IMPLEMENTING GROUP SELECTION IN APPALACHIAN HARDWOODS USING ECONOMIC GUIDELINES[1]

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Abstract.--A method is described for designing plans for group selection harvests in Appalachian hardwoods. Product market values, tree quality, tree growth potential, and local logging costs are used to develop the most profitable operation. In this way, forest stands may be located where this regeneration prescription can be practically applied. A field computer is demonstrated as a means of generating marking guides and tallying cut and leave data.

INTRODUCTION

For the past decade there has been contention between the public and the administration of the national forests in the Appalachians over the systems of silviculture and harvest cutting to be used. Primarily the contention has stemmed from the public objections on aesthetic grounds to clearcutting of large areas. The Forest Service has supported this practice on the silvicultural basis that it leads to regeneration of the more shade-intolerant species which are of higher value.

More recently, the contention has been brought into sharp focus by the requirements of the National Forest Management Act that each national forest must prepare every ten to fifteen years a management plan, and that this planning process must include a formal process of public review, which can include the appeal to higher administrative levels. This entire process on the Jefferson National Forest (JNF) has led to the provision in the finally approved management plan that about 24,000 acres will receive uneven-aged management (Alcock 1985). On this area, "group selection" will be the regeneration method used. This decision was made to see if the small groups, 2 acres or less in area, on which most or all the trees will be harvested, will better achieve the plan's visual and wildlife management goals, while being large enough to regenerate and grow the more commercially desirable, light-demanding species.

Although group selection has been a method of regeneration recognized in forestry literature for many years, its application in regular commercial forest operations is practically absent. Its implementation and regulation raise many questions such as:

How can the inventories be conducted to properly regulate the volume for sustained yield?
How will the groups be initially located and marked for harvest or treatment?
What impact will this type of harvest have on stumpage values, logging costs, and on costs of timber sale administration to the Forest Service?

This is a report of a joint study by the Jefferson National Forest and Virginia Tech School of Forestry and Wildlife Resources to develop and test techniques of inventory and management decisions that can be used to implement group selection. It is recognized that techniques developed during the study, even though very usable in facilitating the initiation of the first marking and harvesting activity, will be insufficient to judge how successful this method will be in regenerating desirable intolerant species. It will take much longer term studies to determine that.

The approach of this project is to recognize first that all areas of the Forest are not equally suitable to such management, and in some areas its implementation at this time is not

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silviculturally and economically feasible. Therefore, the need exists for a method of locating groups in such a way as to make any proposed sale area most favorable to the subsequent growth and regeneration of the more valuable species, while at the same time yielding an adequate profit to a logging contractor. Aesthetic appeal, wildlife encouragement, and hydrologic protection must be considered simultaneously. If analysis shows that the sale cannot be made profitably, it can be dropped or modified. In this way, the uneven-aged management program will get the most realistic test, and the public will have assurance of continued implementation, perhaps with appropriate modifications.

Although the viewpoint in this project is primarily that of the Forest Service managing national forest lands, it is believed that the methods developed would be equally applicable on other public or private hardwood lands in the same region.

In the course of the project, we have monitored areas on the Jefferson National Forest where group selection timber sales are proposed or being carried out. The Taylor Branch Timber Sale on the New Castle Ranger District was the first group selection operation sold. It was very carefully designed by the Forest Service staff without using the method described here. We have visited the site a number of times after it was marked and while logging was going on. Based on several interviews held with the logging contractor, a reasonable profit was realized from the operation, and no unusual operational problems were encountered.

DISCUSSION

Although group selection appears in forestry texts as far back as the "First Book of Forestry" by Filbert Roth in 1902, recent discussion among the professionals suggests there are still many differences of opinion regarding its definition, biological effects, regulation, and economic feasibility. Regarding the above questions, no absolute assessments are offered here to fuel the debate, only comments as the topics apply to this project.

The most basic decision in any uneven-aged system is "Should we cut this tree or not?" In group selection, the emphasis must be on the predominate characteristics of the entire group of trees (Marquis 1978). A system is needed which locates and selects the best groups of trees for the regeneration harvest. Landowner objectives, both immediate and future, along with the answers from the above questions will dictate which trees are best for removal. To make the basic decision for group selection, the character of these "best groups" must first be defined.

Once it is established which kinds of groups are the ones to leave or cut, a method for locating these groups in the field must be designed to enable the forester to implement the objectives of the landowner. It is the problem of developing a method that this paper confronts. Landowner objectives vary, as do the opinions of foresters, on what the forest should look like after a harvest operation. What diameter distribution should it have? What should be the maximum tree size and the residual basal area? The initial step in solving the "group selection problem" might seem be to answering these questions, but this is a formidable task in itself.

This project proposes a method to implement group selection, or modifications of it, that will assist the forester in assembling the information to perform the marking for harvest so that the objectives of the landowner, whatever they may be, will be satisfied (restricted of course by the ecology of the forest). This information and its manipulation is the decision support system that will aid the forester in making the "basic decision" by providing information on a single tree, a group of trees, and the area surrounding the trees, in the field where the decision must be made. Therefore, identifying the variables that would enable the marker to make decisions on a range of landowner objectives was the first step of this project. Following is a discussion of the traditional decision variables and the additional ones proposed.

Traditional Views on Tree Grouping and Selection

"Group selection is a regeneration method in the uneven-aged silvicultural system... but you define a group" (D.W. Smith, personal communication). Deriving from a dictionary definition, a "group" in this context is a number of trees to be removed together because of certain similarities, such as species or size. Traditional decision variables used in selecting between cut and leave trees under uneven-aged management, as described in a priority order by Arbogast (1957), are risk, cull, crown form and branching habit, value, crown position, and size.

One widely accepted method of regulation for uneven-aged forests has been the reversed J-shaped curve of diameter distribution addressed by many authors, with stand density and maximum tree size as other controlling factors (Leak 1985, Smith and Lamson 1982, Marquis 1978, Roach 1974). Economic factors (Cayen and Hall 1987) and financial maturity (Trimble et. al. 1974), have also been introduced. Therefore, tree grade, tree diameter, stand density, and financial maturity are used as decision variables.

Bringing in Economic Factors and Landowner Objectives

Tree value as it reflects quality, and value growth percent, the tree's rate of value increase, are also variables to be used when selecting trees to cut and leave. Because stumpage value is a residual representing the dif-

ference between the selling price of the final product and the total operating costs and profits in harvesting the timber and converting it into the final product (Kingsley 1986, Zaremba, 1963), it serves as a measure of tree value.

Tree value growth percent (VG%) allows trees to be compared to one another as capital investments. There is a limited amount of growing space for each "investment" and prudent investors would do well to have their portfolio stocked with the investments returning the higher rates. Exact value growth percents are difficult to determine, but relative ones are all that is required to make decisions between trees.

Not only timber value, but all of the land owner's objectives, however diverse, must be considered in the decision process. It must be remembered that in many cases group selection will be practiced because there are several objectives. Generally, we want decisions to bring about the maximum net benefits received from the forest (of course, limited by the allowable area to harvest). In addition to immediate profit, other objectives might include:

Positive financial benefit for dollars invested
Increase in the forest's rate of return
Increased forest access
Enhancement of wildlife habitat
Minimum impact on the environment
Minimum visual impact

The combination of all the biological, economic and regulatory objectives must be included in that most basic decision, "Should we cut this tree or not?"

Combining the list of current objectives with the traditional ideas for making cut/leave decisions for a single tree, and then a group of trees, requires a vast amount of information to be related by the deciding forester. Thus, to implement group selection, it is necessary to build this knowledge into a sort of decision support system, incorporated into several computer programs to be held in a field computer.

The Suggested Method for Group Selection Management Introduction

The method proposed demands no new techniques regarding tree mensuration and only requires simple observations of the area surrounding the place (point) where the forester is standing in the field. The way the information is stored, processed, and utilized, however, is unique. First a brief summary of the method is described which includes a clarification of several terms. Following that is a more detailed presentation of the proposed method.

A flow chart, figure 1, helps to link the stages of implementation. Notice that the left side of the chart references office work, the right side field work.

Method: Summary

The traditional method of marking for a regeneration harvest is to first review any office records of the stand's history. Then, the forester goes to the field to collect current information. After returning to the office to analyze the information gathered and plan the marking operation, he/she returns to the field with marking rules in hand to mark the trees for harvest. When enough volume is marked or the entire area covered, the forester returns to the office and prepares the sale prospectus. After testing many departures from this traditional sequence, we chose it as the one to follow.

Although the basic method is similar, the information provided for decision making in the field is a step up from traditional. The data is gathered from point samples. The first pass, the reconnaissance cruise, is for the purposes of: obtaining tree data, collecting area information on site quality, regeneration, and wildlife, and location of skid roads. The reconnaissance cruise is laid out on a wide spaced grid of sample points (6X6 chain).

The information gathered is summarized in the office and a determination made as to whether or not a harvest is possible based on current volume and market prices. Given a positive decision, the forester returns to the field for the a marking/cruise. Again, the forester takes point samples using a closer spacing (3X3 chain grid) to collect information for decision making. Cruise data is tallied on the field computer, and information is provided as a decision aid to determine whether or not this "point" should be considered for harvest. Once the required marked volume is obtained, or the end of the tract reached, the forester returns to the office to prepare the sale prospectus and store the inventory information for future management.

Clarification of terms is required here. A point sample is used to sample an area that is being considered for harvest. A 3X3 chain grid for the marking/cruise is chosen because it approximates a point in every acre (this is not a fixed requirement). The trees selected by the prism, around the center of the acre, represent this acre as a group in the decision of whether this should be a group to harvest or to leave. If the point is selected for harvest, the trees included in the sample, and suitable trees surrounding the point are marked for removal or treatment. Therefore, in this discussion "group" is defined as two or more trees marked for removal or treatment in a contiguous area, with a maximum of as many trees as can be found on that one acre (or the area represented by the selected grid size). The point then, initially represents a group, although the final marked group can include part of, all, or more trees than the "point". Also, several points could be combined to form any shape, and any practical size group, or harvested area. The size and

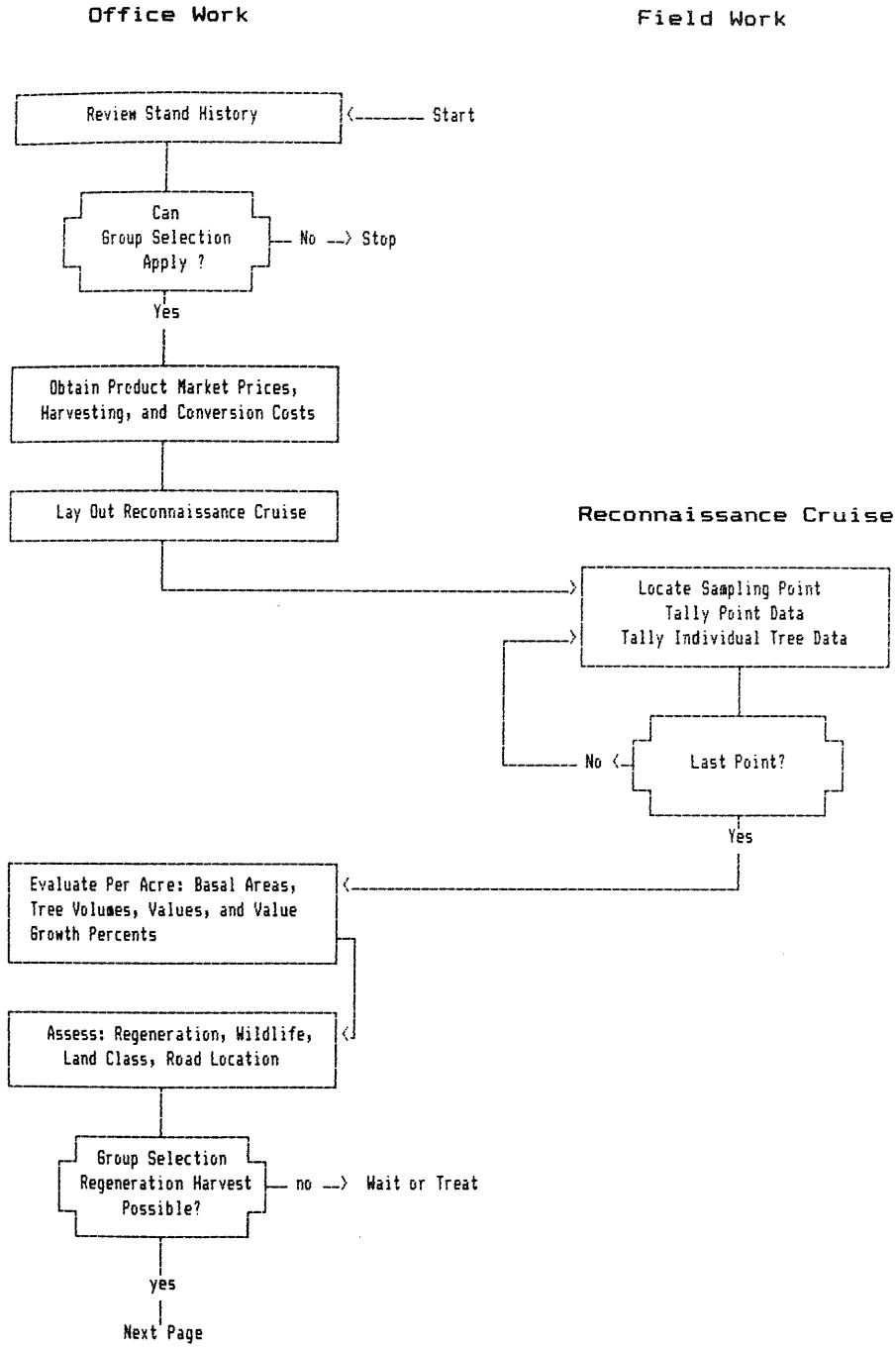

Figure 1.--Flow Chart For Group Selection Implementation

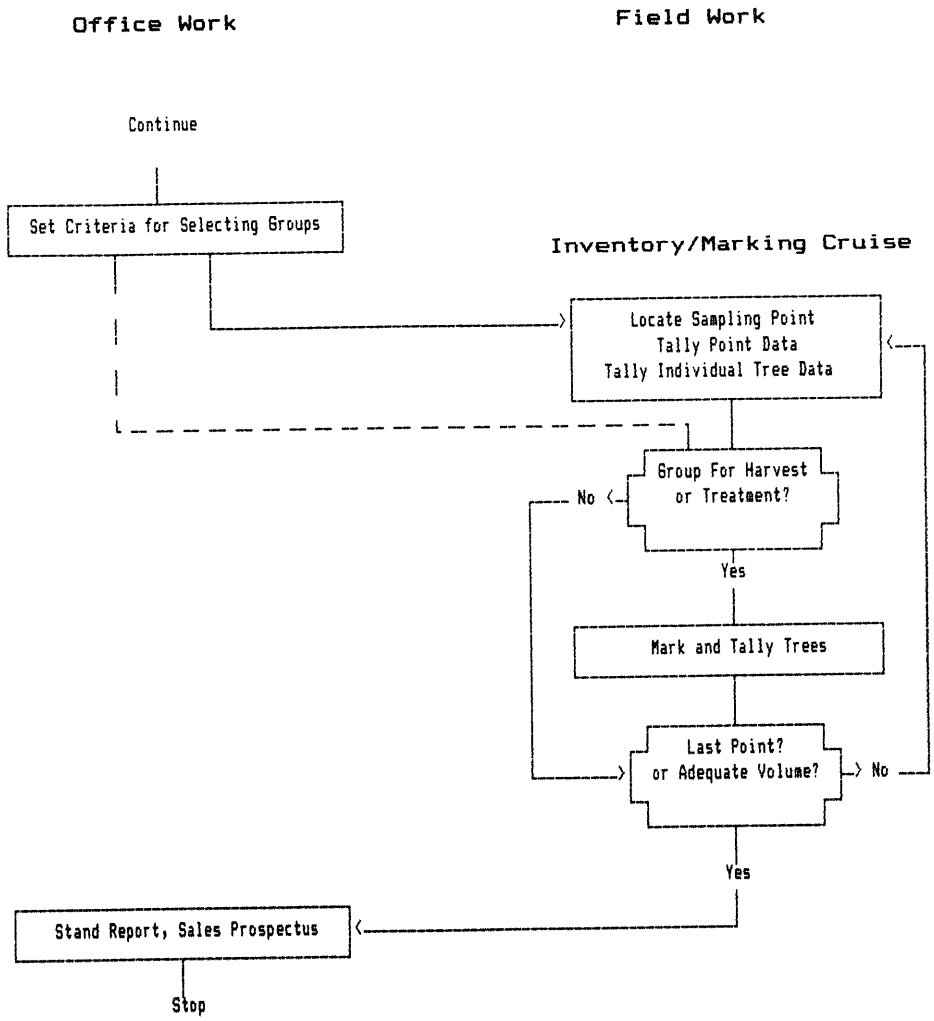

Figure 1.1--Flow Chart For Group Selection Implementation

shape is restricted by the silvicultural judgment of the forester and the objectives of the landowner.

This is not to say that the group will be easily identifiable or its boundaries distinct. Trees in the group, yet not ideal for removal based on their potential to become valuable crop valuable crop trees may have to be marked for harvest. This is because they will most likely be damaged or destroyed in logging and/or leaving them will result in an insufficient opening for regeneration. The alternative would be to move the group boundary to exclude them.

Method: Detailed

More detail of the cruise and decision method is now provided. First, an examination is made of the maps and other records on the tract for information on the stand's history and current condition, site index, soils, wildlife, land use class, existing roads, etc.. If the group selection regeneration method still seems suitable for this stand a reconnaissance is planned. A field map is made of the area with sampling points located on a 6x6 chain square grid.

Additionally in the office are noted factors for the entire area affecting logging cost, such

as estimated average skidding distance, existing or future landing locations, hauling distances, and special equipment needed. These factors are used to estimate logging costs per thousand board feet of timber harvested. Logging cost is one of the most variable costs associated with tree value. However, reasonable approximations are all that is required in order to compare one "point" (representing a group) to another. (Logging costs for group selection are currently under study at Virginia Polytechnic and State University.)

To prepare for the computations performed in the field computer the following information is collected and downloaded to the field computer:

1. Lumber prices for the species, or species groups, to be inventoried, from the Hardwood Market Report, Appalachian Hardwoods.
2. Sawmilling costs for typical operations.
3. Pulpwood or firewood stumpage prices from Timbermart South or local mills if these are potential products.

Reconnaissance Cruise

After going to the field, the forester carries out a point cruise with a 20BAF prism (factor optional, based on timber type), varying from the grid to assure that several points are located in each strata as determined by topographic inspection. The reconnaissance is the time for skid road inspection or location and for noting any physical barriers that will preclude logging of certain areas. At each point, data on the following are entered in the field computer:

1. Land Classification Code, Appendix I: Includes site index (low, medium, high) for standard forest land based on general inspection or topography
2. Wildlife Class Code
3. Regeneration; Upper/Lower
4. Age Class Code
5. For each tree counted:
   a. Species
   b. Diameter at breast height
   c. Merchantable height
   d. Estimate of possible merchantable height growth
   e. Tree Grade (Hanks 1976)
   f. Estimate of possible grade increase

Office Data Summary

Upon return to the office, the cruise tally and point values are transferred to the office computer. The tree volumes, values, and value growth percents have been calculated and totaled by point in the field computer providing a listing by point of the reconnaissance cruise. Land class, wildlife class, regeneration, and age class codes are also transferred to the office computer for evaluation. A point-by-point listing giving the status of each tree, as well as point per-acre totals and tract averages are available. Examples of two point lists are shown in table 1.

Overall Stand Assessment and Selection Criteria.

From the point summaries and the overall statistics the forester is in a position to make a more accurate determination of whether or not group selection is feasible on this area. If it is feasible, what criteria should be used to select the groups to mark for harvest?

In selecting between points to mark for harvest there are many point characteristics to consider. The problem: "If" a forester had a list of the all the point samples from the tract in question, which points would be best to harvest? With multiple-use a goal and both short and long term objectives to satisfy, what variables should be considered as having the highest priority? The variables that have the most influence seem to be land class, wildlife class, regeneration, point value and point value growth percent.

The solution for the problem is a series of rules designed to assist the forester in the field to arrive at a conclusion based on the information given about the point. Such a series has been given many names: a decision tree, a decision support system, or an expert system. The rules have the format of an "if-and-then" statement leading to a treatment recommendation. Two examples follow.

If the land class is standard forest land,
medium site index
and the wildlife class, snag
and the upper regeneration, dogwood
and the age class, small sawtimber
then leave this point to grow

A second example:

If the land class is standard forest land,
medium site index
and the wildlife class, none
and the upper regeneration, oaks and the age class, sawtimber
and the value growth percent is less that the tract average
and the point's value is greater than 80% of all other points
then consider this point for harvest.

The entire decision tree is too large to illustrate and explain within the confines of this paper. It contains 76 rules. Rules can be easily modified, or added to accomplish an individual landowner's goals or management preferences. An expert system is never considered finished and is in a constant state of evolution as new demands and objectives are placed upon it.

The treatment recommendations are only provided as aids to help the forester make the selection decisions between points; they are not requirements. The forester must combine this recommendation with other knowledge and observations about the area to arrive at a final decision.

Table 1.--Example of Data Collected and Information Provided For Two Points

Explanation of abbreviations is found in Appendix II

Treatment Recommended; leave

Land Class Code; standard forest land, medium site index
Wildlife Class Code; large active snag present
Regeneration Upper; dogwood
Regeneration Lower; none
Age Class; small sawtimber

Recorded Field Data						Single Tree			Per Acre Values; Point Sample				
Spp	Dbh	Ht	HI	GT	GI	CF	BF	$/T	CF	BF	$/Ac	$/Ac10	VG%
NRO	11	1	1	3	0		40	8		1209	231	372	4.86
HIC	12	2	1	3	1		105	7		2662	166	318	6.72
HIC	10	1	0	3	0		29	.1		1078	3	57	36.17
SUM	3	0	0	0	0								
NRO	16	1	0	3	1		119	34		1701	482	793	5.11
YEP	12	1.5	1	2	0		77	8		1951	200	242	1.92
Totals (weighted avg. for VG%)										8601	1082	1782	4.97

Treatment Recommended; mark for harvest

Land Class Code; standard forest land, medium site index
Wildlife Class Code; none
Regeneration, Upper; oaks
Regeneration, Lower; oaks
Age Class; sawtimber

Recorded Field Data						Single Tree			Per Acre Values; Point Sample				
Spp	Dbh	Ht	HI	GT	GI	CF	BF	$/T	CF	BF	$/Ac	$/Ac10	VG%
WHO	16	2	0	2	0		161	36		2309	516	623	1.90
CHO	14	9	1	4	0	27		1	500		25	28	1.23
HIC	11	1	0	3	0		39	1		1170	37	78	7.65
CHO	22	1.5	0	2	0		260	54		1972	410	423	0.29
WHO	18	2	0	1	0		205	60		2315	677	791	1.56
Totals									500	7766	1665	1943	1.48

Part of the decision tree addresses the question of regulation. An estimate of harvest age and cutting cycle will be sufficient to guide the amount of volume or area that can be removed each cutting cycle. If 100 years are required to grow a tree to harvest size and a cutting cycle of 10 years selected, then approximately 10% of the area should be removed each cycle. An exact determination of this factor is not essential in the early stages of implementing group selection.

Many of the stands being considered for uneven-aged management are currently even-aged or two-aged stands making volume control difficult. Although not in line with traditional methods of uneven-aged management, area control is suggested as a feasible regulation method. Volume growth checks should also be made, and monitoring the diameter distribution of the stand is also possible.

The rules of the decision tree aid the marker in maintaining regulation in several ways. When entering the stand for the marking operation, statistics from the reconnaissance cruise provide the decision tree with valuable information about the stand, namely, the distribution parameters of values and value growth percents (VG%) of the points. Now, in the field for the marking operation and standing on the point in question, a comparison can be made with all other points previously sampled. Assuming the values and value growth percents are normally distributed, an estimate of where this point is on the distribution can be made. For example: if our primary objective is to increase the value growth percent of the stand, then it would be best to select those points for harvest that have the lowest percents. If our goal is to remove 10% of the stand, then any point having a VG% lower than the cutoff value which represents the lower 10% of the distribution, would be recommended for harvest.

Value works in a similar way, except one would be marking those points that fell above the upper cutoff point on the distribution. Combining the two objectives creates problems and the answers are not clear cut. Field testing of this regulation method is not complete. However, bench tests indicate that it will at least provide a helpful rule when deciding between points to harvest. Simpler methods are also included in the decision tree such as the volume cruised/volume marked ratio. Also by knowing the number of points sampled, and the number points marked for harvest, a running approximation is provided of the percent of the stand that has been marked.

Cruise/Marking

Then returning to the field, the forester re-cruises the sale area on a 3X3 chain grid, using a 20 BAF prism. At each point, the same information as in the reconnaissance cruise is collected and the tally entered into the field computer. Often the point to be sampled has little chance of becoming a harvested or treated point. Such a case would exist if the area was harvested within the last two cutting cycles, or, if the area contained but one hemlock tree and was near a spring surrounded by rhododendrons. The data input portion of the program recognizes points that are inefficient to continue sampling and stops after such cases are recognized.

If the point being sampled is a possible harvest point the information about each tree found in the sample is tallied. The tree's volume, value, and value growth percent, is calculated and displayed. The point totals and averages are calculated and a treatment is recommended.

The cut/leave decision is made at this time, based on the marker's judgment and the treatment recommended by the decision model. If a leave decision is made, the sample point data are added to the cumulative leave file, providing a steadily improving estimate of the structure of the stand. If a cut decision is made, marking begins. Trees surrounding the sampling point with characteristics that make them desirable for harvest are marked until the appropriate group size is attained. When the group marking is finished, its outline is sketched on the field map, and the tally is added to the cumulative cut file being carried in the computer. This file includes cumulative volume and value figures for judging the adequacy of the marked timber for a commercially feasible operation.

As the flow chart indicates, it may be possible in some locations to mark for intermediate improvement or thinning treatments at some points. If such an operation is feasible, a tally of the points to treat, or the number of trees to treat, is made.

Single tree data can be entered into the computer to check volume, value, and VG%. During skid road location trees to be removed can be entered into the cumulative cut file. Additionally single trees located beside skid roads or in proximity to a harvested group might be selected for harvest; these also can be entered and added to the harvest file. When the entire tract has been covered, or the desired volume or area to harvest obtained, the marking cruise is terminated.

Return to Office

The forester returns to the office and the files of marked trees and inventory information are transferred from the field computer into the office computer. Possible summaries include:

1. The cumulative leave file providing a record for use at the next cutting cycle. By comparing this file to the total inventory file, which includes the harvested points, a measure is obtained of the effect on the productivity potential of the tract.

2. The tally of points showing the percent of the tract that falls in each land class, wildlife class, and age class.
3. The regeneration of the tract in percent by species group.
4. Listing of points, or marked trees, to receive various treatments.
5. The cumulative marking file, used for the preparation of the timber sale prospectus.

A Comment on Computers

The entire procedure is built upon software developed by the one of the authors, for use on the IBM Personal Computer for office work and on the Hewlett Packard HP-71 Computer for field use. The field computer was specially configured by Oregon Digital with a maximum of 357K memory and a special case to withstand rugged use. It is felt to be an illustration of the way the portable computer can assist in making available to the field forester an enormously expanded volume of essential information to guide the marking decision.

Concluding Remarks

Any experienced forester is going to ask if such a seemingly complex procedure is really practical. Yet, except for tree grade and possibilities of increase, all the other information collected is normally tallied for a presale inventory. The information is just calculated differently and made available while the forester is still in the field.

It is believed that following such a procedure can be excellent training and that with experience the procedure will be streamlined. In some applications certain details may be omitted. But, if all the landowner's objectives are to be considered, a procedure similar to this will need to be followed until it is broadly established and accepted under what circumstances uneven-aged management and group selection can be successfully carried out. In many cases, provision for options is made without recommending the decision to give latitude to those owning and managing the forest.

Until, in the mind of the decision maker, the tree, with the local costs of removal considered, is associated with its market value, both present and future, and until the marking decision of that tree along with the other trees of the group is based on all of the landowners objectives, less than satisfactory management will occur.

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Appendix I: Classification Codes

Land Class Codes

Non-Forest Land; field, rhododendron, young forest.
Utility; transmission lines, gas, oil, railroad.
Road Buffer; width depending upon road class/use.
Recreation Area, Special use: trail buffer, cultural.
Wildlife Area; designated clearing, special habitat
Spring, Seep, Wetlands
Water Buffer; width depending upon size or use.
Hardwood/Pine Low; SI 50 oak, 9-13" DBH is mature.
Hardwood/Pine Normal & White Pine; SI 60, 11-17" DBH oak.
Cove & Upland Hardwood; SI 70+ oak, 14-30" DBH.

Wildlife Class Codes

None
Insect, Pathogen
Beaver sign
Cliff System, Rock out-crop.
Water Area; trout stream, wood duck habitat, watering hole.
Bedding area, Den, Squirrel nest, Caves, Sink holes, Drumming logs.
Snags, Wolf Tree, High mast producer, Large pines >30" Dbh, Den tree.
Feeding area; orchards, old home sites, grass, rare forage, grape arbor, alder thickets.
Red-Cockaded, Piliated, Hawk nest, Heronry, Endangered spp.

Regeneration Codes: Upper/Lower

None
Grapevines (Greater than 50 stems per acre / Grass
Rhododendrons / Ferns
Dogwood, Sourwood, Sassafras, Striped Maple, Blackgum.
Maples, Beech, Birch, Black locust.
Yellow-Poplar, Basswood.
Pines; Pitch, Virginia, Table Mountain.
Pines; White, Hemlock.
Desirable Hardwoods: Ash, Walnut, Hickories.
Oaks; red and white.

Age Class Codes

Saplings; 0-5 inches in diameter at breast height.
Poles; 6-9 inches DBH.
Small Sawtimber; 10-13 inches DBH.
Sawtimber; 14+ inches DBH.

Appendix II: Explanations of Abbreviations Found in Table 2

Spp - Species

Dbh - Diameter breast height

Ht - Merchantable height in number of 16 foot logs for tree grades 1-3, and number of 5 ft. sticks for grade 4 trees and trees less than 10 inches in Dbh.

HI - Possibility of merchantable height increasing in the next 10 years; 0= no possibility, 1= possibility of increasing. The increase added depends upon site index, dbh, and height of the tree.

GT - Tree Grade. Forest Service grades 1,2,3 (Hanks 1971). Grade 4 is pulpwood and trees less than 10 inches dbh.

GI - Possibility of tree grade increasing with growth due only to the overgrowth of a present minor defect. 0= no possibility. 1= possibility of grade increasing in 10 years. Note; a grade increase will occur automatically if the tree's diameter increases enough to place it in the next higher grade even if GI=0.

CF - Cubic feet, BF - Board feet

$/T - Dollars per tree - For sawtimber (BF trees), this is a stumpage value based on the board feet of dry lumber produced, as estimated by Hank's (1976) equations for each graded tree, multiplied by the graded dry lumber prices from the Hardwood Market Report, minus logging, conversion costs and profits. Trees with CF volume are valued by: the estimated cubic foot volume multiplied by the price reported in Timber Mart South, or from local mills. The price of firewood, if higher and a realistic alternative, would replace the CF price.

Per Acre Values; CF, BF, and $/Ac are individual tree values multiplied by the tree's per acre conversion factor (basal area factor/basal area of the tree).

$/Ac10- Estimated value per acre in 10 years.

VG% - Value Growth Percent; calculated by: $i = [(Vn/Vo)^{(1/n)}] - 1$ and $VG\% = 100(i)$ Where; n is the number of years, 10, Vo is the tree's value in the present day, and Vn is the value n years in the future. Analysis has shown that the most important factors in determining VG% (in order of importance) are grade, height, and diameter increases. Grade and height are direct field estimates. Diameter growth can be estimated from any one of the growing number of growth functions for the hardwood region. Due to its simplicity, Mawson's (1982) formula: $\ln DG = \ln 1.65 - 2.64 / Dbh$ where DG = 10 year diameter growth in inches, is used here for testing of the method. The VG% in the "total" line is not a total but an average of the tree's VG% weighted by value.