) is an obsidian site that is undisturbed (a control). CC,SILTY (Clear Cut, Silty soil) a representation of normal soils and disturbance levels on the Gallatin N. F., is used for comparison and perspective.

Soil fertility, texture, bulk density, and structure

Soil fertility is low, but adequate for lodgepole pine (Klages and Southard, 1965). Organic matter content is not significantly different between the 3 obsidian sites (Table 2). The silty soil is higher, indicating a higher potential for supplying plant nutrients. Cation exchange capacity is also higher on silty sites. Field fertility trials on existing seedlings showed no significant response to fertilizer (ibid.). Greenhouse trials have indicated a 30 percent decrease in height and a 60 percent decrease in top weight on disturbed sites (Perry, et. al., 1982). Nitrogen fertilization eliminated these growth differences. In field trials, the fertility limits were probably masked by the more important limitations of available water, whereas greenhouse trials were not water stressed. This suggests that low fertility is another stress factor on disturbed sites.

Variation in the silt and clay fractions is within the range of the other obsidian sand sites. Bulk density does not measurably increase with disturbance (ibid., Stermitz, et. al., 1974), because of the large content of subangular sand and gravel, which resists compaction. Average bulk density is close to the mean for the Forest (Montagne and Munn, 1980). Soil macrostructure (visible with naked eye) was generally weaker at the CC,DIST site than at the FS,UNDIST site (Table 3).

Water Holding and Transmitting Properties

Maximum available water content in the root zone of the obsidian sand sites is only about 10 percent of that held in the CC,SILTY soils (3.3 cm vs. 29 cm). To illustrate this difference over time, field moisture was modeled (Warrington and Weatherred, 1983). The model predicted soil moisture status by month for 1983 (Figure 2). The CC,SILTY site never reached the wilting point over the summer. The obsidian sand sites reached wilting point soon after snowmelt, illustrating a very droughty environment.

Soil macrostructure is important to infiltration of precipitation. Saturated infiltration tests measure the soils' ability to transmit water under saturated conditions, such as after a heavy rain, or during snow melt (Table 3). Infiltration for CC,DIST is about 1/2 FS,UNDIST, and total porosity is reduced about 15 percent. This indicates the water transmitting capacity is reduced significantly and correlates to the observed reduction in structure after disturbance (Table 2).

Field observations support this trend. Water puddles on roads and in disturbed clear cuts after rains even with the sandy soils, but not where the soil is undisturbed. Depth of saturation was measured after a large storm (Table 4). The CC,DIST site was wetted to 20 cm, where as the FS,UNDIST site was wet to over 60 cm. Soil disturbance apparently plays a larger part in this infiltration than does canopy cover, since the CC,UNDIST was also wetted to 60 cm.

Unsaturated infiltration tests measure the water transmitting ability under unsaturated conditions. This is controlled by microporosity and occurs when water redistributes after moistening, or when moisture is removed by plants. The speed of infiltration is about the same between sites (Figure 4). The amount held by CC,DIST is about 1/2 of the FS,UNDIST (Figure 4). This indicates there is a small change in micropore arrangement (which controls speed of infiltration), and a large reduction in micropore size and number which controls water holding capacity. Field measurements of water content at about 10 cm were made two days after a major storm. Over twice the water remained in the FS,UNDIST as in the CC,DIST site (18% vs. 8%).

Seedling Characteristics

Nature responds to the droughty characteristics of the obsidian sand soils. The pattern of vegetation indicates a gradual forestation of the natural area has occurred. Seed production and dispersal is very large. Perry and Lotan (1977) indicate over 500,000 seeds per ha are dispersed every year. A sampling of natural seedlings showed that, on normal soils (site CC,SILTY) growth rate is about 1.6 times that of obsidian soils (sites FS,UNDIST and CC,DIST) (Table 5). The obsidian soils have root area/shoot area ratios that are larger than those for normal soils. These observations indicate nature responds to the droughty conditions on natural and disturbed sites by retarding early height growth while extending root systems.

Planted seedlings have early growth rates corresponding to those on normal soils, and a root to shoot ratio that is much lower than natural seedlings. Since two year old seedlings are generally planted, the nursery conditions and planting methods are responsible for the present growth and root area.

Implications to Seedling Survival

On undisturbed sites, the entire soil/ water/ plant ecosystem is near a "threshold" between forest and non-forest vegetation. The soil water holding capacity is about 3.3 cm in the root zone, before disturbance. Precipitation during the summer is low, usually 2.5-5.0 cm per month. Lodgepole pine seedlings, grown under greenhouse conditions, need about 2.5 cm of water per month for adequate survival (Shepperd and Noble, 1976). Even when undisturbed, there is just enough moisture held to produce a long term forest canopy.

Some soil disturbance is normal during harvest and site preparation, and is generally not critical to regeneration. Here the disturbance has radically affected water related properties. Water transmitting and water storing capacity have been reduced almost 50 percent (Table 3, Figure 4). If we overlay this on the soils' 3.3 cm water holding capacity, seedlings will probably have less than 2.5 cm of available water per month on disturbed sites. This, added to the harshness of the site, results in high seedling mortality. This varies with summer rainfall. Over about 5.0 cm rainfall, seedlings should survive the year. Less rainfall, no seedlings may survive. Field observations indicate that, plantations established in "rainy" years and on relatively undisturbed sites have much higher survival than those planted in "dry" years or on severely disturbed sites.

IV. SUMMARY AND RECOMMENDATIONS

Results indicate:

1. The obsidian sand sites are harsher than normal sites on the Gallatin National Forest, in terms of soil properties and site characteristics such as frost, temperature, rainfall, fertility, and water holding capacity.

2. Nature has responded to the harsh conditions by the characteristics of natural seedlings, and by foresting the area gradually over time.

3. Most soil properties, such as fertility, texture, and bulk density have not been affected very much by disturbance.

4. Soil water holding and transmitting properties have been affected drastically by machine disturbance.

5. The change in soil and site properties have probably pushed the severely disturbed sites below the threshold of a forest environment.

Recommendations for harsh sites:

(1) Future harvesting should be based on very low soil disturbance and the conservation of moisture.

(a) Field observations indicate that most disturbance occurs when soils are wet, so harvesting should occur only during periods of dry soil conditions.

(b) Scarification may be detrimental because of the fragile nature of the soils, and because of low vegetation cover with consequently lesser competition.

(c) Treatments such as logging over snow, leaving slash on the ground, using low ground pressure machinery, and winching to dedicated skid trails should be considered (Shovic and Kracht, 1984).

(2) For cutover (backlog) sites.

(a) The soils' water storage ability should be renewed with some moisture conserving treatments (Shovic and Kracht, 1985).

(b) We should try to retain nature's original soil moisture regime and site characteristics.

V. CONCLUSIONS

Based upon these recommendations, the Forest has observed the following changes in survival and stocking:

(1) Natural Regeneration -- stocking (based on walk-through exams) has increased from 0-20 percent stocked to 40-60 percent stocked. There are some additional problems, not related to site preparation techniques, that when corrected should increase this to 80-90 percent stocked.

(2) Artificial Regeneration -- survival (based on stake row surveys) has increased from 20-30 percent to 70-90 percent.

It appears that Light Touch - Site Preparation techniques have paid off on the Gallatin National Forest. While it is too early to tell the exact increases in survival and stocking that these techniques will provide, continued monitoring over the next several years will provide the answers.

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List of Tables

Table 1. Characteristics of Four Representative Sites.

Table 2. Soil Fertility and Texture of the Four Representative Sites

Table 3. Soil Structure, Saturated Infiltration, and Total Porosity for Three of the Four Representative Sites

Table 4. Depth of Moisture Penetration and Soil Moisture Content after a Major Storm for Three of the Four Representative Sites.

Table 5. Growth Rate and Root Area/Shoot Area Ratios for Seedlings About Four Years Old, Growing on Three of the Four Representative Sites.

List of Figures

Figure 1. Representative Soil Profiles

Figure 2. 1983 Soil Moisture Simulation for Two Sites

Figure 3. Unsaturated Infiltration: Depth of Wetting vs. Time

Figure 4. Unsaturated Infiltration: Water Intake vs. Time

Table 1. Characteristics of Four Representative Sites.

	Site			
	CC,DIST	CC,UNDIST	FS,UNDIST	CC,SILTY
VEG.	Sparse grass, few saplings	litter, grass, seedlings	lodgepole pine, lit- ter, bitter- brush	dense grass, saplings
SLOPE	0	0	0	15 percent
ASPECT	LR ¹	LR	LR	North
GEOLOGY	obsidian sand	obsidian sand	obsidian sand	volcanic rocks
LAND- FORM	outwash plain	outwash plain	outwash plain	plateau
HABITAT TYPE	PICO/PUTR	PICO/PUTR	PICO/PUTR	ABLA/CARU ²

Average elevation 6600 feet MSL

¹ Low relief

² subalpine fir/pinegrass (Pfister, et. al,1977)

Table 2. Soil Fertility and Texture of the Four Representative Sites

	SITE			
	CC,DIST	CC,UNDIST	FS,UNDIST	CC,SILTY
ORGANIC MATTER	1.5%	2.3%	1.8%	3.9%
CEC*	8	7	7	12
<u>SAND AND GRAVEL</u>				
A HOR-IZON	78	75	72	32
B HOR-IZON	83	72	75	36
<u>SILT</u>				
A HOR-IZON	10	12	12	46
B HOR-IZON	8	16	12	41
<u>CLAY</u>				
A HOR-IZON	12	13	16	22
B HOR-IZON	9	12	13	23

* CEC = Cation exchange capacity in terms of meq/100liters

Table 3. Soil Structure, Saturated Infiltration, and Total Porosity for Three of the Four Representative Sites

	SITE		
	CC,DIST	FS,UNDIST	CC,SILTY
Structure of surface layer	none or very weak subangular blocky	weak medium subangular blocky, or granular	weak medium subangular blocky
Saturated Infiltration	18 cc/min.	37 cc/min.	
Total Porosity	47%	58%	

Table 4. Depth of Moisture Penetration and Soil Moisture Content after a Major Storm for Three of the Four Representative Sites.

	SITE		
	CC,DIST	CC,UNDIST	FS,UNDIST
Depth of Moist Soil After Storm	20 cm.	60 cm.	60 cm.
Soil Moisture Content after Storm	8%	13%	18%

Table 5. Growth Rate and Root Area/Shoot Area Ratios for Seedlings About Four Years Old, Growing on Three of the Four Representative Sites.

	SITE			
	PLANTED	NATURAL		
	CC,DIST	CC,DIST	FS,UNDIST	CC,SILTY
Growth (in/yr)	2.4	1.7	1.8	2.9
Root Area/ Shoot Area	0.6	1.9	1.5	1.3
Sample Size	3	2	3	2

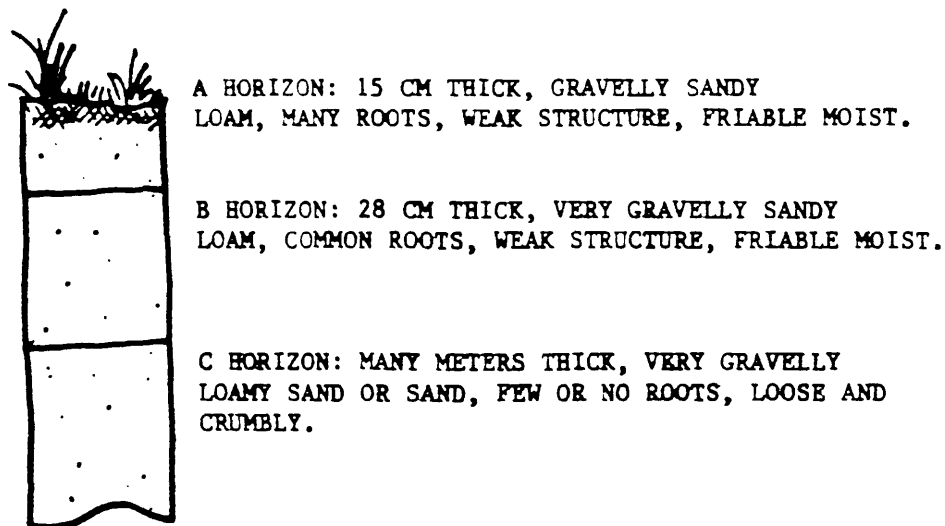


Figure 1 Representative Soil Profile

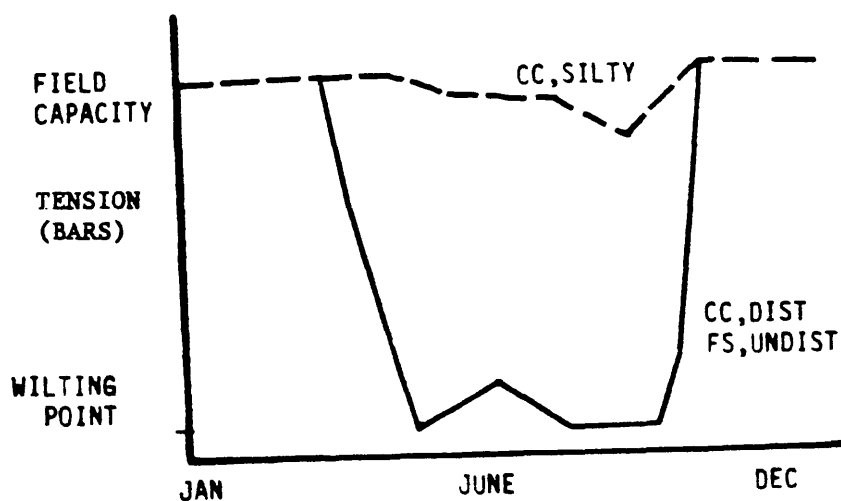


Figure 2 1983 Soil Moisture Simulation for Two Sites

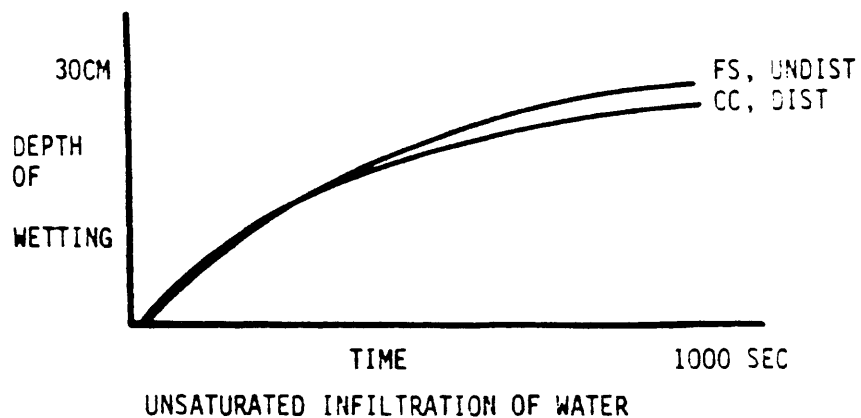


Figure 3 Unsaturated Infiltration: Depth of Wetting vs. Time

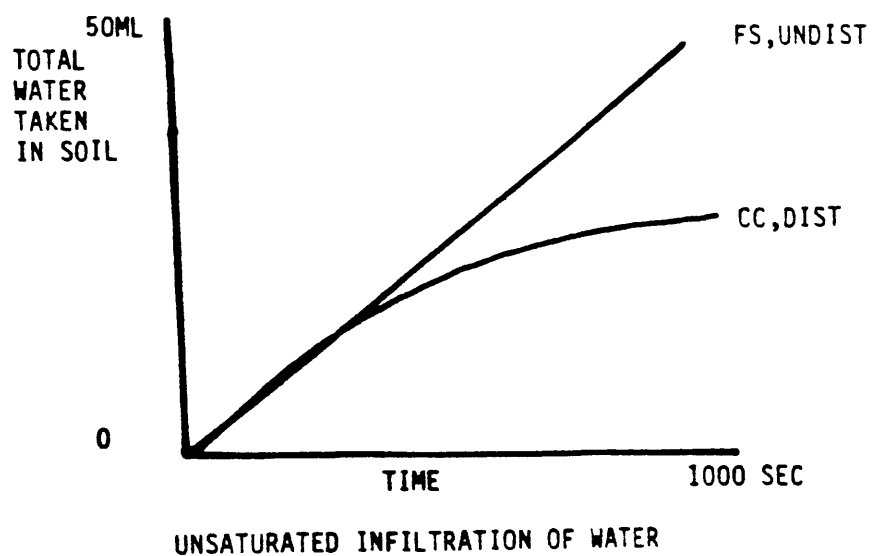


Figure 4 Unsaturated Infiltration: Water Intake vs. Time

THE FOREST CULTIVATOR

A SOIL RESTORATION AND SITE PREPARATION TOOL

BY

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Presented to the National Silviculture Workshop in Rapid City, South Dakota, May 13-16, 1985, by Lloyd A. Musser, District Silviculturist, Bear Springs R.D., Mt. Hood National Forest, Oregon.

INTRODUCTION

Successes in Silviculture, requires that eventually all the paper plans, theories and prescriptions are implemented on the ground. Recently I had the pleasure of being involved in the development of a new tool that makes it now physically possible and practical to accomplish two of silvicultures most important objectives. I have been asked to share this successful experience with you and since no one put any sideboards on this presentation, other than time, I am going to take somewhat unorthodox approach in this presentation. There is really two success stories associated with the Forest Cultivator. One involves a description of the equipment, its application and costs. That dissertation would be fairly conventional. The other story involves the unique development process associated with the Forest Cultivator.

At the risk of sounding boastful or conceited I'd like to share that story also. In doing so I hope it will inspire others who have struggled with Government red tape and restore faith in the quote "SYSTEM" unquote.

The shelterwood silviculture prescription has proven to be the optimum regeneration prescription for certain sites in the Cascade Mountains of the Pacific Northwest. Contrary to popular conception the entire northwest is not a rain forest where you clearcut and regeneration jumps up out of the ground. Higher elevation and gentle east slope sites require the use of the shelterwood regeneration prescription. The Bear Springs R.D. on the Mt. Hood N.F. for example cuts about 500-800 acres per year using shelterwood regeneration prescriptions. Natural regeneration is the desired reforestation method. The primary species involved is Douglas fir. Douglas fir needs a mineral soil seedbed to germinate. Providing this seedbed at the right time, in a practical and economic manner was a major challenge until the advent of the Forest Cultivator.

Soil compaction is another challenge throughout the Northwest forests. The problem has been recognized and the affects documented in the last few years. Most land managers now realize they must implement measures to limit compaction on planned projects in the future and try to restore previously compacted soil if full site productivity is to be achieved. Restoration of compacted soils is not as simple or easy as it sounds. The Forest Cultivator however appears to be a viable tool for this task.

Site Preparation for Natural Regeneration

A natural regeneration silvicultural prescription may require that a mineral soil seedbed for successful establishment of regeneration. The basic prescription, as practiced on Bear Springs R.D., leaves 25 shelter trees per acre. Slash is machine piled without disturbing the duff. A bumper, vigor cone crop develops the third summer following creation of the shelterwood. Establishment of the desired Douglas fir seeding is greatly enhanced if a fresh mineral soil seedbed is provided immediately preceding seedfall.

An exposed mineral soil seedbed can be provided using a variety of tools. In the past, brush rakes, asphalt rippers, disks and dragging logs with spikes have been used. All of these tools will work, but each has some adverse features. The Forest Cultivator was originally conceived and developed to overcome these undesirable features.

The site preparation objectives in this situation are:

1. Provide exposed mineral seedbed sufficient to allow establishment of 1000 Douglas-fir seedlings, equally distributed over the harvest area. Experience indicates a small strip of exposed, fluffy mineral soil about four inches wide, spaced 24 to 36 inches apart is a sufficient seedbed.
2. Leave the majority of duff and forest litter in-place, undisturbed, to preserve nutrient capital.
3. Do not cause soil displacement, mixing of horizons or compaction.
4. Be economical (\$30-40/acre).

One additional objective, that is not mandatory but highly desirable, is that the tilth of the soil be improved if soil compaction occurred during timber harvest and slash piling operations. Proper planning and execution of these operation should, however, preclude unacceptable soil compaction from occurring.

We have been contracting site prep on 500 to 1000 acres each year for several years. We quickly ruled out conventional cat mounted brush rakes as they created too much site disturbance and did not create very good seedbeds. Spiked logs or disks are not practical due to duff depth, large stumps and root masses involved. Asphalt rippers were, therefore, the only available option. We issued contracts every year that required the use of either asphalt ripper or this mythical implement that only existed in our imagination. We talked with every potential bidder and contractor to encourage them to build this hypothetical implement. Most were not the innovative type although one did try to modify some farm implements. As you might surmise farm implements are not designed to encounter stumps, down logs and boulders.

Our big break finally came when a local man came home and started an excavation contracting business. This individual is a mechanical engineer of the old school, they design in their head and fabricate with a welding torch all at the same time. This individual had spent the last 10 years traveling worldwide as a trouble shooting engineer for a major Austrian tram and ski lift company.

I conveyed my idea to him a few times over a brew in the local watering hole. Finally John came in one day and informed me he was going to build my dream. He had studied how farm subsoilers work and thought about the forest condition such an implement would encounter. He had the design all worked out in his head. I explained that I had no way to compensate him for his effort and materials, as I had already tried to issue a negotiated contract to build and test this idea and got all tangled up in purchasing regulations. No problem, he knew where he could scrounge some scrap iron and he would just build and we'd give it a try.

Once I saw his first prototype I was sure it would work. I was able to do some fast talking and convinced our purchasing agent to issue a \$2500 purchase order for crawler tractor with operator to do some unspecified site prep work. John of course, was the only contractor interested.

One morning, early in June of 1983, I met John out in a shelterwood to test our new implement. It worked, in fact it worked to good. An excessive amount of mineral soil was being exposed. If you expose too much mineral soil you will end up with 10,000 seedlings per acre and later have a massive thinning problem. This first model had the five teeth welded in place. John ran home to get his cutting torch and was going to cut off the second and fourth tooth. At that point the Resource Assistant and the Forest Soil Scientist arrived on the site. Unbeknownst to me they had been trying to set up a project to rehabilitate a compacted soil site. They took one look at our new implement and said hold it, don't cut those teeth off we think this will work for our job.

We moved to the soil restoration site and it did what appeared to be a good job of soil restoration. To make a long story short a few weeks later I found myself sitting in the R.O. with a some of Missoula Equipment Development Center (MEDC) engineers, soil scientists from around the region and Jim Edgen the head of the National Site Prep Committee. It turns out that one of this committees goals was to find or have MEDC develop an implement that would do essentially what our prototype would do. Everyone at the meeting listed the criteria and objectives for this new implement. Our implement met or exceeded all their criteria. MEDC had a \$10,000 budget to do a literature search but had not started as of July and this was FY'83 funds. It came my turn to speak and I tried to tell them diplomatically, that our implement met or exceeded their criteria. They really didn't believe me, my goodness, the implement was obviously too small, didn't require a huge tractor, no extensive testing and development had been done. I had a video tape of the implement in operation but the R.O. could not find a player. We went to lunch and on the way back passed a video rental shop. Jim Edgren being the resourceful person he is, ran in and asked them if we could use a VCR on the spot for 10 minutes. We played the tape and it made believers out of everyone. Missoula gave me \$2500 to rent the machine for them to test. They flew over with a van load of test equipment. They tried it out for about 2 days, made a movie and wrapped up a deal at the bar in Timberline Lodge. I'm still not sure how they did it but MEDC made a deal with John West, the developer, that essentially said if you manufacture and market the implement we will do technology transfer. That is part of the reason I'm here today, I'm still fulfilling the Forest Services' part of that agreement. MEDC made the movie, we have written service contract specifications for site prep for natural regeneration, soil restoration and skid trail restoration. John is fulfilling his portions of the agreement. A spin-off company is manufacturing and marketing the implement, which is now known as the Forest Cultivator, marketing efforts include trade shows and conducting on site demos throughout Oregon, Washington and Idaho. They bid on contracts and have an equipment leasing/sub contracting program. In short the Forest Cultivator is operational, and it is a valuable tool for Forest Service Management. Essentially we fulfilled our mission for \$5000. This is the best example of private enterprise and Government cooperation to solve a problem that I'm aware of.

That is the human interest of side of this success story. I think the moral is, if you have an idea don't become discouraged or wait for something to happen. Don't let the Government regulations or Forest Service manual stand in your way. If an idea makes sense there is usually a way to cut thru these regulations. One hint, if your project involves purchasing or contracting make friends with a liberal contracting officer that is dedicated and has a "can do attitude".

Resuming our discussion on the technical details of the Forest Cultivator.

Compacted Soil Restoration

The use of ground-based logging and site preparation equipment can have widespread adverse effects on a forest site. Following a single-entry harvest, 18 to 40 percent of the land may be covered by skid trails and landings (Andrus and Froehlich 1983). Judging from the inquiries I received from various Ranger District personnel, there appears to be a lot of sites that are 30 to 90 percent compacted, that the researchers and Forest Supervisors are never shown.

Research has fairly well documented the effects of timber stand growth loss, mortality and long-term site productivity. The problem is not confined to the northwest. Published literature indicates Australia, New Zealand and Great Britain have also recognized the problem and are actively involved in corrective measures. We are starting to see some reference to soil compaction from the south, which should be no surprise. If you look closely at rubber tired skidder advertisements, often they show a skidder belly deep in mud yarding southern timber.

Restoration of compacted soil to its original tilth is not an easy task. It is generally agreed that some type of tillage is required to ameliorate soil compaction. Soil recovery via natural process require 20-100 years (Froehlich 1983). Contrary to periodic claims we know of no magic chemical or wonder plant that can restore the tilth of compacted soil.

Equipment available for tillage of forest soils is limited. The most common implements in use include: disks, harrows, rototillers, plows, rock rippers and push type brush blades. Some of these implements are effective on certain soil and forest types, but certainly not universal. The problem stems from the fact that most of this equipment was designed for some other function and adapted to soil restoration.

An implement, designed to restore compacted soil, must meet the following basic requirements:

1. Be physically practical
2. Be economical. The cost of restoration should be less than the expected return or gain.
3. Be consistently effective to the depth of compaction, which usually is 15 to 20 inches maximum.
4. Minimize vertical mixing of the soil profile.
5. Reduce bulk density to near natural levels.
6. Effective on a wide range of soil types.
7. End result soil fragment size consistent with proposed revegetation plans and/or within the size range necessary to expedite recovery by natural forces.
8. Capable of treating the entire compacted area.

The Forest Cultivator appears to meet all these requirements. It is very practical because it is an attachment designed for brand name crawler tractors in the 50-70 horsepower range (D-4, Case 750, TD-9, etc.). The equipment is very mobil as it can be moved on a 5th wheel trailer pulled by a one ton pickup.

The implement retails for under \$4000. Experienced cost are approximately A) \$32/acre for site prep, B) \$175-250/mile for skid trail restoration and C) \$175-200/acre for soil rehabilitation. An economic analysis of skid trail restoration in the Cascade true fir zone indicates an increase in PNV of \$5.21 assuming 5% interest and a cost of \$250/mile (Smith-Dixon, 1984).

The Forest Cultivator appears to be effective on most N.W. soil types. The standard teeth do a good job in the sandy loam thru silty clay loam soils. A wing has been designed and is offered as a tooth attachment. Wings, added on the teeth tips, reduce the power required to loosen a given volume of soil. (Andrus 1983). We believe the wings will produce better results on clay soils than the conventional teeth.

End result fragment size can be controlled by the number of passes made over the area. The soil type, degree of compaction and desired fragment size will dictate number of passes to be made over an area. A large portion of the cost for one pass involves the fixed cost of moving the equipment to the site and overhead.

The small crawler tractor and the hydraulic controlled two point mounting system used for the Forest Cultivator provides a very manuverable machine. Second passes can be made at right angles to the first pass. Manuvering around and between stumps is standard procedure. Generally 85 percent of a harvest unit can be treated if necessary. The V configuration of the implement prevents debris clogging, which is a constant problem with asphalt rippers or brush rakes. Debris clogging not only decreases hourly production but also decreases site productivity due to translocation of the A horizon and duff. Subsurface boulders are not pulled to the surface when the Forest Cultivator is used on low horse power tractors. Grass seed and fertilizer can be spread on the last pass if electric spreaders are mounted on the implement frame. The Forest Cultivator is an effective forestry tool as it was designed and built specifically for forestry applications.

This paper is not, or is it intended to be, a U.S. Forest Service enforcement of the Forest Cultivator. A private individual designed and built the implement to fill a need articulated by a USFS Silviculturist without compensation. The U.S. Forest Service, Pacific Northwest Region, and Missoula Equipment Development Center agreed with the equipment developer, that no attempt would be made to purchase, or obtain, by any means, claim to the implement. The Forest Service recognizes a need for an implement of this type for National Forest Management. The Forest Service and the equipment developer, therefore, agreed that he would pursue marketing. The Forest Service will increase promotion of soil restoration and site prep as a viable management practice now that it is apparent an effective implement is available. To help in this effort, a movie by MEDC is available, that depicts the Forest Cultivator in operation.

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ARTIFICIAL REGENERATION PRACTICES ON THE
NORTH KAIBAB RANGER DISTRICT IN ARIZONA 1/

Brian H. Avery 2/

Abstract

Summarizes actions taken to improve seedling survival and growth in artificial regeneration projects. Primary actions discussed include site preparation methods and intensity, seed source, stock type and quality, and protection measures against animals and competing vegetation.

1/ Presented at the National Silviculture Workshop, Rapid City, South Dakota, May 13-16, 1985.

2/ Tree Improvement Staff, Kaibab National Forest, USDA-Forest Service, Williams, Arizona stationed in Fredonia, Arizona.

INTRODUCTION

The 655,000 acre North Kaibab Ranger District lies on the Kaibab Plateau in north central Arizona. The District is located immediately north of the Grand Canyon and is bordered on the east and west by the Colorado River and Kanab Creek, respectively. Elevations of timbered areas range from 6800 feet to 9200 feet (m.s.l.). Soils are derived from a thick layer of limestone parent material. Within the ponderosa pine type, soils are moderately deep (20 to 40 inches) except along ridgetops. Coarse fragment content is between 10 and 80 percent. The mixed conifer area is characterized by shallow soils with coarse fragment contents of 35 to 90 percent. This rockiness presents a barrier to root penetration. Vast timber blowdowns occurred in this area.

Annual precipitation varies from 16 inches to 28 inches with about 52% occurring as snow. Late spring and early summer are exceptionally dry with summer rains beginning in mid-July and continuing through early September. Summer, daytime temperatures average 80 F to 90 F.

Approximately 240,000 acres are classified as suitable forest land containing ponderosa pine, Douglas-fir, white fir, subalpine fir, Engelmann spruce, and blue spruce.

PAST REGENERATION ACTIVITIES

Mixed Conifer

During the mid 1960's to early 1970's clearcutting was a frequently used cutting method in mixed conifer stands. During this period more than 280 clearcuts covering 2900 acres were created. Most were not designed to facilitate natural regeneration. Following harvest, slash was mechanically piled and burned leaving a bare, open site. Although some stands were planted immediately following slash disposal activities, most were planted after a three to five year delay which allowed sedges and grasses to invade. Planting was usually by hand tools with small handscalps for site preparation. Seeds used for the bare root seedlings planted were collected primarily from squirrel caches near 8,000 feet which is about 800 feet lower than the plantations. In many instances the seed source is unknown.

Large blowdowns covering 1700 acres occurred in 1958 and 1972. Salvage operations were promptly completed and slash was mechanically piled and burned. Some seeding of grasses followed. The seeding was directed at soil stabilization. Several types of planting were attempted such as (1) terracing followed by a machine planting, (2) hand planting by auger, preceded by massive mechanical site preparation, and (3) handtool planting. Generally, bare root seedlings were used. Again, seed used was an off-site source or from an unknown source.

With few exceptions, plantings in mixed conifer areas were failures. The seedlings that survived are heavily damaged by snow and animals.

Ponderosa Pine

In the ponderosa pine type natural regeneration is easily established in partially protected openings. Generally, regeneration has not been planned, it just occurred naturally. True regeneration cuts were not made until 1983. As a consequence, artificial regeneration was limited to two large burns and several small blowdowns. Collectively, the areas approach 1400 acres.

Following salvage operations slash was either mechanically piled or crushed. Planting was prompt and seed sources were matched to the plantations. Usually, bare root stock was used although container seedlings were used in some stands. These plantings began in 1976 and were completed within 4 years of the salvage operations.

Plantings in this type usually exhibit good survival since the seed sources are compatible with the plantation sites. However, growth is lacking due to competing vegetation and animal damage.

Results

During the late 1970's the District began assessing past reforestation efforts to determine reasons for failures and successes. Major findings for failure were:

- (1) ineffective site preparation; usually too little or none, but sometimes too much resulting in severe microclimates,
- (2) extensive use of off-site seed - in some cases the seed was collected 1200 feet in elevation lower than the plantation,
- (3) less than ideal District storage conditions and handling procedures,
- (4) inadequate monitoring after planting resulting in failure to (a) identify and remedy animal damage and (b) suppress competing vegetation,
- (5) poor project planning and contract administration,
- (6) an overall lack of application of existing knowledge and technology such as use of artificial shading materials, proper species and stock type selection, etc.

Obviously, stands that were successfully regenerated either avoided all or most of these problems or suffered them to a lesser degree. Looking back we believe this avoidance was more a matter of good fortune than good planning.

ACTIONS TO CORRECT PROBLEMS

Once problems were identified and analyzed, District personnel developed and implemented practical solutions. Many of these were proven techniques widely used in other forest regions. Our efforts were directed at trying different techniques to improve reforestation success and expanding use of the more appropriate techniques.

Site Preparation

The District uses mechanical and chemical methods. Past mechanical measures were restricted to use of large, offset plow (disc.). In most applications over 95% of the soil surface was disturbed to a 6-12 inch depth resulting in an unfavorable environment for seedling survival/growth according to the District soils scientist. This equipment was used primarily in the large, open, blowdown areas which are not suited to this degree of disturbance. The method was simply unsatisfactory for the site.

Currently, the District uses a brush rake mounted on a D-6 tractor to mechanically prepare sites that are small and not exposed to excessive wind and sun. About 80% of the soil surface is disturbed with penetration depths of 4 to 6 inches which is usually satisfactory to remove vegetation and permit better infiltration. Existing slash is scattered to serve as shading material. Reforestation personnel work closely with the soils scientist in the selection of an appropriate degree of scarification.

Chemical measures have produced excellent results. Besides eliminating competing vegetation, herbicide application results in better soil moisture than mechanical measures; thus, extending the potential planting period if necessary. Chemical site preparation is particularly favorable on large, exposed sites or in stands with much competing vegetation. Herbicides used include dalapon at 5 lbs. active ingredient per acre and glyphosate at 2 to 3 quarts of product per acre (in sedge covered stands). Based on observations and trials 1 to 1½ quarts of product per acre (glyphosate) may be sufficient to kill the sedges. Glyphosate has produced better results although the cost/acre is about four times higher than dalapon. Hexazinone has not been used operationally, but in trials it effectively reduced competition even from sedges. However, glyphosate is the preferred herbicide.

Seed Source

Prior to 1979 the District was classified as a single seed zone. Seed collections from 1960 to 1978 were from squirrel caches or purchased from the public. Verification of seed source was practically non-existent. Use of off-site seed contributed to the low survival and growth and increases snow damage in plantations established with this seed. Based on tree improvement work the single seed zone was elevationally subdivided into three sub-zones. The Ten Year Seed Plan was revised according to these sub-zones and seed collection initiated. In 1979 the District began collecting local seed from above average phenotypes. Force account climbing is the only method employed. The climbing crew collects cones for use in the general reforestation program and from select trees for the tree improvement program. Survival and growth have improved since local seed elevationally matched to the planting site has been used. Older, unverified collections are being disposed as new collections are made. Currently, the Ten Year Seed Plan is 85% fulfilled.

Storage and Handling Procedures

In the 1970's storage methods included use of portable refrigerated units which malfunctioned frequently and snow caches which were expensive to construct due to the need to remove snow from access roads and the manpower required to handle the volume of seedlings stored. Neither method was satisfactory for our situation.

In 1978, the District constructed a refrigerated building for seedling storage. The unit maintains temperatures between 33 F and 36 F, operates flawlessly, and handles up to 750,000 bare root seedlings. Although expensive to construct, these structures pay for themselves. They can be used to temporarily store cones after collection and for general purpose storage during the remainder of the year.

Handling procedures have improved. Rather than removing seedlings from cold storage and transporting directly to the planting site for preparation and planting, a process that usually spanned 6 to 8 hours, the District now allows the seedlings a 36 to 48 hour acclimatization period. While transported the seedlings are kept cool and moist by using tarps and performing the transport in early morning. Once on the site seedlings are stored in cool, shaded locations.

If received in trays container stock is stored in a partially shaded location. Trays are kept above the ground surface several inches to prevent roots from anchoring in the soil. Frequent watering keeps the plugs moist. Container seedlings are transported on a trailer to the planting site where a final watering is given if needed.

Proper storage conditions and handling procedures give seedlings a better opportunity to survive and grow after outplanting. We believe the described procedures have significantly improved our reforestation program.

Plantation Monitoring

A common mistake in reforestation is planting an area and believing the task is completed. Lack of timely post-planting monitoring has significantly contributed to low survival and growth on this District. Seedlings that survived the first growing season frequently succumbed to competing vegetation during the second or third growing seasons. Those seedlings fortunate enough to become established often are subjected to cattle trampling and deer browsing which either results in death or hindered growth.

To remedy these situations we began tracking plantations and developed protection programs.

- (1) protection from cattle - the most apparent solution is to fence plantations to exclude cattle. We construct permanent and let-down fences (in high snow fall areas) around plantations near stock tanks and travel ways if an unacceptable level of seedling damage is anticipated. Due to the high costs of fence construction and annual maintenance not all plantations are fenced. The District is willing to accept some seedling losses balanced against the fencing costs. We are considering solar powered electric fences as an alternative to conventional fencing methods.

A less expensive approach is to work with permittees to alter salting locations, temporarily close waters, or herd the animals if necessary. These methods work well providing the permittee is concerned and cooperative.

- (2) release - to reduce competing vegetation a herbicide is applied the second or third growing season depending on the degree of competition. This practice substantially reduces seedling losses and improves growth. Herbicides used include glyphosate and a dalapon/atrazine mixture sprayed within a two foot radius from the seedling. During spraying foliage is protected by covering the seedling with a short piece of plastic or lightweight metal pipe. Broadcast spraying is not permitted.

Due to the recent ban on herbicide application in Arizona national forests we are temporarily substituting a manual release program. This is essentially a handscalping operation. Release using herbicides is preferred over manual methods because the former retains the dead vegetation to create a mulching effect and generally gives longer lasting results.

- (3) protection from deer - several methods are used depending on seedling size. For small, recently planted seedlings 18" x 2" (diameter) vexar tubes anchored by three metal pins are suitable. These afford good protection for about three years before the material degrades in the Southwestern climate. For larger, established seedlings we have used a chemical method and paper budcaps. The chemical method is the popular big game liquid repellent applied in late spring just prior to browsing. This repellent is satisfactory, but fails to provide effective long term protection. For our situation a more preferable protective measure is paper budcaps. These are applied simply and inexpensively. They provide good protection of a terminal leader for at least three months.

Project Planning and Contract Administration

Inadequate project planning was characteristic of many earlier reforestation projects on the District. Our limestone soils have high infiltration rates. Accordingly, it is not unusual for soil to be too dry to plant two weeks after snowmelt. This means that planting must be accomplished expeditiously to allow the seedlings a greater chance for survival and growth. During the 1970's planting contracts specified contract time of 20-25 days. Normally, this resulted in planting dry soil for the last 8-12 days. First year survival was usually less than 10% for these sites. Another confounding factor was starting the actual planting a few days late. Sometimes this was beyond the District's control such as a contractor unable to start due to prior contracts. However, in other instances we hesitated in removing snow from access roads in a timely manner. When snow removal was accomplished south facing slopes were already bare and drying. The snow removal was delayed to permit snow on roads to melt, thus, making the process less expensive. It is common to open 50 to 70 miles of road annually to access planting sites.

Currently, we specify a 10 to 12 day contract time to avoid planting in dry soil. This also permits more trees per acre to be planted in the rockier ground while moisture is still good. Even though costs are increased, our goal is to have access roads open when at least one foot of snow remains on the south slopes. This also allows the roads to adequately dry prior to vehicle use which in turn reduces rutting once planting commences.

Contract administration was sometimes lacking on reforestation projects. As a result contractors frequently over-pruned roots to facilitate planting rocky ground and our contract inspectors failed to notice the short roots. Sometimes too few inspectors were used so the bases were not covered. In other instances on rapidly drying ground, contractors were permitted to plant during high winds so the project could be quickly finished. Use of existing shade was poor and efforts to enforce this contract provision were unsuccessful.

To correct these problems we have added contract inspectors to allow all project phases to be monitored. Since 1980 seedlings are jelly-rolled either by force account crews or by a local community group under contract. These actions and others give us better control over reforestation projects and increase quality. Contract administration is strict, but fair and reasonable. Contract specifications are fully enforced with allowances for common sense and good judgement. We uphold our end of the agreement and expect contractors to do likewise.

Application of Existing Reforestation Knowledge and Technology

Some past reforestation projects failed to incorporate existing knowledge. Examples include improper species selection for a given site/environment, using bare root seedlings rather than container stock in extremely rocky areas, and failure to try artificial shading devices in appropriate situations. Actually, many of the examples discussed in the last five sections also fall into this category. Currently, we review publications, evaluate new ideas and methods, and apply those we feel are practical to our situation. Sometimes we select and implement a method that does not work as expected. In these situations, we consider it a learning experience and benefit from the knowledge gained.

SUMMARY

By implementing these and other actions District personnel have greatly improved the quality and success of the reforestation program. Overall, first year survival is about 70% with third year stocking surveys showing 400 to 500 acceptable seedlings per acre. About 95% of our plantations meet certification standards. Growth is improving due to the release program and animal damage is impacting seedlings to a lesser extent. Although we have come a long way, much work remains to be done.

THE USE OF SHEEP TO CONTROL COMPETING VEGETATION
IN CONIFER PLANTATIONS
ON THE DOWNIEVILLE RANGER DISTRICT,
TAHOE NATIONAL FOREST: 1981 - 1984 1/

By

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Abstract - The use of livestock grazing, specifically sheep, appears to be a useful management tool for controlling competing vegetation in conifer plantations, regardless of plantation age. After four grazing seasons on the Downieville Ranger District, Tahoe National Forest, sheep successfully grazed 500 acres of newly established conifer plantations by significantly reducing densities of competing vegetation without significant damage to the conifers present. Several factors appear to be critical for livestock grazing to be successful, with the most significant being the quantities of desirable vegetation present prior to grazing. Livestock grazing in conifer plantations appears to be a viable management tool for many specific locations, especially in combination with other tools currently available.

Introduction

In 1980, the Downieville Ranger District, Tahoe National Forest was involved in extensive public involvement in assessing public concerns in the District's reforestation and timber stand improvement programs. The District is currently regenerating an average of 1710 acres 3/ of commercial forest land annually, and the trend is increasing. Site preparation, reforestation and plantation maintenance programs are, in turn, increasing significantly. The District's herbicide program normally involves an annual average of 1,000 acres of hand application and 200-500 acres a year of aerial application. 4/ To say the least, the herbicide program is closely scrutinized by the public. During public involvement, the District identified the opportunity to incorporate

- 1/ Presented at the National Silvicultural Workshop, "Successes in Silviculture", Rapid City, South Dakota, May 14, 1985.
- 2/ The project reported here was when the author was District Silviculturist and Program Manager for Range, Wildlife, Soil and Watershed, USDA-Forest Service, Downieville Ranger District, Tahoe National Forest, 1978 to 1984.
- 3/ Environmental Impact Statement and 1978 Timber Management Plan, Tahoe National Forest.
- 4/ Herbicide use on National Forest land in California is temporarily suspended due to a recent Ninth Circuit Court decision in Region 6.

livestock grazing in conjunction with its plantation maintenance programs, primarily as an alternative to herbicide use. Reforestation planners then began assessing potential impacts associated with livestock grazing as required by the National Environmental Policy Act of 1969. After reviewing the available literature, it did not appear feasible to incorporate livestock grazing in conjunction with plantation maintenance programs as many studies indicated high levels of conifer damage and mortality. Most of the literature was specific to the Southwest and was fairly old (i.e. 1920-1940's). Very little literature was specific to California conditions, but interest in livestock grazing in plantations was developing in the late 1970's in the scientific community. A great deal of research in grazing sheep and cattle in conifer plantations is currently underway in Oregon, Washington and California with fairly optimistic preliminary findings.

With little literature available to help develop grazing strategies, the District decided to take a conservative approach in grazing plantations. The area selected to be grazed was the 1978 Cap Fire area, located near Downieville, California. The lightning caused fire consumed 2,000 acres of commercial forest land. Within the fire boundary was a 600 acre brushfield, which was then being assessed for reforestation possibilities. The fire completely removed all brush, and the 600 acre area was planted with conifers in the spring of 1979. Due to extensive sprouting of the brush species present, the area was completely reoccupied with brush within one year, and first year conifer survival dropped to less than 10 percent and was considered a failure. Brush densities were measured during survival exams in September, 1979, and brush densities were approaching 100% cover with 10,000 to 40,000 + cubic feet/acre of brush common. Conifer survival averaged 66 trees/acre, ranging from 0-400 trees/acre. Plantation failure was directly attributable to extreme competition from the brush species present. Within the remainder of the burn, 16.5 MMEF of fire-killed timber was removed in 1979, and the harvested area was successfully reforested in 1980 and 1981. To date, approximately 500 acres have been reforested, with the 600 acre brushfield the only area remaining to be attempted again.

Sheep were selected over cattle as the preferred livestock for grazing, primarily due to the steepness in slope (>30%) within the allotment, and sheep require herding. The preliminary strategy for grazing the area was to concentrate the livestock in the brushfield area, and to lightly graze the newly established plantations. Other older plantations near the burn, with conifers exceeding 5 feet in height, were also proposed for grazing with the objective being to remove as much of the brush competition as possible. As a result, the District created the 7,000 acre Saddleback/ Cherokee Grazing Allotment, with an estimated carrying capacity of 1,000 animal unit months (A.U.M.'S.), which equates to about 1,000 head of sheep for a 5 month period. Within the allotment, there are over 700 acres of existing conifer plantations ranging in age from one to twenty-one years. The grazing strategy for the entire allotment was to lightly graze the younger plantations (age 1-3), or preferably to avoid those younger plantations. Heavy grazing was proposed for the existing brushfields, older plantations and existing timber stands which had an understory of brush species present. Grazing was implemented in the Spring of 1981 with 900 head of sheep moving onto the allotment in June. During the grazing period (June to October), the sheep were encouraged to graze the entire 2,000 acre Cap Fire area. The original objective was to "concentrate" graze within the 600 acre plantation failure, and to "maintenance" graze the plantations considered stocked. The overall objective was to provide some form of vegetation control on the silviculturally less desirable deerbrush and greenleaf manzanita, the primary species present.

During the first grazing season, the sheep inadvertently heavily grazed about 250 acres of younger plantations (i.e. less than 3 years of age). Upon removing the sheep in early October, detailed survival exams were completed, with results showing only 1-2% significant damage to conifers. "Significant damage" is defined as a missing or dead seedling, or a repeatedly nipped terminal bud. Primary damage was in the form of nipped foliage and lateral branches (not considered significant) and minor amounts of trampling. In addition, ocular estimates of percent brush cover were made before and after grazing in an attempt to determine the estimated percent utilization for the various brush species present (see Table 1). Overall, an estimated 25% of existing brush was utilized by the sheep, ranging from 0-5% in the undesirable forage (i.e. greenleaf manzanita) to 100% in areas of deerbrush, the most desirable forage present.

As a result of grazing the first season, several advantages, disadvantages and several general comments became apparent:

Disadvantages

1. Grazing plantations require a great deal of coordination/cooperation between the Forest Service and Permittee. Periodic silvicultural evaluations to monitor brush response and utilization is necessary. Herbicide use within the allotment has to be closely coordinated.
2. Some trailing and bedding areas had to be seeded with grass totaling about 3 acres.
3. Trespassing on non-fenced private land was a minor problem.
4. An estimated 20 to 25 acres of plantations were significantly damaged from a total of 500-600 acres. Five acres of 1 year old white fir were destroyed due to bedding in the plantation. The remaining 15-20 acres were primarily nipped ponderosa pine (primarily "heavily" nipped foliage or lateral branches and nipped terminal buds). Periodically, conifers throughout the area were damaged, but damage was not considered significant as long as the damaged tree had the potential to recover in one growing season.
5. Sheep require a water source relatively close to areas to be grazed, and water chances may have to be developed. Ideally, tree cover should be close to areas to be grazed to provide a shaded afternoon bedding area, and open areas need to be available for night bedding. If plantations are used, significant damage may result.
6. Obtained poor to fair control in plantations in which greenleaf manzanita was the primary species, depending on the age of the manzanita and the season of use.

Advantages

1. Obtained good to excellent vegetation control in most plantations where deerbrush was predominant.
2. Created about 20 to 30% of bare ground on younger brushfields which could be considered plantable areas (i.e. site preparation).

3. Obtained grazing fees of about \$1,350.00 from the Permittee for the allotment, resulting in a net income of 30 to 40 cents per acre of plantation grazed. 1/ Technically, grazing basically occurred at no cost to the government. Some range improvements will be required, necessitating minor investments.
4. Damage to conifers was limited (1 to 2% overall damage) during the 1981 grazing season.
5. Although speculative, grazing appears to convert unusable brush to usable fertilizer. (Note: Powers (1981) 2/ reported 100 to 200 lbs. of nitrogen occurs per acre in greenleaf manzanita brush fields. Deerbrush has a higher nitrogen content per acre, as it is a nitrogen fixer (up to 500 lbs/acre). 3/ Grazing would essentially convert unusable brush to an available form of nitrogen.)
6. No apparent conflicts with wildlife species occurred. In fact, several biologists, including the California Department of Fish and Game, reviewed the area and felt that the wildlife value of the area was increased by providing openness and maintaining browsing availability.
7. Grazing livestock is a socially accepted form of plantation maintenance. Obtained excellent local acceptance. Only one complaint was received involving trespass on private land.
8. Grazing resulted in absolutely no conflicts in older/larger plantations (i.e. 4-6 feet in height).
9. Sheep effectively decreased vegetation densities of preferred brush species and maintained or increased the range value by keeping desirable vegetation to a low height level, and therefore still usable by livestock and wildlife.

General Comments

1. Age of sheep appears to be a major factor in compatibility of grazing and conifer production. Older sheep (4 years +) appear best suited. Younger sheep have a tendency to graze all vegetation, including conifers. This is speculated to be a trial and error process, in which younger sheep may graze conifers not knowing the suitability/palatability as forage and having a higher energy requirement for growth.
 2. The most critical factor appears to be the quantity of desirable browse species. Grazing deerbrush, a highly desirable species, resulted in minor amounts of conifer damage, whereas grazing greenleaf manzanita, a non-desirable species, had higher associated damage levels to conifers.
- 1/ Region Five Draft Vegetation Management Environment Impact Statement, 1984; Analysis by Barbara Kosco, Regional Ecologist, based on data from Thomas, 1983.
- 2/ 1981 Attainment Report, R-5/PSW Cooperative Forest Fertilization Program.
- 3/ Personal communication with Bob Powers, P.S.W., Redding, California, June 5, 1984.

3. Time of year of grazing seems to be a factor, especially with regard to utilization of less desirable vegetation. Greenleaf manzanita, whitethorn (both considered less desirable) and various grasses had "fair" utilization early in the season (especially young shoots), and almost no utilization later in the season. The grasses had excellent utilization early in the season until seed heads formed and the grass died out. At that time, almost no utilization occurred. Excellent control resulted throughout the grazing period in deerbrush and black oak sprouts; fair control in bracken fern, gooseberry and thistle; and fair to good control in bittercherry.
4. Better utilization of the grazing area may be obtained if the livestock are "force" herded to grazing areas, instead of "sheep's choice".
5. On the Saddleback/Cherokee Allotment, water developments can be installed to better utilize the area. One water development was installed in 1982, resulting in additional acres being available for intensive grazing. Water was previously considered a limiting factor to effectively graze the area. Also, semi-permanent bedding areas (i.e. preferably non-stocked with conifers) should be identified prior to grazing. Bedding areas may require grass seeding.
6. The herder "must" monitor levels of browse vegetation within plantations. Once the level of vegetation is decreased to acceptable levels, the sheep should be moved promptly to avoid damage to conifers.
7. Non-grazing areas must be identified prior to grazing with the Permittee. Critical areas, such as progeny areas, administrative studies, etc., may require fencing.

The allotment has been grazed three additional seasons with the same advantages and disadvantages as previously stated, with two major differences noteworthy. First, there is an obvious trend developing in the response of the vegetation being grazed. There is a definite decline in the quantity of desirable vegetation (i.e. deerbrush) and a definite increase in the quantity of the less desirable vegetation (i.e. greenleaf manzanita), both trends directly attributable to the intensity of grazing the area has received for four seasons. As a result, the District is currently considering changing the grazing strategy to a "pasture system", with the objective of maintaining a higher proportion of desirable vegetation, while still maintaining low densities of brush cover. The system that is currently being considered is to break the allotment into several pastures, in which each pasture would be grazed heavily (or grazed normally) one season, not grazed the second season and lightly grazed the third season. Second, during the 1984 grazing season, significantly more damage occurred within young plantations (i.e. age 1-2). The major factor contributing to more damage was poor herding practices (or lack of herding), resulting in the sheep grazing too long in several areas.

In 1982, the Pacific Southwest Region has entered into a cooperative agreement with the Pacific Southwest Forest and Range Experiment Station to quantify the impacts and conifer response to grazing livestock in conifer plantations. Twelve permanent plots were established in the Spring, 1983, before grazing occurred. The area was inventoried prior to grazing and directly after grazing. Although the data has not been summarized as yet, first and second year results appear very promising. Very little damage to conifers occurred, with brush densities greatly reduced after the 1983 and 1984 grazing season. The study is planned for ten years, with the results to be periodically published.

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TABLE I

ESTIMATED PERCENT COVER OF VEGETATION BEFORE AND AFTER GRAZING

AND

ESTIMATED RANGE OF PERCENT UTILIZATION AFTER GRAZING
FOR THE 1981 GRAZING SEASON

<u>Species</u>	<u>% Cover Before Grazing</u>	<u>% Cover After Grazing</u>	<u>% Utilization 1/</u>
Greenleaf Manzanita	15-25%	10-25%	<5%
Deerbrush	35-45%	10-20%	60% (20-100%)
Whitethorn	10%	8-9%	1-3%
Bittercherry	2%	1%	40%
Bracken Fern	2%	1%	15% 2/
Black Oak (primarily sprouts)	5%	2%	50%
Orchard Grass (Seeded-1979)	10%	9%	10%
Alfalfa (Seeded-1979)	2%	1%	N.A.
Wedgeleaf Ceanothus (Seeded - 1979)	2%	1%	50%
Chinquapin	<1%	<1%	<1%
Thistle	<1%	<1%	10%
Bare Ground	<5%	20-30%	90-100%

1/ Percent utilization was obtained by estimating the amount of vegetation consumed by sheep. Percent utilization was obtained by comparing the amount of plant remaining after grazing to the amount of plant before grazing.

2/ Bracken fern is somewhat of a noxious weed; utilization occurred on young plants.

EQUIPMENT FOR HAND AND OTHER GROUND APPLICATION OF HERBICIDES
By Max Williamson*

In the past few years, a significant number of new herbicides and uses have appeared on the market for use for forestry site preparation and release. These herbicides are formulated for applications as liquids, granules and pellets.

Application equipment, especially for mechanized ground and hand applications, have not kept pace with the development of forestry herbicides. In the Southern Region, we have many small clearcut areas for treatment, and areas where aerial application, without the deferral, is not an acceptable method. For these reasons, we have given emphasis to improving ground and hand application methods. This emphasis has been coupled with a rather intensive training program on the characteristics and uses for forestry herbicides, and safety in applications, as well as the improved methods for application.

The following is a brief discussion of three of these methods.

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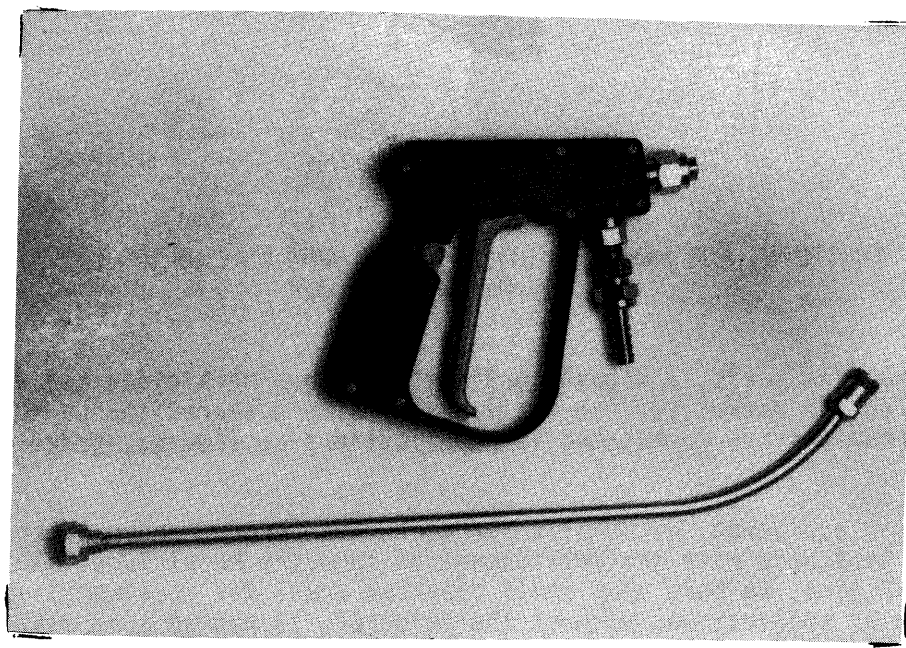


Figure 1

Herbicide Handgun Applicator
for Foliar, Soil Spot, and Thinline
Basal Bark Applications

Figure 1 shows a handgun that can be attached to a solo backpack sprayer or any other hand sprayer that will produce a pressure of about 20 to 40 pounds per square inch.

The handgun can be used for site preparation, conifer release, and herbaceous weed control.

The unit will apply Velpar L or other soil active herbicides for spot applications. It will apply a Garlon 4 solution in a thinline basal application, and also can be utilized for foliar spray in directed or banded applications by adding an extension and changing the spray tip.

The cost of the basic handgun is about \$35.

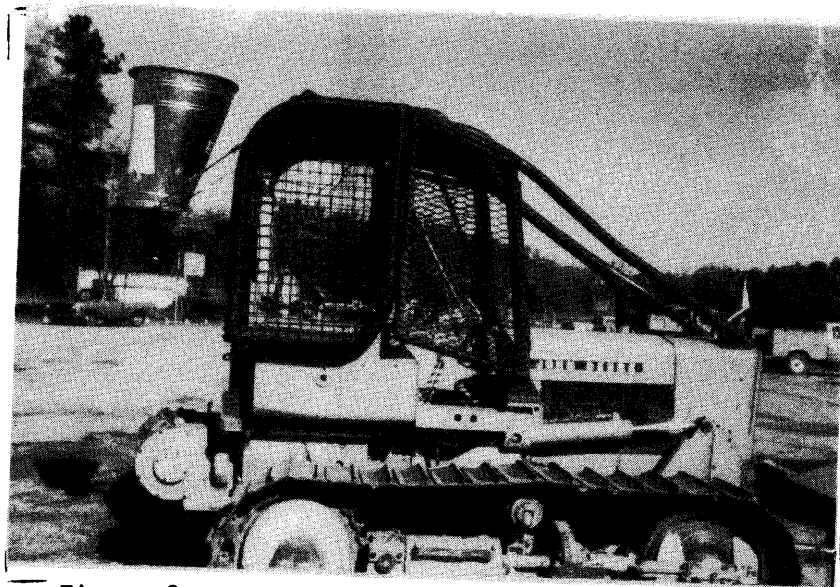


Figure 2

Crawler Tractor Mounted
Granular Herbicide Applicator,
Herd Model 1-92-P

This system is designed to mount on a John Deere 350 or 450 Crawler Tractor. The unit is shown mounted on the John Deere 450 tractor, in figure 2. This system can be adapted for other crawler or wheel tractors. The unit can be used for both site preparation and conifer release.

The applicator (hopper) will hold 140 to 150 pounds of the herbicide Pronone. The application width is about 48 to 50 feet.

The applicator will empty the hopper in about 35 to 45 minutes. In this time, the unit can cover 6 to 15 acres, depending upon the application rate.

The unit can be mounted and removed from the tractor in about 30 minutes.

The cost of the applicator is \$333.

Source is Herd Seeder Company
PO Box 448
3600 East on US 35 SE
Logansport, IN 46947

Phone: 219/753-6311

Trade names are mentioned solely to provide specific information. Mention of a trade name does not constitute a warranty of the product by the US Department of Agriculture or an endorsement by the Department over other products not mentioned.



Figure 3

Tractor Mounted Herbicide Spray System

Figure 3 shows a spray system designed for mounting onto a John Deere 450 tractor. The unit also can be adapted to fit other make tractors.

The system can be used for both site preparation and conifer release.

The spray system tanks holds 200 plus gallons, and is calibrated for putting out about 25 gallons per acre.

The unit will apply the 200 gallons in approximately 45 minutes, covering about 8 acres. The application rate varies with the calibration for differing species and terrains.

The spray width is from 40 to 42 feet from a height of 16 feet.

After the initial installation, the spray unit can be mounted onto or removed from the tractor in about 1 hour.

The cost of the materials for constructing the unit is approximately \$2,000.

For additional information, including sources and construction plans, contact Max Williamson.

MANAGEMENT OF LODGEPOLE PINE UNDER CATASTROPHIC CONDITIONS

by

Mike Znerold
Forest Silviculturist
Deschutes National Forest

During the past 15 years, the Deschutes National Forest has made important changes in the management of lodgepole pine. Silvicultural strategies have shifted from diameter limit cutting to clearcutting and finally to a new emphasis on reducing costs and use of the seedtree system. These changes were prompted by a mountain pine beetle epidemic and the need to accelerate management of lodgepole pine, the timely application of new research on tree vigor, and a well thought out public information program. As a result, lodgepole pine can be managed with more flexibility and reduced costs in concert with the needs of other resources.

LODGEPOLE PINE: DISTRIBUTION AND ECOLOGY

Lodgepole pine on the Deschutes National Forest is of the subspecies *murrayana*. It dominates 474,000 acres, or 40 percent of the 1,200,000 acres of commercial forest land on the Forest. Even-aged stands of mature or overmature lodgepole pine, susceptible to mountain pine beetle, occupy 297,400 acres, or 25 percent of the commercial forest land base. Here the species appears to have a stable ecological role which is not related to fire (Wheeler and Critchfield 1985). Cones are typically non-serotinous. Lodgepole pine occurs in pure stands on flats or basins on the pumice-mantled plateau which covers much of Central Oregon. Pumice soils on the plateau are deep and well drained. Radiation frosts are frequent and may occur throughout the growing season because of the plateau's high elevation, relatively dry air mass, predominance of clear night skies, and low soil thermal conductivity (Cochran and Berntsen 1973, Cochran 1975). Frost pockets within these basins can pool cold air to a depth of 3 feet. On these sites, opportunities for species conversion are few. Ponderosa pine's sensitivity to low night temperatures restricts it to the adjacent higher ground (Cochran and Berntsen 1973). Lodgepole pine invades both ponderosa pine and mixed conifer stands on mesic upland sites but seldom occurs as pure stands. It does occur in pure stands as a climax species in several wetland plant communities and in several cold, high elevation plant communities near the crest of the Cascades.

Presented at the 1985 National Silvicultural Workshop, Rapid City, South Dakota, May 13-17, 1985.

EARLY MANAGEMENT: 1961 to 1971

Before 1970, management of lodgepole pine was restricted to removal of selected older and larger diameter trees in multi-aged stands. Control measures for mountain pine beetle suggested by the Region's Insect and Disease Control Branch called for (1) harvesting the oldest and most susceptible stands or (2) removing all merchantable trees to as small a diameter as economically feasible (Dolph 1971). Trees 11 inches in diameter and larger were typically designated for cutting. Prescriptions also focused on removal of trees infected with dwarf mistletoe. Entomologists further recommended that sales should be large enough to alter the beetle breeding site. Sales prepared during this period on the Forest typically included partially cut units of 1,500 to 2,000 acres.

Mountain Pine Beetle at an Endemic Level

Between 1961 and 1971, little mountain pine beetle activity was detected. The total area within the Forest boundary infested remained below 28,000 acres (less than 10 percent of the susceptible acres). Infestations in second-growth ponderosa pine were substantially smaller, averaging 3,300 acres annually. Lodgepole pine volume sold during the period averaged 22 million board feet annually.

CHANGING MANAGEMENT IN RESPONSE TO MOUNTAIN PINE BEETLE: 1972 to 1980

By 1972 mountain pine beetle activity began to accelerate. Outbreaks were occurring in even-aged, overmature stands of lodgepole pine rather than the multi-aged stands treated earlier. As management activity focused on these new outbreaks, diameter limit cutting used extensively in the previous decade became less appropriate, and the strategy shifted to regeneration cutting.

Clearcutting Introduced

Forest scientists presented few options for managing lodgepole pine in light of a growing mountain pine beetle epidemic. Control efforts concentrated on the conversion of all acres at risk. The silvicultural system of preference was clearcutting. Lodgepole pine stands at risk were identified using criteria including average stand and site characteristics as well as the extent of beetle activity (Amman 1978, Safranyik and others 1974). These data indicated that much of the 1.4 million acres of lodgepole pine in Central Oregon met the high hazard category. Recommendations from Forest Pest Management, Pacific Northwest Region focused first on managing stands where the beetle was already present. The second step included hazard rating the remaining acres, establishing a harvesting schedule, and removing high risk stands before they were attacked by beetles. However, actual management activities concentrated on the first step. As the epidemic increased, management of the outbreak was largely reactive. Timber sales were planned in areas hard hit by the beetles.

Little harvest activity was actually concentrated in areas without beetles.

The "One-Third" Policy

The Forest Supervisor issued a draft Resource Impact Policy in 1972 which restricted the amount of openings created by clearcutting to one third of the total planning area. The policy was prompted in response to the growing number of acres regenerated by clearcutting. The "one third" policy restricted clearcut size to 25 acres, shelterwoods to 40 acres, and required that units be irregularly shaped. This policy eventually provided a smooth transition to the restrictions legislated by the National Forest Management Act. Lodgepole pine volumes harvested from 1972 to 1975 remained fairly constant, averaging 20 million board feet annually. Mountain pine beetle were detected on fewer than 30,000 acres each year.

The Infestation Accelerates

Between 1975 and 1978 mountain pine beetle activity increased to 50,000 acres. Figure 1. illustrates the increase in acres infested by mountain pine beetle between 1975 and 1984. In 1979 the infested area in lodgepole pine more than doubled, reaching 133,800 acres. The Forest experienced record breaking drought between 1977 and 1979. Precipitation dropped to 65 percent of normal. The outbreak was accelerating, perhaps triggered by the drought. In 1980 the infested area doubled again, reaching 300,400 acres on all ownerships within the Forest boundary. The average annual volume killed by beetles during this period was 4 times greater than the volume killed 10 years earlier. Figure 2. illustrates the increase in volume killed by mountain pine beetle between 1975 and 1984. At this time, 10,500 acres of second-growth ponderosa pine were also infested. Timber sales sold during the period from 1976 to 1980 harvested an average 33 million board feet of lodgepole pine on 6,600 acres annually. The increased harvest was highly dependent on the volatile chip market. Regeneration treatments focused on clearcutting. Roughly 900 clearcut acres were planted annually. Silviculturists prescribed planting rather than natural regeneration because of the harsh environment associated with these basin sites and the non-serotinous nature of lodgepole pine. The reforestation investment costs exceeded \$300 per acre. As new sales appraised more acres of dead lodgepole pine and the product value fluctuated widely, Forest managers worried about the reforestation costs for lodgepole pine relative to its market value. Emphasis shifted toward finding ways to reduce investment costs. Managers also sought alternatives to clearcutting to manage campgrounds and areas with high visual quality dominated by susceptible trees.

Figure 1.

LODGEPOLE PINE ACRES INFESTED BY MPB
DESCHUTES NATIONAL FOREST, 1975-1984

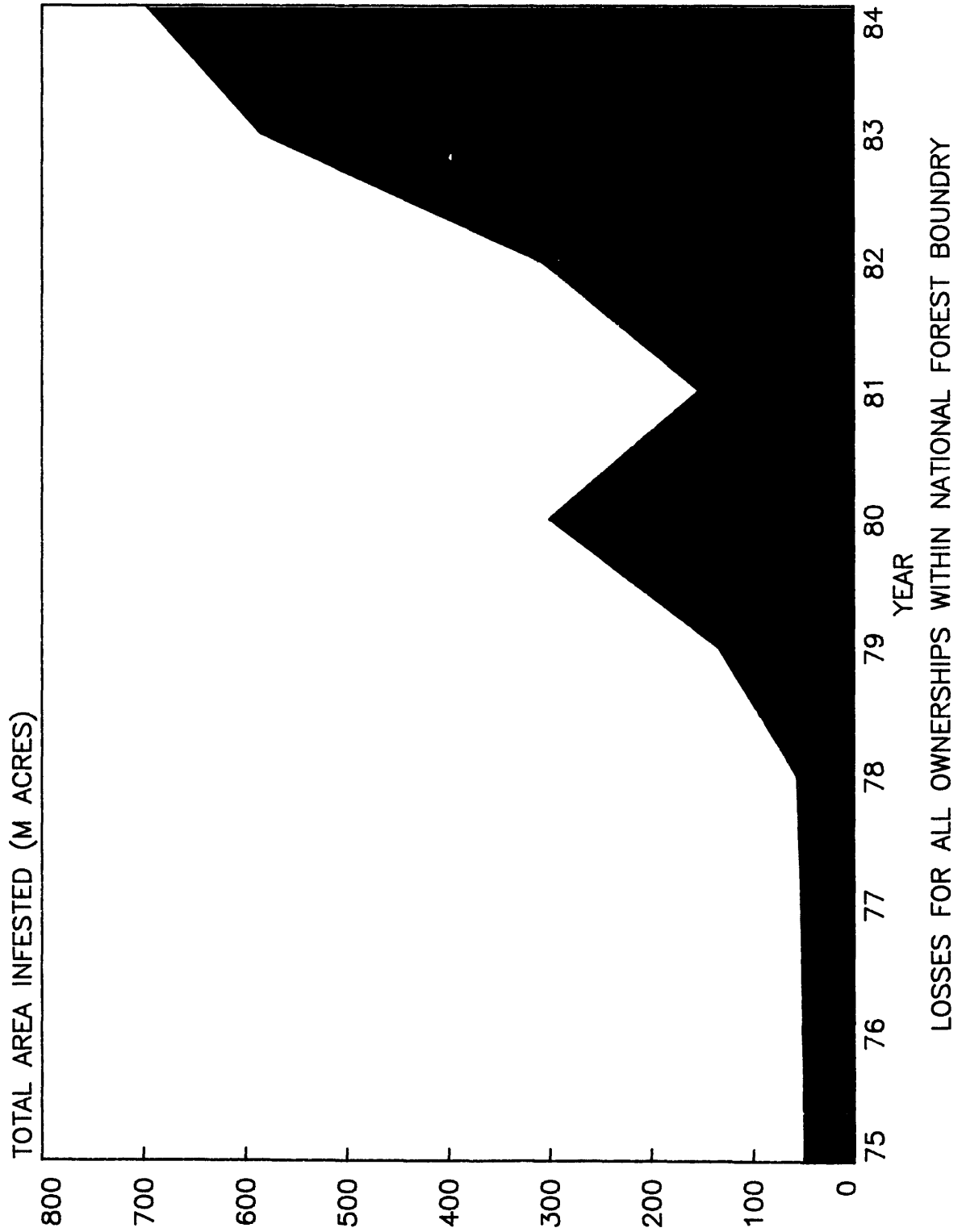
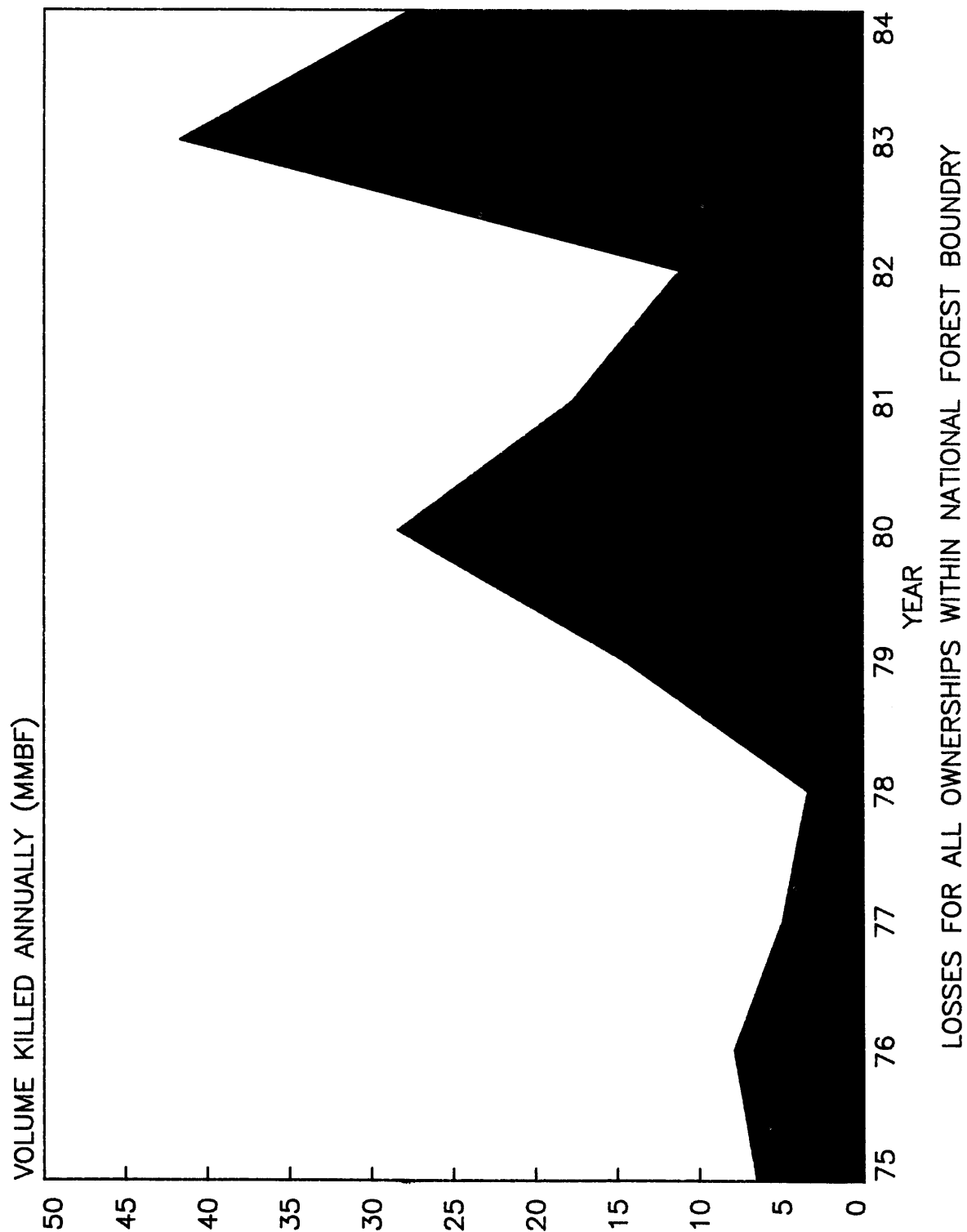


Figure 2.

LOGGEPOLE PINE VOLUME KILLED BY MPB
DESCHUTES NATIONAL FOREST, 1975-1984



NEW RESEARCH ON A TREE VIGOR INDEX

Stand regeneration using the clearcut system was inflexible as well as expensive and ignored the significance of tree vigor and its relationship to mountain pine beetle attacks. Although commercial thinning was recognized as a silvicultural technique for control of mountain pine beetle in second-growth ponderosa pine, this strategy was largely untested in lodgepole pine (Sartwell and Stevens 1975, Sartwell and Dolph 1976). After measuring numerous stands on the Deschutes National Forest, scientists from Oregon State University and the Bend Silviculture Lab identified another factor which proved useful in identifying why mountain pine beetles attack certain lodgepole pines and not others. Waring and others (1980) had previously identified the use of leaf area as an indicator of vigor. Based on the discovery that sapwood basal area is a linear index to leaf area (Grier and Waring 1974), a relationship was identified between basal area growth and leaf area. This relationship, described as a tree vigor index, became a useful predictor of an individual tree or stand's susceptibility to insect attack. Waring and Pitman (1980) proposed that trees with high resistance to attack by mountain pine beetle produced a relatively large amount of sapwood each year. Trees attacked in study plots verified this relationship. Trees freed from competition in widely spaced, thinned stands seemed to become more resistant to beetle attack. This relationship was observed even though trees in their study were 120 years old.

Mitchell and others (1983) confirmed these results in thinned and unthinned stands of lodgepole pine in Eastern Oregon which were evaluated to determine their susceptibility to mountain pine beetle. These authors strongly suggested that stocking level control would produce fast growing trees with no appreciable loss to mountain pine beetle. Larsson and others (1983) found the same relationship between Waring's tree vigor index and susceptibility to mountain pine beetle in a stocking-level experiment of ponderosa pine in Central Oregon. Additional stocking-level experiments of lodgepole pine installed by Mitchell on the Deschutes National Forest also confirmed this relationship. In general, these scientists found that tree vigor decreases directly with increasing canopy density. As stands are thinned from below, the vigor of individual trees increases and beetle attacks decrease.

A New Tool for Field Application

These research developments provided operational foresters with a tool which could be used to identify high risk trees or stands and serve as a basis for prioritizing treatments. Swaby and Chetock (1981) developed a mountain pine beetle stand susceptibility rating system in cooperation with Waring, Pitman, and Mitchell. Their system provided step by step details for risk rating stands of ponderosa or lodgepole pine in the field. Using this system, trees producing more than 100 grams of wood per square meter of leaf area were unlikely to be

attacked, while trees producing less than 50 grams of wood were very likely to be attacked.

Bob Dolph (1982), entomologist with Forest Pest Management, Pacific Northwest Region, assessed four techniques for rating susceptible trees in stands attacked by beetles. The Waring and Pitman tree vigor index proved the most sensitive predictor of future mortality. Dolph (1982, 1983) provided additional guidelines for vigor rating trees and field tested the vigor rating system in thinned second-growth ponderosa pine on the Deschutes and Ochoco National Forests. During this period, Waring developed a program for calculating tree and stand vigor ratings using a hand held programmable calculator. Dolph adapted this program for ponderosa pine. These programs, as well as a graph developed by Heiken (1981) for field calculation of vigor without the use of a calculator, were distributed to the National Forests by Forest Pest Management. This new research was implemented even before it was published because of the close contact between research scientists, Forest Pest Management, and the field forester. This technique provided the forester and entomologist with a subjective and mathematical approach to rating susceptible trees and proved a vital link between research and on-the-ground application.

LODGEPOLE PINE MANAGEMENT ACCELERATES

In light of the rapidly accelerating infestation, the Forest began work in 1980 on the Environmental Assessment for Lodgepole Pine Management, better known as the Swatter EA, which proposed to increase the harvest of lodgepole pine. Entomologists predicted that the beetle would remain at epidemic levels and within the next 20 years kill essentially all the lodgepole pine on the Forest over 8 inches in diameter. The selected alternative, signed by the Forest Supervisor in July, 1981, proposed converting mature and overmature lodgepole pine in 20 years in areas allocated to wood/forage and game species and in 30 years in areas allocated to developed recreation and visual management. These combined allocations accounted for 297,400 acres of lodgepole pine and an annual harvest target of 14,302 acres.

Catastrophic Damage Defined

In conjunction with the Swatter EA, the Forest developed a set of criteria used to evaluate the point at which mountain pine beetle damage became catastrophic. Where beetles reduced live, merchantable volume by more than 30 percent, mature and overmature unmanaged stands were defined as being in a catastrophic condition and became exempt from cutting unit size limitations imposed by the National Forest Management Act. Swatter did require that management activities provide hiding cover on 25 percent of the area being treated.

Figure 3.

LODGEPOLE PINE VOLUME SOLD BY HARVEST SYSTEM
DESCHUTES NATIONAL FOREST, 1976-1988

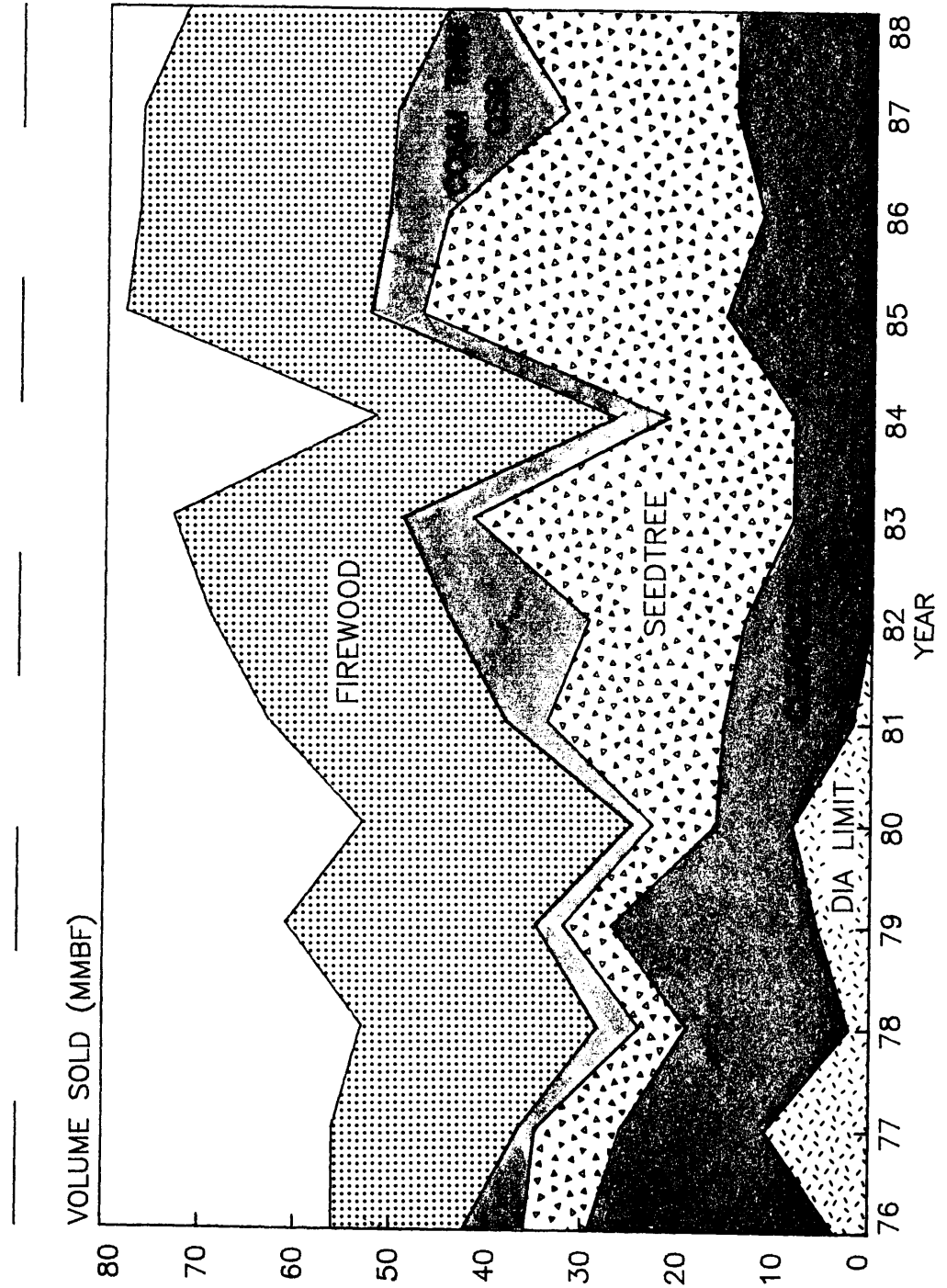
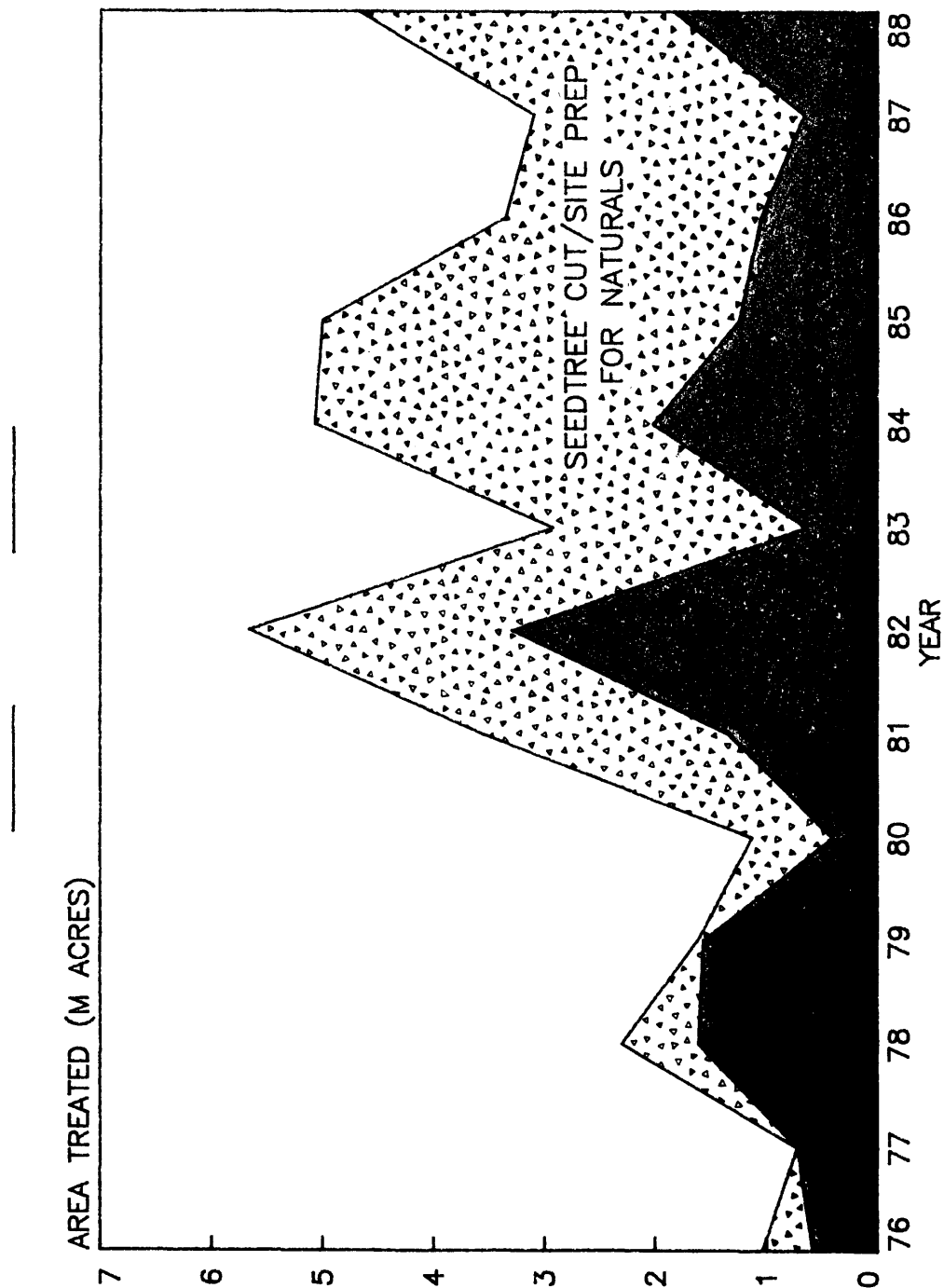


Figure 4.

LODGEPOLE PINE TREATED BY REGENERATION METHOD
DESCHUTES NATIONAL FOREST, 1976-1988



The "Condition Red" Program

In 1980 the Forest also began work on what would become an important public information program called "Condition Red". The Condition Red program promoted public awareness of the mountain pine beetle outbreak in Central Oregon and the increased emphasis on treatment of infested and susceptible lodgepole pine stands. The program involved the cooperative efforts of the Deschutes, Winema, and Fremont National Forests; the Bureau of Land Management; Oregon State Department of Forestry and Department of Fish and Wildlife; Oregon State University Extension Service; and major industrial landowners. Together, these organizations have coordinated the management of more than a billion board feet of lodgepole pine on 1.4 million acres in Central Oregon.

Condition Red developed a number of interpretive and public awareness programs. A newsletter is published periodically. Posters, suitable for use in a standard fire prevention sign board, interpreted areas with beetle damage or where treatment had been implemented. These posters have been of particular value in campgrounds. A brochure was distributed at major public contact points using a stand up counter display. This brochure provided information on how to recognize the insect and its damage and explained the increased emphasis on lodgepole pine management. A Condition Red slide-tape program was also created for interpretive use, particularly in public schools.

NEW APPROACHES TO LODGEPOLE PINE MANAGEMENT: 1981 to 1985

Armed with the Swatter EA, "Condition Red", and the vigor research of Waring, Pitman, and Mitchell, silviculturists and sale planners began to accelerate the lodgepole pine program. Between 1980 and 1984, the area infested by mountain pine beetle on all ownerships within the Forest boundary grew from 300,400 acres to 698,480 acres. Timber sales sold during the 5-year period grew to an average 42 million board feet of lodgepole pine on 8,100 acres annually. This represented a 25 percent increase when compared to the previous 5-year period. Clearcuts were prescribed and sold on 1,700 acres annually (21 percent of the total area treated). Figure 3. illustrates the volume of lodgepole pine sold or planned to sell by all harvest systems between 1976 and 1988. An equivalent number of acres were planted annually. In response to an increasing demand for firewood by commercial firewood cutters, the Forest implemented a commercial firewood program which sold an additional 25 million board feet of dead and dying lodgepole pine annually.

Seedtree Cutting

Anxious to implement this new vigor research, during the next 5 years, sold sales prescribed for seedtree cutting increased to 4,300 acres annually (53 percent of the total acres sold). Site preparation for natural regeneration was accomplished on 2700 acres annually. Figure 4. illustrates the acres treated or planned to treat by regeneration

method between 1975 and 1988. The seedtree system has been used to avoid further increases in the growing workload and steadily increasing costs of artificial regeneration. Reforestation investment costs have been reduced by 60 percent with natural regeneration. Where whole tree yarding has been prescribed, all silvicultural requirements for natural regeneration can often be met by the timber sale purchaser. Seedtree prescriptions typically call for retaining 10 to 30 full crowned, cone bearing seed trees per acre. Stocking surveys conducted on these stands suggest that approximately 70 percent of the treated acres are stocked at acceptable levels within 5 years. Acres poorly stocked are typically re-treated using spot scarification. Only in rare instances has windthrow of seedtrees proven to be a detriment to timely reforestation. Where dwarf mistletoe is present in seedtrees, the probability of reinfecting regeneration is minimized by timely removal of the overstory. The seedtree system has produced positive spin-offs for other resources as well. Treated stands retain a higher level of visual quality. Residual trees provide roosts and nest sites for many species of wildlife.

Commercial Thinning

Commercial thinning in lodgepole pine has been prescribed on less than 100 acres annually. Sales scheduled to sell between 1986 and 1988 average 1,400 acres per year. Where beetle activity is present, commercial thinning is rarely an option. Trees selected as crop trees are often killed before the harvest occurs. Where beetle activity is absent, it has been prescribed as an effective treatment to "risk-proof" both immature and mature stands. The vigor rating system has proven most useful in second-growth ponderosa pine stands where beetle activity is more commonly at an endemic level. Here, sufficient lead time is usually available to accomplish the commercial thinning and to allow crop trees to increase in vigor. Commercial thinning of second-growth ponderosa pine was prescribed on 1,130 acres annually between 1981 and 1985. Sold volume averaged 13 million board feet per year. The average annual sale program also included an additional 1,760 acres sold as overstory removal in naturally regenerated, unmanaged two-story stands. Units prescribed for commercial thinning or overstory removal also provide benefits for other resources. These units typically meet a high level of visual quality and provide cover needed by big game and other wildlife species.

Timber Management in Campgrounds

Numerous campgrounds dominated by mature lodgepole pine have been prescribed for commercial thinning and the harvest accomplished by timber sales. The silvicultural intent is to increase small scale diversity in both size class and species mix. Where beetle activity was already present, seedtree cutting has been prescribed. The use of an alternative to clearcutting in areas with high recreational use

provides much needed flexibility. Conifer species other than lodgepole pine have been introduced where appropriate. Condition Red posters interpret beetle activity and treatments for campground users. The seedtree system has also been prescribed along highways where visual quality objectives are high. In some cases clearcuts were prescribed where opportunities were available to develop scenic vistas.

Results Evaluated

Post treatment evaluations of acres harvested by commercial thinning or the seedtree system have suggested that both immature and mature, large diameter lodgepole pine remained free from beetle attack. Results in second-growth ponderosa pine also confirm this finding. The work by Waring, Pitman, and Mitchell substantiates the concept that individual trees which demonstrate a low vigor and high susceptibility to beetle attack can be silviculturally treated and in a relatively short period of time demonstrate a reduced susceptibility. Resistance has developed in 1 or 2 years. It is curious that resistance has apparently developed in 120 year old trees despite the fact that diameter growth did not increase appreciably. It remains unclear whether the apparent resistance to mountain pine beetle can be attributed to an increase in vigor, a dramatic modification of the micro-climate within the stand, or simply the limited numbers of trees as targets for attack. Despite this uncertainty, the system works and provides silviculturists with a technique to attack the problem in a positive and cost effective way.

Economic Analysis

Stand regeneration using the seedtree system displays tremendous economic advantages when compared to clearcutting. Figure 5. presents a detailed present value analysis of clearcut and seedtree strategies in lodgepole pine. The present net value of lodgepole pine managed by clearcutting and hand planting is \$-112 per acre. The negative value here testifies to the low product value and high investment costs for lodgepole pine management. Machine planting can reduce the investment cost by \$25. The present net value when managed using the seedtree system and natural regeneration is \$57 per acre. This analysis allows for planting 30 percent of the acres prescribed for natural regeneration. The net difference between systems is \$144 to 169 per acre. For the 5 year period from 1981 to 1985, over 21,500 acres were prescribed for natural regeneration. This represents a total increase in present net value of between \$3,096,000 and 3,644,000 for the acres treated or a savings of between \$619,200 and 728,000 annually in reforestation investment costs for the Forest.

Figure 5.

1/

PNV ANALYSIS

SILVICULTURAL STRATEGIES FOR LODGEPOLE PINE

CLEARCUT/PLANT

SEEDTREE/NATURAL

YEAR	ACTIVITY	COST	VOL(CF)	YEAR	ACTIVITY	COST	VOL(CF)
0	Clearcut	\$ 30	1850	0	Seedcut	\$ 28	1490
1	Site Prep	40		1	Site Prep	30	
2	Plant	247		5	Reprep	9	
17	PCT	70		6	Plant	74	
57	CT1	31	1150	8	Final Cut	3	360
77	CT2	42	1170	17	PCT	70	
107	Clearcut	73	2740	57	CT1	31	1150
				77	CT2	42	1170
				107	Seedcut	51	1910
				115	Final Cut	22	830
PNV \$-112				PNV \$57			

1/ Yields from Deschutes National Forest Managed Yield Tables, intensive strategy, site index 75, all cost and benefits from draft Forest Plan, 4% discount rate

LOGGEPOLE PINE MANAGEMENT IN THE FUTURE

Natural regeneration will continue to play a vital role in the management of lodgepole pine. The current Forest goal is to regenerate 80 percent of all lodgepole acres using the seedtree system. Opportunities for natural regeneration may be in jeopardy as the beetle continues to kill the majority of potential seedtrees on thousands of acres. Although the harvest targets established in the Swatter EA have proven optimistic, the sale program in lodgepole pine continues to increase. Proposed sales for 1986 to 1988 suggest an additional 15 percent increase in volume sold. The commercial firewood program continues to grow as the Deschutes National Forest becomes a major supplier for firewood markets in California and Nevada.

Opportunities remain for the development of new markets for lodgepole pine to supplement the unstable market for chips. Additional refinement is necessary to identify acres suitable for natural regeneration. Fuels treatment and site preparation require refinement to control stocking by natural regeneration. As the new Land Forest Plan is approved, new directions will solidify for lodgepole pine management. When compared to second-growth ponderosa pine, lodgepole has modest regeneration costs, adaptability to a wide range of sites, and an increased product value in small diameters. With its suitability for a wide variety of products including lumber, chips, roundwood products and firewood, it may well become the tree of the future.

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INTEGRATED PEST MANAGEMENT IN SOUTHERN FORESTS

Roger P. Belanger¹

ABSTRACT

Integrated pest management is critical to the success of silviculture in the management of southern forests. Significant losses from insects and diseases can occur throughout the life of the stand. Choice and implementation of proper regeneration methods, intermediate practices, and harvest cutting will reduce these losses. Emphasis in this paper is on the integrated management of fusiform rust. Attention is also given to the multiple of other insects and diseases that impact the productivity of southern forests.

Keywords. fusiform rust, silviculture.

Insect and disease pests cause significant reductions in the growth and yield of southern forests. These losses amount to millions of dollars annually and erase many of the gains made by intensive forest practices. Integrated pest management (IPM)--as an integral part of forest management--can reduce these losses.

IPM may be defined as the maintenance of destructive agents at tolerable levels in management situations by the planned use of a variety of preventive, suppressive, or regulatory tactics and strategies that are ecologically and economically efficient and socially acceptable. The actions taken must be compatible with and incorporated into the total resource management process, both in planning and operational programs. The key to IPM success is based on understanding relationships between pests, silvicultural treatments, and long-term management strategies. Briefly stated, IPM is intelligent pest management (Coster 1984).

Large-scale advances in pest management are being made in the South. This paper summarizes the art and science of IPM with primary emphasis on methods of reducing losses from fusiform rust caused by *Cronartium quercum* (Berk.) Miyabe ex Shirai f. sp. *fusiforme*. Fusiform rust is the most widespread and destructive forest tree disease in the southern United States. In 1974, surveys showed more than 800-million slash (*Pinus elliottii* Engelm. var. *elliottii*) and loblolly pine (*Pinus taeda* L.) trees in South Carolina, Georgia, and Florida had potentially lethal stem infections (Powers et al. 1975); the disease is equally as severe in other parts of the South. Other estimates made in 1974 indicated an annual stumpage loss to fusiform rust of \$30-million and a finished wood products loss of \$150-million (Phelps 1973). In addition, infection rates are estimated to be increasing by 2 to 3 percent each year (Schmidt et al. 1974). Losses to rust occur from mortality, stem defects, and wind breakage. These problems are often increased markedly by the intensive management of pine plantations (Dinus 1974; Dinus and Schmidt 1977). Management strategies have been proposed for reducing losses from fusiform rust throughout the life of the

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stand (Dinus and Schmidt 1977; Powers et al. 1981; Schmidt and Klapproth 1982). Attention to fusiform rust does not, however, exclude the need to consider the multiple of insect and disease pests relevant to stand, forest, and regional considerations. Integration implies that management recommendations for one pest do not aggravate other pest problems. Recommendations must also be integrated in time such that present activities do not adversely affect the future development of the stand.

STAND ESTABLISHMENT

In his monograph "Planting the Southern Pines", Phil Wakely noted in 1954 that fusiform rust was the most serious disease in the southern pine planting program. The same holds true today. The key to preventing and managing rust is through careful planning and practices during stand establishment. This is when planted stands are most susceptible to rust infection and associated mortality.

Planning

Before seedlings are planted the site should be evaluated for all potential pest problems. Several sources of information are available to help in this evaluation. Maps have been published that show geographic variation in fusiform rust incidence for slash and loblolly pine (Phelps 1973; Squillace 1976). Studies are now being conducted to develop methods for evaluating rust hazard specific to individual planting sites. Guidelines are available that identify soil conditions associated with littleleaf disease and annosus root rot (Campbell et al. 1953; Froelich et al. 1977). Research and practice have shown how time of cutting, the volume of pine removed, and time of planting affect losses from regeneration weevils (Doggett 1981). In the South--dealing with second and third forests--we sometimes have the luxury of detailed stand inventory records that identify previous pest problems. State and Federal pest survey records can be used to supplement stand inventory records. The Forest Service is strengthening its continuous forest inventory with more detail on causes of tree mortality. Industry is doing the same. Computer printouts and graphics provide the means to integrate and summarize these different sources of information (Anderson et al. 1985).

In most instances the experienced forester is well aware of major pests within a region, subregion, or forest. Consideration of these pests is an important first step in planning regeneration methods. However, more detailed information may be necessary to make specific pest management recommendations for individual stands. Having detail on stand characteristics and knowing the relationships between the stand and pests may be the difference between success or failure in meeting management objectives.

Practices

The most ready and promising solution to reduce fusiform rust infections is through tree improvement and breeding programs. In areas with a high rust incidence, planted seedlings should be highly resistant to rust. This resistance can be obtained by using different species, different geographic sources within species, or resistant individuals (Goddard et al. 1975a, 1975b). Tree improvement programs in the South are accelerating the incorporation of rust resistant material into their selection and breeding practices. Concurrently, studies are evaluating the genetic compatibility of rust resistance, volume growth, and desired wood properties.

Care is also being taken to reduce fusiform rust problems in the nursery. Protective fungicides are the primary means of control. The purpose of pest management in nurseries should be to produce the healthiest seedlings economically possible for planting. When diseased or unhealthy seedlings are outplanted mortality can be severe, stocking is reduced, growth is slowed, and pest problems are compounded. The price paid for poor quality seedlings is a decrease in production throughout the rotation.

Cultural practices can add to the benefits of using rust resistant materials. Oaks, for example, are the alternate host for fusiform rust. Unfortunately; exact relationship between oak populations and rust levels are still not clearly understood. In addition, forest managers have been reluctant to accept oak control as a preventive treatment. In high hazard rust areas, however, reducing oak populations by burning, chemical, or mechanical treatment may be essential and practical for obtaining desired stocking levels and increasing forest productivity.

Slash pine and loblolly are most susceptible to fusiform rust infections during the first 5 years of growth. This is when the majority of potential lethal stem infections occur. Seedlings survival counts and an assessment of rust incidence at 4 to 5 years of age will indicate the extent of the damage and whether the stand should be replaced or carried to rotation. Mortality and volume growth associated with the incidence of rust infected young stands can be projected into the future (Nance et al. 1983).

If possible, fertilization in moderate to high hazard rust areas should be delayed until plantations are 8 to 10 years of age and thus unlikely to develop lethal stem galls if infected. Fertilization has little significant impact on rust incidence on low hazard rust areas.

Dense stocking is not recommended to offset losses from rust. Slow growth, the need for early thinning, associated pests, and the uncertainties of resulting spacing and stocking can seriously compound management problems. Pest managers and forest managers have to guard against creating more problems than they solve.

Other Pests

When an area is planted immediately after harvesting, regeneration insects can be a serious problem. Debarking insects, for example, are attracted to the odor of fresh pine resin; female deposit eggs in the large roots of fresh pine stumps; and new adults emerge and feed on the needles and tender bark of pine seedlings. Damage by weevils can be reduced by delaying planting for 9 to 12 months after harvest (Cade et al. 1981). In the South this delay allows deterioration of fresh stumps and other logging debris that serves as breeding habitat for weevils. If planting cannot be delayed, seedlings can be treated with pre- or post-planting chemicals to protect them from insect attack (Nord et al. 1975).

Tip moth is another common pest of loblolly pine throughout most of the South. The insect feeds on newly developing shoots causing deformities and growth reduction of young pine seedlings. A recent study has shown that seedlings

damaged by tip moth have significantly more fusiform rust than healthy seedlings.² Either pest can affect stand growth and productivity. Interactions between tip moth and fusiform rust may compound these losses. Registered insecticides are available that effectively control tip moth.

INTERMEDIATE PRACTICES

Pest management options decrease as stands mature. Of economic concern are losses occurring from rust mortality and stem degrade in merchantable stands. A recent study (Belanger et al. 1985) showed that salvage cutting is a viable option when managing pine plantations for sawtimber or veneer products. The removal of stems with severe stem infections improved the quality of the residual trees significantly. Residual stem galls were small and had little cankering. Annual mortality in unthinned plantations averaged 44 cu. ft./acre compared to 17 cu. ft./acre for the treated stands. Salvage cutting is not recommended for plantations being managed on 20-25 year pulpwood rotations.

Mortality attributable to insects and root diseases has been minimal in the above study. In some instances, however, intermediate cutting can aggravate annosus root rot and bark beetle problems if not done properly. Annosus root rot is a threat to residual trees on sandy, well-drained soils. Guidelines are available for preventing annosus root rot in the South (Froelich et al. 1977). Damage from recent logging favors SPB attack. Equipment operators and ground crews should be trained to minimize damage to the residual stand.

Prescribed burning and chemical treatments should be scheduled periodically to reduce the number of host oaks. How mature stands are treated before and during harvest may determine the extent and severity of rust problems in future stands.

If stands do not received intermediate treatments, they eventually become crowded and vigor declines. When this happens, insect and disease problems usually intensify. Over most of the South, a decrease in stand vigor means problems with the southern pine beetle.

As a result of the Expanded Southern Pine Beetle Research Effort (Thatcher et al. eds. 1981) we know more about insect dynamics, utilization of beetle-killed timber, impact, aerial survey, navigational techniques, and pest management systems than we did before. We know what stand, site, and tree characteristics are associated with southern pine beetle attack. Systems are now available to rate the relative susceptibility of stands to attack by the beetle (Mason et al. 1985). Silvicultural and management recommendations have been developed to prevent or reduce damage from the southern pine beetle (Belanger and Malac 1980). Many of these findings are now being applied on an operational basis.

IPM CAN INCREASE FOREST PRODUCTIVITY

The concept and practice of IPM are realities in the South. Old information is being integrated with new findings to develop comprehensive regional strategies for reducing losses to major insect and disease pests. Research and experience continue to strengthen this effort. The Forest Service has been an active partner in this progress. Pest management is part of planning and implementing their silvicultural programs. As such, it provides the opportunity to increase the productivity of multiple management objectives.

²Personal communications with Harry R. Power, Jr., Chief Research Plant Pathologist, USDA Forest Service, Southeastern Forest Experiment Station, Athens, GA.

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THE FREMONT FUELS APPRAISAL PROCESS

An explanation given to the National Silvicultural Workshop
In Rapid City, S.D. 5/16/85

by John R. Nesbitt

Forest Silviculturist
Fremont National Forest

INTRODUCTION

We all fear the unknown. Change is something we approach with much caution, unless it was initiated by us.

Some of us on the Fremont National Forest initiated a suggestion of changing some ancient truths and found reticence on the part of them to jump on the bandwagon. This should not surprise us, because I have spent a good share of my career learning how to successfully plant trees, and now I am fearful they will tell me to dwell into the mysterious valley of natural regeneration.

The Forest Service's tradition, if not policy, has been to clean up slash 100% so we would not run the risk of wildfire being fed by it and destroying valuable timber. To suggest it may be worthwhile to take that risk, just to save money, goes against tradition, gut feelings and Smokey Bear.

The Fremont National Forest decided to take this risk. We have been spending about \$2,600,000 a year to reduce hazards from slash and prepare planting sites. These costs include work done by timber purchasers as well as work done by the Forest Service. Our estimate of future expenditures for these purposes is \$400,000 or a savings of \$2,200,000. Another way to look at it is our costs have been reduced 84% by using the Fremont Fuels Appraisal Process..

I share this preamble with you to explain that I am sensitive to the concerns of those folks that wonder if the Fremont Fuel Appraisal Process is just another brand of snake oil that will go away with the next shift in winds, change in administration or balanced budget. To those people I say I am sympathetic, but we have looked at our process from many different aspects, had it reviewed by numerous people from different disciplines and we think it is worth trying. I said "worth trying" because we have not been into the program long enough to have tested the unknown problems and the wrong assumptions. However, we have looked at our process closely enough to make it policy on our forest.

OBJECTIVE

I will present to you "The Fremont Fuel Appraisal Process" which is our answer to putting a dollar value on taking risk.

BACKGROUND

The Fremont National Forest is the southeastern most forest in Region six and is located in Oregon on the California border just halfway across the state from the Pacific Ocean. The forest starts on the high desert at 5,000 feet and climbs to alpine zones just under 9,000 feet.

We are an eastside or dry or pine type forest with six commercial species of trees. These are Ponderosa, White, Sugar and Lodgepole Pines, Incense Cedar and White Fir. We precommercially thin from 5,000 to 10,000 acres a year. This is mostly in released understory, as opposed to new plantations. Our 1979 Timber Resource Plan has an earned harvest effect that calls for this level of stocking control, which in turn creates a sale offering increase of about 10 million board feet.

The forest policy, which we felt was following regional policy, which we assumed followed national policy, required us to 100% treat the slash we laid down while precommercial thinning. Our fuel management program also had us getting rid of slash in regeneration units way beyond the point that we needed for site preparation. This caused concern to the silviculturists from five angles.

First, our cost of doing business became excessive. This is especially important on low value sales and non-sale (appropriated money) projects. Secondly, fuels were usually treated one year after the thinning. This creates the problem of not knowing whether you will receive appropriated money next year for the targets you are achieving this year. Third, sometimes the fuel treatment dictated the prescription with regard to spacing of precommercial thinning and timing. The latter concern is especially critical in site preparation when the planting is held up a year while waiting for the burning to be accomplished. Fourth, the treatment can be worse than the disease. An example of this is that tractors piling fuels and/or underburning can and usually will create infection ports for rots such as Indian Paint fungus. This is particularly bad on terrain over 20%. Lastly, because of these considerations, we were backing more and more away from stands needing treatment, not because there were conflicts with other resources, but just because we couldn't follow fuels policy.

During the last five years our forest has conducted an activity review on fuels and one on timber stand improvement. In addition we were host to a regional T.S.I. activity review. This question of fuels treatment in precommercial thinning units came up during all three reviews. At the same time our fire people became concerned with the high cost in dollars and F.T.E.'s of all fuel treatment.

We started analyzing the risk of leaving fuels untreated or partially treated. How often would a fire occur on this acre? How big would it get? What would it cost? Was the treatment cost more than possible loss?

The forest planning process gave us many tools to help answer these questions. All we had to do was borrow these tools and create a model for risk analysis. This we did.

PROCESS

The first step was to plot all the historical fire occurrences on a map of the forest. Next we divided the map into high, moderate and low fire occurrences, which gave us a step towards defining risk. (appendix 1) We then created a number of custom fuel models, primarily slash, that covered a spectrum of fuel tonnage and fuel bed depth. The models were combined with historical ignitions and weather situations. These were then applied to the IAA computer model to determine the consequences of the various fuels complexes in terms of expected burned area by fire intensity level.

The size of fire was converted to acres burned per year per 1000 acres by one of the three fire occurrence zones. The fire intensity was stratified by flame length into three groups. These were: less than 2' flame length, 2' to 4' flame

length, and greater than 4' flame length.(appendix II) These strata were used later to determine the amount of loss to a stand.(appendix III)

At this point, we shifted to the economic question and determined what the net value loss would be to a stand that is burned with a given intensity fire. The yields, species groups, intermediate entries and stumpage values used in this analysis were all taken from the Land Management planning process. This was done to insure uniformity within the forest as well as credibility. This data was also readily available. The format we used in this analysis -- as a matter of fact, the form used-- was taken directly from the fire planning process. Basically what this analysis does is determine future values to be derived by harvesting and then discounting these values back to the stated age of the stand.(appendix IV) This is done for all species groups modeled in the planning process, for three different ages and for the three different fire intensities. Then the analysis values the stand that would replace the burned stand. The values forgone, by being burned up, and the delay of rotation caused by having to replace the stand, comprise the net value lost.

With the chance of a fire occurring on any given acre and the present value of that acre determined, we were prepared to integrate them and measure, in dollars, the risk of leaving precommercial thinning slash untreated. We did this with two simple formulas. One formula dealt with a stand that would have no salvage value after a fire while the second formula modeled stands that had a salvage value. Formula one is:

$$\frac{(\text{acres burned yearly})}{1000} \times (\text{years of risk}) \times (\text{max. present value loss}) +$$

(discounted reestablishment cost) = risk value

Formula two is:

$$\frac{(\text{acres burned yearly})}{1000} \times (\text{years of risk}) \times (\text{max. present value loss}) =$$

risk value

Appendix V is an example of the use of this formula.

The difference between these two formulas is the reestablishment cost. If there is salvable material, it's sale will pay for the new stand. If there is no salvage value, funds will have to be appropriated to do the reestablishment.

The resultant value, called a risk value, is in dollars and is used as an index. All things being equal, if more is spent on fuels treatment than the risk value, it is more cost efficient to take the risk of a fire.

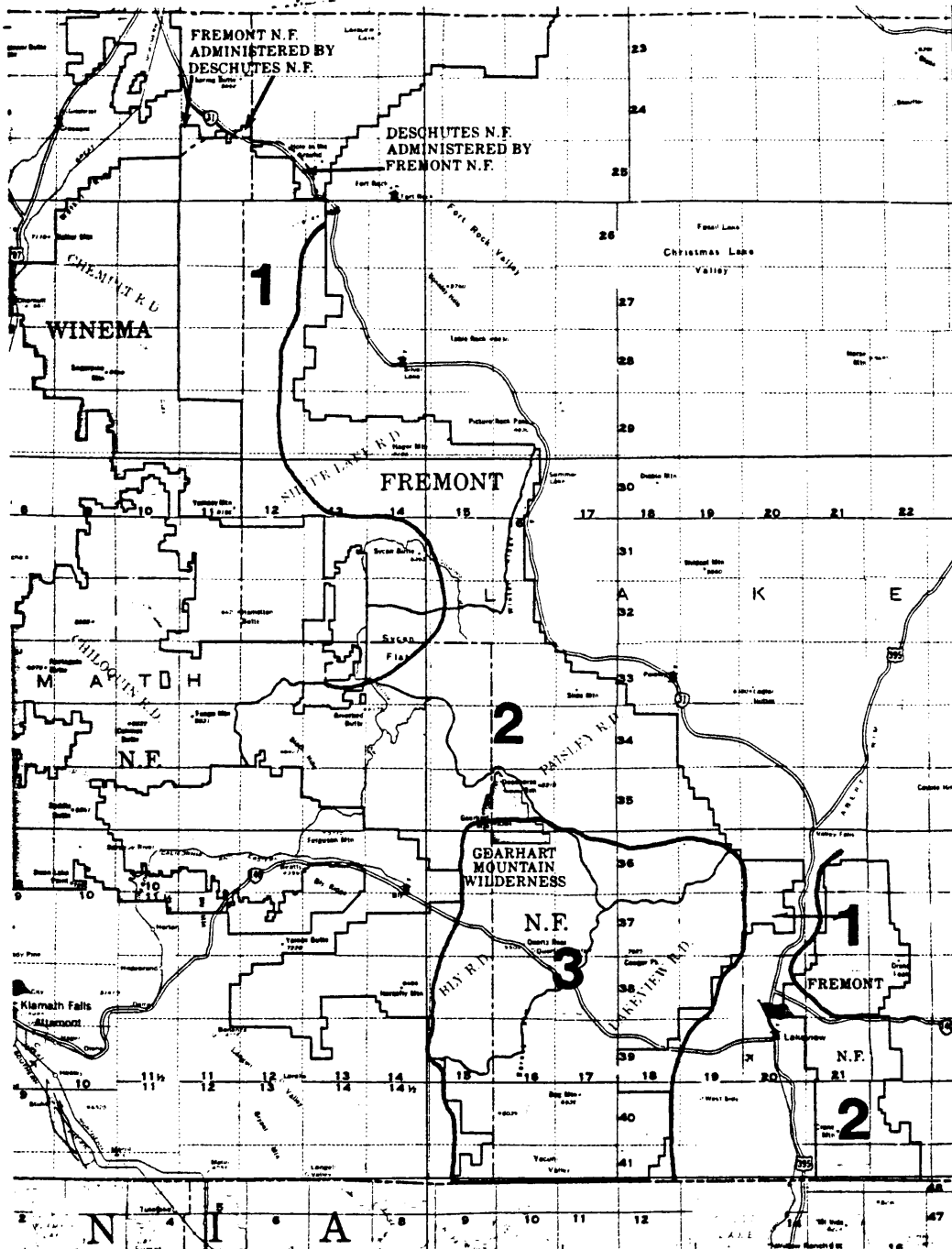
We use this as an index to make decisions. Other values, both timber or non-timber resources, have to be considered, along with political implications, to decide whether to treat the fuels and/or how much to treat them. One way we use this system is to run iterations with different treatments. We can assume a given treatment, then model the post treatment fuel bed and see the risk value. This we compare with the fuel bed created by a different treatment.

The two risk values and the treatment costs are then compared to come up with the most efficient treatment alternative.

THE FUTURE

Region 6 is presently working on expansion of this system to create the most efficient mix of treatments, values and protection costs. When this comes out of committee and is approved by the Regional Forester, it will become regional policy.

APPENDIX I



FIRE OCCURRENCE ZONES

- 1** 030 FIRES/1000 ACRES/YEAR
- 2** 074 FIRES/1000 ACRES/YEAR
- 3** 157 FIRES/1000 ACRES/YEAR

[illegible]

TABLE I

[illegible]

Fire Effects Aggregation

RESOURCE	Less than 2 ft. flame length	2 to 4 ft. flame length	Greater than 4 ft. Flame Length

CW (Associated Species)
Age 1 to 15

(-) = Negative effects
(+) = Positive effects
(-) 40% to 100% kill depending on age. Infection ports on non-killed tree boles.

Stand destruction

Age 16 to 40

(-) 10% to 40% kill. Infection ports on non-killed tree boles

Stand destruction

60% to 100% kill

Age 41 to 100

(-) Infection ports on 30% of non-killed tree boles.

(-) 10% to 50% kill. Infection ports on 50% of non-killed trees. Stand destruction

(+) Release from unwanted reproduction and shrubs. Some mineral release.

Greater than 101

(-) Infection ports on 5% of non-killed tree boles.

(-) 5% to 15% kill. Infection ports on 30% non-killed trees. 50% kill Infection ports on remaining trees.

(+) Same as above.

APPENDIX III

Form 7-10-77

ES. ATION OF MAXIMUM VALUE WOULD BE: ACTUAL IMMEDIATE STANDS

Forest/Unit _____ Plan Alternative _____
 Management Area _____ FMAZ OL ASSOC
 Representative Location _____ Option Identifier _____
 P/L: _____

APPENDIX IV

SPECIES (GROUP)		PRESENT AVERAGE AGE <u>50</u>						
Lines	Expected Future Harvest	Expected Harvest Per Acre (MBF/Ac.)	Current Stumpage Price (\$/MBF)	Years to Expected Harvest (=n)	Price Increase Factor (1) (1 + ARPI) ⁿ	Future Value (1) x (2) x (4)	Discount Factor (1.04) ⁿ	Present Value Per Acre (5) x (6)
1	Thinning	1.42	40	0	1.00	56.80	1.00	56.80
2	Thinning	6.04	40	50	2.44	589.50	7.11	82.91
3	Final	17.60	95	60	2.92	4882.24	10.52	464.09
4	Total present Value/Ac.	Sum column 7 entries for lines 1, 2 and 3.						
5	$\left[\frac{1.04}{1 + ARPI} \right]^p = 2.211$	Enter in Col. 7 the value for the rate on WORKSHEET 7 TABLE which is closest to rate calculated. (p = present stand age) --*						
6	Factor	Divide (1.00) by entry on Line 5						
7	Adjustment	Multiply (Line 4) x (Line 6)						
8	Maximum Present Value Loss Per Acre	Subtract (Line 4) - (Line 7)						

(1) ARPI = average annual real price increase in timber values as defined in directions for Forest planning = 0.18 (decimal) (default = .025)

(2) Enter on Worksheet 9, Line 5.

APPENDIX V

$$\frac{(\text{acres burned yearly})}{1000} \times (\text{years of risk}) \times (\text{max. present value loss})$$

= risk value

$$\frac{\overset{\backslash 1}{(2.53)}}{1000} \times \overset{\backslash 2}{(10)} \times \overset{\backslash 3}{(\$380.39)} = \overset{\backslash 4}{\$8.94}$$

\1 Taken from Table I, APPENDIX II

\2 An estimate made locally that the fuels will be at a given hazard level for 10 years.

\3 Taken from line 8, APPENDIX IV

\4 This "risk value" is an index the manager uses that says the breakeven point between the amount to be spent on fuels reduction and the discounted value of the stand is \$8.94. If fuels reduction costs more than this amount, the manager should consider taking the risk of non-treatment.

ELEMENTS OF A SUCCESSFUL
FERTILIZATION PROGRAM

by

Tom Beckman

Gifford Pinchot National Forest

Presented at the National Silvicultural Workshop
held May 13-17, 1985, at Rapid City, South Dakota

TABLE OF CONTENTS

	<u>Page No.</u>
INTRODUCTION	1
PLANNING	2
Program of Work	
Stand/Area Selection	
Environmental Analysis	
Project Layout	
Contract Preparation	
IMPLEMENTATION	5
Logistics/Communication	
Contract Administration	
Spill Contingency Plans	
Security and Coordination w/Air Operations	
QUALITY CONTROL	10
Fertilizer Distribution	
Water Sampling	
Response Monitoring (Falldown)	
CONCLUSIONS	13
APPENDIX	14

INTRODUCTION

Forest fertilization in the Pacific Northwest Region became an acceptable silvicultural practice only recently. One reason for its late start is due to the large acreages of needs in other more traditional areas of Timber Stand Improvement. Competitive advantage has been weighted to these other areas due to the lack of background both in the literature and in the actual doing of fertilization projects.

In 1969 the Regional Nutrition Research Project was established at the University of Washington. In the following years a systematic approach sampled, at first, second-growth Douglas-fir (Pseudotsuga menziesii [Mirb.] Franco), and later, western hemlock (Tsuga heterophylla [Raf.] Sarg.) forests.

A cooperative was formed and began an organized system of information sharing. I believe this single step has contributed more to the practice of fertilization in the Pacific Northwest than any other reason. The cooperative has members representing both large and small private corporations, and several state and federal agencies.

In the following pages I will describe several categories which are quite familiar to many readers. Several of the items emphasized will not sound foreign either. One item, above all others, will be made clear that has been the major difference in the success of the fertilization program on the Gifford Pinchot National Forest. That item is--ATTITUDE!

PLANNING

Fertilization is a practice to be considered along with precommercial thinning and release. Of four funding priorities, fertilization is ranked third. The current timber management plan recognized fertilization and, through this document, the practice became a familiar topic of conversation. A change in the ATTITUDE of our decisionmakers resulted. As subtle as it may be, the notion changed from, "We don't want to do that--we have higher priorities", to, "If we can fund our higher priorities, we will also consider fertilization".

One of the largest planning obstacles to overcome is the determination of where fertilizer should be applied. There are two biological rules that are followed on the Gifford Pinchot:

1. Responsive Soils

The University of Washington program provided some basic information on a regional basis. That data indicated that most soils were at least somewhat deficient in available nitrogen and that supplementation of about 200 pounds of nitrogen per acre appeared to give the most response for the effort expended.

We added to the test base by including major soil types covering fairly large areas. Today, responsive soils total about 520,000 acres, or 40 percent of the Forest. In addition, we have some localized data indicating response duration and quantification.

2. Suitable Stands

The second rule is that stands must be identifiable. This is nothing more than the stand conditions encountered in testing the soils. The stand which is "best" qualified contains crop trees which are 80 percent Douglas-fir, has crown ratios that are at least 40 percent, where stocking level control is completed, is 80 to no younger than 13 years old, and on site 3 (120 CF/AC/Yr.) a middle productivity; site 1 is high and site 4 is low productivity.

This information can be sorted and arranged into a rating table for stand selection as shown by Table 1.

TABLE 1
PRIORITY BY TREATMENT
50-YEAR SITE CLASS, AND AGE

SITE AGE	UNTHINNED				THINNED			
	4	3	2	1	4	3	2	1
25	31	29	28	30	27	25	24	26
35	23	21	20	22	19	13	12	17
45	16	10	14	18	9	4	6	11
55	9	5	8	15	3	1	2	7

NOTE: Six of the first 10 priorities are site 3 or lower.
Sixteen of the first 19 priorities are the older age classes.

The biological rules previously mentioned can be incorporated into an Environmental Analysis. This document is prepared ahead of time. Presented in the Analysis is a description of the action, alternatives considered, environmental effects summarized and contact with others. An example of a cover page, summary and table of contents may be found in Appendix No. 1.

During preparation of the environmental assessment field verification of logical project areas is done. Fertilizer projects cause logistical problems associated with the movement and positioning of heavy, bulky loads. We have found that closely packed project areas are most efficient by minimizing flying time and bulk hauling costs (a cluster concept). By experience, a project size of at least 1,000 acres is most desirable to minimize per acre costs (bigger the better). Good road access is essential along with having large helispots available.

With an approved environmental analysis and field verification completed, a service contract is prepared up to the point of advertisement. From Appendix No. 2 -- the contracts indicate the Contractor must secure and deliver the fertilizer, and be uniformly spread over a specified number of acres. Contractor-furnished property and services, and Government-furnished property and services are detailed. Fertilizer specifications are indicated and minimal weather conditions for work are outlined. Fertilizer is spread in two flights, usually at right angles to each other or in reverse direction. One half of the fertilizer is applied in each flight to increase uniformity and reduce skips (zebra effect). Lastly, the application rate is specified for absolute clarity.

The planning phase is about three-fourths of the total job. Our success has resulted from having all of the planning completed ahead of time--an ATTITUDE which leads to understanding the necessity of "shelf stock".

Remember, the relative funding priority is low. As timber stand improvement money becomes available, Region-wide, we have been able to respond quickly to fulfill an extra target. We intend to continue to create shelf stock and to maintain competitive status, especially for second and third funding allocations during any given year.

IMPLEMENTATION

Approximately 20 percent of the job is related to various implementation portions. A common courtesy is to notify neighbors and interested publics before starting a project. It is very difficult to convince someone that the helicopter flying over the forest was applying fertilizer and not an herbicide.

The Contracting Officer's Representative (COR) has several logistical situations to maintain. The Contractor needs to be continuously located on the project area. Inspectors need to be in the proper place at the right times to observe the application and to inspect the arriving fertilizer.

Good communications are of two types and are vital in this type of project. The COR and Contractor should go over the project areas in the field and cover any unclear contract language before starting the project. Shared telephone numbers are also essential so that late night changes can be made.

The second kind of communication is that which is used on the project. A Forest Service net radio between the COR and pilot can solve problems before they get big and cause a stop in the work.

At the heart of the project is the application and contract administration. It is up to the Contractor to purchase and deliver the fertilizer to the project area, and apply it at the proper rate. A variety of equipment is available; it is up to the Contractor to tailor the equipment and operation to perform according to the contract.

Effective administration of the contract is related to a list of "do's":

1. Keys to effective administration

- a. Have a sufficient number of personnel available.
- b. Have pilot, ground crew supervisor, Contractor, and COR attend the pre-work meeting.
- c. Have an open line of communication between COR and Contractor. Stress the need to have the Contractor communicate with his fertilizer supplier. Have the Contractor inform his supplier of the Ranger Station telephone number so messages can be relayed to the project COR.

- d. Plan in advance how to get fertilizer supply vehicles to heliport and away from heliport.
- e. Have access roads well signed so truck drivers can locate the project.
- f. Have all Inspectors well briefed in advance of the project so they know their duties and responsibilities and the location of the project on the ground. They need to know where they should be inspecting from, where the water monitoring spots are, time required to travel to the inspection sites, chain-of-command--who has what authority--who do I talk to. Provide all people with a copy of the Implementation Plan.
- g. Have project signed to warn public of possible delays and also to direct traffic.
- h. Have an information person to control public at the helispots.
- i. Stress safety - Everyone needs to know what's going on.
- j. Have person at District office who can be a runner or supplier (supply radio batteries, smoke bombs, balloons or gas, etc.).

- k. It's going to be a full-time job for the COR's and Inspectors to administer and inspect this project. Arrange for someone else to administer other contracts.
 - l. Be sure you have approved all the time it will require of you to administer the project (overtime, comptime, over 12 hour days, 7 days per week, etc.).
 - m. Prepare a contingency plan for spills.
2. Items that need emphasizing
- a. Planning operating ahead of schedule. Meet the night before so everyone knows where they are to be the next morning.
 - b. Chain-of-command--who has what authority.
 - c. Communications.
 - d. Keep calm--don't get excited. Something is going to break down or the weather is going to shut you down. Small amounts of fertilizer and fuel are going to spill.
 - e. Gather weather forecasts, both long range and local predictions, if available.
 - f. Don't help the Contractor perform.

3. Documentation

- a. Everyone on the project needs to keep a Daily Diary or provide the COR with information to prepare a consolidated Daily Diary.
- b. Weights of fertilizer.
- c. Fertilizer test results.
- d. Flight log.
- e. Radio log.

Although not technically a pesticide, fertilization projects are given the same attention as those that involved the application of herbicides. A contingency plan is prepared which outlines accidental spill and cleanup procedures. Emergency and non-emergency spills are described and procedures are covered which apply to each case. A priority system of notification of specific individuals is detailed. The Forest Pesticide Use Coordinator is the first person to be notified. We have never had an emergency spill involving fertilizers; our contingency plans remain untested under actual conditions.

Security on a project is often overlooked. There is always a danger that any equipment left in the field could be vandalized or stolen. Certain groups or individuals are opposed to the application of pesticides, and the same may decide that fertilizers are also undesirable. Marijuana growers may try to interfere with the operation for fear of detection of a garden.

It is very easy to advise your Law Enforcement Coordinator of the location and time of each project. That person should know who to contact if assistance is needed.

If there is suspicion that some overt interference or violent opposition will occur, then the Forest or Zone Special Agent should be advised of the situation, date, and location. The Agent will coordinate with the local law enforcement agencies and the Regional Office.

To date, a formal plan has not been necessary because of the lack of previous incidents involving fertilizer application projects.

QUALITY CONTROL

Three concerns appear to have a major influence on fertilization in the Pacific Northwest. They are distributing the fertilizer evenly, keeping the fertilizer out of important bodies of water, and the falldown in predicted versus actual response from the treatment.

Uniform spreading of fertilizer in mountainous forest land can be extremely perplexing. Two factors can affect the distribution patterns; one, the amount of fines or dust in the bulk product, and two, the ability of the pilot. Representative samples of fertilizer are measured for dust content with load rejection provisions in the contract if exceeding a specified percentage.

The distribution pattern actually reaching the forest floor requires fast moving Forest Service ground checkers. These people are usually in contact with pilots and can advise of distribution, skips between flight lines, and other missed acres.

It is highly advised that provisions be made for calibration flights. This involves flying over containers of known surface area in a systematic grid. A measurement is made of the swath width and weighing the collected fertilizer in the containers. Visual inspection of this calibration procedure can also provide the field checkers an idea of how 440 pounds of Urea appears on an acre.

Project layout can somewhat help in the accomplishment of even distribution. Use boundaries which are visible when airborne, and are uniform with long, smooth lines. We can help by marking boundaries with flags, helium-filled balloons, and flares.

Water quality standards are constantly being addressed in many projects, and from sampling to develop natural (as closely as possible) background levels of sediment, chemical content, and temperature. Fertilization projects fit very nicely with other water monitoring activities. The only difference is increased sampling during the project and shortly thereafter. Eventually water sampling decreases to pretreatment frequencies.

Fortunately, unlike other chemicals used in forestry, fertilizers do not carry the sensitivity that pesticides do. However, the consideration given to a fertilization project carries, by design, the same concerns as does an application of herbicides. We have not been disappointed by the small price required to carefully exclude streams and lakes from the project area and to monitor for compliance.

The difference in response predicted from a closely measured, carefully applied research or administrative trial and large scale project is termed "falldown". Our response monitoring plan, developed at the Regional level, provides the means of assessing that difference by remeasurement at five-year intervals. In the overall prediction process, this factor can be incorporated to increase the reliability of the treatment response. In turn, future assessments can be made with a better linkage to typical situations which are not as closely controlled. Based on feedback from a variety of response monitoring plots, the followdown factor is about 25 percent.

CONCLUSIONS

This paper briefly describes a process from beginning to end of a fertilization project. Work in building attitudes and background information is described.

Based on experience, the several items covered are a checklist for project development. Examples are provided. Early planning is a must and may proceed an actual project^{by} several years.

On the other hand, quality control items, such as water monitoring, may run several years after a project has been completed.

Funding is a major concern. In the Pacific Northwest there are, in my opinion, two time periods when fertilizer should be applied. Spring and fall mark times when trees are actively growing and moisture is at a maximum. Fiscal response and biological opportunity must coincide or the fertilization program will be less than successful.

APPENDIX

Environmental Assessment
Aerial Fertilization Project
Wind River Ranger District
Gifford Pinchot National Forest
Skamania County, Washington

Responsible Agency: USDA Forest Service

Responsible Official: Robert D. Tokarczyk
Forest Supervisor
Gifford Pinchot National Forest
500 West 12th Street
Vancouver, Washington .98660

For further information, contact: George Regas
c/o District Ranger
Wind River Ranger District
Carson, WA 98610
(509) 427-5645

Abstract:

This Environmental Assessment describes four alternatives to increase growth on 2,770 acres of 31-68 year old Douglas-fir. The assessment discusses the estimated effects of implementing each of the alternatives. The Forest Service Preferred Alternative (Use urea to supply nitrogen to trees) is identified. The rationale for this identification is shown.

Comments regarding this Environmental Assessment should be sent to the Forest Supervisor, Gifford Pinchot National Forest.

Summary
Environmental Assessment
Aerial Fertilization Project
Wind River Ranger District

Responsible Federal Agency: Robert D. Tokarczyk
Forest Supervisor
Gifford Pinchot National Forest
500 W 12th Street
Vancouver, WA 98660

For more information contact: George Regas
c/o District Ranger
Wind River Ranger District
Carson, WA 98610

Date of transmission to the public:

Summary

I. Brief Description of the Action

Fertilize 31-68 year old Douglas-fir on 2,770 acres at 200 pounds per acre nitrogen (as urea) by helicopter.

II. Alternatives Considered

1. No action.
2. Increase nitrogen fixing plants.
3. Use animal manure or municipal sewage to supply nitrogen to trees.
4. Use urea to supply nitrogen to trees.

III. Summary of Environmental Effects

1. Increase wood growth (3.1469 MM cubic feet), in five years
(Fuel value of wood - 212.404 billion kilocalories in five years)
2. Use nonrenewable resource (fossil fuels - 4.8 billion kilocalories one time for the project)

IV. Consultation With Others

Federal Agencies

1. USDA, Forest Service, Gifford Pinchot National Forest, Forest Supervisor's Office
2. USDA, Forest Service, Pacific Northwest Forest and Range Experiment Station
3. USDA, Forest Service, R-6 Regional Office, Insect and Disease Management

State Agencies

1. State of Washington Department of Ecology
2. State of Washington Department of Game
3. State of Washington Department of Natural Resources
4. State of Washington Department of Social and Health Services
5. University of Washington

TABLE OF CONTENTS

ABSTRACT	i
SUMMARY	ii
I. INTRODUCTION	1
A. Need and Purpose	
B. Management Objectives and Policies	
C. Management Opportunities	
D. Concerns	
E. Nature of Decision	
II. AFFECTED ENVIRONMENT	3
A. Physical Factors	
1. Location	
2. Soils	
3. Watershed	
4. Visuals	
5. Air	
6. Transportation System	
7. Energy	
8. Fuels Management	
9. Recreation	
10. Safety	
B. Biological Factors	
1. Timber and Vegetation	
2. Root Rots	
3. Select Phenotypic Trees	
4. Winter Range	
III. EVALUATION CRITERIA	7
IV. ALTERNATIVES CONSIDERED	8
A. No action	
B. Increase nitrogen fixing plants	
C. Use animal manure or municipal sewage to supply nitrogen to trees	
D. Use urea to supply nitrogen to trees	
V. EFFECTS OF IMPLEMENTATION	10
A. Environmental Impacts	
1. Soils	
2. Watershed	
3. Visuals	
4. Air	
5. Transportation System	
6. Energy	
7. Fuels Management	
8. Recreation	
9. Safety	

10.	Timber	
	a. Volume	
	b. Fertilizer loss to suppressed and intermediate trees	
	c. Falldown in yield from visual constraints, special harvest components	
	d. Mortality	
	e. Harvest Schedule	
	f. Allowable cut effect	
	g. Economics	
	h. Wood Quality	
11.	Root Rots	
12.	Select or Phenotypic Trees	
13.	Winter Range	
	B. Favorable Environmental Effects	
	C. Adverse Environmental Effects Which Cannot Be Avoided	
	D. Relationship Between Short-Term Uses of Man's Environment and Maintenance of Long-Term Productivity	
	E. Irreversible and Irretrievable Commitment of Resources	
VI.	EVALUATION OF ALTERNATIVES	21
VII.	IDENTIFICATION OF THE FOREST SERVICE PREFERRED ALTERNATIVE -- USE UREA TO SUPPLY NITROGEN TO TREES	22
VIII.	CONSULTATION WITH OTHERS	23
	APPENDIX	24
	REFERENCES	40
	MAPS	43

DIVISION 100 - GENERAL SPECIFICATIONS

110 - Scope of Contract

- A. The intent of this solicitation and any resultant contract is to obtain the services of helicopters fully operated by qualified personnel and equipped to meet specifications to uniformly apply 971 tons of Contractor-furnished fertilizer by helicopter to 4,409 acres on the Gifford Pinchot National Forest.

111 Special Safety Requirements

1. In order to protect life and health and to prevent damage in the performance of this contract, the Contractor will use due diligence in preventing accidents and will comply with applicable Federal and State laws.
2. The Contractor shall maintain a record of all cases of death, aircraft incidents, accidents, and injury arising in the course of work under this contract. The Contractor agrees to fully cooperate in any investigation and provide any needed records, statements, or parts in any investigation of any accident related to this contract. These records will be made available upon request of the Contracting Officer.
3. In the event of a major accident, all wreckage and equipment which might be involved in the accident shall be under the exclusive control of the Contracting Officer or other persons or agencies designated by the Contracting Officer for the duration of the investigation or until release by the Contracting Officer.

112 Reconnaissance Flights

Reconnaissance flights are not authorized under this contract.

120 - Description and Location

- 121 Helicopters must fly and apply urea fertilizer over Forest land that varies from gentle to rough as shown on the attached map.
- 122 The helispot location shown on the attached map will be provided by the Government. The Contractor may arrange for other helispots but any helispots must be approved by the COR prior to use. The helispots are accessible by road. Bidders are encouraged to examine the attached map and note the elevations of helispots and units prior to bidding.

DIVISION 100 - GENERAL SPECIFICATIONS (Continued)

130 - Contractor-furnished Property and Services

131 The Contractor shall furnish:

1. Helicopter and pilots.
2. Sufficient quantities of fertilizer to fertilize the contract area, plus all other services, equipment, and other materials that may be required to perform the work except those listed below in Government-furnished Property and Services.
3. Equipment move-in, move-out, moves of ground equipment, and ferry flights between helispots, if required, on the project.
4. Sufficient personnel to move ground support vehicles. A tow bar arrangement may be used in lieu of additional personnel. Government employees will not drive Contractor's equipment nor transport Contractor's employees.
5. Labor necessary to load the urea fertilizer into the helicopter.
6. Certificate of weight and measure for each transport truckload of fertilizer or railroad car load delivered to each transfer point.
7. Weighing equipment on site for accurately determining quantity of fertilizer in spreader.

132 The following information is summarized to aid the Contractor in obtaining all required licenses and permits.

133 The Contractor is advised that vandalism of equipment may be anticipated in all areas of operation. Therefore, he should consider providing watchman service for his equipment during all periods of no activity on the project, to include overnight, regardless of location. The Government assumes no responsibility for vandal damages and no special payment will be made for watchman services.

DIVISION 100 - GENERAL SPECIFICATIONS (Continued)

→ 140 - Government-furnished Property and Services

141 The Government will deliver to the Contractor the following listed materials, supplies, property or services (hereinafter referred to as "Government-furnished property") at the places and times specified in the Specifications. The Contractor shall be liable for all loss or damage of such delivered Government-furnished property. If the Government fails to make timely delivery of such Government-furnished property suitable for its intended use, and upon written request from the Contractor, the Contracting Officer will make an equitable adjustment of contract delivery or performance dates or contract price, or both, pursuant to the "Changes" clause of the General Provisions of this contract.

142 The Government will furnish:

1. Aerial photos or large-scale operational maps of areas to be fertilized.
2. Usable helispots.
3. Ready communication facilities from or near the contract area to a base point where commercial telephone is available. This service is provided to facilitate operation of work and use in event of accident.
4. Balloons or smoke bombs to mark buffers and project boundaries.

DIVISION 200 - TECHNICAL SPECIFICATIONS

→ 210 - Fertilizer

211 Fertilizer furnished shall be Urea Prill 46-0-0, spheroid. At least 90 percent by weight shall be retained by a number 14 Tyler mesh screen. Fertilizer shall be in accordance with Interim Federal Specification No. 0-F-241C and Amendment 1, and shall comply with the manufacturer's guaranteed analysis. Nitrogen is understood to be chemical. The composition of items is shown by percentage of nitrogen, phosphoric oxide and soluble potash, in that order; for example, Grade 46-0-0 indicates 46 percent nitrogen, 0 percent phosphoric oxide and 0 percent potash.

DIVISION 200 - TECHNICAL SPECIFICATIONS (Continued)

210 - Fertilizer (Continued)

- 212 Contractor shall provide delivery to use sites and furnish handling equipment and personnel for unloading, storage and loading into the helicopter distribution system.
- 213 The Contractor shall be responsible for any loss of fertilizer or any damage of product in storage or transit, or loss through application error, and in addition shall be responsible for any damages or claims filed against the Government by reason of application errors or losses of fertilizer onto lands not owned by the Government except if caused by erroneous unit boundary information provided by the Government.

220 - Fertilizer Spreading System

- 221 Helicopter shall be equipped with controllable power-driven spreading system which will permit even spreading of fertilizer with minimum fracturing of the fertilizer prill.
- 222 Spreading system shall have adjustable calibration and a positive shut-off system.
- 223 System shall have a minimum capacity of 500 pounds.

230 - Fertilizer Spreading

- 231 The Contracting Officer's Representative (COR) will decide, using the following conditions as guidelines, when spreading operations shall begin or cease. Spreading operations will usually be prohibited when any one of the following conditions exist on the project units:
1. Wind velocity exceeds ten miles per hour using spheroid fertilizer.
 2. Snow covers the project area.
 3. Fog or rain makes visibility poor.
 4. Surface runoff from melting snow or rain is excessive.
 5. Air turbulence (thermal updrafts, etc.) is so great as to seriously affect the normal spreading pattern.

DIVISION 200 - TECHNICAL SPECIFICATIONS (Continued)

230 - Fertilizer Spreading (Continued)

232 Spreading of fertilizer shall be confined within designated project unit boundaries. The following measures shall be taken to avoid adjacent streams and roads and road right-of-way through the project units:

1. Insure that the spreading pattern reaches no closer to a stream than the distance shown on the project map.
2. Avoid spreading fertilizer on roads and road right-of-way within the unit boundaries to the extent possible.

→ 233 Fertilizer spreading shall be made in two flights. The second flight shall be made as near right angle to the first flight as topography and safety will allow. If the area cannot be cross-flown, the second flight shall be flown in the reverse direction to the first flight. On each of the two flights, one-half of the fertilizer specified per acre shall be spread.

1. Consistent with the requirements established through equipment calibration, the aircraft shall be operated at a uniform height and speed whenever possible to obtain the most uniform fertilizer application.

234 The maximum air speed at which fertilizer shall be spread is 60 miles per hour.

235 Fertilizer spreading shall be made at a maximum elevation of 150 feet above the forest canopy when terrain and safe flying practice will permit.

236 Calibration of the spreading system will be checked prior to start of fertilization operations. The rate of spread from the spreading system will be checked periodically during the fertilization operation and the spreading maintained within plus or minus ten percent of the desired application rate per acre.

→ 237 The target effective application rate to all areas is approximately 200 pounds of nitrogen per acre. Application rate shall be 440 pounds of urea per acre in all cases. Equipment shall be adjusted to disseminate fertilizer at a rate of 220 pounds of urea per acre at all times during flight. Variation shall not exceed plus or minus ten percent of that rate.

UNEVEN-AGED STAND MANAGEMENT ON THE CROSSETT EXPERIMENTAL FOREST

James B. Baker
Project Leader
Southern Forest Experiment Station
Monticello, Arkansas

Shortly after the Crossett Experimental Forest was opened in 1934, Russ Reynolds and his co-workers initiated research to test the use of uneven-aged (selection) management in loblolly-shortleaf pine stands. The research effort with selection management was begun out of necessity to some degree because the second-growth stands, which developed following the old-growth timber harvest at the turn of the century, were generally understocked with pines of various sizes and ages. These stands consisted of remnants of the virgin stands, plus pines and hardwoods that had seeded-in over the previous 20 to 30 years. Nearly all acreage had overstory and midstory hardwoods and hardwood brush patches intermingled with pine.

Because of the existing uneven-aged character of the stands, Reynolds felt that uneven-aged management might be a logical system for rehabilitating and managing the second-growth timberlands in the South. To test this theory, he initiated three studies on the Crossett Experimental Forest in the mid-1930's. Two of the studies (the Farm Forestry Study and the Cutting-Cycle Study) utilized a series of 40-acre compartments, while the third (Methods-of-Cutting Study) was installed on 5-acre test areas.

This paper summarizes the results of these studies as reported by Reynolds, et al. (1984), Reynolds (1959, 1969), and Baker and Murphy (1982). It also provides a production and financial comparison of uneven-aged and even-aged management systems.

FARM FORESTRY STUDY

In 1937, the "Poor" and "Good" farm forestry forties were established to determine whether previously unmanaged, understocked, second-growth loblolly-shortleaf pine stands could be successfully rehabilitated and managed using the uneven-aged techniques of selection silviculture.

Study Areas

Two areas on the Experimental Forest were selected for the study. One area, representing a typically understocked, second-growth, unmanaged pine-hardwood forest, was called the "Poor Forty". In 1937, the Poor Forty averaged 85 merchantable pines per acre. Of these, only 18 per acre were sawlog size (12 inches d.b.h. and larger). The forty averaged 36 square feet of pine basal area, 980 cubic feet of total merchantable volume, and 2,340 board feet (Doyle) of sawlog volume per acre.

The second area was a reasonably well-stocked tract that became known as the "Good Forty". It averaged 133 merchantable pines per acre, 30 of which were 12 inches d.b.h. and larger. The forty averaged 75 square feet of basal area, 1,794 cubic feet of total merchantable volume, and 5,074 board feet of sawlog volume per acre.

Selection Management

In 1937, the two stands were placed under selection management. For the first 15 years (1937-52), the management consisted of (1) removal of all competing midstory and overstory hardwoods, (2) control of competing understory hardwood brush with herbicides applied in 1948, and (3) annual improvement cutting in the merchantable pine component. The improvement cuts removed about 50 percent of the annual growth; thus, stocking was increased. The improvement cuts and the competition control treatments promoted growth on the residual trees and the establishment of pine reproduction. After 15 years of such management, the understocked stand had reached full stocking.

After the understocked stand reached full stocking (1953) and until 1979, management consisted of (1) periodic control of competing understory hardwoods, primarily with herbicides applied at approximately 10-year intervals; (2) improvement and harvest cutting (annually through 1968, then again in 1973) with cuts removing annual or periodic growth; and (3) regulation of stand structure by volume control in the sawlog component.

Under the selection system, some trees were harvested regularly on a selective basis, with total volume cut at any one time being roughly equal to the growth that had occurred since the last harvest. This resulted in continuous stand improvement. Within the limits of the allowable cut, the poorest quality trees and most biologically mature trees were marked for removal. The immature stems with greatest potential for improvement in size and quality were left to grow.

Selection management permitted a gradual improvement in stocking, an accelerated growth of the best trees, and a gradual increase in the proportion of each acre that was growing high-value sawlog timber. Selection management also maintained a stand of trees of many sizes and insured a continuous progression of stems into the pool of the larger and more valuable size classes.

Results

Growth and production of stands

Annual net cubic-foot growth of merchantable pines 4 inches d.b.h. and larger for the 41-year management period (1937-78) averaged 116 and 95 cubic feet per acre on the Poor Forty and Good Forty, respectively (Table 1). Though not large in terms of cords per acre per year, this was excellent growth from the standpoint of sawlog production. For example, the Poor Forty averaged 397 board feet per acre per year, while the Good Forty averaged 412 board feet per acre per year (Table 1). However, the Good Forty's larger, better quality logs assured higher grade and value in board-foot production. On the Poor Forty, about 60 percent of the total cubic-foot production was high-value sawlogs, but about 75 percent on the Good Forty was sawlog material.

Table 1. Pine growing stock, volume of cut, and growth on the Crossett Farm Forties from 1937 to 1978

Area	Growing stock		Increase in growth	Total volume harvested	Net growth	
	1937	1978			Total	Average annual
-----cubic feet per acre-----						
Poor Forty	980	2,393	1,413	3,359	4,772	116
Good Forty	1,793	2,442	649	3,229	3,878	95
-----board feet (Doyle) per acre-----						
Poor Forty	2,341	7,341	5,000	11,291	16,291	397
Good Forty	5,074	9,465	4,391	12,521	16,912	412

It is noteworthy that the understocked Poor Forty was built up to full stocking during the first 2 decades of management. The Poor Forty produced a harvest of 3,359 cubic feet of logs, pulpwood, and posts per acre during the 41-year period (Table 1), equivalent to approximately 11,300 board feet of logs, 14 cords of pulpwood, and 260 posts. In addition, 1,413 cubic feet of total merchantable volume, or 5,000 board feet of sawlog volume, were added to the growing stock.

The original stand on the Good Forty obviously reached full stocking more rapidly than did the Poor Forty, so more of the growth in log-sized trees could be harvested over the period. The harvest amounted to about 12,500 board feet of logs (Table 1), 11 cords of pulpwood, and 400 posts. An additional 649 cubic feet of total merchantable volume, or 4,391 board feet of sawlog volume, were added to the growing stock (Table 1).

Harvests, 1937-73

Twenty-nine harvests of forest products were made on the Poor Forty from 1937 to 1973. The total material produced was 451,640 board feet of pine logs; 581 cords of pine pulpwood; 186 cords of hardwood pulpwood, chemicalwood and fuelwood; and 260 pine fence posts (Table 2). This was equivalent to 11,291 board feet per acre, or 314 board feet per acre per year, in pine sawlogs.

Thirty harvests of products were made on the Good Forty from 1937 to 1973. Total measured products were 500,840 board feet of logs; 569 cords of pine pulpwood; 228 cords of hardwood pulpwood, chemicalwood, and fuelwood; and 418 fence posts (Table 2). This was equivalent to 12,521 board feet per acre, or 348 board feet per acre per year, in pine sawlogs. In addition, pine growing stock was increased by 4,391 board feet per acre.

Table 2. Harvests from the Crossett Farm Forties, 1937-73

Item	Sawlogs, Doyle (bd ft)	Pine pulpwood (cords)	Hardwood pulpwood (cords)	Posts (No.)
-----POOR FORTY-----				
Total	451,640	581	186	260
Per acre	11,291	15	5	6
Per acre per year	314	0.4	0.1	0.2
-----GOOD FORTY-----				
Total	500,840	569	228	418
Per acre	12,521	14	6	10
Per acre per year	348	0.4	0.2	0.3

CUTTING-CYCLE STUDY

The objective of this study was to determine if a short cutting cycle (3 years) would result in better growth than a medium (6 years) or long (9 years) cutting cycle. Each cutting cycle was replicated 8 times on 40-acre compartments, thus each treatment was tested on a total of 320 acres. After 29 years of management (1937-66), cutting cycle length had little effect on total yield, as shown in the following tabulation:

Cutting cycle (years)	Periodic annual increment	
	Cubic feet	Board feet (Int. 1/4)
3	85.7	427
6	84.5	432
9	82.0	431
Mean	84.1	430

Over this period, cubic-foot and board-foot growth were basically the same for all cutting cycles, averaging 84.1 cubic feet and 430 board feet per acre per year. Though there were no differences in growth or production, the study indicated that a short cutting cycle (3 years) permitted better control over stand structure than a long cutting cycle (9 years). The frequent harvest cuts allowed for better manipulation of trees in each diameter class and promoted establishment of reproduction at more frequent intervals.

METHODS-OF-CUTTING STUDY

The methods-of-cutting study was initiated in 1943 to compare four reproduction cutting methods. It tested two even-aged management systems (clearcutting and shelterwood) and two uneven-aged systems (selection and diameter-limit cutting). The objectives of the study were to determine if the four reproduction cutting methods would provide adequate pine regeneration to establish or maintain well-stocked stands, and what growth and yield could be produced.

The treatments were replicated 3 times and installed on 5-acre plots. For the clearcut treatments, all merchantable pines and hardwoods were harvested in January 1943. Plots were prescribe-burned in the spring of 1943 to reduce logging slash, prepare a seedbed, and control small hardwoods. The seed source was adjacent uncut stands. In 1946, all hardwoods larger than 3.5 inches d.b.h. were cut to release pine reproduction. On the shelterwood plots, all merchantable pines and hardwoods were harvested in January 1943, except for 15 to 20 seed trees per acre. In 1946, all hardwoods larger than 3.5 inches d.b.h. were cut to release pine reproduction. The seed trees were harvested in 1958. Beginning in 1943, the selection and diameter-limit plots were harvested on 5- and 10-year cutting cycles, respectively. Merchantable hardwoods were harvested in 1943, and all remaining hardwoods (larger than 3.5 inches d.b.h.) were cut in 1946.

All cutting methods provided adequate pine reproduction. Five years after treatment, pine reproduction varied from 2,470 to 3,845 seedlings per acre on clearcut and shelterwood plots, respectively.

Table 3 gives the volume production by treatment after 36 years of management (1943-79). The production values do not include yields from the initial cut made in 1943. Shelterwood and diameter-limit cutting resulted in significantly (about 27%) more cubic-foot production than did clearcutting or selection management. However, in terms of sawlog production, clearcutting resulted in significantly (about 37%) less board-foot production than did the other three treatments.

Table 3. Volume production^{1/} for methods-of-cutting treatments through 36 years

Treatment	Total production		Periodic annual increment	
	Cubic feet	Board feet (Doyle)	Cubic feet	Board feet (Doyle)
Clearcut	3,348 b	9,360 b	93 b	260 b
Shelterwood	4,212 a	13,032 a	117 a	362 a
Diameter-limit	3,852 a	11,880 a	107 a	330 a
Selection	3,024 b	13,572 a	84 b	337 a

^{1/} Treatment means followed by the same letter are not significantly different at the 5% level of probability.

The yields possibly would have been different had the two even-aged treatments, shelterwood and clearcut, been thinned. Cubic-foot yield may not have been affected much except for capturing mortality, but board-foot volume production could have been enhanced by distributing growth on fewer trees. However, no appreciable cubic-foot volume could have been harvested from the even-aged stands before 1963 (20 years after the initial harvests). As the study progresses through a rotation, annual cubic-foot growth will probably decline and board-foot growth will increase rapidly for the even-aged treatments. Hence, total board-foot production among all treatments will probably equalize as time goes on.

PRODUCTION AND FINANCIAL COMPARISONS OF UNEVEN-AGED AND EVEN-AGED MANAGEMENT

Past research has demonstrated that loblolly pine can be regenerated and managed under a variety of silvicultural systems ranging from selection management to intensive plantation culture. However, the question is often asked, "Which is the best management system?" The answer, of course, depends on the objectives of the landowner. If the sole purpose of land management is the production of timber products and/or income from those products, then a production and financial analysis is required. If the purpose of land management includes other amenities, such as wildlife, water, recreation, or aesthetics, then the values of these amenities must be considered.

Let's first look at production and financial comparisons of uneven-aged and even-aged management. To do this, two uneven-aged and two even-aged management scenarios are considered.

The uneven-aged management schemes include:

1. Building and maintaining an uneven-aged stand at a relatively high stocking level--7,000 board feet (Doyle) of sawlog volume immediately before a cyclic harvest cut. The initial stand averaged 2,358 board feet of sawlog volume. Estimates of production and harvest volumes were generated with an uneven-aged growth and yield model (Farrar et al. 1984) that simulates management on the Crossett Poor Farm Forty as discussed earlier.
2. Building and maintaining an uneven-aged stand at a relatively low stocking level--5,000 board feet (Doyle) of sawlog volume immediately before a cyclic harvest cut. The initial stand averaged 2,358 board feet of sawlog volume. Estimates of production and harvest volumes were also generated with the growth and yield model for uneven-aged stands (Farrar et al. 1984). This scenario allows for an initially understocked stand to reach a prescribed full stocking level sooner than management scheme 1 and also carry a lower growing stock volume (or investment).

The even-aged management schemes include:

1. Management of a stand that originated from natural reproduction obtained from a shelterwood reproduction cutting method. The overwood (2,358 board feet) was removed at the beginning of the management period. Estimates of production and harvest volumes were generated from a growth and yield model for natural even-aged stands (Murphy 1983).
2. Management of a pine plantation established after clearcutting the 2,358 board feet of sawlog volume at the beginning of the management period and then followed by site preparation. Production and harvest volumes were obtained from a 40-year-old plantation adjacent to the Crossett Experimental Forest.

The comparisons are based on a simulation of the four management systems, assuming that they were initiated on the Poor Farm Forty in 1937. For the two uneven-aged systems, the initial stand that existed in 1937 was assumed to be

managed under the selection system. Growing stock was improved to prescribed (low or high) levels, and the stand was harvested on a 5-year cutting cycle. Production and financial analyses were performed for a 50-year management period.

For the even-aged (natural stand) system, the initial stand that existed on the Poor Forty in 1937 was assumed to be a shelterwood having an adequate amount of pine regeneration established underneath the overwood. The overwood (2,358 board feet) was harvested at the beginning of the management period. The regenerated stand was thinned periodically and clearcut at the end of the 50-year period.

For the even-aged plantation, the initial stand (2,358 board feet) that existed in 1937 was assumed to have been clearcut at the beginning of the management period. The site was prepared and planted to loblolly pine. The stand was thinned periodically and clearcut at the end of the 50-year period.

Timber Production

A summary of stand development, harvest cuts, and timber production for the four management systems over a 50-year management period is presented in Table A-1 (appendix). Timber production for the four systems is summarized in Table 4.

Based on the growth and yield predictions, plantation management would produce 57, 86, and 39 percent more total merchantable cubic-foot volume per acre than uneven-aged (high stocking), uneven-aged (low stocking), or even-aged natural stand management, respectively. Plantation management would average about 130 cubic feet of total merchantable volume growth per acre per year as compared to about 90 cubic feet for even-aged natural stand management and only 70 to 80 cubic feet for uneven-aged management. Thus, in terms of pulpwood or fiber production, plantation management would be clearly superior.

Table 4. Summary of total and mean annual production for four management systems over a 50-year management period

Management system ^{1/}	Production per acre			
	Total		Mean annual	
	Tot. merch. cubic feet	Board feet (Doyle)	Tot. merch. cubic feet	Board feet (Doyle)
Uneven-aged (HS)	4,106	17,618	82	352
Uneven-aged (LS)	3,452	13,762	69	275
Even-aged (Natural)	4,621	10,882	92	218
Even-aged (Plantation)	6,433	11,970	129	239

^{1/} HS = high stocking; LS = low stocking.

In terms of sawlog production, uneven-aged (high stocking) management would result in 28, 62, and 47 percent more board-foot volume per acre than uneven-aged (low stocking), even-aged (natural), or even-aged (plantation) management, respectively. Uneven-aged management (utilizing high stocking levels) would average about 350 board feet per acre per year of sawlog growth, while the even-aged systems would average only 220 to 240 board feet. Thus, in terms of sawlog production, the conventional uneven-aged management system appears to be best, using these growth and yield predictions.

Financial Analyses

Based on the production values presented in Table A-1 (appendix) and the following assumptions, financial analyses were performed for the four management systems. The assumptions are:

Costs:

- (1) Selection management
 - (a) Annual management costs = \$2 per acre
 - (b) Supplemental management cost (inventory & marking) = \$2 per acre every 5 years (prior to harvest cut)
 - (c) Timber stand improvement (TSI) = \$45 per acre applied every 10 years
- (2) Natural even-aged management
 - (a) Annual management costs = \$2 per acre
 - (b) Initial TSI = \$45 per acre
 - (c) Pine release at age 5 = \$45 per acre
 - (d) Prescribed burning = \$5 per acre every 5 years beginning at age 15
- (3) Plantation management
 - (a) Annual management costs = \$2 per acre
 - (b) Site preparation and planting = \$150 per acre
 - (c) Pine release at age 5 = \$45 per acre
 - (d) Prescribed burning = \$5 per acre every 5 years beginning at age 15

Returns:

- (1) Pulpwood stumpage = \$15 per cord
- (2) Sawlog stumpage = \$150 per thousand board feet (Doyle)

Discount Rate: 7% compounded annually

Cash flows for the four management systems are presented in Table A-2 (appendix). A summary of the financial analyses is given in Table 5.

Table 5. Economic parameters for four management systems for a 50-year management period at a 7% discount rate

Management system ^{1/}	Net present value \$/Acre	Benefit/cost ratio	Cost efficiency ^{2/}	
			cu ft	bd ft
			----per dollar----	
Uneven-aged (HS)	341	3.76	33.4	143.2
Uneven-aged (LS)	369	4.00	28.1	111.9
Even-aged (Natural)	463	5.14	41.2	97.2
Even-aged (Plantation)	444	3.05	29.6	55.2

^{1/} HS = high stocking; LS = low stocking.

^{2/} Cost efficiency = total production/total discounted cost.

For the 50-year management period, the even-aged systems had a more favorable net present value (about \$450 per acre) than did the uneven-aged systems (about \$350 per acre). In terms of benefit/cost ratios, even-aged (natural) stand management had the advantage with a ratio of 5 to 1. Plantation management provided the lowest benefit/cost ratio (3 to 1), while uneven-aged management was intermediate with ratios of 4 to 1. If capital (money) were limiting, investing in the alternative having the highest benefit cost ratio would be financially best. However, if money is not limiting, then the alternative having the highest net present value would be best.

When cost efficiency (volume produced per discounted dollar spent) is considered, the two even-aged systems were generally more efficient in terms of total merchantable cubic-foot production. However, in terms of sawlog production, the selection system (high stocking) was the most efficient. Thus, if the management objective is to produce small products (or wood fiber), the even-aged systems would be the best alternatives; but if large products (sawlogs) are the management objective, then selection management with high stocking would be most efficient.

Management systems with higher cost efficiency values would also imply that, for those systems, larger land bases could be managed per dollar or that the same size land bases could be managed for fewer dollars. The generally higher cost efficiency values for sawlog production associated with natural stand management also suggests that management cost savings can be obtained by managing what you have (existing stands) rather than engaging in intensive plantation culture.

SUMMARY AND CONCLUSIONS

Research initiated on the Crossett Experimental Forest in 1937 to test the possibility and feasibility of selection management indicates that it is a viable system for establishing and maintaining productive pine stands. It is especially suitable for (1) rehabilitating cut-over, understocked stands, (2) managing small tracts (40 to 1,000 acres), (3) maximizing sawlog production, and (4) producing frequent periodic income.

Growth and yield studies conducted on the forest indicate that selection management may produce more sawlog volume, under certain circumstances, than even-aged natural stand management or plantation management. From a financial standpoint, uneven-aged management ranks below even-aged management in terms of net present value of the investment but is comparable to even-aged management in terms of benefit/cost ratios. When cost efficiency is compared, however, uneven-aged management surpasses even-aged management.

There are definite advantages and disadvantages to the management systems, depending upon management objectives. The two even-aged systems are generally more practical and economically efficient for larger holdings. Even-aged systems allow management operations to be concentrated in time and space, permit management areas to be easily defined and treated, and require a relatively low level of technical skill and supervision.

For many landowners, however, the even-aged systems have certain disadvantages that tend to make them less attractive. Some of the drawbacks include a long waiting period before realizing financial returns from the first intermediate cut and possible loss of the entire stand from fire, ice storms, insects, or disease, since the stand remains homogeneous. It may also be difficult to put a small tract into a regulated condition for even-aged management without sacrificing income or yields.

Uneven-aged management is not as vulnerable to complete devastation by fire, biotic, or climatic agents. It provides periodic income without interruption for stand regeneration and allows net income to be spread out over time. Also, a reserve of larger timber is available to take advantage of favorable market conditions. With periodic harvests at frequent intervals, it is easier to time cash flows from harvest and cultural treatments so that debt financing is minimized. In addition, uneven-aged management provides a continuous forest cover, is more aesthetically pleasing to some people, and provides an excellent habitat for wildlife.

Uneven-aged management also has some disadvantages. It requires a higher level of technical skill and supervision to administer; some efficient area-wise silvicultural practices, such as prescribed burning and chemical treatments, are difficult to apply; and harvesting operations may be more difficult and expensive.

As a testament to the feasibility of uneven-aged management of loblolly-shortleaf pine, it is successfully being used to manage approximately a million acres of industrial lands and over a million acres of private nonindustrial lands in the South today.

With the new technology that is being developed to simplify regulation of stand structure and inventory and marking techniques, uneven-aged management will prove to be an even more attractive and useful management tool in the future.

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APPENDIX

Table A-1. Characteristics, harvests, and timber production of stands under four management systems for 50 years^{1/}

Time(yr)	Before Harvest			Harvest		
	BA	Total merch. cu ft	Board- feet (Doyle)	BA	Total merch. cu ft	Board- feet (Doyle)
UNEVEN-AGED MANAGEMENT (HIGH STOCKING)						
0	36	977	2,358	--	---	----
5	49	1,333	3,721	9	245	1,014
10	53	1,461	4,178	9	248	1,056
15	58	1,603	4,705	9	250	1,042
20	64	1,759	5,369	9	252	1,093
25	70	1,928	6,103	10	281	1,204
30	75	2,079	6,826	15	432	1,802
35	75	2,079	6,960	15	432	1,935
40	75	2,079	6,960	15	432	1,935
45	75	2,079	6,960	15	432	1,935
50	75	2,079	6,960	15	432	1,935
Residual	60	1,647	5,025			
Increase	24	670	2,667			
Harvest				121	3,436	14,951
Yield				145	4,106	17,618
PAI				2.9	82	352

UNEVEN-AGED MANAGEMENT (LOW STOCKING)						
0	36	977	2,358	11	304	----
5	36	969	3,171	10	268	1,099
10	37	1,003	3,252	9	247	1,009
15	39	1,070	3,482	9	259	1,066
20	42	1,137	3,712	9	243	1,004
25	45	1,236	4,089	9	244	1,027
30	49	1,349	4,539	9	261	1,118
35	53	1,461	4,987	12	331	1,445
40	55	1,509	5,140	13	365	1,598
45	56	1,525	5,145	13	367	1,603
50	56	1,540	5,151	13	367	1,603
Residual	43	1,173	3,548			
Increase	7	196	1,190			
Harvest				117	3,256	12,572
Yield				124	3,452	13,762
PAI				2.5	69	275

(Continued)

Table A-1. Characteristics, harvests, and timber production of stands under four management systems for 50 years (continued)

Time(yr)	Before Harvest			Harvest		
	BA	Total merch. cu ft	Board-feet (Doyle)	BA	Total merch. cu ft	Board-feet (Doyle)
EVEN-AGED MANAGEMENT (NATURAL STAND)						
0	36	977	2,358	36	977	2,358
5	--	---	----	--	---	----
10	--	---	----	--	---	----
15	--	---	----	--	---	----
20	100	1,537	460	20	303	----
25	101	1,945	2,291	21	397	----
30	97	2,177	4,240	23	508	1,022
35	88	2,201	5,073	18	439	1,009
40	82	2,220	5,800	16	417	1,012
45	76	2,201	6,385	14	395	1,026
50	70	2,153	6,813	70	2,153	6,813
Residual	0	0	0			
Harvest				218	5,589	13,240
Yield				182	4,621	10,882
MAI				3.6	92	218

EVEN-AGED MANAGEMENT (PLANTATION)						
0	36	977	2,358	36	977	2,358
5	--	---	----	--	---	----
10	--	---	----	--	---	----
15	100	1,691	----	20	426	----
20	106	2,140	522	26	624	----
25	105	2,612	2,749	35	1,082	----
30	90	2,641	4,665	20	558	1,124
35	88	2,553	5,580	18	483	1,110
40	88	2,570	6,212	18	458	1,113
45	86	2,550	6,844	16	434	1,129
50	85	2,368	7,494	85	2,368	7,494
Residual	0	0	0			
Harvest				274	7,410	14,328
Yield				238	6,433	11,970
MAI				4.8	129	239

1/ BA = basal area in square feet per acre; PAI = periodic annual increment;
MAI = mean annual increment.

Table A-2. Cash flow for four management systems over a 50-year period

Time(yr)	Management system							
	Uneven-aged				Even-aged			
	High stocking		Low stocking		Natural		Plantation	
	Cost	Return	Cost	Return	Cost	Return	Cost	Return
-----dollars per acre-----								
0	47	--	47	58	47	450	152	450
1	2	--	2	--	2	--	2	--
2	2	--	2	--	2	--	2	--
3	2	--	2	--	2	--	2	--
4	2	--	2	--	2	--	2	--
5	4	158	4	172	47	--	47	--
6	2	--	2	--	2	--	2	--
7	2	--	2	--	2	--	2	--
8	2	--	2	--	2	--	2	--
9	2	--	2	--	2	--	2	--
10	49	163	49	158	2	--	2	--
11	2	--	2	--	2	--	2	--
12	2	--	2	--	2	--	2	--
13	2	--	2	--	2	--	2	--
14	2	--	2	--	2	--	2	--
15	4	156	4	167	7	--	7	82
16	2	--	2	--	2	--	2	--
17	2	--	2	--	2	--	2	--
18	2	--	2	--	2	--	2	--
19	2	--	2	--	2	--	2	--
20	49	168	49	157	7	58	7	120
21	2	--	2	--	2	--	2	--
22	2	--	2	--	2	--	2	--
23	2	--	2	--	2	--	2	--
24	2	--	2	--	2	--	2	--
25	4	186	4	159	7	76	7	208
26	2	--	2	--	2	--	2	--
27	2	--	2	--	2	--	2	--
28	2	--	2	--	2	--	2	--
29	2	--	2	--	2	--	2	--
30	49	281	49	173	7	173	7	207
31	2	--	2	--	2	--	2	--
32	2	--	2	--	2	--	2	--
33	2	--	2	--	2	--	2	--
34	2	--	2	--	2	--	2	--
35	4	295	4	222	7	168	7	202
36	2	--	2	--	2	--	2	--
37	2	--	2	--	2	--	2	--
38	2	--	2	--	2	--	2	--
39	2	--	2	--	2	--	2	--
40	49	295	49	242	7	169	7	203

(Continued)

Table A-2. Cash flow for four management systems over a 50-year period
(continued)

Time(yr)	Management system							
	Uneven-aged				Even-aged			
	High stocking		Low stocking		Natural		Plantation	
	Cost	Return	Cost	Return	Cost	Return	Cost	Return
-----dollars per acre-----								
41	2	--	2	--	2	--	2	--
42	2	--	2	--	2	--	2	--
43	2	--	2	--	2	--	2	--
44	2	--	2	--	2	--	2	--
45	4	295	4	246	7	171	7	205
46	2	--	2	--	2	--	2	--
47	2	--	2	--	2	--	2	--
48	2	--	2	--	2	--	2	--
49	2	--	2	--	2	--	2	--
50	4	1,044 ^{1/}	4	860 ^{1/}	2	1,141	2	1,255
Total Undiscounted								
	347	3,041	347	2,614	227	2,406	332	2,932
Total Discounted								
	123	463	123	492	112	576	217	661

^{1/} Value of standing volume at 50 years.

REFORESTATION WITH FIREWOOD SALES

BY

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Introduction

The Targhee National Forest has been actively pursuing use of personal use fuelwood sales in an effort to meet the public demand for fuelwood and regenerate extensive mountain pine beetle killed lodgepole pine stands. The effort has been ongoing since 1982. Success of the program is demonstrated by good public acceptance and the large acreage annually regenerated. This fuelwood activity is making a significant contribution toward meeting the Forest Land Management Plan objective for regenerating decadent lodgepole pine stands.

Background

The Targhee National Forest is located in southeastern Idaho. The Forest is bounded by the Continental Divide on the north and Yellowstone and Grand Teton National Parks on the east. Approximately 1.0 million acres or 57 percent of the total Forest acreage is classified as commercial Forest land. Of this 450,351 acres or 45 percent, is lodgepole pine forest type. Topography of the lodgepole type is generally flat to rolling with slopes under 30 percent.

Lodgepole pine stands are predominately mature and overmature, moderately to heavily infected with disease, and contain high volumes of dead trees killed by mountain pine beetles and frequent wind and ice storms. A 1975 timber inventory indicated 90 percent of all stands were mature and overmature and 78 percent of these were sawtimber size. Dwarf mistletoe is the major disease agent affecting over 67 percent of all stands. Moderate to heavy levels of infection are found in 41 percent of all lodgepole stands.

The Targhee has experienced wide-spread epidemic levels of mountain pine beetle over the past 25 years. Extensive stands of even-aged mature (100 years+) and sawtimbered sized lodgepole posed a high risk for a successful mountain pine beetle attack. Beginning in the 1960's, repeated cycles of mountain pine beetle have occurred, with the last major attack in 1979-1981. The epidemic began in the south end of the Forest and moved northward and eastward over the entire Forest spilling over into the Gallatin National Forest and Yellowstone National Park.

Efforts to control the epidemic in the 1960's and 1970's included harvesting and chemical treatments. These treatments were successful in slowing down the rate of infestation not in controlling the epidemic. Chemical treatments were halted in 1970.

Today 20 to 90 percent of merchantable sized trees are dead in the lodgepole pine stands. The majority of these stands are in the 50 to 90 percent dead category. Dead trees begin falling five to 15 years after being killed. This material is now falling at an accelerated rate, causing problems and concern for recreation, range, transportation, and fire and fuels management activities.

The closed cone or serotinous characteristic of lodgepole stands on the Forest is extremely important to the current and future management of this timber source. Most stands on the Targhee exhibit 10 to 90 percent cone serotiny. Dead standing trees hold viable seed in the closed cones for long periods estimated to be in excess of 30 years. Through a basic silvicultural treatment of clearcutting, with delayed slash piling for cone opening and seed fall, followed by soil scarification and slash piling, natural regeneration is guaranteed in over 90 percent of all treatments.

Management Practices of The 1970's

During the 1970's Forest management made many predictions and plans for treating the epidemic situation. Both marketing predictions and harvesting capabilities fell significantly short of the actual utilization standards of today. Emphasis during this period was primarily on salvage of dead material. Harvesting of the dead lodgepole without adequate funding and emphasis on natural reforestation created much of the backlog reforestation on the Targhee requiring expensive hand planting.

At the end of each cycle of mountain pine beetle activity, assumptions were made by Forest managers that the epidemic was over and current stand conditions would remain static for the long term. This put into effect management strategies such as partial cutting of lodgepole termed "dead only". During the interim of two to five years, many timber sales were implemented under this strategy. When the epidemic peaked again, these stands were left in a badly deteriorated condition highly susceptible to windthrow. Many stands did windthrow and some were entered again with timber sales. Since regeneration was not the objective in the first entry and windthrow caused additional loss of the initial natural seeding potential, probability for successful natural regeneration after final harvest became very low. This also caused some of the reforestation backlog and additional hand planting.

The fuelwood program was in its infant stages prior to the energy crises of the mid-1970's. When the crises occurred, the public demand for fuelwood skyrocketed. Only a free use program was implemented in the 1970's to handle this demand. All cutting was done by partial cutting and primarily along roads. Reforestation was not an objective, only salvage and fuels reduction.

Forest Land Management Plan 1980's

The Targhee began its Forest Plan process 1979-1980 and published a draft in 1981. One of the driving issues for the plan was the utilization and reforestation of the lodgepole pine timber stands. The preferred alternative established a harvest objective of 160,000 acres of lodgepole with 140,000 acres planned reforestation in the decade. Harvest objectives included 108,000 acres of lodgepole in a category termed "Other Products". These "Other Products" included all lodgepole outputs except sawtimber. Fuelwood was included as a major portion of these "Other Products". Natural regeneration of lodgepole was the method of reforestation to be emphasized on more than 90 percent of all acres reforested in the decade. Short term trade-offs in visual and wildlife cover values were made in the plan to accommodate the outputs in the selected alternative.

Fuelwood Program

The fuelwood program includes both commercial fuelwood sales and personal use fuelwood sales. Commercial sales make up 16 percent of the program with the remaining 84 percent as personal use charge (PUC). The PUC program began in 1980-1981. Fuelwood gathering during these years was an extension of the free use system carried on in the 1970's. Wood gatherers were allowed to cut along roads and in large designated areas resulting in partial cut or "Dead Only" situations without established reforestation objectives. Administration costs were minimal with only occasional patrolling. Problems with cutting in undesignated areas, cutting without permits, and cutting in timber sale log decks were common. Fuelwood cutting included only standing dead with some down dead material being removed.

In 1982 the PUC program was designated in lodgepole stands having the least potential or no potential for commercial sawtimber timber sales. A variety of prescribed treatments were offered in an effort to determine the best one(s) for meeting public demand, economic efficiency, and reforestation objectives. All areas to be treated were prepared in a manner identical to a commercial timber sale except for appraisal, cruising, and scaling. Public demand for fuelwood revolved around two primary needs. First, the volume of wood necessary to meet demands was substantial (15 to 20 million board feet) and second, the wood cutter preference for having a choice of standing dead and/or downed dead. Several treatments were implemented to gain experience in cost, contract administration, and success in achieving natural regeneration. The following treatment sequences were implemented:

Treatment #1

- Step 1. Fuelwood Cutter - Select and cut standing dead and down and live trees in designated units.
- Step 2. Contract - Felling of residual stand (7" DBH+) and skid merchantable volume into decks to be sold by Forest Service.

Step 3. Seed Fall - Allow adequate time for serotinous cone opening and seed drop.

Step 4. Contract - Slash piling and soil scarification (dozer with brush blade).

Step 5. Free Use - Offer piled slash as free use in following season.

Treatment #2

Step 1. Contract - Prefelling of live trees only (7" DBH+) in designated units.

Step 2. Fuelwood Cutters - Select and cut standing and down dead in addition to green felled trees in designated units.

Step 3. Same as Treatment #1.

Step 4. Same as Treatment #1.

Step 5. Same as Treatment #1.

Treatment #3

Step 1. Contract - Prefelling of all live and dead trees (7" DBH+) in designated units.

Step 2. Fuelwood Cutters - Select and cut all felled trees and any residual trees.

Step 3. Same as Treatment #1.

Step 4. Same as Treatment #1.

Step 5. Same as Treatment #1.

Treatment #4

Step 1. Fuelwood Cutters - Select and cut standing dead and down, and live trees in designated units.

Step 2. Contract - Felling of all residual trees (7" DBH) in designated units.

Step 3. Same as Treatment #1.

Step 4. Same as Treatment #1.

Step 5. Same as Treatment #1.

Results of these treatments are summarized as follows:

Treat- ment	Cost Comparison	Public Accep- tance <u>2/</u>	Reforestation Objectives	Safety and Administration
1	High \$350/ Ac. <u>1</u> /	High	Moderate - The combination of firewood cutting, felling and skidding contracts, and slash piling and scarification contracts caused extreme difficulty in coordinating proper site preparation with seed drop.	Administration difficult because more area or units needed to give cutters space to safely fell trees. Hazard to wood cutters very high.
2	Moderate \$215/ AC. <u>1</u> /	High - Public did not readily remove much of the green felled trees.	High	Same as Treatment #1
3	Moderate \$215/ AC. <u>1</u> /	High - Same as Treat- ment #2	High	Administration easier than other treatments and safety to cutter is optimized.
4	Moderate \$215/ Ac. <u>1</u> /	High Same as Treat- ment #2	Moderate - The coordination of activities to achieve site preparation with seed fall very difficult	Same as Treatment #1 and Treatment #2

1/ Approximate average costs.

2/ Public acceptance was high. The change from traditional uncontrolled cutting "Dead Onlys" to more confined cutting areas did create a large amount of concern by the public. The fuelwood program was a highly sensitive program on the Forest as measured by annual Congressional inquiries. Public concern has now subsided. An ongoing major public information effort is required.

After our experience from 1982 Treatments #1 and #2 were discontinued. Treatment #1 was too high cost and Treatment #2 did not reflect any cost savings in felling green trees only. Treatments #3 and #4 satisfactorily met public demand for quantity and variety of cutter preferences, and costs were similar. Utilization of available fuelwood in units posed significant problems. These were due to lack of adequate access. A pre-roading program for fuelwood access in addition to small timber sale pre-roading programs was accelerated. These were specified roads. In addition to the specified road, stump roads were developed in each cutting unit by use of a dozer. Only stumps and downed dead trees were pushed aside to allow pickup truck and trailer access to all areas inside cutting units. These were very low cost investments which significantly increased wood utilization. All evidence of these stump roads were obliterated during the slash piling and soil scarification activities.

Over the past three years the PUC program has annually issued 6,000 permits for verified removal of 17 million board feet of fuelwood and naturally regenerated 1,500 acres. For 1985, 2,981 acres are scheduled for natural regeneration under this program. Nearly 100 percent of the PUC program is conducted on two Ranger Districts: Island Park and Ashton.

Intensive administration is the key to a successful fuelwood program. One of the major factors is the large numbers of people to work with to maintain a good host attitude and provide service. The challenge to the Districts is to be able to handle the peak flows of wood cutters on and near weekend days. These peaks strain the best laid plans for being able to promptly issue permits and satisfy the public need for areas to cut in. One District has set up a mobile office (trailer house) near the fuelwood area. This office is used as a base to sell permits and administer the cutting areas. This concept has been highly successful as measured by service to the public. Congestion in the District Ranger Station has been alleviated.

A fine line has to be followed to achieve natural regeneration with the PUC program. Coordination of prefelling, wood removal, and soil scarification and slash piling has to be very precise to ensure good utilization and achieve natural regeneration. The timing of seed fall from opened serotinous cones must be carefully monitored to accomplish soil scarification at the proper time. Timing of these sequences, in light of the number of people and contracts involved, is extremely challenging.

Currently \$2.50/cord is the fee charged for this fuelwood. Collections are distributed as follows: KV=\$.25; SSF=\$.25; Road Maintenance=\$.75; and BD=\$1.25. The current District cost for preparation and administering of PUC is approximately \$215/acre. This cost is multi-financed with compartment examination, sale preparation and administration, forest pest management, appropriated reforestation, road maintenance, KV, and BD funds.

Results of the program have been very positive. The public demand and Forest objectives for resource values and uses have been achieved. Continuing this program for the foreseeable future is expected to produce the same results.

Conclusions:

1. The PUC program is a successful method for reforestating dead lodgepole pine stands.
2. Public demand is met and acceptance is high.
3. Significant accomplishment of the Forest Plan objectives are being met.
4. An intensive Inform and Involve program is necessary to sell PUC program to public.
5. The PUC program cost for naturally regenerating dead lodgepole stands is less than 50 percent hand planting costs.
6. Forest Service employees involved in PUC must be highly skilled and motivated to deal with the wood cutting public in a positive manner.
7. All levels of the Forest Service organization must be supportive and committed to the success of PUC.

Overstory Removal: An Assessment

Gary O. Fiddler and Robert J. Laacke

A wide range of situations make rapid regeneration of commercial forest land desirable. Although market value of timber is still subject to wide fluctuations (as the past few years indicate) long term demand trends continue to be upward and new markets for material formerly considered valueless continue to open. Ongoing reductions of old-growth inventories lead to reliance on young stands for yield and income. Even under extensive management, the shorter rotations do not allow long delays in achieving regeneration following harvest and place a premium on rapid and sustained early growth. In addition, managers of both public and private forest land are compelled by state and federal legislation to demonstrate that harvested land meets certain standards of forest tree cover in a relatively short time following harvest.

At the same time, concerns of segments of the public over use of chemical pesticides (mostly herbicides) have resulted in steadily increasing regulatory restrictions and many useful tools for protecting seedlings have been eliminated. Similar public concerns about cutting methods result in pressures against clearcutting and other regeneration activities that result in major changes in forest conditions.

In net, as the pressures mount to keep forest land occupied by a rapidly growing tree cover, regeneration becomes more and more difficult to ensure. As a result, any approach that avoids the need for regeneration, and keeps forest land under tree cover while allowing harvesting, tends to be extremely attractive. The classic concept of overstory removal (OR) offers such opportunities.

An overstory removal cut is applied to a stand in which there are at least two widely differing age and/or size classes, the older (or larger) of which is merchantable and is removed. The purpose of an OR is to leave an adequately stocked stand with well distributed crop trees; trees which have the capacity to produce a product with a combination of time, volume, and value considerations equal to or exceeding those attainable by seedlings established, naturally or artificially, following a regeneration harvest. If the stand following harvest can not meet this criterion, overstory removal should not be attempted and the stand should be regenerated.

Protection of crop trees in the understory is of paramount importance in an overstory removal and is possible, although relatively expensive (Barrett et al. 1976). Therefore, to avoid the double costs of completing an overstory removal and then being forced to remove and regenerate an unacceptable and perhaps unmerchantable residual stand, OR should only be prescribed when there is a high probability of success. However, before any particular stand can be assessed, two general pieces of information must be known: (1) what set of characteristics identify understory trees as acceptable crop trees; (2) what combination of site, stand, and logging factors unacceptably reduce the chances of successfully removing the overstory.

Recent work by John Helms and Rick Standiford at the University of California in Berkeley, has provided a reasonable answer to the first (Helms and Standiford, 1984; Standiford, 1978). This study was designed to approach an answer to the second.

Methods

Sixteen overstory removal sales on the Plumas, Modoc, Klamath, Lassen, and Shasta/Trinity National Forests in northern California were chosen for study. All sales were in the true fir, "east-side pine", or Sierra Nevada mixed-conifer timber types. All sales were standard, operational, overstory removal sales and were not chosen for any special reason. The sales chosen were logged with either tractors or cable systems.

Depending on size and stand condition, 3 to 5 homogenous units were delineated in each sale. Unit size ranged from 1.5 to 7.0 acres. Overstory data were collected on a 100% sample of the overstory trees to be removed from the unit. The following measurements were taken for all overstory trees in each unit:

1. species
2. dbh
3. height to base of live crown
4. total tree height
5. radius of base of crown
6. radius of top of crown

The above data were used to calculate basal area, and the longitudinal cross-sectional area of the bole, crown, and total tree. These areas were used as estimates of the surface area impacted (and therefore area potentially damaged) when the tree fell. The following data summarize the overstory component:

trees/acre	3 - 31	
average trees/acre	14	
average trees/acre cable units only		19
average diameter	34"	
volume/acre	5 - 68MBF	
average volume/acre	28MBF	
average volume/acre cable units only		36MBF

Understory data were collected from circular plots systematically located in a randomly oriented grid. Each plot was divided into quarters and data collected separately, by quadrant, to provide an estimate of within and between plot variation. This represented a sample of between 15 and 30%.

All understory trees in each quadrant of each preharvest plot were counted and the following data collected:

1. species
2. dbh by 2-inch classes
3. trees less than 4.5 feet tall were listed as "dbh"

Each understory tree in the plots was judged acceptable or unacceptable as a crop tree by estimating its ability to respond quickly to release. This

estimate was made in the field based on a set of criteria patterned after those of Helms and Standiford (1984). The criteria used to determine acceptable trees for all species in this study were:

1. dominant or codominant in its strata
2. constant or increasing yearly height growth
3. vigorous appearance (eg. good crown density, needle length and needle color)
4. no crown damage
5. 30% or greater live crown ratio

The following data summarizes the understory:

total trees/acre 346 - 2301; average dbh = 4.7"
acceptable trees/acre 14 - 795; average dbh = 8.5"
average total trees that were acceptable = 22%

All units were harvested through normal Forest Service timber sale procedures. To avoid possible operator bias, sampling was done without the operator's knowledge and sample plots were not marked. This resulted in two independent sets of data for each area, one pre-harvest and one post-harvest.

All residual stands were judged as satisfactory or unsatisfactory by a set of stocking standards developed before analysis. The standards (Table 1 - Page 7) represented reasonable crop tree stocking and were based on number of acceptable trees per acre by species and average stand diameter. Stepwise discriminant analysis was used to identify the stand factors associated with satisfactory and unsatisfactory residual stands.

The following independent variables were chosen for stepwise discriminant analysis:

1. average overstory dbh
2. number of overstory trees per acre
3. total cross-sectional overstory tree area per acre
4. sum of dbh of acceptable understory trees per acre preharvest
5. sum of dbh of all understory trees per acre preharvest
6. total basal area per acre of acceptable understory trees preharvest
7. total basal area per acre of all understory trees preharvest
8. total number of acceptable understory trees per acre preharvest
9. total number of all understory trees per acre preharvest
10. average dbh of acceptable understory trees preharvest
11. average dbh of all understory trees preharvest

Results

The first and clearest result was that none of the operational units met the post-harvest test for stocking.

The purpose of discriminant analysis is to identify those variables or characteristics that are associated with a difference in category (eg. satisfactory and unsatisfactory). Since the initial stocking standards resulted in only one class of stand--unsatisfactory--analysis as originally intended was not possible. It was deemed important to identify those factors

associated with satisfactory and unsatisfactory residual stands, even if the stocking criteria had to be reduced (for analysis only). To allow analysis, criteria for satisfactory stocking with crop trees were reduced to divide the stands into two roughly even-sized classes. The reduced stocking standards represented stocking levels that were marginally adequate. With this reduced criteria 45% of the stands were deemed satisfactory and 55% unsatisfactory post harvest.

The four preharvest characteristics most important in classifying whether stands were satisfactorily or unsatisfactorily stocked (using the lower stocking standards) following harvest were:

1. Average dbh of the overstory
2. total cross-sectional overstory tree area per acre
3. total number of all understory trees per acre preharvest
4. sum of dbh of acceptable understory trees per acre preharvest

Of the above only the first 2 were significant enough to be included in the discriminant analysis. Discriminant functions correctly classified stands that ended up with acceptable post-harvest stocking 83% of the time and those that ended up with unacceptable post-harvest stocking 82% of the time.

The average volume removed from those units that were considered satisfactorily stocked (by the reduced stocking standards) following harvesting was 19.6MBF per acre. Average number of overstory trees removed was 13.3 per acre. Between 38 - 55% of the understory trees were lost during harvesting. Skid trails or cable corridors occupied 16 - 18% of the area in the units. The larger portion of damage to the residual stand was from falling as compared to yarding.

It is common for California timber stands designated for overstory removal to have more than 20MBF per acre. It was decided to determine if, by including more restrictive sale preparation and harvesting procedures, larger volumes could be removed while leaving a satisfactorily stocked residual stand.

Seven units were logged on Swain Mountain Experimental Forest. Although the data collected were the same as on the operational sales, these seven units differed from the others in several ways. They were designed, advertised and administered as research plots on an Experimental Forest. Each unit included contract restrictions designed to reduce damage to residual trees and added costs for each of the treatments were recorded or calculated. The special provisions imposed singly or in combination, on these units were:

1. directional falling (predetermined and including jacking)
2. stage logging
3. predesignated falling beds and skid trails
4. predesignated and prelogged falling beds and skid trails
5. predesignated and marked reserve (crop) trees

Additional differences were that all units were tractor-logged because of terrain limitations and all were in the true fir type with large overstory trees. There was no attempt to disguise the plot locations and the operator was fully aware of the purpose of the sales. Units on Swain Mountain were not analyzed with the operational units because of the differences described above.

All seven of the Swain Mountain units met the reduced stocking standards for satisfactory stocking following harvesting. Three of the units met the original stocking standards which required many more trees per acre. Volumes removed from Swain Mountain ranged between 18.5 and 64MBF per acre and averaged 45.5MBF per acre. The average number of overstory trees removed per acre was 21.1.

Conclusions and Recommendations

The units on Swain Mountain demonstrate that it is possible to remove large overstory volumes and to leave an acceptably stocked stand. In order to result with satisfactorily stocked residual stands, operational overstory removal sales are not removing even half as much volume as reported from Swain Mountain.

To increase significantly the volume that can be successfully removed in an overstory removal harvest, several activities and restrictions must be considered. They can be grouped under presale preparation and sale administration activities.

Presale Preparation

1. Do not allow logging of stands whose understory is composed of thin-barked species during the spring and early summer when the sap is flowing and bark is not tight.
2. Restrict the size and type of logging equipment. On slopes steeper than 35%, use cable systems. Match size of logging equipment to size of material being removed.
3. Mark the residual trees that are to be saved during harvesting. This simple activity reduced damage to the residual stand on Swain Mountain to 8% compared with 45 - 55% on the operational sales.
4. Lay out skid trails and cable corridors before the timber sale is advertised. Use straight-line patterns. Such patterns minimize yarding distance.
5. Predesignate beds for the overstory trees to be dropped into. This not only lessens damage to the residual stand, but it also greatly reduces that portion of the stand area occupied by logging slash. This reduction can be as much as 35 - 50%.
6. Designate "rub" trees or cull logs along the edges of skid trails to protect residual trees.

Sale Administration

1. Gain cooperation of the logger and explain the objectives of the overstory removal.
2. Fell and yard trees in skid trails and beds before cutting overstory trees. Cut stumps in these areas as low as possible.
3. Require directional felling of all overstory trees into predesignated beds or skid trails.
4. Limb and top trees prior to yarding. Limb flush to the bole.
5. Require end-lining from predesignated skid trails.
6. Require stage logging (falling and skidding).

Designation of falling beds took about 15 minutes longer per tree for the marking crew. All trees were required to be dropped into the beds and there was no noticeable increase in falling time.

Predesignation of falling direction for individual trees was accomplished by the marking crews and identified by arrows painted on the tree. The effort did not noticeably increase time required to mark the stand. Initially, falling costs for these trees were increased about one third. However, as the fallers became familiar with the additional equipment (hydraulic jacks) costs gradually fell to about 25% above normal.

Units with predesignated skid trails required end-lining and increased skidding costs-about 25% over conventional skidding. This compares favorably with results reported by Bradshaw (1979).

In conclusion, overstory removal is an acceptable, although risky and limited, alternative to regeneration. The extra care necessary to protect the new stand while removing more than about 20MBF per acre (even less than this amount on cable ground) may increase harvest costs by between 25 and 30 percent. Without this extra care, most overstory removal harvests will be unsuccessful.

Table 1: STOCKING STANDARDS FOR POST HARVEST STANDS

Mean Stand Diameter	Species*	Number /ha (/ac)	
12.7 cm (5.0 in)	all	988	(400)
12.7 to 27.7 cm (5.0 to 10.9 in)	PP	494	(200)
	DF	618	(250)
	WF	865	(350)
	RF	865	(350)
	MC	741	(300)
27.8 to 42.9 cm (11.0 to 16.9 in)	PP	284	(115)
	DF	371	(150)
	WF	556	(225)
	RF	593	(240)
	MC	442	(170)
42.9 cm (17.0 in)	PP	173	(70)
	DF	222	(90)
	WF	346	(140)
	RF	371	(150)
	MC	247	(100)

* PP=Ponderosa pine: DF=Douglas-fir: WF=white fir: RF=California red fir:
MC=mixed conifers.

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C OMPUTERIZED

H ABITAT ANALYSIS

A ND

M ULTIPLE-USE

P RESCRIPTION

S YSTEM

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ABSTRACT: The Computerized Habitat Analysis And Multiple-use
Prescription System (CHAMPS) is a micro-computer based forest management plan
implementation and control program. CHAMPS is described and an example of the
application of stage 1 of 3 is presented.

The intent of this paper is to inform you of our progress in the development of the Computerized Habitat Analysis and Multiple-use Prescription System, CHAMPS. "Computerized" because, like many other professions, foresters are working hard to harness the power of the new generation of inexpensive micro-computers. "Habitat Analysis" refers to a 4-square-mile area of land used in wildlife research for studying the dynamics of white-tailed deer populations in northern Minnesota. "Multiple-use" because in CHAMPS we integrate the management of timber, wildlife, and watershed resources. "Prescription System" because CHAMPS assists the field forester in decision-making through advice and recommendations.

First, let's put CHAMPS in perspective. It is not a growth and yield prediction system such as Prognosis (Wycoff et al. 1982) or STEMS (Belcher et al. 1982), although it will contain a variant of TWIGS (Belcher 1982) within it. CHAMPS deals with spatial juxtaposition, not with stands of timber in isolation to each other. CHAMPS provides prescriptions for a management unit containing many stands. CHAMPS is like SILVAH (Ernst 1982) because both systems provide silvicultural prescriptions and recommendations. CHAMPS, however, will integrate timber, wildlife, and watershed management considerations across a management unit, whereas SILVAH deals only with the timber resource and does not include the spatial arrangement of stands in the landscape as part of the prescription. Additionally, CHAMPS helps the field forester realize management goals because its focus is on recommending prescriptions that will move the entire management unit toward a set of goals. This difference has important implications because recommendations are not based solely on silvicultural needs, but on the broader concerns of forest management.

CHAMPS is being developed by scientists of the USDA Forest Service's North Central Forest Experiment Station, the Computer Science Department of Alabama A&M University in Huntsville, Alabama, the University of Minnesota Cooperative Soil Survey, St. Paul, Minnesota, and personnel of the Itasca County, Minnesota Land Department. The objectives of the CHAMPS program are to: (1) demonstrate the feasibility of a computer-assisted decision support system for field foresters; (2) implement CHAMPS for Itasca County, Minnesota and field test the system; and (3) document CHAMPS and our experience in enough detail to allow for adaptation and use by others.

The County Land Department administers 282,640 acres in Itasca County. A field forester in the county is directly responsible for 60,000 to 85,000 acres containing about 9,000 stands. Every stand has been measured for species composition, age, site index, volume by species, etc., for up to 80 variables (Table 1). Not only do we have the stand inventory data, but also the mapping data to contend with (Fig. 1). All of this vast amount of information becomes an asset only when it is organized, indexed, and readily available.

Forest management has been divided into three phases (Clutter et al. 1983) (Fig. 2). The function of the planning phase is to produce desirable goals and make value judgments as to what should be done. CHAMPS does not assist in forest management planning. Goals must be created outside CHAMPS. Once the planning has been done, so we know where we want the tract to be at the end of the planning period, CHAMPS can be used to implement those goals. Implementation is concerned with the selection of stands and prescriptions to best achieve the goals. The control phase provides feedback to the other phases about the result of cultural activities. Seldom do we experience 100

percent success even if we could actually do everything our implementation plan calls for.

We believe that the productivity of field foresters is generally limited by their ability to collect, manipulate, and understand resource specific information and then formulate management decisions based on that information. The major function of CHAMPS, therefore, is to assist the field forester in the decision making process for the implementation and control phases of forest management.

We feel that no computer program can adequately analyze the intangible or subjective elements of a proposal. Field foresters are as much a part of CHAMPS as the inventory records discussed earlier. The forester provides judgment to the system, the inventory data provide a reflection of the physical reality of the landscape, and "expert system" software provides compiled knowledge gleaned from over 30 years of research in timber, wildlife, and watershed management. The expert system also includes knowledge that experienced field foresters have gained in performing their jobs. After all, the experienced field forester is the expert at doing that particular job and provides locally applicable knowledge to the system.

Expert systems, then, are computer programs that can harness knowledge to help solve problems and aid in making decisions based on incomplete, uncertain and possibly contradictory information (Harmon and King 1985). Knowledge may be public or private (Hays-Roth et al. 1983). Public knowledge is more or less available in some published form. Private knowledge consists of personal rules-of-thumb and experience that together with public knowledge, make human experts expert. "Elucidating and reproducing such knowledge is the central task in building expert systems" (Hays-Roth et al. 1983).

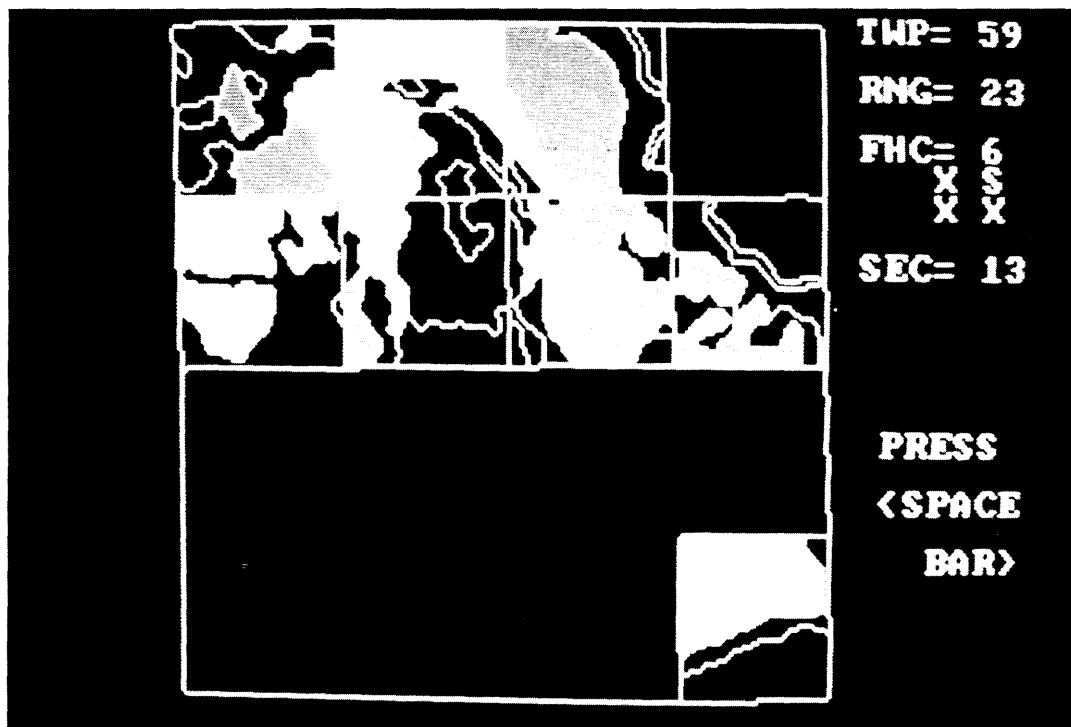


Fig. 1. Stands within fortys in Section 13, Compartment number 6, Range 23 and Township 59

Table 1. Sample display showing all currently active variables in the
inventory data base of CHAMPS

NOTE: -1 = NO DATA

```
***** DISPLAY #1 *****
*      TOWNSHIP      : 59.      QUARTER SECTION : 1. *
*      RANGE         : 23.      FORTY           : 1. *
*      COMPARTMENT    : 2.      STAND            : 6. *
*      SECTION        : 10.     GOVERNMENT LOT   : 1. *
*
*      TYPE          SIZE      DENSITY      PLANTATION
*
* OVERSTORY . : 50.      4.      4.      -1. *
* UNDERSTORY  : -1.     -1.     -1.     -1. *
*
* ACRES        : 5.00      CONDITION          : 1. *
* AGE          : 66.      TOPOGRAPHY          : 1. *
* SITE INDEX   : 65.      SOILS              : 3. *
* BASAL AREA/ACRE : -1.0  WILDLIFE COMMUNITY : -1. *
* # TREES/ACRE : -1.      MANAGEMENT REC.   : 1. *
* APPRAISAL YEAR : 1982.  REGENERATION      : -1. *
* GROWTH YEAR   : 1982.  DAMAGE CODE       : -1. *
* NEXT EVENT YEAR : 19-1. MISCELLANEOUS      : -1. *
* NEXT EVENT CODE : -1.
*****
```

NOTE: -1 = NO DATA

```
***** DISPLAY #2 *****
*
*      VOLUME
*      CORDWOOD      SAWTIMBER
*
* SPECIES  CORDS  CDS/AC  SPECIES  MBF  MBF/AC
* 1      50.    85.    17.00  -1.    -1.    -1.00
* 2      11.     5.     1.00  -1.    -1.    -1.00
* 3      41.    10.     2.00  -1.    -1.    -1.00
* 4      -1.    -1.    -1.00  -1.    -1.    -1.00
* 5      -1.    -1.    -1.00  -1.    -1.    -1.00
* 6      -1.    -1.    -1.00  -1.    -1.    -1.00
* 7      -1.    -1.    -1.00  -1.    -1.    -1.00
* 8      -1.    -1.    -1.00  -1.    -1.    -1.00
* 9      -1.    -1.    -1.00  -1.    -1.    -1.00
* 10     -1.    -1.    -1.00  -1.    -1.    -1.00
*
* TOTAL      100    20.00      0      .00
*
* REMARKS: Stand is adjacent to state-owned land. Coordinate
*          activities with them.
*****
```

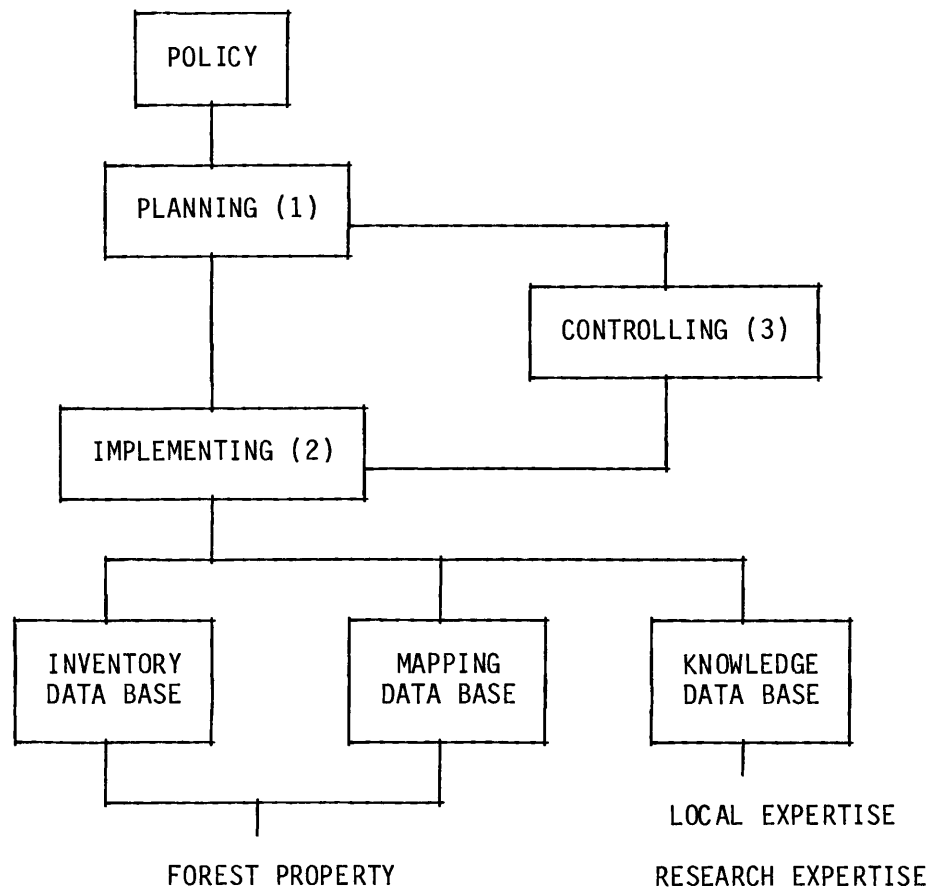


Fig. 2. The three phases of the forest management process and the data base requirements of the implementation phase

The expert system methodology can capture human expertise in a friendly and powerful computer system that is open to examination by the user and thus builds confidence. Expert systems report on demand what assumptions and line of reasoning were used to arrive at a conclusion. They report alternative, less favored conclusions. They provide us with the limitations of knowledge and estimates of uncertainty of their conclusions. They allow modification of the knowledge items in the knowledge base without requiring users to program. They can be constructed to help us interpret, predict, diagnose, design, plan, monitor, and instruct. They offer the opportunity to greatly increase our productivity by helping individuals solve problems more quickly and efficiently than currently possible (Harmon and King 1985).

CHAMPS is only one-third completed. We have finished the development and implementation of stage one, the Geographic Information System (GIS). The conceptual development of stage two, the Expert Prescription System, is also done; the implementation is due for completion in the winter of 1985-86. The final stage, the Goal Evaluation System, has not yet been designed.

Now, let's work through an example of how we might use CHAMPS. While we cannot yet demonstrate the integration of wildlife, timber, and watershed management knowledge into the prescription process, we can show how to use the first stage, the GIS alone, to work an example. Suppose we have as a goal in township 59, range 23, to harvest 4,300 cords of aspen. Other species have allowable cuts in this township as well, but for the present example we can ignore them.

How can we use CHAMPS to implement this goal? Management units are subdivided into various numbers of townships (23,040 acres each). Townships are further divided into nine forest habitat compartments (2,560 acres each)

Each forest habitat compartment contains four sections (640 acres each). The forest habitat compartment has been determined to be a meaningful unit in the management of the white-tailed deer in northern Minnesota.

The question then is: what stands should we harvest in order to make up our allowable cut of aspen?. We can quickly request an age profile from CHAMPS for this township (Table 2). Based on silvicultural research, a 50-year rotation for aspen was decided upon earlier. Aspen older than 50 years, depending upon site quality, will suffer increasingly higher mortality rates, poorer form, and greater defect until the stand becomes unmerchantable. Worse yet, regenerating these old stands to aspen becomes more and more difficult. A 50-year rotation requires roughly 20 percent of the acreage in aspen to be in each 10-year age class. The current situation is far from this goal. Unfortunately, this compartment more or less reflects the status of aspen stands in the entire upper Great Lakes region. The principal challenge for the Itasca County Land Department in timber management is how best to bring the aspen age structure into line with the goals without losing a large acreage in the aspen type.

Through the planning process, it was decided that the oldest stands should be harvested to make up the allowable cut. Using CHAMPS, we found that if we harvested aspen age 64+ in this township, we would harvest about 7,000 cords. Where is this volume? Using CHAMPS, we can summarize the over-age aspen volume by forest habitat compartment (Table 3). Because we do not have resources to offer all the over-aged aspen stands for sale, we concentrate on the compartments with the greatest volume, numbers 1, 3, 6, and 9. These four compartments total 5,147 cords, enough to meet our allowable cut goal. Looking at one compartment, number 6, we use CHAMPS to provide a grid map

Table 2. Age class distribution of aspen stands in township 59-23, Itasca
County, Minnesota

<u>Age Class</u>	<u>Actual Percentage</u>	<u>Goal Percentage</u>
1-10	8	20
11-20	13	20
21-30	<1	20
31-40	7	20
41-50	22	20
51-60	36	--
61 +	14	--

Total Aspen Volume in Township	:	84,000 cords
Allowable Cut for Aspen	:	4,300 cords

Table 3. Aspen volume by forest habitat compartment for stands 64 years
and older

<u>Compartment</u>	<u>No. of stands</u>	<u>Cords</u>	<u>Percent of total volume</u>	<u>Acres</u>
1	3	1233	18	41
2	3	505	7	17
3	3	1057	15	34
4	2	356	5	9
5	5	484	7	26
6	7	1285	18	63
7	-	--	--	--
8	1	534	7	17
9	6	1572	23	56

* = Sum of Volume = 5147 cords

TOWNSHIP = 59

RANGE = 23

FOREST HABITAT COMPARTMENT = 6

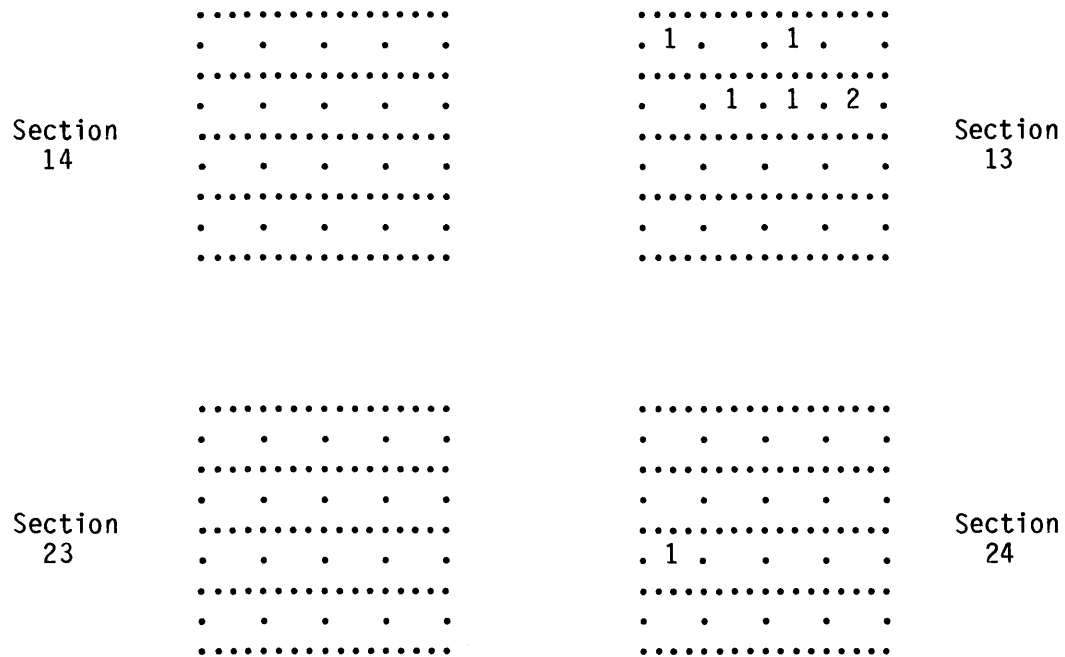


Fig. 3. Example of a grid map developed by CHAMPS

Table 4. Volumes in over-aged aspen stands by species

<u>Identification Code</u>				<u>Volume in Cords</u>		
<u>Section</u>	<u>1/4Section</u>	<u>Forty</u>	<u>Stand</u>	<u>Aspen</u>	<u>Fir</u>	<u>Birch</u>
13	1	2	4	398	128	-
13	1	3	1	525	-	-
13	1	4	2	100	24	4
13	1	4	6	104	53	-
13	2	2	3	205	4	-
13	2	4	5	63	-	-
Total				1395	209	4
				Percent Actual	Balsam Fir Goal	
				17	<20	

(Fig. 3), showing which 40-acre parcels contain these stands. We immediately realize that one of the sections in this compartment contains 6 of the 7 over-aged stands. This is a key piece of information. Now we can look at the map of each of these stands in the section (Fig. 1).

Before going to the field to mark out this sale, we need to get the species composition from CHAMPS (Table 4). Experience in timber sales in this locality tells us that sales are difficult where the proportion of balsam fir is greater than 20 percent. In this case we are fortunate to have only 17 percent.

With this information in hand, we can go to the field to verify that our information in the data base is correct and mark out our sale. The Appendix contains the timber sale offered and sold for this area.

In summary, the importance of stage 1 of CHAMPS lies not in the capabilities provided, but the fact that they are offered to the field forester on his/her demand more or less instantaneously. Because of its low cost (Table 5), the microcomputer is dedicated to the practitioner and the numeric and graphic data bases describing his/her area of managerial responsibility are immediately accessible. No computer programming skills are required and yet the range of retrieval combinations are essentially unlimited.

With the completion of stages 2 and 3 of CHAMPS, we are confident that we will have developed a decision-support system for the field forester currently unequalled in power and flexibility. It will be a system well able to incorporate the changes demanded by our dynamic world. It can be used to compile, on a continuing basis, new research knowledge. CHAMPS, we believe, will dramatically improve the productivity of field foresters.

Table 5. CHAMPS hardware and software requirements

HARDWARE

IBM COMPATIBLE MICROCOMPUTER
640k RAM, 1-FLOPPY DISK DRIVE
1-10 MEGABYTE HARDDISK DRIVE

RGB COLOR MONITOR AND ADAPTER
COLOR GRAPHICS BOARD (16 COLOR CAPABILITY)
IN MEDIUM RESOLUTION GRAPHICS)

COLOR PRINTER (DOT MATRIX)

APPROXIMATE COST: \$5,000 - \$8,000

SOFTWARE

RBASE 4000 DATA BASE (MICRORIM, INC.)
RBASE 40000 INTERFACE PROGRAM (MICRORIM, INC.)
FORTRAN-77 LANGUAGE COMPILER (MICROSOFT)
GRAPHICS PROGRAM LIBRARY

APPROXIMATE COST: \$700 - \$1,000

TOTAL SYSTEM APPROXIMATE COST: \$5,700 - \$9,000

Literature Cited

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APPENDIX

TIMBER SALES REPORT, ITASCA COUNTY LAND DEPARTMENT

Timber Report

APPRAISAL OF Itasca COUNTY TAX FORFEITED TIMBER

APPRAISAL NO. _____

Request by: Auction Address: _____

Appraised by: Wayne Perreault + Inv. data Date: 4/15/83

LEGAL DESCRIPTION: Subd. NW 1/4, W 1/2 NE 1/4, SENE 1 Sec. 13 Twp. 59 Rge. 23

Acres 280

Name of Township Unorganized

DESCRIPTIVE FEATURES AND FACTORS:

Topography level to gently rolling
Dist. to Public Road on to 1 mi. Miles
Dist. to Market _____ Miles
Permit Area 86 Acres
Logging Condition Good

SCALE:

- (a) Regular _____
(b) Consumer ☒ _____
(c) Estimate _____

CUTTING REGULATIONS:

non-merchantable conifer
Reserve cedar
Selective Cut _____
Marked Timber _____
Clearcut crosshatched area, all species 2 stic
up unless otherwise designated. All un-
merchantable wood 2" up must
be knocked down excluding conifer
slash must be kept 25' back from all
roads & trails. Roads & landings are to be chg.
ed with forester. No travel is permitted outside
of timber sale area. Tree tops must not be let
across lines. Tipped & leaning trees must be pulled
down & utilized. Maintain 5' off slash free zone
along all boundary lines & reserve timber types.
Stumps must be kept low.
Products sold at prevailing prices.

APPRAISAL OF MERCHANTABLE TIMBER

Species	Volume	Unit	Price	Value	Age	Cutting Diameter & Condition of Timber
Aspen Woodruff	3117	cds.	3.65	7727.05	64-66	clearcut, 4" top - defective (sit index 67-74)
Balsam	123	cds.	4.50	553.50		clearcut
Balm	152	cds.	3.00	456.00		clearcut
Spruce	31	cds.	12.00	372.00		clearcut
Jack Pine	318	cds.	12.00	3816.00	57-62	clearcut, 3" top - good
Birch	28	cds.	3.00	84.00		

TOTAL 13,028.55

MAILED OUT

The above appraisal has been examined by me and approved.

Therefore, recommend PUBLIC ☒ PRIVATE SALE

Land Commissioner

Date

MAY 2 1983

OFFICE DATA

ITASCA COUNTY

CONS.

CO. BD.

LAND COMMISSIONER

P. SALE

HOLD

SOLD

The timber appraisals and forestry practices as designated are hereby approved

- Check one: a. ☒ based on a partial sampling of appraisals.
b. ☐ based on complete appraisals.

Commissioner of Conservation

Area Forester

Date

ELK THERMAL COVER: A DILEMMA FOR
THE FOREST PLANNER

DAVID S. WINN, Wildlife Management Staff, USDA Forest Service, Ogden, UT 84401

Abstract: This paper presents the overviews of integrating the concepts of elk thermal cover into the forest planning process. The Prognosis Model is used to display thermal cover across an array of site conditions and thinning alternatives. Implications associated with analyzing elk thermal cover in a relatively undisturbed area are discussed.

It is not the intent of this paper to provide answers but, in a rational way, present a sequence for thought.

To date, a significant effort has been made to understand the habitat requirements of elk. The results of these efforts provide criteria to evaluate goal-oriented silvicultural prescriptions. Using thermal cover as a standard for evaluating elk habitat, a series of stand variables can be projected with the Stand Prognosis Model (Wykoff et al. 1982). Though the author accepts responsibility for the paper's contents, the efforts of Jim Cole, Robert Cottingham, and Ronald Hamilton are acknowledged for their aid in data collection, summary, and interpretation of the Prognosis Model.

One of the most influential pieces of legislation that impacted the planning effort was the National Environmental Policy Act (NEPA). This Law required that the effects of management activities be examined in an integrated and far-reaching manner. More explicit guidelines for conducting these environmental analyses were provided by the Council on Environmental Quality (CEQ) in 1978. The Endangered Species Act (1973) also requires that biological assessments evaluate the cumulative effects of land uses and management activities. This Act defines cumulative effects as the combined effect upon a species or its habitat that results from an activity.

The assessment and evaluation of a project's long-range impacts and consequences includes the vexing problem of estimating direct and indirect effects. Or, if you will, the anticipated and unanticipated consequences of successional relationships that result from competitive interactions.

Land use and resource planning on National Forests is not new. However, within the last decade, the planning policies have been changed in at least three major ways.

1. Planning units correspond to budgetary and administrative levels.
2. Planning addresses management goals and objectives.
3. Planning is to be carried out as prescribed by Federal law and regulation. In essence, by decree, man has agreed to share the habitat resources with wild and free-roaming species.

While increased wood production of merchantable-sized trees is commonly the primary objective of silvicultural thinning, this practice also exerts an influence on understory production and wildlife habitat. These resource values, or similar values, resulted in the Federal District Court of the Northern District of West Virginia limiting the Forest Service's authority to sell timber. Weitzman (1977) summarized this action, known as the "Monongahela Decision," which interpreted the Organic Act of 1897 as allowing for only the harvest of individually-marked "dead, physiologically mature and large growth" trees. In conjunction with the "Monongahela Decision," Congress initiated the National Forest Management Act of 1976. The rules and regulations governing the Act's implementation are interpreted as allowing harvests after the point of stand growth culmination. For planning purposes, this means the minimum age of rotation is the length of time required to achieve volume production equivalent to at least 95% of the culmination of mean annual increment (CMAI). This age is graphically displayed as the intersection of the periodic annual increment (PAI) and mean annual increment (MAI) curves (Fig. 1). The PAI represents the average annual volume for each decade, and the MAI the average annual volume at any given stand age. Exceptions to this rule are allowed only when the loss of the stand is imminent from other natural causes or when sound silvicultural practices, such as thinning, can be prescribed to achieve other resource values. One of these values might be thermal cover. However, Forest ecologists must recognize that those who challenge the resource values can also be expected to inquire as to the process that determined the value.

Let's digress and explore the idea of rule sets. Rule sets are merely a model's way of converting spatial, non-spatial, and ecological relationships

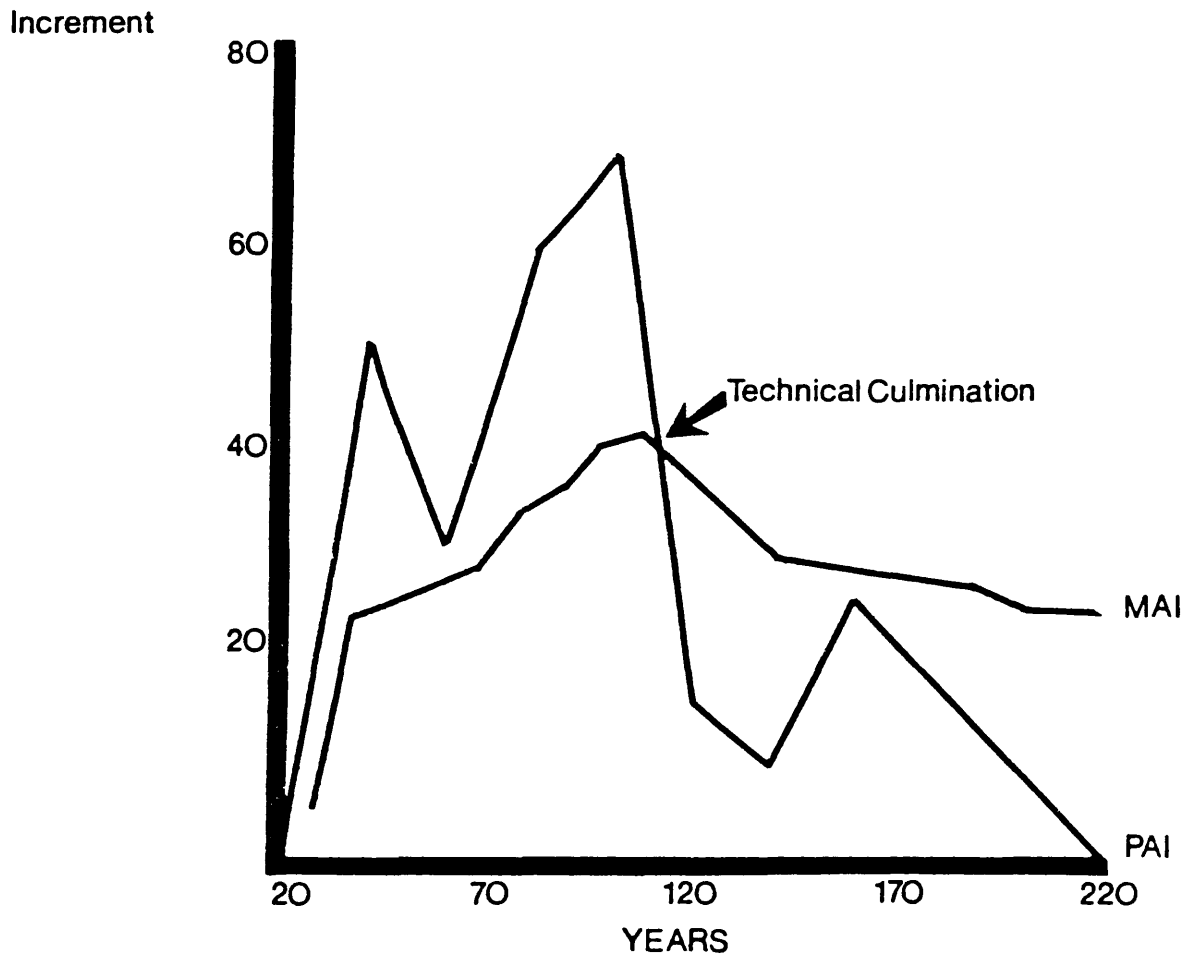


Figure 1. Technical point of culmination, Periodic Annual Increment (PAI), and Mean Annual Increment (MAI) for unmanaged lodgepole pine on a poor Uinta Mountain north slope site.

into mathematical functions. It is the power of these mathematical functions that provides the model's utility in predicting the so-called planning products. This is an important point, for it separates science, planning, and conjecture.

Romesburg (1981), in his paper dealing with gaining reliable wildlife knowledge, proposed the idea that confusions associated with conceptual definitions, such as carrying capacity, viable populations, stand density indices, or the reliability of knowledge gained from computer simulations, stem from either inadequate or misuse of scientific methods. Romesburg's thesis makes two additional important points:

1. Many research hypothesis are proposed and either become a law through verbal repetition or lose favor and are forgotten.
2. The domains of science and planning are philosophically distinct; yet, because they share similar tools of analyses and simulation, their differences often pass unnoticed.

It is the last point that is critical to the interpretation and development of planning models. Ecological modelers and planners must recognize the essential difference wherein science uses fact as its standard for selection while planning relies on value sets. On the other hand, conjecture is at the threshold of hope.

The conflict in planning arises when value is not fact or when value added to value is conjectured to be fact. For example, in the timber-wildlife issue, the term "forage-cover ratio," depending on your point of view, probably spans the realm from science to conjecture. The actual data base ratio is fact, but its biological interpretation is oftentimes construed to be fact.

On the other side of the coin there are some well-defined rule sets and specific species habitat requirements that have been documented. For example, the population dynamics and management implications of the mountain pine beetle can be adapted to forest planning models (McGregor and Cole 1985). The relationship of elk habitat use and road activity (Lyon 1979) and the interaction between grazing cattle and elk (Painter 1980) have been identified, and these relationships can be reliable components of a planning model.

For this analysis, the study area is centered on the north slopes of the Uinta Mountains in Utah and lies between 8,500 and 11,000 feet in elevation. The landscape is characterized by steep drainages dominated by sub-climax lodgepole pine (Pinus contorta) communities. The most common habitat type is Abies lasiocarpa/Vaccinium scoparium. Meadow communities comprise most of the level landscape and represent important elk breeding and rearing areas.

Elevation, aspect, and local wind patterns are the major determinants of micro-meteorological conditions and the risks associated with major infestations of the mountain pine beetle (Dendroctonus monticolae). The long term, frost-free season is about 30 days and occurs during the month of July. The

30-year normalized minimum temperature between May and October is -7° C. and the recorded wind nearly doubles from the lower to higher elevations.

Seventy-five percent of the area's 101,270 acres is commercial forest, 14% wilderness, and 6% non-forested. Only 7,341 acres (72% clearcut) have been harvested over the last 20 years. Twenty-five percent of the stands are less than 80 years old and dwarf mistletoe (Arceuthobium americanu) is prevalent on 50% of the area.

Recreational activities have increased by 178% during the last 10 years and currently total 321,500 visitor-days. Camping, fishing, and hunting activities account for 58%, 21% and 8%, respectively, of these visitor-days. Road densities of 1.1 miles/section on the northern half of the area and .5 miles/section on the south half are conducive to effective habitat (Lyon 1979).

The long-term trends for domestic cows and sheep are on the decline. Since 1921, 1,753 animal unit months (AUM's) have been vacated by livestock operators. However, the current livestock use centers on the meadows, riparian areas, clearcuts, and roadways.

Historically, the area supports the State's only native elk herd. The herd has been hunted for over 40 years with a series of special hunts. Since 1967, it has been included in the Statewide open bull hunt. The annual elk harvest since 1963 has increased from 32 to 119 animals. In the period 1972-82, the harvest increased 240%, with an average annual hunter success of 14%. This success figure is comparable to the overall State average. When compared with

surrounding units, the north slope unit characteristically produces more mature bulls (53% versus 44%) and is characterized by bull-cow ratio of 1/4 and about 51 calves per 100 cows. The typical north slope hunter enjoys hunting with friends in remote areas and considers the kill secondary to the quality of the unit. Based on these findings, Kimball (1984) states that the Utah Division of Wildlife Resources recommends future management objectives for the area consider this hunter attitude. It should be noted that hunter attitude is a planning value.

Methods

Stand data from the study area were projected by the Utah variant of the Stand Prognosis Model. The projected stand conditions for unmanaged stands were compared to data taken from stands of similar age and site conditions. These comparisons indicated the model predicted the stand structure for unmanaged sites within reasonable stand development expectations.

Thermal cover was selected as a comparative guideline because, depending on your point of view, it is easily defined and a realistic goal for silvicultural prescriptions. Thermal cover is considered the habitat segment that provides elk protection from extreme differences between a fixed body temperature and the ambient temperature. Black et al. (1976) defined these conditions as 40-foot trees with a canopy closure of 70%. Marcum (1976) substantiated these conditions in western Montana. Lyon (1979) considered the importance of maintaining body temperature at some relatively constant level comparable to

feeding as a daily preoccupation for elk. Thermal cover values are straightforward and related directly to cover/forage ratios, stand size, and road densities. In addition, stand rotation periods are easily predicted.

Results and Discussion

Beall (1974) concluded elk selected bedding sites only after lengthy wanderings through timber stands. He believes that some proper micro-climatic conditions are sensed and that this condition correlated more closely with intensities of thermal and solar radiation rather than the ambient air temperature.

When the theoretical potential extraterrestrial radiation was calculated for north slope habitats, a difference between sites during the month of October totaled 395 langleys (Table 1). This difference occurs between north-western and south-easterly aspects and for the elk represents an additional estimated stress of 8% due to radiant energy loss. These data suggest the notion that one set of guidelines cannot be used over a broad range of habitat conditions. This notion is the first planning dilemma. The data also raises questions regarding the definition of wildlife requisites versus species preferences and the practices of relegating marginal, non-productive forest habitats as cover to meet these habitat needs. This practice is probably most significant in areas of cold air accumulation. Under conditions of cold air accumulation, habitat types probably are good indicators of heat regimes and could be used to modify current thermal cover definitions. In addition, the

Table 1. Theoretical potential Extraterrestrial Radiation at latitude 41° (monthly daily average).

Aspect	Slope	MONTH							
		May		June		September		October	
45°	1%	966.95 ¹	(95) ²	1018.70	(100)	725.87	(71)	543.68	(53)
	45%	858.58	(84)	939.17	(92)	541.38	(53)	334.31	(33)
135°	1%	968.65	(95)	1018.70	(100)	733.46	(72)	554.17	(54)
	45%	960.01	(94)	972.66	(95)	845.31	(83)	728.89	(72)
225°	1%	968.65	(95)	1018.52	(100)	733.46	(72)	554.17	(54)
	45%	960.01	(94)	972.66	(95)	845.31	(83)	728.89	(72)
315°	1%	966.95	(95)	1018.70	(100)	725.87	(71)	543.60	(53)
	45%	858.58	(84)	939.17	(92)	541.38	(53)	334.31	(33)

1. Total average langleys/day
2. Percent of June maximum (1018.70)

tendencies for habitat types to reflect site potential suggests the possible opportunity of combining habitat type and stand density indices into a more accurate predictor of thermal cover conditions.

Understanding the successional stages of canopy development is important in appraising the management implications of thermal cover development. To facilitate studies of wildlife-forest cover relationships, Cole (1983) recently developed this comprehensive model to depict vertical crown development in lodgepole pine (Pinus contorta) communities. However, the distinction between patchiness and structural complexity is also important if we are to fully understand elk habitat relationships. Additionally, Long and Smith (1983/1984) partitioned canopy development into four stand structure classes. The initial stage in stand development is characterized by small trees growing without competitive interaction. Crowns grow at their maximum and respond rapidly to management. During the second stage, crowns begin to interact, individual tree growth is below potential, about 35% of the maximum stand density index is achieved, and a timely response to management is hard to achieve. By the third phase, crown competition results in the total stand growth lagging behind the maximum growth rate. Individual tree growth results in size differences, response to management is limited, and the stand density index approaches 55% of the maximum. In the final stage, known as the zone of imminent mortality, both canopy and stand growth decline and density-related mortality occurs.

Thus, growth regimes provide the second planning dilemma. Failure to manage a stand can result in crown suppression and reduced thermal cover. As a result, subtle consequences to management opportunities decrease the habitat

effectiveness. In other words, stands left alone will not guarantee consistency in ideal wildlife habitat. In fact, in all probability, successional change will result in the deterioration of the current habitat quality.

To evaluate the development of thermal cover, three silvicultural prescriptions were projected with the Stand Prognosis Model. The results of these projections are displayed in Table 2. One projection represents the natural growth characteristics of a lodgepole pine stand on a poor site. For the same site conditions, the other two prescriptions set timber production goals. One prescription is designed to grow a 10-inch dbh tree by thinning overstories at a stand age of 10 years. Another consists of thinning twice, once at 10 years and again at 30 years. A 14-inch dbh is the proposed goal.

It is apparent from these projections that the development of thermal cover can be enhanced by silvicultural treatment. During natural canopy succession, it takes 90 years to develop a dominant tree height of 40 feet and the point of growth culmination is reached in 110 years. After reaching a height of 40 feet, thermal cover canopy closure remains for an additional 50 years. At the point of culmination, the dominant tree height is 40 feet, the dbh equals 9.9 inches, and the merchantable volume is 4,721 cubic feet/acre.

Stands thinned once at 10 years reach the point of culmination in 140 years. In these stands, thermal cover conditions develop by a stand age of 70 and remain until the stand reaches 190 years. At culmination, dominant trees

are 47 feet tall, have a dbh of 9-14 inches, and the merchantable volume is 7,238 cubic foot/acre and the 10-inch dbh is achieved in 50 years.

Stands thinned initially at 10 years and again at 30 years achieved the 14-inch dbh goal and reached the point of culmination within 140 years. At culmination, the dominant trees are 62 feet tall and the average dbh is 17.5 inches. These stands produced a merchantable 6,423 cubic foot volume/acre. Fourteen-inch dbh trees develop in 80 years and the stand provides thermal cover during the 120- to 160-year period.

When the goal of growing a 10-inch tree on two different sites is compared, we find that an average site reaches culmination in 140 years and provides thermal cover from a stand age of 60 to 220 years. For this same 10-inch dbh goal on a good site, culmination is reached in 100 years and thermal cover requirements are met during the stand's development period between 50 and 220 years.

It is obvious from Table 2 that an array of planning tradeoffs exist between sites, prescriptions, and the interaction at the point of culmination. For example, in areas characterized by insect infestation, the one-time thinning at 10 years provides both thermal cover and volume under a greatly reduced rotation schedule. However, this prescription requires additional road activity, frequent stand entries, and detailed planning for juxtaposition. Thus, the controversy associated with management tradeoffs becomes the third planning dilemma.

Table 2. Prognosis lodgepole pine growth projections for three sites and three silvicultural treatments.

Year	No Treatment			POOR SITE			AVERAGE SITE			GOOD SITE		
	10" Goal			14" Goal			10" goal			10" Goal		
	Ht	%	QMD	Ht	%	QMD	Ht	%	QMD	Ht	%	QMD
20	15	61	3.6	15	61	3.6	15	61	3.6	15	61	3.6
30	24	113	5.3	24	37	5.3	27	43	5.8	30	49	6.3
40	27	142	6.3	28	60	8.6	32	71	9.6	37	83	10.6
50	28	119	6.8	32	51	10.1	37	83	11.1	42	97	12.3
60	32	107	7.4	36	81	11.2	42	90	12.3	48	104	13.5
70	35	96	8.1	40	82	12.0	45	92	13.1	51	107	14.3
80	39	98	8.8	43	82	12.7	47	93	13.7	55	108	14.9
90	41	97	9.2	45	82	13.1	50	94	14.2	57	109	15.5
100	44	95	9.6	47	82	13.6	52	95	14.7	60*	110	15.9
110	46*	95	9.9	50	83	14.0	56	97	15.1	62		16.4
120	49	83	10.1	54	84	14.4	59	99	15.5	65		16.8
130	51	75	10.4	56	85	14.6	61	99	15.8	67		17.1
140	53	69	10.8	58*	85	14.9	63*	100	16.1	69		17.4
150	56	68	11.1	60	85	15.1	65		16.3	71		17.5
160	58	66	11.3	62	85	15.3	67		16.4	72		17.7
170	60	65	11.5	64	85	15.4	68		16.6	74		17.9
180	62	63	11.7	65	78	15.5	70		16.7	75		18.0
190	63	61	11.8	67	72	15.6	72		16.8	76		18.0
200	65	59	11.9	68	69	15.7	73		16.9	78		18.1
210	66	56	12.0	69	66	15.8	74		16.9	79		18.2
220	68	54	12.1	70	63	15.8	75		17.0	80		18.2

1. Height (ft.) dominant tree.

2. % canopy closure.

3. Quadratic mean diameter.

* Point of culmination.

Two basic points stand out as planners attempt to integrate thermal cover concepts into the ramifications of forest planning. One is economics; the other deals with biopolitical understanding.

Zivnуска (1980) points out that a small per capita effect on a large number of people can have a greater social impact than a large impact on a limited number of people. However, larger groups are generally not represented in the public participation process, while a smaller and more cohesive group almost always are.

Another aspect of public involvement is that planning issues generally impact a centralized local value rather than a general public value.

The current planning policy is further complicated by stressing that forest resources are held in trust at the national level. Thus, at times, rather than responding to the traditionally conservative issues of local communities, the forest manager must deal with the disaggregated goals and objectives of larger areas. With regard to biopolitical understanding, when one considers the timeframe in which elk habitat models have been developed, it is not surprising that planning guidelines have been interpreted inconsistently (Lyon 1984).

When the study area is put in historical perspective, we can appraise the interaction of planning fact and value. The area is characterized by:

1. Predominantly overmature stands that are not overly susceptible to catastrophic fire, insect, or diseases. A fact.

2. A balance of cover/forage ratios (85/15) that has been maintained for man's view of history. A fact.

3. Non-market recreational values that rely on the current vegetation mosaics. A value.

4. Road densities and road use patterns that are conducive to effective elk habitat. A fact.

5. A group of hunters who enjoy the remote hunt and are satisfied with the harvest success. A value.

6. A healthy elk herd that produces mature bulls. A value.

7. Declining livestock competition. A fact.

8. A Forest canopy that responds favorably to silvicultural prescriptions that "enhance" elk and other wildlife values while producing merchantable timber volumes. A fact.

Therefore, the paramount planning dilemma regarding thermal cover is what to do or not to do and how to evaluate that which is done. Evaluation is the fourth planning dilemma, and this evaluation is usually translated into dollar values, relates to the current political climate, and combines fact and value.

Years ago, Aldo Leopold pointed out that the basic weakness in a conservation system based on economic motives is that most members of the ecosystem do not have defined economic values. The fact of the matter is that, generally speaking, wildlife standards and guides do not propose wildlife goals; rather their intent is to restrain other resource management activities. For example, for each wildlife habitat structural goal the planner should expect a definition of what the corresponding prescription means in terms of wildlife, not habitat.

Additionally, wildlife habitat guides are more factual than legal. One merely has to observe the 60-40 cover ratio to conclude that this set of conditions has a serious pitfall; that being the more site-specific you apply this guide, the greater the chance you have of being outside the overall area guides.

One must recognize that guides represent the assumptions of the planning process. Once this is recognized, a basic question can be formulated. Can specific standards and guides be implemented without impacting the ecological consequence of the planning alternative of which they are a part? This brings to focus in the study area some important questions. Should elk objectives be outside the budgetary objectives? Are we obligated to provide the greatest public benefit for the least cost? Are non-market benefit values presently within the scope of our management guidelines or do they fluctuate with the latest political whims? If, in the analysis of alternatives, not all things are deterministic, can elk habitat variables be dealt with in the realm

of chance constraints? For example, can we address population change as a result of the silvicultural planning decisions?

For areas similar to the study area, environmental evangelists are not needed. What is needed is intelligent "tinkering" by managers who understand the complexity of the component parts and who can propose, in a reasonable way, long range, ecologically sound planning scenarios that maximize the public benefit. Thus, the development of long range, ecologically sound planning scenarios represents the final dilemma.

In Summary

Regardless of the planner's position with regard to the development of timber volumes or thermal cover, the planning dilemmas discussed must be dealt with in an active or passive way. Habitat conditions of juxtaposition, density-related mortality, and canopy closure change under the driving force of competition. Management is merely an opportunity to interject some control into the production of forest fiber while developing an effective habitat mosaic of successional communities.

However, what we must convey to the public is our intent to manage the land resource and that there are "value" trade-offs that result from activities of commission or activities of omission. The key, then, is to balance these activities within the law through techniques devised by skillfull, thoughtful professionals.

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IMPROVING BALD EAGLE HABITAT WITH SILVICULTURAL MANIPULATION
IN NORTHEASTERN CALIFORNIA

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ABSTRACT

Bald eagle nesting habitat is improved using silvicultural manipulation to provide desired nest tree and stand conditions over time. Treatments include modified high risk selection and shelterwood cutting of the overstory trees and precommercial and commercial thinnings to spacings which maximize individual tree growth. Approximately 320 acres of nesting habitat were treated.

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INTRODUCTION

The Forest Service is required to provide for the protection and management of the bald eagle and its habitat. Historically this has been done by avoidance or prohibiting harvesting in the vicinity of active nest sites. This approach may provide immediate protection, but it does not address the question of long term habitat needs. Due to the loss of suitable habitat through human development activities in the past, the available nesting habitat has become more confined. With the disruption of natural processes in the remaining habitat, the "avoidance" approach may actually result in habitat deterioration.

Lehman (1980) identified habitat characteristics that bald eagles require for nesting. These characteristics were determined by observing eagle nest sites under natural conditions. Due to timber harvesting and other influences, however, stands require specialized manipulation to develop suitable nesting habitat.

MANAGEMENT AREA

The management area is located in Shasta County in northeastern California. It is part of the Shasta National Forest and is administered by the Hat Creek Ranger District. The nest territories are near Lake Britton, an impoundment on the Pit River. Numerous streams feed the river, which drains westward to the Sacramento River.

The area encompasses the densest concentration of nesting bald eagles in the contiguous United States, and is a heavily used wintering area for adults and immatures.

HABITAT DESCRIPTION

The habitat is composed of a Pacific ponderosa pine type (Eyre, 1980) in a relatively untouched condition. The stand was initially examined in 1979 at the end of a prolonged drought. Many of the overstory ponderosa pine trees were in a severe state of decline with a significant number of dead trees already present. The condition of the stand was such that suitable nest trees were being lost much faster than they would ever be replaced naturally by the existing unmanaged understory.

Three plant aggregations were identified within the 320 acre stand. The first aggregation, comprising about 85 percent of the stand, consisted of an overstory of old growth trees (10 per acre), a negligible intermediate layer, and an overstocked understory of saplings and poles (900+ per acre). The second aggregation made up about 5 percent of the stand and consisted of old

growth trees (80 per acre) and no manageable understory. The trees making up both of these aggregations were ponderosa pine. Old growth trees were vigor class 3 and 5 under Dunning's classification (Figure 1). The third aggregation was comprised of clumps of oak trees.

MANAGEMENT OBJECTIVE AND PRESCRIPTIONS

The silvicultural objective for the stand, which was drawn from Lehman's 1980 study, was to maintain an average of 8 Dunning Class 5 ponderosa pine trees per acre. This would meet the desired parameters of overstory stocking density, overstory crown closure (less than 20 percent), species composition, and form (dominant, large limbed ponderosa pine trees with openings in the crown).

To accomplish this objective, a three part strategy was developed. The first step, and also the highest priority, was to maintain as many of the existing overstory trees as possible to meet immediate and near term nest tree requirements. The second part was to accelerate the growth of the existing understory to serve as replacement nest trees. The final step was to begin a regeneration process which would provide for a continual supply of nest trees using a long term rotation of 250 or more years. This was achieved by applying the following prescriptions:

Aggregation 1 (Scattered mature ponderosa pine overstory with an overstocked understory) - In this aggregation the prescription called for removing only those Dunning Class 3 and 5 trees expected to die within 5 to 10 years using a modified risk class rating system (see Table 1). This will maintain a balance between keeping the best potential nest trees while minimizing losses due to insect build-up in high risk trees which could spread to adjacent trees. In addition, the treatment included precommercially thinning the overstocked understory to the point where maximum individual tree growth could be achieved while still having enough stocking to account for long term mortality. Based on work by Oliver (1972), this point was established at 15 square feet of basal area and 55 trees per acre. Spacing was variable ± 50 percent to allow for retention of the best trees. No thinning was done within 200 feet of an active nest tree.

Aggregation 2 (Dense ponderosa pine overstory with no understory) - In this area the prescribed treatment was to regenerate those portions of the aggregation where the understory was inadequate and existing vegetation and soil conditions indicated a good chance of planting success. The overstory stocking would be reduced to leave all but 15 of the very best overstory trees per acre and then underplanted with 2-0 ponderosa pine on 10 by 10 foot spacing. When the planted trees are about 10 to 15 feet tall they will be thinned to 55 trees per acre.

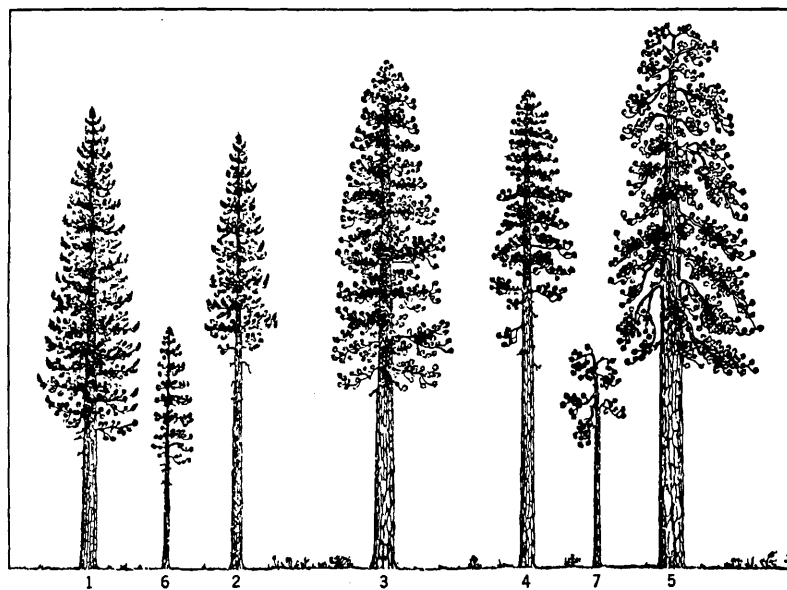


Figure 1. The 7 tree classes recognized in Dunning's classification for uneven-aged ponderosa pine.

Future treatments of both Aggregations 1 and 2 call for commercially thinning the previously precommercially thinned stands by removing about 50 percent of the basal area when the basal area exceeds 125 square feet per acre.

Aggregation 3 (Black and white oak clumps) - This type was not considered for manipulation due to its low to non-existent value for bald eagle nesting habitat and its high value as winter habitat for black-tailed deer and band-tailed pigeons.

The entire Bald Eagle Management Area will be re-evaluated on 10 to 20 year cycles to pinpoint the areas requiring any of the treatments previously described. An average of about 4 percent of the area must be regenerated each decade to maintain a stand structure with 250 year old trees.

TABLE 1. Modified penalty system for rating high insect risk pine trees (from U.S.F.S., 1957).

<u>Needle Condition</u>	<u>Penalty</u>
1. <u>Needle Complement</u>	
a. Needle complement normal.....	0
b. Less than normal complement through crown. No contrast between upper and lower crown.....	2
c. Thin complement in upper crown, normal in lower crown. Contrast evident between upper and lower crown.....	5
2. <u>Needle Length</u>	
a. Needle length normal.....	0
b. Needles shorter than normal throughout crown. No contrast between upper and lower crown.....	2
c. Needles short in top, normal below. Marked contrast evident.....	5
3. <u>Needle Color</u>	
a. Normal.....	0
b. Off color.....	2
c. Fading.....	8

<u>Risk Class</u>	<u>Penalty Score</u>	<u>Marking</u>
I	0	Leave tree
II	1 to 4 inc.	Leave tree
III	5 to 7 inc.	Leave tree
IV	8 and higher	Cut tree

RESULTS

After formal consultation with the U. S. Department of Interior's Fish and Wildlife Service, the plan for treating the 320 acre Bald Eagle Management Area was approved and included as part of a District timber sale. Logging operations were

restricted to the months of September and October while tree marking and other general activities were restricted to the period between July 1 and November 30 to avoid disturbance to the nest sites.

Logging was completed in October of 1983, and the precommercial thinning leave trees were designated shortly thereafter. Actual thinning will commence as soon as the seasonal operating restriction is lifted in the summer of 1985. That operation will utilize feller buncher and chipping equipment to produce fuel for a wood fired power plant and will also reduce fuel loading within the management area.

To date the objectives of the project have been met and the total number of nesting pairs has increased from two to three within the management area. The area has also produced a significant amount of wood fiber although at a level below that produced during normal timber operations. Long term management of the area for bald eagle habitat is expected to generate about 32 percent of the revenue of a forest managed primarily for timber production.

CONCLUSION

Silvicultural manipulation can be effective in providing long term bald eagle nesting habitat. This has been made possible largely as the result of studies defining desired habitat characteristics which allow silvicultural strategies to be designed to meet them. Other analyses that define habitat in silvicultural terms (Mathisen, 1983) and other Bald Eagle nesting habitat management plans (Goold and Horton, 1981) illustrate the trend toward aggressive management of bald eagle habitat. Well-tested silvicultural methodology provides a low risk means of maintaining and improving the habitat.

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ONE-QUARTER CENTURY OF TREE IMPROVEMENT

IN THE SOUTHERN REGION 1/

by

Robert N. Kitchens 2/

The Southern Region's Tree Improvement Program is one of the really great success stories of the U.S. Forest Service. In the last 2 years, 47,000 pounds of first generation orchard seeds were harvested. Through the 1985 planting season, approximately 325,000 acres of improved trees have been planted on National Forests in the South. This acreage is increasing at the rate of about 50,000 acres per year.

Payoffs are great by any measure. These trees will produce 10 to 20 percent more volume than average wild trees. They are also bred to be straighter, more disease-resistant, and to have better wood qualities than their wild cousins.

It took 25 years of hard work by many people to get to this point, but the most important phase lies just ahead--that of second generation superior trees. These trees are expected to grow a whopping 35 to 45 percent faster than the wild population!

First Generation Program

In 1959, under the guidance of Thomas F. Swofford, the first Regional Geneticist, planning for the program was started. He consulted many people and organizations in developing the program. The following is a list of some who contributed and deserve recognition: John Kraus, Bruce Zobel, Hans Van Buijtenen and Ray Goddard, Southern, Southeastern and Southwestern Forest Experiment Stations, and Tree Improvement Cooperatives at North Carolina State University, University of Florida, and Texas A & M University. Programs already underway in Portugal, Sweden and England were also examined. Swofford retired in 1975 and was replaced by Jim McConnell, the present Regional Geneticist.

The pine program was started first. Actual selections begun in 1961 and were essentially completed by 1967. Thirty-eight species-geographic source combinations were recognized in the original selection program; consisting of shortleaf, loblolly, longleaf, slash, eastern white, Virginia, and Ocala sand pines. All original orchard sites and species were successful except for sand pine. It was first included as part of the Erambert Seed Orchard in south Mississippi. Survival and growth was poor so the sand pine orchard was moved to central Florida, which is in the native range of the species.

1/Presented to the National Silviculture Workshop, USDA Forest Service, Rapid City, South Dakota, May 16, 1985.

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Approximately 6 million acres of National Forest pinelands were intensively searched for the very best trees as candidate parent trees for first generation orchards. After a candidate was found, it had to pass several screens before it was finally accepted. Faster growth, pruning ability, straightness, disease resistance, and specific gravity were the traits sought after in the superior tree selections. About 50 selections for each species-geographic source were approved. Then the selections were grafted into clonal orchards. The Ocala sand pine orchard has both a clonal orchard and a 120-family seedling seed orchard. The Region now has 1,975 pine selections in 1,256 acres of pine seed orchards at six (6) orchard sites.

The first collectible crop of seed was harvested in 1970; through 1984, collections have totalled 81,000 pounds. Most pine sources in the program are now producing enough seeds for total planting requirements.

The hardwood program started in 1968. Six species are in the program--black, white, northern red, and chestnut oaks, cherry and yellow poplar. To date, 382 selections have been made for clonal orchards and 29 acres of clonal orchards have been established. A 220-family, 16 acre, northern red oak seedling seed orchard was established, which was originally a Tennessee Valley Authority progeny test on National Forest land.

Of the hardwood clonal orchards, only yellow-poplar and black cherry are producing enough seed for operational plantings. Sure-fire techniques for successful oak seeding or planting are still not developed; however, within a few years, crops will be harvested from the orchard and attempts at using them for reforestation will be made.

Managing first generation orchards presented some unique problems that had to be solved. Foremost was how to harvest all the cones or seeds without harming the trees. During regular woods cone collection, trees were usually cut down and the cones picked; however, since cutting trees was not possible in a seed orchard, various methods were used to place people in the trees, including ladders and bucket trucks. Besides being expensive and slow, these methods were somewhat hazardous. With the cooperation of the Georgia Forestry Commission, a new system was developed, called the Net Retrieval System. Netting was placed on the ground where the seeds fell, and a combine-type machine was used to roll the net and separate the seeds. The Net Retrieval System is now in operation on all or part of four Forest Service orchards, and others are considering using this system.

Because a seed orchard has many trees of the same age, it is an attractive home for insects--especially those that like to eat cones and seeds. Safe and effective ways had to be found to control these seed-destroying insects. Entomologists worked closely with orchard managers on pesticide formulation, application, and timing for effective control. With the help of several organizations, technology for the aerial application of insecticide was developed. Now an orchard can be treated in hours instead of the weeks that was required for ground application methods. In addition, aerial applications place the insecticide in the top portion of the crown, where the cones are. This means less insecticide is necessary to do an effective job.

Progeny Testing

In 1974, controlled crosses among orchard trees began according to a plan that employed disconnected half-diallels for all species except sand pine. Individual matings were made to match desirable characteristics as indicated by the original scoring sheets, fusiform rust disease resistance screening tests, and progeny performance (where available). Over 9,500 individual crosses will have been made when the plan is completed.

Progeny testing was done to; (1) measure gains, (2) test worth of parents, and most importantly, (3) as a source of selections for second generation orchards. A few open-pollinated tests were installed, mainly for demonstration purposes. To date, over 250 tests have been planted representing about 6,500 families. About 20 percent of the tests are 5 years old or older. Early results have been quite surprising. Of course, early results must be used with a great degree of caution. Nevertheless, they indicate that large genetic gains can be made.

A white pine open-pollinated test at the Cradle of Forestry, on the Pisgah National Forest in North Carolina, showed orchard trees to have a 25 percent superiority in diameter growth and a 15 percent superiority in height growth over general forest area stock at age 5. The 10-year results for the same test showed an accelerating difference--28 percent in height and 36 percent in diameter. The 10-year mean for orchard stock was 24.75 feet tall and diameter of 4.97 inches; for general forest area stock the respective means were 19.25 feet and 3.65 inches.

Another important result, and one expected by geneticists, was that the range of trait variation was the same for seed orchard material as general forest area stock. Only the mean of the two populations was different. This is evidence that orchard populations will continue to have large amounts of variation for some traits.

One of the largest actual heights and diameters occurred in a loblolly pine test in Southern Mississippi. At age 5, the average of all orchard families was 16.6 feet, the tallest family was 18.2 feet, and the tallest individual tree was 29.1 feet.

Other early results are quite impressive. However, the number of tests analyzed is small relative to the total number planned. During the next few years many more tests will be analyzed so that greater confidence can be placed in the gain percentages.

Plans are to use 8- to 10-year test results to begin making selections for second generation orchards. That time is almost here.

Second Generation Breeding

The second generation plan for pines has been developed. Actually, it goes beyond the second generation because selection of new genetic material to infuse into second and successive generation breeding is also planned.

As stated earlier, since second generation gains are expected to double first generation gains, full speed ahead is in order.

Orchard site selection has already begun. In general, second generation sites will be near first generation sites in order to efficiently utilize present personnel, facilities, and equipment.

The 38 pine geographic source-species combinations used in the first generation were streamlined into 20 breeding populations for the second generation, based on latest research results. Reducing the breeding population to 20 will increase program efficiency. It also gives a broader genetic base for second generation selections since some first generation populations were combined.

The 20 breeding populations for the second generation have been prioritized based on the species importance in National Forest reforestation and on progress of first generation progeny tests. The highest priorities will be developed first and others will be done as timing and budgets allow. Other flexibilities have also been built into the plan so that developing technology can be incorporated along the way.

Guiding Principles

Several guiding principles have been used which contributed greatly to the success of the program.

Knowledge and experience of a large part of the tree improvement community has been drawn upon in formulating strategic plans and critiquing the program. The Regional Geneticist and a small staff are responsible for strategic planning, but they consult frequently with many others. John Kraus and Ozzie Wells, Southeastern and Southern Forest Experiment Stations respectively, are constant advisors. The interchange of tree improvement information under the umbrella of the Southern Forest Tree Improvement Committee is used. One almost has to be a part of tree improvement in the South to fully realize the spirit and degree of cooperation within this community.

Maximum involvement of Forest and District personnel is fostered. There is no tree improvement organization as such below the Regional level. Forest Supervisors are responsible for the program on their respective forests. Orchard Managers and workers who do actual test plantings and measurements are on the District Ranger's staff. By having this type of involvement, ownership of the program is vested in all levels of the organization and each level takes pride in program accomplishments. Work is accomplished in a timely fashion and the quality of work is high.

The Tree Improvement Program is continually evaluated with respect to current silvicultural practices used on National Forest lands. Greater productivity is the goal of tree improvement. Greater productivity cannot take place without the proper integration of genetics and silviculture. In fact, on the National Forests, tree improvement is viewed as an integral part of silviculture.

Closing

A quarter-century has brought the Southern Region's program a long way, but the challenge to breed another generation of trees to reach higher production goals is great and exciting. The next 25 years will no doubt bring accomplishments unimaginable today.

"PAINT GUN TREE IMPROVEMENT"

THE ROLE OF GENETIC MODELS FOR SILVICULTURAL SYSTEMS

A PROPOSAL

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and

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Tree improvement deals with species that are planted in large numbers which, it is believed, justifies the increased cost of improved seed or seedlings. An immediate question that follows is: what is the value of the trees which are not subject to such improvement efforts? Does the failure or lack of efforts, to demonstrate short-term economic attractiveness imply that we should not consider improvement of such species or trees. We will discuss tree improvement in naturally regenerated stands as it relates to past and present silvicultural practices. We will outline the need and means to enhance knowledge on the impact of natural regeneration on the genetic quality of populations.

THE SITUATION

We have inherited our forest resource which provides many benefits; timber for our homes, fiber for paper, habitat for wildlife, and the sheer beauty of being a forest, just to name a few. As managers of the National Forests, we have an obligation to use, improve, and perpetuate this resource for future generations. We have to identify and correct poor practices of the past and present, and develop improved practices for the future. A lack of resolution to improve this resource is a decision in itself and will result in practices which could seriously jeopardize the future genetic resource.

In 1984, 142 thousand and 38 thousand acres were naturally regenerated in the Nations National Forest and Region Nine, respectively (USFS, 1985). On other non-federal lands in the northeast natural regeneration is and probably will continue to be the primary method of regeneration (Johnson, 1984). The large magnitude of natural regeneration suggests that the concern is more than just a matter of our own moral obligation to future generations. The cost of not knowing the impact of natural regeneration could be much more immediate and profound than our perception allows us to appreciate. Therefore, tree improvement has a critical role in natural regeneration.

Current tree improvement activity in natural regeneration is limited to general statements referring to the undesirable effects of dysgenic practices. Johnson, 1984, stated that a forest can be degraded by dysgenic practice such as high-grading, diameter-limited cutting, etc. Dysgenic selection will result when the best trees are harvested leaving the poorer trees to produce the next generation, (Zobel and Talbert, 1984). Although many such statements on the effects of dysgenic practice have been available for decades (Lindquist, 1948; Larsen, 1956) they have not made a significant impact on forestry practices. The avoidance of dysgenic practices does not necessarily imply eugenics. Eugenic practices may not always be in harmony with economic, ecological, or aesthetic requirements imposed by the society. The most important reason dysgenic practices continue is the lack of attention paid by researchers and managers. Past forest genetics research singularly focused on breeding problems in artificially regenerated populations. Critical natural regeneration management and research problems have not yet been defined or classified. Consequently, we know little about the impact of our current harvesting and natural regeneration practices. For example, will an extremely poor cull tree left for seed production provide a population that can be improved by subsequent silvicultural practices?

Suppose a quality criterion of a natural stand is distributed in a manner shown in Figure 1. We need to know which way the mean will shift in the next generation as a result of our silvicultural practices. Furthermore, we need to explicitly define the improvement criteria and determine how they relate to the future societal value system. We as silviculturists and geneticists must move beyond the "gut feeling" that certain practices are poor from an economical or genetic point of view toward positive efforts to improve naturally regenerated stands.

AVAILABLE INFORMATION

To define and classify natural regeneration management and research problems we need to gather and assimilate available information on forest genetics and silviculture. Over the years many silvicultural research efforts have addressed a variety of areas. The silvicultural research efforts, however, gave only minor consideration on the genetic aspects of the problems. Conversely, research in tree improvement and genetics ignored silviculture in natural populations.

Despite such lack of coordination, much information on silviculture and forest genetics is available and, if assembled into a coordinated effort, could readily begin to provide means of defining and classifying management and research problems, and generating necessary management prescriptions.

There has also been a similar effort in the area of tree improvement and genetics. These efforts have only involved the silvicultural aspects to a minor degree.

THE PROPOSAL

To resolve questions on the effects of past and present natural regeneration practices, the talents and data of many people must be assembled. This "team" would consist of researchers and practitioners in genetics and silviculture, economics, ecology, computer modelers (including growth modelers), and other fields as needed.

The assembly of a group and existing data in itself will not provide all necessary information for immediate management decisions. There will be gaps in the information. The group will depend on short-term studies to generate firsthand knowledge. Subsequently, it will design and execute long-term research and develop strategies for improving the knowledge necessary for natural resource management.

The approach to accomplish this mission is diagrammed in Figure 2. It simply shows that the strategy lies within the dynamic sphere of the resource and its use. The group, as described above, uses existing information and technology to generate immediate prescriptions for management. The data from this research effort, however, flows back into the system. As this process goes on, output as management tools is produced to give the land manager the means to enhance the resource and its products.

The effort would be aimed at developing the hardware and software to accommodate all aspects of data that exists, and to accommodate new data as it is produced, thus constantly upgrading the reliability of the management tools for the on-the-ground forester.

One could certainly ask; can this be done in today's climate. It is certainly possible. The personnel or organization that can perform the job are not lacking. It will certainly require a dedicated coordinator who will insure that the commitment of all related research and practical programs are geared to a central objective. However, the general perception on natural regeneration must be changed. Natural regeneration does not mean foresters have no role in the process. The harvesting is initiated by foresters, and they cannot expect nature to mend all the problems caused by them, while continuously producing abundant quality resources for future generations.

RESULTS

As this effort unfolds we can expect the following results:

1. A basic strategy and methodology to accomplish the objectives for any area and forest management situation.
2. Immediate management tools that the practicing land manager can use.
3. A frame work that will provide for long-term data input and refinement of management tools.
4. The bases for future research which will improve management tools and increase confidence using firsthand information.
5. Pedagogic tools, including training video units that illustrate and explain genetic principles to be considered in applying silvicultural practices to promote improved natural regeneration stands.

CONCLUSION AND RECOMMENDATIONS

It is our belief that the implementation of this approach to tree improvement and silvicultural research and practice can provide many practical applications while enhancing our genetic resource for all people. The management tools can be developed to give the field forester the ability to know when a stand can be improved genetically by silvicultural treatments, when it should be terminated, and when it should be artificially replaced with genetically improved material.

It is our recommendation that this integrated approach to research and practical management be undertaken now, so that the necessary tools for management can be obtained in a timely manner. The sooner the effort is undertaken the sooner we can reap the benefits in all areas of our natural resource now and in the future.

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Figure 1 - Genetic quality distribution in a typical stand.

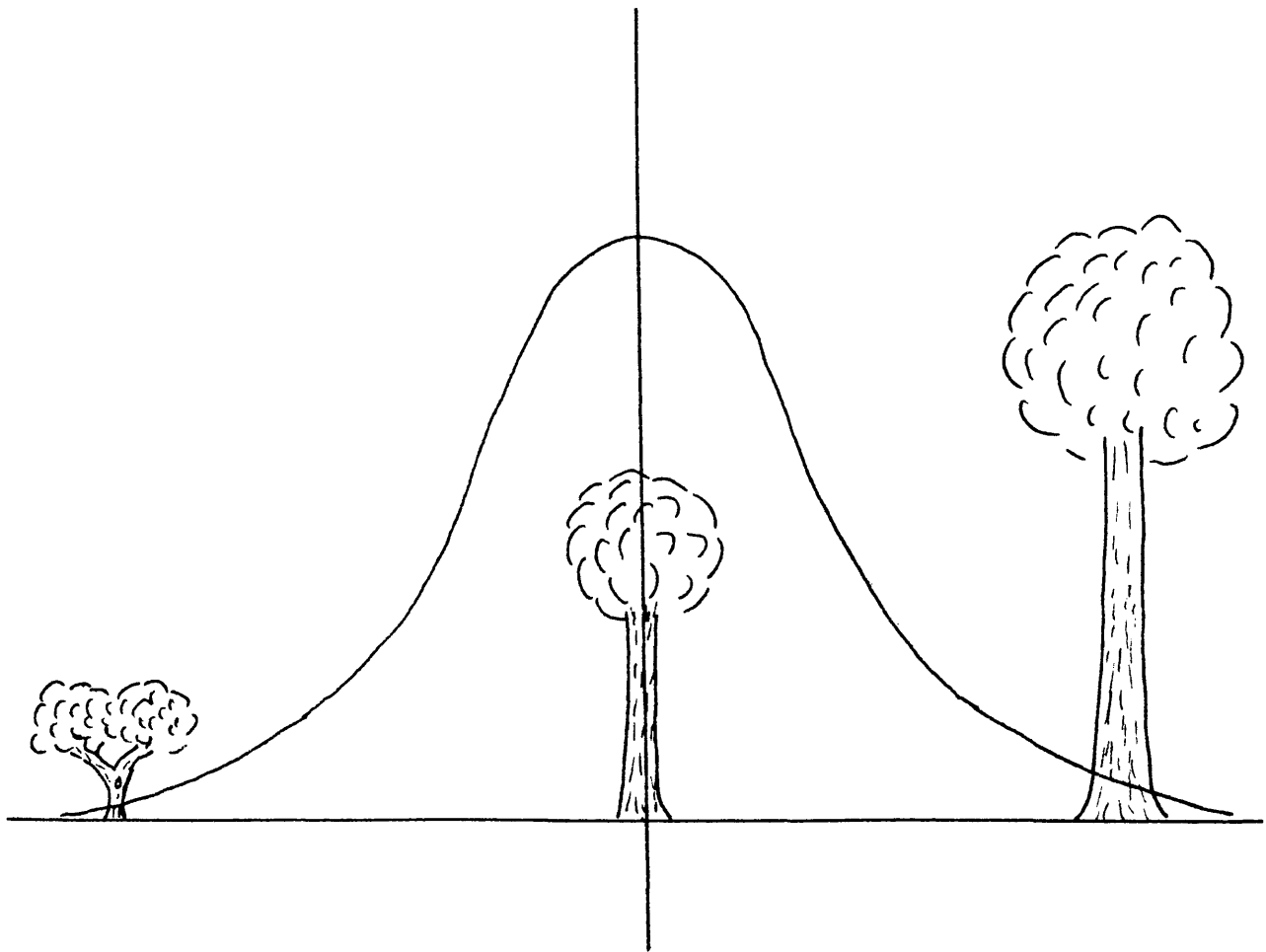


Figure 2 - The approach for Incorporating tree Improvement in natural regeneration.

