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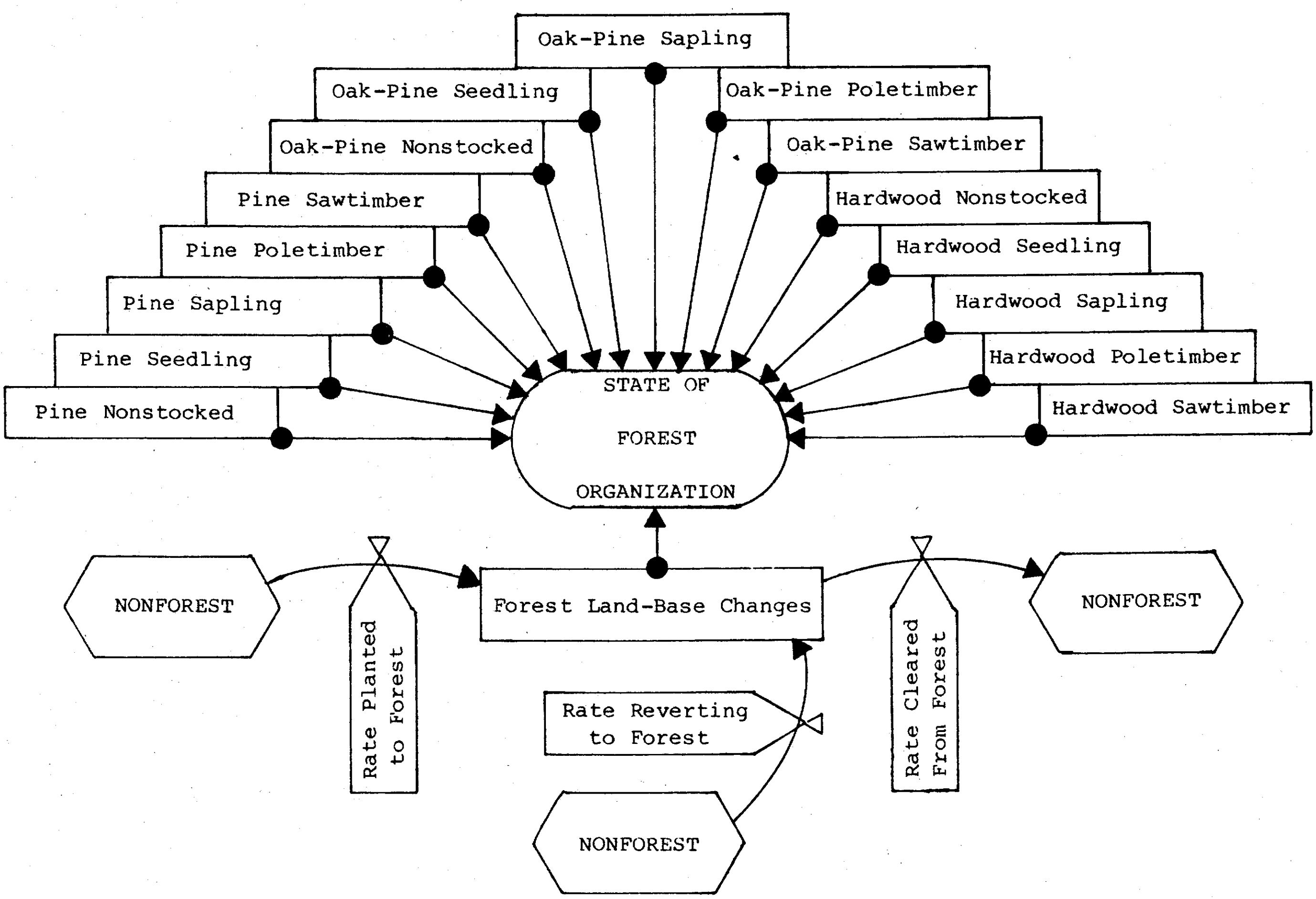
DYNARIP:
A Technique for Regional Forest Inventory Projection and Policy Analysis

William A. Bechtold



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Southeastern Forest Experiment Station
200 Weaver Blvd.
Asheville, North Carolina 28804

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William A. Bechtold, Resource Analyst
Forest Inventory and Analysis
Asheville, North Carolina

ABSTRACT

This paper describes the Dynamic Regional Inventory Projection computer model (DYNARIP). DYNARIP is an area-based simulation model, written in the DYNAMO language, which projects the state of forest organization over time in terms of stand size and broad forest type. The model was developed primarily to aid legislators, regional planners, forest industry, and resource analysts assess the impacts of regional trends and forest policy decisions. The State of Georgia was selected for a pilot analysis to demonstrate how the model is built and applied.

DYNARIP is a policy-oriented model capable of tracking all of the treatments and disturbances experienced by the forest resources of an entire State or regional area. It can also isolate the impact of any one of 27 man-caused or natural disturbances (including natural succession and forest land-base changes). The model is driven by empirical rates of change as measured by forest inventories between two points in time. A few simple controls permit the entry of the user's own perceptions of the future into the model.

Keywords: Forest policy, forest simulation, forest inventory projection, resource evaluation, ecosystem dynamics.

Contents

Introduction

Dynamic Regional Inventory Projection (DYNARIP) is an area-based forest simulation model designed to aid legislators, forest industry, regional planners, and resource analysts assess the impact of forest trends and policy decisions. DYNARIP is a policy-oriented model capable of tracking all of the treatments and disturbances experienced by the forest resources of an entire State or regional area. It can also isolate the regional effect of any one of 27 treatments or natural disturbances. This paper describes how the model works and demonstrates its use through the analysis of a forest policy issue of current concern in the State of Georgia.

Neither DYNARIP nor any other model is capable of predicting the future. Results obtained from such models are highly sensitive to basic assumptions. The forests of a region experience a diverse and independent variety of treatments and natural disturbances. The response of the resource to these disruptions is tremendously complex. In contrast to most forest models, which are driven by some form of growth equation coupled with numerous assumptions about ingrowth, mortality, and timber cut, DYNARIP is driven by empirical rates of response to treatment or disturbance as measured by forest inventories between two points in time. The assumptions necessary for the user to make thus become simplified to specifying the amount and type of acreage experiencing treatment or disturbance. The model is designed so the user's subjective perceptions can be incorporated into the model through the manipulation of a few simple controls or additional algorithms. If these perceptions are correct, DYNARIP will accurately quantify the future state of forest organization. Perhaps of equal value to the specific numbers output by the program are the trends and interrelationships that become apparent.

I. The Core Model

The DYNARIP core model projects the state of forest organization over time in terms of acres by broad forest type and stand size. Because the empirical rates of change driving the model are endemic to a given region, a new core model with unique rates must be developed for each region undergoing analysis. This concept has two advantages: Each model is built individually from data collected in the region to be analyzed, and the empirical rates of change are recalibrated each time a new inventory is conducted.

Any forest parameter that can be related to a regional forest-type/stand-size distribution can be added to the core and carried by the simulation.

DYNARIP is written in the DYNAMO language partly because the types of algorithms developed by Boyce (1980) can be used to track such nontimber benefits as wildlife habitat and recreation. DYNAMO also lends itself to integrating the complex rates of change needed to run a continuous simulation of this type (Pugh 1980; Richardson and Pugh 1981).

Model Input

DYNARIP is built with data collected during Statewide multiresource inventories. In the Southeast, forest resource data are collected on a 10-year cycle from 24,775 permanent sample plots located throughout Florida, Georgia, North Carolina, South Carolina, and Virginia (McClure and others 1979). The three main inventory classifications used as input to the model are forest type, stand size, and primary past treatment or disturbance.

The State of Georgia was selected for a pilot analysis to show how the model is built and interpreted. Similar analyses can be performed for most combinations of Survey Units in the Southeast, or for the Southeast as a whole. Data used to build the Georgia core model were screened from the fourth and fifth multiresource inventories of the State (Knight and McClure 1974; Sheffield and Knight 1984). Fieldwork for the Georgia fifth survey was completed in 1982. A period of 10.12 years separates the two inventories.

A total of 6,134 permanent plots was used to construct the Georgia model. Sample plots were first separated into groups representing four types of acreage: acres that were forest in 1972 and remained forest over the 10-year remeasurement period, acres that were forest at the time of the initial inventory but were cleared to some nonforest land use prior to 1982, nonforest acres planted to forest between the two surveys, and nonforest acres that reverted naturally to forest. The last three categories account for forest land-base changes over the remeasurement period.

All plots were further grouped by three forest-type classifications (pine, oak-pine, and hardwood), and five stand-size classifications (nonstocked, seedling, sapling, poletimber, and sawtimber). Forest Survey determines forest type on the basis of all live trees not overtopped. Pine forest types are given to stands in which pines account for more than 50 percent of the stocking, oak-pine types to stands in which pines make up at least 25 but not more than 50 percent of live-tree stocking, and hardwood types to stands where pines constitute less than 25 percent of the stocking. In the determination of these three broad forest types, the stocking of redcedar, hemlock, spruce, and fir is included with the pines. Stand size is based on numbers of growing-stock stems per acre not overtopped. Seedlings are defined as trees less than 1.0 inch d.b.h. and saplings as trees between 1.0 and 4.9 inches d.b.h. Softwoods between 5.0 and 8.9 inches d.b.h. and hardwoods between 5.0 and 10.9 inches d.b.h. are classed as poletimber. Softwoods greater than 8.9 and hardwoods greater than 10.9 inches d.b.h. are sawtimber. Seedling through sawtimber stand sizes are assigned to whichever grouping of tree diameter classes contains the plurality of stocking. A nonstocked stand size is assigned to stands less than 16.7 percent stocked with growing-stock trees. Forest acres cleared to nonforest over the remeasurement period were assigned the forest type and stand size recorded at the time of the initial (1972) inventory. Nonforest acres planted and reverted to forest were assigned the forest type and stand size recorded at the time of the final (1982) inventory.

On forest-to-forest acres, the forest type and stand size at both the initial and final inventories were screened from plot data. These forest-to-forest plots were further ordered by the primary treatment or disturbance they experienced over the remeasurement period. During the Georgia inventory, 27 individual treatments and disturbances were recognized by Forest Survey. For this analysis, some were combined to form 13 treatment/disturbance categories. These could be rearranged or further condensed to suit individual needs. The 13 categories used for this analysis and the Survey treatment/disturbance classes included in them are listed below:

1. <u>Natural Succession</u>.[1] No treatment or disturbance; significant damage from weather or other natural destructive agents.
2. <u>Harvesting Followed by Artificial Regeneration</u>. Harvesting followed by artificial regeneration.
3. <u>Harvesting Followed by Natural Regeneration</u>. Harvesting followed by natural regeneration; harvesting leaving seed trees with satisfactory regeneration.
4. <u>Harvesting Without Regeneration</u>. Harvesting without regeneration; harvesting leaving seed trees without satisfactory regeneration.
5. <u>Highgrading</u>. Removal of selected trees resulting in highgrading.
6. <u>Artificial Regeneration on Forest Land</u>. Artificial regeneration after site preparation; artificial regeneration without site preparation.
7. <u>Other Intermediate Cutting</u>. Cleaning, release, or other intermediate cutting.
8. <u>Commercial Thinning</u>. Commercial thinning.
9. <u>Prescribed Burning</u>. Prescribed burning.

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[1] Although true natural succession includes damage from insects and disease, these disturbances were kept separate because they can be controlled to some extent.

10. Disease Damage. Significant damage from disease.

11. Insect Damage. Significant damage from insects.

12. Grazing. Grazing or other activity that retards or precludes development of the understory.

13. Miscellaneous Treatments/Disturbances. Turpentining; construction of woods roads, fences, firebreaks, or trashpits; salvage cut; clearing or other site preparation; precommercial thinning; girdling or poisoning of undesirable trees; significant damage from wildfire; major drainage efforts; major man-caused flooding; other significant disturbance.

All forest-to-forest plots having the same initial forest type and stand size were arranged under each treatment/disturbance category. Resulting forest types and stand sizes as measured by the final inventory were then examined to determine the effect of each treatment on inventory dynamics. A certain percentage of these plots retained the same forest type and stand size at the time of the final inventory, but some had shifted to other type-size combinations.

Figure 1 illustrates this concept for stands which were pine poletimber at the time of initial inventory and had undergone a commercial thinning over the remeasurement period. About 39 percent were still classified as pine poletimber at the final inventory, 53 percent had moved on to pine sawtimber, and the remainder were scattered among several other type-size combinations. The dispersion pattern for pine poletimber stands experiencing other treatments or disturbances looks entirely different. For example, of all the pine poletimber stands that experienced harvesting with artificial regeneration, none remained in poletimber, 60 percent resulted in pine seedling, and 37 percent resulted in pine sapling stands by the time of the final inventory.

For each of the 13 treatment/disturbance categories, a matrix of empirical rates of change among forest type and stand-size combinations between the initial and final inventories was calculated from the plot data. Everything that happened to the forest resource is built into the rates, and it is possible to

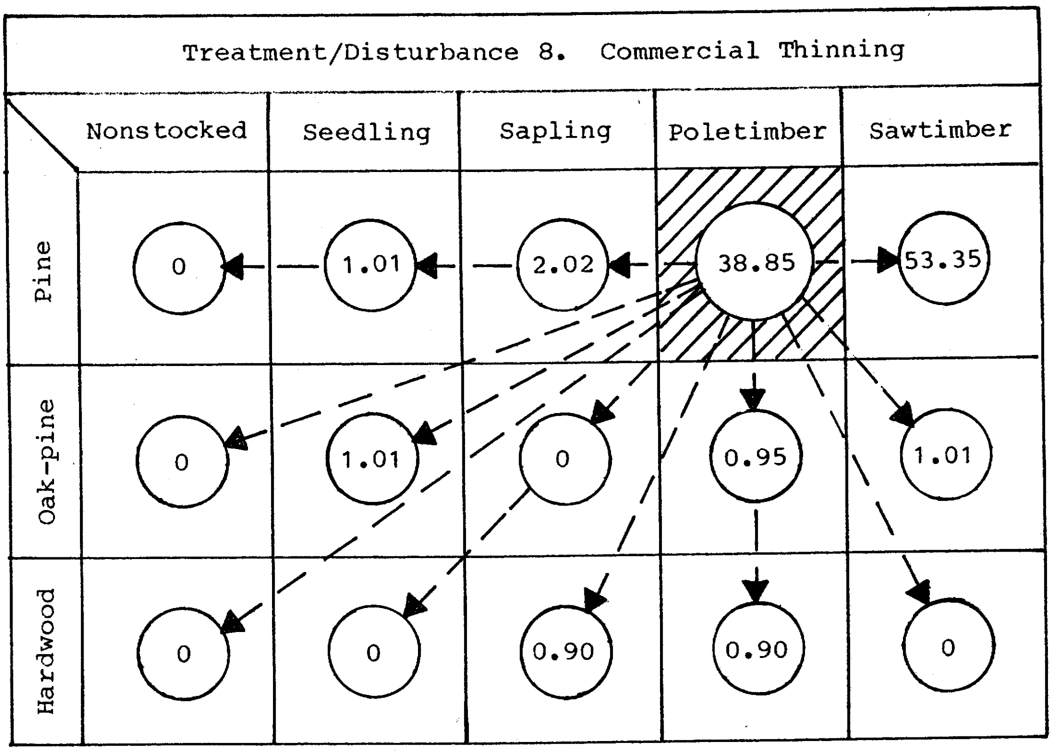

Figure 1. Percentage distribution of forest type and stand-size changes experienced over the remeasurement period by pine poletimber stands undergoing commercial thinning, Georgia, 1972-1982.

single out the effect of any of the 27 disturbances Survey recognizes. In all, 2,925 empirical rates of change were measured from all possible combinations (3 initial forest types x 5 initial stand sizes x 3 final forest types x 5 final stand sizes x 13 treatments/disturbances).

Biologicial Response to Treatment

The major premise of DYNARIP is that the matrix of type-size changes observed under a given primary treatment or disturbance captures the regional biological response of the forest to that disruption. These matrices of empirical rates are unique to a given region for a given treatment. They are recalibrated each time a new inventory is completed. The main controlling factor dictating inventory changes between two points in time is the number of acres of each type-size combination experiencing each treatment or disturbance.

DYNARIP uses this concept to build a foundation of empirical rates from recent observations upon which the model user can interject personal perceptions about the future.

Model Flow Charts

In this section, a segment of DYNARIP is flow-charted to facilitate a basic understanding of how the model works. The matrix of change for pine poletimber stands that experience treatment 8 (commercial thinning) was arbitrarily chosen for demonstration. A detailed listing of the program along with additional technical notes is provided in Appendix A.

Figure 2 illustrates how the initial pine poletimber inventory is broken down. The initial inventory is first separated at time 0 into pine poletimber acres that are to be cleared to nonforest and into pine poletimber acres that will remain in a forest condition (not necessarily pine poletimber) over the model's 10-year timespan. The cleared acres are then transferred to a level equation that keeps track of pine poletimber land-base changes. Level equations simply calculate the number of acres held in a given category at a particular instant in time. The land-base change level will be discussed in more detail later. The initial pine poletimber acres that are to remain in forest for the span of the model are then split by the percentage that are to experience treatment 8. This amount of acreage is then fed into the treatment 8 matrix of change (fig. 3). Acres enter the matrix at a linear rate determined by the total number of acres to experience treatment 8, divided by the total number of iterations in the model timespan.

As pine poletimber acres move into the treatment 8 matrix, some remain in pine poletimber, but some are dispersed to other forest-type/stand-size levels at the rates calculated from the latest Survey regional plot data. The bottom half of figure 3 illustrates dispersion from the treatment 8 pine poletimber level. Simultaneously, some of the other type-size combinations are also experiencing treatment 8. This, in turn, causes some of the acres in those levels to flow into the pine poletimber level. The top half of figure 3 represents acres converging on the treatment 8 pine poletimber level. At the end of each computational iteration the acres remaining in the treatment 8 pine poletimber level exemplify the net effect of treatment 8 on pine poletimber up to that point in time.

Upon completion of an iteration, the acreage in the treatment 8 pine poletimber level is added to the pine poletimber levels from the other 12 treatments (fig. 4). This sum, when combined with the acres in the pine poletimber land-base change level, equals the net pine poletimber inventory at that time.

At the beginning of the model run, the acres in the pine poletimber land-base change level are equal to the amount of acres that are to be cleared to nonforest over the span of the model. Acres flow out of this level at a rate determined by the total acres to be cleared, divided by the total number of iterations in the model. If this level were not being supplemented by nonforest acres planted and reverting to pine poletimber, it would be exactly zero at the end of the model run. However, it is being replenished at the rate calculated by the sum of planted and reverted acres resulting in pine poletimber, divided by the number of model iterations. If the number of acres cleared to nonforest exceeds the

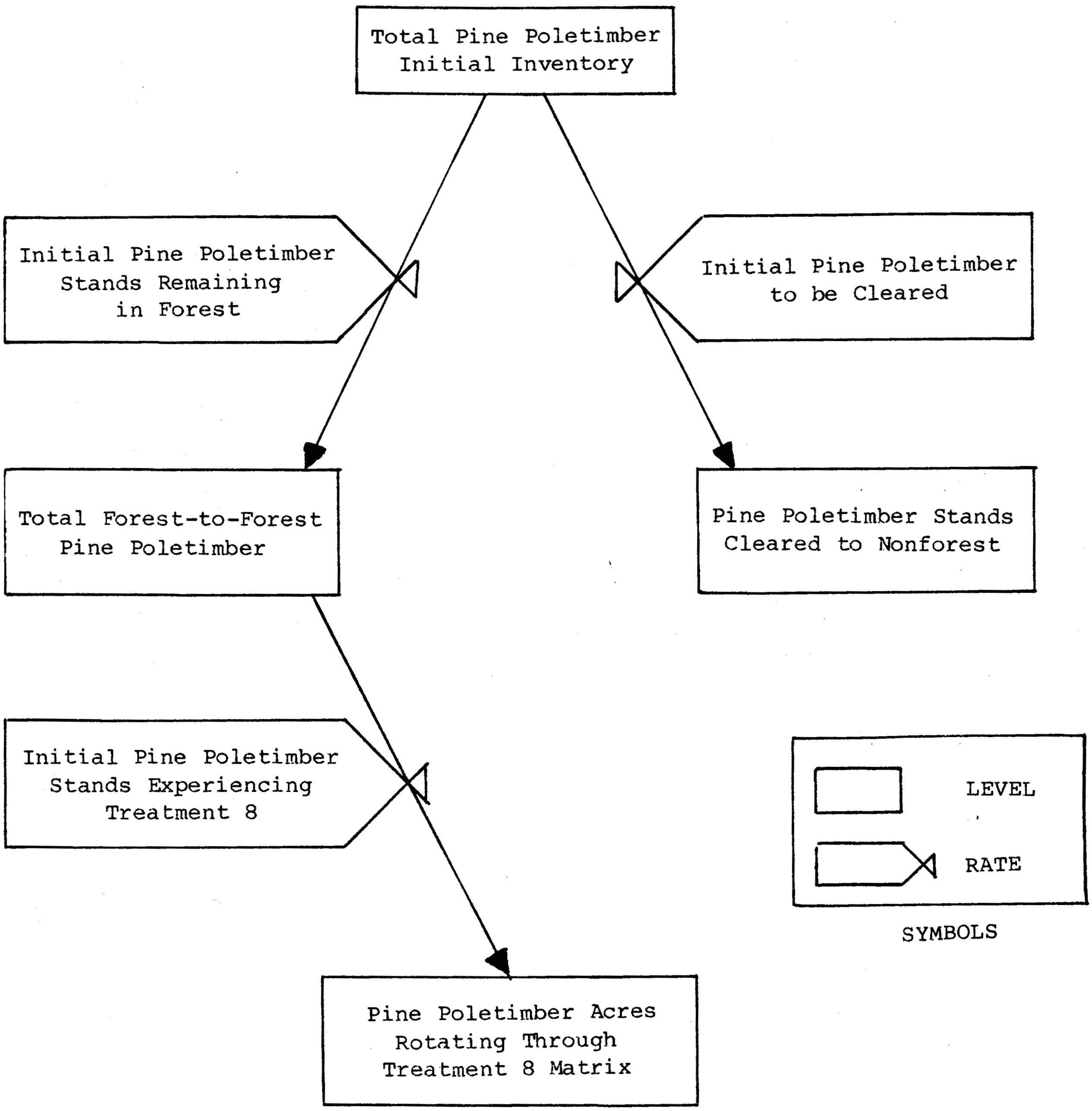

Figure 2.--Flow chart illustrating DYNARIP initial forest type and stand-size model input breakdowns, treatment 8, pine poletimber.

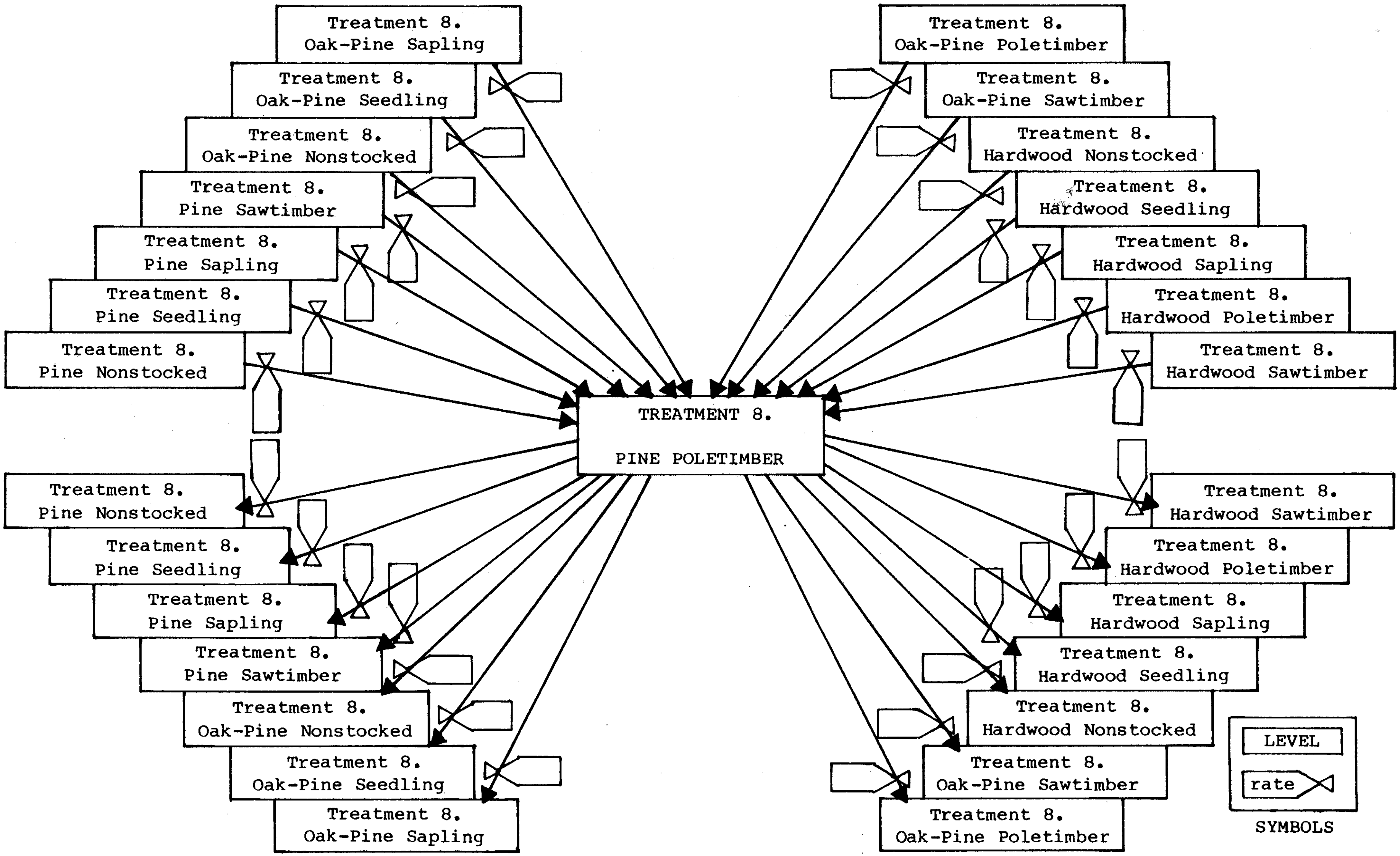

Figure 3.--Flow chart illustrating DYNARIP treatment 8 matrix of change, pine poletimber.

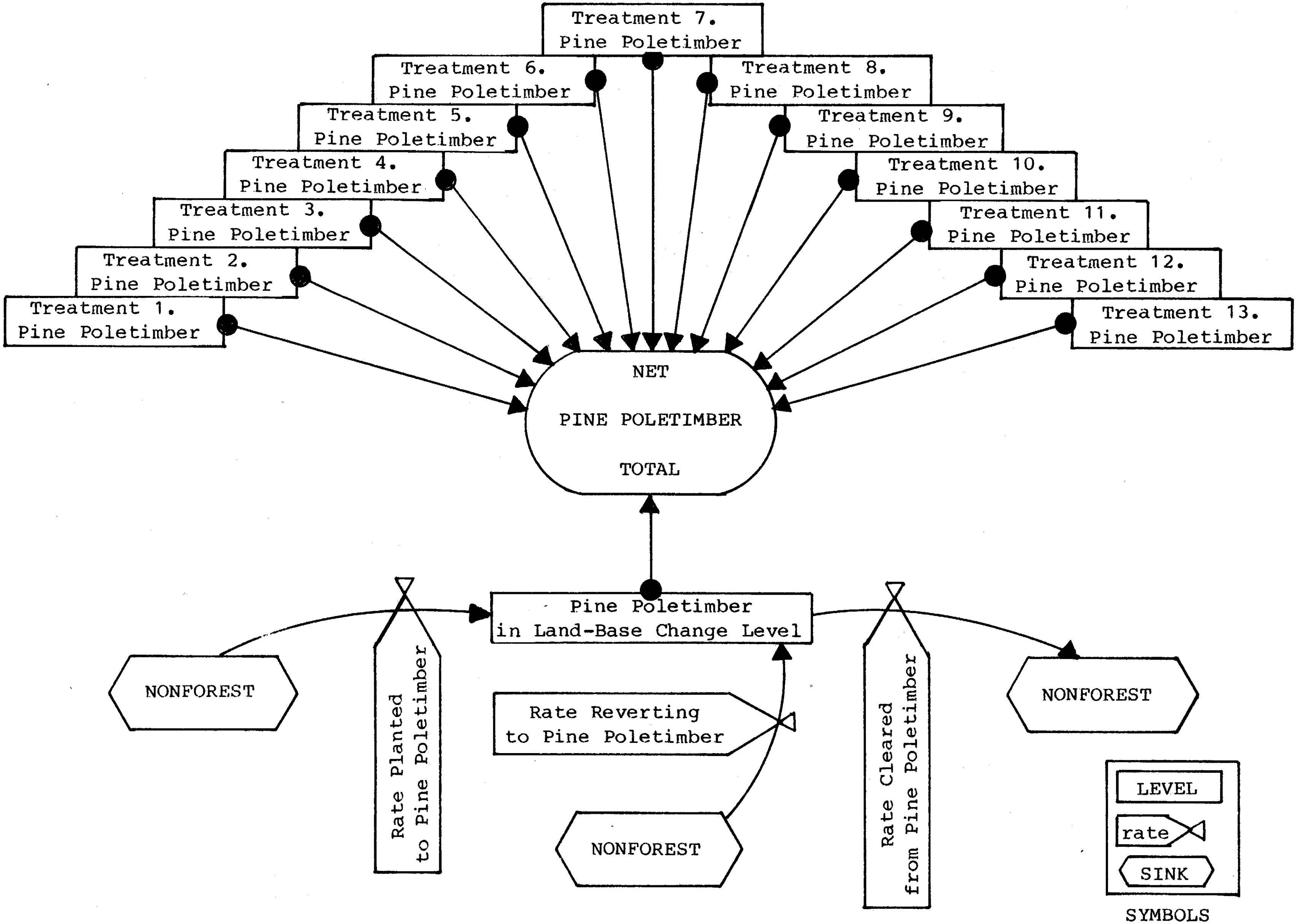

Figure 4.--Flow chart illustrating DYNARIP tabulation of pine poletimber level.

number of nonforest acres planted and reverted, the net pine poletimber acres (and total forest acres) in the regional inventory will diminish accordingly.

Each of the 15 initial forest types and stand sizes are broken down and partialled out to the 13 treatment matrices in exactly the same manner as described above. Each treatment/disturbance matrix is a closed loop that tracks the movement of acreage among the 15 type-size levels enclosed within it. The effect of each treatment or disturbance can thus be isolated. To incorporate assumptions into the model, all the user need do is specify the amount and type of initial acreage rotating through each of the 13 treatment/disturbance matrices. The empirical rates of biological response to treatment then take over and drive the model. The resulting type-size state of regional forest organization is output at the end of each iteration as individual levels are tabulated. Any inventory parameter (such as timber volume) that can be linked to a forest-type/stand-size inventory can be calculated by multiplying the acres in each type-size level by an average factor or stochastic distribution representing that paramenter.

Model Test Run

Since all rates for the Georgia model were developed from the 1972 and 1982 multiresource inventories of the State, one test of model performance is achieved by plugging the 1972 initial inventory into DYNARIP to see how the results compare with what was actually measured in 1982. An obvious advantage, in this case, is that we know what percentages of the 1972 inventory experienced each of the treatments. Although these breakdowns will not be known when the model is projected into the future, such records from the past can be used as a reference upon which to base assumptions about the future.

The results of the model test run are posted in table 1. As should be the case, the differences between the 1982 reported inventory and the 1982 DYNARIP projections are small. Some discrepancy is to be expected because individual plot expansion factors used for the DYNARIP-model input were not calculated in exactly the same manner as they were for the reported inventory. Revision was necessary to make the model more sensitive to individual Survey Units and because lost or added plots could not be used in the calculation of forest-to-forest rates of change. The largest discrepancy between projected and reported 1982 inventory figures is about 8 percent in the pine nonstocked category.

Table 1.--Comparison of 1982 reported Georgia forest inventory and 1982 inventory as projected by DYNARIP using 1972 input data

Forest type-stand size	1982 Reported inventory	1982 DYNARIP inventory projection	Percent difference
	Acres	Acres	Percent
Pine			
Nonstocked	205,658	221,570	+7.7
Seedling	1,232,882	1,235,100	+0.2
Sapling	1,787,115	1,790,500	+.2
Poletimber	3,769,165	3,761,500	-.2
Sawtimber	4,444,099	4,436,200	-.2
Oak-pine			
Nonstocked	37,998	37,035	-2.5
Seedling	458,372	440,160	-4.0
Sapling	476,945	457,980	-4.0
Poletimber	923,878	972,000	+5.2
Sawtimber	1,062,357	1,031,700	-2.9
Hardwood			
Nonstocked	449,893	473,250	+5.2
Seedling	678,457	676,110	-.3
Sapling	1,176,027	1,172,700	-.3
Poletimber	3,028,577	2,971,600	-1.9
Sawtimber	4,002,261	4,055,900	+1.3
Total	23,733,684	23,733,605	--[a]

[a]Negligible.

II. Georgia Pilot Analysis

Before the DYNARIP model could be used to project the 1982 Georgia forest inventory into the future, a problem inherent to the data had to be corrected. The 1972 inventory was slightly confounded by plots straddling more than one condition. For example, if one portion of a plot was in an oak-hickory stand and the other in a pine stand, the plot may have been typed as oak-pine. Although this practice was eliminated and plots were confined to a single condition in the 1982 survey, its prior use meant that some of the rates of change measured between the two surveys were due to Survey procedural change and not real change. These confounded rates were used in the previous model test run, but cannot be used for future projections. For this reason, 1,900 straddler plots were screened from the data so that pure rates of change could be developed. These pure rates are used in all subsequent DYNARIP runs. The total number of plots supporting the Georgia DYNARIP model was reduced from 6,134 to 4,234.

Regional Response to Individual Treatments/Disturbances

Figures presented in table 2 isolate the potential impact of 11 man-caused and natural disturbances (treatments 2 through 12) on the Georgia forest resource over the next 10 years. The 1982 inventory, which was used as input to the model, is listed in the first column. The 1992 DYNARIP base inventory projection, which assumes that rates of treatment and forest land-base changes will continue at rates observed between 1972 and 1982, is shown in the second column. A complete listing of the base-run output is provided in Appendix B. The remaining columns in table 2 list the output from DYNARIP runs exactly like the base run, except that the effect of one treatment/disturbance at a time was nullified. In other words, the acres which experienced treatments 2, 3, 4, etc., under the base run were relegated to Treatment 1 under each of the null runs. This sequence of runs simulates what the response of the resource would be if one of man's activities or a natural disturbance were completely discontinued and the acres affected by that disturbance were allowed to proceed as they would if totally undisturbed. The potential influence of each treatment or disturbance can be quantified by comparing each of the null runs with the base-run projection and initial (1982) inventory. While the complete cessation of a particular activity may be unrealistic, this exercise demonstrates that analyses of this type can be used to estimate the range of response that can be expected from modifying the amount of acres affected by a particular disruption. As is evident from table 2, harvesting and regeneration practices bear the most potential influence on the future state of forest organization in Georgia. Most of the other treatments and disturbances would not have an overwhelming impact on the regional inventory by the end of 10 years. This means that the instances of these other disturbances are relatively insignificant when viewed in the context of the regional inventory as a whole and/or the resource is highly buffered and reacts to them somewhat slowly.

Georgia Forest Policy Analysis

In addition to isolating the effects of individual disturbances, it is much more meaningful from the standpoint of some forest policy issues to analyze the results of shifting acres from one active treatment to another. If, for instance, a legislative body were interested in changing the composition of a regional inventory, it could use the model to evaluate what is biologically possible within a certain time frame and then to determine what human activities might be modified to best bring about the change. By the same token, if a change in some activity becomes apparent or is anticipated, the model can be used to simulate the prospective results. To show how DYNARIP might be used to satisfy such a role, a forest policy issue of regional significance was chosen for analysis.

For over a decade, much concern has been raised about declining rates of pine regeneration in the South (U.S. Department of Agriculture, Forest Service 1978). Past failure to regenerate harvested pine stands has made future declines of softwood timber supplies in the South almost inevitable (Boyce and Knight 1979). Conspicuously low rates of pine regeneration on lands held by nonindustrial private forest (NIPF) owners have been identified as a major cause of the problem (Knight 1978; National Forest Products Association 1980; Society of American Foresters 1979).

Table 2.--Georgia 1992 projected inventories based on 1972-1982 observed rates of treatment/disturbance, with one treatment/disturbance at a time nullified

Forest type-stand size	1982 Inventory input	1992 Inventory output											
		Base run	Treatment/disturbance nullified										
			2[a]	3[b]	4[c]	5[d]	6[e]	7[f]	8[g]	9[h]	10[i]	11[j]	12[k]
	Thousand acres												
Pine													
Nonstocked	205.7	217.9	227.0	218.1	74.7	218.3	222.5	213.1	218.1	222.9	218.2	218.0	218.2
Seedling	1,232.9	1,215.6	502.9	1,091.0	1,115.8	1,206.8	1,145.0	1,193.1	1,205.7	1,203.4	1,222.3	1,212.5	1,219.2
Sapling	1,787.1	1,858.8	1,509.4	1,819.3	1,843.7	1,857.1	1,649.5	1,814.8	1,861.0	1,872.2	1,935.9	1,852.3	1,861.9
Poletimber	3,769.2	3,029.1	3,219.0	3,142.5	3,178.7	3,034.0	3,053.2	2,982.2	3,009.4	2,974.3	2,917.8	3,068.5	3,038.7
Sawtimber	4,444.1	4,082.3	4,749.7	4,536.8	4,715.7	4,226.1	4,116.2	4,354.3	4,079.8	4,090.6	4,040.5	4,173.3	4,081.9
Oak-Pine													
Nonstocked	38.0	38.0	38.2	38.0	11.3	38.1	39.6	34.7	38.0	38.2	38.1	38.0	38.1
Seedling	458.4	416.1	355.3	266.9	360.5	417.1	420.4	402.3	418.5	391.2	420.6	418.6	418.1
Sapling	476.9	440.5	449.3	373.2	426.3	419.4	453.9	446.2	446.2	447.6	459.4	451.5	447.7
Poletimber	923.9	816.5	847.6	821.5	775.6	798.1	826.4	765.8	828.7	831.6	830.2	777.1	810.2
Sawtimber	1,062.3	940.9	1,001.1	986.3	1,000.3	968.8	950.7	963.9	956.9	945.6	948.3	969.7	938.2
Hardwood													
Nonstocked	449.9	432.5	439.6	435.2	243.8	425.4	469.6	439.0	435.1	416.1	432.8	435.0	439.7
Seedling	678.4	609.5	596.1	393.3	407.9	589.6	611.2	564.9	609.6	579.5	610.3	604.4	610.3
Sapling	1,176.0	1,081.4	1,107.6	967.1	989.1	1,067.3	1,128.1	1,070.7	1,069.7	1,109.2	1,083.2	1,046.3	1,087.4
Poletimber	3,028.6	2,918.1	2,972.6	2,919.6	2,789.6	2,806.5	2,979.8	2,833.1	2,909.2	2,945.2	2,887.9	2,879.5	2,932.2
Sawtimber	4,002.3	4,556.1	4,637.9	4,644.5	4,720.3	4,580.7	4,587.2	4,575.2	4,567.4	4,585.7	4,607.8	4,508.6	4,511.5
Total	23,733.7	22,653.3	22,653.3	22,653.3	22,653.3	22,653.3	22,653.3	22,653.3	22,653.3	22,653.3	22,653.3	22,653.3	22,653.3

[a]Harvest followed by artificial regeneration.
[b]Harvest followed by natural regeneration.
[c]Harvest without regeneration.
[d]Highgrading.
[e]Artificial regeneration on forest land.
[f]Other intermediate cutting.
[g]Commercial thinning.
[h]Prescribed burning.
[i]Disease damage.
[j]Insect damage.
[k]Grazing.

In 1971 the Virginia General Assembly passed the Reforestation of Timberlands Act, designed to increase the rate of pine regeneration on NIPF land in Virginia. The passage of the Federal Forestry Incentives Program (FIP) in 1973 offered the private landowner in Virginia additional stimulus to regenerate more acres to pine. With both programs fully operational by 1975, the average annual acres planted to pine on NIPF land between 1975 and 1981 increased by 131 percent over the average annual acres planted between 1962 and 1971, when no major incentives programs were in effect (U.S. Department of Agriculture, Forest Service 1963-1974, 1974-1980, 1982).

Suppose the Georgia State Legislature were interested in estimating the impact of a bill similar to Virginia's Reforestation of Timberlands Act on Georgia's softwood timber inventory over the next 30 years. The average acres planted annually on NIPF land in Georgia between 1975 and 1981 when FIP was the only major incentives program in effect in Georgia was 25 percent greater than acres planted between 1962 and 1974, when no major programs were in effect. If one assumes that 25 percent of the Virginia increase between 1975 and 1981 was due to the FIP legislation, then one might logically conclude that the other 106 percent of the total increase was likely due to the State bill. This calculation suggests that Georgia might also expect about 100 percent increase in the rate of pine regeneration on NIPF land by enacting legislation similar to Virginia's. This assumption is supported by comparing the rate of NIPF planting in Virginia during the 3 years when only the State bill was in effect (1972-74) with the rates of planting in the State between 1962 and 1971. The comparison indicates the Reforestation Timberlands Act increased planting by 101 percent.

As if the hypothetical Georgia bill were to be passed in 1985 and become operational by 1986, the assumed 100 percent increase in NIPF planting rates was entered into the DYNARIP model to assess the prospective ramifications of the policy change. Between 1972 and 1982, Georgia NIPF owners planted a total of 255,616 acres following a final harvest (treatment 2), 55,690 acres of poorly or nonstocked forest land (treatment 6), and 60,375 acres of nonforest land (land-base change). For the first decade (1982-92), NIPF acres experiencing each of the above three treatments were increased only by 60 percent since the legislation would not become effective until 1986. For the following 2 decades, each was increased by 100 percent. Acres added to treatment 2 were proportionately subtracted from treatments 3 and 4. Acres added to treatment 6 were proportionately subtracted from acres experiencing treatments 1, 10, and 11, hence assuming these acres would otherwise have been left to nature. Additional acres of planted nonforest were treated as a direct increase to the forest land base. Prospective results of the policy change on the pine resource of Georgia are presented in column 2 of table 3. A measure of the impact of the policy change can be obtained by comparing the policy-change-run with the base-run projection.

By the end of the first decade, pine nonstocked and pine seedling stands are perceptibly impacted. Nonstocked acreage declines and pine seedling stands

Table 3.--Comparison of DYNARIP pine acreage base-run projection, and projected pine acreage resulting from hypothetical policy change, Georgia, 1992-2012

Year/pine stand sizes	Base-run projection	Policy change projection	Percent difference
	- - Thousand acres - -		Percent
1982:			
Nonstocked	217.9	206.6	-5.2
Seedling	1,215.6	1,316.2	+8.3
Sapling	1,858.8	1,930.9	+3.9
Poletimber	3,029.1	3,024.4	-.2
Sawtimber	4,082.3	4,071.0	-.3
Total	10,403.7	10,549.1	+1.4
2002:			
Nonstocked	203.5	185.7	-8.7
Seedling	1,099.3	1,256.4	+14.3
Sapling	1,755.9	1,897.1	+8.0
Poletimber	2,792.5	2,859.8	+2.4
Sawtimber	3,612.4	3,602.9	-.3
Total	9,463.6	9,801.9	+3.6
2012:			
Nonstocked	185.7	170.6	-8.1
Seedling	1,003.8	1,159.2	+15.5
Sapling	1,609.4	1,768.8	+9.9
Poletimber	2,567.8	2,716.0	+5.8
Sawtimber	3,236.5	3,262.9	+.8
Total	8,603.2	9,077.5	+5.5

increase. These trends continue throughout the 30-year simulation. Also by 1992, some of the increased pine regeneration is beginning to boost the area of pine saplings. Pine poletimber and sawtimber stands remain largely unaffected, except for slight reductions due to the liquidation of some poorly stocked and marginally productive stands.

By the year 2002, the effect of the policy change on pine saplings becomes apparent as the acres in this category are increased by about 8 percent over what would be present without the legislation. Some of the stands planted early under the imaginary program are now starting to reach poletimber size. Pine sawtimber still remains relatively unchanged.

By 2012, pine poletimber acreage is expanded by 6 percent. The program is just starting to influence pine sawtimber. If our assumptions are reasonably accurate, the hypothetical bill would increase the total area of pine by about 0.5 million acres at the end of 30 years. However, even with legislation such as this in effect, the DYNARIP simulation indicates the total pine acreage would still decline by about 2.4 million acres from what was measured in 1982.

To further quantify the effects of the policy change, average standing volume factors were developed and added to the core model. From the 1982 inventory, the average standing growing-stock cubic-foot volume per acre by softwood and hardwood, by sawtimber and poletimber was calculated for each of the 15 forest-type/stand-size combinations. These factors were then multiplied by the acreage in each of the type-size levels to simulate the Georgia growing-stock inventory. The DYNARIP 30-year softwood volume projection output is presented in table 4.

If the stated assumptions become reality, and there are no substantial reductions of softwood removals, increased planting now would not significantly increase softwood volume in the State for at least 20 years. Most of the additional planted acres would not reach poletimber size until they were at least 15 years of age. By the end of 30 years, the softwood growing-stock inventory volume under the program of increased NIPF planting could be increased by about 200 million cubic feet over the prospective volume if no legislation is enacted. Even so, this still represents a 3.6 billion cubic-foot decline from the present softwood growing-stock inventory.

The relatively meager potential increase in the 30-year softwood volume inventory indicated by the policy-change projection stems from three main factors:

1. The most notable factor is the present low rate of artificial regeneration on NIPF land. NIPF owners planted only 22 percent of the total stands planted in Georgia between 1972 and 1982. However, they harvested 61 percent of all pine stands harvested during this same period. Even if they doubled their rate of planting, this would still leave 62 percent of their harvested pine stands unplanted. In contrast, forest industry artificially regenerated about the equivalent of what pine stands they harvested. In order to substantially increase the softwood standing inventory volume, NIPF planting rates would have to be more than doubled.

2. Some of the additional acres of pine planted under the hypothetical program would have regenerated naturally to pine anyway. Also, some of the additional pine plantations would be unsuccessful.

3. The entire benefit of the policy change is not represented by the inven-

Table 4.--Comparison of DYNARIP softwood growing-stock inventory volume base-run projection, and projected softwood volume resulting from hypothetical policy change, Georgia, 1992-2012

Year/softwood timber size	Base-run projection	Policy-change projection	Percent difference
	Billion cubic feet		Percent
1992:			
Poletimber	4.241	4.242	--
Sawtimber	10.291	10.269	-0.2
Total	14.532	14.511	-.1
2002:			
Poletimber	3.892	3.950	+1.5
Sawtimber	9.425	9.420	-.1
Total	13.317	13.370	+.4
2012:			
Poletimber	3.579	3.704	+3.5
Sawtimber	8.693	8.762	+.8
Total	12.272	12.466	+1.6

[a]Negligible.

tory figures in table 4 because extra volume is also being put on the market due to the early liquidation of some poorly stocked stands, as well as extra volume generated by the planting program. This additional volume put on the market could make the program look more attractive.

Although beyond the scope of this paper, the hypothetical Georgia policy-change analysis could be carried further. Average growing-stock removals per acre by forest type, stand size, and treatment could be developed to gain a measure of softwood growing-stock volume put on the market over the projection period. With this additional information, analysts would have much of the input necessary for a detailed economic analysis of the hypothetical legislation. Algorithms tracking wildlife habitat, recreation value, esthetics, shifts of forest ownership, etc., could also be added to the core model to follow prospective trends in these areas of concern.

As can be gleaned from the above analysis, the trends mapped by the DYNARIP model reinforce what common sense would reveal to the regional analyst if events take place as described. The value of the DYNARIP model results from its ability to quantify these perceptions of the future and to highlight any unexpected consequences resulting from a proposed course of action.

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Appendix A.

DYNARIP Model Listing

The DYNARIP core model used for the Georgia 1982-1992 base-run projection is listed below. The output from the program as listed here is provided in Appendix B.

This program will run on a DYNAMO/370 mainframe compiler. The mainframe compiler is capable of handling up to 13 separate treatments/disturbances with adequate storage capacity for most algorithms that might be added to the core model. DYNARIP runs should generally cost less than $5.

Program Listing

```
*  GEORGIA DYNARIP,OUTPUT SCALED
NOTE  <<<<<<<<<< FOREST TO FOREST SECTOR >>>>>>>>>>
NOTE
NOTE  RATE TRANSFERRED TO A TYPE
NOTE
MACRO  RTOTYP(FRTP1,FRTP2,FRTP3,FRTP4,FRTP5,FRTP6,FRTP7,FRTP8,FRTP9,
X  FRTP10,FRTP11,FRTP12,FRTP13,FRTP14,FFBT1,FFBT2,FFBT3,FFBT4,FFBT5,
X  FFBT6,FFBT7,FFBT8,FFBT9,FFBT10,FFBT11,FFBT12,FFBT13,FFBT14)
R  RTOTYP.KL=
X  (FRTP1*FFBT1/REMEAS)+
X  (FRTP2*FFBT2/REMEAS)+
X  (FRTP3*FFBT3/REMEAS)+
X  (FRTP4*FFBT4/REMEAS)+
X  (FRTP5*FFBT5/REMEAS)+
X  (FRTP6*FFBT6/REMEAS)+
X  (FRTP7*FFBT7/REMEAS)+
X  (FRTP8*FFBT8/REMEAS)+
X  (FRTP9*FFBT9/REMEAS)+
X  (FRTP10*FFBT10/REMEAS)+
X  (FRTP11*FFBT11/REMEAS)+
X  (FRTP12*FFBT12/REMEAS)+
X  (FRTP13*FFBT13/REMEAS)+
X  (FRTP14*FFBT14/REMEAS)
```

```
00240 MEND
00250 NOTE
00260 NOTE  AREA AT TIME K BY SIZE/TYPE AND TREATMENT
00270 NOTE
00280 MACRO  TYPBTR(INTYP,CLE,PERTR,TOTP1,TOTP2,TOTP3,TOTP4,TOTP5,TOTP6,
00290 X  TOTP7,TOTP8,TOTP9,TOTP10,TOTP11,TOTP12,TOTP13,TOTP14,D1,D2,D3,D4,D5,
00300 X  D6,D7,D8,D9,D10,D11,D12,D13,D14,DD1,DD2,DD3,DD4,DD5,DD6,DD7,DD8,DD9,
00310 X  DD10,DD11,DD12,DD13,DD14,FFBT)
00320 L  TYPBTR.K=TYPBTR.J+DT*($TOTYP.JK-$FRTYP.JK)
00330 N  TYPBTR=(INTYP-(CLE*TACA*REMEAS))*PERTR
00340 N  FFBT=TYPBTR
00350 R  $FRTYP.KL=$RFRTYP*FFBT/REMEAS
00360 N  $RFRTYP=TOTP1+TOTP2+TOTP3+TOTP4+TOTP5+TOTP6+TOTP7+TOTP8+TOTP9+
00370 X  TOTP10+TOTP11+TOTP12+TOTP13+TOTP14
00380 R  $TOTYP.KL=RTOTYP(D1,D2,D3,D4,D5,D6,D7,D8,D9,D10,D11,D12,D13,D14,
00390 X  DD1,DD2,DD3,DD4,DD5,DD6,DD7,DD8,DD9,DD10,DD11,DD12,DD13,DD14)
00400 MEND
00410 NOTE
00420 NOTE  TREATMENT 1.
00430 NOTE
00440 NOTE  PINE NONSTOCKED
00450 A  PA1.K=TYPBTR(IPA,CPA,PATD1,PAPB1,PAPC1,PAPD1,PAPE1,PAOA1,
00460 X  PAOB1,PAOC1,PAOD1,PAOE1,PAHA1,PAHB1,PAHC1,PAHD1,PAHE1,
00470 X  PBPA1,PCPA1,PDPA1,PEPA1,OAPA1,OBPA1,OCPA1,ODPA1,OEPA1,
00480 X  HAPA1,HBPA1,HCPA1,HDPA1,HEPA1,FFPB1,FFPC1,FFPD1,FFPE1,
00490 X  FFOA1,FFOB1,FFOC1,FFOD1,FFOE1,FFHA1,FFHB1,FFHC1,
00500 X  FFHD1,FFHE1,FFPA1)
00510 NOTE  PINE SEEDLING
00520 A  PB1.K=TYPBTR(IPB,CPB,PBTD1,PBPA1,PBPC1,PBPD1,PBPE1,PBOA1,
00530 X  PBOB1,PBOC1,PBOD1,PBOE1,PBHA1,PBHB1,PBHC1,PBHD1,PBHE1,
00540 X  PAPB1,PCPB1,PDPB1,PEPB1,OAPB1,OBPB1,OCPB1,ODPB1,OEPB1,
00550 X  HAPB1,HBPB1,HCPB1,HDPB1,HEPB1,FFPA1,FFPC1,FFPD1,FFPE1,
00560 X  FFOA1,FFOB1,FFOC1,FFOD1,FFOE1,FFHA1,FFHB1,FFHC1,
00570 X  FFHD1,FFHE1,FFPB1)
00580 NOTE  PINE SAPLING
00590 A  PC1.K=TYPBTR(IPC,CPC,PCTD1,PCPB1,PCPA1,PCPD1,PCPE1,PCOA1,
00600 X  PCOB1,PCOC1,PCOD1,PCOE1,PCHA1,PCHB1,PCHC1,PCHD1,PCHE1,
00610 X  PBPC1,PAPC1,PDPC1,PEPC1,OAPC1,OBPC1,OCPC1,ODPC1,OEPC1,
00620 X  HAPC1,HBPC1,HCPC1,HDPC1,HEPC1,FFPB1,FFPA1,FFPD1,FFPE1,
00630 X  FFOA1,FFOB1,FFOC1,FFOD1,FFOE1,FFHA1,FFHB1,FFHC1,
00640 X  FFHD1,FFHE1,FFPC1)
00650 NOTE  PINE POLETIMBER
00660 A  PD1.K=TYPBTR(IPD,CPD,PDTD1,PDPB1,PDPC1,PDPA1,PDPE1,PDOA1,
00670 X  PDOB1,PDOC1,PDOD1,PDOE1,PDHA1,PDHB1,PDHC1,PDHD1,PDHE1,
00680 X  PBPD1,PCPD1,PAPD1,PEPD1,OAPD1,OBPD1,OCPD1,ODPD1,OEPD1,
00690 X  HAPD1,HBPD1,HCPD1,HDPD1,HEPD1,FFPB1,FFPC1,FFPA1,FFPE1,
00700 X  FFOA1,FFOB1,FFOC1,FFOD1,FFOE1,FFHA1,FFHB1,FFHC1,
00710 X  FFHD1,FFHE1,FFPD1)
00720 NOTE  PINE SAWTIMBER
00730 A  PE1.K=TYPBTR(IPE,CPE,PETD1,PEPB1,PEPC1,PEPD1,PEPA1,PEOA1,
00740 X  PEOB1,PEOC1,PEOD1,PEOE1,PEHA1,PEHB1,PEHC1,PEHD1,PEHE1,
00750 X  PBPE1,PCPE1,PDPE1,PAPE1,OAPE1,OBPE1,OCPE1,ODPE1,OEPE1,
00760 X  HAPE1,HBPE1,HCPE1,HDPE1,HEPE1,FFPB1,FFPC1,FFPD1,FFPA1,
00770 X  FFOA1,FFOB1,FFOC1,FFOD1,FFOE1,FFHA1,FFHB1,FFHC1,
00780 X  FFHD1,FFHE1,FFPE1)
00790 NOTE  OAK-PINE NONSTOCKED
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```
00800 A   OA1.K=TYPBTR(IOA,COA,OATD1,OAPB1,OAPC1,OAPD1,OAPE1,OAPA1,
00810 X   OAOB1,OAOC1,OAOD1,OAOE1,OAHA1,OAHB1,OAHC1,OAHD1,OAHE1,
00820 X   PBOA1,PCOA1,PDOA1,PEOA1,PAOA1,OBOA1,OCOA1,ODOA1,OEOA1,
00830 X   HAOA1,HBOA1,HCOA1,HDOA1,HEOA1,FFPB1,FFPC1,FFPD1,FFPE1,
00840 X   FFPA1,FFOB1,FFOC1,FFOD1,FFOE1,FFHA1,FFHB1,FFHC1,
00850 X   FFHD1,FFHE1,FFOA1)
00860 NOTE   OAK-PINE SEEDLING
00870 A   OB1.K=TYPBTR(IOB,COB,OBTD1,OBPB1,OBPC1,OBPD1,OBPE1,OBOA1,
00880 X   OBPA1,OBOC1,OBOD1,OBOE1,OBHA1,OBHB1,OBHC1,OBHD1,OBHE1,
00890 X   PBOB1,PCOB1,PDOB1,PEOB1,OAOB1,PAOB1,OCOB1,ODOB1,OEOB1,
00900 X   HAOB1,HBOB1,HCOB1,HDOB1,HEOB1,FFPB1,FFPC1,FFPD1,FFPE1,
00910 X   FFOA1,FFPA1,FFOC1,FFOD1,FFOE1,FFHA1,FFHB1,FFHC1,
00920 X   FFHD1,FFHE1,FFOB1)
00930 NOTE   OAK-PINE SAPLING
00940 A   OC1.K=TYPBTR(IOC,COC,OCTD1,OCPB1,OCPC1,OCPD1,OCPE1,OCOA1,
00950 X   OCOB1,OCPA1,OCOD1,OCOE1,OCHA1,OCHB1,OCHC1,OCHD1,OCHE1,
00960 X   PBOC1,PCOC1,PDOC1,PEOC1,OAOC1,OBOC1,PAOC1,ODOC1,OEOC1,
00970 X   HAOC1,HBOC1,HCOC1,HDOC1,HEOC1,FFPB1,FFPC1,FFPD1,FFPE1,
00980 X   FFOA1,FFOB1,FFPA1,FFOD1,FFOE1,FFHA1,FFHB1,FFHC1,
00990 X   FFHD1,FFHE1,FFOC1)
01000 NOTE   OAK-PINE POLETIMBER
01010 A   OD1.K=TYPBTR(IOD,COD,ODTD1,ODPB1,ODPC1,ODPD1,ODPE1,ODOA1,
01020 X   ODOB1,ODOC1,ODPA1,ODOE1,ODHA1,ODHB1,ODHC1,ODHD1,ODHE1,
01030 X   PBOD1,PCOD1,PDOD1,PEOD1,OAOD1,OBOD1,OCOD1,PAOD1,OEOD1,
01040 X   HAOD1,HBOD1,HCOD1,HDOD1,HEOD1,FFPB1,FFPC1,FFPD1,FFPE1,
01050 X   FFOA1,FFOB1,FFOC1,FFPA1,FFOE1,FFHA1,FFHB1,FFHC1,
01060 X   FFHD1,FFHE1,FFOD1)
01070 NOTE   OAK-PINE SAWTIMBER
01080 A   OE1.K=TYPBTR(IOE,COE,OETD1,OEPB1,OEPC1,OEPD1,OEPE1,OEOA1,
01090 X   OEOB1,OEOC1,OEOD1,OEPA1,OEHA1,OEHB1,OEHC1,OEHD1,OEHE1,
01100 X   PBOE1,PCOE1,PDOE1,PEOE1,OAOE1,OBOE1,OCOE1,ODOE1,PAOE1,
01110 X   HAOE1,HBOE1,HCOE1,HDOE1,HEOE1,FFPB1,FFPC1,FFPD1,FFPE1,
01120 X   FFOA1,FFOB1,FFOC1,FFOD1,FFPA1,FFHA1,FFHB1,FFHC1,
01130 X   FFHD1,FFHE1,FFOE1)
01140 NOTE   HARDWOOD NONSTOCKED
01150 A   HA1.K=TYPBTR(IHA,CHA,HATD1,HAPB1,HAPC1,HAPD1,HAPE1,HAOA1,
01160 X   HAOB1,HAOC1,HAOD1,HAOE1,HAPA1,HAHB1,HAHC1,HAHD1,HAHE1,
01170 X   PBHA1,PCHA1,PDHA1,PEHA1,OAHA1,OBHA1,OCHA1,ODHA1,OEHA1,
01180 X   PAHA1,HBHA1,HCHA1,HDHA1,HEHA1,FFPB1,FFPC1,FFPD1,FFPE1,
01190 X   FFOA1,FFOB1,FFOC1,FFOD1,FFOE1,FFPA1,FFHB1,FFHC1,
01200 X   FFHD1,FFHE1,FFHA1)
01210 NOTE   HARDWOOD SEEDLING
01220 A   HB1.K=TYPBTR(IHB,CHB,HBTD1,HBPB1,HBPC1,HBPD1,HBPE1,HBOA1,
01230 X   HBOB1,HBOC1,HBOD1,HBOE1,HBHA1,HBPA1,HBHC1,HBHD1,HBHE1,
01240 X   PBHB1,PCHB1,PDHB1,PEHB1,OAHB1,OBHB1,OCHB1,ODHB1,OEHB1,
01250 X   HAHB1,PAHB1,HCHB1,HDHB1,HEHB1,FFPB1,FFPC1,FFPD1,FFPE1,
01260 X   FFOA1,FFOB1,FFOC1,FFOD1,FFOE1,FFHA1,FFPA1,FFHC1,
01270 X   FFHD1,FFHE1,FFHB1)
01280 NOTE   HARDWOOD SAPLING
01290 A   HC1.K=TYPBTR(IHC,CHC,HCTD1,HCPB1,HCPC1,HCPD1,HCPE1,HCOA1,
01300 X   HCOB1,HCOC1,HCOD1,HCOE1,HCHA1,HCHB1,HCPA1,HCHD1,HCHE1,
01310 X   PBHC1,PCHC1,PDHC1,PEHC1,OAHC1,OBHC1,OCHC1,ODHC1,OEHC1,
01320 X   HAHC1,HBHC1,PAHC1,HDHC1,HEHC1,FFPB1,FFPC1,FFPD1,FFPE1,
01330 X   FFOA1,FFOB1,FFOC1,FFOD1,FFOE1,FFHA1,FFHB1,FFPA1,
01340 X   FFHD1,FFHE1,FFHC1)
01350 NOTE   HARDWOOD POLETIMBER
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01360 A   HD1.K=TYPBTR(IHD,CHD,HDTD1,HDPB1,HDPC1,HDPD1,HDPE1,HDOA1,
01370 X   HDOB1,HDOC1,HDOD1,HDOE1,HDHA1,HDHB1,HDHC1,HDPA1,HDHE1,
01380 X   PBHD1,PCHD1,PDHD1,PEHD1,OAHD1,OBHD1,OCHD1,ODHD1,OEHD1,
01390 X   HAHD1,HBHD1,HCHD1,PAHD1,HEHD1,FFPB1,FFPC1,FFPD1,FFPE1,
01400 X   FFOA1,FFOB1,FFOC1,FFOD1,FFOE1,FFHA1,FFHB1,FFHC1,
01410 X   FFPA1,FFHE1,FFHD1)
01420 NOTE  HARDWOOD SAWTIMBER
01430 A   HE1.K=TYPBTR(IHE,CHE,HETD1,HEPB1,HEPC1,HEPD1,HEPE1,HEOA1,
01440 X   HEOB1,HEOC1,HEOD1,HEOE1,HEHA1,HEHB1,HEHC1,HEHD1,HEPA1,
01450 X   PBHE1,PCHE1,PDHE1,PEHE1,OAHE1,OBHE1,OCHE1,ODHE1,OEHE1,
01460 X   HAHE1,HBHE1,HCHE1,HDHE1,PAHE1,FFPB1,FFPC1,FFPD1,FFPE1,
01470 X   FFOA1,FFOB1,FFOC1,FFOD1,FFOE1,FFHA1,FFHB1,FFHC1,
01480 X   FFHD1,FFPA1,FFHE1)
01490 NOTE
01500 NOTE
01510 NOTE
01520 NOTE  TREATMENTS 2-13 OMITTED
01530 NOTE
01540 NOTE
01550 NOTE
01560 NOTE  <<<<<<<<<< FOREST LANDBASE CHANGE SECTOR >>>>>>>>>>
01570 NOTE
01580 L   NLBCPA.K=(NLBCPA.J+DT*RLBCPA.JK)
01590 N   NLBCPA=CPA*TACA*REMEAS
01600 R   RLBCPA.KL=(PPA*TAPA)+(RPA*TARA)-(CPA*TACA)
01610 L   NLBCPB.K=(NLBCPB.J+DT*RLBCPB.JK)
01620 N   NLBCPB=CPB*TACA*REMEAS
01630 R   RLBCPB.KL=(PPB*TAPA)+(RPB*TARA)-(CPB*TACA)
01640 L   NLBCPC.K=(NLBCPC.J+DT*RLBCPC.JK)
01650 N   NLBCPC=CPC*TACA*REMEAS
01660 R   RLBCPC.KL=(PPC*TAPA)+(RPC*TARA)-(CPC*TACA)
01670 L   NLBCPD.K=(NLBCPD.J+DT*RLBCPD.JK)
01680 N   NLBCPD=CPD*TACA*REMEAS
01690 R   RLBCPD.KL=(PPD*TAPA)+(RPD*TARA)-(CPD*TACA)
01700 L   NLBCPE.K=(NLBCPE.J+DT*RLBCPE.JK)
01710 N   NLBCPE=CPE*TACA*REMEAS
01720 R   RLBCPE.KL=(PPE*TAPA)+(RPE*TARA)-(CPE*TACA)
01730 L   NLBCOA.K=(NLBCOA.J+DT*RLBCOA.JK)
01740 N   NLBCOA=COA*TACA*REMEAS
01750 R   RLBCOA.KL=(POA*TAPA)+(ROA*TARA)-(COA*TACA)
01760 L   NLBCOB.K=(NLBCOB.J+DT*RLBCOB.JK)
01770 N   NLBCOB=COB*TACA*REMEAS
01780 R   RLBCOB.KL=(POB*TAPA)+(ROB*TARA)-(COB*TACA)
01790 L   NLBCOC.K=(NLBCOC.J+DT*RLBCOC.JK)
01800 N   NLBCOC=COC*TACA*REMEAS
01810 R   RLBCOC.KL=(POC*TAPA)+(ROC*TARA)-(COC*TACA)
01820 L   NLBCOD.K=(NLBCOD.J+DT*RLBCOD.JK)
01830 N   NLBCOD=COD*TACA*REMEAS
01840 R   RLBCOD.KL=(POD*TAPA)+(ROD*TARA)-(COD*TACA)
01850 L   NLBCOE.K=(NLBCOE.J+DT*RLBCOE.JK)
01860 N   NLBCOE=COE*TACA*REMEAS
01870 R   RLBCOE.KL=(POE*TAPA)+(ROE*TARA)-(COE*TACA)
01880 L   NLBCHA.K=(NLBCHA.J+DT*RLBCHA.JK)
01890 N   NLBCHA=CHA*TACA*REMEAS
01900 R   RLBCHA.KL=(PHA*TAPA)+(RHA*TARA)-(CHA*TACA)
01910 L   NLBCHB.K=(NLBCHB.J+DT*RLBCHB.JK)
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01920 N   NLBCHB=CHB*TACA*REMEAS
01930 R   RLBCHB.KL=(PHB*TAPA)+(RHB*TARA)-(CHB*TACA)
01940 L   NLBCHC.K=(NLBCHC.J+DT*RLBCHC.JK)
01950 N   NLBCHC=CHC*TACA*REMEAS
01960 R   RLBCHC.KL=(PHC*TAPA)+(RHC*TARA)-(CHC*TACA)
01970 L   NLBCHD.K=(NLBCHD.J+DT*RLBCHD.JK)
01980 N   NLBCHD=CHD*TACA*REMEAS
01990 R   RLBCHD.KL=(PHD*TAPA)+(RHD*TARA)-(CHD*TACA)
02000 L   NLBCHE.K=(NLBCHE.J+DT*RLBCHE.JK)
02010 N   NLBCHE=CHE*TACA*REMEAS
02020 R   RLBCHE.KL=(PHE*TAPA)+(RHE*TARA)-(CHE*TACA)
02030 NOTE
02040 NOTE  <<<<<<<<<< SUMMATION OF TYPE-SIZES FOR OUTPUT >>>>>>>>>>
02050 NOTE
02060 A   PA.K=MAX((PA1.K+PA2.K+PA3.K+PA4.K+PA5.K+PA6.K+PA7.K+PA8.K+PA9.K+PA10.
02070 X   K+PA11.K+PA12.K+PA13.K+NLBCPA.K),0)
02080 A   PB.K=MAX((PB1.K+PB2.K+PB3.K+PB4.K+PB5.K+PB6.K+PB7.K+PB8.K+PB9.K+PB10.
02090 X   K+PB11.K+PB12.K+PB13.K+NLBCPB.K),0)
02100 A   PC.K=MAX((PC1.K+PC2.K+PC3.K+PC4.K+PC5.K+PC6.K+PC7.K+PC8.K+PC9.K+PC10.
02110 X   K+PC11.K+PC12.K+PC13.K+NLBCPC.K),0)
02120 A   PD.K=MAX((PD1.K+PD2.K+PD3.K+PD4.K+PD5.K+PD6.K+PD7.K+PD8.K+PD9.K+PD10.
02130 X   K+PD11.K+PD12.K+PD13.K+NLBCPD.K),0)
02140 A   PE.K=MAX((PE1.K+PE2.K+PE3.K+PE4.K+PE5.K+PE6.K+PE7.K+PE8.K+PE9.K+PE10.
02150 X   K+PE11.K+PE12.K+PE13.K+NLBCPE.K),0)
02160 A   OA.K=MAX((OA1.K+OA2.K+OA3.K+OA4.K+OA5.K+OA6.K+OA7.K+OA8.K+OA9.K+OA10.
02170 X   K+OA11.K+OA12.K+OA13.K+NLBCOA.K),0)
02180 A   OB.K=MAX((OB1.K+OB2.K+OB3.K+OB4.K+OB5.K+OB6.K+OB7.K+OB8.K+OB9.K+OB10.
02190 X   K+OB11.K+OB12.K+OB13.K+NLBCOB.K),0)
02200 A   OC.K=MAX((OC1.K+OC2.K+OC3.K+OC4.K+OC5.K+OC6.K+OC7.K+OC8.K+OC9.K+OC10.
02210 X   K+OC11.K+OC12.K+OC13.K+NLBCOC.K),0)
02220 A   OD.K=MAX((OD1.K+OD2.K+OD3.K+OD4.K+OD5.K+OD6.K+OD7.K+OD8.K+OD9.K+OD10.
02230 X   K+OD11.K+OD12.K+OD13.K+NLBCOD.K),0)
02240 A   OE.K=MAX((OE1.K+OE2.K+OE3.K+OE4.K+OE5.K+OE6.K+OE7.K+OE8.K+OE9.K+OE10.
02250 X   K+OE11.K+OE12.K+OE13.K+NLBCOE.K),0)
02260 A   HA.K=MAX((HA1.K+HA2.K+HA3.K+HA4.K+HA5.K+HA6.K+HA7.K+HA8.K+HA9.K+HA10.
02270 X   K+HA11.K+HA12.K+HA13.K+NLBCHA.K),0)
02280 A   HB.K=MAX((HB1.K+HB2.K+HB3.K+HB4.K+HB5.K+HB6.K+HB7.K+HB8.K+HB9.K+HB10.
02290 X   K+HB11.K+HB12.K+HB13.K+NLBCHB.K),0)
02300 A   HC.K=MAX((HC1.K+HC2.K+HC3.K+HC4.K+HC5.K+HC6.K+HC7.K+HC8.K+HC9.K+HC10.
02310 X   K+HC11.K+HC12.K+HC13.K+NLBCHC.K),0)
02320 A   HD.K=MAX((HD1.K+HD2.K+HD3.K+HD4.K+HD5.K+HD6.K+HD7.K+HD8.K+HD9.K+HD10.
02330 X   K+HD11.K+HD12.K+HD13.K+NLBCHD.K),0)
02340 A   HE.K=MAX((HE1.K+HE2.K+HE3.K+HE4.K+HE5.K+HE6.K+HE7.K+HE8.K+HE9.K+HE10.
02350 X   K+HE11.K+HE12.K+HE13.K+NLBCHE.K),0)
02360 A   P.K=PA.K+PB.K+PC.K+PD.K+PE.K
02370 A   O.K=OA.K+OB.K+OC.K+OD.K+OE.K
02380 A   H.K=HA.K+HB.K+HC.K+HD.K+HE.K
02390 A   T.K=P.K+O.K+H.K
02400 A   A.K=PA.K+OA.K+HA.K
02410 A   B.K=PB.K+OB.K+HB.K
02420 A   C.K=PC.K+OC.K+HC.K
02430 A   D.K=PD.K+OD.K+HD.K
02440 A   E.K=PE.K+OE.K+HE.K
02450 A   PERA.K=(A.K/T.K)*100
02460 A   PERB.K=(B.K/T.K)*100
02470 A   PERC.K=(C.K/T.K)*100
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02480 A   PERD.K=(D.K/T.K)*100
02490 A   PERE.K=(E.K/T.K)*100
02500 A   PERP.K=(P.K/T.K)*100
02510 A   PERO.K=(O.K/T.K)*100
02520 A   PERH.K=(H.K/T.K)*100
02530 A   PERPA.K=(PA.K/T.K)*100
02540 A   PERPB.K=(PB.K/T.K)*100
02550 A   PERPC.K=(PC.K/T.K)*100
02560 A   PERPD.K=(PD.K/T.K)*100
02570 A   PERPE.K=(PE.K/T.K)*100
02580 A   PEROA.K=(OA.K/T.K)*100
02590 A   PEROB.K=(OB.K/T.K)*100
02600 A   PEROC.K=(OC.K/T.K)*100
02610 A   PEROD.K=(OD.K/T.K)*100
02620 A   PEROE.K=(OE.K/T.K)*100
02630 A   PERHA.K=(HA.K/T.K)*100
02640 A   PERHB.K=(HB.K/T.K)*100
02650 A   PERHC.K=(HC.K/T.K)*100
02660 A   PERHD.K=(HD.K/T.K)*100
02670 A   PERHE.K=(HE.K/T.K)*100
02680 NOTE
02690 NOTE   <<<<<<<<<< EQUATIONS TO STOP RUN IF LEVEL FALLS BELOW 0 >>>>>>>>>>
02700 NOTE
02710 A   STOPPA.K=1/PA.K
02720 A   STOPPB.K=1/PB.K
02730 A   STOPPC.K=1/PC.K
02740 A   STOPPD.K=1/PD.K
02750 A   STOPPE.K=1/PE.K
02760 A   STOPOA.K=1/OA.K
02770 A   STOPOB.K=1/OB.K
02780 A   STOPOC.K=1/OC.K
02790 A   STOPOD.K=1/OD.K
02800 A   STOPOE.K=1/OE.K
02810 A   STOPHA.K=1/HA.K
02820 A   STOPHB.K=1/HB.K
02830 A   STOPHC.K=1/HC.K
02840 A   STOPHD.K=1/HD.K
02850 A   STOPHE.K=1/HE.K
02860 NOTE
02870 NOTE   <<<<<<<< SUMMATION OF STANDING MERCH. CU. VOL. (CU. FT.) >>>>>>>>
02880 NOTE
02890 A   TSSV.K=PASSV.K+PBSSV.K+PCSSV.K+PDSSV.K+PESSV.K+OASSV.K+OBSSV.K+
02900 X   OCSSV.K+ODSSV.K+OESSV.K+HASSV.K+HBSSV.K+HCSSV.K+HDSSV.K+HESSV.K
02910 A   THSV.K=PAHSV.K+PBHSV.K+PCHSV.K+PDHSV.K+PEHSV.K+OAHSV.K+OBHSV.K+
02920 X   OCHSV.K+ODHSV.K+OEHSV.K+HAHSV.K+HBHSV.K+HCHSV.K+HDHSV.K+HEHSV.K
02930 A   TSPV.K=PASPV.K+PBSPV.K+PCSPV.K+PDSPV.K+PESPV.K+OASPV.K+OBSPV.K+
02940 X   OCSPV.K+ODSPV.K+OESPV.K+HASPV.K+HBSPV.K+HCSPV.K+HDSPV.K+HESPV.K
02950 A   THPV.K=PAHPV.K+PBHPV.K+PCHPV.K+PDHPV.K+PEHPV.K+OAHPV.K+OBHPV.K+
02960 X   OCHPV.K+ODHPV.K+OEHPV.K+HAHPV.K+HBHPV.K+HCHPV.K+HDHPV.K+HEHPV.K
02970 A   TV.K=TSSV.K+THSV.K+TSPV.K+THPV.K
02980 NOTE
02990 NOTE   <<<<<<<<<< MODEL CONTROLS >>>>>>>>>>
03000 NOTE
03010 SPEC   DT=.25/PRTPER=1/PLTPER=.2
03020 N      LENGTH=MIN(10,REMEAS)
03030 PRINT   PA,OA,HA,A,(0,1)PERA,PERPA,PEROA,PERHA,TSSV(9,3)
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03040 PRINT  PB,OB,HB,B,(0,1)PERB,PERPB,PEROB,PERHB,THSV(9,3)
03050 PRINT  PC,OC,HC,C,(0,1)PERC,PERPC,PEROC,PERHC,TSPV(9,3)
03060 PRINT  PD,OD,HD,D,(0,1)PERD,PERPD,PEROD,PERHD,THPV(9,3)
03070 PRINT  PE,OE,HE,E,(0,1)PERE,PERPE,PEROE,PERHE,TV(9,3)
03080 PRINT  (6,4)P,O,H,T,*,(0,1)PERP,PERO,PERH
03100 PLOT  PA=A,PB=B,PC=C,PD=D,PE=E(0,5E+6)
03110 PLOT  OA=A,OB=B,OC=C,OD=D,OE=E(0,5E+6)
03120 PLOT  HA=A,HB=B,HC=C,HD=D,HE=E(0,5E+6)
03130 PLOT  P=P,O=O,H=H(0,15E+6),T=T(15E+6,25E+6)
03140 PLOT  A=A,B=B,C=C,D=D,E=E(0,15E+6)
03150 PLOT  TSSV=1,THSV=A,TSPV=2,THPV=B(0,15E+9)/TV=T(20E+9,35E+9)
03160 NOTE
03170 NOTE  --------------------------PROGRAM INPUT--------------------------
03180 NOTE
03190 NOTE  STANDING MERCH. CU. VOL. FACTORS
03200 NOTE
03210 A   PASSV.K=PA.K*22
03220 A   PAHSV.K=PA.K*0
03230 A   PASPV.K=PA.K*15
03240 A   PAHPV.K=PA.K*0
03250 A   PBSSV.K=PB.K*62
03260 A   PBHSV.K=PB.K*10
03270 A   PBSPV.K=PB.K*49
03280 A   PBHPV.K=PB.K*11
03290 A   PCSSV.K=PC.K*67
03300 A   PCHSV.K=PC.K*6
03310 A   PCSPV.K=PC.K*124
03320 A   PCHPV.K=PC.K*12
03330 A   PDSSV.K=PD.K*363
03340 A   PDHSV.K=PD.K*28
03350 A   PDSPV.K=PD.K*705
03360 A   PDHPV.K=PD.K*62
03370 A   PESSV.K=PE.K*1561
03380 A   PEHSV.K=PE.K*122
03390 A   PESPV.K=PE.K*281
03400 A   PEHPV.K=PE.K*92
03410 A   OASSV.K=OA.K*66
03420 A   OAHSV.K=OA.K*0
03430 A   OASPV.K=OA.K*0
03440 A   OAHPV.K=OA.K*0
03450 A   OBSSV.K=OB.K*152
03460 A   OBHSV.K=OB.K*33
03470 A   OBSPV.K=OB.K*57
03480 A   OBHPV.K=OB.K*45
03490 A   OCSSV.K=OC.K*207
03500 A   OCHSV.K=OC.K*33
03510 A   OCSPV.K=OC.K*104
03520 A   OCHPV.K=OC.K*20
03530 A   ODSSV.K=OD.K*279
03540 A   ODHSV.K=OD.K*181
03550 A   ODSPV.K=OD.K*264
03560 A   ODHPV.K=OD.K*351
03570 A   OESSV.K=OE.K*804
03580 A   OEHSV.K=OE.K*524
03590 A   OESPV.K=OE.K*95
03600 A   OEHPV.K=OE.K*296
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03610 A   HASSV.K=HA.K*11
03620 A   HAHSV.K=HA.K*13
03630 A   HASPV.K=HA.K*4
03640 A   HAHPV.K=HA.K*15
03650 A   HBSSV.K=HB.K*37
03660 A   HBHSV.K=HB.K*77
03670 A   HBSPV.K=HB.K*25
03680 A   HBHPV.K=HB.K*89
03690 A   HCSSV.K=HC.K*79
03700 A   HCHSV.K=HC.K*103
03710 A   HCSPV.K=HC.K*36
03720 A   HCHPV.K=HC.K*124
03730 A   HDSSV.K=HD.K*104
03740 A   HDHSV.K=HD.K*407
03750 A   HDSPV.K=HD.K*46
03760 A   HDHPV.K=HD.K*663
03770 A   HESSV.K=HE.K*232
03780 A   HEHSV.K=HE.K*1393
03790 A   HESPV.K=HE.K*22
03800 A   HEHPV.K=HE.K*428
03810 C   REMEAS=10.120                   INVENTORY REMEASUREMENT PERIOD (YRS.)
03820 NOTE
03830 NOTE  <<<<<<<<<< TYPE-SIZE BIOLOGICAL RESPONSE TO TREATMENT >>>>>>>>>>
03840 NOTE
03850 NOTE  ***** TREAT. 1-NATURAL SUCCESSION *****    PERIOD RATES (DECIMAL)
03860 NOTE
03870 C   PAPB1=.0000/PAPC1=.5281/PAPD1=.0000/PAPE1=.0000/PAOA1=.0000
03880 C   PAOB1=.2271/PAOC1=.0000/PAOD1=.0000/PAOE1=.0000/PAHA1=.0000
03890 C   PAHB1=.0000/PAHC1=.0000/PAHD1=.0000/PAHE1=.0000/PBPA1=.0000
03900 C   PBPC1=.4567/PBPD1=.3291/PBPE1=.1394/PBOA1=.0000/PBOB1=.0000
03910 C   PBOC1=.0255/PBOD1=.0000/PBOE1=.0000/PBHA1=.0000/PBHB1=.0000
03920 C   PBHC1=.0000/PBHD1=.0119/PBHE1=.0000/PCPA1=.0000/PCPB1=.0000
03930 C   PCPD1=.6572/PCPE1=.0998/PCOA1=.0000/PCOB1=.0000/PCOC1=.0070
03940 C   PCOD1=.0447/PCOE1=.0086/PCHA1=.0000/PCHB1=.0000/PCHC1=.0000
03950 C   PCHD1=.0000/PCHE1=.0000/PDPA1=.0000/PDPB1=.0000/PDPC1=.0133
03960 C   PDPE1=.5256/PDOA1=.0000/PDOB1=.0074/PDOC1=.0128/PDOD1=.0358
03970 C   PDOE1=.0330/PDHA1=.0074/PDHB1=.0000/PDHC1=.0000/PDHD1=.0152
03980 C   PDHE1=.0000/PEPA1=.0000/PEPB1=.0000/PEPC1=.0000/PEPD1=.0578
03990 C   PEOA1=.0000/PEOB1=.0000/PEOC1=.0000/PEOD1=.0000/PEOE1=.0336
04000 C   PEHA1=.0000/PEHB1=.0000/PEHC1=.0062/PEHD1=.0000/PEHE1=.0133
04010 C   OAPA1=.0000/OAPB1=.5013/OAPC1=.0000/OAPD1=.0000/OAPE1=.0000
04020 C   OAOB1=.0000/OAOC1=.0000/OAOD1=.0000/OAOE1=.0000/OAHA1=.4987
04030 C   OAHB1=.0000/OAHC1=.0000/OAHD1=.0000/OAHE1=.0000/OBPA1=.0000
04040 C   OBPB1=.0000/OBPC1=.3220/OBPD1=.0855/OBPE1=.0474/OBOA1=.0000
04050 C   OBOC1=.3009/OBOD1=.0000/OBOE1=.0000/OBHA1=.0000/OBHB1=.0000
04060 C   OBHC1=.1206/OBHD1=.0413/OBHE1=.0411/OCPA1=.0000/OCPB1=.0000
04070 C   OCPC1=.0177/OCPD1=.2392/OCPE1=.0609/OCOA1=.0000/OCOB1=.0000
04080 C   OCOD1=.1789/OCOE1=.0748/OCHA1=.0000/OCHB1=.0000/OCHC1=.0681
04090 C   OCHD1=.1265/OCHE1=.0380/ODPA1=.0000/ODPB1=.0000/ODPC1=.0000
04100 C   ODPD1=.1580/ODPE1=.2020/ODOA1=.0000/ODOB1=.0000/ODOC1=.0000
04110 C   ODOE1=.1770/ODHA1=.0000/ODHB1=.0000/ODHC1=.0000/ODHD1=.0787
04120 C   ODHE1=.1575/OEPA1=.0000/OEPB1=.0129/OEPC1=.0000/OEPD1=.0287
04130 C   OEPE1=.2480/OEOA1=.0000/OEOB1=.0000/OEOC1=.0239/OEOD1=.0129
04140 C   OEHA1=.0000/OEHB1=.0000/OEHC1=.0129/OEHD1=.0546/OEHE1=.1714
04150 C   HAPA1=.0227/HAPB1=.0000/HAPC1=.0229/HAPD1=.0229/HAPE1=.0000
04160 C   HAOA1=.0227/HAOB1=.0439/HAOC1=.0211/HAOD1=.0000/HAOE1=.0227
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04170 C   HAHB1=.0229/HAHC1=.0895/HAHD1=.0963/HAHE1=.0879/HBPA1=.0000
04180 C   HBPB1=.0000/HBPC1=.0737/HBPD1=.0310/HBPE1=.0311/HBOA1=.0000
04190 C   HBOB1=.0288/HBOC1=.0623/HBOD1=.0310/HBOE1=.0380/HBHA1=.0000
04200 C   HBHC1=.3176/HBHD1=.2887/HBHE1=.0979/HCPA1=.0112/HCPB1=.0000
04210 C   HCPC1=.0000/HCPD1=.0000/HCPE1=.0224/HCOA1=.0000/HCOB1=.0000
04220 C   HCOC1=.0129/HCOD1=.0577/HCOE1=.0466/HCHA1=.0112/HCHB1=.0000
04230 C   HCHD1=.3878/HCHE1=.0803/HDPA1=.0000/HDPB1=.0000/HDPC1=.0000
04240 C   HDPD1=.0103/HDPE1=.0064/HDOA1=.0000/HDOB1=.0000/HDOC1=.0000
04250 C   HDOD1=.0445/HDOE1=.0311/HDHA1=.0032/HDHB1=.0037/HDHC1=.0253
04260 C   HDHE1=.4408/HEPA1=.0000/HEPB1=.0000/HEPC1=.0000/HEPD1=.0000
04270 C   HEPE1=.0000/HEOA1=.0000/HEOB1=.0000/HEOC1=.0000/HEOD1=.0086
04280 C   HEOE1=.0389/HEHA1=.0076/HEHB1=.0025/HEHC1=.0086/HEHD1=.1224
04290 NOTE
04300 NOTE
04310 NOTE  TREATMENTS 2-13 OMITTED
04320 NOTE
04330 NOTE
04340 NOTE
04350 NOTE  <<<<<<<<<< TYPE-SIZE DISTRIBUTION OF FOREST BASE CHANGES >>>>>>>>>
04360 NOTE
04370 NOTE  ***** PLANTED NF ACREAGE RESULTING TYPE-SIZES *****      (DECIMAL)
04380 NOTE
04390 C   PPA=.0311/PPB=.5211/PPC=.2656/PPD=.1822/PPE=.0000
04400 C   POA=.0000/POB=.0000/POC=.0000/POD=.0000/POE=.0000
04410 C   PHA=.0000/PHB=.0000/PHC=.0000/PHD=.0000/PHE=.0000
04420 NOTE
04430 NOTE  ***** REVERTED NF ACREAGE RESULTING TYPE-SIZES *****     (DECIMAL)
04440 NOTE
04450 C   RPA=.0000/RPB=.0931/RPC=.2998/RPD=.1491/RPE=.0600
04460 C   ROA=.0000/ROB=.0361/ROC=.0516/ROD=.0000/ROE=.0000
04470 C   RHA=.0261/RHB=.0486/RHC=.1731/RHD=.0624/RHE=.0000
04480 NOTE
04490 NOTE  ***** CLEARED TO NONFOREST BY INITIAL TYPE-SIZE *****    (DECIMAL)
04500 NOTE
04510 C   CPA=.0208/CPB=.0215/CPC=.1082/CPD=.2087/CPE=.1664
04520 C   COA=.0040/COB=.0134/COC=.0450/COD=.0253/COE=.0552
04530 C   CHA=.0831/CHB=.0333/CHC=.0559/CHD=.0997/CHE=.0594
04540 NOTE
04550 NOTE  <<<<<<<<<< ANALYTICAL CONTROLS >>>>>>>>>>
04560 NOTE
04570 NOTE  ***** FOREST BASE CHANGES *****                     (ANNUAL ACRES)
04580 NOTE
04590 C   TAPA=9239.8                         NONFOREST ACRES PLANTED ANNUALLY
04600 C   TARA=27173.2                      NONFOREST ACRES REVERTING ANNUALLY
04610 C   TACA=144387.4                         FOREST ACRES CLEARED ANNUALLY
04620 NOTE
04630 NOTE  ***** INITIAL INVENTORY ACREAGE *****                  (TOTAL ACRES)
04640 NOTE
04650 C   IPA=205658/IPB=1232882/IPC=1787115/IPD=3769165/IPE=4444099
04660 C   IOA=37998/IOB=458372/IOC=476945/IOD=923878/IOE=1062357
04670 C   IHA=449893/IHB=678457/IHC=1176027/IHD=3028577/IHE=4002261
04680 NOTE
04690 NOTE  ***** PERCENT OF INITIAL ACRES UNDERGOING TREATMENT *****(DECIMAL)
04700 NOTE
04710 NOTE  PINE NONSTOCKED
04720 C   PATD1=.2721/PATD2=.1998/PATD3=.0000/PATD4=.0666
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04730 C  PATD5=.0000/PATD6=.2616/PATD7=.0000/PATD8=.0000
04740 C  PATD9=.1998/PATD10=.0000/PATD11=.0000/PATD12=.0000/PATD13=.0000
04750 NOTE  PINE SEEDLING
04760 C  PBTD1=.4349/PBTD2=.0206/PBTD3=.0210/PBTD4=.0571
04770 C  PBTD5=.0000/PBTD6=.0412/PBTD7=.0424/PBTD8=.0162
04780 C  PBTD9=.1490/PBTD10=.1464/PBTD11=.0155/PBTD12=.0199/PBTD13=.0357
04790 NOTE  PINE SAPLING
04800 C  PCTD1=.3225/PCTD2=.0289/PCTD3=.0141/PCTD4=.0582
04810 C  PCTD5=.0120/PCTD6=.0091/PCTD7=.0943/PCTD8=.0448
04820 C  PCTD9=.1482/PCTD10=.1843/PCTD11=.0302/PCTD12=.0094/PCTD13=.0440
04830 NOTE  PINE POLETIMBER
04840 C  PDTD1=.2180/PDTD2=.0996/PDTD3=.0664/PDTD4=.1237
04850 C  PDTD5=.0113/PDTD6=.0073/PDTD7=.0913/PDTD8=.0922
04860 C  PDTD9=.0635/PDTD10=.1125/PDTD11=.0717/PDTD12=.0177/PDTD13=.0247
04870 NOTE  PINE SAWTIMBER
04880 C  PETD1=.2431/PETD2=.1244/PETD3=.0889/PETD4=.1213
04890 C  PETD5=.0284/PETD6=.0015/PETD7=.1055/PETD8=.0317
04900 C  PETD9=.0820/PETD10=.0438/PETD11=.0747/PETD12=.0104/PETD13=.0442
04910 NOTE  OAK-PINE NONSTOCKED
04920 C  OATD1=.2830/OATD2=.0000/OATD3=.0000/OATD4=.2823
04930 C  OATD5=.0000/OATD6=.0000/OATD7=.0000/OATD8=.0000
04940 C  OATD9=.2936/OATD10=.0000/OATD11=.0000/OATD12=.1411/OATD13=.0000
04950 NOTE  OAK-PINE SEEDLING
04960 C  OBTD1=.5045/OBTD2=.0208/OBTD3=.0000/OBTD4=.0829
04970 C  OBTD5=.0207/OBTD6=.1039/OBTD7=.0208/OBTD8=.0000
04980 C  OBTD9=.0592/OBTD10=.0831/OBTD11=.0208/OBTD12=.0208/OBTD13=.0623
04990 NOTE  OAK-PINE SAPLING
05000 C  OCTD1=.4887/OCTD2=.0272/OCTD3=.0086/OCTD4=.0731
05010 C  OCTD5=.0259/OCTD6=.0353/OCTD7=.1217/OCTD8=.0000
05020 C  OCTD9=.0846/OCTD10=.0372/OCTD11=.0806/OCTD12=.0000/OCTD13=.0172
05030 NOTE  OAK-PINE POLETIMBER
05040 C  ODTD1=.4053/ODTD2=.0483/ODTD3=.0568/ODTD4=.0691
05050 C  ODTD5=.0396/ODTD6=.0000/ODTD7=.1170/ODTD8=.0043
05060 C  ODTD9=.0090/ODTD10=.0608/ODTD11=.1169/ODTD12=.0231/ODTD13=.0499
05070 NOTE  OAK-PINE SAWTIMBER
05080 C  OETD1=.3860/OETD2=.0411/OETD3=.0376/OETD4=.1270
05090 C  OETD5=.0867/OETD6=.0000/OETD7=.0703/OETD8=.0218
05100 C  OETD9=.0288/OETD10=.0200/OETD11=.0835/OETD12=.0414/OETD13=.0558
05110 NOTE  HARDWOOD NONSTOCKED
05120 C  HATD1=.4632/HATD2=.0211/HATD3=.0000/HATD4=.0836
05130 C  HATD5=.0203/HATD6=.2144/HATD7=.0211/HATD8=.0000
05140 C  HATD9=.0203/HATD10=.0106/HATD11=.0000/HATD12=.0203/HATD13=.1251
05150 NOTE  HARDWOOD SEEDLING
05160 C  HBTD1=.4674/HBTD2=.0146/HBTD3=.0134/HBTD4=.0447
05170 C  HBTD5=.0000/HBTD6=.1651/HBTD7=.0705/HBTD8=.0000
05180 C  HBTD9=.0682/HBTD10=.0000/HBTD11=.0177/HBTD12=.0479/HBTD13=.0904
05190 NOTE  HARDWOOD SAPLING
05200 C  HCTD1=.5706/HCTD2=.0394/HCTD3=.0187/HCTD4=.0133
05210 C  HCTD5=.0183/HCTD6=.0252/HCTD7=.0910/HCTD8=.0128
05220 C  HCTD9=.0644/HCTD10=.0142/HCTD11=.0064/HCTD12=.0074/HCTD13=.1185
05230 NOTE  HARDWOOD POLETIMBER
05240 C  HDTD1=.6392/HDTD2=.0129/HDTD3=.0064/HDTD4=.0427
05250 C  HDTD5=.0361/HDTD6=.0082/HDTD7=.0978/HDTD8=.0041
05260 C  HDTD9=.0107/HDTD10=.0429/HDTD11=.0262/HDTD12=.0390/HDTD13=.0337
05270 NOTE  HARDWOOD SAWTIMBER
05280 C  HETD1=.6925/HETD2=.0126/HETD3=.0226/HETD4=.0566
```

```
05290 C  HETD5=.0526/HETD6=.0000/HETD7=.0695/HETD8=.0016
05300 C  HETD9=.0016/HETD10=.0298/HETD11=.0110/HETD12=.0209/HETD13=.0288
05310 RUN BASE PROJECTION STRADDLERS OUT 1982-1992
END OF DATA
```

Program Technical Notes

Outlined below is a brief description of the major sectors of the model. In the interest of space, it is impractical to individually define the thousands of variable names used by the program. Many are repetitious and can be deciphered by means of a simple relationship:

Forest Type	Stand Size
P = pine	A = nonstocked
O = oak-pine	B = seedling
H = hardwood	C = sapling
	D = poletimber
	E = sawtimber

Combinations of the above codes are used to define forest-type/stand-size combinations; i.e., PA = pine nonstocked, PB = pine seedlings ,..., HE = hardwood sawtimber. These coding combinations form the roots of most variable names. The specific variable names necessary to understand the program are provided in order of occurrence as each sector is described.

Forest-to-Forest Sector (lines 10-1550)

The entire forest-to-forest sector is controlled by the macros RTOTYP and TYPBTR (lines 10-400). These macros tabulate each type-size treatment level, are made up of dummy variables, and are defined by the 13 treatment blocks directly below them. In this listing, only treatment 1 is shown (lines 420-1480). Each type-size combination under each of the 13 treatment blocks invokes and defines the macros. Variable names for the treatment 1 pine nonstocked combination (lines 440-500) are defined as follows:

PA1 = pine nonstocked treatment 1 level.
IPA = initial pine nonstocked acreage inventory.
CPA = the percentage of all acres cleared annually which are pine nonstocked.
PATD1 = the percentage of initial pine nonstocked acres to experience treatment 1.
PAPB1 = the percentage of initial pine nonstocked acres dispersed from pine nonstocked to pine seedling under treatment 1.
PAPC1 = the percentage of initial pine nonstocked acres dispersed from pine nonstocked to pine sapling under treatment 1.
.
.
.
PAHE1 = the percentage of initial pine nonstocked acres dispersed from pine nonstocked to hardwood sawtimber under treatment 1.
PBPA1 = the percentage of initial pine seedling acres dispersed from pine seedling to pine nonstocked under treatment 1.
PCPA1 = the percentage of initial pine sapling acres dispersed from pine sapling to pine nonstocked under treatment 1.
.
.
.
HEPA1 = the percentage of initial hardwood sawtimber acres dispersed from hardwood sawtimber to pine nonstocked under treatment 1.

FFPB1 = the amount of initial pine seedling acres which are to experience treatment 1 that are to remain in forest over the model run.

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FFHE1 = the amount of initial hardwood sawtimber acres which are to experience treatment 1 that are to remain in forest over the model run.

FFPA1 = the amount of initial pine nonstocked acres which are to experience treatment 1 that are to remain in forest over the model run.

Forest Land-Base Change Sector (lines 1560-2020)

The 15 levels and rates listed here keep track of all additions to and subtractions from the forest land base. Variable names for the pine nonstocked land-base change level (lines 1580-1600) are defined as follows:

NLBCPA = pine nonstocked net land-base change level.
RLBCPA = pine nonstocked annual rate of land-base change.
CPA = the percentage of all acres cleared annually which are pine nonstocked.
TACA = total acres cleared annually (all type-size combinations).
REMEAS = the number of years separating the initial and final surveys.
PPA = the percentage of all nonforest acres planted annually resulting in pine nonstocked.
TAPA = the total nonforest acres planted annually (all type-size combinations).
RPA = the percentage of all nonforest acres annually reverting naturally to pine nonstocked.
TARA = the total nonforest acres reverting naturally to forest (all type-size combinations).

Summation of Type-Sizes for Output (lines 2040-2670)

Here the type-size combinations under each treatment are summed to calculate the 15 net total forest-type and stand-size levels (lines 2060-2350). Land-base change levels are also included in these equations. The net type-size level equations are constrained by a MAX function to prohibit them from falling below 0. Additional auxiliary equations for program output are calculated in this sector also (lines 2360-2670).

Equations to Stop Run if Level Falls Below 0 (lines 2690-2850)

In the rare instance that a user might specify a set of circumstances which cause a type-size level to fall below 0, these equations will stop the run because results are unpredictable.

Summation of Standing Merchantable Cubic Volume (ft^3) (lines 2870-2970)

Although not part of the core model, these equations were used to produce the volume output presented in table 4 and Appendix B. Variable name root modifiers are defined as follows:

SSV = softwood sawtimber volume.
HSV = hardwood sawtimber volume.
SPV = softwood poletimber volume.
HPV = hardwood poletimber volume.

Model Controls (lines 2990-3150)

Equations controlling the length of the model run, DT interval, scaling of output variables, etc., are listed here. The model length should not be greater than the Survey remeasurement period because results are unpredictable (line 3020). If the user desires to run the model more than 10 years into the future, the final inventory values of the previous 10-year run should be used as initial values for the next 10-year run.

Program Input (lines 3170-5310)

In this section, all variables used in the model are assigned values. These values are unique to each user-defined region and are screened from Survey plot data. All values listed here apply to the State of Georgia between the years of 1972 and 1982. The type-size biological response to treatment dispersion rates for treatments 2-13 were omitted to conserve space.

Analytical Controls

All variables recommended for manipulation by the user are listed in lines 4550-5310 of the program.

Forest Base Changes (lines 4570-4610)

These values represent annual changes in the forest land base. The numbers presented in the program listing are the amount and type of change measured in Georgia between 1972 and 1982. The user can change these values according to perceptions of the future.

Initial Inventory Acreage (lines 4630-4670)

These values represent the type-size breakdown of the regional inventory at the beginning of the model run. The values shown in the program listing are the inventory breakdown as measured by the 1982 multiresource inventory of Georgia. These initial inventory values were used to project the Georgia inventory from 1982 to 1992. To project the model another 10 years, these values should be replaced with the 1992 projection inventory values.

Percent of Initial Acres Undergoing Treatment (lines 4690-5310)

The most powerful analytical controls are located in this section of the program. It is here that the user can change assumptions about what percentage of each of the 15 initial forest-type and stand-size combinations experience each of the 13 treatments/disturbances. The values presented in the program listing are the rates of treatment measured in Georgia between 1972 and 1982. To change the proportion of the inventory experiencing a particular treatment or disturbance, all the user need do is increase the percentage of acres experiencing one treatment and decrease the percentage of acres experiencing another treatment. For example, if one perceives that the rate of pine poletimber acres experiencing commercial thinning (treatment 8) will increase by 25 percent, one should increase the value of PDTD8 by 25 percent, and decrease the value of PDTD1 by the same amount. This change loads the model with the assumption that the increase in commercially thinned pine poletimber acres will come from pine poletimber acres that otherwise would have experienced no treatment or disturbance. NOTE: The 13 treatment/disturbance rates under each of the type-size combinations should always add to 1 (within rounding); i.e., PATD1 + PATD2 + ,..., + PATD13 = 1.0.

Using the Model

It is important to keep in mind that when one assigns a percentage of the initial inventory to experience a treatment/disturbance, it is the forest type and stand size at the time of the initial inventory (year 0 of the model run) to which the treatment rate is assigned. For instance, when acres of pine poletimber at year 0 are destined to experience commercial thinning, some may grow into pine sawtimber before the thinning is administered. The model automatically takes this into account, so the user need be concerned only with the composition of the initial inventory, and not all of the complex changes that take place before treatment are actually carried out.

DYNARIP can be used to project a regional inventory any number of years into the future. However, as the model proceeds further into the future, the results become correspondingly less reliable because our assumptions become less reliable. Also, the treatment/disturbance patterns associated with the sawtimber stand sizes may become less dependable if the median age of the trees within these projected classes deviates very far from the median stand age at the time of inventory. The sawtimber stand sizes are susceptible to such slippage because they encompass a potentially wide range of stand ages.

DYNARIP rates of change are based on 10-year rates between two points in time. For this reason, once a set of assumptions is entered, the model should be allowed to run for a 10-year timespan before any assumptions are changed. This allows the 10-year rates built into the model to exert their full impact on the inventory. Assumptions can be changed to any degree desired, but only at 10-year intervals.

The model uses a combination of differential and linear rates of change. On a decade basis, the DYNAMO simulation translates the empirical rates of change into differential rates. Between decades, on an annual basis, the empirical rates are treated as linear rates of change since this is all that can be inferred from inventories at two points in time. In reality, most of these annual rates are not linear, but we do not know their true form. Although the model outputs inventory values for all intermediate years for each 10-year run, these intermediate values should be used cautiously with the knowledge that the deviation between the assumed linear rate and the true rate is unknown. Year 10 is therefore the most reliable year of any DYNARIP simulation.

Appendix B.

Georgia 1982-1992 Base-Run Sample Output

The following tables and graphs are a sample of the output produced by the DYNARIP base-run projection for Georgia. The base run assumes that all rates measured between 1972 and 1982 will remain unchanged between 1982 and 1992. Growing-stock inventory volume projections have been added to the core model acreage simulation.

Table 5.--DYNARIP base-run area and growing-stock volume projections, Georgia, 1982-1992

				Variable name[a]					
TIME	PA	OA	HA	A	PERA	PERPA	PEROA	PERHA	TSSV
	PB	OB	HB	B	PERB	PERPB	PEROB	PERHB	THSV
	PC	OC	HC	C	PERC	PERPC	PEROC	PERHC	TSPV
	PD	OD	HD	D	PERD	PERPD	PEROD	PERHD	THPV
	PE	OE	HE	E	PERE	PERPE	PEROE	PERHE	TV
	P	O	H	T		PERP	PERO	PERH	
				Scale					
	Acres				Percent				Cubic feet
E+00	E+03	E+03	E+03	E+03	E+00	E+00	E+00	E+00	E+09
	E+03	E+03	E+03	E+03	E+00	E+00	E+00	E+00	E+09
	E+03	E+03	E+03	E+03	E+00	E+00	E+00	E+00	E+09
	E+03	E+03	E+03	E+03	E+00	E+00	E+00	E+00	E+09
	E+03	E+03	E+03	E+03	E+00	E+00	E+00	E+00	E+09
	E+06	E+06	E+06	E+06		E+00	E+00	E+00	
1982	205.64	37.998	449.89	693.53	2.9	0.9	0.2	1.9	11.155
	1232.8	458.28	678.39	2369.4	10.0	5.2	1.9	2.9	8.413
	1787.1	476.99	1176.2	3440.3	14.5	7.5	2.0	5.0	4.900
	3768.8	923.97	3028.3	7721.1	32.5	15.9	3.9	12.8	5.280
	4443.7	1062.4	4002.6	9508.7	40.1	18.7	4.5	16.9	29.748
	11.44M	2.9596	9.3355	23.73M		48.2	12.5	39.3	
1983	206.87	37.997	448.16	693.02	2.9	.9	.2	1.9	11.068
	1231.0	454.07	671.50	2356.6	10.0	5.2	1.9	2.8	8.469
	1794.3	473.33	1166.8	3434.4	14.5	7.6	2.0	4.9	4.834
	3694.8	913.21	3017.3	7625.3	32.3	15.6	3.9	12.8	5.279
	4407.5	1050.2	4058.0	9515.7	40.3	18.7	4.4	17.2	29.651
	11.33M	2.9288	9.3617	23.63M		48.0	12.4	39.6	
1984	208.09	37.996	446.42	692.51	2.9	.9	.2	1.9	10.982
	1229.3	449.85	664.61	2343.8	10.0	5.2	1.9	2.8	8.525
	1801.5	469.68	1157.3	3428.4	14.6	7.7	2.0	4.9	4.768
	3620.9	902.46	3006.2	7529.6	32.0	15.4	3.8	12.8	5.278
	4371.4	1038.1	4113.3	9522.8	40.5	18.6	4.4	17.5	29.553
	11.23M	2.8980	9.3879	23.52M		47.8	12.3	39.9	
1985	209.32	37.995	444.68	692.00	3.0	.9	.2	1.9	10.896
	1227.6	445.63	657.72	2331.0	10.0	5.2	1.9	2.8	8.581
	1808.6	466.02	1147.8	3422.4	14.6	7.7	2.0	4.9	4.702
	3546.9	891.71	2995.2	7433.8	31.8	15.2	3.8	12.8	5.278
	4335.3	1025.9	4168.7	9529.9	40.7	18.5	4.4	17.8	29.456
	11.13M	2.8673	9.4141	23.41M		47.5	12.2	40.2	

Continued

Table 5.--DYNARIP base-run area and growing-stock volume projections, Georgia, 1982-1992--Continued

TIME	PA	OA	HA	A	PERA	PERPA	PEROA	PERHA	TSSV
	PB	OB	HB	B	PERB	PERPB	PEROB	PERHB	THSV
	PC	OC	HC	C	PERC	PERPC	PEROC	PERHC	TSPV
	PD	OD	HD	D	PERD	PERPD	PEROD	PERHD	THPV
	PE	OE	HE	E	PERE	PERPE	PEROE	PERHE	TV
	P	O	H	T		PERP	PERO	PERH	
1986	210.55	37.994	442.94	691.48	3.0	.9	.2	1.9	10.809
	1225.9	441.41	650.83	2318.1	9.9	5.3	1.9	2.8	8.637
	1815.8	462.37	1138.3	3416.5	14.7	7.8	2.0	4.9	4.636
	3472.9	880.95	2984.2	7338.1	31.5	14.9	3.8	12.8	5.277
	4299.1	1013.8	4224.0	9536.9	40.9	18.5	4.4	18.1	29.359
	11.02M	2.8365	9.4403	23.30M		47.3	12.2	40.5	
1987	211.77	37.992	441.21	690.97	3.0	.9	.2	1.9	10.723
	1224.2	437.20	643.94	2305.3	9.9	5.3	1.9	2.8	8.693
	1823.0	458.71	1128.8	3410.5	14.7	7.9	2.0	4.9	4.570
	3399.0	870.20	2973.2	7242.4	31.2	14.7	3.8	12.8	5.276
	4263.0	1001.6	4279.4	9544.0	41.2	18.4	4.3	18.5	29.262
	10.92M	2.8057	9.4665	23.19M		47.1	12.1	40.8	
1988	213.00	37.991	439.47	690.46	3.0	.9	.2	1.9	10.637
	1222.5	432.98	637.05	2292.5	9.9	5.3	1.9	2.8	8.749
	1830.1	455.06	1119.4	3404.5	14.7	7.9	2.0	4.8	4.504
	3325.0	859.45	2962.2	7146.6	31.0	14.4	3.7	12.8	5.275
	4226.9	989.5	4334.7	9551.0	41.4	18.3	4.3	18.8	29.165
	10.82M	2.7750	9.4928	23.09M		46.9	12.0	41.1	
1989	214.22	37.990	437.73	689.95 663	3.0	.9	.2	1.9	10.550 11.061
	1220.7	428.76	630.16	2279.7 7385	9.9	5.3	1.9	2.7	8.805 9.479
	1837.3	451.40	1109.9	3398.6	14.8	8.0	2.0	4.8	4.439 4.537
	3251.0	848.70	2951.2	7050.9 6294	30.7	14.1	3.7	12.8	5.274 5.656
	4190.7	977.3	4390.0	9558.1 1928	41.6	18.2	4.3	19.1	29.068 30.733
	10.71M	2.7442	9.5190	22.98M 2343		46.6	11.9	41.4	
1990	215.45	37.989	436.00	689.44	3.0	.9	.2	1.9	10.464
	1219.0	424.54	623.27	2266.8	9.9	5.3	1.9	2.7	8.861
	1844.5	447.75	1100.4	3392.6	14.8	8.1	2.0	4.8	4.373
	3177.1	837.94	2940.1	6955.1	30.4	13.9	3.7	12.9	5.273
	4154.6	965.2	4445.4	9565.2	41.8	18.2	4.2	19.4	28.971
	10.61M	2.7134	9.5452	22.87M		46.4	11.9	41.7	
1991	216.68	37.988	434.26	688.93	3.0	1.0	.2	1.9	10.378
	1217.3	420.32	616.38	2254.0	9.9	5.3	1.8	2.7	8.917
	1851.6	444.10	1090.9	3386.7	14.9	8.1	2.0	4.8	4.307
	3103.1	827.19	2929.1	6859.4	30.1	13.6	3.6	12.9	5.272
	4118.5	953.0	4500.7	9572.2	42.1	18.1	4.2	19.8	28.874
	10.51M	2.6826	9.5714	22.76M		46.2	11.8	42.1	

Continued

Table 5.--DYNARIP base-run area and growing-stock volume projections, Georgia, 1982-1992--Continued

TIME	PA PB PC PD PE P	OA OB OC OD OE O	HA HB HC HD HE H	A B C D E T	PERA PERB PERC PERD PERE	PERPA PERPB PERPC PERPD PERPE PERP	PEROA PEROB PEROC PEROD PEROE PERO	PERHA PERHB PERHC PERHD PERHE PERH	TSSV THSV TSPV THPV TV
1992	217.90	37.987	432.52	688.41	3.0	1.0	.2	1.9	10.291
	1215.6	416.11	609.49	2241.2	9.9	5.4	1.8	2.7	8.973
	1858.8	440.44	1081.4	3380.7	14.9	8.2	1.9	4.8	4.241
	3029.1	816.44	2918.1	6763.7	29.9	13.4	3.6	12.9	5.271
	4082.3	940.9	4556.1	9579.3	42.3	18.0	4.2	20.1	28.777
	10.40M	2.6519	9.5976	22.65M		45.9	11.7	42.4	

[a]Variable name definitions:

PA = pine nonstocked
PB = pine seedling
PC = pine sapling
PD = pine poletimber
PE = pine sawtimber
P = pine

OA = oak-pine nonstocked
OB = oak-pine seedling
OC = oak-pine sapling
OD = oak-pine poletimber
OE = oak-pine sawtimber
O = all oak-pine

HA = hardwood nonstocked
HB = hardwood seedling
HC = hardwood sapling
HD = hardwood poletimber
HE = hardwood sawtimber
H = all hardwood

A = all nonstocked
B = all seedling
C = all sapling
D = all poletimber
E = all sawtimber
T = total commercial forest

PERA = percentage of all nonstocked
PERB = percentage of all seedling
PERC = percentage of all sapling
PERD = percentage of all poletimber
PERE = percentage of all sawtimber

PERPA = percentage of pine nonstocked
PERPB = percentage of pine seedling
PERPC = percentage of pine sapling
PERPD = percentage of pine poletimber
PERE = percentage of pine sawtimber
PERP = percentage of all pine

PEROA = percentage of oak-pine nonstocked
PEROB = percentage of oak-pine seedling
PEROC = percentage of oak-pine sapling
PEROD = percentage of oak-pine poletimber
PEROE = percentage of oak-pine sawtimber
PERO = percentage of all oak-pine

PERHA = percentage of hardwood nonstocked
PERHB = percentage of hardwood seedling
PERHC = percentage of hardwood sapling
PERHD = percentage of hardwood poletimber
PERHE = percentage of hardwood sawtimber
PERH = percentage of all hardwood

TSSV = softwood sawtimber volume
THSV = hardwood sawtimber volume
TSPV = softwood poletimber volume
THPV = hardwood poletimber volume
TV = total growing-stock volume

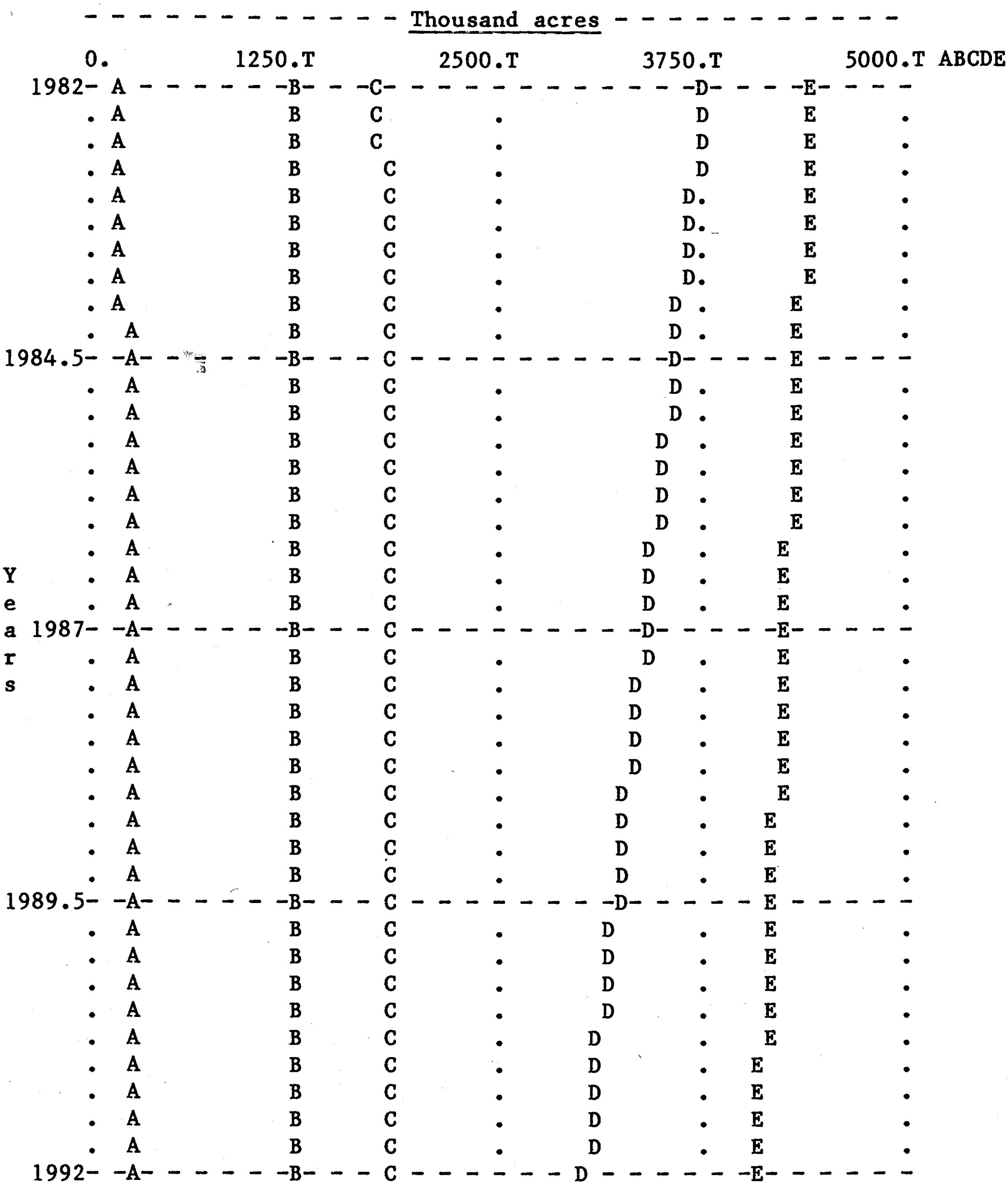

Figure 5.--DYNARIP base-run area projection of pine forest types by stand size, Georgia, 1982-1992. A = pine nonstocked, B = pine seedling, C = pine sapling, D = pine poletimber, E = pine sawtimber.

```
              - - - - - - - - - - - - Thousand acres - - - - - - - - - - - -
              0.          1250.T          2500.T          3750.T          5000.T ABCDE
        1982  A - -BC - -D-E- - - - - - - - - - - - - - - - - - - - - - -
              A    BC    D E .              .               .               .
              A    BC    D E .              .               .               .
              A    BC    D E .              .               .               .
              A    BC    D E .              .               .               .
              A    BC    D E .              .               .               .
              A    BC    D E .              .               .               .
              A    BC    DE  .              .               .               .
              A    BC    DE  .              .               .               .
              A    BC    DE  .              .               .               .
        1984.5A - -BC - -DE - - - - - - - - - - - - - - - - - - - - - - -
              A    BC    DE  .              .               .               .
              A    BC    DE  .              .               .               .
              A    BC    DE  .              .               .               .
              A    BC    DE  .              .               .               .
              A    BC    DE  .              .               .               .
              A    BC    DE  .              .               .               .
              A    BC    DE  .              .               .               .
      Y       A    BC    DE  .              .               .               .
      e       A    BC   D E  .              .               .               .
      a 1987  A - -BC - D E - - - - - - - - - - - - - - - - - - - - - - -
      r       A    B    D E  .              .               .               . BC
      s       A    B    D E  .              .               .               . BC
              A    B    D E  .              .               .               . BC
              A    B    D E  .              .               .               . BC
              A    B    D E  .              .               .               . BC
              A    B    D E  .              .               .               . BC
              A    B    D E  .              .               .               . BC
              A    B    D E  .              .               .               . BC
              A    B    D E  .              .               .               . BC
        1989.5A - -B- - D E - - - - - - - - - - - - - - - - - - - - - - - BC
              A    B    D E  .              .               .               . BC
              A    B    D E  .              .               .               . BC
              A    B    D E  .              .               .               . BC
              A    B    D E  .              .               .               . BC
              A    B    DE   .              .               .               . BC
              A    B    DE   .              .               .               . BC
              A    B    DE   .              .               .               . BC
              A    B    DE   .              .               .               . BC
              A    B    DE   .              .               .               . BC
        1992  A - -B- - DE- - - - - - - - - - - - - - - - - - - - - - - - BC
```

Figure 6.--DYNARIP base-run area projection of the oak-pine forest type, by stand size, Georgia, 1982-1992. A = oak-pine nonstocked, B = oak-pine seedling, C = oak-pine sapling, D = oak-pine poletimber, E = oak-pine sawtimber.

```
         - - - - - - - - - - - - Thousand acres - - - - - - - - - - - -
         0.         1250.T         2500.T         3750.T         5000.T ABCDE
  1982   - - -A- B - - C - - - - - - - - - - - D - - - - - E - - - - - -
         .    A  B     C.              .     D        .  E           .
         .    A  B     C.              .     D        .  E           .
         .    A  B     C.              .     D        .   E          .
         .    A  B     C.              .     D        .   E          .
         .    A  B     C.              .     D        .   E          .
         .    A  B     C.              .     D        .   E          .
         .    A  B     C.              .     D        .   E          .
         .    A  B     C.              .     D        .   E          .
         .    A  B     C.              .     D        .    E         .
  1984.5 - - -A- B - - C - - - - - - - - - - - D - - - - - - E - - - - -
         .    A  B     C.              .     D        .    E         .
         .    A  B     C.              .     D        .    E         .
         .    A  B     C.              .     D        .    E         .
         .    A  B     C.              .     D        .    E         .
         .    A  B     C.              .     D        .     E        .
         .    A  B     C.              .     D        .     E        .
         .    A  B     C.              .     D        .     E        .
Y        .    A  B     C.              .     D        .     E        .
e        .    A  B     C.              .     D        .     E        .
a 1987   - - -A- B - - C - - - - - - - - - - - D - - - - - - -E- - - - -
r        .    A  B     C.              .     D        .      E       .
s        .    A  B    C .              .     D        .      E       .
         .    A  B    C .              .     D        .      E       .
         .    A  B    C .              .     D        .      E       .
         .    A  B    C .              .     D        .      E       .
         .    A  B    C .              .    D         .      E       .
         .    A  B    C .              .    D         .       E      .
         .    A  B    C .              .    D         .       E      .
         .    A  B    C .              .    D         .       E      .
  1989.5 - - -A- B - -C- - - - - - - - - - - -D- - - - - - - - -E- - - -
         .    A B     C .              .    D         .       E      .
         .    A B     C .              .    D         .       E      .
         .    A B     C .              .    D         .        E     .
         .    A B     C .              .    D         .        E     .
         .    A B     C .              .    D         .        E     .
         .    A B     C .              .    D         .        E     .
         .    A B     C .              .    D         .        E     .
         .    A B     C .              .    D         .        E     .
         .    A B     C .              .    D         .         E    .
  1992   - - -A-B- - -C- - - - - - - - - - - -D- - - - - - - - - - -E- - -
```

Figure 7.--DYNARIP base-run area projection of hardwood forest types, by stand size, Georgia, 1982-1992. A = hardwood nonstocked, B = hardwood seedling, C = hardwood sapling, D = hardwood poletimber, E = hardwood sawtimber.

```
          - - - - - - - - - - - - Million acres - - - - - - - - - - - -
              .0          3.75M           7.5M          11.25M          15.M POH
            15.M          17.5M           20.M           22.5M          25.M T
  1982   - - - - - - O - - - - - - - - - - - - - -H- - - - P - - T - - - - -
         .            O  .              .      H       .P     T        .
         .            O  .              .      H       .P     T        .
         .            O  .              .      H       P      T        .
         .            O  .              .      H       P      T        .
         .            O  .              .      H       P      T        .
         .            O  .              .      H       P     T         .
         .            O  .              .       H      P     T         .
         .            O  .              .       H      P     T         .
         .            O  .              .       H      P     T         .
  1984.5 - - - - - - O - - - - - - - - - - - - - - H - - -P- - -T- - - - -
         .           O   .              .       H      P     T         .
         .           O   .              .       H      P    T          .
         .           O   .              .       H     P.    T          .
         .           O   .              .       H     P.    T          .
         .           O   .              .       H     P.    T          .
         .           O   .              .       H     P.    T          .
         .           O   .              .       H     P.    T          .
Y        .           O   .              .       H     P.   T           .
e        .           O   .              .       H     P.   T           .
a 1987   - - - - - -O- - - - - - - - - - - - - - - H - - P - -T- - - - - -
r        .           O   .              .       H     P.   T           .
s        .           O   .              .       H    P .   T           .
         .           O   .              .       H    P .   T           .
         .           O   .              .       H    P .   T           .
         .           O   .              .       H    P .  T            .
         .           O   .              .       H    P .  T            .
         .           O   .              .       H    P .  T            .
         .           O   .              .       H    P .  T            .
         .           O   .              .       H    P .  T            .
  1989.5 - - - - - -O- - - - - - - - - - - - - - - H - -P- - T - - - - - -
         .           O   .              .       H    P . T             .
         .           O   .              .       H   P  . T             .
         .           O   .              .       H   P  . T             .
         .           O   .              .       H   P  . T             .
         .           O   .              .       H   P  . T             .
         .           O   .              .       H   P  . T             .
         .           O   .              .       H   P  .T              .
         .           O   .              .       H   P  .T              .
         .           O   .              .       H   P  .T              .
  1992   - - - - - -O- - - - - - - - - - - - - - - H - P - T - - - - - - -
```

Figure 8.--DYNARIP base-run area projection of all broad forest types, Georgia, 1982-1992. P = pine, O = oak-pine, H = hardwood, T = total.

```
             - - - - - - - - - - - - - Million acres - - - - - - - - - - - - -

             .0           3.75M            7.5M          11.25M           15.M ABCDE
        1982 - -A- - -B- - C - - - - - - - - -D- - - E - - - - - - - - - - - -
             .  A     B    C.               .D       E       .              .
             .  A     B    C.               .D       E       .              .
             .  A     B    C.               .D       E       .              .
             .  A     B    C.               .D       E       .              .
             .  A     B    C.               D        E       .              .
             .  A     B    C.               D        E       .              .
             .  A     B    C.               D        E       .              .
             .  A     B    C.               D        E       .              .
             .  A     B    C.               D        E       .              .
      1984.5 - -A- - -B- - C - - - - - - - -D - - - -E - - - - - - - - - - - -
             .  A     B    C.               D        E       .              .
             .  A     B    C.               D        E       .              .
             .  A     B    C.               D        E       .              .
             .  A     B    C.               D        E       .              .
             .  A     B    C.              D.        E       .              .
             .  A     B    C.              D.        E       .              .
             .  A     B    C.              D.        E       .              .
Y            .  A     B    C.              D.        E       .              .
e            .  A     B    C.              D.        E       .              .
a 1987       - -A- - -B- - C - - - - - - -D- - - - E - - - - - - - - - - - -
r            .  A     B    C.              D.        E       .              .
s            .  A     B    C.              D.        E       .              .
             .  A     B    C.              D.        E       .              .
             .  A     B    C.              D.        E       .              .
             .  A     B    C.             D .        E       .              .
             .  A     B    C.             D .        E       .              .
             .  A     B    C.             D .        E       .              .
             .  A     B    C.             D .        E       .              .
             .  A     B    C.             D .        E       .              .
      1989.5 - -A- - -B- - C - - - - - - -D - - - - -E - - - - - - - - - - - -
             .  A     B    C.             D .        E       .              .
             .  A     B    C.             D .        E       .              .
             .  A     B    C.             D .        E       .              .
             .  A     B    C.             D .        E       .              .
             .  A     B    C.             D .        E       .              .
             .  A     B    C.            D  .        E       .              .
             .  A     B    C.            D  .        E       .              .
             .  A     B    C.            D  .        E       .              .
             .  A     B    C.            D  .        E       .              .
        1992 - -A- - -B- - C - - - - - -D- - - - - E - - - - - - - - - - - -
```

Figure 9.--DYNARIP base-run area projection of all stand-size classes, Georgia, 1982-1992. A = nonstocked, B = seedling, C = sapling, D = poletimber, E = sawtimber.

```
         - - - - - - - - - - - Billion cubic feet - - - - - - - - - - -

            .0          3.75B           7.5B          11.25B           15.B 1A2B
          20.B         23.75B          27.5B          31.25B           35.B T
   1982  - - - - - - - - - - 2B- - - - - - A - -T- - -1- - - - - - - - -
         .              .    2B         .   A    T     1              .
         .              .   2 B         .   A    T    1.              .
         .              .   2 B         .   A    T    1.              .
         .              .   2 B         .   A    T    1.              .
         .              .   2 B         .   A    T    1.              .
         .              .   2 B         .   A   T     1.              .
         .              .   2 B         .   A   T     1.              .
         .              .   2 B         .   A   T     1.              .
         .              .   2 B         .   A   T     1.              .
   1984.5 - - - - - - - - - -2-B- - - - - - A - T - - 1 - - - - - - - - -
         .              .   2 B         .   A   T     1.              .
         .              .   2 B         .   A   T     1.              .
         .              .   2 B         .   A   T    1 .              .
         .              .   2 B         .   A   T    1 .              .
         .              .   2 B         .   A   T    1 .              .
         .              .   2 B         .    A T     1 .              .
         .              .  2  B         .    A T     1 .              .
 Y       .              .  2  B         .    A T     1 .              .
 e       .              .  2  B         .    A T     1 .              .
 a 1987  - - - - - - - - - - 2 -B- - - - - - -A-T- - -1- - - - - - - - -
 r       .              .  2  B         .    A T     1 .              .
 s       .              .  2  B         .    A T     1 .              .
         .              .  2  B         .    A T     1 .              .
         .              .  2  B         .    A T     1 .              .
         .              .  2  B         .    A T    1  .              .
         .              .  2  B         .    AT     1  .              .
         .              .  2  B         .    AT     1  .              .
         .              .  2  B         .    AT     1  .              .
         .              .  2  B         .    AT     1  .              .
   1989.5 - - - - - - - - - - 2 -B- - - - - - -AT - - 1 - - - - - - - - - -
         .              .  2  B         .    AT     1  .              .
         .              . 2   B         .    AT     1  .              .
         .              . 2   B         .     A     1  .              . AT
         .              . 2   B         .     A     1  .              . AT
         .              . 2   B         .     A     1  .              . AT
         .              . 2   B         .    TA     1  .              .
         .              . 2   B         .    TA    1   .              .
         .              . 2   B         .    TA    1   .              .
         .              . 2   B         .    TA    1   .              .
   1992  - - - - - - - - - -2- -B- - - - - - -TA - -1- - - - - - - - - - -
```

Figure 10.--DYNARIP base-run growing-stock-inventory volume projection, by broad species and size class, Georgia, 1982-1992. 1 = softwood sawtimber, 2 = softwood poletimber, A = hardwood sawtimber, B = hardwood poletimber, T = total.

Glossary

All live trees. All trees 1.0 inch d.b.h. and larger which are not dead at the time of inventory.

Broad forest type. A classification of forest land based on the species forming a plurality of live-tree stocking.

Hardwood forest type. Stands in which pines constitute less than 25 percent of live-tree stocking.

Oak-pine forest type. Stands in which pines account for at least 25 but not more than 50 percent of live-tree stocking.

Pine forest type. Stands in which pines constitute more than 50 percent of live-tree stocking.

Commercial species. Tree species conventionally regarded as being able to develop into trees suitable for the manufacture of industrial timber products. Species which typically exhibit small size, poor form, or inferior quality are excluded.

D.b.h. Tree diameter (outside bark) at breast height (4.5 feet above the ground).

Forest land. Land at least 16.7 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use.

Growing-stock trees. Live sawtimber-size trees of commercial species containing at least a 12-foot log, or two noncontiguous saw logs each 8 feet or longer, meeting minimum grade requirements (hardwoods must qualify as either a log grade 3 or 4; softwoods must qualify as a log grade 3) with at least one-third of the gross board-foot volume (International 1/4-inch rule) between a 1-foot stump and the minimum saw-log top being sound, or a live tree below sawtimber size that will prospectively qualify under the above standards.

Growing-stock volume. Volume (cubic feet) of solid wood in growing-stock trees 5.0 inches d.b.h. and larger, from a 1-foot stump to a minimum 4.0-inch top diameter, outside bark, on the central stem. Volume of solid wood in primary forks from the point of occurrence to a minimum 4.0-inch top diameter outside bark is included.

Hardwoods. Angiosperms; dicotyledonous trees (including all palm species which are monocotyledonous), usually broadleaf and deciduous.

Ingrowth. The number or net volume of trees that grow large enough during a specified year to qualify as saplings, poletimber, or sawtimber.

Level. The quantity of a given material at a particular instant in time.

Manageable stand. Commercial forest land at least 60 percent stocked with growing-stock trees that can be featured together under a management scheme.

Mortality. The merchantable volume in trees that have died from natural causes during a specified period.

Nonindustrial private forest (NIPF) lands. Forest land owned by farmers, individuals, or corporations; excluding forest industry land or land leased to forest industry.

Primary treatment or disturbance. The treatment or disturbance, man-caused or natural, in evidence as having occurred during the most recent remeasurement period and judged to have had the greatest influence toward creating the existing forest conditions.

Artificial regeneration after site preparation. The reestablishment of a timber stand by planting trees or direct seeding following site preparation on forest land that was harvested prior to the most recent remeasurement period.

Artificial regeneration on nonforest land. The establishment of a timber stand, at least 16.7 percent stocked with live trees, by planting trees or direct seeding on lands previously classed as nonforest.

Artificial regeneration without site preparation. The reestablishment of a timber stand by planting trees or direct seeding without site preparation of forest land harvested prior to the most recent remeasurement period. Includes artificial regeneration on forest sites prepared prior to the remeasurement period.

Cleaning, release, or other intermediate cutting. The act of freeing an immature stand of growing-stock trees from competition, by the mechanical removal of overstory trees and other inhibiting vegetation. Excludes prescribing burning, girdling, poisoning, and thinning.

Clearing or other site preparation. The mechanical removal of residual trees, inhibiting vegetation, and other physical obstacles, and/or chopping, raking, disking, and bedding to prepare the site for planting trees or direct seeding.

Commercial thinning. The removal of some of the merchantable trees from an immature stand to improve the growth and quality of the remaining trees. A sufficient stocking of growing-stock trees is left for a manageable stand.

Construction of fences, woods roads, firebreaks, trash pits, etc. The introduction of these or similar disturbances into a timber stand, if such activity has significantly influenced the stand condition.

Girdling or poisoning undesirable trees. The act of freeing an immature stand of growing-stock trees from competition by the killing or poisoning, but not felling, of poor-quality trees.

Grazing or other activity that retards or precludes development of the understory. Grazing of domestic livestock, repeated mowing, or any similar activity which inhibits the establishment and development of the understory trees within a forest condition.

Harvesting followed by artificial regeneration. The reduction of a merchantable stand of timber below a manageable level of stocking, and the subsequent reestablishment of a manageable stand of growing-stock trees by planting or direct seeding, either with or without site preparation.

Harvesting followed by natural regeneration. The reduction of a merchantable stand of timber below a manageable level of stocking, and the subsequent reestablishment of a manageable stand of growing-stock trees from advanced regeneration, natural seeding, or sprouting. Excludes conventional seed-tree method of harvesting.

Harvesting leaving seed trees, with satisfactory regeneration. The reduction of a merchantable stand of timber below a manageable level of stocking, but leaving a sufficient number of seed trees for regeneration as evidenced by the reestablishment of a manageable stand of growing-stock trees from the seed tree reproduction.

Harvesting leaving seed trees, without satisfactory regeneration. The reduction of a merchantable stand of timber below a manageable level of stocking, but leaving a number of seed trees for regeneration. A manageable stand of reproduction from the seed trees has not yet become established.

Harvesting without regeneration. The reduction of a merchantable stand of timber below a manageable level of stocking without leaving seed trees, and no manageable stand of natural reproduction exists.

Major drainage efforts. Construction of canals, ditches, or similar drainage efforts which permanently reduce the water table within the stand as evidenced by existing stand conditions.

Major man-caused flooding. Construction of dams, ponds, lakes, or similar activities which raise the water table within the stand as evidenced by existing stand conditions.

Natural regeneration on nonforest land. The establishment of a timber stand, at least 16.7 percent stocked with live trees, through natural reproduction on lands previously classed as nonforest.

No treatment or disturbance. Existing forest conditions exhibit no discernible evidence of any significant treatment or disturbance during the remeasurement period.

Other. Existing forest conditions exhibit evidence of a significant treatment or disturbance during the remeasurement period other than those described here.

Precommercial thinning. The mechanical removal or destruction of seedlings, saplings, or other small, unmerchantable trees from a young, overstocked stand to enhance the growth and dominance of the residual trees in a manageable stand.

Prescribed burning. The practice of using controlled fire to eliminate or reduce unincorporated organic matter on the forest floor or low, undesirable vegetation.

Removal of selected trees resulting in high grading. The removal of selected trees (usually the best or highest valued) from a merchantable stand of timber, but leaving sufficient stocking of residual trees for a manageable stand.

Salvage cut. The harvesting of a merchantable stand of recent mortality trees, or trees in imminent danger of mortality.

Significant damage from disease. Damage to a stand of timber severe enough to significantly reduce current or prospective growth, and caused by fungi, bacteria, rusts, blights, or other agents of disease.

Significant damage from insects. Damage to a stand of timber severe enough to significantly reduce current or prospective growth, and caused by the direct activity of insects.

Significant damage from weather and other natural destructive agents. Damage to a stand of timber severe enough to significantly reduce current or prospective growth, and caused by severe weather conditions such as high winds, freezing, ice storms, drought, flooding (other than man-caused), or damage associated with wildlife such as beaver.

Significant damage from wildfire. Damage to a stand of timber severe enough to significantly reduce current or prospective growth, and caused by uncontrolled fire.

Turpentining. The working of pine trees within a stand of timber for the commercial production naval stores.

<u>Poletimber-size trees</u>. All live trees at least 5.0 inches d.b.h., but smaller than sawtimber size.

<u>Rotation age</u>. The period of years required to grow a stand of timber to economic or natural maturity.

<u>Saplings</u>. Live trees 1.0 to 4.9 inches d.b.h.

<u>Sawtimber-size trees</u>. Softwoods 9.0 inches d.b.h. and larger and hardwoods 11.0 inches d.b.h. and larger.

Seedlings. Live trees of commercial species less than 1.0 inch d.b.h. that are expected to survive and develop.

Softwoods. Gymnosperms; in the order Coniferales, usually evergreen (includes the genus *Taxodium* which is deciduous), having needles or scalelike leaves.

Stand-size class. A classification of forest land based on the diameter class distribution of growing-stock trees in the stand.

Nonstocked stands. Forest land less than 16.7 percent stocked with growing-stock trees.

Poletimber stands. Stands at least 16.7 percent stocked with growing-stock trees of which half or more of total stocking is in poletimber and sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

Sapling stands. Stands at least 16.7 percent stocked with growing-stock trees of which more than half of the total stocking is saplings and seedlings, and with sapling stocking at least equal to that of seedlings.

Sawtimber stands. Stands at least 16.7 percent stocked with growing-stock trees, with half or more of total stocking in sawtimber and poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

Seedling stands. Stands at least 16.7 percent stocked with growing-stock trees of which more than half of the total stocking is saplings and seedlings, and with seedling stocking exceeding that of saplings.

Stocking. The degree of occupancy of land by trees, measured by basal area or the number of trees in a stand, compared with a minimum standard required to fully utilize the growth potential of the land.

Timber removals. The merchantable volume of trees removed from the inventory by harvesting, cultural operations such as stand improvement, land clearing, or changes in land use.

Bechtold, William A.
DYNARIP: A technique for regional forest inventory projection and policy analysis. Res. Pap. SE-243. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1984. 43 p.

DYNARIP is a policy-oriented model capable of tracking all of the treatments and disturbances experienced by the forest resources of an entire State or regional area. It can also isolate the impact of any one of 27 man-caused or natural disturbances (including natural succession and forest land-base changes). The model is driven by empirical rates of change as measured by forest inventories between two points in time. A few simple controls permit the entry of the user's own perceptions of the future into the model.

KEYWORDS: Forest policy, forest simulation, forest inventory projection, resource evaluation, ecosystem dynamics.

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The Forest Service, U.S. Department of Agriculture, is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.