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**Northeastern Forest
Experiment Station**

General Technical Report NE-183

Quantitative Silviculture for Hardwood Forests of the Alleghenies

Dedication

This publication is dedicated to the memory of Roe S. (Sandy) Cochran, former Forest Resource Specialist with the Extension Service, The Pennsylvania State University. Sandy was a guiding light in the Allegheny Hardwood Silviculture Training Sessions on which this publication is based. He was instrumental in initiating, promoting, and conducting every session, from their inception in 1978 until his death in 1991. Sandy contributed to the technical and administrative aspects of the Training Sessions in many, many ways, but may best be remembered for his famous Wednesday night steak fry. It is to his untiring efforts to provide educational opportunities leading to good forestry practices in the Allegheny Region, his commitment to the forestry profession, and his exceptional drive and character that this publication is dedicated.

Cover Photo

The cover photograph was taken during one of the first Allegheny hardwood silviculture training sessions at the Kane Experimental Forest, sometime during 1976 or 1977. The individuals in the photograph represent the wide range of participants in the sessions, including University professors, consulting and industrial foresters, and foresters from public land management agencies. Among those in this photograph are several of the individuals who intiated the course, including Dave Marquis, at the left of the front row; Sandy Cochran, in the center in a light jacket, Ben Roach, on the right of the front row, and Rich Ernst, second from the left in the back row.

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Quantitative Silviculture for Hardwood Forests of the Alleghenies

David A. Marquis
Editor

A collection of lectures from the annual
Silviculture Training Sessions
conducted by the

USDA Forest Service
Northeastern Forest Experiment Station
Warren, Pennsylvania

and

The Pennsylvania State University
Cooperative Extension Service
University Park, Pennsylvania

Contents

Preface

Forest Service research on hardwood silviculture has been under way in northern Pennsylvania since the Kane Experimental Forest was established in 1929. Throughout the 1930's the Civilian Conservation Corp provided the manpower to initiate many long-term studies of ecology and forest growth. The experimental forest was closed during World War II, and after the war, a small silviculture research program was maintained at both the Kane Experimental Forest and the Pocono Experimental Forest. The Pocono forest was privately owned, but research was conducted there by Forest Service personnel. Many studies were maintained and remeasured by Ashbel Hough and others throughout the long period of reduced activity until the late 1960's.

In the 1960's, the program was revitalized by combining the minimal staffs of the Kane and Pocono Experimental Forests and establishing a new laboratory in Warren, Pennsylvania. The silviculture research staff at Warren was expanded in 1970, which led to a comprehensive research program on the forest management problems of the region.

The new program, combined with the reopening of the 1930 studies at Kane, provided for rapid accumulation of scientific knowledge on the ecology and management of Allegheny hardwoods. Special efforts were made to organize that knowledge into a coordinated set of management guidelines. Initial guidelines included procedures to obtain satisfactory regeneration after harvest cutting, and to control stand density and structure during thinning. These guidelines have since been expanded into a complete system of stand evaluation and silvicultural prescriptions that cover the full range of forest conditions and management alternatives in the region.

Much other research is also applicable to the Allegheny region. Oak silviculture research at the Central States Forest Experiment Station (later divided between the Northeastern and North Central Forest Experiment Stations) in Ohio, Kentucky, and other Central States has been used extensively, as has research of The Pennsylvania State University; West Virginia University; and the College of Environmental Science and Forestry, State University of New York at Syracuse. Research conducted or sponsored by the Hammermill Paper Company, Tg Forest Products (formerly Armstrong Forests), and Glatfelter Pulp Wood Company has been important also.

In 1976, the Northeastern Forest Experiment Station and the Cooperative Extension Service of The Pennsylvania State University organized several training sessions to explain and demonstrate the silvicultural prescription system to practicing foresters. Since then, two to four sessions have been held each year, with 20 to 30 participants at each session. The sessions are updated periodically as new research information becomes available. In 1985, a new classroom facility was built at Kane and in 1987 the sessions were lengthened from 3 to 4 days each. In addition, some supplementary 1-day sessions were added to provide in-depth coverage of techniques outlined in the basic sessions.

The sessions have been attended by representatives from nearly every forest management organization in the region: Allegheny National Forest, Monongahela National Forest, other Eastern Region national forests and headquarters offices, State and Private Forestry, Northeastern Forest Experiment Station, Pennsylvania Bureau of Forestry, Pennsylvania Game Commission, New York Department of Environmental Conservation, forestry faculty of eight or nine eastern universities, Hammermill Paper Co., International Paper Co., Tg Forest Products Inc., Kane Hardwoods Division of Collins Pine Co., National Fuel Gas,

Westvaco, Charmin Paper Division of Proctor and Gamble, Glatfelter Pulp Wood Co., 15 to 20 forestry consulting firms and others. Ontario Ministry of Natural Resources has participated and others have come from as far away as Chile, Italy, Holland, and New Zealand.

The sessions provide excellent feedback on research needs. Some 60 to 80 participants each year provide candid evaluations on the applicability of the research, and help to identify areas needing further study or refinement. The result is an improved research product as well as an effective technology transfer process.

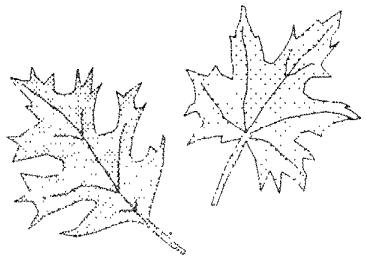
About half of the time in each training session is devoted to classroom lectures in which results of research and basic principles of silvicultural technique are presented. The remaining time is devoted to practical field exercises in which participants have an opportunity to apply the techniques under the guidance of course instructors. The sessions represent an exceptional collection of practical information on the systematic and scientific application of silviculture to a particular forest region.

Acknowledgments

Lectures presented here were prepared by scientists at the U. S. Department of Agriculture, Forest Service, Forestry Sciences Laboratory, Warren, Pennsylvania. A number of other scientists have contributed immeasurably to these lectures, or to the research leading to the silvicultural knowledge on which the guidelines are based. Some of these include: Ashbel F. Hough, Carl E. Ostrom, Thomas W. Church, Ted J. Grisez, Harold J. Huntzinger, Benjamin A. Roach, John C. Bjorkbom, Kurt W. Gottschalk, John A. Stanturf, David S. deCalesta, Coleman Holt, and Nancy G. Tilghman. For their contributions, we are especially grateful.

Ash Hough deserves special mention as a pioneer researcher who initiated -- and kept alive during nearly 30 years of official neglect -- the many long-term studies that have since helped tremendously to verify responses of forest stands to treatment. Likewise, Ben Roach deserves special mention for his early efforts in formulating systematic silvicultural prescription procedures in the Central States. His guide served as a model for the Allegheny system.

Special thanks also to the dedicated group of forest technicians of the Forestry Sciences Laboratory in Warren. Without these skilled assistants, the research leading to these guidelines could not have been completed: Virgil L. Flick, Vonley D. Brown, John A. Crossley, David L. Saf, and Harry S. Steele.



Pesticide Precautionary Statement

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife--if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

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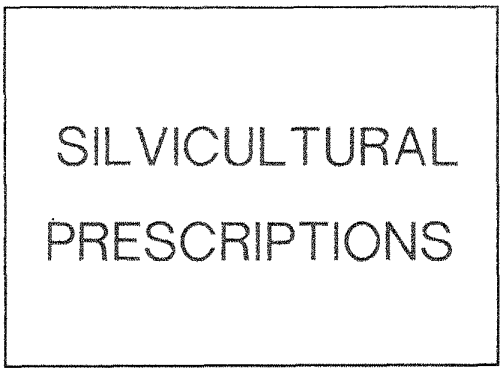
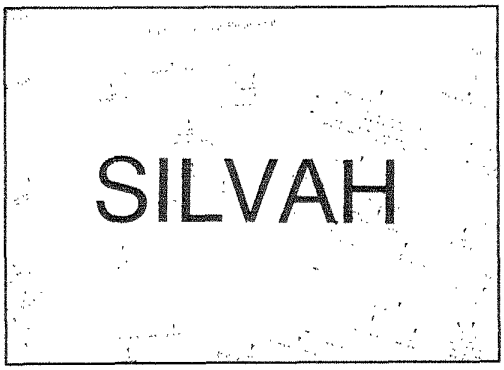
Development of a Silvicultural Prescription

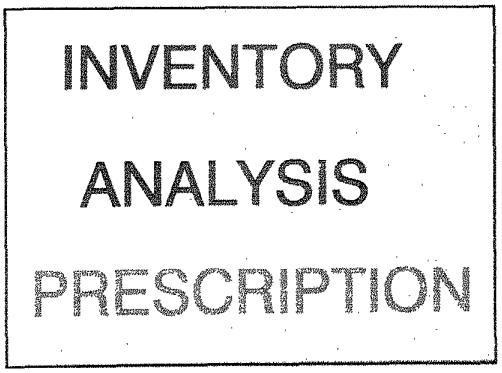
Richard L. Ernst



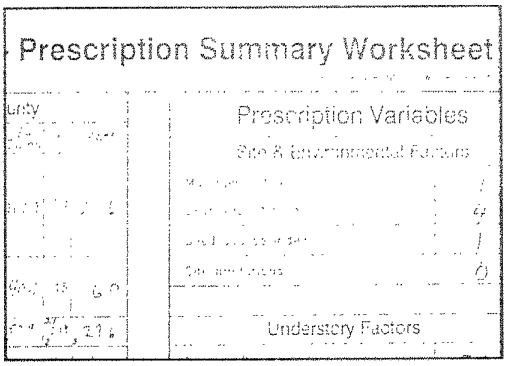
1. Once the overstory and understory conditions in a stand are known, you can decide on the best treatment in the stand. The process of deciding the best treatment based on current stand conditions is known as writing a silvicultural prescription.



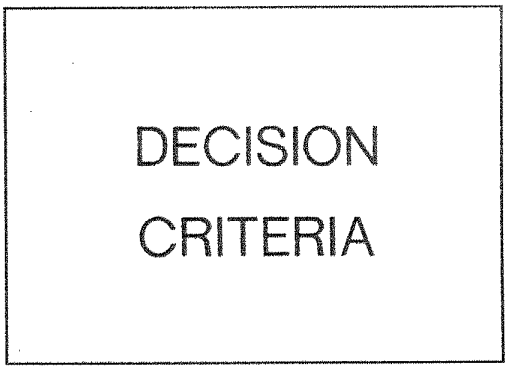
2. The SILVAH system is a set of tools or guidelines that helps the practicing forester decide on a forest stand treatment. It is fully described in "Prescribing Silvicultural Treatments in Hardwood Stands of the Alleghenies (Revised)" by Marquis, Ernst, and Stout (1992). The charts described here and reproduced in Appendix A are from that handbook.



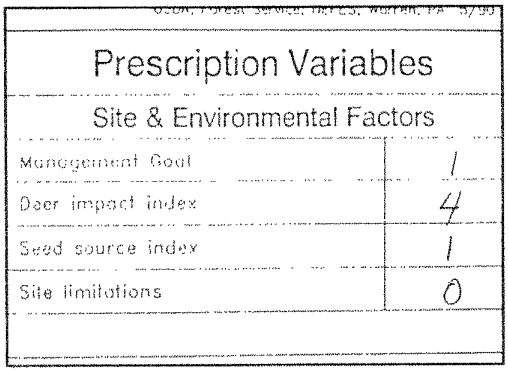
3. SILVAH has three main steps: inventory, analysis, and prescription. The inventory phase is described by Redding in the article "Stand Examination Procedures", and the analysis phase is described by Stout in the article "Stand Data Summary and Analysis". This article deals with the last of these three steps, the stand prescription process.



4. All the information needed to write a prescription is obtained during stand inventory and analysis, and (if done without a computer) is recorded on the Prescription Summary Worksheet (Appendix B).



5. The decision criteria summarized on the Prescription Summary Worksheet can be placed conveniently into three groups.

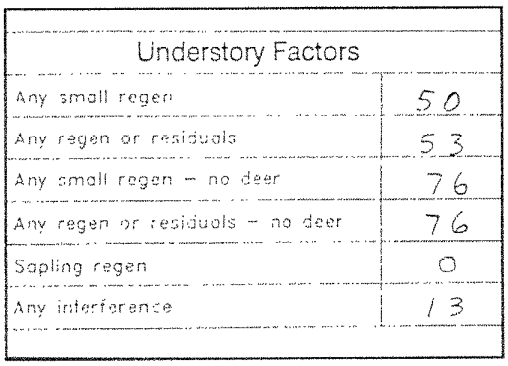


Prescription Variables

Site & Environmental Factors

Management Goal	1
Deer impact index	4
Seed source index	1
Site limitations	0

6. The first group of factors includes the site conditions and management objective. These factors may place some restrictions on the types of cutting that are appropriate. For example, the landowner may wish to avoid particular types of cutting for aesthetic reasons, or a large deer herd or poor soil drainage may make regeneration difficult.



Understory Factors

Any small regen	50
Any regen or residuals	53
Any small regen – no deer	76
Any regen or residuals – no deer	76
Sapling regen	0
Any interference	13

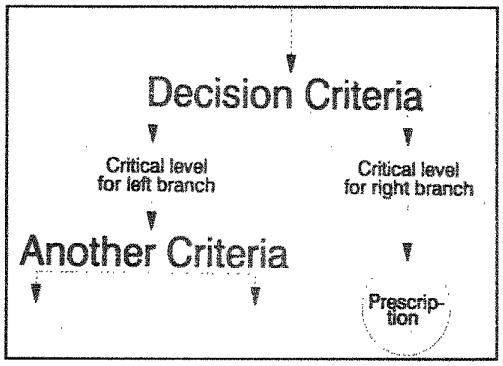
7. The next group of factors includes understory vegetation. We need to be aware of factors that both aid and hinder regeneration. For example, we need to know if there is enough advance regeneration to establish the next stand if this one is harvested, or if there are interfering plants present that can hinder establishment. These factors suggest what should be done to ensure successful regeneration.

Overstory Factors	
Sapling basal area	11
Stand [illegible] basal area	40
[illegible] stand density	97
Relative density ASS	63
Stand diameter (MD)	13.7
Merch. stand diameter (MDM)	14.5
Years to maturity	19

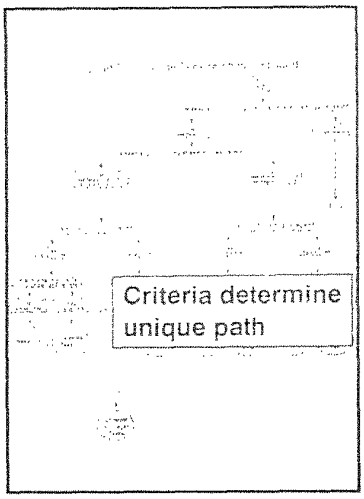
8. The last group includes the overstory conditions. These criteria provide information on stage of development of the stand, and indicate whether partial cutting or final harvesting is desirable at present.

Actual levels of decision criteria determine prescription

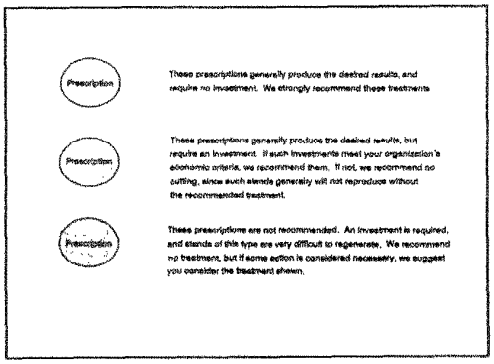
9. Different levels of decision criteria lead to different prescriptions. For example, we would not want to harvest a stand if there were not enough advance seedlings to establish a new stand. We would not want to thin in a stand that did not have enough material to support a cut without ruining the future value of the stand. By examining the stand, then looking at the levels of the decision criteria for that stand, we can decide on a course of action. Here we describe how to systematically look at these overstory and understory conditions when writing a prescription.



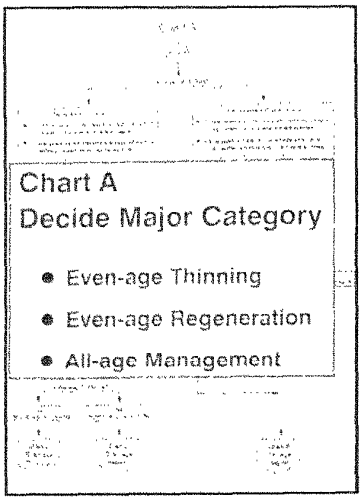
10. The prescription process involves comparing each of the decision criteria with the critical level of that factor. The decision criteria are organized along with the critical levels into decision charts where two or more paths emanate from each decision point. The criterion is printed above the line, and the path is chosen by comparing the sample stand value to the critical levels in the boxes on either path. Each path can lead to another decision criteria branch, or may terminate with a prescription indicated by an oval.



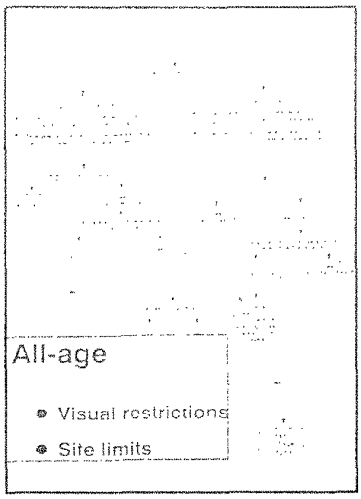
11. To determine the prescription, trace a path through the chart comparing stand values with critical levels, then follow the indicated path until you reach one of the ovals, or prescriptions.



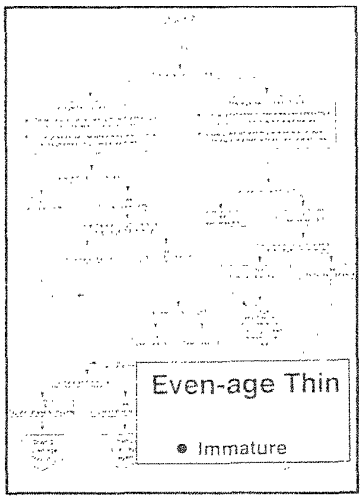
12. Note the prescription legend on chart B; it applies to all of the charts. The unshaded ovals represent prescriptions that we strongly recommend. The lightly shaded ovals represent treatments that require an investment. We believe these investments to be necessary to achieve management objectives. If the investment is considered unprofitable by your organization, we recommend that no cutting be done in these stands. The heavily shaded ovals are problem situations that require considerable investment; even with such investments, the desired results may not be obtained. We recommend postponing treatment of these stands, but list these prescriptions if you find it necessary to proceed with a treatment.



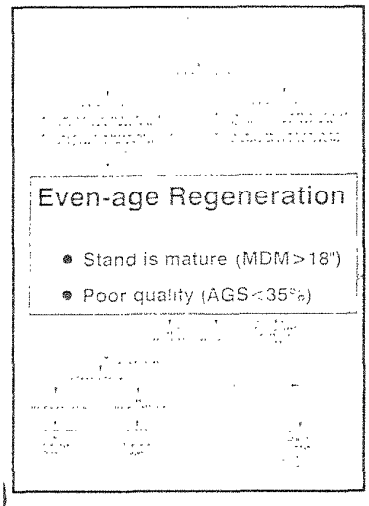
13. There are three major categories of prescriptions with a chart for each. The general categories are all-age management, even-age regeneration, and even-age thinning. Chart A is used to determine which of these major categories of prescription is appropriate, thus, it directs you to the proper prescription chart.



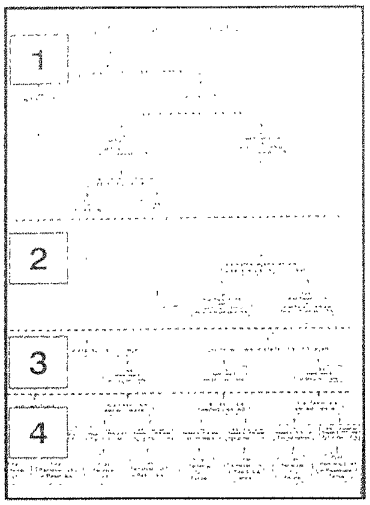
14. In Chart A, the first decision point considers owner objectives or management goals. Visual and wildlife goals may lead to all-age management. For example, if the owner desires to maintain a high forest cover at all times, then all-age management is indicated. Or, if the owner wishes to favor late successional wildlife; again, all-age management will be indicated. These goals lead to the right branch in Chart A, and then direct you to Chart B, uneven-age management. Chart B is covered in detail in the article "Principles and Practices of Uneven-age Management" by Stout.



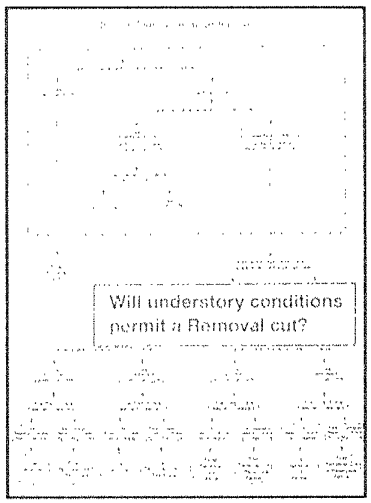
15. If, on the other hand, the management goal is for maximum timber production, a high proportion of intolerant species, a wide variety of wildlife, or wildlife species of early successional vegetation, then an even-age management regime would best meet those objectives. These goals will lead to the left branch in Chart A. Under even-age management there are two major types of prescriptions, depending upon stand maturity. If the stand is immature an intermediate thinning (Chart E) may be appropriate to provide intermediate yield and increase the growth rate on the larger, better trees in the stand. Thinning prescriptions are covered in detail in the "Thinning Principles and Practices" article by Marquis.



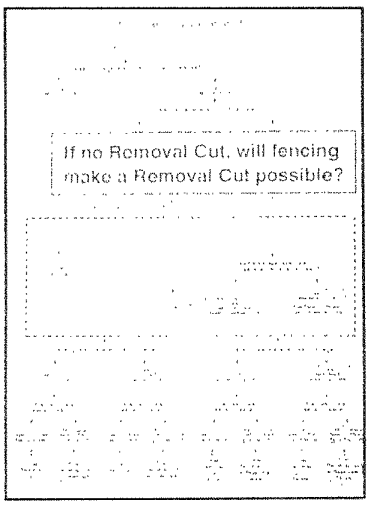
16. If the stand is mature, then harvest and regeneration may be in order. These prescriptions are detailed in charts D and E. We use chart D to illustrate the process of determining a prescription.



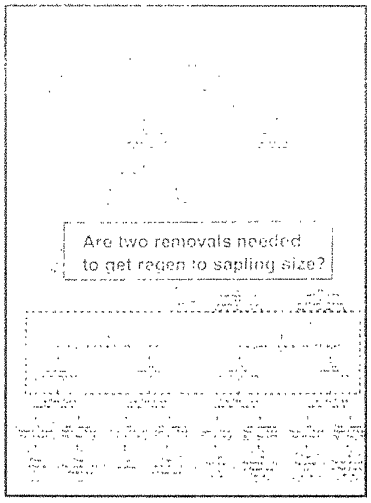
17. We can subdivide chart D into zones that deal with different aspects of determining a regeneration/harvest prescription.



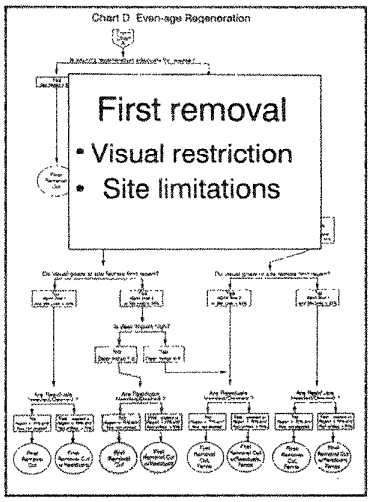
18. In zone 1, consider advance regeneration to determine if a removal cut is feasible. There must be established regeneration without a severe problem of competing vegetation.



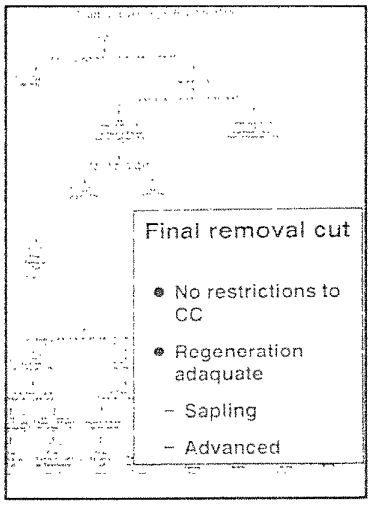
19. In zone 2, if a removal cut is not feasible with current conditions, consider whether it might be if deer browsing was eliminated by fencing the stand.



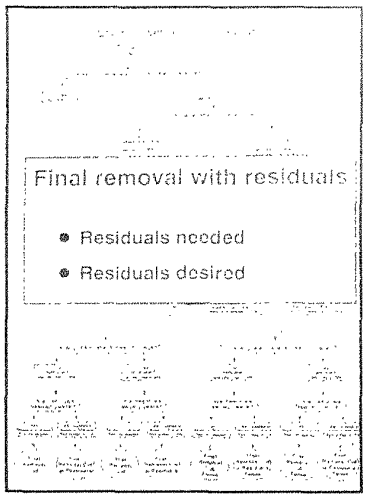
20. In zone 3, if a removal cut is appropriate, consider the need to make the removal over an extended period to bring the advance seedlings to sapling size. Large regeneration may be desirable because of visual objectives or site limitations.



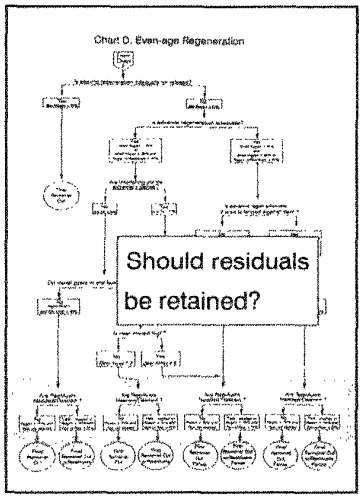
21. And finally, in zone 4, consider retention of residuals as part of the harvest, either out of necessity, or because they are desirable. Reconsider deer impact in this zone, too.



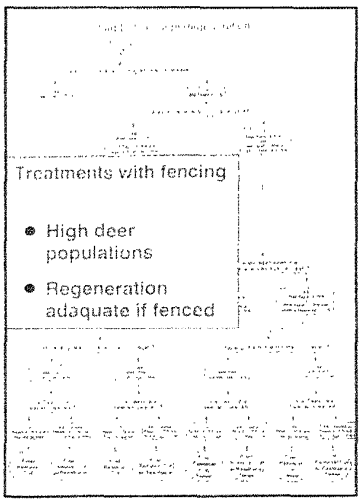
22. Keeping these general zones in mind, look at the individual prescriptions in chart D. Notice that all of the prescriptions deal with removal cuts. The final removal cut, or clearcut is appropriate if adequate sapling regeneration is already present, or advance regeneration is adequate, and there are few interfering plants and few visual or site limitations.



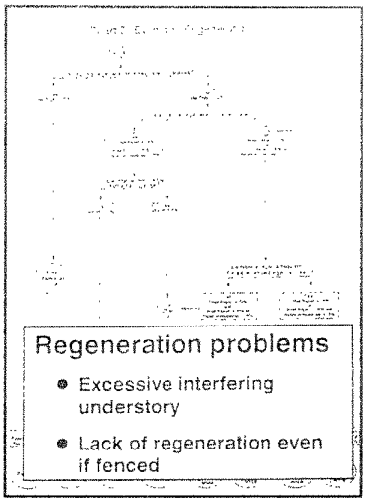
23. Notice that although there are eight prescriptions on the chart, they represent four pairs of treatments, one with and one without residuals being retained. Residuals are retained if needed to have sufficient numbers of plots stocked, or if your organization's policy required retaining tolerant species in these stands.



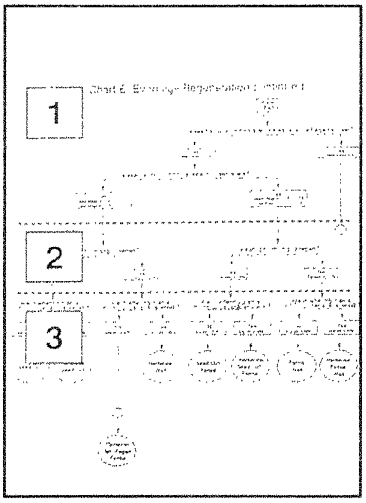
24. Visual restrictions or site limitations would lead to a similar pair of harvest prescriptions, but done over two cuts rather than one. The first removal cut allows the advance regeneration to grow to sapling size before the final removal cut, ameliorating the harsh look of a clearcut for visually sensitive areas, or ensuring establishment of vigorous saplings for either poorly drained or rocky sites. Thus, the prescription now is a first removal cut, rather than final removal. As before, the first harvest may include retention of residuals if they are needed or desired. A first removal cut is usually part of a three-cut shelterwood sequence where the seed cut was made previously, and the advance regeneration is already established. If deer impact is high, fencing will be part of this prescription.



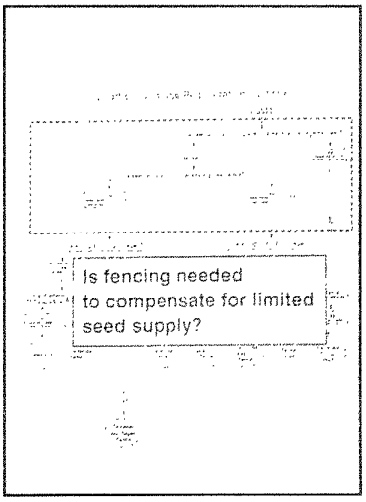
25. Another set of four prescriptions similar to the two final removals, and two first removals just discussed would be obtained if neither sapling regen nor advance regen were adequate at the existing deer level but were adequate at low deer. This leads down the right path in chart D to four prescriptions that are identical to the four just identified with the exception of fencing. Note that the ovals containing these prescriptions are lightly shaded, which indicates an investment, and all cautions regarding these prescriptions should be considered.



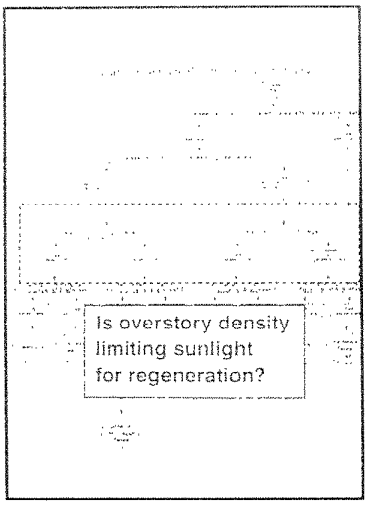
26. The final path in chart D includes stands that do not have sapling regeneration, and that have either adequate advance regeneration with excessive numbers of interfering plants or inadequate advance regeneration even if fenced to exclude deer browsing. These conditions lead to chart E.



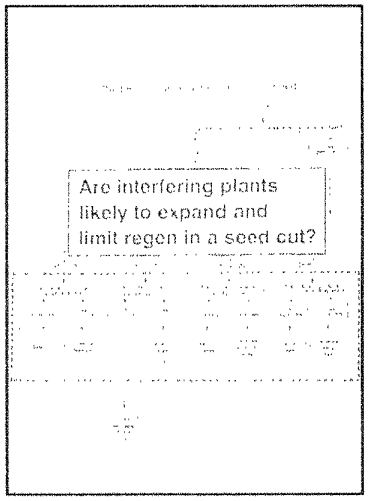
27. As with chart D, chart E can be divided into several zones.



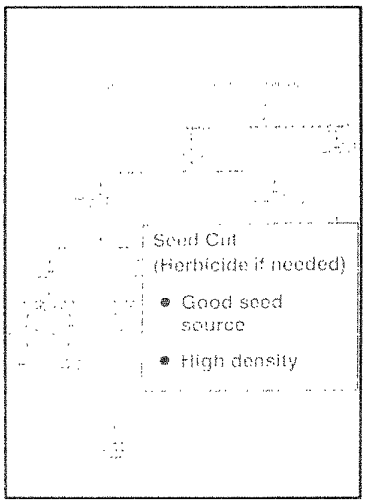
28. In zone 1, consider the need for fencing to compensate for situations where the combination of limited seed supply and high deer population make establishment of new seedlings difficult.



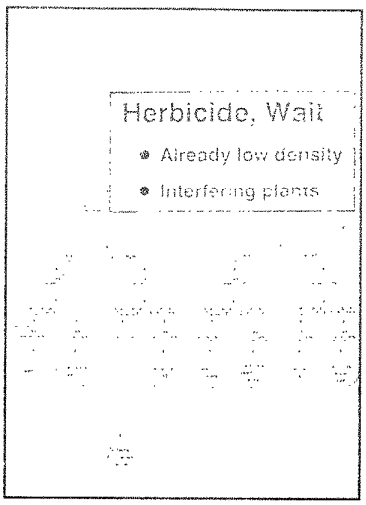
29. In zone 2, consider overstory density and whether it is dense enough to limit sunlight for seedling establishment.



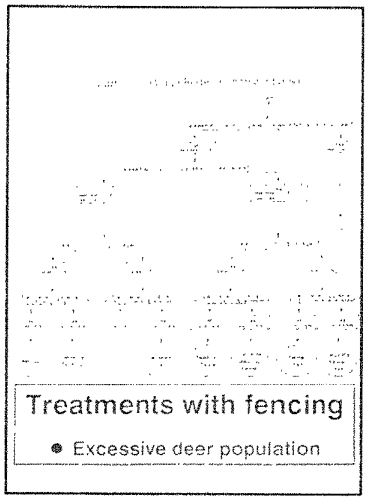
30. In zone 3, consider understory vegetation that may interfere with the establishment of advance regeneration.



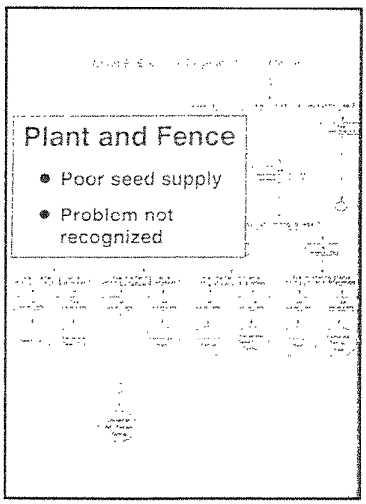
31. If sunlight is the only limiting factor, then a shelterwood sequence is appropriate to open the canopy.



32. If an interfering understory is a limiting factor, then an herbicide is appropriate to remove it. The herbicide is used in combination with a shelterwood seed cut if sunlight is also limiting, or by itself if sunlight is not limiting.

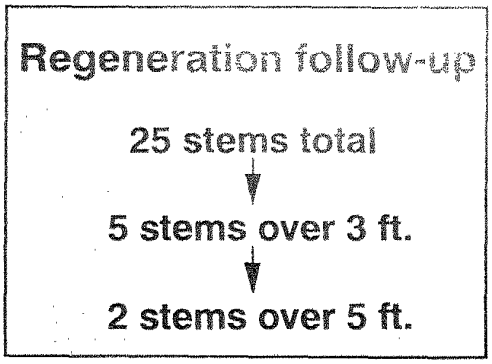


33. Another major pathway in chart E concerns stands where seed supply is limiting at current deer levels, but would not be if the area were fenced. This produces a set of prescriptions that include fencing in addition to the previous combinations of shelterwood seed cut and herbicide.

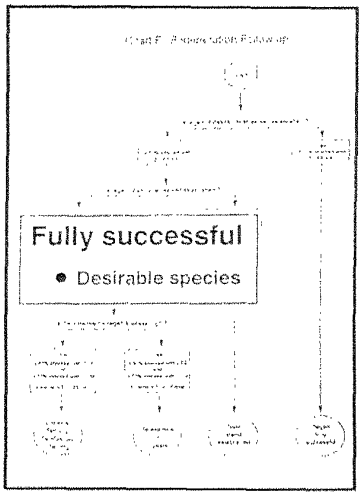


34. The final prescriptions in chart E are heavily shaded ones, one of which is shown here. The heavy shading identifies these prescriptions as ones you might consider, but ones that we do not advocate. They may or may not produce the desired result, and require a substantial investment.

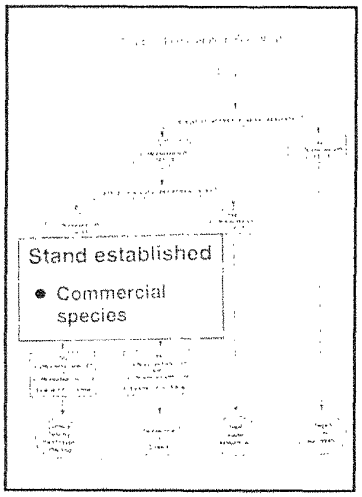
There are two paths that lead to this prescription: stands where advance regeneration and seed supply are limiting even if fenced against deer, and stands where advance regeneration is inadequate even though sunlight, interfering plants, and seed supply do not seem limiting. In both situations, there may be some factor not identified in the SILVAH system that is limiting regeneration, and an attempt should be made to identify the cause of the problem first. Consider planting and fencing as a possible solution.



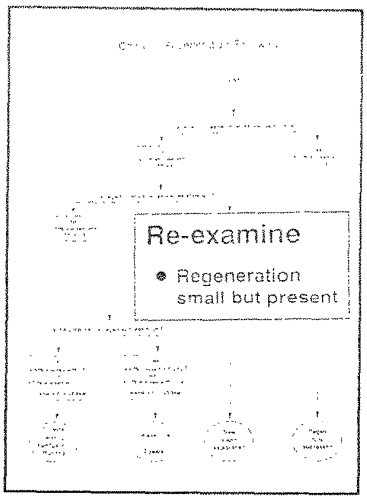
35. After a stand has had a final harvest, you should not forget it; the stand should be examined to see if it has indeed regenerated. Examinations 2 and 5 years after cutting are appropriate. Three criteria are evaluated on the 6-foot radius plots: 25 stems total, 5 stems over 3 feet, and 2 stems over 5 feet. Normally, stands start with large numbers of seedlings, and as they grow, the seedlings grow taller and number of seedlings decreases.



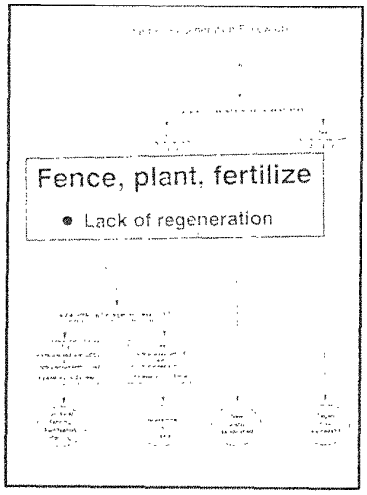
36. If the stand regenerates satisfactorily, it will take 5 to 10 years before 70 percent of the plots have two stems over 5 feet -- the measure we use to judge the regeneration complete. When that regeneration is of desirable species, then the regeneration can be considered fully successfully.



37. When 70 percent of the plots have two stems over 5 feet, but these are of other than the desired species, regeneration is complete but less than fully successful.



38. Before regeneration exceeds 5 feet, we use the average of the proportion of plots with five stems over 3 feet, and the proportion of plots with 25 stems total to judge progress toward regen establishment. If this average proportion is greater than 70 percent, the stand is on its way to becoming established. All you need do is re-examine the stand in a few years to ensure that the progress continues as expected.



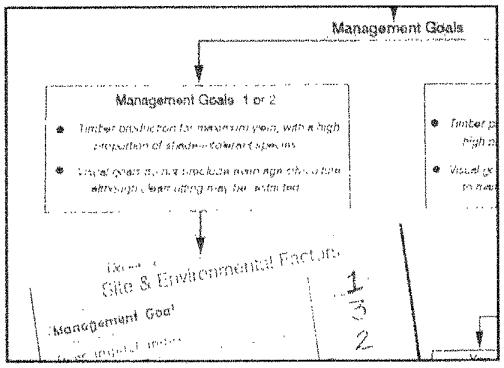
39. If the average proportion of plots stocked is low, there is high probability that regeneration will not be fully successful. Fertilization, planting, or seedling protection may all be necessary to encourage the successful regeneration of the stand.

Example Stand

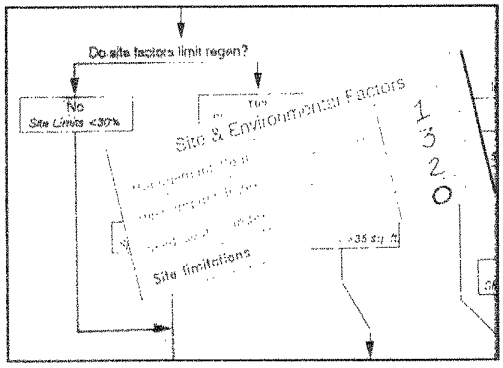
40. Now that we understand how these charts work, we can derive a prescription for a sample stand. The summary data for that stand are:

Site:	Management goal	1
	Deer impact index	3
	Seed Source Index	2
	Site limits	0
Understory:	Any regen	33
	Any w/residuals	40
	Any regen no deer	33
	Any w/residuals no deer	40
	Sapling regen	27
	Interfering plants	32
Overstory:	Sapling BA	7
	Basal area shade tolerants	58
	Relative stand density	91
	Density AGS	53
	Stand diameter	18.2
	Merchantable stand diameter	18.8
	Years to maturity	0

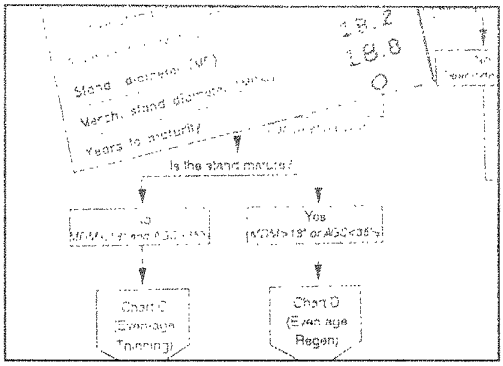
Use these values to step through the decision charts.



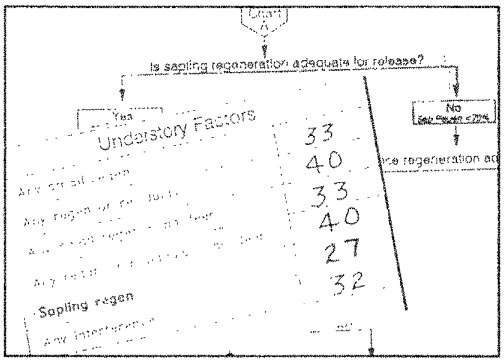
41. Chart A is used to determine which of the other charts to use (which major type of prescription). The first decision point in chart A is the management goal. A goal of 1 -- management for maximum timber yields of shade intolerant species without restrictions on clearcutting -- leads down the left branch.



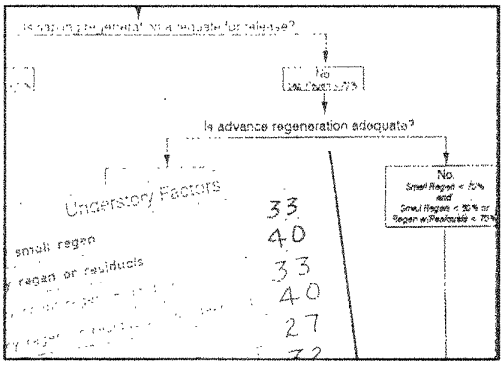
42. The left branch leads to a site limitations decision point. There are no site limitations for regeneration in this stand, which leads down the left branch again.



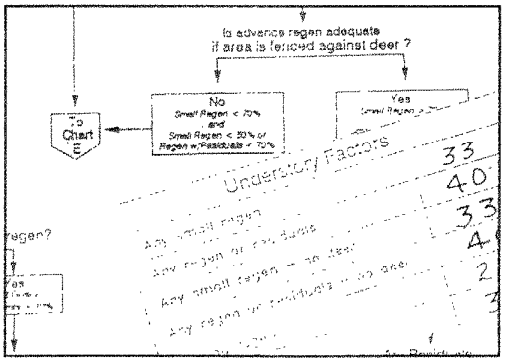
43. The next decision point concerns the stand's stage of maturity. The sample stand is mature, since the years to maturity is 0; that is, the merchantable diameter is greater than 18 inches. This leads down the right branch, which directs us to the even-age regeneration chart D.



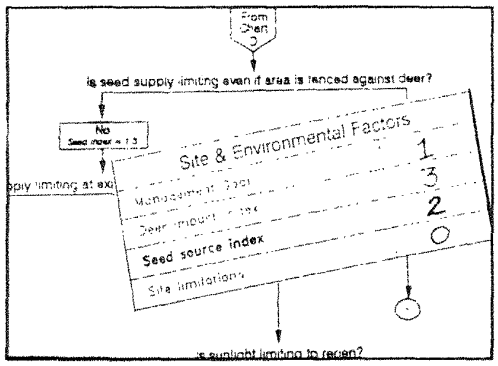
44. In chart D, the first decision point is the sapling regeneration. It is less than 70 percent in this stand, indicating that there is not a sapling understory ready for release. This leads down the right branch



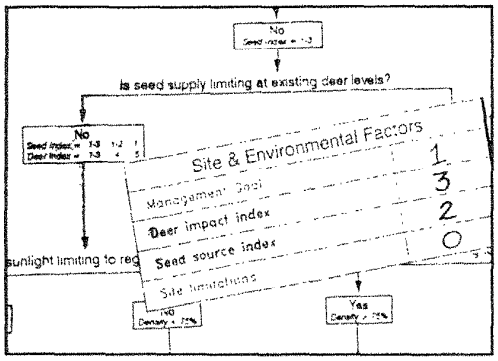
45. to a decision point on advance regeneration stocking. Only 33 percent of the plots are stocked with advance regeneration in this stand, and only 40 percent stocked if you include residuals. Since the advance seedlings are not adequate for final harvest, measures will need to be taken to increase them. This again leads down the right branch to



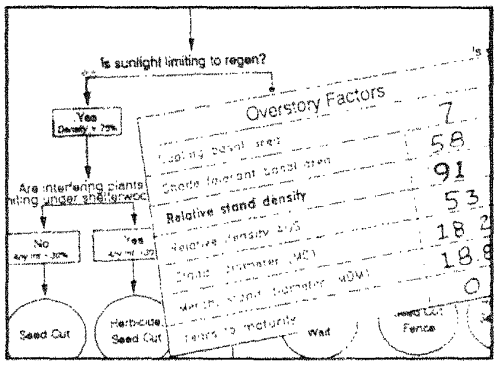
46. a decision point concerning the adequacy of advance regeneration if the stand is fenced against deer. In this stand, regeneration is not adequate even if fenced to exclude deer, which leads down the left branch to chart E.



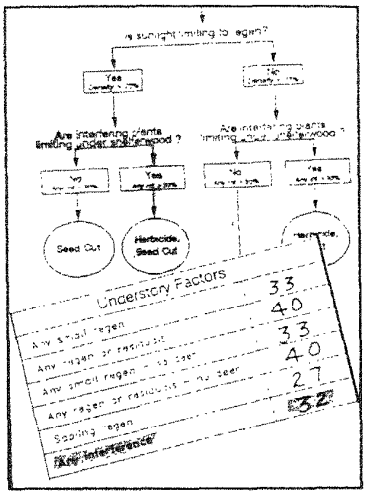
47. The first decision point in chart E concerns seed supply if the area is fenced. With a seed source index of 2, seed supply is not limiting, which leads down the left branch



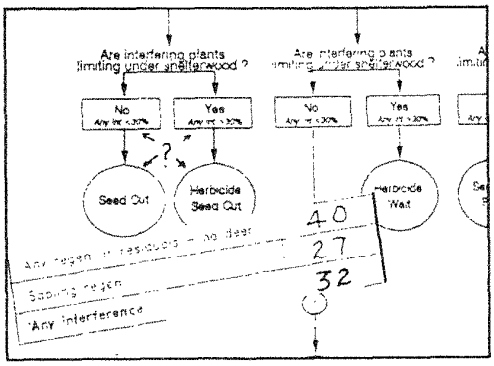
48. to a decision point concerning the combination of deer level and seed supply. In the sample stand, deer impact index is 3 and seed source index is 2. The combination should not be limiting. This leads down the left branch



49. to a decision point concerning overstory density. In our sample stand, a density greater than 75 percent, sunlight would be limiting to the establishment of new seedlings. This leads down the left branch



50. to the final decision point concerning interfering plants. In this stand, they are greater than 30 percent, so an herbicide will be needed to remove them. This leads down the right branch to a prescription of herbicide/shelterwood seed cut.

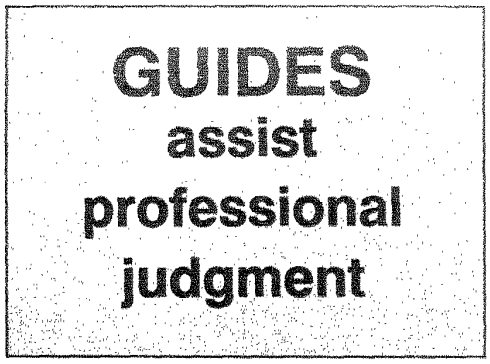


51. When a stand value falls just above or below a breaking point consider both paths. Although the breaking points are stated precisely, no such precision is implied. For example, the difference between having 29 percent and 31 percent of the understory plots stocked with fern is not discernible. Yet, these two values send you down two different paths. It is important to understand what question is being considered at each breaking point, and why it is important. This, together with a knowledge of the stand will allow you to make an informed decision. In this situation, the two paths are both shelterwoods, one with an herbicide application, the other without. You will need to consider the need for herbicide carefully in this stand, since it is near the borderline for such treatments.

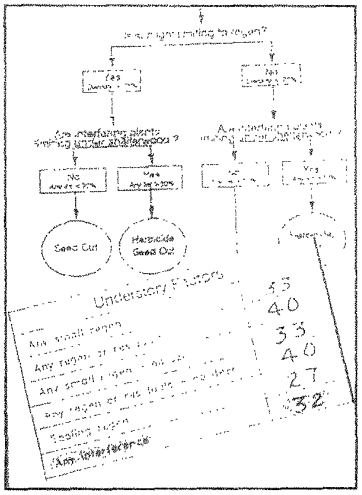
Herbicide -- Seed Cut

- Mature
- No Visual Restrictions
- No Site Limits
- Inadaquate Regen
- High Interference

52. The final prescription for this stand is an herbicide/seed cut of a shelterwood sequence. That is, this stand is mature and ready for final harvest. There are no restrictions on cutting or site limitations that would prevent a clearcutting. But, advance regeneration is inadequate to do the cutting, so we need to increase the number of advance seedlings. Furthermore, there is an abundance of interfering understory plants that would prevent establishment of the new seedlings, so we need to apply an herbicide before the shelterwood. In this way, we will decrease understory competition, and at the same time, encourage establishment of new regeneration.



53. These decision charts are guides to be used in combination with professional judgment to help you make a decision. Before using these decision charts, you must consider your objectives and the stand conditions. The guides should lead to an intuitively appropriate decision. If they do not, reconsider your path through the decision chart. Keep in mind the logic behind the flow charts; do not use or accept the recommendations without thinking. There are reasons for looking at each of those overstory and understory factors. By being aware of the stand conditions, and the "ideal" conditions necessary for establishing the next stand, you can properly treat the stand and avoid regeneration failures. Appendix C contains some data from a hypothetical stand that you may use to practice the prescription process described in this article.



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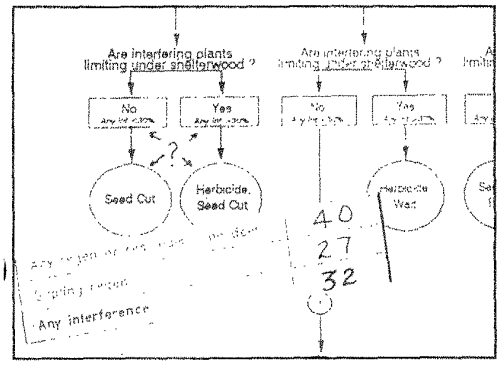

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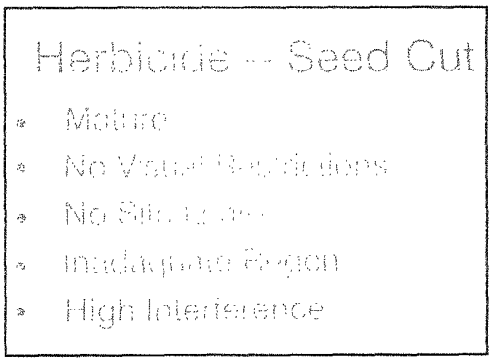
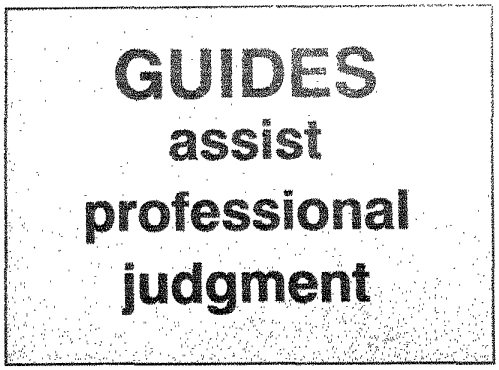


52. The final prescription for this stand is an herbicide/seed cut of a shelterwood sequence. That is, this stand is mature and ready for final harvest. There are no restrictions on cutting or site limitations that would prevent a clearcutting. But, advance regeneration is inadequate to do the cutting, so we need to increase the number of advance seedlings. Furthermore, there is an abundance of interfering understory plants that would prevent establishment of the new seedlings, so we need to apply an herbicide before the shelterwood. In this way, we will decrease understory competition, and at the same time, encourage establishment of new regeneration.



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SELECTED REFERENCES

Marquis, David A.; Ernst, Richard L.; Stout, Susan L. 1992. Prescribing silvicultural treatments in hardwood stands of the Alleghenies (Revised). Gen. Tech. Rep. NE-96. Radnor, PA: U. S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 101 p.

Chart A

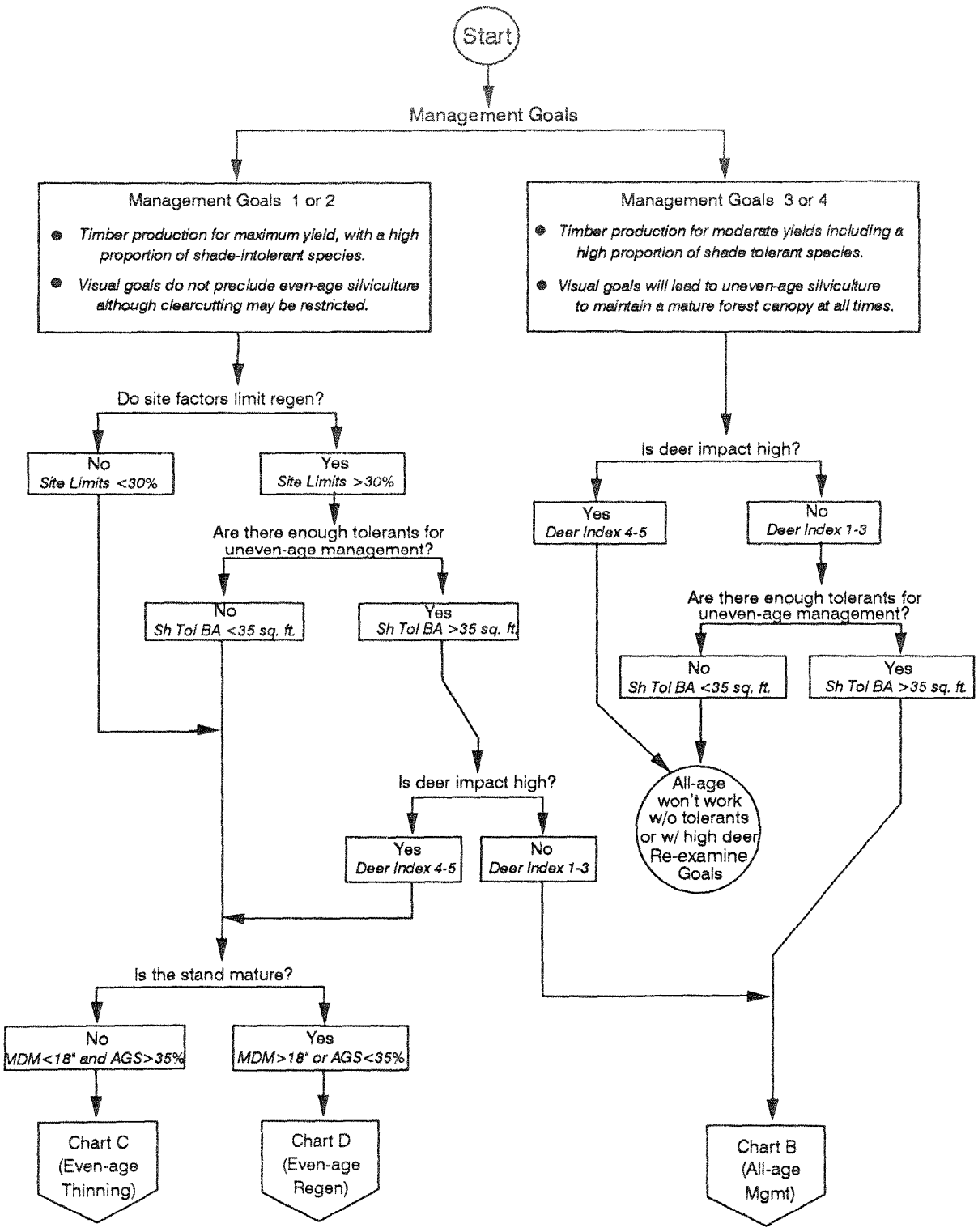
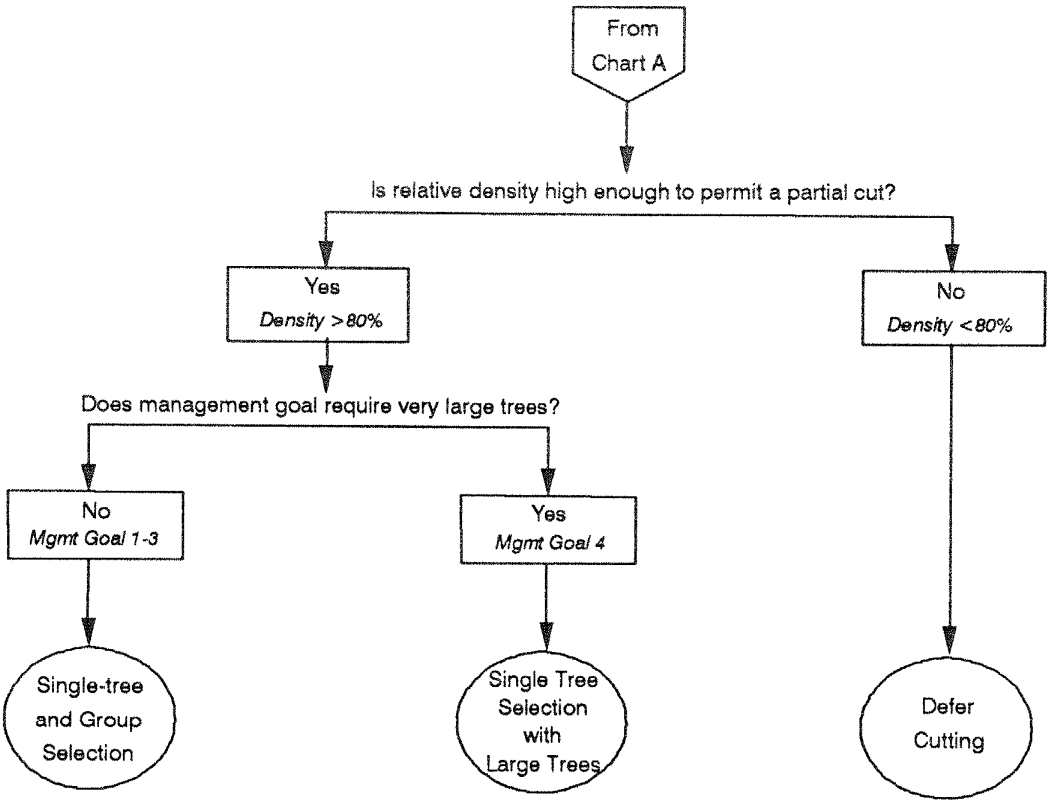

Start
Management Goals
Management Goals 1 or 2
Timber production for maximum yield, with a high proportion of shade-intolerant species.
Visual goals do not preclude even-age silviculture although clearcutting may be restricted.
Management Goals 3 or 4
Timber production for moderate yields including a high proportion of shade tolerant species.
Visual goals will leed to uneven-age silviculture to maintain a mature forest canopy at all times.
Do site factors limit regen?
No
Site Limits <30%
Yes
Site Limits >30%
Are there enough tolerants for uneven-age management?
No
Sh Tol BA <35 sq. ft.
Yes
Sh Tol BA >35 sq. ft.
Is deer impact high?
Yes
Deer Index 4-5
No
Deer Index 1-3
Is deer impact high?
Yes
Deer Index 4-5
No
Deer Index 1-3
Are there enough tolerants for uneven-age management?
No
Sh Tol BA <35 sq. ft.
Yes
Sh Tol BA >35 sq. ft.
All-age won't work w/o tolerants or w/ high deer Re-examine Goals
Is the stand mature?
No
MDM<18" and AGS>35%
Yes
MDM>18" or AGS<35%
Chart C (Even-age Thinning)
Chart D (Even-age Regen)
Chart B (All-age Mgmt)

Chart B. All-age Management



Prescription Type Legend

Prescription

These prescriptions generally produce the desired results, and require no investment. We strongly recommend these treatments.

Prescription

These prescriptions generally produce the desired results, but require an investment. If such investments meet your organization's economic criteria, we recommend them. If not, we recommend no cutting. In the case of regeneration prescriptions, stands generally will not reproduce without the recommended treatment.

Prescription

These prescriptions are not recommended. An investment is required, and stands of this type are very difficult to regenerate. We recommend no treatment, but if some action is considered necessary, we suggest you consider the treatment shown.

Chart C. Even-age Thinning

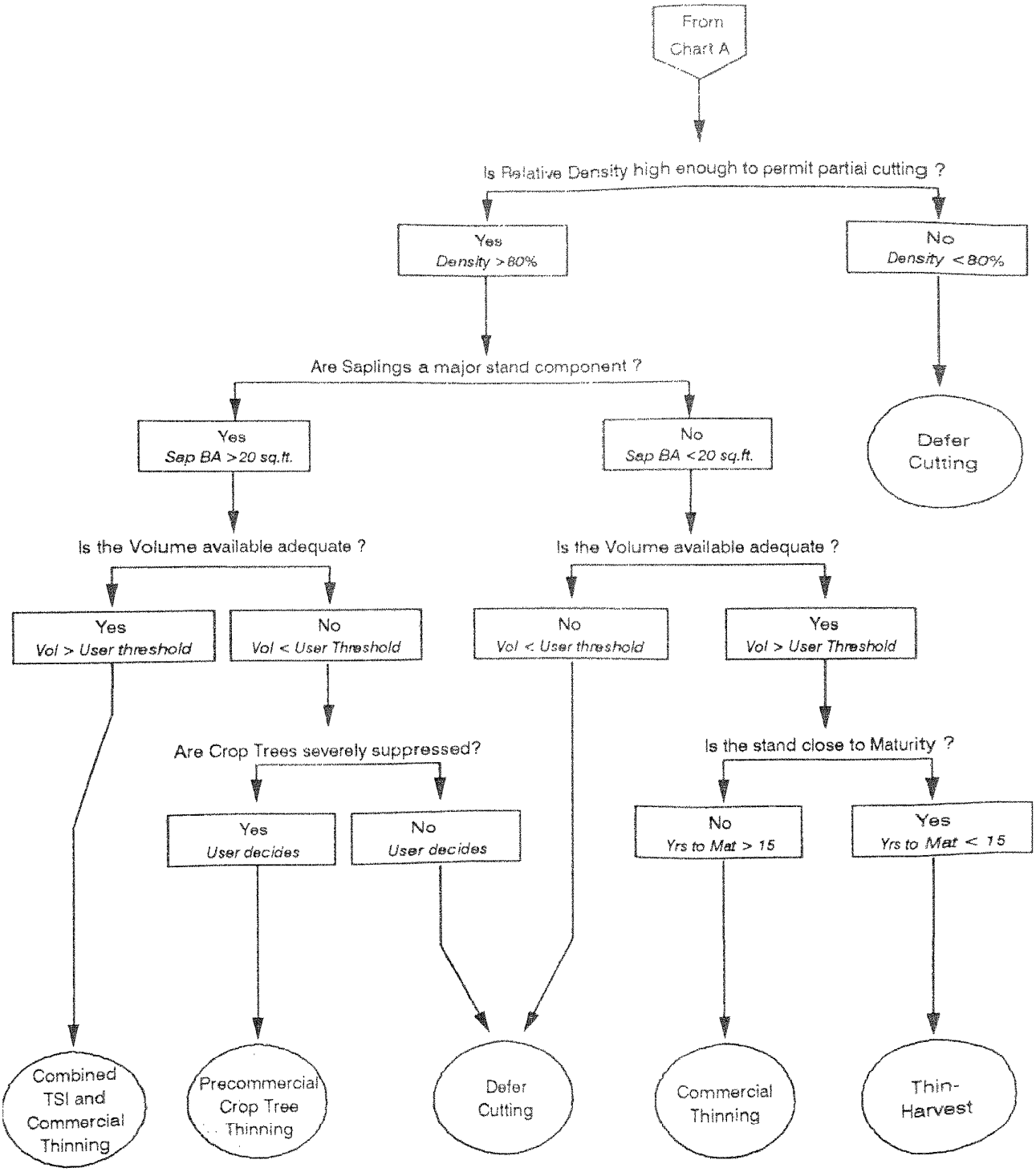


Chart D. Even-age Regeneration

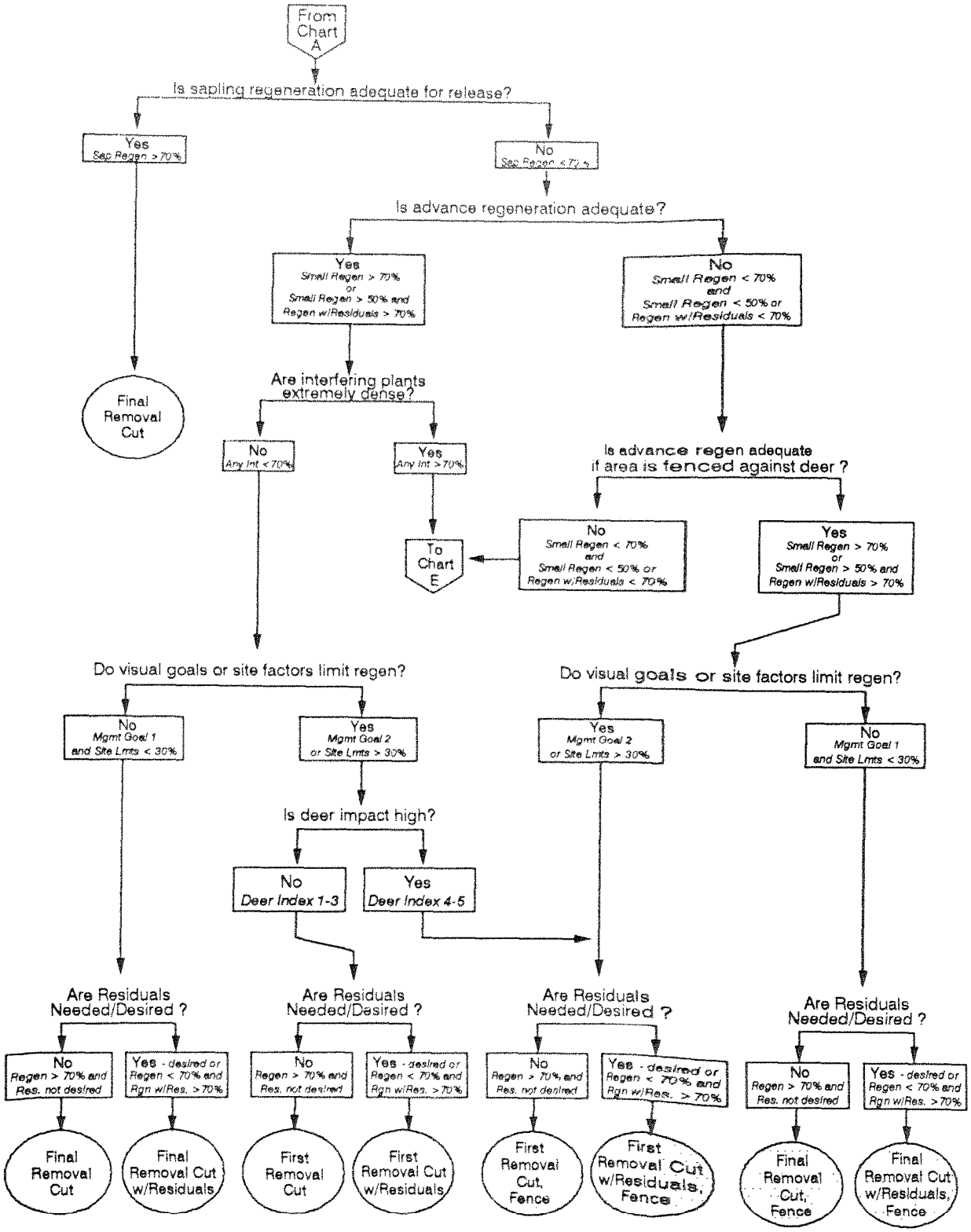


Chart E. Even-age Regeneration continued

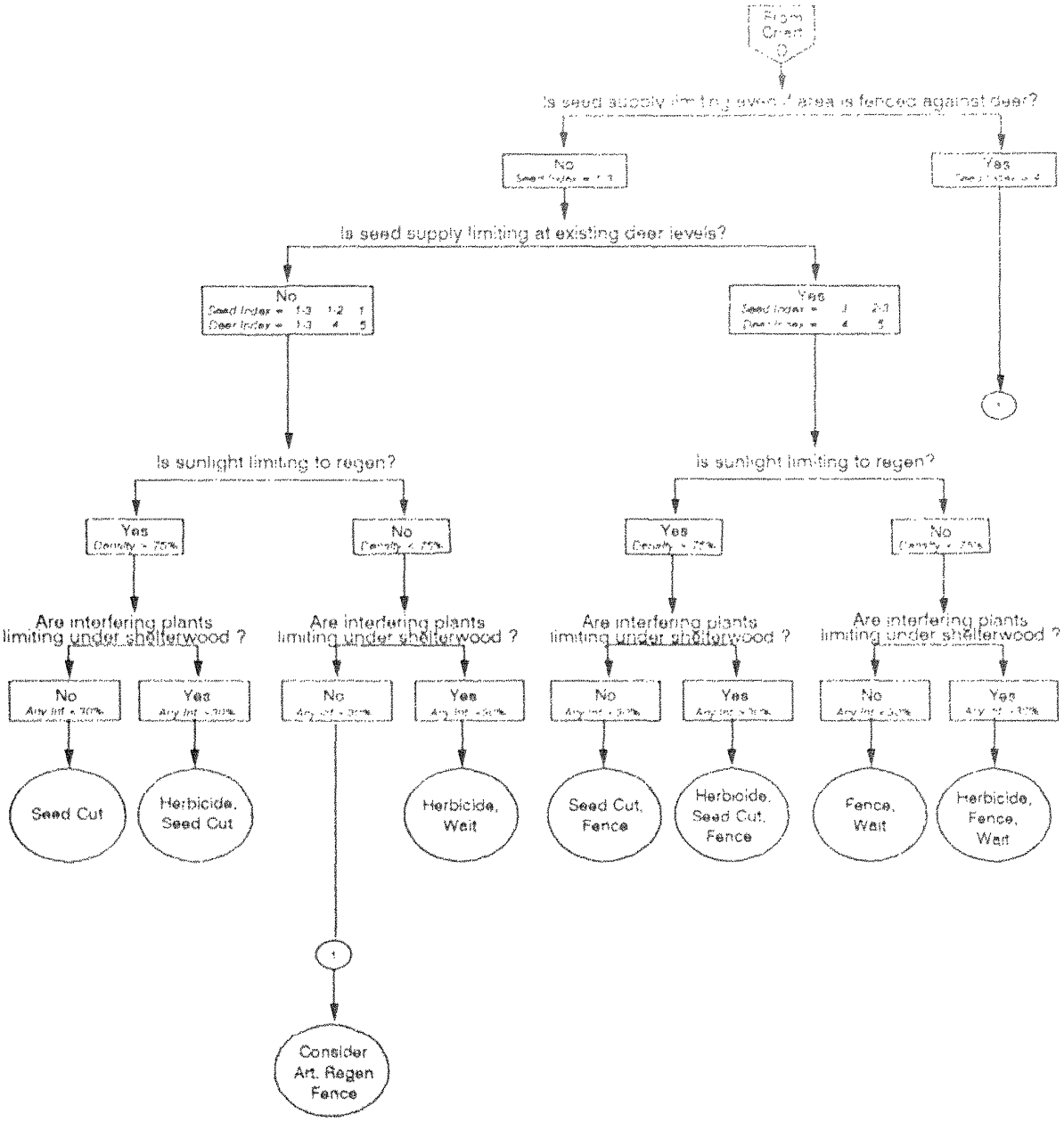
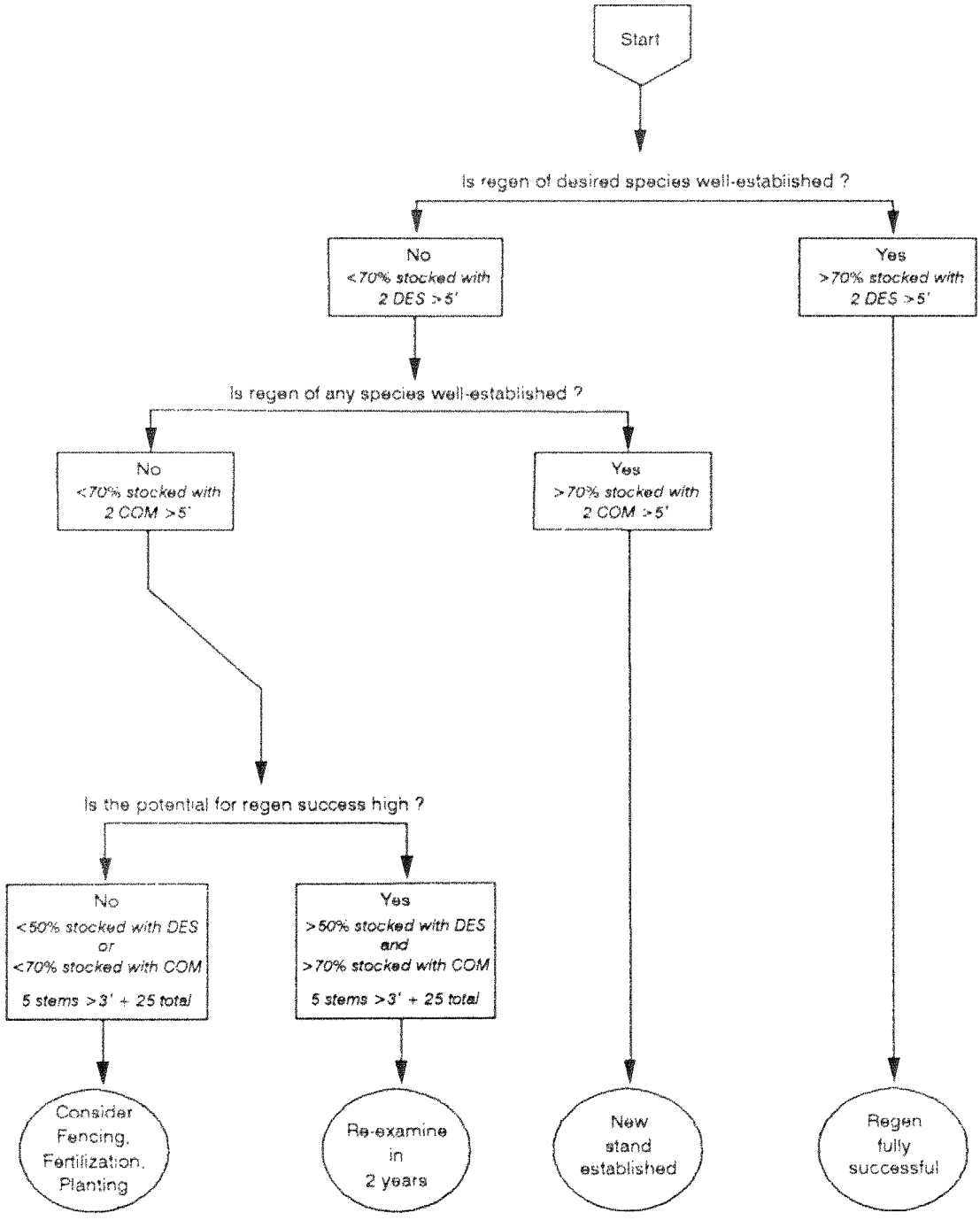


Chart F. Regeneration Follow-up



SILVAH - Prescription Summary Worksheet

Stand ID

USDA, Forest Service, NEFES, Warren, PA 5/90

Years to Maturity

Species	BA	BA Sums	f	BA*f
Black cherry White ash Yellow poplar Red maple No. red oak Eastern hemlock All others			.20	
Sugar maple American beech Striped Maple Other oaks, hick.			.15	
Total		1	3/1 2	3

Yrs. to Mat. = (18 − MDM)/growth factor (2)

Seed Source Index

Species	f	BA Poles +	M Seedlings BA*f
Black cherry	4.0		
Sugar maple good	2.4		
Sugar maple poor	1.2		
White ash	1.5		
Red maple	1.5		
Oaks	1.0		
Total			4

M Seedlings (4)	0 -32	33-83	83-134	135+
Seed Source Index	4	3	2	1

Shade Tolerant Composition

Species	Total basal area
Sugar maple	
American beech	
Eastern hemlock	
Total	

Oak Stump Sprouting BA*f

Species	Size	BA	f	Sprouting stumps
N.Red Oak	Saps		20.4	
	Poles		1.7	
	SSaw		0.4	
	MSaw		0.1	
	LSaw		0.0	
Other oaks	Saps		18.6	
	Poles		2.1	
	SSaw		0.4	
	MSaw		0.1	
	LSaw		0.0	
Total				5

Adv. Regen Adjustment	0	5	10	15	20
Stumps @ high deer (5)	0	46	97	147	198
Stumps @ low deer (5)	0	21	46	71	97

Prescription Variables

Site & Environmental Factors

Management Goal	
Deer impact index	
Seed source index	
Site limitations	

Understory Factors

Any small regen	
Any regen or residuals	
Any small regen − no deer	
Any regen or residuals − no deer	
Sapling regen	
Any interference	

Overstory Factors

Sapling basal area	
Shade tolerant basal area	
Relative stand density	
Relative density AGS	
Stand diameter (MD)	
Merch. stand diameter (MDM)	
Years to maturity	

Prescription:

APPENDIX C

This exercise is designed to reenforce the concepts used in prescription writing. Table 1 contains data from a stand of 24 acres that was subdivided into 4 subplots, A through D, of about 6 acres each (Fig. 1). The data in this table are based on an inventory from the sub-plot, but a few of the values have been changed to better illustrate some regeneration principles. Stand T is the actual data for the entire 24-acre stand.

In this exercise, use the data from each "stand" to trace the proper prescription using charts A through E in Appendix A.

As you develop the prescriptions, be sure to consider these questions:

1. Is the stand mature?
2. Does it have adequate regen for clearcutting?
3. Is shelterwood cutting needed to develop advance seedlings?
4. Is an herbicide needed to eliminate interfering understory?
5. Are there factors that will prevent shelterwood from working?
6. Is an extended harvest needed to overcome site limits or visual restrictions?

Tracing the path through the charts should result in the following prescriptions.

Stand	Prescription
A.	FINAL REMOVAL CUT. This stand is mature, management goals permit even-age management, advance regen is adequate, and interfering plants are not limiting so a final removal cut or clearcut is possible.
B.	SEED CUT (Strictly a THIN-HARVEST). This stand is within 5 years of maturity--it could be considered mature. Following the charts strictly would result in a thin-harvest prescription; recognizing the understory conditions along with the effective age, will lead to the shelterwood sequence. This is a situation where strict adherence to the guideline can be relaxed. Management goals permit even-age management, but advance regeneration is inadequate. Interfering plants should not be a problem since they occur on less than 30 percent of the plots. Seed source, deer pressure, site limits, and present stocking do not prevent shelterwood.
C.	FIRST REMOVAL CUT AND FENCE. The stand is mature and there are no restrictions to even-age management. While the regeneration is inadequate in the presence of the large deer herd, it is adequate with a low deer impact. Fencing along with a clearcut would be adequate if it were not for the site limitations. The site limitations require the overstory to be removed over an extended period, thus, this is the first removal cut of a three-cut shelterwood. If fencing is not possible, then a do-nothing prescription may be appropriate.
D.	HERBICIDE, SEED CUT. This stand is mature, not because of age, but because of lack of quality. Management goals permit even-age management. The advance regen is inadequate, and interfering plants require herbicide. Notice that site limits will require the three-cut herbicide shelterwood sequence; that is, if the seed cut is successful in establishing regeneration, then site limits will require the overstory to be removed in two cuts.
T.	HERBICIDE, SEED CUT. This stand is mature and management goals permit even-age management. The advance regen is inadequate, and interfering plants require herbicide. The seed source, deer pressure, and overstory density allow the shelterwood sequence.

Notice that the prescription for the entire 25-acre area is an herbicide-shelterwood cut, while the prescription for the individual subplots varies from clearcut to shelterwood with fencing or herbicide to do nothing. Although a few of the numbers in the data set were altered for purposes of this exercise, the actual regeneration conditions do vary within this stand. There are some wet spots that total 5 or 6 acres. A small amount of advance regeneration that exists is confined to the northern subplot, and fern, which occurs throughout the area, is heaviest in the southern subplot. It is not at all

unusual to find that understory conditions vary within a stand that is quite uniform throughout the overstory. Because of this variability, you must take twice as many understory plots .

In this particular stand, use of the overall herbicide-shelterwood cut prescription should produce satisfactory results in most of the area, but could easily be a problem in the wet spots. Five or six acres of regeneration failures in a 25-acre stand is not a very desirable result. How do you deal with these spatial variations in understory conditions within a single stand? For that matter, how do you even recognize the variation when data are only available for the entire stand?

It is a good practice to keep notes on your cruise map as the inventory is being made. When you find wet spots, islands of fern or seedlings, or other changing conditions, sketch them in as best you can as you traverse the stand. Do not hesitate to note important conditions even if they do not fall on one of your plots. The more information you have, the better. Figure 2 is an example of a working cruise map that was prepared while working through the stand.

If you have access to a computer, there are programs that can analyze your cruise data and map out areas of interest or concern. To use such programs, you need to keep track of your cruise line location and plot sequence so that you can determine X,Y coordinates for each plot. Figures 3 to 5 are examples of the output from such a program showing the location of the wet spots, the advance regen, and the fern in the stand.

Whether done by computer or via field notes on your cruising map, knowledge of the distribution of key understory parameters can be a big help in identifying the need to modify overall stand prescriptions to accommodate the variation in conditions.

In this stand, for example, there are several possible courses of action. The wet spots could be treated as inclusions, and left uncut or partially cut. Such islands of standing trees are often left intentionally in clearcuts for their visual or wildlife value--here is another reason for leaving them. They break up the appearance of the clearcut, and since the overstory has some hemlock and beech in the wet spots, they should have considerable value as mast production or winter cover habitat for wildlife.

Another option might be to harvest the entire stand and to fence the wet spots against deer browsing to ensure that regeneration will develop there.

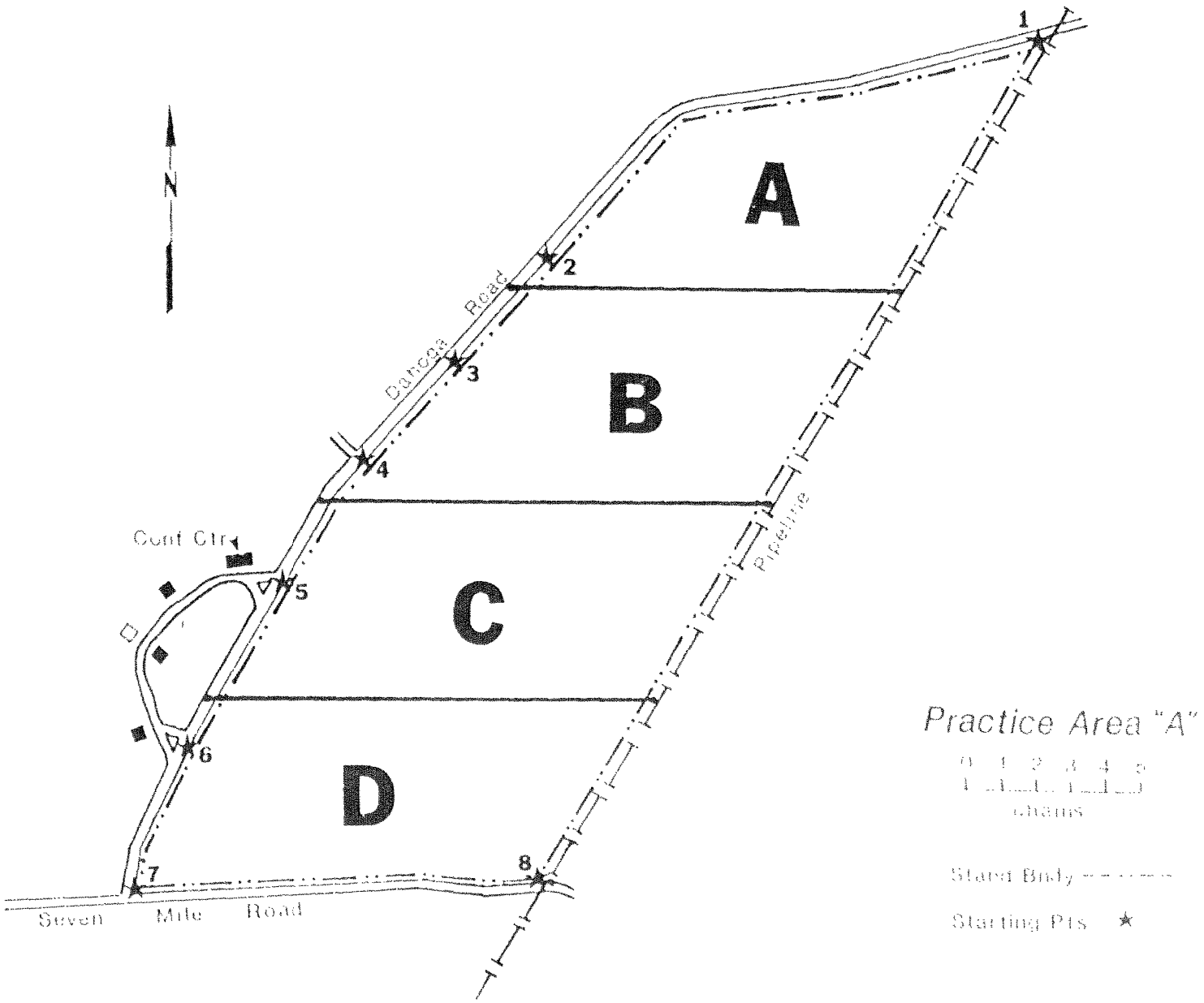
In this stand, there are interfering plants throughout, but in many stands the interfering plants are confined to one part of the stand. In such cases, there is a big savings in applying the shelterwood to the entire stand and treating with herbicide only those areas that need it. Caution must be exercised here, though, not to miss areas needing treatment in an effort to save a little money on herbicide.

In some situations, the conditions may vary so much that there is no choice but to split the stand into several smaller stands, with separate prescriptions for each. For practical reasons though, stands less than 10 acres are difficult to deal with, and it is better to look for ways to treat the area so as to increase the uniformity rather than subdividing into smaller and smaller stands.

So, considerable judgment is necessary to ensure that the overall prescription arrived at through the SILVAH guidelines makes sense in all parts of the stand. But if used systematically, those procedures provide the basis for sound decisions.

Table 1. Exercise in Silvicultural Prescription Writing

	STAND CONDITIONS				
CRITERION	A	B	C	D	T
Management Goal	1	1	1	1	1
Deer Impact Index	4	4	4	3	4
Seed Source Index	1	1	1	3	1
Site Limits	0	15	40	30	20
Any Small Regen	70	5	30	20	14
Any Small Regen or Residuals	75	5	35	20	20
Any Small Regen NO DEER	70	5	73	20	14
Any Small Regen or Residuals NO DEER	75	5	76	20	20
Sapling Regen	0	0	0	0	0
Any Interference	45	25	45	50	45
Sapling BA	12	8	7	12	9
Shade Tolerant BA	15	20	55	30	35
Relative Density	105	94	93	88	95
AGS Density	90	80	70	20	65
Stand Diameter (MD)	17.9	17.1	18.0	15.5	17.3
Merchantable Stand Diameter (MDM)	18.6	17.7	18.8	16.1	18.1
Years to Maturity	0	2	0	11	0
Volume > Threshold	Y	Y	Y	Y	Y


N
A
B
C
D
1
2
3
4
5
6
7
8
Conf Ctr
Seven Mile Road
Pipeline
Practice Area "A"
0 1 2 3 4 5
chains
Stand Bndy
Starting Pts

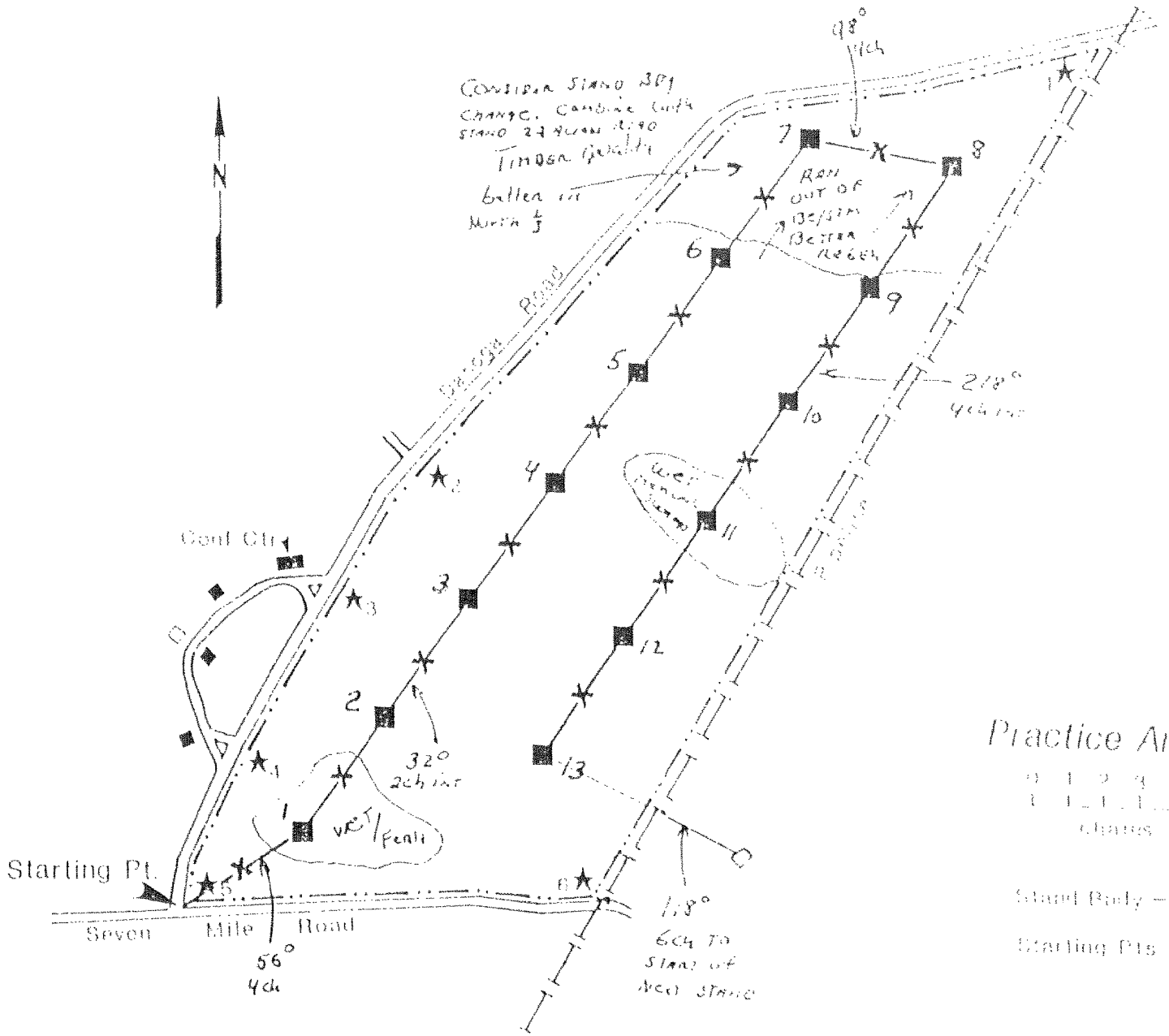

N
Starting Pt.
Seven Mile Road
Cont Ctr
Practice Area "A"
Stand Path
Starting Pts
Chains

Figure 3. -- Site Limitations for Training Area A

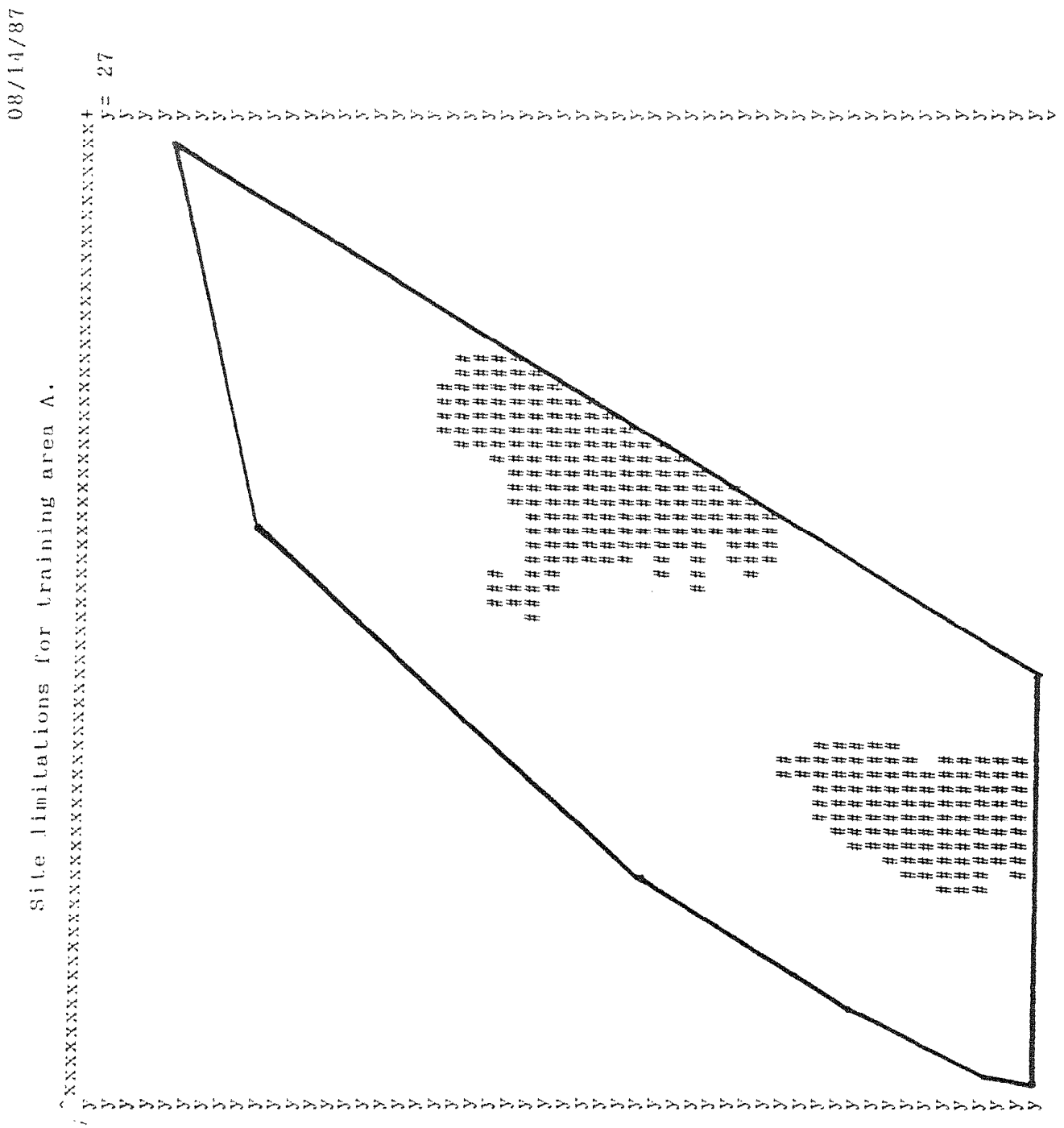
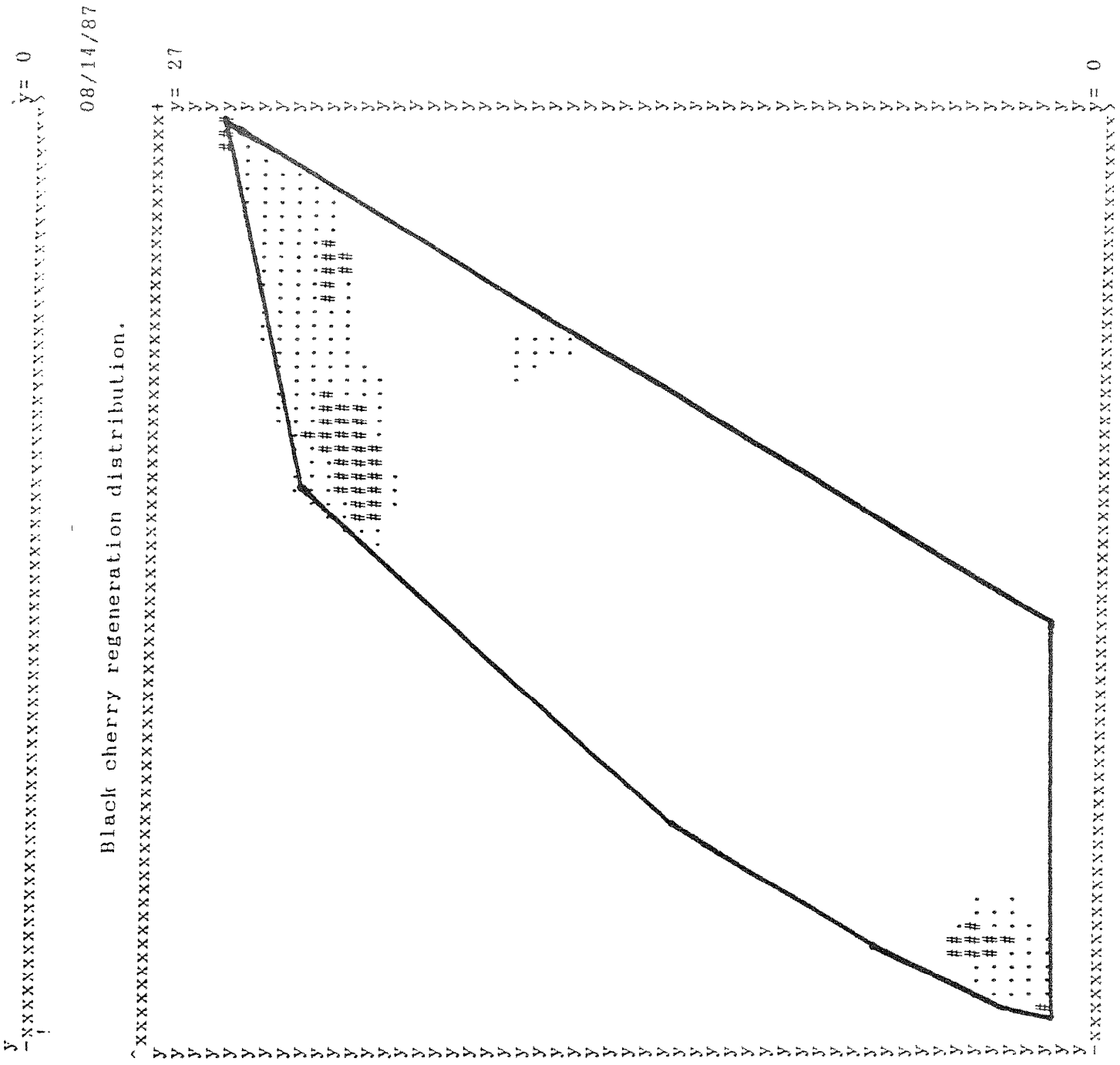
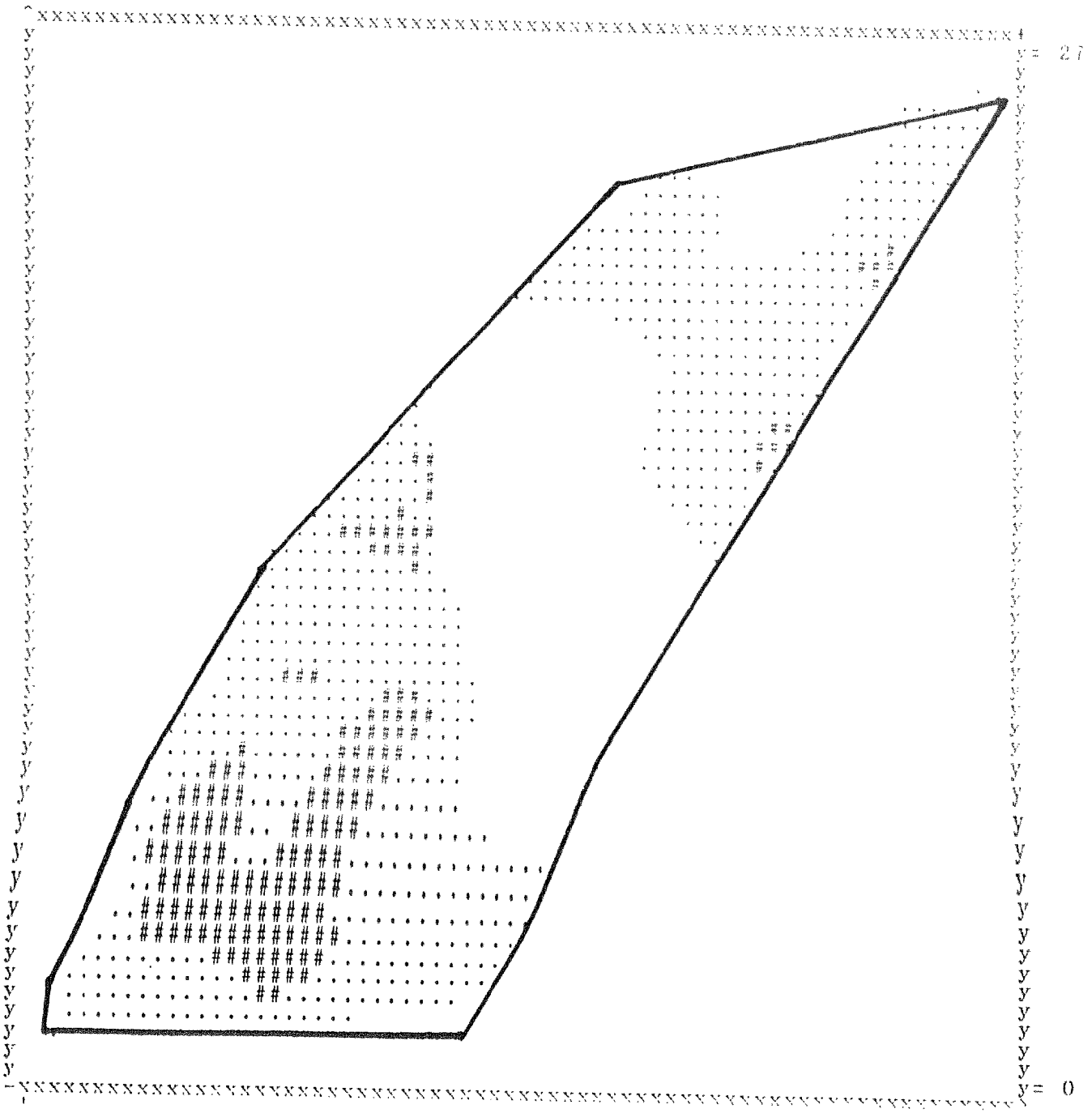


Figure 4. -- Black Cherry Regeneration Distribution for Training Area A

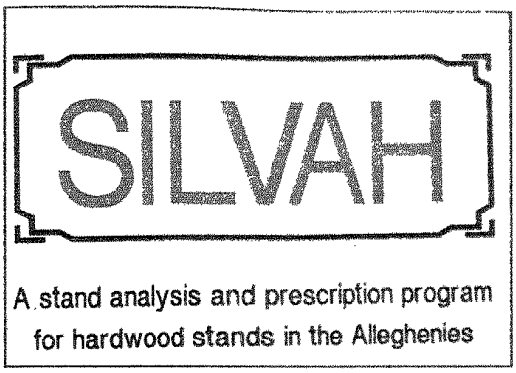


Fern distribution training area A.



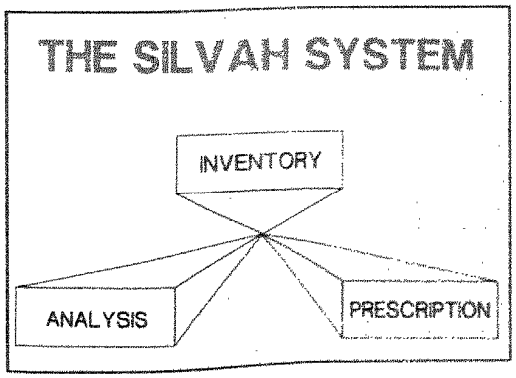
SILVAH Computer Analysis

David A. Marquis

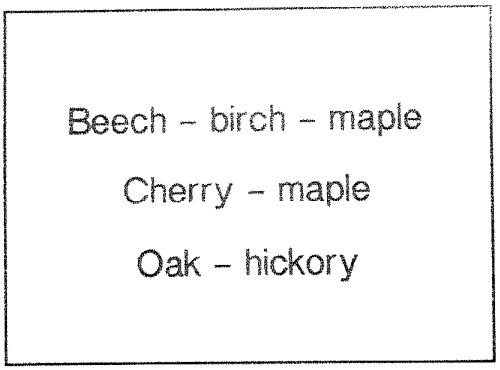


1. The SILVAH computer program integrates all of the many silvicultural guidelines that have been developed for hardwood forests of the Alleghenies into a complete stand analysis and prescription procedure.

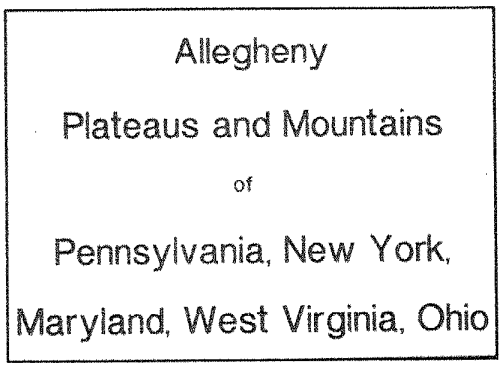
2. The acronym SILVAH stands for SILViculture of Allegheny Hardwoods.



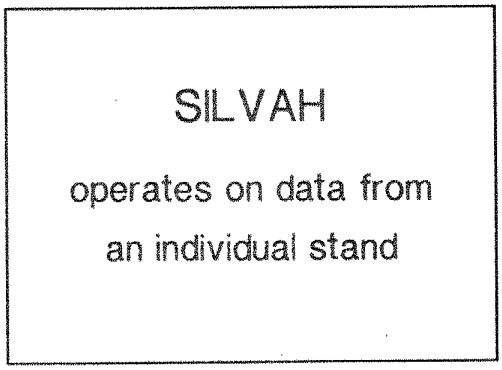
3. The SILVAH system involves an inventory of basic vegetation and site variables that is analyzed in specific ways to estimate the stand's potential for growth and regeneration. Then a prescription is determined based on critical levels of the stand variables.



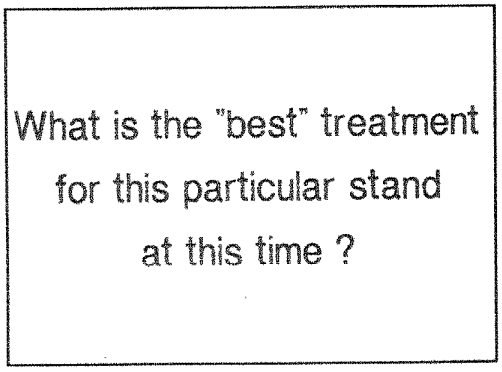
4. SILVAH is applicable to the beech-birch-maple, cherry-maple, and oak-hickory forest types



5. in the Allegheny Plateau and Allegheny Mountain sections of Pennsylvania, New York, Maryland, West Virginia, and Ohio. Parts of the program may be used outside this range, but with caution.



6. SILVAH operates on data from an individual stand



7. and is designed to answer the basic question: "What is the 'best' silvicultural treatment for this particular stand at this time?"

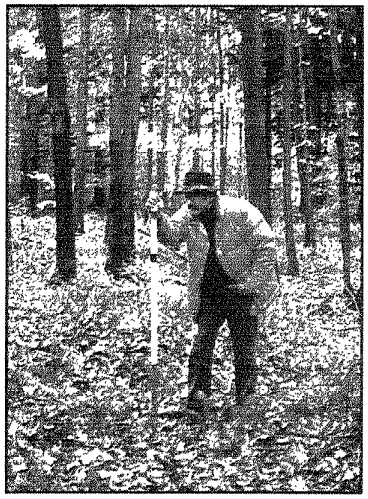
SILVAH FUNCTIONS

EXPERT SYSTEM	OTHERS
Inventory Processing	Tests of Alternative Cuts
Stand Analysis	Growth Projection
Prescription	Report Writing
	Data Base Generation

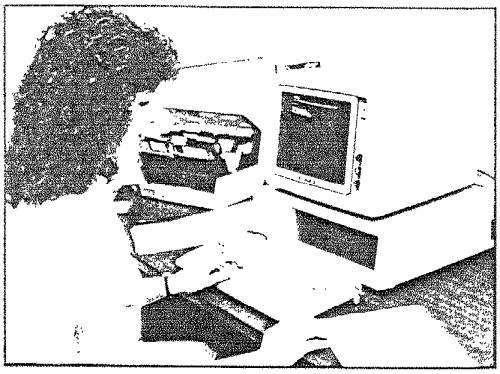
8. As such, SILVAH is an "expert system". It automates the three basic functions of the silvicultural prescription procedure. In addition, SILVAH can perform the functions of report writing, data-base generation, comparison of alternative cuts, and stand growth simulation. We will look at each of these functions in detail.

INVENTORY PROCESSING

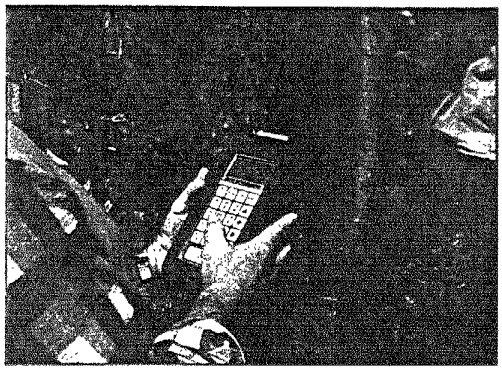
9. Inventory processing is the first and most basic function of the SILVAH program.



10. Data on overstory, understory, and site variables are collected during the stand inventory



11. and entered into SILVAH along with general information on stand conditions and management objectives. The tally form is shown as Appendix A-1. The Appendix contains samples of the various SILVAH forms and printouts. Data entry may occur either through the computer keyboard, or



12. electronically from a field data recorder.

ERROR CHECKING

Height too large for diameter

Diameter exceeds 40 inches

Pole tree graded sawtimber

Any Regen less than Cherry Regen

Etc., Etc.

13. Data entered into SILVAH are error checked to ensure that values are within acceptable ranges and internally consistent (Appendix A-2). For example, it will inform you of an error if you classify a 6-inch tree as veneer, or enter a 90-inch d.b.h., or 20 log merchantable height.

14. SILVAH processes the information entered and outputs all of the usual tabular data that one expects from a forest inventory. The number and type of inventory printouts that can be obtained are very large, and the user is free to select all, none, or any combination of these outputs.

CRUISE INFORMATION

Overstory	Understory
Prism or Fixed	Standard or Detailed
Ind. Tree or Dot Tally	----
No. Plots	No. Plots
Factor or Plot Size	Plot Size
Standard Error	----
Additional Plots Needed	Additional Plots Needed

15. If desired, SILVAH will output a page of information on the type and accuracy of the cruise (Appendix A-3). This page describes the type of overstory cruise used (prism or fixed plot by individual trees or dot tally), standard or detailed understory data, number of plots of each type, standard error in overstory basal area, and number of additional plots (if any) required to estimate basal area within both 10 percent and 15 percent of the mean.

REGENERATION STATUS

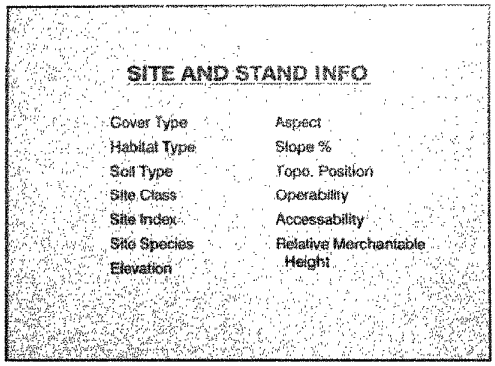
% plots with Regeneration

% plots with interfering plants

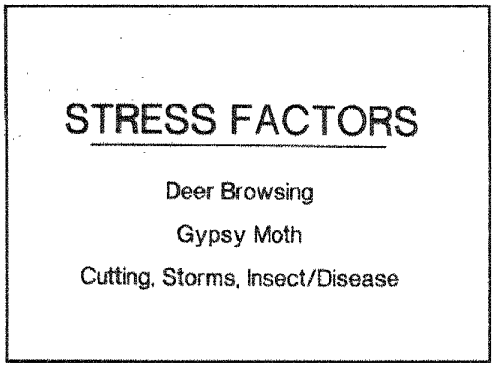
Oak Stump Sprouting

Regeneration Difficulty

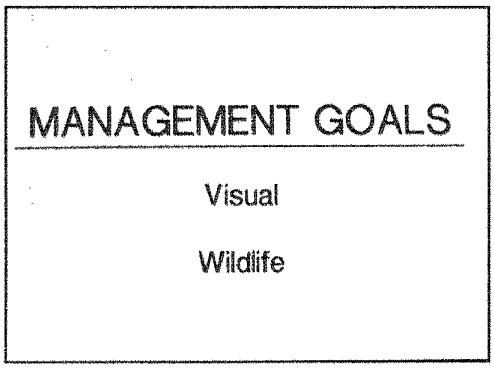
16. If desired, SILVAH will output a page of information summarizing tree regeneration status (Appendix A-4). This includes a summary of the proportion of plots stocked with ten categories of desirable regeneration, and six categories of interfering understory plants. It also provides data on the proportion of oak stumps that are expected to sprout and the effect it will have on reducing the amount of advance oak regeneration needed. Estimates of factors that will affect the ease or difficulty of securing regeneration (such as deer impact, seed supply index, and site limitations) are given also. Where coded values are used, the printout provides a brief definition. More complete definitions are provided in the SILVAH user's guide.



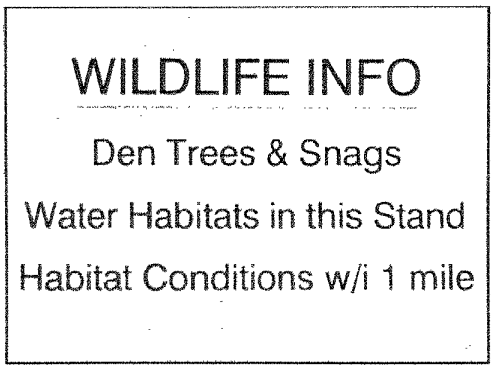
17. If desired, SILVAH will output a page of site and general stand information (Appendix A-5). Site information is supplied by the user and includes: cover type, habitat type, soil type, site class, site species, site index, relative merchantable height (which can be used as an indicator of site quality if the stand has not been high-graded), elevation, aspect, percent slope, topographic position, operability, and accessibility.



18. Stress factors also may be supplied by the user and may include: deer impact, danger of gypsy moth defoliation, and stress created by recent cutting, storms, or insect and disease outbreaks.



19. Management goals are stated in terms of the extent to which timber prescriptions may be (or must be) modified to accommodate visual or wildlife objectives (Appendix A-6).

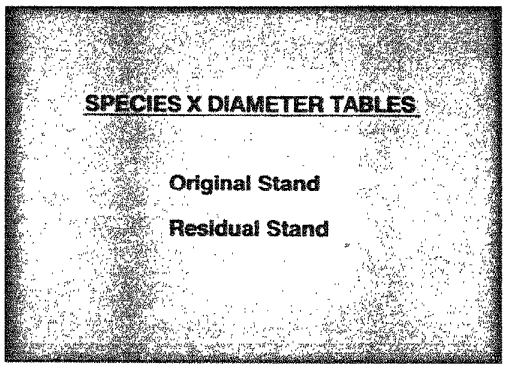


20. If desired, SILVAH will output information on wildlife variables (Appendix A-6). At present, this information is limited to number per acre of potential and existing den trees and snags, plus information on water habitat and vegetative conditions in areas surrounding the stand.

SPECIES X DIAMETER TABLES

Number of Trees
Basal Area
Relative Density
Total Cubic Volume
Pulpwood Volume
Sawlog Volume
Dollar Value

21. If desired, SILVAH will output overstory data by species and diameter (Appendix A-7, A-8). These tables also contain a summary by major size classes and quality classes. The tables can be generated showing per acre values for number of trees, basal area, relative density, net total cubic-foot volume, net pulpwood cubic-foot volume, net board-foot volume (using International 1/4", Doyle & Scribner log rule), and dollar value.



22. These tables can be printed for the original stand and for any residual stands generated in SILVAH.

CONDENSED TABLES

Three Species Groups
Five Size Classes
Two Quality Classes

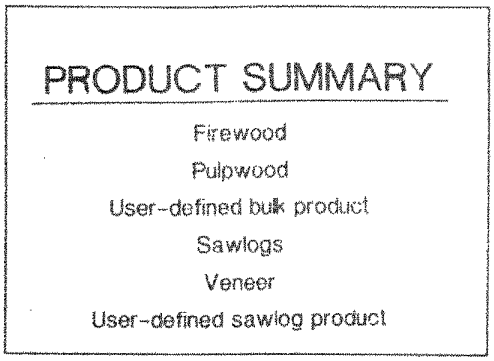
23. If desired, a condensed version of these tables can be printed showing only three species groups, five size classes, and two quality classes (Appendix A-9). This format is identical to that on the Manual Tally and Summary Forms.

OVERSTORY SUMMARY

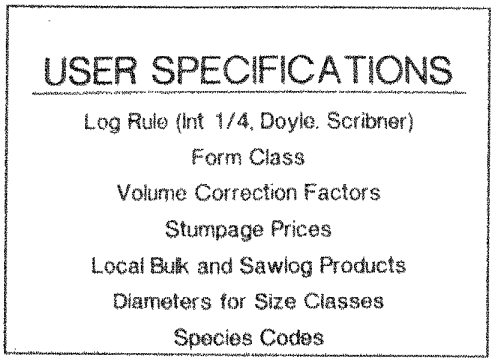
BY SPECIES

No. Trees	Quality Distribution
Basal Area	Stand Diameter
Relative Density	Stand Structure
Volume	Years to Maturity
Value	Species Composition

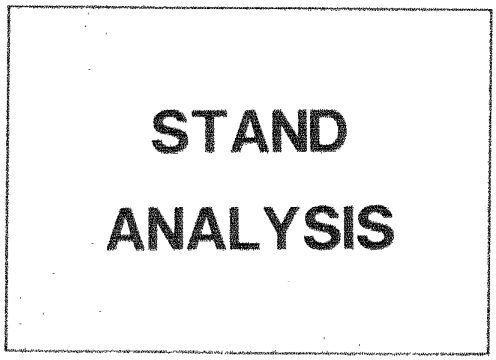
24. If desired, SILVAH will output a one-page summary of all overstory data (Appendix A-10), showing values by species for such variables as number of trees, basal area, relative density, percent species, total cubic-foot volume, total pulpwood volume, board-foot volume, and dollar value. This summary page also shows the distribution of acceptable quality trees by species and size class. In addition, several stand diameters, several measures of stand structure, estimates of effective stand age and years to maturity are presented.



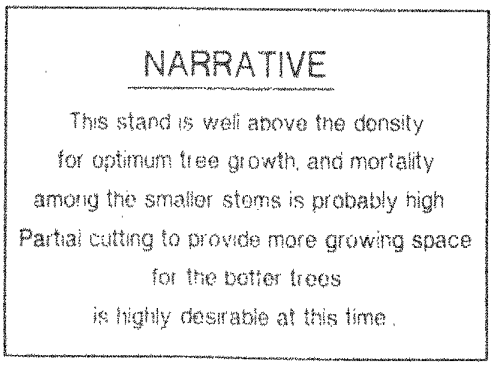
25. If desired, SILVAH will print a one-page summary of timber products, by species, grade, and size class (Appendix A-11, A-12). These products include: firewood, pulpwood, a user-defined bulk product such as boltwood, sawtimber, veneer, and a user-defined sawlog product such as pallet logs or construction-grade logs. This product printout can be obtained on either a per acre or total stand basis.



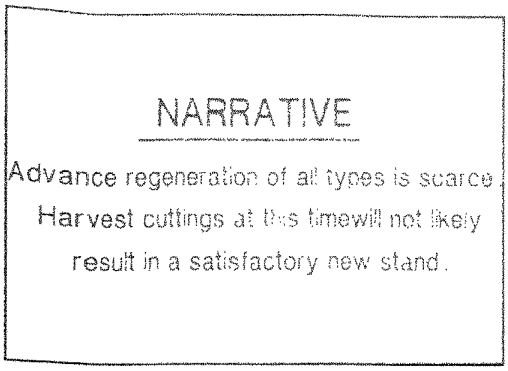
26. In all of these inventory printouts, the user can adapt SILVAH to meet the needs of the particular organization or geographic area (Appendix A-13, A-14). Users may specify: the log rule to use, stumpage prices for all products by species, diameters to be included in each product, form class to be used for each species, volume correction factors to be used for each species, and minimum volumes required for commercial sales. The user can also insert his or her own species codes into the system, and may name one bulk and one sawlog product other than the usual ones.



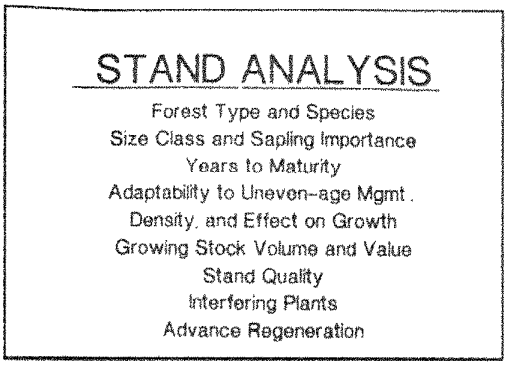
27. In the second step of the SILVAH process, all inventory data are then analyzed to provide an assessment of the silvicultural potential of the stand. The analysis includes categorization of the stand into type-size-density class, evaluation of the potential for regeneration, the status of this stand in approaching financial maturity, the potential of the stand for growth and accumulation of value, and the need for partial cutting.



28. The analysis is presented in an easily read narrative report (Appendix A-15). For example, data on stand density and tree volume may be interpreted in the narrative as: "This stand is well above the density for optimum tree growth, and mortality among the smaller stems is probably high. A thinning to provide some intermediate yield is highly desirable at this time."

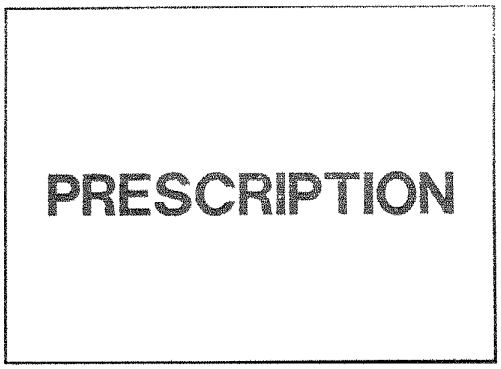


29. Or, data on overstory density and tree size combined with understory information may produce the message: "Advance regeneration of all types is scarce; harvest cuttings at this time probably will not result in a satisfactory new stand." Such evaluations, routinely printed for each stand, ensure that the user's attention is systematically focused on all of the characteristics of the stand.

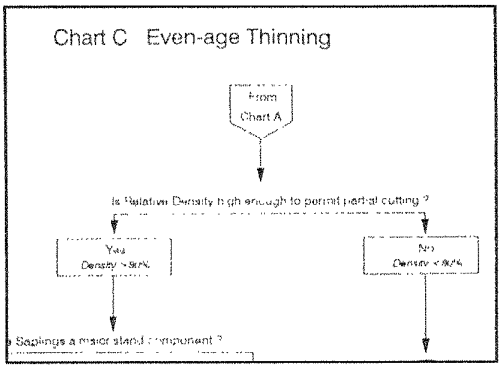


30. The stand analysis narrative includes the following information:

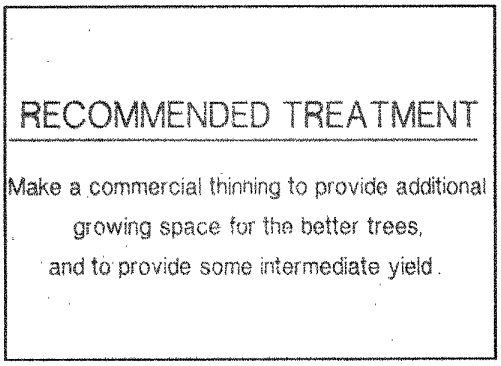
- o Forest type and names of the dominant species.
- o Stand size class, and an indication of the importance of including noncommercial saplings in partial cutting considerations.
- o Expected time to financial maturity if the stand is managed under an even-age system, and the degree to which all species will mature at the same time.
- o Adaptability of the stand to uneven-age management, based upon "q" factor, proportion of sawtimber, and proportion of shade-tolerant species.
- o Relative stand density or stocking, and the expected effect of that density on individual tree growth and stand growth and mortality.
- o The desirability of partial cutting.
- o A statement of total growing stock, merchantable volumes, and dollar value.
- o Information on overall stand quality.
- o Evaluation of the impact that interfering plants and site limitations will have on seedling regeneration.
- o An evaluation of the amount of advance regeneration present, and the stand's ability to regenerate if harvested. Information on the dominant species in the next stand also may be provided.



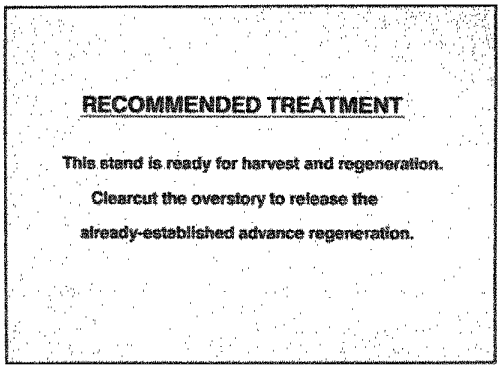
31. The third step in the decisionmaking process is the determination of a management prescription. This determination is based on the goals of the landowner, and on the characteristics of the site and present vegetation. So, owner objectives must be clearly identified for the prescription function to work properly.



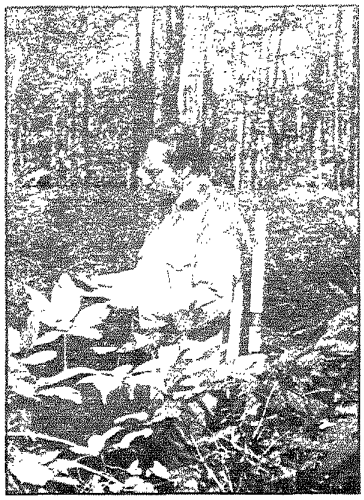
32. A series of decision charts is used to find a recommended treatment for the present stand. The decision charts are constructed in such a way that there is only one possible treatment for each combination of goals and stand conditions. The program scans through the charts using the data from the stand analysis and the owner's goals to find a treatment.



33. The result is our recommendation on the silvicultural treatment that will best meet management objectives based upon current knowledge. SILVAH will print this recommended treatment (Appendix A-16). It may call for a commercial thinning,



34. a final harvest, or any of about 50 other silvicultural activities.



35. No system of this sort can substitute for professional judgment, nor is it intended to do so. The decision tables are based on average situations. Circumstances not evaluated or other considerations may dictate that the recommendations be modified. So, the procedure provides a starting point or standard that must be verified by professional judgment. Nevertheless, it removes much of the subjectivity formerly associated with silvicultural decisionmaking, and ensures that a wide range of factors are systematically considered in the process. It also provides for uniformity in prescriptions among stands and among individual prescribers.

BREAKPOINT WARNINGS

Relative density is just below the 80% breakpoint; a cutting prescription may also be appropriate.

Interfering plants are just below the 30% breakpoint; an herbicide treatment may also be appropriate.

36. SILVAH provides some help even on the use of professional judgment. When stand conditions fall very close to a decision point, SILVAH prints a warning to that effect (Appendix A-17). For example, if SILVAH recommends the use of an herbicide prior to shelterwood cutting because 31 percent of the plots have interfering plants (30 percent is the breaking point), SILVAH will alert you that herbicide may not be required. In such situations, you might get by without any herbicides; or you might treat only the portion of the stand where the interfering plants are dense.

MARKING INSTRUCTIONS

Residual density and basal area

Proportion of trees to cut from each size class

Proportion of trees to cut that are poor quality

37. If the recommended treatment includes a partial cutting of any type, a set of marking instructions is then generated. Desired residual stands are calculated using a stand structure model suitable for either even-age or all-age management, as appropriate. Then the number of trees to be removed to achieve that objective is calculated. The narrative indicates the residual density desired, and provides a series of ratios for each major size class, indicating the proportion of trees to be cut from each class (Appendix A-16).

COMPARISON TABLE

Overstory Summary Data Comparing Original, Cut, and Residual Stands

38. If desired, SILVAH will output a page of overstory summary data comparing the original, cut, and residual stands (Appendix A-18). This provides data on volumes and values available for cutting, and provides summary data on the effect of that cutting on the residual stand. One can evaluate the effects of the cut on such parameters as stand quality, stand diameter, years to maturity, species composition, stand structure, and so on.

    More complete information on the residual stand is available if desired; any of the overstory tables previously described for the original stand also can be printed for the residual stand (Appendix A-19).

STAND ANALYSIS AND PRESCRIPTION

OTHER SILVAH FEATURES

39. The computer program SILVAH does all of the described analyses and prescription writing automatically, once provided with inventory data and management goals. Regular use provides for data processing and decisionmaking on large numbers of individual stands without timeconsuming and costly testing of possible alternatives.

    SILVAH also provides a number of other important features.

TESTING OF ALTERNATIVE CUTS

40. SILVAH provides the opportunity to test alternative cuts, if that is desired. The user can choose to ignore the recommended treatment and specify any other cutting treatment desired. The effect of that treatment on the residual stand that results will be assessed in the same way as for a SILVAH-recommended treatment. Thus, one can compare the effect of as many alternative treatments as desired.

ALTERNATIVES

Select Different Std. Treatment

Modify Standard Treatments

Build Your Own Treatments

41. There are three ways to specify other treatments. You can: a) select one of the other standard SILVAH treatments; b) select any of the standard SILVAH treatments but modify it by specifying your own residual density or structure; or c) specify the cut in detail, selecting individual species, diameter, and quality classes to cut.

CUT SPECIFICATIONS

Minimum density and maximum to remove

Structure factor or 'q' factor

Maximum tree size to retain

Percent to cut by:

Species, Diameter, Quality, Priority

42. The printout of any user-specified treatment shows the specifications used (Appendix A-20, A-21). Any of the printouts described earlier showing the residual stand and cut volumes can be obtained for user-specified treatments, providing a means to compare the effects of any desired treatments.

STAND GROWTH SIMULATOR

43. In addition, SILVAH contains a stand growth simulator, so that one can project the stand into the future after any treatment. Stand analyses like those produced on the actual inventory data can be produced for any future date, permitting detailed comparisons of impacts of any number of possible treatments on future timber yields.

SIMULATOR OUTPUTS

All inventory tables

Product Yields at each cut

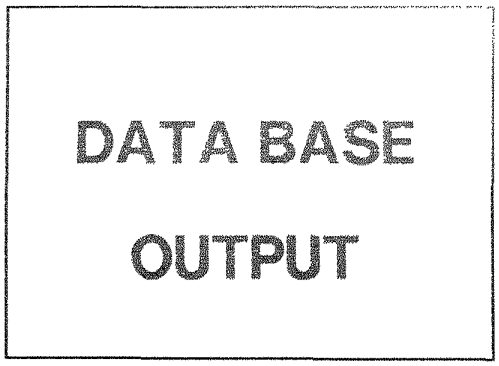
Stand Development Record:

No. trees, basal area, density, stand diameter, species composition, pulp and sawlog volumes, dollar values.

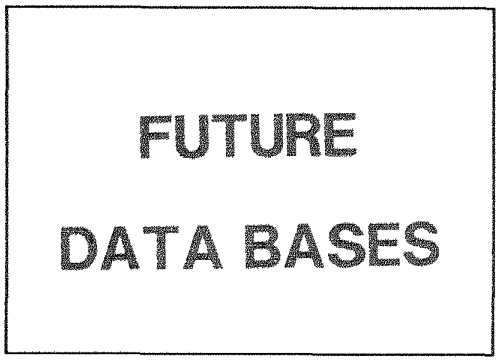
44. Summary pages from a typical simulation run include product yield and stand stocking and volume data over the entire projection period (Appendix A-22, A-23). Any of the tables printed on the original stand inventory also can be printed on the simulated stand, for any of the 5-year intervals projected (Appendix A-24).

REPORT WRITING

45. SILVAH also serves as a report writer, in that the stand analysis and prescription printouts are in narrative form and can be sent to a computer file for use with a word processor. Thus, narrative information from these printouts can be combined with other text and graphics and incorporated into management plans and similar reports. Consultants and service foresters often do this for small properties, and we have seen several management plans where most of the material came directly from SILVAH printouts.

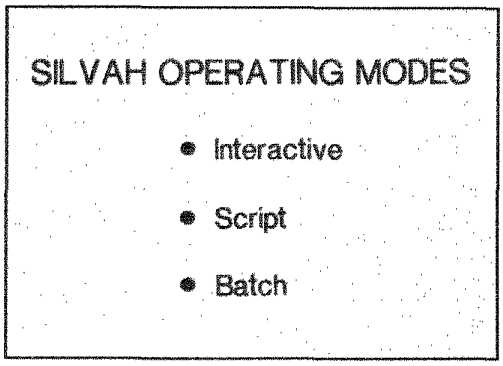


46. SILVAH also provides the option of writing the stand summary data to a computer file, from which it can be incorporated into a forest-wide data base for management planning. With such a data base, it is easy to obtain summaries of volumes and values across selected stands, compartments, properties, or ownerships. One can quickly determine how many acres (stands) are ready for harvest or thinning; how many need herbicide treatments, and so on. Unlike data bases generated by many other inventory systems, the data base generated from SILVAH summary records permits users to identify each of the stands included in any summaries generated.



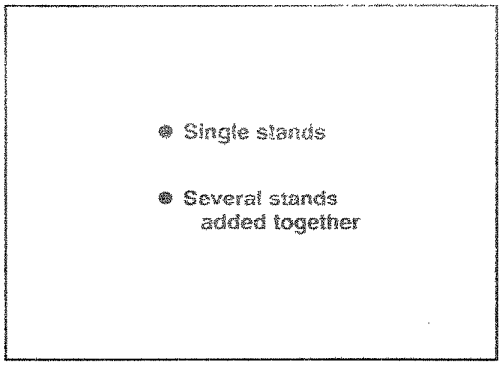
47. Still another feature is the ability to combine the use of the data base output feature and the stand growth simulator to produce data bases for any future date. Thus, one could produce a data base for the year 2000 that could be used to estimate how many stands will be ready for harvest, thinning, and so on in that decade, and what volumes will be available for cutting.

    By using these data bases of future forest conditions in combination with a program of retallying stands after treatment, it is possible to establish a continuous forest inventory process that will materially reduce the cost of traditional forest inventories.

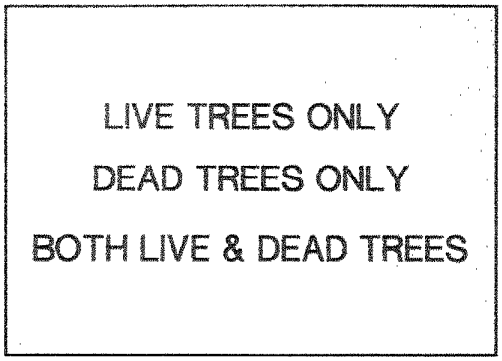


48. SILVAH is a very flexible program. It can be run in three different modes:

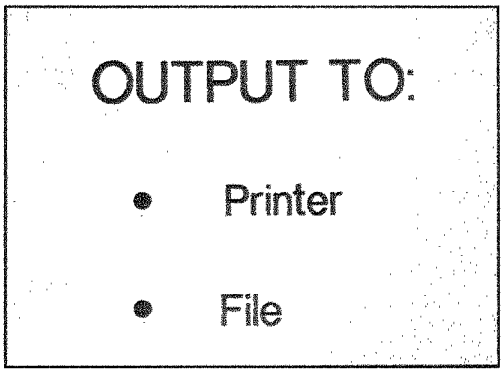
    - o Interactive mode allows the user to interact directly with the program, viewing the results of one step before deciding what to do next.
    - o Script mode allows the user to set up a file containing processing instructions. Since many users process their data in the same way, getting the same printouts each time, this script file enables the program to run without answering the same questions for each stand.
    - o Batch mode carries automatic processing a step further, allowing the user to create a file that lists a number of stands to be run at one time. Thus, it is possible to process data from a large number of stands without user intervention (overnight, for example).



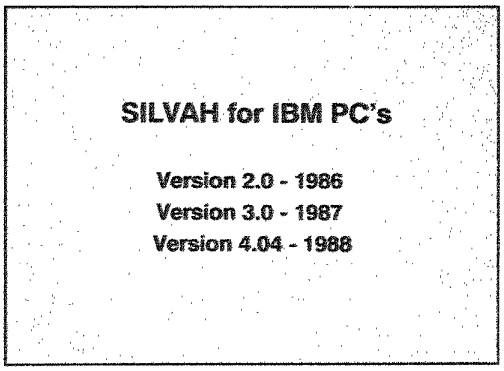
49. SILVAH also permits data from several stands to be added together and treated as one stand. This is often convenient to get total volumes from a compartment or property, or to permit combining of data from adjacent stands.



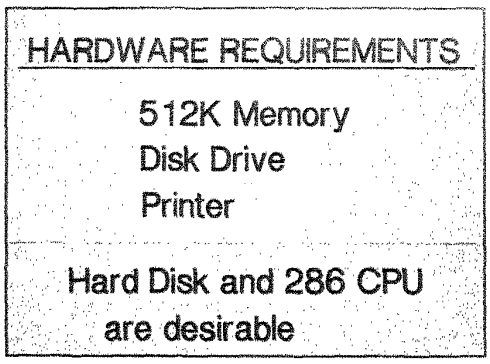
50. Another option is to include only live trees, only dead trees, or both live and dead trees. Inclusion of dead trees in volume estimates is occasionally useful for salvage timber sales and similar programs.



51. Finally, output is usually directed to a printer, but it can easily be redirected to a disk file. This enables printouts to be imported to a word processor and easily incorporated into reports and management plans. It also enables SILVAH to be run without a printer.



52. The current version of SILVAH is version 4.04, released in October of 1988 for use on IBM compatible microcomputers. Minor revisions and updates are made as the need arises. An identical version is also available for Data General minicomputers.



53. Minimum hardware required to run SILVAH on a microcomputer consists of:

- o 512K memory
- o disk drive
- o printer
- o Hard disk and a 286 or faster CPU are highly desirable.

Selected References

Ernst, Richard L. 1982. Computerized prescription for Allegheny hardwoods. In: Microcomputers: a new tool for foresters - Conference Proceedings; 1982 May 18-20; West Lafayette, IN; SAF Pub. NO. SAF 82-05. West Lafayette, IN: Purdue University: 103-105.

Marquis, David A. 1986. SILVAH: A stand analysis, prescription and management simulator program for hardwood stands in the Alleghenies. Compiler. 4(3):42-46.

Marquis, David A. 1986. SILVAH: A stand analysis, prescription and management simulator program for hardwood stands in the Alleghenies. In: Wiant, Harry V., Jr.; Yandle, David O.; Kidd, William E., eds. Forestry Microcomputer Software Symposium: Proceedings of a symposium; 29 July - 2 June 1986; Morgantown, WV. Morgantown, WV: West Virginia University: 224-240.

Marquis, David A.; Ernst, Richard L. 1992. User's Guide to SILVAH: Stand analysis prescription, and management simulator program for hardwood stands of the Alleghenies. Gen. Tech. Rep. NE-162. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 124 p.

Marquis, David.A.; Ernst, Richard.L.; Stout, Susan.L. 1992. Prescribing silvicultural treatment in hardwood stands of the Alleghenies (Revised). Gen Tech. Rep. NE-96. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 101 p.

Stout, S.L. 1983. Computer program helps foresters write prescriptions for Allegheny hardwoods. Allegheny Society of American Foresters; Allegheny News; Spring 1983: 14-15.

SILVAH V4 - Stand Analysis Tally Form

USDA, Forest Service, NEFES, Warren, PA 5/90

Identification Data

Sheet ___ of ___

Owner/Agency								
Forest/Property								
County/District								
Compartment/Unit		Stand No.						
Remarks								
Species Codes	dbh classes		Tally month		Year			
Overstory Cruise	Type	# plots		BAF/plot size				
Regen Cruise	Type	# plots		Plot size				
Acreage in stand			Stand age					
Cover Type	Habitat type		Soil type		Site class			
Site species		Site Index		Height adjustment				
Elevation		Aspect		Slope %		Topo. position		
Operability	Access		Water code		Water code			
Acres W/I 1 mi.	Clearcuts		Cultivation		Open		Water code	
Management goal	Mgmt. value		Deer impact index		Gypsy moth		Stress	

Regeneration Data

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Black cherry														
Small oak														
Other desirables														
Large oak														
Residuals														
Sapling regen														
Woody interference														
Ferns														
Grasses														
Laurel & Rhod.														
Grapevines														
Site limitations														

Overstory Data

Species	dbh	Quality	Ht. or Count	Grade	Defect	Crown	Wildlife	Species	dbh	Quality	Ht. or Count	Grade	Defect	Crown	Wildlife

```
          SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
       STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
     DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

 OWNER/AGENCY     -- US Forest Serv.       DATE TALLIED:      AUG/1988
 FOREST/PROPERTY  -- Allegheny NF          DATE PRINTED:   17/SEP/1988
 COUNTY/DISTRICT  -- Ridgway               FILE: A:\T1.SIL
 COMPT - STAND    -- 12     32             DEFAULT: SILVAH.DEF
 ACRES            --       .00               TYPE:
 STAND AGE        -- UNKNOWN                 SIZE:
 SITE             --   70 FOR  BC            DENSITY:

This is a test of read time error messages.



 FILE = A:\T1.SIL
**WARNING** ONE OF THE ADVANCE REGEN VALUES IS LARGER THAN "ANY REGN"
**WARNING** THE "ANY REGN" VALUE IS LARGER THAN THE "ANY+RESD" VALUE
**WARNING** ONE OF THE INTERFERING PLANT VALUES IS LARGER THAN "ANY INTF"
**WARNING** NO MATCH FOR SPECIES CODE IN PLOT 1 TREE NO. 1;  CODED OHW
**WARNING** DBH NOT BY 2" CLASS IN PLOT 1 TREE NO. 2;  DBH RAISED 1"
**WARNING** DBH EXCEEDS 40" IN PLOT 1 TREE NO. 3; DBH CHANGED TO 40"
**WARNING** QUALITY CLASS OUT OF RANGE IN PLOT 1 TREE NO. 4;TREATED AS AGS
**WARNING** HEIGHT APPEARS HIGH IN  PLOT 1 TREE NO. 7
**WARNING** HEIGHT ON BULK PRODUCT IN PLOT 1 TREE NO. 8; HEIGHT IGNORED
**WARNING** HEIGHT ON SAPLING OR POLE IN PLOT 1 TREE NO. 11;HEIGHT IGNORED
**WARNING** SAP OR POLE GRADED SAW IN PLOT 1 TREE NO. 12; CHANGED TO PULP
```

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US Forest Serv.
FOREST/PROPERTY -- Allegheny NF
COUNTY/DISTRICT -- Ridgway
COMPT - STAND -- 12 32
ACRES -- 125.00
STAND AGE -- 68
SITE -- 70 FOR BC
SAMPLE TRANSITION STAND

DATE TALLIED: AUG/1988
DATE PRINTED: 17/SEP/1988
FILE: A:\T2.SIL
DEFAULT: SILVAH.DEF
TYPE: TRANSITION HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

OVERSTORY CRUISE INFORMATION

Overstory data is from an individual tree tally prism cruise,
using a 10 factor prism, and with trees tallied by
2 inch dbh classes, and heights in the HT/COUNT column.

Overstory data based on 10. plots;
0. additional plots needed to reach 15 % of the mean;
8. additional plots needed to reach 10 % of the mean.

Mean basal area is 116. plus or minus 16. square feet per acre
at 90 % confidence (13. % of mean).

UNDERSTORY CRUISE INFORMATION

Data on advance regeneration, site limitations, and understory
is from a standard (checkmark) tally
using 6-ft radius plots.

Understory data is based on 30. plots.

****** WARNING ******
Regeneration data is not based on an adequate number of plots to give
reliable results. At least 1. additional plots needed in this stand.

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
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OWNER/AGENCY -- US Forest Serv.
FOREST/PROPERTY -- Allegheny NF
COUNTY/DISTRICT -- Ridgway
COMPT - STAND -- 12 32
ACRES -- 125.00
STAND AGE -- 68
SITE -- 70 FOR BC
SAMPLE TRANSITION STAND

DATE TALLIED: AUG/1988
DATE PRINTED: 17/SEP/1988
FILE: A:\T2.SIL
DEFAULT: SILVAH.DEF
TYPE: TRANSITION HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

SPECIES OR CATEGORY	% OF PLOTS STOCKED	VALUE	
DESIRABLE TREE REGENERATION			
BLACK CHERRY	73.		
NORTHERN HDWD	77.		
SMALL OAK	27.		
LARGE OAK	3.		
ANY REGEN	83.		
RESIDUAL TREES	7.		
ANY REGEN + RESD	87.		
SAPLING REGEN	0.		
OAK SPROUT POTENTIAL	46.	352.	(OAKS/A EXPECTED TO SPROUT)
ANY REGEN + SPROUTS	100.		
FACTORS AFFECTING REGENERATION DIFFICULTY			
DEER IMPACT		4	High
SEED SUPPLY		1	Abundant seeds
REGEN DIFFICULTY		5	Somewhat difficult
INTERFERING UNDERSTORY			
WOODY INTERFRNCE	10.		
LAUREL & RHOD	0.		
FERN	30.		
GRASS	0.		
ANY INTERFERENCE	33.		
GRAPEVINE	0.		
SITE LIMITATIONS FOR REGENERATION			
SITE LIMITATIONS	7.		

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
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OWNER/AGENCY -- US Forest Serv.
FOREST/PROPERTY -- Allegheny NF
COUNTY/DISTRICT -- Ridgway
COMPT - STAND -- 12 32
ACRES -- 125.00
STAND AGE -- 68
SITE -- 70 FOR BC
SAMPLE TRANSITION STAND

DATE TALLIED: AUG/1988
DATE PRINTED: 17/SEP/1988
FILE: A:\T2.SIL
DEFAULT: SILVAH.DEF
TYPE: TRANSITION HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

SPECIES OR CATEGORY	% OF PLOTS STOCKED	VALUE	
SITE INFORMATION			
COVER TYPE		1	Forest
HABITAT TYPE		9	Unknown
SOIL TYPE		9	Unknown
SITE CLASS		2	Medium site
SITE SPECIES		BC	
SITE INDEX		70	
REL MERCH HT		1.26	
ELEVATION		2000	
ASPECT		25	
SLOPE %		5	
TOPO POSITION		6	Upper flat
OPERABILITY		1	No limitations
ACCESSABILITY		1	2-wh road at stand
STRESS FACTORS			
DEER IMPACT		4	High
GYPSY MOTH		1	Unimportant
OTHER STRESS		2	Light cutting

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
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OWNER/AGENCY	-- US Forest Serv.	DATE TALLIED:	AUG/1988
FOREST/PROPERTY	-- Allegheny NF	DATE PRINTED:	17/SEP/1988
COUNTY/DISTRICT	-- Ridgway	FILE:	A:\T2.SIL
COMPT - STAND	-- 12 32	DEFAULT:	SILVAH.DEF
ACRES	-- 125.00	TYPE:	TRANSITION HARDWOOD
STAND AGE	-- 68	SIZE:	SMALL SAW
SITE	-- 70 FOR BC	DENSITY:	GT 95 %

SAMPLE TRANSITION STAND

MANAGEMENT GOALS

No restrictions on mgmt for either visual or wildlife goals.
For this goal, stand value is Medium

WILDLIFE TREES	NO./ACRE
POTENTIAL DEN TREES	12.1
EXISTING DEN TREES	5.1
SNAGS WITH POTENTIAL CAVITIES	.0
SNAGS WITH EXISTING CAVITIES	15.2
OTHER STANDING DEAD TREES (Not Snags)	.0

WATER HABITATS WITHIN THIS STAND INCLUDE:

Spring seep
Stream < 15 ft wide

HABITAT CONDITIONS SURROUNDING THIS STAND

CLEARCUT ACRES W/I 1 MILE	56.00
CULTIVATED ACRES W/I 1 MILE	6.00
OPEN ACRES W/I 1 MILE	30.00
WATER HABITATS INCLUDE:	Lake

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US FOREST SERV.
FOREST/PROPERTY -- KEF
COUNTY/DISTRICT -- Trng Area B
COMPT - STAND -- 4 A
ACRES -- 1.00
STAND AGE -- UNKNOWN
SITE -- UNKNOWN
SAMPLE CHERRY-MAPLE STAND

DATE TALLIED: JUL/ 88
DATE PRINTED: 17/SEP/1988
FILE: A:\4A.SIL
DEFAULT: SILVAH.DEF
TYPE: ALLEGHENY HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

ORIGINAL STAND

BASAL AREA - SQ. FT. PER ACRE

SPECIES > DIA.	ALL SP	BC	AB	SM	RM	YP	B	CUC	STM
1	.2	.0	.2	.0	.0	.0	.0	.0	.0
2	1.6	.0	1.1	.4	.0	.0	.0	.0	.0
3	3.2	.0	1.8	1.3	.0	.0	.0	.0	.0
4	4.4	.0	1.7	2.4	.3	.0	.0	.0	.0
5	6.5	.0	2.0	3.8	.5	.0	.1	.0	.0
6	5.1	.0	.6	4.1	.4	.0	.0	.0	.0
7	6.7	.3	2.1	3.2	.5	.0	.3	.3	.0
8	5.6	.7	1.7	2.4	.3	.0	.3	.0	.0
9	7.1	4.4	.4	1.8	.4	.0	.0	.0	.0
10	15.8	8.2	2.2	2.2	1.1	.0	2.2	.0	.0
11	9.2	5.9	.7	.0	2.6	.0	.0	.0	.0
12	18.8	8.6	4.7	.8	4.7	.0	.0	.0	.0
13	24.0	19.4	1.8	.0	1.8	.0	.9	.0	.0
14	15.0	12.8	2.1	.0	.0	.0	.0	.0	.0
15	12.3	8.6	2.5	.0	.0	1.2	.0	.0	.0
16	11.2	8.4	.0	.0	1.4	.0	.0	1.4	.0
17	9.5	7.9	.0	.0	1.6	.0	.0	.0	.0
18	3.5	.0	.0	.0	.0	3.5	.0	.0	.0
SAPS	15.9	.0	6.9	8.0	.9	.0	.1	.0	.0
POLES	49.5	19.5	7.8	13.7	5.4	.0	2.8	.3	.0
SM SAW	90.7	65.7	11.1	.8	9.5	1.2	.9	1.4	.0
MED SAW	3.5	.0	.0	.0	.0	3.5	.0	.0	.0
LG SAW	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	159.6	85.2	25.8	22.5	15.8	4.8	3.9	1.7	.0
SPECIES%	100.	53.	16.	14.	10.	3.	2.	1.	0.

ACCEPTABLE GROWING STOCK ONLY

SAPS	11.1	.0	4.7	5.7	.6	.0	.0	.0	.0
POLES	42.5	18.2	6.4	10.7	5.0	.0	2.0	.3	.0
SM SAW	80.1	56.8	11.1	.0	9.5	1.2	.0	1.4	.0
MED SAW	1.8	.0	.0	.0	.0	1.8	.0	.0	.0
LG SAW	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	135.4	75.0	22.2	16.4	15.1	3.0	2.0	1.7	.0

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US FOREST SERV.
FOREST/PROPERTY -- KEF
COUNTY/DISTRICT -- Trng Area B
COMPT - STAND -- 4 A
ACRES -- 1.00
STAND AGE -- UNKNOWN
SITE -- UNKNOWN
SAMPLE CHERRY-MAPLE STAND

DATE TALLIED: JUL/ 88
DATE PRINTED: 17/SEP/1988
FILE: A:\4A.SIL
DEFAULT: SILVAH.DEF
TYPE: ALLEGHENY HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

ORIGINAL STAND

NET VOLUME: DOYLE LOG RULE - BD. FT. PER ACRE

SPECIES > DIA.	ALL SP	BC	AB	SM	RM	YP	B	CUC	STM
1	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	160.	120.	4.	0.	35.	0.	0.	0.	0.
12	411.	247.	52.	17.	96.	0.	0.	0.	0.
13	813.	718.	29.	0.	51.	0.	15.	0.	0.
14	632.	587.	45.	0.	0.	0.	0.	0.	0.
15	614.	468.	64.	0.	0.	83.	0.	0.	0.
16	701.	529.	0.	0.	71.	0.	0.	101.	0.
17	657.	565.	0.	0.	92.	0.	0.	0.	0.
18	318.	0.	0.	0.	0.	318.	0.	0.	0.
SAPS	0.	0.	0.	0.	0.	0.	0.	0.	0.
POLES	160.	120.	4.	0.	35.	0.	0.	0.	0.
SM SAW	3829.	3113.	190.	17.	311.	83.	15.	101.	0.
MED SAW	318.	0.	0.	0.	0.	318.	0.	0.	0.
LG SAW	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL	4306.	3232.	194.	17.	346.	401.	15.	101.	0.
SPECIES%	100.	75.	5.	0.	8.	9.	0.	2.	0.

ACCEPTABLE GROWING STOCK ONLY

SAPS	0.	0.	0.	0.	0.	0.	0.	0.	0.
POLES	160.	120.	4.	0.	35.	0.	0.	0.	0.
SM SAW	3404.	2719.	190.	0.	311.	83.	0.	101.	0.
MED SAW	159.	0.	0.	0.	0.	159.	0.	0.	0.
LG SAW	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL	3723.	2839.	194.	0.	346.	242.	0.	101.	0.

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US FOREST SERV.
FOREST/PROPERTY -- KEF
COUNTY/DISTRICT -- Trng Area B
COMPT - STAND -- 4 A
ACRES -- 1.00
STAND AGE -- UNKNOWN
SITE -- UNKNOWN
SAMPLE CHERRY-MAPLE STAND

DATE TALLIED: JUL/ 88
DATE PRINTED: 17/SEP/1988
FILE: A:\4A.SIL
DEFAULT: SILVAH.DEF
TYPE: ALLEGHENY HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

ORIGINAL STAND

	B. CHER. W. ASH Y. POP.	R. MAPLE RED OAK OTHERS	SUGAR MAPLE BEECH STR. MAP. OTH. OAK	ALL SPECIES
BASAL AREA - SQ. FT. PER ACRE				
AGS				
SAPS	.0	.6	10.4	11.1
POLE	18.2	7.2	17.1	42.5
SSAW	58.0	10.9	11.1	80.1
MSAW	1.8	.0	.0	1.8
LSAW	.0	.0	.0	.0
TOT	78.0	18.8	38.7	135.4
UGS				
SAPS	.0	.4	4.4	4.8
POLE	1.3	1.3	4.4	7.0
SSAW	8.9	.9	.8	10.6
MSAW	1.8	.0	.0	1.8
LSAW	.0	.0	.0	.0
TOT	12.0	2.6	9.6	24.2
ALL				
SAPS	.0	1.0	14.8	15.9
POLE	19.5	8.5	21.5	49.5
SSAW	66.9	11.8	11.9	90.7
MSAW	3.5	.0	.0	3.5
LSAW	.0	.0	.0	.0
TOT	89.9	21.4	48.3	159.6

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US FOREST SERV.
FOREST/PROPERTY -- KEF
COUNTY/DISTRICT -- Trng Area B
COMPT - STAND -- 4 A
ACRES -- 1.00
STAND AGE -- UNKNOWN
SITE -- UNKNOWN
SAMPLE CHERRY-MAPLE STAND

DATE TALLIED: JUL/ 88
DATE PRINTED: 17/SEP/1988
FILE: A:\4A.SIL
DEFAULT: SILVAH.DEF
TYPE: ALLEGHENY HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

ORIGINAL STAND

SPECIES >	ALL SP	BC	AB	SM	RM	YP	B	CUC	STM
				COMPOSITION -- BA, % OF BA, TREES					
TOT BA	159.6	85.2	25.8	22.5	15.8	4.8	3.9	1.7	.0
SPECIES%	100.	53.	16.	14.	10.	3.	2.	1.	0.
# TREES	486.	99.	187.	156.	30.	3.	8.	2.	1.
				QUALITY -- % IN AGS					
SAPS	70.	0.	68.	72.	74.	0.	0.	0.	0.
POLES	86.	93.	82.	78.	91.	0.	71.	100.	0.
SM SAW	88.	86.	100.	0.	100.	100.	0.	100.	0.
MED SAW	50.	0.	0.	0.	0.	50.	0.	0.	0.
LG SAW	0.	0.	0.	0.	0.	0.	0.	0.	0.
ALL SIZE	85.	88.	86.	73.	96.	63.	51.	100.	0.
				DIAMETERS AND AGES -- INCHES, YEARS					
DIAM	11.5	13.2	9.2	6.6	11.8	17.2	10.2	14.6	2.0
DIAM MER	12.4	13.2	11.3	7.8	12.2	17.2	10.3	14.6	.0
QUAD DIA	7.8	12.6	5.0	5.1	9.8	17.1	9.4	12.3	2.0
YRS MAT	31.	24.	45.	68.	29.	4.	51.	17.	120.
EFCT AGE	67.	66.	75.	52.	61.	86.	69.	73.	0.
				STRUCTURE					
Q FACTOR	1.35	.97	1.24	2.42	.85	.63	.00	.00	.00
WEIB C	.00	.00	.00	.00	.00	.00	.00	.00	.00
				RELATIVE DENSITY -- %					
REL DEN	101.	36.	26.	23.	10.	2.	3.	1.	0.
AGS RDEN	84.	32.	22.	17.	10.	1.	1.	1.	0.
				VOLUMES AND VALUES - INT 1/4" LOG RULE					
GTOT CDS	41.9	27.0	4.5	2.9	4.4	1.6	.9	.5	.0
NTOT CDS	33.5	21.6	3.6	2.4	3.5	1.3	.7	.4	.0
PULP CDS	23.2	13.7	3.1	2.3	2.7	.4	.7	.2	.0
GRS BDFT	9769.	6891.	889.	63.	1021.	652.	69.	184.	0.
NET BDFT	7072.	5354.	328.	32.	591.	585.	25.	156.	0.
DOLLARS	938.	856.	8.	5.	25.	34.	2.	7.	0.

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US FOREST SERV.
FOREST/PROPERTY -- KEF
COUNTY/DISTRICT -- Trng Area B
COMPT - STAND -- 4 A
ACRES -- 1.00
STAND AGE -- UNKNOWN
SITE -- UNKNOWN
SAMPLE CHERRY-MAPLE STAND

DATE TALLIED: JUL/ 88
DATE PRINTED: 17/SEP/1988
FILE: A:\4A.SIL
DEFAULT: SILVAH.DEF
TYPE: ALLEGHENY HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

ORIGINAL STAND

PRODUCT LISTING (per acre)

SPECIES >	ALL SP	BC	AB	SM	RM	YP	B	CUC	STM
NET LOG VOLUME (INT 1/4" LOG RULE) - MBF PER ACRE									
VENEER	.3	.2	.0	.0	.0	.0	.0	.0	.0
GRADE 1	1.5	1.1	.0	.0	.2	.2	.0	.1	.0
GRADE 2	3.5	2.8	.2	.0	.1	.4	.0	.0	.0
GRADE 3	1.8	1.3	.2	.0	.3	.0	.0	.0	.0
PALLET	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	7.1	5.4	.3	.0	.6	.6	.0	.2	.0
NET BULK VOLUME - CORDS PER ACRE									
BOLTWOOD	.0	.0	.0	.0	.0	.0	.0	.0	.0
PULPWOOD	23.2	13.7	3.1	2.3	2.7	.4	.7	.2	.0
FIREWOOD	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	23.2	13.7	3.1	2.3	2.7	.4	.7	.2	.0
VALUE - DOLLARS PER ACRE									
VENEER	54.	49.	0.	0.	2.	2.	0.	1.	0.
GRADE 1	303.	277.	0.	0.	10.	12.	0.	4.	0.
GRADE 2	399.	373.	1.	0.	4.	19.	0.	1.	0.
GRADE 3	136.	130.	1.	0.	4.	0.	0.	1.	0.
PALLET	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL	892.	829.	2.	0.	20.	34.	1.	7.	0.
$/MBF	126.	155.	6.	5.	34.	57.	20.	42.	0.
BOLTWOOD	0.	0.	0.	0.	0.	0.	0.	0.	0.
PULPWOOD	46.	27.	6.	5.	5.	1.	1.	0.	0.
FIREWOOD	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL	46.	27.	6.	5.	5.	1.	1.	0.	0.
$/CORD	2.	2.	2.	2.	2.	2.	2.	2.	0.
GR.TOTAL	938.	856.	8.	5.	25.	34.	2.	7.	0.

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US Forest Serv.
FOREST/PROPERTY -- Allegheny NF
COUNTY/DISTRICT -- Ridgway
COMPT - STAND -- 12 32
ACRES -- 125.00
STAND AGE -- 68
SITE -- 70 FOR BC
SAMPLE TRANSITION STAND

DATE TALLIED: AUG/1988
DATE PRINTED: 17/SEP/1988
FILE: A:\T2.SIL
DEFAULT: SILVAH.DEF
TYPE: TRANSITION HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

ORIGINAL STAND

PRODUCT LISTING (total stand)

SPECIES >	ALL SP	SM	NRO	CO	BC	WO	AB	RM
	NET LOG VOLUME (INT 1/4" LOG RULE) - MBF / 1							
VENEER	.0	.0	.0	.0	.0	.0	.0	.0
GRADE 1	353.3	.0	50.7	.0	302.6	.0	.0	.0
GRADE 2	102.4	.0	102.4	.0	.0	.0	.0	.0
GRADE 3	317.8	.0	.0	145.0	.0	58.8	107.0	7.0
PALLET	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	773.5	.0	153.1	145.0	302.6	58.8	107.0	7.0
	NET BULK VOLUME - CORDS / 10							
BOLTWOOD	.0	.0	.0	.0	.0	.0	.0	.0
PULPWOOD	131.1	32.5	15.4	31.8	18.4	26.1	6.0	.9
FIREWOOD	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	131.1	32.5	15.4	31.8	18.4	26.1	6.0	.9
	VALUE - DOLLARS / 100							
VENEER	.0	.0	.0	.0	.0	.0	.0	.0
GRADE 1	766.4	.0	76.8	.0	689.6	.0	.0	.0
GRADE 2	137.3	.0	137.3	.0	.0	.0	.0	.0
GRADE 3	68.2	.0	.0	18.6	.0	31.6	17.3	.8
PALLET	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	971.9	.0	214.0	18.6	689.6	31.6	17.3	.8
$/MBF	126.	0.	140.	13.	228.	54.	16.	11.
BOLTWOOD	.0	.0	.0	.0	.0	.0	.0	.0
PULPWOOD	26.2	6.5	3.1	6.4	3.7	5.2	1.2	.2
FIREWOOD	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	26.2	6.5	3.1	6.4	3.7	5.2	1.2	.2
$/CORD	2.	2.	2.	2.	2.	2.	2.	2.
GR.TOTAL	998.1	6.5	217.1	25.0	693.3	36.8	18.4	1.0

SILVAH V4.5 -- SYSTEM DEFAULTS

For default file: SILVAH.DEF

Owner/Agency:	US Forest Serv.
Species codes:	1
Dbh classes:	2
Overstory cruise type:	7
BAF/Plot size:	10
Regen cruise type:	1
Plot size:	1
Management goal:	1
Management value:	2
Deer pressure:	4
Log Rule:	1
Name of local boltwood product:	BOLTWOOD
Name of local log product:	PALLET
Data drive & path: A:\	
List drive & path: C:\SCRATCH\	
Script drive & path: C:\FORESTRY\SILVAH\	
How SILVAH interacts:	2
Trees included (1=live, 2=dead, 3=both):	1
Output list dev. (1=printer, 2=file):	1

COMMERCIAL SALE BREAKPOINTS

	Board Feet	Cords
Sawtimber sale	2000.	0.
Integrated sale	1500.	5.
Cordwood sale	0.	7.

MINIMUM DIAMETERS FOR VOLUME CALCULATIONS

	Hardwoods	Softwoods
Pulp	5.5	5.5
Sawtimber	10.5	8.5

SILVAH V4.5 -- SPECIES DEFAULTS

For default file: SILVAH.DEF

-- SPECIES --			FC	PCF	SCF	$/MBF	$/VEN	$/CD	$/BOLT.	$/CONST.
OSW	0	1	82.	1.00	1.00	12.	0.	2.00	.00	0.
OHW	88	4	82.	1.00	1.00	20.	0.	2.00	.00	0.
BF	0	12	82.	1.00	1.00	12.	0.	2.00	.00	0.
ERC	0	68	82.	1.00	1.00	12.	0.	2.00	.00	0.
L	0	70	82.	1.00	1.00	12.	0.	2.00	.00	0.
TAM	0	71	82.	1.00	1.00	12.	0.	2.00	.00	0.
S	0	90	82.	1.00	1.00	12.	0.	2.00	.00	0.
NS	0	91	82.	1.00	1.00	12.	0.	2.00	.00	0.
WS	0	94	82.	1.00	1.00	12.	0.	2.00	.00	0.
BS	0	95	82.	1.00	1.00	12.	0.	2.00	.00	0.
RS	0	97	82.	1.00	1.00	12.	0.	2.00	.00	0.
P	0	100	82.	1.00	1.00	12.	0.	2.00	.00	0.
JP	0	105	82.	1.00	1.00	12.	0.	2.00	.00	0.
RP	0	125	82.	1.00	1.00	12.	0.	2.00	.00	0.
PP	0	126	82.	1.00	1.00	12.	0.	2.00	.00	0.
WP	1	129	82.	1.00	1.00	80.	0.	2.00	.00	0.
VP	0	132	82.	1.00	1.00	12.	0.	2.00	.00	0.
SP	0	170	82.	1.00	1.00	12.	0.	2.00	.00	0.
NWC	0	241	82.	1.00	1.00	12.	0.	2.00	.00	0.
EH	6	261	82.	1.00	1.00	20.	0.	2.00	.00	0.
M	0	310	82.	1.00	1.00	12.	0.	2.00	.00	0.
RM	21	316	82.	1.00	1.00	54.	100.	2.00	.00	0.
SVM	0	317	82.	1.00	1.00	12.	0.	2.00	.00	0.
SM	20	318	82.	1.00	1.00	55.	150.	2.00	.00	0.
BUC	0	330	82.	1.00	1.00	12.	0.	2.00	.00	0.
B	50	370	82.	1.00	1.00	36.	0.	2.00	.00	0.
YB	0	371	82.	1.00	1.00	36.	150.	2.00	.00	0.
SB	0	372	82.	1.00	1.00	12.	0.	2.00	.00	0.
PB	0	375	82.	1.00	1.00	12.	0.	2.00	.00	0.
H	60	400	82.	1.00	1.00	12.	0.	2.00	.00	0.
BH	0	402	82.	1.00	1.00	12.	0.	2.00	.00	0.
PH	0	403	82.	1.00	1.00	12.	0.	2.00	.00	0.
PCN	0	404	82.	1.00	1.00	12.	0.	2.00	.00	0.
SLH	0	405	82.	1.00	1.00	12.	0.	2.00	.00	0.
SGH	0	407	82.	1.00	1.00	12.	0.	2.00	.00	0.
MH	0	409	82.	1.00	1.00	12.	0.	2.00	.00	0.
HAC	0	460	82.	1.00	1.00	12.	0.	2.00	.00	0.
YW	0	481	82.	1.00	1.00	12.	0.	2.00	.00	0.
PER	0	521	82.	1.00	1.00	12.	0.	2.00	.00	0.
AB	54	531	82.	1.00	1.00	19.	0.	2.00	.00	0.
A	0	540	82.	1.00	1.00	12.	0.	2.00	.00	0.
WA	55	541	82.	1.00	1.00	118.	400.	2.00	.00	0.
BA	0	543	82.	1.00	1.00	12.	0.	2.00	.00	0.
GA	0	544	82.	1.00	1.00	12.	0.	2.00	.00	0.
HL	0	552	82.	1.00	1.00	12.	0.	2.00	.00	0.
BUT	71	601	82.	1.00	1.00	12.	0.	2.00	.00	0.
BW	0	602	82.	1.00	1.00	12.	0.	2.00	.00	0.
SG	0	611	82.	1.00	1.00	12.	0.	2.00	.00	0.
YP	59	621	82.	1.00	1.00	53.	0.	2.00	.00	0.
CUC	84	651	82.	1.00	1.00	44.	0.	2.00	.00	0.

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY	-- US Forest Serv.	DATE TALLIED:	AUG/1988
FOREST/PROPERTY	-- Allegheny NF	DATE PRINTED:	17/SEP/1988
COUNTY/DISTRICT	-- Ridgway	FILE:	A:\T2.SIL
COMPT - STAND	-- 12 32	DEFAULT:	SILVAH.DEF
ACRES	-- 125.00	TYPE:	TRANSITION HARDWOOD
STAND AGE	-- 68	SIZE:	SMALL SAW
SITE	-- 70 FOR BC	DENSITY:	GT 95 %

SAMPLE TRANSITION STAND

This transition stand is dominated by
Sugar Maple, Red Oak, Chestnut Oak, Black Cherry, White Oak, and Beech,
which together comprise 92. % of the basal area.

This is a small sawtimber stand, with average diameter of 12.1 inches.
Sapling trees too small to be merchantable do not represent
a significant proportion of stand stocking and need not be
included in any partial cuttings.

If this stand is managed under an even-age silvicultural system,
The several species groups will mature at markedly different times.
The average number of years to maturity is 24.
Effective stand age is about 81. years.

If this stand is managed under an all-age silvicultural system,
the distribution of diameters, proportion of sawtimber, and
density of shade-tolerant species
are adaptable to selection cutting.

Relative stand density is 97. % of the average maximum stocking
expected in undisturbed stands of similar size and species composition.
This density is well above the optimum for best individual tree growth.
At this relative density, growth rate of the biggest trees is probably
moderate, while growth rate of the medium and smaller-sized trees
is probably poor and mortality due to crowding high.

Partial cutting to provide more growing space for the better stems is
highly desirable at this time.

Total growing stock amounts to 116. sq. ft. of basal area per acre.
Gross total volume in all trees, to a 4-inch top, is 18. cords per acre;
if divided into pulpwood and sawtimber, the net merchantable volume
is 10. cords of pulp wood and 6188. board feet of
sawtimber Int 1/4"log rule.
The total stand value is estimated to be about 798. dollars per acre.

Trees of acceptable quality for future growing stock
provide a fully stocked stand by themselves.

Undesirable understory plants may interfere with regeneration.
Dense fern understory may limit regeneration.

Advance seedlings are abundant and should provide the basis
for successful natural regeneration if the overstory is harvested.
The next stand will be dominated by Black Cherry

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY	-- US FOREST SERV.	DATE TALLIED:	JUL/ 88
FOREST/PROPERTY	-- KEF	DATE PRINTED:	17/SEP/1988
COUNTY/DISTRICT	-- Trng Area B	FILE:	A:\4A.SIL
COMPT - STAND	-- 4 A	DEFAULT:	SILVAH.DEF
ACRES	-- 1.00	TYPE:	ALLEGHENY HARDWOOD
STAND AGE	-- UNKNOWN	SIZE:	SMALL SAW
SITE	-- UNKNOWN	DENSITY:	GT 95 %

SAMPLE CHERRY-MAPLE STAND

******RECOMMENDED TREATMENT:******

Make a COMMERCIAL THINNING (INTEGRATED)
to provide additional growing space for the better trees,
and to provide some intermediate yield.
The volumes to be removed are:
1704. bd ft (Int 1/4" log rule) and 9.0 cords.

MARKING INSTRUCTIONS

Reduce relative stand density to 66. %
leaving 106. sq. ft. of basal area per acre.
Remove trees in the size and quality classes shown below.

Cut 2. out of 3. trees from the pole size class.

Cut 1. out of 5. trees from the ssaw size class.

Cut 3. out of 5. trees from the msaw size class.

About 36 % of the trees cut will be UGS.
This will result in removal of about 80 % of the UGS in this stand,
and about 100 % of the merchantable-size UGS.

Within the size and quality constraints above, favor the best trees
whenever possible. Try to preserve seed sources of scarce species
if they are desired in the regeneration, and strive for uniform spacing
among residuals whenever possible.

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY	-- US Forest Serv.	DATE TALLIED:	AUG/1988
FOREST/PROPERTY	-- Allegheny NF	DATE PRINTED:	17/SEP/1988
COUNTY/DISTRICT	-- Ridgway	FILE:	A:\T2.SIL
COMPT - STAND	-- 12 32	DEFAULT:	SILVAH.DEF
ACRES	-- 125.00	TYPE:	TRANSITION HARDWOOD
STAND AGE	-- 68	SIZE:	SMALL SAW
SITE	-- 70 FOR BC	DENSITY:	GT 95 %

SAMPLE TRANSITION STAND

******RECOMMENDED TREATMENT:******

NOTE: A COMMERCIAL THINNING (INTEGRATED)
would normally be recommended for this stand,
but there is insufficient volume available for such a cutting. Therefore:

Defer any cutting now and re-examine the stand in about 10 years.

** WARNING ** Relative density is just above the 35% decision point;
A harvest cutting may also be appropriate.

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US FOREST SERV.
FOREST/PROPERTY -- KEF
COUNTY/DISTRICT -- Trng Area B
COMPT - STAND -- 4 A
ACRES -- 1.00
STAND AGE -- UNKNOWN
SITE -- UNKNOWN
SAMPLE CHERRY-MAPLE STAND

DATE TALLIED: JUL/ 88
DATE PRINTED: 17/SEP/1988
FILE: A:\4A.SIL
DEFAULT: SILVAH.DEF
TYPE: ALLEGHENY HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

	ORIGINAL	CUT	RESIDUAL
BASAL AREA - SQ FT/A			
SAPS	15.9	.0	15.9
POLES	49.5	33.8	15.7
SM SAW	90.7	17.8	72.9
MED SAW	3.5	2.2	1.4
LG SAW	.0	.0	.0
TOTAL	159.6	53.7	105.8
NUMBER OF TREES - #/A			
# TREES	486.	107.	379.
DIAMETERS - IN.			
DIAM	11.5		11.9
DIAM MER	12.4		13.3
QUAD DIA	7.8		7.2
RELATIVE DENSITY - %			
REL DEN	101.		66.
AGS RDEN	84.		60.

	ORIGINAL	CUT	RESIDUAL
SPECIES COMPOSITION - %			
% BC	53.		55.
% YP	3.		2.
% CUC	1.		1.
% SM	14.		11.
% RM	10.		11.
% AB	16.		18.
QUALITY -- % IN AGS			
% AGS	85.		95.
AGES - YRS.			
YRS MAT	31.		26.
EFCT AGE	67.		72.
STRUCTURE			
Q FACTOR	1.4		1.0
WEIB C	.0		.0

BD FT INT 1/4", VALUE/A			
GR. BDFT	9769.	2373.	7396.
NET BDFT	7072.	1704.	5368.
DOLLARS	938.	220.	718.
CORD VOLUME/A			
TOT CDS	41.9	14.4	27.5
NET CDS	33.5	11.5	22.0
PULP CDS	23.2	9.0	14.1

TOTAL STAND

BD FT INT 1/4", VALUE			
GR. MBF	9.8	2.4	7.4
NET MBF	7.1	1.7	5.4
M DOLLAR	.9	.2	.7
CORD VOLUME			
TOT CDS	42.	14.	27.
NET CDS	33.	12.	22.
PULP CDS	23.	9.	14.

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US FOREST SERV.
FOREST/PROPERTY -- KEF
COUNTY/DISTRICT -- Trng Area B
COMPT - STAND -- 4 A
ACRES -- 1.00
STAND AGE -- UNKNOWN
SITE -- UNKNOWN
SAMPLE CHERRY-MAPLE STAND

DATE TALLIED: JUL/ 88
DATE PRINTED: 17/SEP/1988
FILE: A:\4A.SIL
DEFAULT: SILVAH.DEF
TYPE: ALLEGHENY HARDWOOD
SIZE: SMALL SAW
DENSITY: 50 TO 80 %

RESIDUAL STAND

BASAL AREA - SQ. FT. PER ACRE

SPECIES > DIA.	ALL SP	BC	AB	SM	RM	YP	B	CUC	STM
1	.2	.0	.2	.0	.0	.0	.0	.0	.0
2	1.6	.0	1.1	.4	.0	.0	.0	.0	.0
3	3.2	.0	1.8	1.3	.0	.0	.0	.0	.0
4	4.4	.0	1.7	2.4	.3	.0	.0	.0	.0
5	6.5	.0	2.0	3.8	.5	.0	.1	.0	.0
6	1.3	.0	.1	1.1	.1	.0	.0	.0	.0
7	2.0	.1	.7	1.0	.1	.0	.0	.1	.0
8	1.8	.3	.5	.8	.1	.0	.1	.0	.0
9	2.0	1.1	.2	.5	.2	.0	.0	.0	.0
10	5.2	3.0	.6	.6	.4	.0	.6	.0	.0
11	3.4	2.2	.2	.0	1.0	.0	.0	.0	.0
12	13.6	5.0	4.3	.0	4.3	.0	.0	.0	.0
13	18.5	15.1	1.7	.0	1.7	.0	.0	.0	.0
14	13.6	11.7	1.9	.0	.0	.0	.0	.0	.0
15	11.2	7.8	2.2	.0	.0	1.1	.0	.0	.0
16	8.9	6.4	.0	.0	1.3	.0	.0	1.3	.0
17	7.2	5.7	.0	.0	1.4	.0	.0	.0	.0
18	1.4	.0	.0	.0	.0	1.4	.0	.0	.0
SAPS	15.9	.0	6.9	8.0	.9	.0	.1	.0	.0
POLES	15.7	6.7	2.4	3.9	1.8	.0	.7	.1	.0
SM SAW	72.9	51.7	10.1	.0	8.7	1.1	.0	1.3	.0
MED SAW	1.4	.0	.0	.0	.0	1.4	.0	.0	.0
LG SAW	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	105.8	58.4	19.4	11.9	11.4	2.5	.9	1.4	.0
SPECIES%	100.	55.	18.	11.	11.	2.	1.	1.	0.
ACCEPTABLE GROWING STOCK ONLY									
SAPS	11.1	.0	4.7	5.7	.6	.0	.0	.0	.0
POLES	15.7	6.7	2.4	3.9	1.8	.0	.7	.1	.0
SM SAW	72.9	51.7	10.1	.0	8.7	1.1	.0	1.3	.0
MED SAW	1.4	.0	.0	.0	.0	1.4	.0	.0	.0
LG SAW	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	101.0	58.4	17.2	9.7	11.1	2.5	.7	1.4	.0

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US Forest Serv.
FOREST/PROPERTY -- Allegheny NF
COUNTY/DISTRICT -- Ridgway
COMPT - STAND -- 12 32
ACRES -- 125.00
STAND AGE -- 68
SITE -- 70 FOR BC
SAMPLE TRANSITION STAND

DATE TALLIED: AUG/1988
DATE PRINTED: 17/SEP/1988
FILE: A:\T2.SIL
DEFAULT: SILVAH.DEF
TYPE: TRANSITION HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

******TREATMENT SPECIFIED BY USER:******

The volumes to be removed are:
1560. bd ft (Int 1/4" log rule) and 4.0 cords if an integrated sale
or 4.3 cords if a pulpwood only sale.

MARKING INSTRUCTIONS

Reduce relative stand density to 60. %,
leaving 75. sq. ft. of basal area per acre.
Remove trees in the size classes shown below.

Cut 1. out of 2. trees from the pole size class.

Cut 1. out of 2. trees from the ssaw size class.

Cut 1. out of 6. trees from the msaw size class.

Cut 5. out of 6. trees from the lsaw size class.

About 100 % of the trees cut will be UGS.
This will result in removal of about 89 % of the UGS in this stand,
and about 89 % of the merchantable-size UGS.

SPECIFICATIONS USED FOR THIS CUT ARE BASED ON
A SELECTION CUT

MINIMUM DENSITY	MAXIMUM REMOVED	STRUCTURE FACTOR	MAXIMUM DIAMETER	Q FACTOR
60	45		26	1.2

SPECIES	DIA TO DIA		QUAL TO QUAL		% CUT	PRIORITY
ALL	6	11	2	2	100	2
ALL	12	17	2	2	83	2
ALL	18	23	2	2	83	2
ALL	24	40	2	2	83	2

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US Forest Serv.
FOREST/PROPERTY -- Allegheny NF
COUNTY/DISTRICT -- Ridgway
COMPT - STAND -- 12 32
ACRES -- 125.00
STAND AGE -- 68
SITE -- 70 FOR BC
SAMPLE TRANSITION STAND

DATE TALLIED: AUG/1988
DATE PRINTED: 17/SEP/1988
FILE: A:\T2.SIL
DEFAULT: SILVAH.DEF
TYPE: TRANSITION HARDWOOD
SIZE: SMALL SAW
DENSITY: GT 95 %

******TREATMENT SPECIFIED BY USER:******

The volumes to be removed are:
2966. bd ft (Int 1/4" log rule) and 4.1 cords if an integrated sale
or 6.6 cords if a pulpwood only sale.

MARKING INSTRUCTIONS

Reduce relative stand density to 60. %,
leaving 70. sq. ft. of basal area per acre.
Remove trees in the size classes shown below.

Cut 1. out of 3. trees from the pole size class.

Cut 2. out of 5. trees from the ssaw size class.

Cut 3. out of 5. trees from the msaw size class.

Cut all of the trees from the lsaw size class.

About 77 % of the trees cut will be UGS.
This will result in removal of about 76 % of the UGS in this stand,
and about 76 % of the merchantable-size UGS.

SPECIFICATIONS USED FOR THIS USER-DEFINED CUT:

MINIMUM DENSITY	MAXIMUM REMOVED	STRUCTURE FACTOR	MAXIMUM DIAMETER	Q FACTOR
60	45	0/ 0		

SPECIES	DIA TO DIA		QUAL TO QUAL		% CUT	PRIORITY
AB	6	40	1	2	100	1
ALL	20	40	1	2	71	2
ALL	6	18	2	2	71	2
ALL	6	40	1	1	0	3

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US FOREST SERV.
FOREST/PROPERTY -- KEF
COUNTY/DISTRICT -- Trng Area B
COMPT - STAND -- 4 A
ACRES -- 1.00
STAND AGE -- VARIOUS
SITE -- UNKNOWN
SAMPLE CHERRY-MAPLE STAND

DATE TALLIED: JUL/ 88
DATE PRINTED: 17/SEP/1988
FILE: A:\4A.SIL
DEFAULT: SILVAH.DEF
TYPE:
SIZE:
DENSITY:

SIMULATED STAND DEVELOPMENT

YRS	NO. TREES	BASAL AREA	REL DEN	DIA MER	% CAP	% M&B	% OAK	TOT CDS	PULP CDS	MBF	$	NET GROWTH	MORT
0	486	160	101	12.4	56	30	0	33	23	7.1	938		
CUT	107	54	35					12	9	1.7	220		
RES	379	106	66	13.3	58	30	0	22	14	5.4	718		
												2.49	.05
5	375	118	71	14.0	59	28	0	26	15	7.0	1097		
												2.55	.05
10	370	131	76	14.8	60	27	0	29	17	8.7	1611		
												2.59	.06
15	364	144	80	15.6	61	26	0	33	18	10.6	2248		
CUT	58	33	20					7	5	2.0	461		
RES	307	111	60	16.2	64	23	0	26	14	8.6	1787		
												2.46	.04
20	302	124	64	17.1	66	22	0	30	15	10.4	2398		
												2.49	.04
25	297	136	69	17.9	67	21	0	33	16	12.3	3037		
												2.49	.04
30	293	149	73	18.7	67	20	0	37	18	14.2	3713		
CUT	293	149	73					37	18	14.2	3713		
RES	0	0	0	.0	0	0	0	0	0	.0	0		

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PRARREN, PA.

OWNER/AGENCY -- US FOREST SERV.
FOREST/PROPERTY -- KEF
COUNTY/DISTRICT -- Trng Area B
COMPT - STAND -- 4 A
ACRES -- 1.00
STAND AGE -- VARIOUS
SITE -- UNKNOWN
SAMPLE CHERRY-MAPLE STAND

DATE TALLIED: JUL/ 88
DATE PRINTED: 17/SEP/1988
FILE: A:\4A.SIL
DEFAULT: SILVAH.DEF
TYPE:
SIZE:
DENSITY:

SIMULATED PRODUCT YIELD

YRS	DATE	TOTAL CORDS	PULP CORDS	MBF SAW	$ TOTAL
INITIAL STAND					
0	88	22.0	14.1	5.4	718.
CUTTING YIELDS					
0	88	11.5	9.0	1.7	220.
15	103	7.4	4.6	2.0	461.
30	118	37.3	17.6	14.2	3713.
FINAL STAND					
30	118	.0	.0	.0	0.
TOTAL YIELD		56.2	31.3	17.9	4394.

SILVAH -- SILVICULTURE OF ALLEGHENY HARDWOODS - V4.5
STAND SUMMARY, PRESCRIPTION, AND MANAGEMENT SIMULATOR PROGRAM
DEVELOPED BY THE NORTHEASTERN FOREST EXPERIMENT STATION, WARREN, PA.

OWNER/AGENCY -- US FOREST SERV.
FOREST/PROPERTY -- KEF
COUNTY/DISTRICT -- Trng Area B
COMPT - STAND -- 4 A
ACRES -- 1.00
STAND AGE -- UNKNOWN
SITE -- UNKNOWN
SAMPLE CHERRY-MAPLE STAND

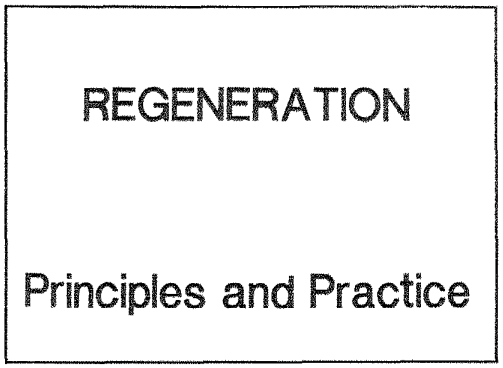
YEAR SIMULATED: 10 (98)
DATE PRINTED: 17/SEP/1988
FILE: A:\4A.SIL
DEFAULT: SILVAH.DEF
TYPE: ALLEGHENY HARDWOOD
SIZE: MEDIUM SAW
DENSITY: 50 TO 80 %

SIMULATED STAND

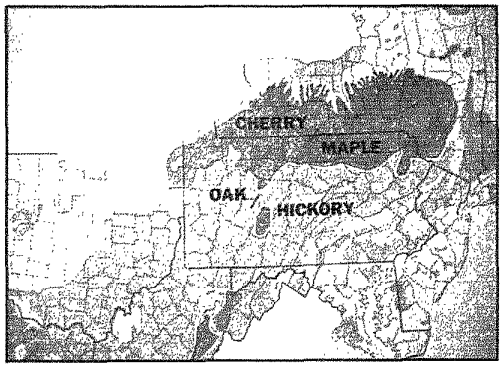
SPECIES >	ALL SP	BC	AB	SM	RM	YP	B	CUC	STM
				COMPOSITION -- BA, % OF BA, TREES					
TOT BA	131.0	75.6	22.1	13.4	13.8	3.2	1.0	1.7	.0
SPECIES%	100.	58.	17.	10.	11.	2.	1.	1.	0.
# TREES	370.	61.	166.	116.	20.	2.	2.	1.	1.
				QUALITY -- % IN AGS					
SAPS	68.	0.	66.	71.	73.	0.	0.	0.	0.
POLES	96.	100.	95.	94.	95.	0.	92.	100.	0.
SM SAW	100.	100.	100.	100.	100.	100.	100.	100.	0.
MED SAW	100.	100.	0.	0.	100.	100.	0.	100.	0.
LG SAW	0.	0.	0.	0.	0.	0.	0.	0.	0.
ALL SIZE	96.	100.	89.	82.	98.	100.	86.	100.	0.
				DIAMETERS AND AGES -- INCHES, YEARS					
DIAM	13.6	15.7	10.0	5.9	13.9	19.0	10.0	17.2	2.0
DIAM MER	14.8	15.7	12.8	7.7	14.3	19.0	10.5	17.2	.0
QUAD DIA	8.1	15.1	4.9	4.6	11.2	18.7	8.9	15.6	2.0
YRS MAT	17.	11.	35.	69.	18.	0.	50.	4.	120.
EFCT AGE	80.	79.	85.	51.	72.	95.	70.	86.	0.
				STRUCTURE					
Q FACTOR	1.09	1.03	1.12	3.12	.80	.00	.00	.00	.00
WEIB C	.00	.00	.00	.00	.00	.00	.00	.00	.00
				RELATIVE DENSITY -- %					
REL DEN	76.	28.	22.	14.	8.	1.	1.	1.	0.
AGS RDEN	70.	28.	20.	11.	8.	1.	1.	1.	8.
				VOLUMES AND VALUES - INT 1/4" LOG RULE					
TOT CDS	36.7	25.5	3.9	1.3	4.1	1.1	.2	.6	.0
MOT CDS	29.4	20.4	3.1	1.0	3.3	.9	.2	.4	.0
PULP CDS	16.9	10.6	2.5	1.0	2.2	.3	.2	.2	.0
GRS BDFT	11029.	8090.	998.	41.	1175.	466.	38.	221.	0.
NET BDFT	8703.	6838.	420.	18.	790.	427.	10.	200.	0.
DOLLARS	1611.	1516.	9.	2.	44.	29.	0.	11.	0.

Regeneration Principles and Practices

Stephen B. Horsley, L. R. Auchmoody, Russell S. Walters



1. The SILVAH stand analysis and prescription system provides a systematic procedure for analyzing data from forest stands in order to choose a silvicultural prescription. In stands being managed under an even-age system, regeneration cuttings will be prescribed by the SILVAH system when the stand has reached maturity. This paper describes the underlying principles behind even-age regeneration practices recommended by the SILVAH system, and gives guidance on the proper application of these regeneration practices.



2. The principles and practices presented here apply to the cherry-maple, northern hardwood, and oak-hickory forests that occur on the Allegheny Plateau and Allegheny Mountain sections of New York, Pennsylvania, Maryland, and West Virginia.

3. The cherry-maple type is a variation of the northern hardwood type consisting primarily of black cherry, red maple, sugar maple, and beech. Associated species include white ash, yellow-poplar, sweet and yellow birch, cucumbertree, and hemlock. Cherry and the maples usually dominate stands in Pennsylvania and southward; white ash and sugar maple tend to be more important, and red maple less important, in the New York portion of the range. Stands with less than 25 percent basal area in black cherry are considered part of the northern hardwood type. The small proportion of cherry affects ease of regeneration, however, the two types are at opposite ends of a continuum.

NORTHERN HARDWOOD SEED SUPPLY

Species	Periodicity (yrs)
Black Cherry	2 - 3
Red Maple	2 - 3
White Ash	3 - 5
Sugar Maple	3 - 5
Yellow-Poplar	1
Beech	6

10. Black cherry and red maple produce abundant seed, with good crops occurring every 2 or 3 years. White ash and sugar maple have good seed crops much less frequently approximately every 3 to 5 years. Yellow-poplar may produce a good seed crop almost every year; crop failures as well as bumper crops, only occur infrequently. Although yellow-poplar produces a lot of seed, viability is extremely low, seldom more than 5 percent. Beech produces a good seed crop at approximately 6-year intervals.

OAK SEED SUPPLY

Species	Periodicity (yrs)
Northern Red Oak	4 - 5
White Oak	4 - 5
Scarlet Oak	4 - 5
Chestnut Oak	4 - 5
Black Oak	3

11. In general, oak acorn production is very erratic. Black oak may produce a good acorn crop approximately every 3 years, whereas red, white, chestnut, and scarlet oaks may only have a good crop every 4 or 5 years. Bumper crops occur irregularly and may be as infrequent as 10 years apart. It is believed that significant quantities of oak seedlings originate only in years of a bumper seed crop, when quantities in excess of those consumed by mammals and insect predators are produced. These seedlings are generally from acorns cached but not retrieved by small mammals.

SEED STORAGE IN FOREST FLOOR

Northern Hardwoods	Years
Black Cherry	3 - 5
White Ash	3 - 5
Yellow-Poplar	3 - 5
Red Maple	1 - 2
Birch	1 - 2
Hemlock	1 - 2
Sugar Maple	0
Beech	0

12. Buried seed is an important source of regeneration in Allegheny stands. Seeds of some species remain viable for several years. Among the northern hardwoods, black cherry, white ash, and yellow-poplar seeds may remain dormant and viable in the forest floor for 3 to 5 years. This helps ensure a relatively constant seed supply for these species. Red maple, birch, and hemlock seeds seldom remain viable in the forest floor for more than a year or two. But, these species have frequent seed crops, so their seed supply is also relatively constant. Sugar maple and beech seeds commonly germinate following dispersal, and do not store in the forest floor.

SEED STORAGE IN FOREST FLOOR

Oaks	Years
Northern Red Oak	0
White Oak	0
Scarlet Oak	0
Chestnut Oak	0
Black Oak	0

13. Lack of seed storage in the forest floor also is common to the northeastern oaks.

14. Some species, notably beech and aspen, also reproduce abundantly from root suckers.

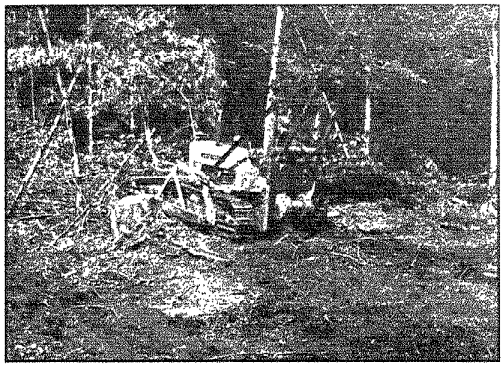
15. Striped maple, an undesirable species, produces seeds almost every year, but the seeds do not remain viable for more than a year or so. However, striped maple seedlings can persist in the shade of a closed canopy, growing very slowly for up to about 40 years.

SEED STORAGE IN FOREST FLOOR

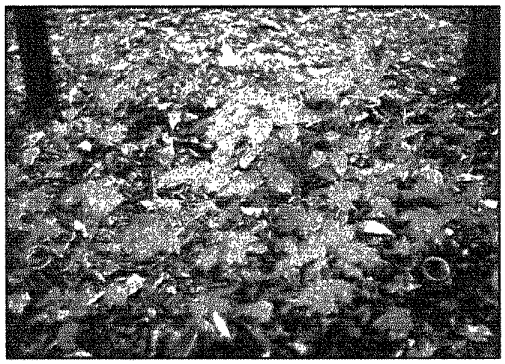
Noncommercial Species

Species	Years
Striped Maple	1 - 2
Pin Cherry	30+
Rubus spp.	30+
Grass	Many
Sassafras	5
Grapevine	11+
Rhododendron	5
Dogwood	0
Sourwood	0
Blackgum	0
Laurel	?

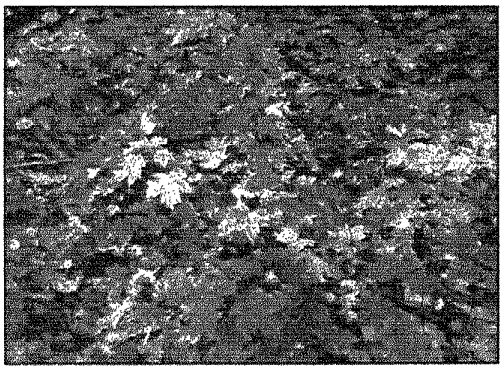
16. Buried seeds of non-commercial and undesirable species also are important in revegetation of disturbed stands. These include pin cherry, blackberry, raspberry, grass, other herbaceous plants, sassafras, grapevine, and rhododendron. Seeds of dogwood, sourwood, blackgum, and mountain laurel have little or no storage life.



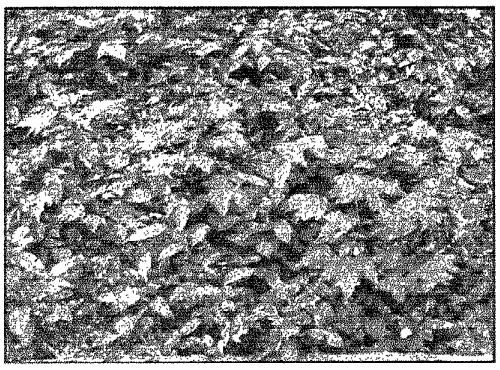
17. Seedbed requirements vary among species. Birches regenerate more abundantly on scarified seedbeds, but scarification is not required. Red maple, white ash, and hemlock germinate better where the surface organic layers have been disturbed or mixed with mineral soil.



18. Sugar maple, beech, and black cherry germinate as well on undisturbed forest floor as on disturbed sites. High surface moisture is necessary for good germination of all species.



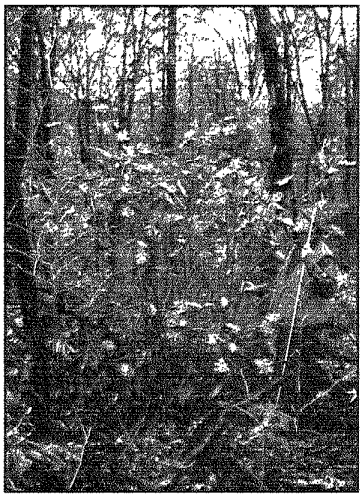
19. Advance reproduction of sugar maple, beech, and hemlock is very shade-tolerant and can survive and grow in uncut or lightly cut stands for many years.



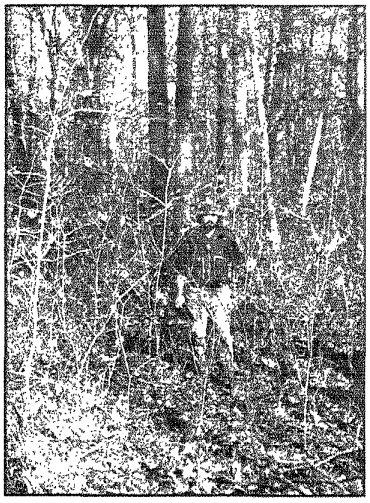
20. Even the less tolerant cherry, ash, most oaks, and red maple can germinate and survive for 3 to 5 years under a moderately heavy canopy. These seedlings will die, if the overstory is not reduced, but new seedlings are constantly germinating to replace them.

21. In addition, all of the hardwood species can also reproduce from sprouts. Red maple is well known as a prolific sprouter. Black cherry, white ash, sugar maple, beech, birch, and the oaks sprout readily from dormant buds around the base of stumps. Stumps of small trees less than 4 inches in diameter sprout more frequently than stumps of larger diameter trees.

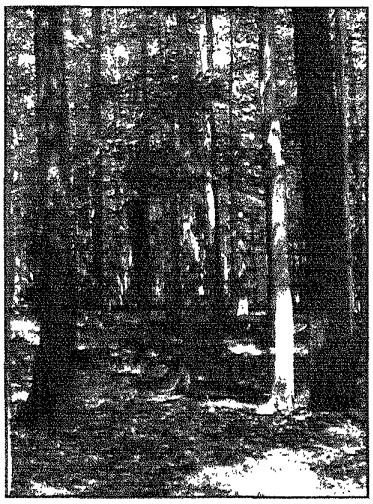
22. Because of its strong sprouting ability, oak regeneration can survive browsing, breakage, drought, and fire. Top dieback and resprouting of seedlings usually occurs a number of times. Each successive shoot is taller and the root system is stronger. These shoots are called seedling sprouts.



23. Where oak regeneration is obtained, seedling sprouts and stump sprouts usually form much of the new stand. Thus, oak stands are regenerated before, not after, the harvest cut.



24. Many oak stands are transitory on sites where shade-tolerant hardwoods are the climax. The trend toward this climax is very strong. Without adequate large oak advance regeneration, a new oak forest will not regenerate. Small oak seedlings, if present, cannot grow fast enough to compete with faster growing species, such as black cherry, red maple, and yellow-poplar.



25. Stand density controls the quantity of light available to advance regeneration, and is an important environmental factor affecting seedling development. Reducing stand density to 60 percent of full stocking improves conditions for seed germination and seedling survival, but permits only a small amount of growth. Thus, the number of small advance seedlings increases gradually over a 5- to 10-year period.

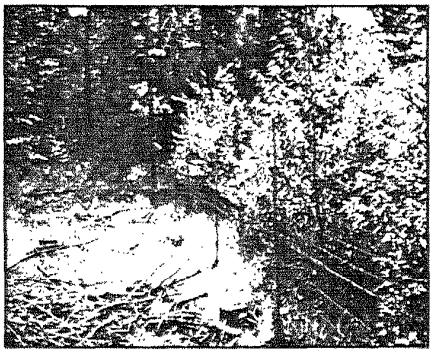
Deer Browsing

26. Even in the presence of adequate light, the understory of hardwood stands in Pennsylvania lacks the waist-high regeneration commonly found in other eastern hardwood types. When desirable seedlings are present, they are normally only a few inches tall. The dramatic difference in regeneration between hardwood stands in Pennsylvania and similar stands elsewhere has been brought about by long-term browsing from a large herd of white-tailed deer. Deer browsing has caused continuous damage to forest vegetation since the 1920's.

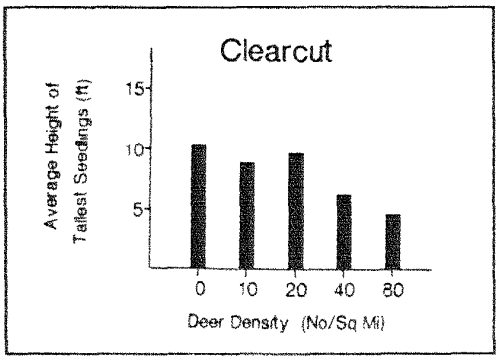
Deer Browsing Effects

- Fewer seedlings
- Smaller seedlings
- Altered species composition

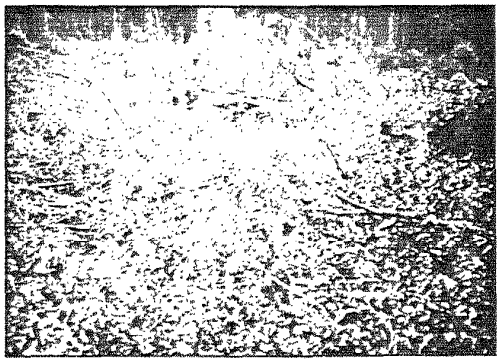
27. Deer browsing has several effects on regeneration. The number of seedlings is reduced, surviving seedlings are smaller, and the species composition is altered.



28. Deer dramatically affect regeneration stocking. Where deer were excluded by fencing (right), regeneration was successful; but where they were not (left), regeneration failed. Browsing by white-tailed deer is presently recognized as the most important cause of regeneration failure in the forests of Pennsylvania.



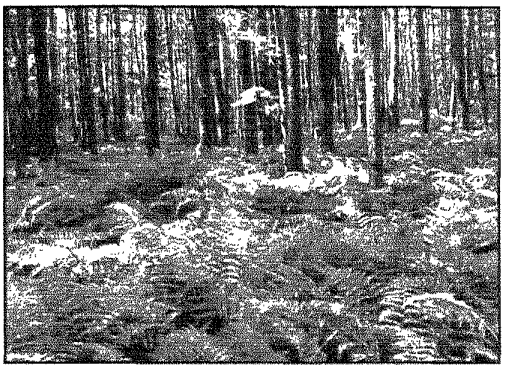
29. Deer browsing also has strong effects on seedling height. This chart shows the average height of the tallest seedling in 5-year-old clearcuts where different deer densities were maintained. Seedling height is reduced dramatically at higher deer densities. At 40 and 80 deer per square mile, seedlings were only half as tall as those at 10 and 20 deer per square mile. Thus, the amount of time required to establish a new stand increases with increasing deer densities.



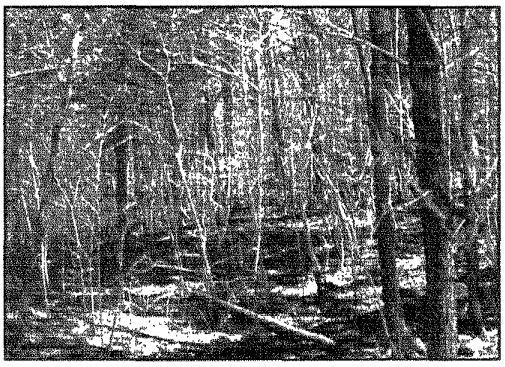
30. Deer browsing effects the species composition of regeneration. Desirable timber species, such as the maples, ash, and yellow-poplar, are highly preferred by deer and tend to be eliminated when they are small seedlings. Since black cherry is very abundant and is intermediate in food preference, it is browsed to a lesser extent. Thus, with the higher deer populations found on the Allegheny Plateau, if any desirable regeneration is present it tends to be black cherry, as shown here. Stands composed mostly of black cherry have shortcomings for timber production and deer habitat. Monotypic stands are vulnerable to insect and disease attacks and they lack the diversity needed for high-quality wildlife habitat.

Interfering Plants

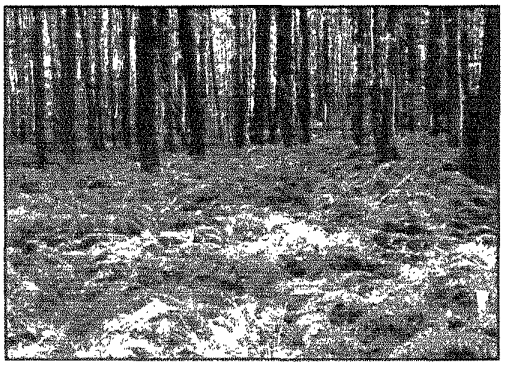
31. In addition to causing fewer seedlings of smaller size, deer browsing also increases the abundance of undesirable herbaceous and woody plants. Such changes are most obvious in stands that have had thinnings or shelterwood cuttings in the past 25 years or so. These cuttings have dramatically increased hayscented fern, New York fern, short husk grass, striped maple, and beech in the understory.



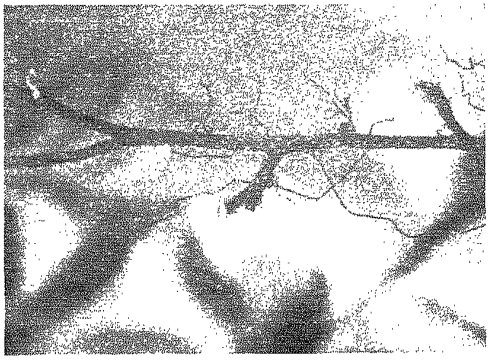
32. Increases in the amounts of these plants seem to have occurred for several reasons. First, they are either low on the food preference list of deer, or they tolerate browsing, or they resprout readily. Ferns and grass form a very small portion of the deer's diet and are not browsed extensively. Striped maple and beech are browsed to some extent, but they are not killed and are able to respond with vigorous new growth.



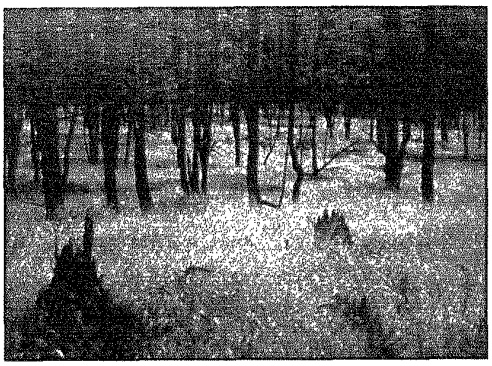
33. Second, all of these species are tolerant of understory shade. Beech is one of the most shade-tolerant species in the eastern hardwood forest. And, the ferns and striped maple actually grow better in partial shade than when fully exposed in a clearcut.



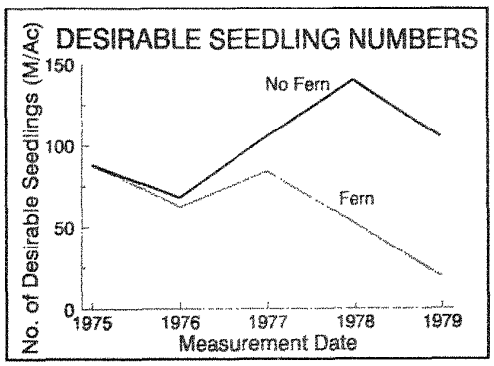
34. Lacking competition from the more palatable species, undesirable species are able to thrive in the understory. Understanding how these plants regenerate and become established is an important first step in learning how to control them.



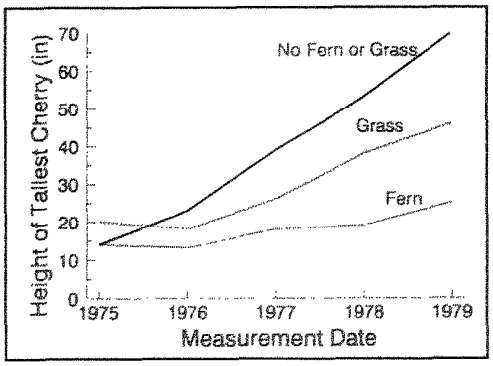
35. Hayscented and New York fern regenerate from spores where bare mineral soil is present, but they spread primarily from a perennial underground stem or rhizome. The ferns spread by repeated forking and extension of the rhizome. In stands where a portion of the overstory has been removed, the rhizome not only grows faster and forks more frequently than in uncut stands, but it also forms many new rhizome buds. These buds grow out rapidly and greatly expand the area covered by the fern plant.



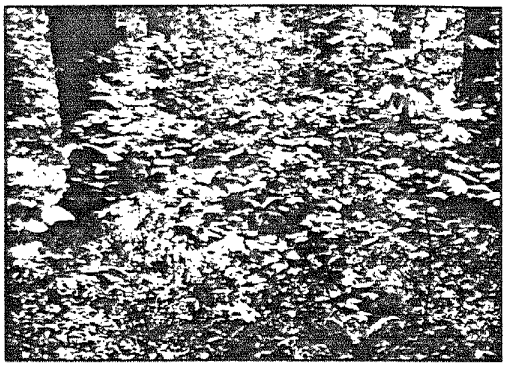
36. Short husk grass has a rhizome system similar to that of the ferns, but this species also produces large quantities of seed that fall to the ground and are stored in the forest floor. The forest floor also contains seeds of other grasses and sedges that germinate after logging disturbance.



37. These plants interfere with the development of advance regeneration of Allegheny hardwoods. We found that ferns have a major effect on the buildup of desirable seedlings. After 5 years, where seedlings were fenced and weeded of ferns, there were 106,000 desirable seedlings per acre. But where seedlings were fenced, and ferns were not removed, there were only 19,000 desirable seedlings per acre.



38. After a shelterwood removal cut, desirable seedlings, such as black cherry, grow less in the presence of fern and grass. Both fern and grass reduce seedling height growth, but ferns have a greater effect than grass. Hardwood seedlings are inhibited by fern and grass, and with the present high deer population few are able to grow above the reach of deer.



39. Dense understories of tolerant hardwoods also have undesirable effects on hardwood advance regeneration. Even small stems of tolerant species can be troublesome in partially cut stands because they often develop faster than the less tolerant regeneration of desirable species.

INTERFERENCE IN OTHER FOREST TYPES

- Fern and Grass
- Rhododendron and Mountain Laurel
- Undesirable Hardwood Understories
- Grapevine

40. In addition to fern, grass, striped maple, and beech, many oak stands contain dense understories of rhododendron and mountain laurel or understories of tolerant species, such as dogwood, sourwood, sassafras, red maple, and black gum. When these species are present in dense stands, oaks either fail to become established or are not able to outgrow these competitors. Climbing grapevines can also physically damage or kill large saplings or small poles by breaking tops and branches, twisting and bending stems and uprooting trees. Grapevines are an important problem in northern hardwood stands where deer populations are low.

INTERFERENCE

›30% of Plots

Stocked with

Interfering Plants

41. Our studies show that if more than 30 percent of the 6-foot radius regeneration sample plots in a stand are stocked with interfering plants, adequate regeneration of desirable species is not likely to develop under the partial shade of a shelterwood seed cut. A plot is considered stocked with interfering plants if it contains at least 12 stems (weighted by size) of any woody interfering plant, at least 30 percent ground cover by fern on the 1/20-acre area surrounding the plot center, or at least 30 percent ground cover by grass on the 1/20-acre plot surrounding the plot center. Any plot with at least 1 grapevine is considered stocked with grapevines.

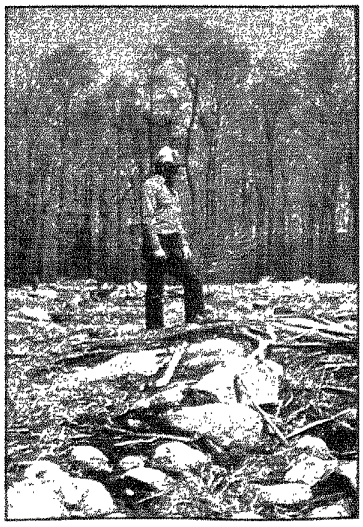
SITE LIMITATIONS

- Wet Soils
- Droughty Soils
- Stony Soils
- Logging Damage

42. The last major factor that can affect regeneration is limitations imposed by site conditions. In northwestern Pennsylvania, the most important site limitations are wet, droughty, and stony soils. Soil type also affects the amount of damage to advance regeneration that can occur during logging.

43. Wet soils almost always lack adequate regeneration. This is caused by excess water, poor soil aeration, the tendency of these poorly drained sites to be frost pockets, and presence of undesirable fern and grass cover. Slow growth of the seedlings that do get established exposes them to deer browsing for an extended time, further reducing the chances for regeneration success.

44. Droughty soils affect regeneration, not only because they cause seedlings to desiccate and die, but also because they affect species composition of the overstory and, hence, the seed supply to the site.



45. Very rocky surface soils also present difficulties for regeneration. Such sites are characterized by a thin forest floor that covers the underlying rocks over a high percentage of the area. In uncut stands, seedlings may be present, but they are often rooted only in the forest floor and humus covering the rocks. When the overstory is removed, the thin forest floor dries out rapidly and the seedlings die. Rocky surface soil usually can be identified before cutting by its hard uneven surface and scattered areas of exposed rock.

Special Precautions Needed

When

Wet or Stoney Soils

Exceed 30 Percent

46. We recommend that limiting site factors be recorded during the advance regeneration survey. If 30 percent or more of the 1/20-acre area around regeneration plot centers have limitations from wet or stony soils, then special cutting measures must be used to regenerate the stand.

47. One last point about soils concerns the survival of advance regeneration during and after logging. Logging disturbance and soil compaction can eliminate many of the advance seedlings in areas used by skidders, resulting in patchy regeneration. Destruction of seedlings from uncontrolled skidding on vulnerable soils can easily account for failure of regeneration on 30 percent of an area. Disturbance stimulates development of grass ground cover from seed buried in the forest floor. And deer further compound the problem because severe browsing eliminates the few seedlings that remain. Generally, the wetter the soil, the greater the number of seedlings that will be destroyed.

Obtaining Successful Regeneration

- Cutting Techniques
- Increase Seed Supply
- Reduce Deer Browsing
- Control Logging Damage to Seedlings
- Special Measures

48. Despite barriers to obtaining reproduction, it is possible to regenerate most stands. By evaluating the amounts of advance regeneration and the barriers to obtaining it, we can recognize the treatments necessary to successfully reproduce the stand. Regeneration success can be improved by using proper cutting techniques, increasing the seed supply, reducing deer browsing, controlling logging damage, and by using special measures that include herbicides, fertilization, and fencing.

Cutting Techniques

49. Using proper cutting techniques is the primary way we establish desirable regeneration.

50. In areas of high regeneration potential, simple overstory removal, or clearcutting, will usually provide satisfactory regeneration.

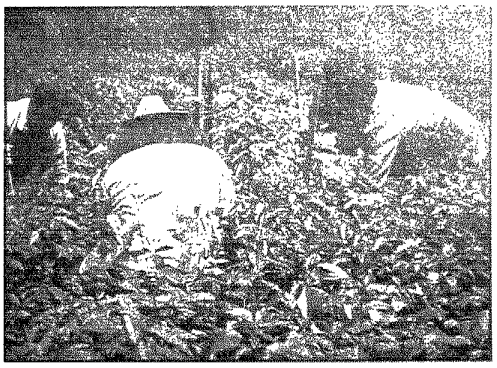
Areas with High Regen Potential

- Abundant advance seedlings
- Established sapling/small pole regen
- High potential to develop new stems

51. The key is to recognize these areas of high regeneration potential before prescribing a cut. These are stands with abundant advance seedlings, established sapling or small pole regeneration, or high potential to develop new stems from stump sprouts, buried seed, or seeds produced on site.

52. Advance seedlings are the primary source of reproduction in all forest types in the Allegheny region. The number of advance seedlings required varies, depending upon species, seedling size, and the amount of deer browsing expected.

53. In areas of high deer population, deer will consume many seedlings after cutting. So, large numbers are required to provide more than deer can eat. This situation is made worse by the fact that advance seedlings tend to be small from constant browsing in these areas. Since survival after cutting is relatively low for small seedlings, even larger numbers are required.



54. In areas of high deer population in northwestern Pennsylvania, no stands with less than 20,000 seedlings per acre have qualified for harvesting under our advance regeneration guidelines, and stands that do qualify average more than 50,000 advance seedlings per acre. Obviously, very large numbers of small advance seedlings are required to provide regrowth dense enough to overwhelm the deer.

FEWER DEER

FEWER SEEDLINGS REQUIRED

55. In areas of lower deer population, advance seedlings tend to be larger. Not only do the larger stems survive better after cutting, but also it is not necessary to provide excess quantities for deer consumption. So, fewer advance seedlings are required to assure successful regeneration.

Advance Regen Stocking

Weighted Number per Plot

Deer Index	Black Cherry	Small Oak	Other Des.	All Des.	Large Oak
5	50	60	200	200	1
4	25	40	100	100	1
3	20	30	50	50	1
2	15	20	30	30	1
1	10	10	15	15	1

56. Our guides to advance regeneration reflect these factors. For a 6-foot-radius regeneration sample plot to be adequately stocked in areas of high deer population, (Deer Impact Index = 4) we require 25 black cherry, 40 small oaks, or 100 other desirable seedlings assuming all are less than 1 foot tall. A single oak seedling greater than 4.5 feet tall will do. In areas of low deer population (Deer Impact Index = 2), fewer seedlings are required: 15 black cherry, 20 small oaks, or 30 other desirable seedlings are adequate if all are less than 1 foot tall. Since advance seedlings tend to be larger than (over 1 foot) in areas of low deer, the required number of seedlings may be even less. For example, 100 other desirable seedlings are required when deer population is high and seedlings are small, but only 15 other desirable seedlings are required when deer population is low and seedlings are large.

CLEARCUTTING GUIDES

Advance Seedlings > 70%

57. The number of advance seedlings present can be used to determine whether a single 6-foot-radius regeneration plot is adequately stocked. To ensure that an entire stand will regenerate satisfactorily, a large proportion of the stand area must have adequate regeneration. Any stand with less than 70 percent of the area stocked when it reaches merchantable size is unsatisfactory; so, 70 percent of the regeneration plots must be adequately stocked with advance seedlings before there is assurance that overstory removal or clearcutting is warranted.

58. In some situations, regeneration may come from sources other than advance seedlings. Oak stump sprouts are an important source of oak regeneration, and it is possible to predict their potential numbers from data on overstory species and size. Potential stump sprouts can thus be substituted for advance seedlings in determining regeneration potential.

Expected percentage of oak stumps that will sprout after cutting

Size	CO	SO	RO	BO	WO
Saps	100	100	100	85	80
Poles	90	85	60	65	50
SSaw	75	50	45	20	15
Larger	50	20	30	5	0

59. This table shows that the expected percentage of oak stumps that will sprout after cutting varies with oak species and stump size. Chestnut oak is the most prolific sprouter, while white oak is the least prolific sprouter. Moving down the chart, notice that as stump size gets larger, the percentage of sprouting stumps gets smaller. Oak stump-sprouting ability is not influenced by site quality and season of cutting has very little effect. Stumps cut at the time of full leaf development may sprout slightly less than stumps cut at other times. SILVAH estimates the potential contribution of oak stump sprouts to regeneration stocking by multiplying the overstory tally of oaks by species and diameter times the factors shown in this table.

60. Pole size trees of shade-tolerant species in existing stands can also be retained as sources of regeneration. Only trees with good crowns and clear straight boles that are free of epicormic branches are suitable. We suggest leaving 30 to 80 trees per acre that are 3 to 10 inches in diameter as shown here. The goal is to leave up to 10 square feet of basal area in tolerant residuals. The present value of these small trees is low, but they respond rapidly and some can be harvested in the first thinning, helping to defray costs. And they also serve as a seed source of tolerant species when the stand is regenerated at the end of the next rotation. With a head start, these trees will mature at about the same time as the faster growing black cherry. Each 6-foot-radius regeneration plot containing at least one acceptable residual tree can be used as a substitute for advance seedlings.

RESIDUAL TREES

UP TO 20% OF

REGEN SAMPLE PLOTS

61. However, if too many plots are stocked with residual tolerant trees, their crowns will quickly close, reducing the amount of light reaching the forest floor. Intolerant species, such as black cherry, white ash and yellow-poplar, which require high levels of light to survive and grow, will not form a significant part of the new stand. So, at least half of the plots must be stocked with small advance regeneration; residuals may be used for the rest to reach 70 percent stocking.

62. Sapling-size trees in the understory of existing stands are still another source of regeneration. These are usually the result of past cutting, either a shelterwood seed cut or a high-grading of some sort. The dense sapling understory usually precludes small advance regeneration, but will form the next stand by itself if released from the remaining overstory trees.

SAPLING REGENERATION GUIDES

70% of Plots Must Have

2 Stems 0.5 - 2.0" dbh

or

1 stem 2" - 6" dbh

63. To be stocked with sapling regeneration, a 6-foot-radius plot must contain two stems 1/2 to 2 inches in diameter, or one stem 2 to 6 inches in diameter. The saplings must be commercial species of acceptable quality and vigor.

SAPLING REGENERATION

ADEQUATE WHEN 70%

OF PLOTS ARE STOCKED

64. With sapling regeneration, we do not substitute plots stocked with sapling regeneration for plots stocked with advance seedlings. Instead, the entire stand must have adequate sapling regeneration over 70 percent of the area before overstory removal is recommended. Thus, the overstory removal is essentially a release cut for the large advance reproduction resulting from some prior cutting operation.

65. Buried and wind blown seed are also sources of regeneration. For black cherry, the presence of advance seedlings is usually an indicator that there is seed stored in the forest floor seed bank. Some of this seed germinates each year and tends to compensate in years with small seed crops. Only two species, birch and yellow-poplar, often regenerate in large numbers from buried seed when there is no advance regeneration. In the Alleghenies, birch is not considered a desirable species, so we do not count birch seed sources in our assessments of regeneration potential. Yellow-poplar is different. In areas of low deer population, when seed sources are present, significant yellow-poplar regeneration may arise from seed stored in the forest floor.

SHELTERWOOD SEQUENCE

SEED CUT

Reduce stocking to 60% (50% where deer browsing is low) to establish large numbers of small seedlings

REMOVAL CUT

Release established seedlings and let them grow quickly above deer

66. If advance seedlings are scarce before the final harvest, seedling numbers usually can be increased by a sequence of shelterwood cuts. The seed cut should reduce the overstory to 60 percent of full stocking, where deer browsing is high, and to 50 percent where deer browsing is low. This makes additional sunlight, moisture, and nutrients available for the establishment of new seedlings.

Shelterwood Increases Numbers

Study Report	No Shelterwood	With Shelterwood
Bjorkbom & Walters 1986	3,000	28,000
Horsley 1982	33,000	161,000
Marquis 1979	0	49,000

67. The 60 percent shelterwood in high deer areas greatly increases the number of advance seedlings, but permits only small increases in seedling growth. This is an advantage in areas of high deer population, because the small understory seedlings are browsed only lightly, making it easier to build up the large numbers of stems required. In low deer areas, the 50 percent shelterwood provides for both increases in seedling numbers and moderate growth.

68. Once an adequate number of seedlings has become established, the remaining overstory can be removed. This usually requires 3 to 10 years. The overstory removal in this two-cut shelterwood sequence is essentially identical to the clearcutting recommended when advance seedlings are naturally abundant.

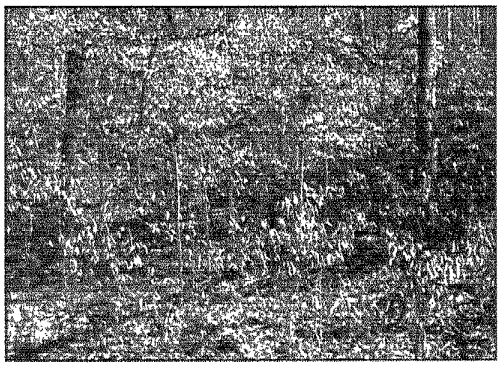
DO NOTHING

Where Shelterwood Needed

but

Overstory Density <70%
Deer Impact - High
Seed Production - Low

69. There are several situations where shelterwood cutting probably will not work without combining it with other remedial measures. Shelterwood cutting probably will not work when the overstory density is already below 70 percent. At these densities, overstory density is already low enough to provide adequate light, water, and nutrients for seedling establishment. Further overstory reduction will do no good and may stimulate the spread of undesirable plants. Shelterwood cutting also may not work where there is a combination of high deer browsing and low seed production.



70. Shelterwood cutting usually will not work where undesirable understory plants, such as beech root suckers, striped maple seedlings, and herbaceous fern and grass, are present in moderate amounts because these plants are stimulated so much by the increased resources created by the cutting that they interfere with establishment of desirable seedlings.

INTERFERING PLANT GUIDE
UNCUT STANDS

≥ 30% of plots stocked
with interfering plants and
regeneration stocking ≥ 70%

Apply Herbicide
Make Shelterwood Cut

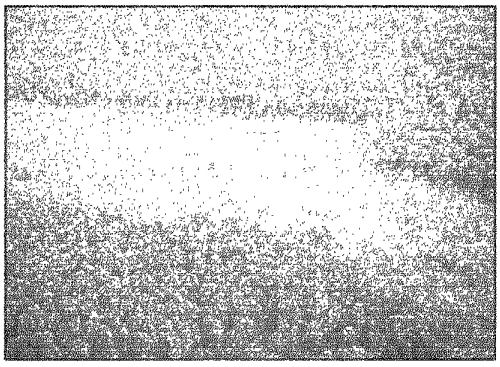
71. In stands where a shelterwood seed cut is proposed to increase advance regeneration, but where interfering plants are already moderately dense, herbicides should be applied to remove the interfering plants before making the shelterwood seed cut. As a guide to levels of interfering plant density that may cause problems during the shelterwood seed cut, we use the proportion of plots stocked with any interfering plant. If 30 percent of all plots examined are stocked with interfering plants, an herbicide is recommended before the shelterwood seed cut.

72. If oak advance regeneration already is adequate, shelterwood cutting may actually be detrimental to establishment of a new oak stand. The oaks grow more slowly than many desirable and undesirable species with which they compete, so providing partial sunlight for faster growing species may give quick-starting competitors an advantage over oak. If adequate large oak advance reproduction is present, clearcuttings usually will reproduce rapidly growing new stands containing oaks, other light-demanding species, and a few shade-tolerant species, especially on site index 60 and below.

Shelterwood Cutting Alone Won't Regenerate Oaks

Determine Problem
Take Remedial Action

73. In the absence of adequate oak advance regeneration, clearcutting eliminates oaks from the site, except for a few stump sprouts. On good sites, the stand will be converted to other fast growing, shade-intolerant species, such as yellow-poplar, black cherry, and red maple. Shelterwood cutting provides a starting point for increasing the numbers of oak seedlings in the stand. But best results have been obtained with very light cutting, even non-commercial timber stand improvement. Shelterwood cutting may need to be combined with measures to control competitors. These techniques are still under study.

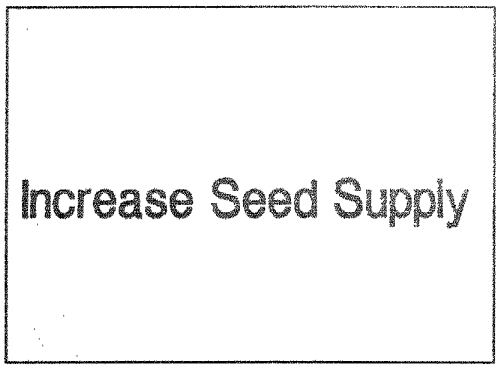


74. Removal cuts in the shelterwood sequence in all forest types can begin as soon as the amount of advance regeneration meets the guidelines described earlier for removal cuts. This will usually take 3 to 10 years. The removal cut may be made in either one or two stand entries. In most situations, a single removal cut produces the best regeneration with the least damage to advance seedlings and is the most efficient procedure.

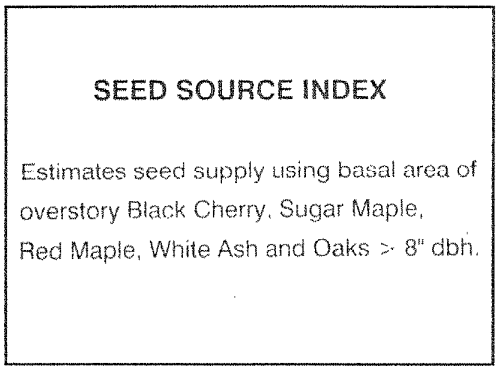
USE A 3-CUT SHELTERWOOD WHERE THERE ARE

- **Site limitations**
- **Management goal restrictions**

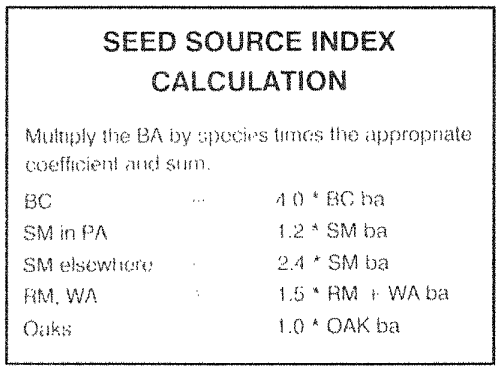
75. Site limitations may make a three-cut shelterwood necessary in some stands. The purpose is to allow seedlings to reach large size and ensure their establishment under the difficult environmental conditions that follow complete overstory removal. This three-cut sequence also can be used when management goals make it desirable to have the new stand tall enough to avoid the undesirable appearance of a fresh clearcut.



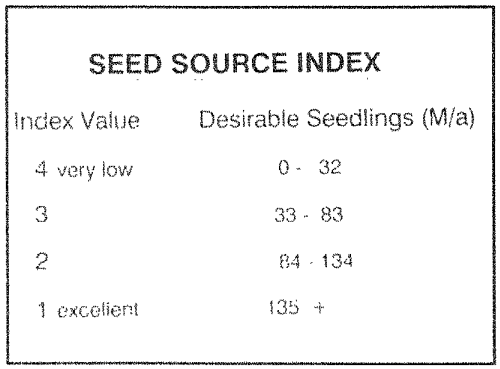
76. Seed supply is a major factor influencing regeneration. If there is not an adequate seed supply, you cannot expect to have seedlings in the understory.



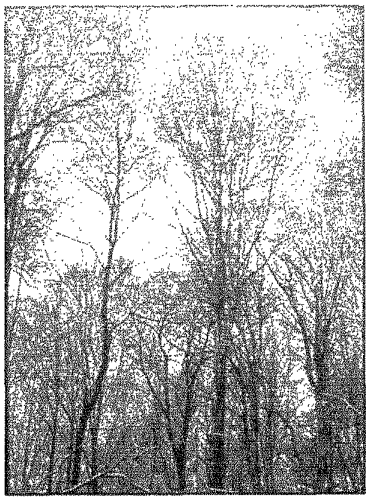
77. The amount of seed produced in a stand is related to basal area of the species in the overstory. A helpful parameter to estimate whether seed sources are limiting natural regeneration is the seed source index. The determination is made using the basal area of overstory black cherry, white ash, red maple, sugar maple, and oaks of any species 8 inches d.b.h. and larger.



78. Sugar maple is the only tolerant among these species and is often overtopped by faster growing species such as black cherry. Furthermore, sugar maple flowers and leaves have been damaged repeatedly by the insect pear thrips in many northern Pennsylvania areas. When either of these situations occur, sugar maple seed production is very limited. Calculation of the seed source index for sugar maple requires a subjective judgment of ability to produce seed. A small seed production coefficient is used when sugar maple are overtopped and thrip-infested, whereas the normal coefficient is used when sugar maple are in the dominant or co-dominant crown position, without thrip infestation.



79. Basal area of each species 8 inches and larger is multiplied by a coefficient and the products totaled. This represents the total number of seedlings likely to originate over a 5-year period from available seed. A seed source index of 1 represents excellent seed production potential, while a value of 4 represents very low seed production potential.

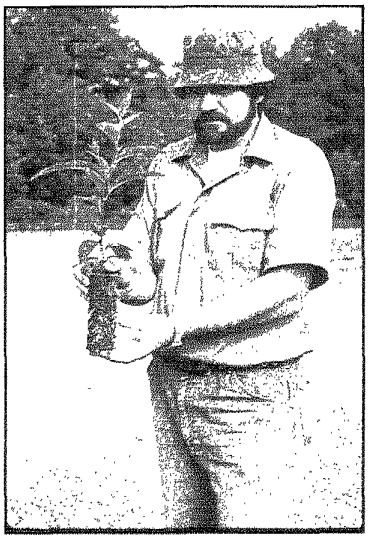


80. Seed production for regeneration of the next stand is an important consideration during the intermediate stage of stand culture. Thinnings should attempt to encourage the species desired in the next stand to assume and maintain dominant and codominant crown positions and remove undesirable species from these positions. Such a program will maximize the stand's potential for natural seed production. Once a stand has reached the stage when it is ready to regenerate, there is little that one can do to increase natural seed production.

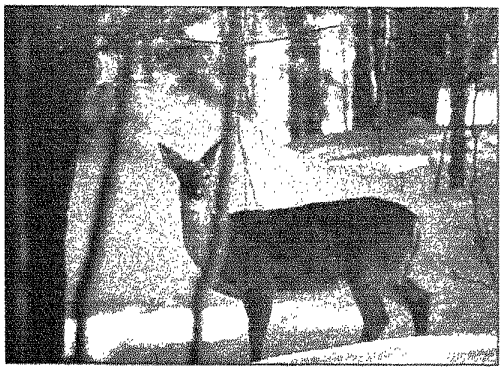
LOW SEED SUPPLY

- Determine cause
- Take remedial action

81. Insects may limit the seed supply of some species. This happens with oaks and sugar maple seed supplies. Fire and insecticides may be appropriate remedial treatments, depending upon the life cycle of the insect. Unfortunately, these are current research topics and clear treatments have not yet emerged.



82. The only way to deal with inadequate natural seed supplies at the end of the rotation is artificial regeneration (to avoid the need for natural seed supplies entirely) or fencing in areas of high deer population (to reduce the numbers of seeds required to establish adequate numbers of seedlings).



83. Excessive deer browsing is the most important single factor limiting regeneration success in Allegheny hardwood stands in Pennsylvania.

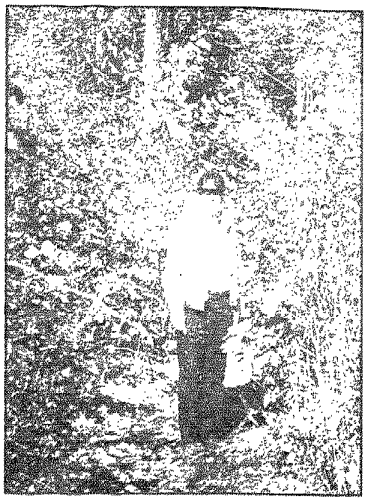
Reduce Deer Browsing

84. The most serious situation occurs when deer populations are high and available deer food is low. So, this means that any reduction in browsing pressure should result in a corresponding increase in successful regeneration. Browsing can be reduced by increasing the amount of available deer food or by decreasing the number of deer, or both.

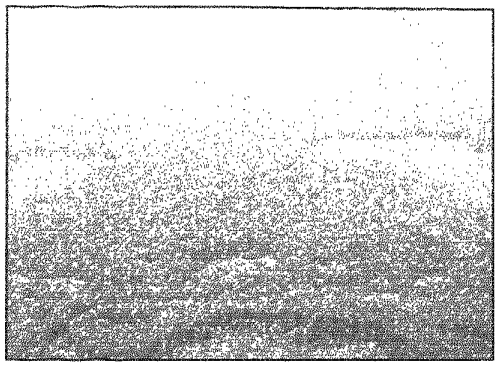
Key to Success

overwhelm the critters
with abundant food

85. Our strategy for securing successful regeneration is to overwhelm the deer with more seedlings than they can eat, so some seedlings can escape to form the next stand. This can be done by selecting areas with abundant advance regeneration,



86. by increasing the number and size of advance seedlings through shelterwood cutting and herbicide control of interfering plants,

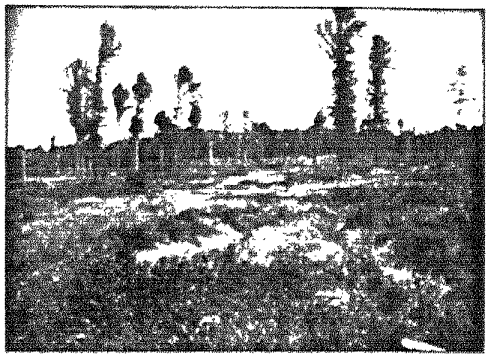


87. and by maximizing the area that is in a high deer-food producing condition. The larger the area in regeneration openings and thinnings, the greater the deer food production, and the lower the browsing impact on regeneration. Thus, to reduce browsing, it is important to schedule as much area as possible in clearcuttings and thinnings, and ensure that clearcuts contain as many advance seedlings as possible. In Allegheny hardwood stands it is possible to regenerate large amounts of black cherry and small amounts of species such as red maple, birch, and cucumber with deer populations as high as 32 deer per square mile, if 10 percent of the area is clearcut and 30 percent of the area is thinned every 10 years.

Control Logging Damage

To Seedlings

88. Logging damage to advance seedlings limits successful regeneration after overstory removal, and must be controlled.



89. Destruction of advance seedlings from uncontrolled logging operations on sensitive soils can easily cause regeneration failure on 30 percent or more of clearcut areas, and result in patchy regeneration as shown in this 3-year-old sale area. The problem usually increases with closeness to the landing because the areas are the most heavily traveled. In areas of high deer population, the seedlings that escape damage, as well as those that may seed in afterwards, are heavily browsed and eventually die leaving logging corridors treeless and covered with grass

Control Logging Damage

- Limit Disturbance
- Apply Soils Information

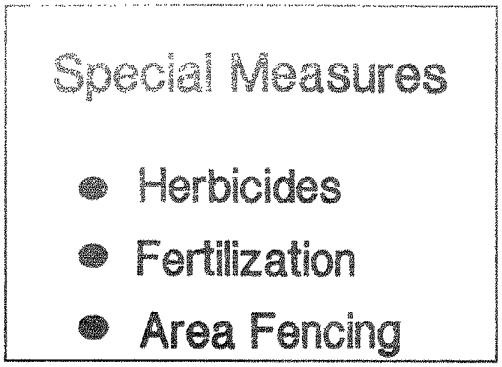
90. Logging damage to advance seedlings and soil compaction can be minimized by placing restrictions on the surface area that can be disturbed during the harvest operation, and by prescribing logging practices that are compatible with the soils in the sale area.

Logging Restrictions

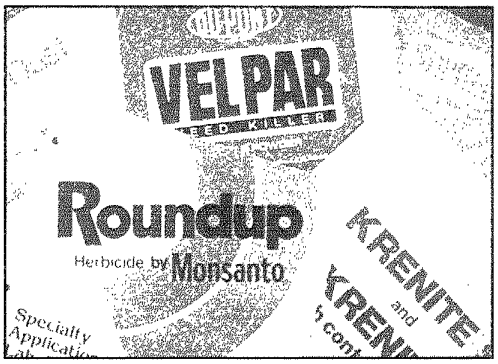
Soil Drainage	Practice
Poorly drained	Traffic control Seasonal restrictions Low bearing pressure equip.
Mod. well drained	Traffic control Seasonal restrictions
Well drained	Traffic control

91. The correct logging practice varies with soil drainage. The wetter the soil, the more vulnerable it is to compaction and the greater the need to prevent damage to advance regeneration. Logging damage can be minimized by controlling traffic patterns, by imposing seasonal restrictions on logging, and by requiring the use of low bearing-pressure equipment.

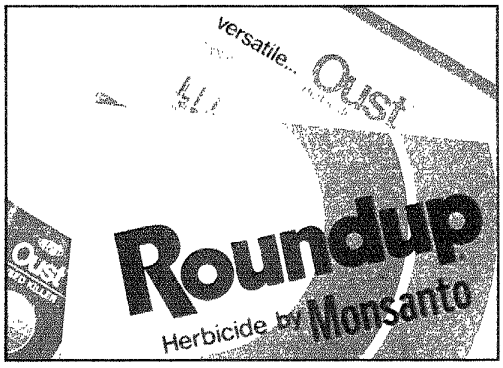
On poorly drained soils, which are the most sensitive, traffic should be confined to a few primary skid trails and logging restricted to the summer when the soils are driest. Low bearing-pressure equipment also should be used. On moderately well-drained soils, traffic also should be confined to a few primary skid trails and logging should be done only when the soils are dry. On well-drained soils, traffic should be dispersed as much as possible. And logging disturbance should be restricted so that less than 15 percent of the sale area is disturbed, even on well-drained soils where skidding traffic is dispersed.



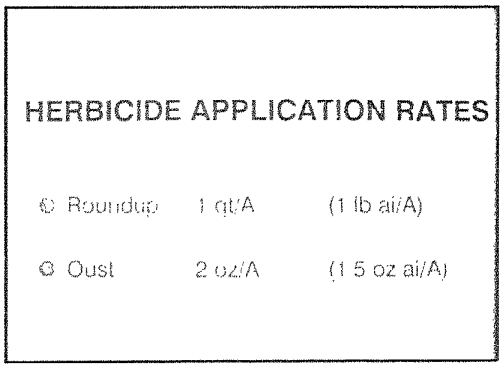
92. Herbicide application, fertilization, and area fencing have been identified as special remedial measures used to increase regeneration success in conjunction with cutting techniques.



93. Herbicides provide a practical way of removing unwanted vegetation in forest stands. Extensive research and commercial application experience has resulted in herbicide and cutting prescriptions for controlling ferns, grasses and sedges, striped maple, and beech in Allegheny hardwood stands. These prescriptions also may be a starting point for vegetation management in other forest types, but caution is advised in applying them where species or forest conditions differ from those in the Allegheny hardwood type.



94. Two herbicides are used in Allegheny hardwoods: Roundup® herbicide, manufactured by Monsanto and Oust® herbicide, manufactured by DuPont. Roundup is applied to foliage of actively growing plants. It is absorbed through the foliage and translocated throughout the plant. Roundup has no residual herbicidal activity in the soil. Oust is also applied to foliage, but it is absorbed by both plant foliage and roots and has residual herbicidal activity in the soil.



95. Roundup is applied at the rate of 1 quart per acre (1 lb. ai/A) and Oust is applied at the rate of 2 ounces per acre (1.5 oz. ai/A). When Roundup and Oust are tank mixed together 0.5 percent (1 qt/100 gal of herbicide solution) of a non-ionic surfactant such as X-77 (Valant) or Frigate (Fermenta) should be added too. The herbicide mix is diluted to 20 to 25 gallons per acre with water.

OPTIMUM DATES OF APPLICATION

Roundup

Oust

July 1 to early October

96. At the 1 quart per acre rate, Roundup effectively controls short husk grass when applied between early June and leaf yellowing in mid-September, and it controls hayscented or New York fern between early July and mid-September. Striped maple and beech are controlled by early August to mid-September applications. Oust also controls the ferns and its residual soil activity reduces the emergence and growth of grass and sedge originating in the forest floor seed bank after soil disturbance, when applied between early July and early October. Where important amounts of regeneration are present with ferns, grasses, and sedges, restricting Oust application to early August to early October will save much of this regeneration. Oust has no herbicidal effect on striped maple or beech.

CHOICE OF HERBICIDE

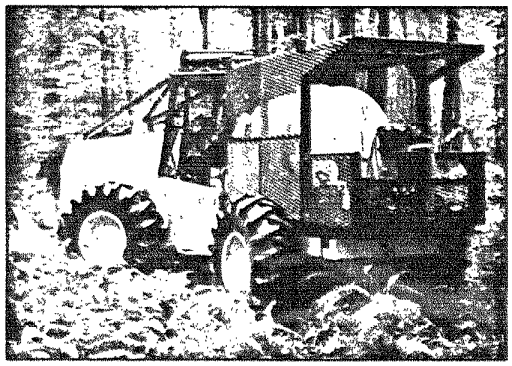
Most situations - use Roundup and Oust

Ferns only - Use Oust

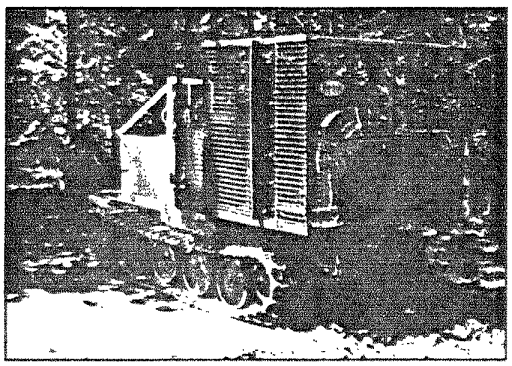
Ferns + Grass and Sedge Seedbank - Use Oust

Striped Maple and Beech only - Use Roundup

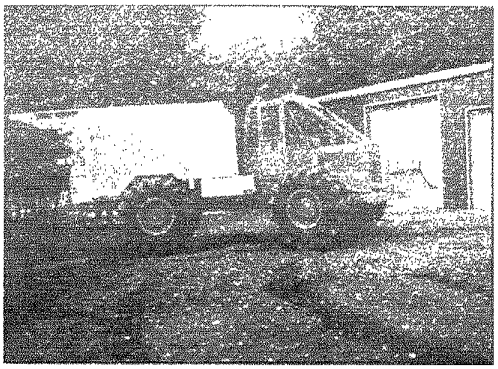
97. Most Allegheny hardwood stands contain a mixture of interfering plants, so a Roundup-Oust tank mix usually should be applied. However, there are several situations when costs can be reduced by applying either Oust or Roundup alone. For example, where ferns or ferns and a grass and sedge seed bank are the only target species, Oust alone gives weed control as good as the Roundup-Oust tank mix. Where striped maple and beech are the only target species, Roundup alone should be applied.



98. Airblast spray equipment, for ground application of herbicide in forest stands, has been developed by private companies and public agencies in Pennsylvania. Airblast sprayers treat a swath of 35 to 75 feet, depending upon sprayer design and vegetation conditions.



99. This Friend air blast sprayer, manufactured by Friend and currently in use by International Paper Company at Coudersport, Pennsylvania, is designed to spray both ground vegetation and understory trees up to about 20 feet tall, simultaneously.



100. Both tracked vehicles and rubber-tired skidders or prehaulers are used to move the sprayer through the woods. Rubber-tired vehicles work best on flat to gently sloping terrain, as long as it is not rocky. Tracked vehicles can negotiate steeper slopes.

HERBICIDE AND CUTTING TECHNIQUES

- Control of Shelterwood seed cut
- Shelterwood seed cut Herbicide
- Herbicide Delay cut-Clearcut

101. Application of herbicide is usually followed within a year or so by a shelterwood seed cut to establish regeneration. Where the forest floor seed bank contains large amounts of grass and sedge or striped maple, other cutting strategies may also be considered. One option is to make the shelterwood seed cut first, then apply herbicide after cutting. Another option, in stands where overstory density is already low to moderate, is to apply an herbicide without any immediate cutting, then clearcut the overstory after regeneration becomes established. Both of these alternative procedures reduce soil disturbance after the herbicide treatment that stimulated grass and sedge seed in the forest floor seed bank to germinate.

DON'T MAKE A REMOVAL CUT WHERE

- Interfering plants stocking > 70%
- Regen Stocking < 70%

102. Also note that the final removal cut should not be made if greater than 70 percent of the regeneration sample plots are stocked with interfering plants or regeneration stocking is less than 70 percent. It will be necessary to remove the interfering plants with herbicides and develop adequate regeneration before making the final removal cut.

REGENERATING HERBICIDED STANDS

- Prompt overstory removal
- Concentration of cutting

103. Two key factors in regenerating stands were herbicide has been used are: prompt overstory removal after regeneration has become established, and concentration of cutting activity in a management area. The first reinvasion of the stand by interfering plants, and the second minimizes the impact of deer in areas of high deer population by increasing the food supply.

ALL STANDS THAT QUALIFY

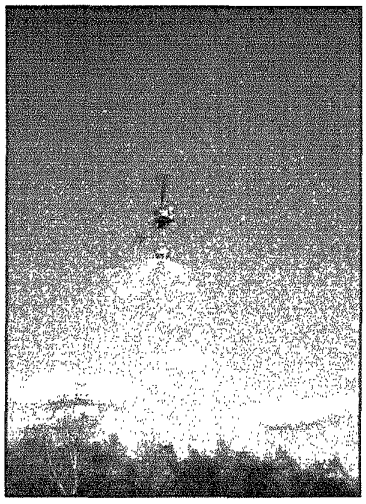
FOR HERBICIDE

SHOULD NOT BE TREATED

104. Every stand that contains an undesirable understory is not a candidate for herbicide treatment. Stands that have a combination of limiting factors such as excessively wet or rocky soil, a long history of understocking, lack of adequate seed sources, or high deer browsing pressure may not regenerate satisfactorily when the interfering understory is removed. Nevertheless, the herbicide and cutting procedures described here are useful for regenerating other hardwood stands, where interfering plants inhibit regeneration.

FERTILIZATION OF REGENERATION

105. Another special method to increase regeneration success is aerial fertilization of the emerging young stand in clearcuts.



106. The technique was developed in the 1970's to help avoid regeneration failures caused by a combination of severe deer browsing, too few advance seedlings, and severe deficiencies of soil nitrogen and phosphorus. It has been used successfully on more than 12,000 acres of the Allegheny National Forest.

107. The growth responses that can be obtained with young black cherry are dramatic, as shown here. The tree on the left is from a fertilized clearcut and grew 6 to 7 feet during the year that fertilizer was applied. The tree on the right is an unfertilized seedling from the same stand; it grew only about 1 foot during the same time period. Both trees are of seedling origin and show the response after two growing seasons.

FERTILIZERS

- Stimulate rapid seedling height growth
- Increase deer food production

108. The basic principle of this strategy is to stimulate enough seedlings to grow rapidly out of reach of deer to produce a new stand and to produce more food than deer can consume.

109. When young clearcuts are fertilized, the tree seedlings, as well as the herbaceous plants, respond vigorously. The increased food supply reduces browsing pressure and allows many seedlings to grow rapidly and attain heights above the reach of deer in a year or so.

FERTILIZER PRESCRIPTION

Nutrient	Source	Rate
Nitrogen	Ammonium Nitrate	200# N/Ac
Phosphorus	Triple Super Phosphate	43# P/Ac

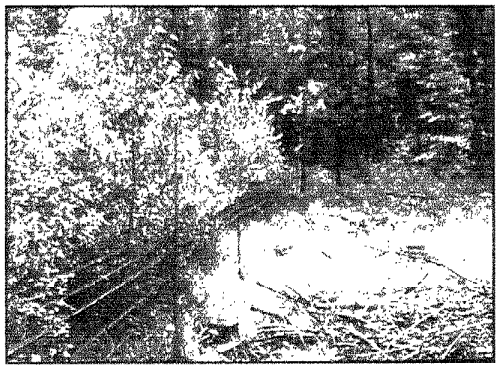
110. If you plan to fertilize, follow these simple guides: First, select the proper fertilizer. We recommend ammonium nitrate and triple superphosphate. Ammonium nitrate is preferred because it provides an immediate supply of nitrate that can be absorbed by the vegetation in large quantities, as well as providing a longer lasting supply of ammonium. Further, it is not subject to volatilization and it seems to stimulate growth more than other nitrogenous materials. Triple superphosphate is commonly used to supply phosphorus.

Second, fertilize at the appropriate rates. We recommend 200 pounds of nitrogen per acre and 43 pounds of phosphorus per acre.

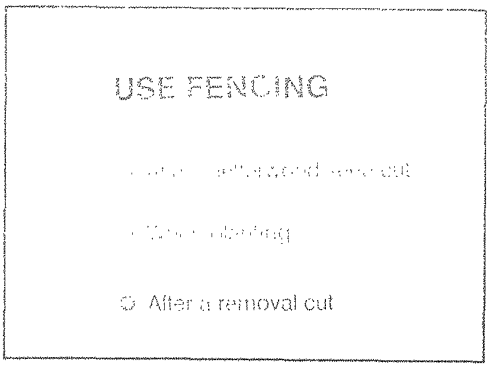
Third, apply nitrogen only in the spring, when leaves are emerging and nutrient demands are high. Earlier applications when the vegetation is dormant are subject to leaching losses. Applications late in the growing season may not provide the nitrogen when needed. Phosphorus is not subject to leaching and can be applied before or simultaneously with the nitrogen.

Area Fencing

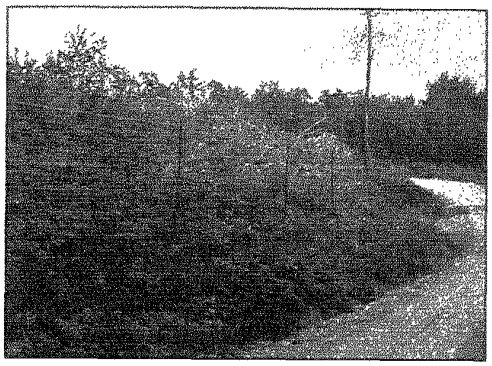
111. Fencing is another special measure for deterring deer damage to hardwood regeneration in areas of extremely high deer concentration.



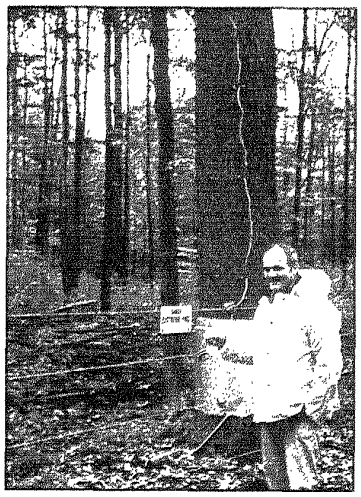
112. In fenced areas, not only are fewer seedlings required to meet regeneration guidelines, but also there is greater species diversity due to reduction in deer browsing. The same species present before cutting are present after cutting, even if only as stump sprouts.



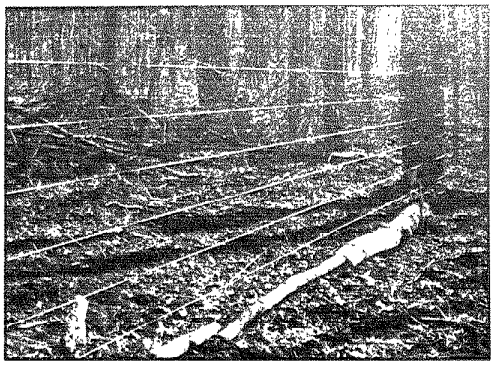
113. Fencing immediately after a shelterwood seed cut can shorten the time required to build up enough regeneration to qualify for removal cutting. And it is required if planting is used to augment seed supply. Fencing may be the only way to salvage declining numbers of seedlings after a removal cut in areas of high deer population.



114. There are two major types of fencing materials, woven wire fence and electric fence. Standard woven wire fences are usually 8 feet tall. When properly sealed at the ground line, they can be very effective in excluding deer.



115. Electric fences are more economical to construct and can be salvaged for reuse. They can be constructed in either a vertical or a slant configuration. This is a 5-wire vertical fence with a solar panel for recharging the battery. We are presently using a 6-wire vertical design with wires installed so that the alternate wires serve as a ground. During the winter, the lower wires can be disconnected so that snow buildup does not short circuit the fence.



116. Although electric fences are considerably cheaper to construct than woven wire fences, they require a 5- to 10-year maintenance commitment to charge batteries, check for electrical continuity, and so on. Selecting the appropriate size solar collector and locating it properly can greatly reduce battery maintenance.

Regeneration Followup

117. Once a regeneration prescription is made and actually applied, it is important not to assume that satisfactory regeneration will develop automatically. Periodic checks are needed to monitor the progress of regeneration.

Regeneration Establishment

70% of plots

2 stems › 5 ft.

118. We usually do not consider regeneration successful until we have at least two stems greater than 5 feet tall on at least 70 percent of the area. This assures that the seedlings are well established and tall enough to escape further browsing. It may require anywhere from 2 or 3 years up to 10 to 15 years for regeneration to meet these criteria.

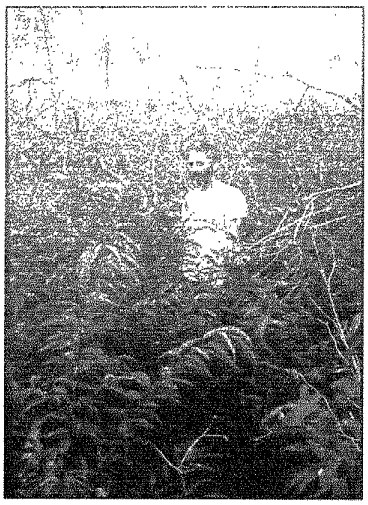
Regeneration Evaluation Criteria

25 stems

5 stems › 3 ft.

2 stems › 5 ft.

119. We use three criteria for evaluating progress of regeneration toward this goal: proportion of regeneration plots containing at least 25 small stems, the proportion of plots with at least five stems greater than 3 feet tall and the proportion of plots with at least two stems over 5 feet tall. All three stocking criteria should be determined both for desirable species alone and for all commercial species. This permits the probable success to be specified in terms of these two species groups.



120. Progress of regeneration development can be estimated at any time after final harvest from the proper combination of stocking criteria. Delays in this process will indicate the need for special measures. If the stand is progressing in the expected time with at least 70 percent stocking, the probability of regeneration success is high and no special treatments are needed. If the stems are not developing in height, deer browsing is probably hindering them: fertilization or fencing should be considered. If none of the stocking criteria exceed 30 percent, fencing, planting, fertilization, and weed control may all be required. When 70 percent or more of the plots are stocked with two stems greater than 5 feet tall, the stand should be considered established, even though it may not be with the most desirable species. Further change in stocking of desirable species is unlikely after the site is occupied by other stems of large size.

SILVAH

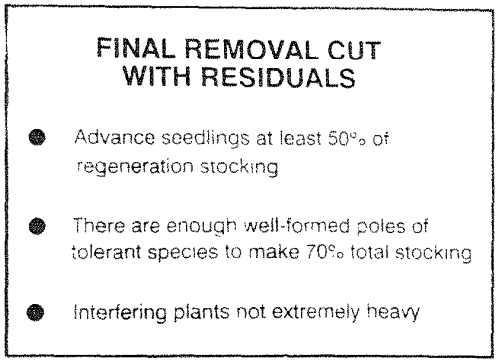
PRESCRIPTION SUMMARY

121. The SILVAH system uses the principles and guidelines we have just discussed to determine which actions may be necessary to successfully regenerate a stand. The next few slides summarize the conditions under which each prescription is reached.

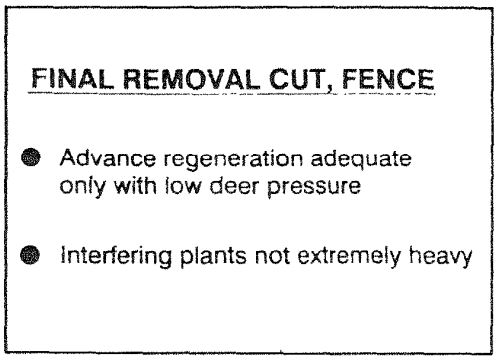
FINAL REMOVAL CUT

- Advance regeneration adequate
- Interfering plants not extremely heavy

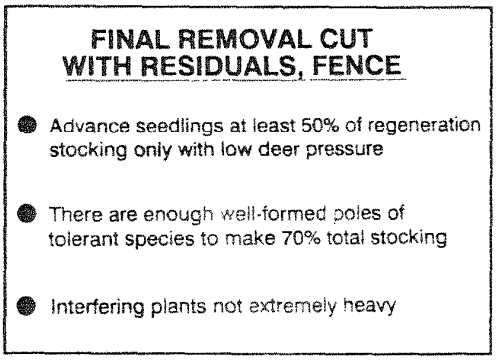
122. A Final Removal Cut is prescribed in mature stands if advance regeneration and expected sprouts or sapling regeneration are adequate and interfering plants are not extremely heavy. All trees 2 inches d.b.h. and larger, including culls and non-merchantable trees should be removed or killed so that they do not interfere with developing regeneration. This may be a clearcut, the second cut in a two-cut shelterwood sequence, or the third cut in a three-cut shelterwood sequence when the advance regeneration is sapling size (as in a three-cut shelterwood or where sapling regen follows any heavy cut). Special care is required to protect saplings from damage during logging.



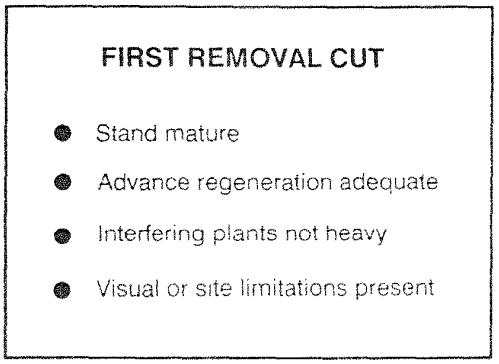
123. A Final Removal Cut with Residuals prescription is the same except that seedling regeneration provides at least 50 percent of the stocking and enough additional plots are stocked with well-formed poles of tolerant species to make 70 percent total stocking. The stand should be cut just as in the final removal cut prescription, but 30 to 80 good quality 3- to 10-inch trees per acre should be retained. Interfering plant stocking should be less that 70 percent.



124. The Final Removal Cut, Fence prescription is appropriate under the same conditions as the Final Removal Cut prescription, except that advance regeneration is only adequate under conditions of very low deer pressure. Erecting a fence at the time of the removal cut reduces deer pressure and the number of advance seedlings needed to successfully regenerate the stand. Interfering plant stocking should be less than 70 percent.



125. A Final Removal Cut with Residuals, Fence prescription is used under the same conditions as the Final Removal Cut, Fence prescription, except that advance regeneration will be supplemented with residuals. Interfering plant stocking should be less than 70 percent.



126. The First Removal Cut prescription is part of a three-cut shelterwood prescription. It is appropriate in stands that are mature, have adequate small advance regeneration to ensure success after overstory removal, that do not have heavy interfering plant problems, but do have visual or site limitations. In these stands spreading the overstory removal over two cuts will retain some overstory shelter while providing enough additional sunlight to allow the small seedlings that are already established to grow to sapling size of 10 or 15 feet tall. These saplings not only improve the visual appearance of the site, but also since they are rooted in mineral soil, will maintain the transpiration pump established by the overstory trees and thus be able to withstand high early season water tables and late season soil drying.

FIRST REMOVAL CUT WITH RESIDUALS

- Stand mature
- Advance seedlings at least 50% of regeneration stocking
- There are enough well-formed poles of tolerant species to make 70% total stocking
- Interfering plants not heavy
- Visual or site limitations present

127. The First Removal Cut with Residuals prescription is used under the same conditions as the previous prescription, except that advance seedlings are supplemented with residual trees. Thus, retention of 30 to 80 good quality trees as described previously is a requirement, not an option.

FIRST REMOVAL CUT, FENCE

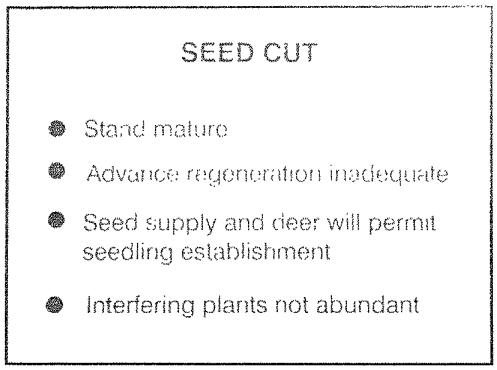
- Stand mature
- Advance regeneration adequate only with low deer pressure
- Interfering plants not heavy
- Visual or site limitations present

128. The First Removal Cut, Fence prescription is appropriate in mature stands under the same conditions of visual or site limitation as its unfenced counterpart. In this situation, however, advance regeneration is only adequate under very low deer pressure. A fence is used to exclude deer, thus reducing the number of seedlings required for adequate advance seedling regeneration.

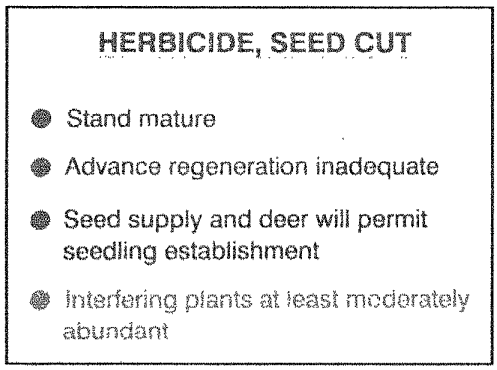
FIRST REMOVAL CUT WITH RESIDUALS, FENCE

- Stand mature
- Advance seedlings at least 50% of regeneration stocking only with low deer pressure
- There are enough well-formed poles of tolerant species to make 70% total stocking
- Interfering plants not heavy
- Visual or site limitations present

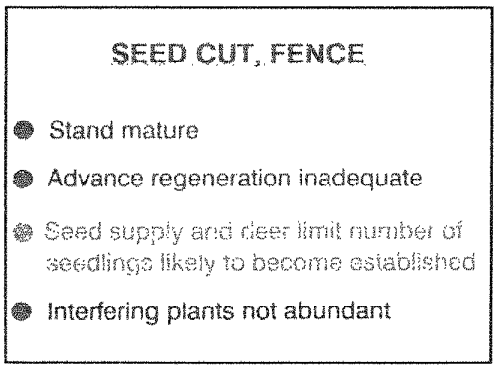
129. The First Removal Cut with Residuals, Fence prescription is identical to the First Removal Cut, Fence prescription, but residual trees are required to supplement small advance seedlings in the regeneration counts.



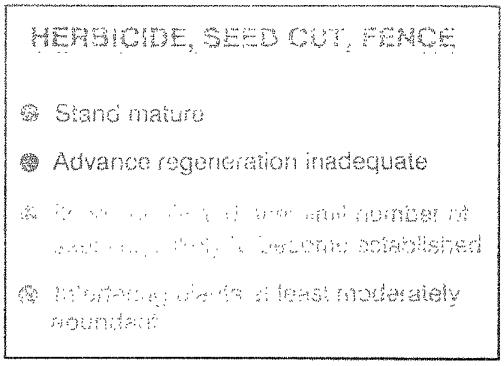
130. A Seed Cut prescription is made in stands that are mature, but advance regeneration is not adequate to permit a final removal cut; seed supply and deer pressure will permit seedling establishment, and interfering plants are not currently abundant. In these stands, a shelterwood sequence will usually provide the best way to establish new seedlings and harvest the overstory. The first cut should reduce overstory relative density to 60 percent to allow establishment of additional seedlings, but not let them grow rapidly enough that they become attractive to deer. Where deer pressure is low, overstory relative density can be reduced to 50 percent to provide slightly larger seedlings. After 3 to 10 years, when adequate seedlings have become established, the overstory can be removed in one cut if there are no visual or site limitations or in two cuts if there are visual or site limitations. If overstory density is already below 75 percent, making a seed cut alone will probably not develop the desired regeneration. It is important in this situation to determine what other limitations may exist and remedy them before proceeding with any cutting.



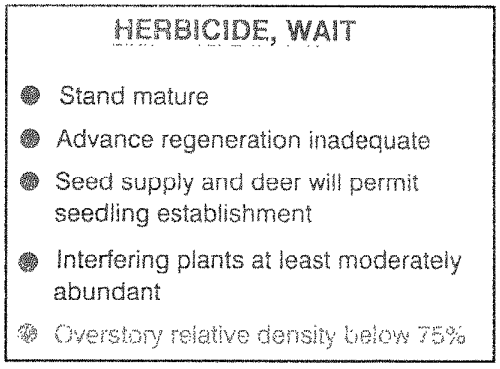
131. The Herbicide, Seed Cut prescription is appropriate under the same conditions as the Seed Cut prescription, except that interfering herbaceous or woody understory plants are at least moderately abundant. In this situation the stand should be treated with herbicide to remove the interfering plants before proceeding with the seed cut.



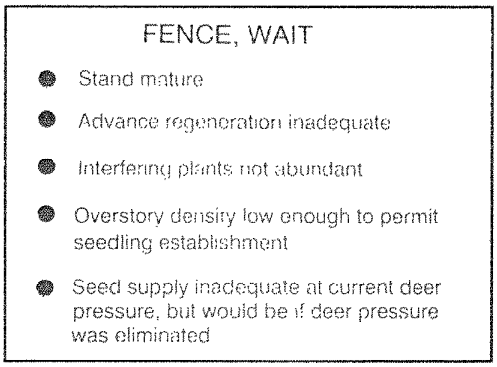
132. The Seed Cut, Fence prescription is used under the same conditions as the Seed Cut prescription, except that a combination of deer pressure and poor seed supply limit the number of seedlings that are likely to become established. A fence reduces the number of seedlings required to provide adequate advance reproduction.



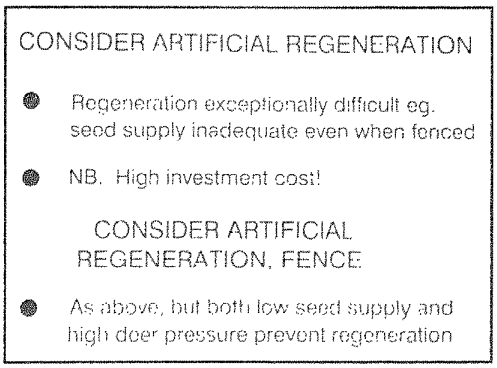
133. The Herbicide, Seed Cut, Fence prescription is appropriate under the same conditions of inadequate advance regeneration as the Seed Cut prescription, except that a combination of poor seed supply, high deer pressure, and at least moderately abundant interfering understory plants are likely to limit seedling establishment and growth.



134. The Herbicide, Wait prescription is used under the same conditions of inadequate regeneration and interfering plant density as the Herbicide, Seed Cut prescription, except that the overstory relative density is already below 75 percent. Under these conditions there should already be enough sunlight to provide for seedling establishment and the only treatment necessary may be control of interfering plants. Since there is no cutting, soil disturbance caused by logging will not risk reestablishment of grasses and sedges, providing additional time to obtain advance seedlings.



135. The Fence, Wait prescription is used in mature stands when advance regeneration is inadequate, interfering plants are not abundant, overstory density is already low enough to permit seedling establishment, and seed supply is inadequate at current deer pressures, but would be adequate if deer pressure is eliminated. Fencing will reduce the amount of seed and numbers of seedlings required.



136. The Consider Artificial Regeneration prescription may be encountered when regeneration is exceptionally difficult, for example where seed supply is inadequate even when the stand is fenced against deer. Artificial regeneration may be the only alternative possible. Due to the high investment involved, we generally recommend that no action be taken in this situation. But, if some action is necessary, it is our best judgment that this is the most likely prescription to obtain regeneration. Similar arguments apply to the Consider Artificial Regeneration and Fence prescription where a combination of seed supply failure and very high deer pressure prevent natural regeneration establishment.

SILVAH GUIDELINES

REGENERATION SUCCESS

137. By systematically following the guidelines in the SILVAH system, successful regeneration can be obtained in most stands.

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